2006 DMAX SERVICE MANUAL

HUMMER H1

AM GENERAL CORPORATION
408 South Byrkit Avenue
P.O. Box 728
Mishawaka, Indiana 46546-0728

AM General
All Rights Reserved. Printed in U.S.A.

TABLE OF CONTENTS

General Information	1
Engine	2
Fuel, Emissions and Exhaust	3
Cooling System	4
Transmission/Transfer Case	5
Wheels and Tires/ Central Tire Inflation System	6
Brake System	7
Steering System	8
Axles/Suspension and Frame	9
Body	10
Heating/Ventilation/ Air Conditioning (HVAC)	11
Electrical	12
Accessories	13
Index	14

Section 1
General Information, Lubrication and Maintenance

TABLE OF CONTENTS

Abbreviations 1-15
Carbon Monoxide 1-2
Customer Assistance HUMMER H1 Service Hotline 1-3
Fluid Capacities 1-14
Identification Numbers
- Engine Identification Number 1-8
- Transfer Case Identification Number 1-7
- Transmission Identification Number 1-6
- Vehicle Identification Number
  - Decoding Chart 1-9
- Vehicle Identification Number (VIN) 1-8

Information Labels
- Emission Control Information Label 1-4
- EPA Noise Emission Label 1-7
- Safety Certification Label 1-5

Jump Starting 1-24
Keys 1-20
Lubrication and Maintenance Items 1-31
Maintenance Items
- Serpentine Belt 1-40
- Wheels/Tires/CTIS 1-40

Maintenance Schedule 1-26
Metric System and Equivalents 1-19
Paint and Trim Colors 1-20
Safety Summary 1-2
Specifications
- Bolt Identification and Torque Limits (Wet and Dry) 1-17
- Cooling System 1-11
- Cylinders 1-10
- Fluid Capacities 1-14
- Fuel/Air System 1-10
- Generator 1-11
- Governed Speed 1-10
- Lubricating System 1-10
- Starter 1-11
- Vehicle Dimensions 1-15
- Vehicle Weights 1-14

Towing
- Cautions 1-21
- Conventional Towing Procedures 1-22
- Hoisting the Vehicle 1-21
- Recommendations 1-21
- Recreational 1-24
- Vehicle Lifting/Jacking Points 1-20
- When Keys Are Not Available 1-24

Towing, Lifting, Jump Starting 1-20
Transfer Case Identification Number 1-7
Transmission Identification 1-6
Vehicle Identification Number (VIN) 1-8

SAFETY SUMMARY

Individuals who decide to perform their own repairs should have proper training and limit repairs to components which will not affect the safety of the vehicle or its occupants.

When replacement parts are required, it is strongly recommended that they are purchased through an authorized HUMMER dealer. It is essential that replacement parts meet or exceed manufacturer's specifications. Vehicle performance and personal safety may be impaired if other than original factory components are installed.

The installation of nonapproved accessories or conversions is not recommended as they could affect the vehicle's driving characteristics and personal safety. AM General LLC will not be liable for personal injury or damage to property resulting from the installation of nonapproved accessories or conversions to the HUMMER H1.

Following the safety precautions as prescribed throughout this manual may greatly reduce the risks of personal injury and damage to the vehicle. However, it is unlikely that AM General LLC will account for all possibilities.

Warnings, cautions, and notes are used throughout this service manual to assist service personnel in the performance of maintenance actions. These statements are designed as reminders for trained and experienced service personnel.

WARNINGS — Indicate potential safety hazards and must be followed to avoid personal injury. Warnings appear as follows:

> ***WARNING: To avoid injury, do not remove surge tank filler cap before depressurizing cooling system when engine temperature is above 190° F (88° C).***

CAUTIONS — Indicate potential equipment damage, and must be followed to avoid damage to components or systems. An example of a caution is shown below:

> **CAUTION:** To avoid starter damage, do not operate starter continuously for more than 15 seconds. Wait 10 to 15 seconds between periods of operation.

NOTES — Indicate methods or actions that may simplify vehicle maintenance or help maintain vehicle performance. An example of a note is shown below:

> **NOTE:** Clean all components, examine for wear or damage, and replace if necessary.

CARBON MONOXIDE

WARNING: Engine exhaust and a wide variety of automobile components and parts, including components found interior furnishings in a vehicle, contain or emit chemicals known to the State of California to cause cancer and birth defects and reproductive harm. In addition, certain fluids contained in vehicles and certain products of component wear contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

WARNING: Brain damage or death can result from heavy exposure to carbon monoxide. The following precautions must be followed to ensure personal safety.

1. Do not operate vehicle engine in enclosed areas. Do not idle the vehicle engine with vehicle windows closed. Be alert at all times for exhaust odors. Be alert for exhaust poisoning symptoms. They are:
   - Headache
   - Dizziness
   - Sleepiness
   - Loss of muscular control

2. If you see another person with exhaust poisoning symptoms:
   - Remove person from area
   - Expose to open air
   - Keep person warm
   - Do not permit physical exercise
   - Administer artificial respiration, if necessary
   - Notify medical personnel

THE BEST DEFENSE AGAINST EXHAUST POISONING IS ADEQUATE VENTILATION.

This service manual contains instructions for maintaining the 2006 commercial HUMMER H1. Spend some time looking through this manual. Features to improve the usefulness of this manual and increase your efficiency are:

Accessing Information - These include: tabulated sections for quick reference, extensive troubleshooting guides for specific systems, and step-by-step directions for service repairs.

Illustrations - A variety of methods are used to make locating and repairing components easy. Locator illustrations, exploded views, and cut-away diagrams make the information in this manual easy to understand.

The service manual is the best source available for providing information and data critical to vehicle operation and maintenance. In this manual you will find the following information:

- Safety Summary
- General Information
- General Service Procedures
- Detailed Service Procedures
- Torque Ranges
- Wiring Diagrams and Schematics

HUMMER H1 owners and dealership service personnel can submit service manual suggestions and comments in writing to:

AM General
Commercial Publications Department
408 S. Byrkit St.
P.O. Box 728
Mishawaka, IN 46546-0728

Forms are furnished at the end of this manual.

Service Manual Revisions

In order to receive future revisions to this service manual, please write to:

AM General
Service Parts Logistics Operations
Commercial Publications/Customer Service
408 South Byrkit Avenue
P.O. Box 728
Mishawaka, Indiana 46546-0728

Be sure to specify publication number.

HUMMER H1 SERVICE HOTLINE

On occasion, an unusual service problem can arise that is not covered in the manual. For this reason, AM General has established a service hotline for dealership assistance. The hotline number is: **1-800-638-8303**

Transfer Case Hotline

If you have questions that are not answered in Section 5 of this Service Manual, you can call the Transfer Case Hotline at **1-800-945-4327** (in the U.S.) for more information. International and Canadian customers and dealers should call**1-315-432-4110**.

EMISSION CONTROL INFORMATION LABEL

The vehicle emission control label contains engine information such as curb idle rpm, engine displacement, catalytic converter type, fuel rate, and vacuum hose routing.

This label is affixed to the air cleaner housing (Figure-1-1).

The California Air Resources Board (CARB) label (Figure-1-2) is also affixed to the air cleaner housing and certifies that the vehicle conforms to EPA and California emission standards.

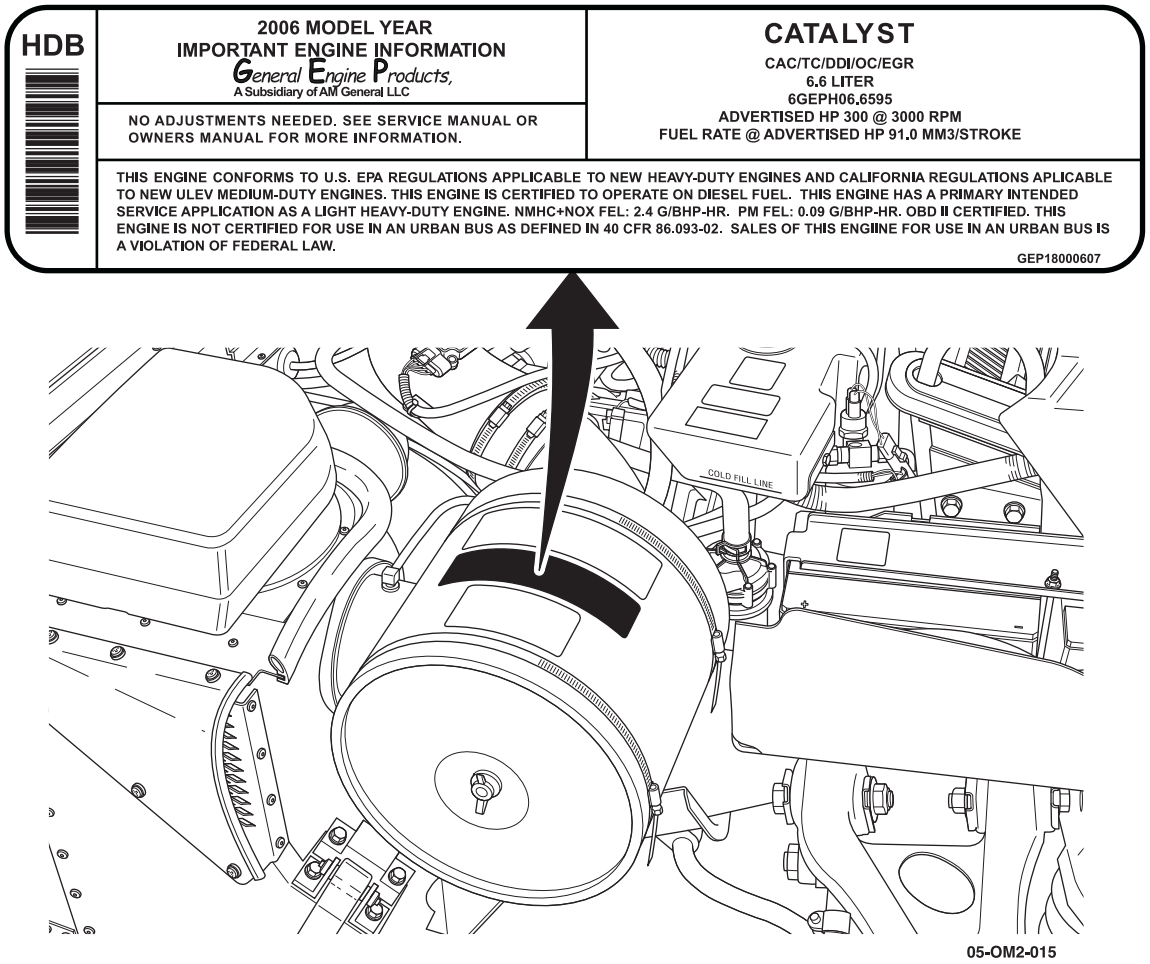


Figure 1-1: Emission Control Information Label

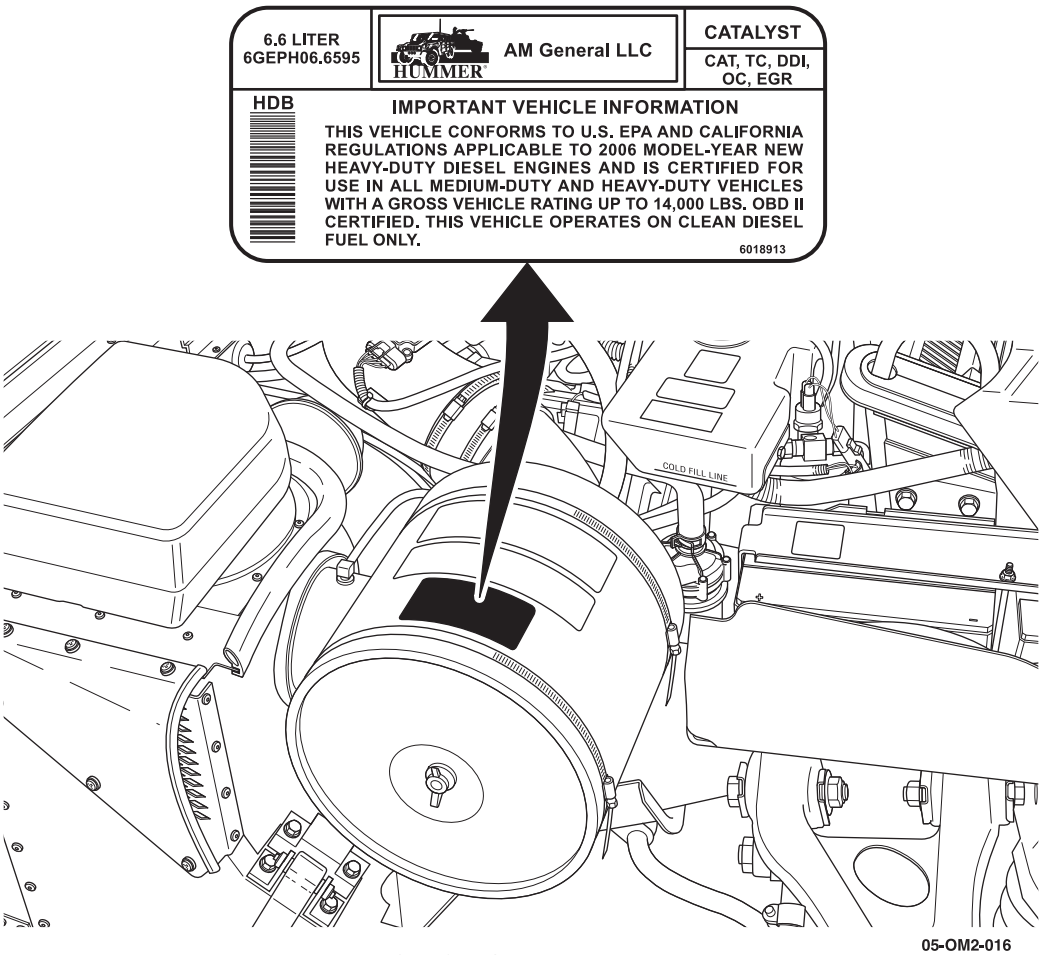


Figure 1-2: California Air Resources Board Label

SAFETY CERTIFICATION LABEL

The safety certification label is located on the driver side B- pillar (door latch post) (Figures 1-3, and 1-4). The label is required by the National Highway Traffic Safety Administration and includes a tamper-proof feature. If the label is tampered with, a void pattern will appear across the label.

The label contains the name of the manufacturer, the month and year the vehicle was manufactured, the certification statement, the vehicle identification number (VIN), and the vehicle model type. It also contains the Gross Vehicle Weight Rating (GVWR), Gross Axle Weight Ratings (GAWR), and wheel and tire information. For more information on the GVWR and GAWR, refer to "VEHICLE LOADING INFORMATION" in the HUMMER H1 Owner's Manual.

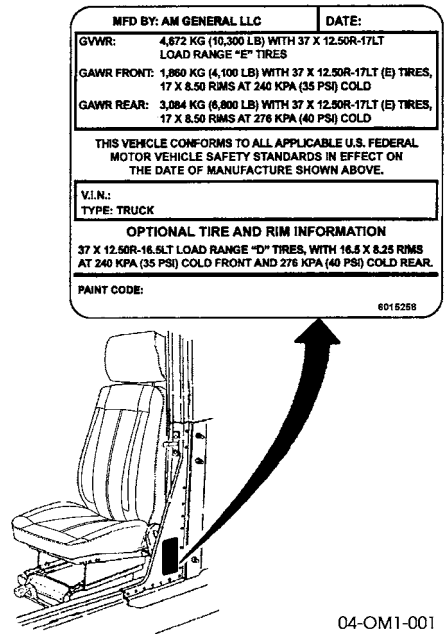


Figure 1-3: Safety Certification Label

TRANSMISSION IDENTIFICATION

An I.D. plate is attached to the passenger side of each Allison Transmission (Figure-1-4). The plate contains the model, date of manufacture, serial number, engineering feature configuration, transmission identification, and the engineering group.

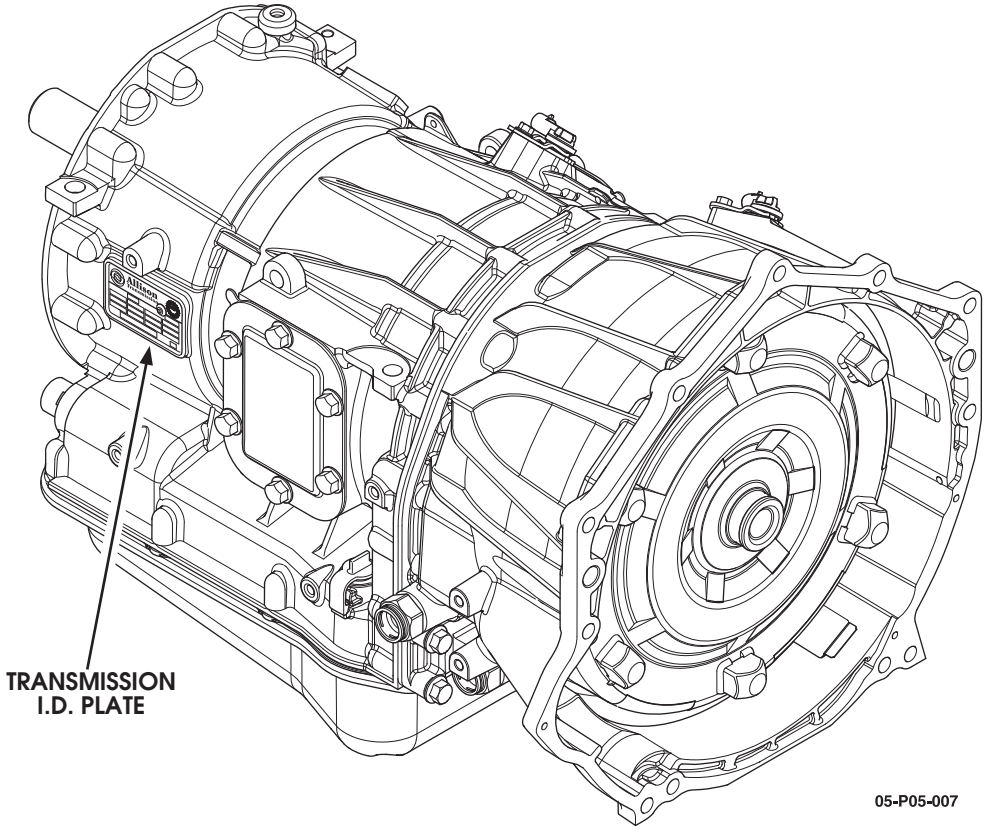


Figure 1-4: Transmission I.D. Plate Location

EPA NOISE EMISSION CONTROL INFORMATION LABEL

The EPA noise emission control information label is located on the passenger side B-pillar (door latch post). The label is required by the EPA and includes a tamper-proof feature. If the label is tampered with, a void pattern will appear across the label. Notify the dealer or the manufacturer if the label is missing or displays a void pattern (Figure-1-5).

The label contains the name of the manufacturer, the month and year the vehicle was manufactured, a statement regarding vehicle conformance to applicable U.S. EPA regulations, and a description of acts prohibited by the Noise Control Act of 1972.

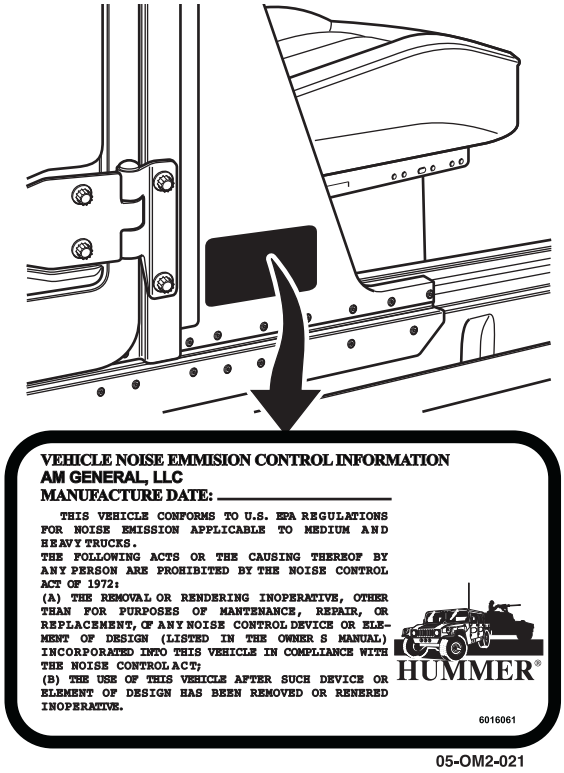


Figure 1-5: EPA Noise Emission Control Information Label Location

TRANSFER CASE IDENTIFICATION

The transfer case serial and assembly numbers are located on a tag attached to the rear case (Figure-1-6).

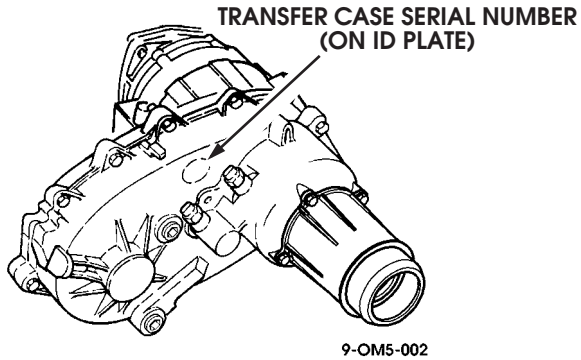


Figure 1-6: Transfer Case I.D. Plate Location

ENGINE IDENTIFICATION

The engine serial number label is located at the rear of the left cylinder head (Figure-1-7).

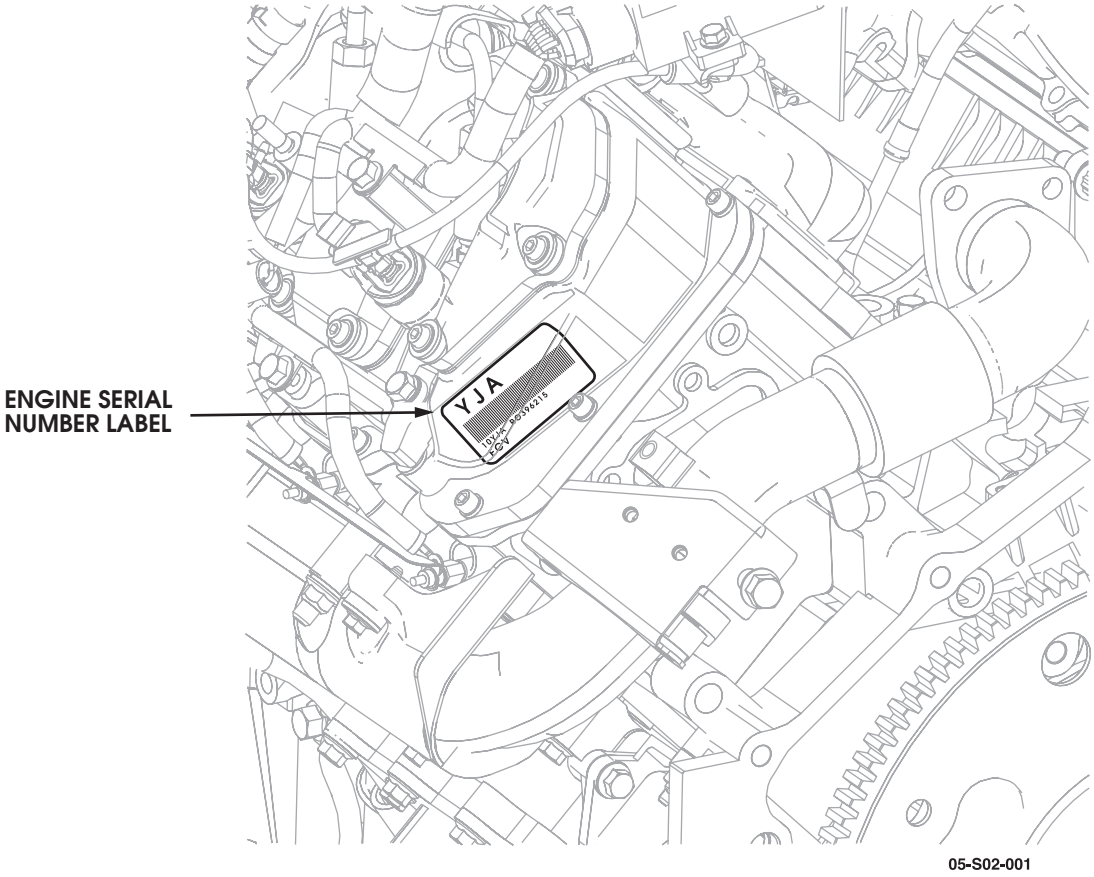


Figure 1-7: Engine I.D. Label Location

VEHICLE IDENTIFICATION NUMBER (VIN)

The VIN plate is located on the driver's side A-pillar. (Figure-1-8).

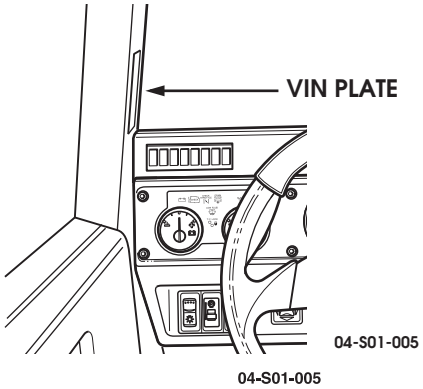
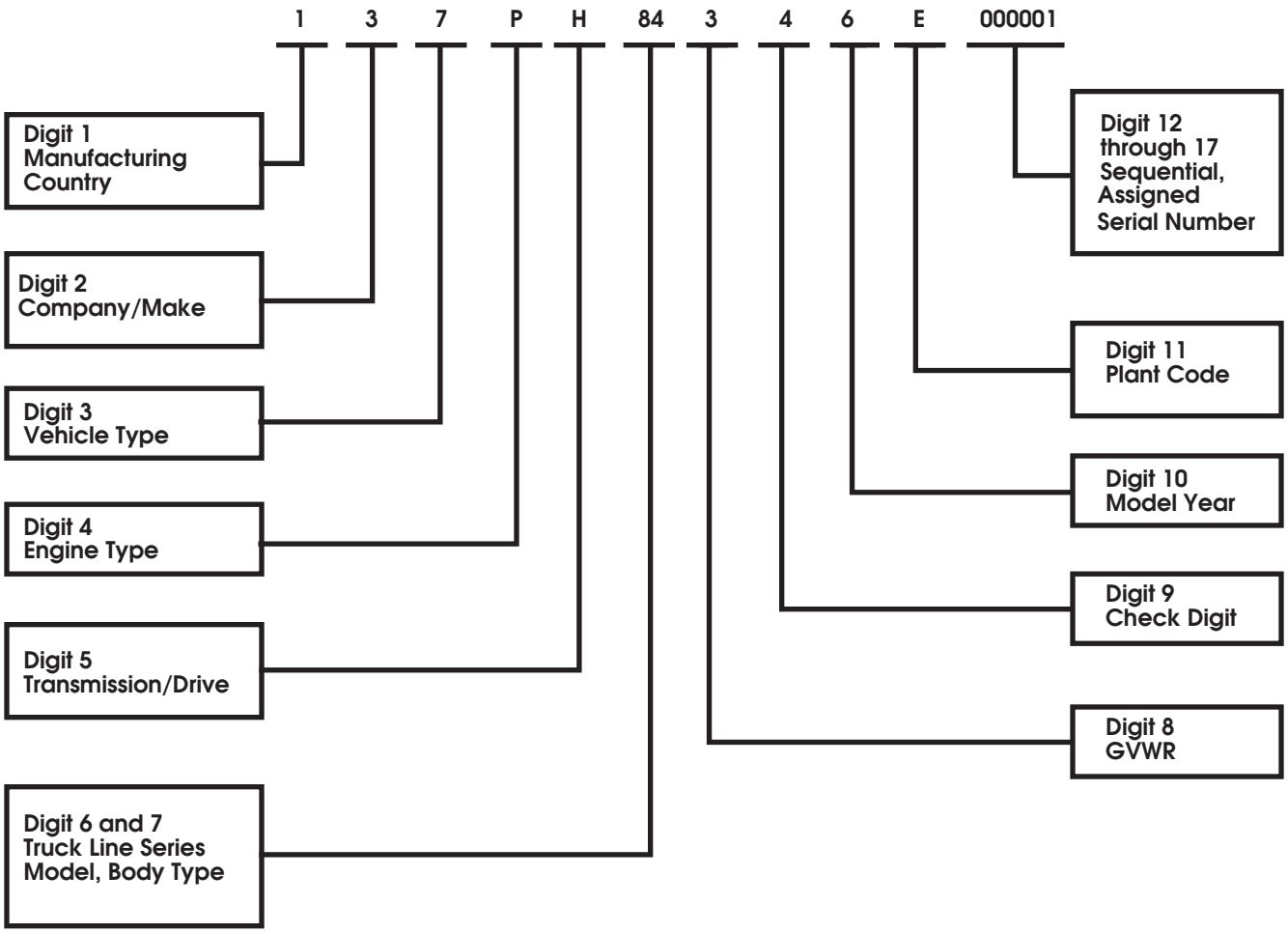


Figure 1-8: VIN Plate Location

The first twelve digits of the seventeen digit VIN are explained in the chart on the following page.



Vehicle Identification Number Decoding Chart

Digit	Code	Code Definition		
1	1	United States		
2	3	AM General LLC		
3	7	Commercial Vehicles		
4	P	6.6L Turbocharged Diesel, GM-Isuzu, 8 cyl., 300 hp		
5	H	5-Speed, Automatic/LHD		
6 & 7	84	1-1/4 ton	Station wagon	Truck, utility - HMDS
	90	1-1/4 ton	Open body w/full hard doors	Truck, utility - HMDO
8	3	Class 3, 10,001 lb - 14,000 lb (4,541 kg - 6,356 kg)		
9	—	Check Digit		
10	6	2006		
11	E	Mishawaka, Indiana		
12-17	—	Sequential Serial Number		

COMPONENT DATA

Engine:)

Manufacturer:	Duramax Inc (GM/ Isuzu)
Model:	6.6 L Turbo Diesel
Type:	Four Cycle, Turbocharged Diesel, with cooled EGR
Configuration:	V8
Turbo Charging:	Variable Nozzel Turbo Charger with Intercooling
Exhaust:	Exhaust Gas Recirculation with Intercooling
Power Output:	300 hp @ 3000 rpm/520 ft lb. Torque @ 1600 rpm
Fuel System:	Common Rail High Presure Direct Injection
Engine control:	Delphi Electronic Control Module
Throttle Control:	Electronic Potentiometer Throttle Pedal
Net Weight:	With fluids 880 lb (400 kg)

Governed Speed:

Full Load:	3,250 RPM
No Load:	3,400 RPM
Idle Speed:	650 RPM

Cylinders:

Number:	8
Arrangement:	90° V
Firing Order:	1-2-7-8-4-5-6-3 (Clockwise)
Bore:	4.055 in. (103. mm)
Stroke:	3.897 in. (9.9 cm)
Displacement:	395 cu. in. (6.6 L)
Compression Ratio:	17:1

Lubricating System:

Type:	Pressure Feed Gear Pump
Operating Pressure:	55 - 60 Psi @ 3250 RPM
(Idle Minimum):	14 psi
System Capacity:	
Crankcase only	10.5 qt
Filter Included	12.25 qt
Filter Capacity:	1.75 qt
Operating Temperature	
(Normal)	180°-250° F (82°-121° C)
Oil Pump	High Output
Filter	Paper Element, Spin On

Fuel System:

Fuel Injection Pump:	Bosch Common Rail
Fuel Filter:	Full Flow, paper element
Glow Plug Type	Fast Start

Starter:

Type:	Torque Reduction
Manufacturer:	Hitachi
Voltage:	12 V

Cooling System:

Type:	Liquid w/Fan and Radiator
Max Operating Temp:	250° F
Min Operating Temp:	-34° F
Filler Cap Pressure:	15 psi (103 kPa)
Radiator Type:	4 Row Core Downflow
Fan Type:	Fan with viscus drive, 23" diameter, Geared Fan Drive 1-1 ratio
Thermostat:	
Starts to Open:	190° F (88° C)
Fully Open:	212° F (100° C)

Generator:

Manufacturer: Delphi	
Output:	145 AMP
Rated Voltage:	13.2 -15.75 V

Batteries:

Manufacturer:	AC Delco
Type:	Low Maintenance
Number:	2
Voltage:	12 V
Amperage:	
@ 0° F	800 Cold Cranking amps Each Battery
32° F	1000 Cold Cranking amps Each Battery
80° F	110 Reserve Capacity (Minutes)

Transmission:

Manufacturer:	Allison Transmission
Mode:	M74 1000 Series
Type:	5-Speed, Automatic
Converter Torque Ratio:	2.0:1
Gear Ratios:	
First:	3.10:1
Second:	1.81:1
Third:	1.41:1
Fourth:	1.00:1
Fifth:	0.71:1
Reverse:	4.49:1
Oil Type:	Dexron® III
Oil Pressure:	130-300 psi

Transfer Case:

Manufacturer:	New Venture Gear
Model:	242
Type:	Full Time Four-Wheel Drive
Gear Ratios:	
High and High Lock:	1:1
Low Range:	2.72:1
Oil Type	Dexron® III

Geared Hub:

Manufacturer:	AM General design, made by Tremec
Type:	Helical Cut
Gear Ratio:	1.92:1
Oil Type:	SAE 80W-90

Axle/Differential:

Manufacturer:	AM General design, made by Dana
Type:	
Axle:	Fixed Mounted Differential W/ Independent Half Shafts
Differential:	Hypoid Torque Biasing (Paired Worm Gears) (Electronic Locking Optional)
Gear Ratio:	2.56:1

Service Brake Caliper (Front):

Manufacturer:	Kelsey-Hayes
Piston Diameter:	2.6 in. (6.6 cm)

Service/Parking Brake Caliper (Rear):

Manufacturer:	Kelsey-Hayes
Piston Diameter:	2.6 in. (6.6 cm)

Service/Parking Brake Rotor:

Manufacturer:	Kelsey-Hayes
Diameter:	12 in. (304.8 mm)
Thickness:	0.87 in. (22 mm)
Minimum Thickness:	0.81 in. (20.7 mm)

Steering System:

Steering Gear	
Manufacturer:	Sheppard
Type:	Recirculating Ball, Worm and Nut
Ratio:	18.3:1
Power Steering Pump	
Manufacturer:	Delphi
Output Pressure: (Max):	1,450
Flow Rate: (Max):	1.7 gpm

Reservoir:	Integral Pump Mounted Tank
Fluid Cooling:	Remote Cooler air to fluid

Frame:

Manufacturer:	AM General design, made by Dana
Type:	Welded Steel Box
No. of Crossmembers:	5

Air Conditioner:

Manufacturer (Compressor):	GM-Harrison
Model	HD-6
Field (Coil)	12 V
Oil Capacity (PAG)	
Main and Auxiliary	8 fl oz (237 ml)
Refrigerant	R-134a
Capacity (system + 2 oz. of oil)	
Main and Auxiliary	2lb 4oz (1.0 kg)

Winch:

Manufacturer	Warn
Model	12,000 lb., 12VDC HUMMER
Type	Electric Drive
Capacity	12,000 lb (5,448 kg)

Wheels and Tires:

Manufacturer	Goodyear Tire Size 37 in. X 12.5R-17
Wheel Type:	
Standard	One-Piece Aluminum
Size	17 x 8.25 in.
Off-Road Adventure Package Option	Two-Piece Aluminum
Size	17 x 8.25 in.

FLUID CAPACITIES

Cooling System	33 qt (31.2 L)
Engine:	
Crankcase (oil pan) only	10.5 qt (9.9 L)
Crankcase and Filter	12.25 qt (11.6 L)
Fuel Tank	27 gal. (102.1 L)
Auxiliary Fuel Tank	24.5gal. (92.7 L)
Axle (front/rear)	2 qt (1.9 L)
Transmission:	
Drain and Refill:	(with Pan Removed) 8.2 qt (7.7 L)
W/Dry Converter:	14 qt (13.3 L)
Transfer Case:	2.5 qt (2.4 L)
Geared Hub:	1 pt (0.47 L)
Steering System	1.75 qt (1.66 L)
Brake Hydraulic System:	(DOT 3)
Master Cylinder:	1.64 pt (0.78 L)
Total System:	3.12 pt. (1.5 L)
Windshield Washer	
Reservoir:	2.5 gal. (9.5 L)
Geared Fan Drive	1.2 pt. (0.6 L)

VEHICLE WEIGHTS

Curb Weight*:	
Four Door Open Top (w/ full doors) (HMDO)	7,847 lb (3,563 kg)
Four-Door Station Wagon (HMDS)	8,114 lb (3,684 kg)
Payload*:	
Four-Door Open Top (w/ full doors) (HMDO)	2,453 lb (1,114 kg)
Four-Door Station Wagon (HMDS)	2,186 lb (992 kg)
Gross Vehicle Weight (GVW)	10,300 lb (4,676 kg)
Gross Axle Weight Rating (GAWR):	
Front	4,100 lb (1,861 kg)
Rear	6,800 lb (3,087 kg)
Gross Combination Weight (GCW)	17,300 lb (7,854 kg)
Maximum Towed Load**:	
Foor-Door Open Top (w/full doors)	9,303 lb (4,224 kg)
Four-Door Station Wagon (HMDS)	9,036 lb (4,102 kg)

*For vehicles equipped with a winch, increase curb weight and reduce payload by 137 lbs (62 kg).

**Maximum trailer ratings are calculated assuming a base vehicle, except for any option(s) necessary to achieve the rating, plus driver (rating is calculated assuming a 150 lb. driver). The weight of other optional equipment, passengers and cargo will reduce the maximum trailer weight the vehicle can tow.

VEHICLE DIMENSIONS

Length:	184.5 in. (468.6 cm) See Note
Height:	77 in. (195.5 cm)
Width (without mirrors):	86.50 in. (219.7 cm)
Ground Clearance:	16 in. (41 cm) (at GVW)
Wheelbase:	130 in (330 cm)
Track Width:	72 in. (183 m)

NOTE: The vehicle weight and dimensions data applies to models without a winch.

ABBREVIATIONS

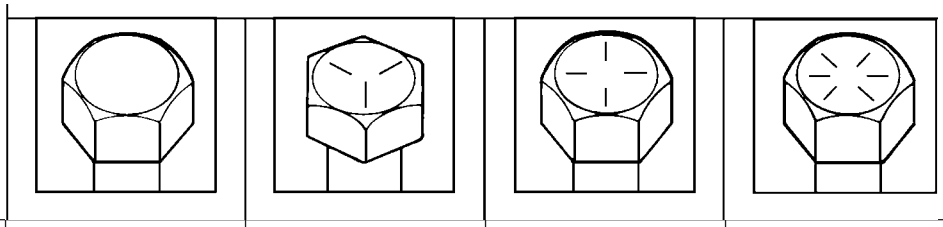
ABS	Antilock Brake System
A/C	Air Conditioning
a.c	Alternating Current
AMP	Ampere
CO	Carbon Monoxide
C	Celsius (centigrade)
cm	Centimeter
CTIS	Central Tire Inflation System
CDR	Crankcase Depression Regulator
cm^3	Cubic Centimeter
$in.^3$	Cubic Inch
cyl	Cylinder
°	Degree (angle or temperature)
DTC	Diagnostic Trouble Code
dia	Diameter
d.c.	Direct Current
EPA	Environmental Protection Agency
F	Fahrenheit
ft	Feet
ft/min	Feet Per Minute
fl oz	Fluid Ounce
gal	Gallon
g	Gram
GAWR	Gross Axle Weight Rating
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating
hp	Horsepower
HVAC	Heat, Ventilation, and Air Conditioning
in	Inch
INC	Include
ID	Identification
I.D	Internal Diameter
kg	Kilograms
km	Kilometer
km/h	Kilometers Per Hour
kPa	Kilopascals

lh	Left Hand
L	Liter
max	Maximum
m	Meter
mpg	Miles Per Gallon
mph	Miles Per Hour
mm	Millimeter
min	Minimum
–	Minus
–	Negative
No	Number
Ohm	Ohms
oz	Ounce
O.D	Outside Diameter
P/N	Part Number
%	Percentage
pt	Pint
+	Plus
+	Positive
lb	Pound
lb-ft	Pound-feet
lb-in	Pound-inch
psi	Pounds Per Square Inch
qt	Quart
:	Ratio
ref.	Reference
RPM	Revolutions Per Minute
rh	Right-Hand
cm^2	Square Centimeters
in^2	Square Inches
TT4	Torque Trac 4
VIN	Vehicle Identification Number
V	Volts
W	Watts
UNC	Unified Coarse
UNF	Unified Fine

BOLT IDENTIFICATION AND TORQUE LIMITS (DRY*)

* A phosphate and oil bolt is considered dry

Bolt Head ID Marks and SAE GRADE

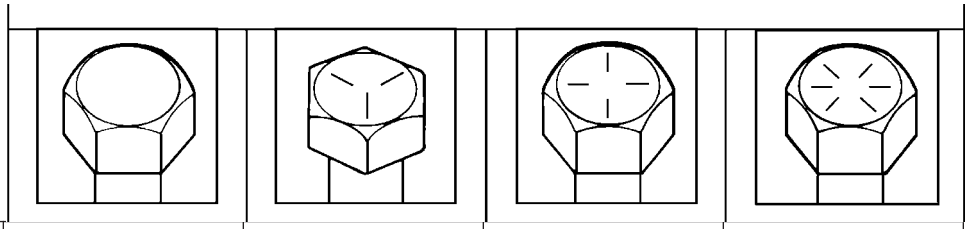


BOLT SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	5(7)	8(11)	10(14)	12(16)
1/4	6	28	6(8)	10(14)	——	14(19)
5/16	8	18	11(15)	17(23)	19(26)	24(33)
5/16	8	24	13(18)	19(26)	——	27(37)
3/8	10	16	18(24)	31(42)	34(46)	44(60)
3/8	10	24	20(27)	35(47)	——	49(66)
7/16	11	14	28(38)	49(66)	55(75)	70(95)
7/16	11	20	30(41)	55(75)	——	78(106)
1/2	13	13	39(53)	75(102)	85(115)	105(142)
1/2	13	20	41(56)	85(115)	——	120(163)
9/16	14	12	51(69)	110(149)	120(163)	155(210)
9/16	14	18	55(75)	120(163)	——	170(231)
5/8	16	11	63(85)	150(203)	167(226)	210(285)
5/8	16	18	95(129)	170(231)	——	240(325)
3/4	19	10	105(142)	270(366)	280(380)	375(509)
3/4	19	16	115(156)	295(400)	——	420(570)
7/8	22	9	160(217)	395(536)	440(597)	605(820)
7/8	22	14	175(237)	435(590)	——	675(915)
1	25	8	235(319)	590(800)	660(895)	910(1234)
1	25	14	250(339)	660(895)	——	990(1342)
1-1/8	29	—	——	800 - 880 (1085 - 1193)	——	1280 - 1440 (1736 - 1953)
1-1/4	32	—	——	—	——	1820 - 2000 (2468 - 2712)
1-3/8	35	—	——	1460 - 1680 (1980 - 2278)	——	2380 - 2720 (3227 - 3688)
1-1/2	38	—	——	1940 - 2200 (2631 - 2983)	——	3160 - 3560 (4285 - 4827)

Bolt Identification and Torque Limits (Wet*)

*A cadmium plated bolt is considered wet.

Bolt Head ID Marks and SAE Grade



BOLT SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	4(5)	7(10)	9(12)	11(15)
1/4	6	28	5(7)	9(12)	——	13(17)
5/16	8	18	10(14)	15(20)	17(23)	22(30)
5/16	8	24	12(16)	17(23)	——	24(33)
3/8	10	16	16(22)	28(38)	31(42)	40(54)
3/8	10	24	18(24)	32(43)	——	44(60)
7/16	11	14	25(34)	44(60)	50(68)	63(85)
7/16	11	20	27(37)	50(68)	——	70(95)
1/2	13	13	35(48)	68(92)	77(104)	95(129)
1/2	13	20	37(50)	77(104)	——	108(146)
9/16	14	12	46(62)	99(134)	108(146)	140(190)
9/16	14	18	50(67)	108(146)	——	153(207)
5/8	16	11	57(77)	135(183)	150(203)	189(256)
5/8	16	18	85(115)	153(207)	——	216(293)
3/4	19	10	95(129)	243(330)	252(342)	338(458)
3/4	19	16	104(141)	266(361)	——	378(513)
7/8	22	9	144(195)	356(483)	396(537)	545(739)
7/8	22	14	158(214)	392(532)	——	608(824)
1	25	8	212(287)	531(720)	594(805)	819(1111)
1	25	14	225(305)	594(805)	——	891(1208)
1-1/8	29	—	——	720 - 792 (976 - 1074)	——	1152 - 1296 (1562 - 1757)
1-1/4	32	—	——	——	——	1638 - 1800 (2221 - 2441)
1-3/8	35	—	——	1314 - 1512 (1782 - 2050)	——	——
1-1/2	39	—	——	1746 - 1980 (2368 - 2685)	——	2844 - 3204 (3857 - 4345)

U.S./METRIC CONVERSIONS AND EQUIVALENTS

Metric Conversions

MULTIPLY	BY	TO GET
INCHES	2.54	CENTIMETERS
FEET	0.3048	METERS
MILES	1.6093	KILOMETERS
SQUARE INCHES	6.451	SQUARE CENTIMETERS
CUBIC INCHES	16.39	CUBIC CENTIMETERS
FLUID OUNCES	29.573	MILLILITERS
PINTS	0.473	LITERS
QUARTS	0.946	LITERS
GALLON	3.785	LITERS
POUNDS	0.454	KILOGRAMS
SHORT TONS	0.907	METRIC TONS
POUND-INCHES	0.113	NEWTON-METERS
POUND-FEET	1.356	NEWTON-METERS
POUNDS PER SQUARE INCH	6.895	KILOPASCALS
MILES PER GALLON	0.425	KILOMETERS PER LITER
MILES PER HOUR	1.609	KILOMETERS PER HOUR

U.S. Standard Conversions

MULTIPLY	BY	TO GET
MILLIMETERS	0.03937	INCHES
CENTIMETERS	0.3937	INCHES
METERS	3.2808	FEET
KILOMETERS	0.6214	MILES
SQUARE CENTIMETERS	0.155	SQUARE INCHES
CUBIC CENTIMETERS	0.061	CUBIC INCHES
MILLILITERS	0.034	FLUID OUNCES
LITERS	2.113	PINTS
LITERS	1.057	QUARTS
LITERS	0.264	GALLONS
KILOGRAMS	2.205	POUNDS
METRIC TONS	1.102	SHORT TONS
NEWTON-METERS	0.738	POUND-FEET
NEWTON-METERS	8.851	POUND-INCHES
KILOPASCALS	0.145	POUNDS PER SQUARE INCH
KILOMETERS PER LITER	2.352	MILES PER GALLON
KILOMETERS PER HOUR	0.621	MILES PER HOUR

Temperature

32° FAHRENHEIT = 0° CELSIUS 212° FAHRENHEIT = 100° CELSIUS

CELSIUS = 0.556 X (F° -32) FAHRENHEIT = (1.8 X C°) +32

PAINT AND TRIM COLORS

Interior trim colors are tan and gray. Seating materials are available in cloth, vinyl and leather.

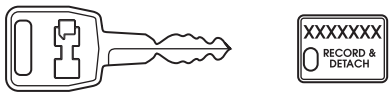
Soft top colors and codes are: Tan (T) and Black (B).

Exterior paint colors and codes are outlined in the following chart.

Top Coat Description	AM General Code
Black Gloss	B25
Bright White	W26
Competition Yellow	Y27
Firehouse Red	R28
Metallic Black	B34
Metallic Diamond Black	B30
Metallic Pewter	P33
Metallic Sand	T32
Summit Silver	S31

REPLACEMENT KEYS

Replacement keys can be cut using Briggs and Stratton or Curtis key cutting tools. Key codes are provided on an identificaion tag included with each key set (Figure-1-9).



03-OM2-005

Figure 1-9: Key Code Location

TOWING, LIFTING, JUMP STARTING

Vehicle Lifting/Jacking Points

Vehicle jacking points are shown in Figure 1-10. The vehicle can be raised with a floor jack at any of the indicated positions. Jacking can be performed at the front, rear, or at any one wheel.

In cases where the entire vehicle must be raised, use jack stands at equidistant points on the frame rails. Use a minimum of four stands to support the vehicle. Suggested capacity for individual jack stands is 3 ton, with a vertical reach of 19 in. (49 cm).

Typical jack stand placement for raising one side of the vehicle is shown in Figure 1-11. Always be sure the jack stand saddle is securely engaged and the stand is level.

Vehicle Hoisting

HUMMER H1 vehicles can be raised on a hoist for service access. Drive-on and swivel arm hoists are both acceptable. Hoist capacity and width are important. The greater width and weight of HUMMER H1 vehicles require a larger hoisting platform. Do not use an under capacity hoist, or modify an existing hoist for use; this practice is neither safe nor recommended.

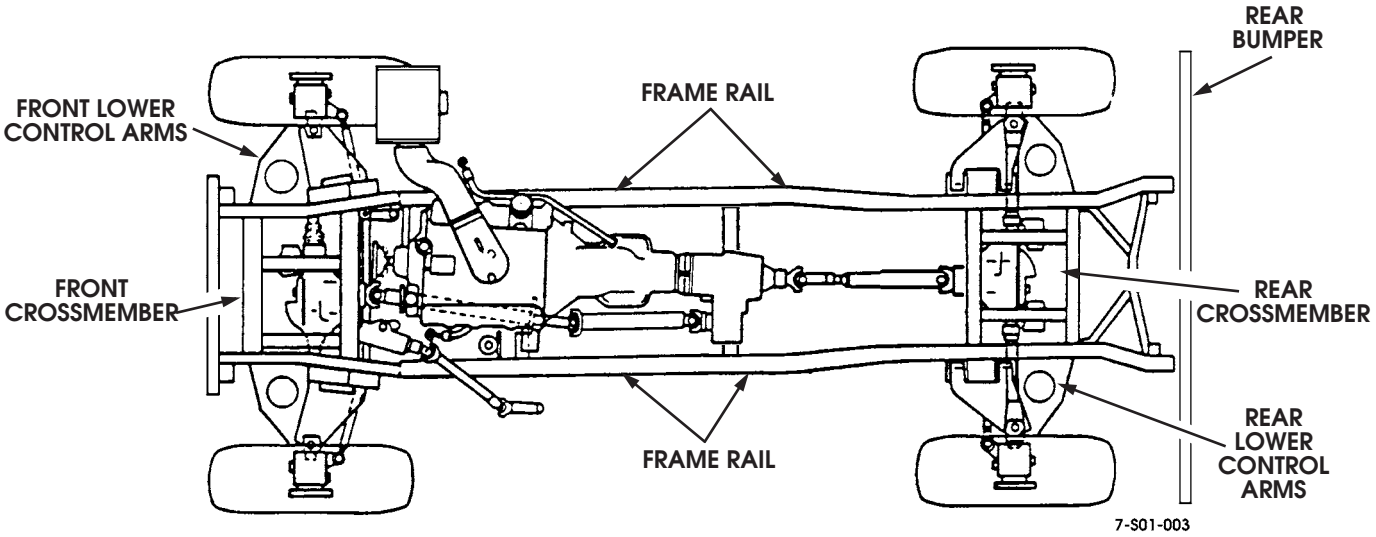


Figure 1-10: Vehicle Jacking Points

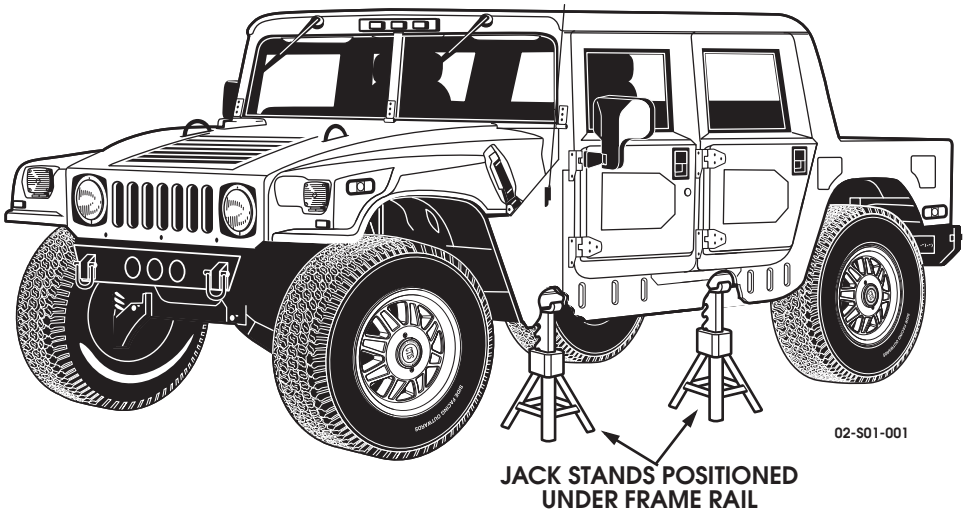


Figure 1-11: Typical Jack Stand Placement

Towing Recommendations

HUMMER H1 vehicles can be towed with wheel lift, sling-type, or flat bed tow equipment.

Flat bed and wheel lift equipment is recommended over sling type or A-frame equipment.

Towing Cautions:

- Remove or secure loads in the towed vehicle
- Never use the shackles on the front bumpers as tie down points
- Always use safety chains on sling towed vehicles
- Always follow the transmission/transfer case shift position recommendations (Transfer Case in N (Neutral); Transmission in P (Park).
- Use a low vehicle trailer for recreational towing (behind an RV or other vehicle) when possible.
- Never put chains, cables or straps on any steering components.

Flat Bed/Wheel Lift Towing Procedures

Flat bed/wheel lift tow vehicles are highly recommended. They keep all of the towed vehicle wheels off the pavement. This is important with full time four wheel drive vehicles.

Loading only requires that the towed vehicle be raised or winched onto the towing platform. A further advantage of this type equipment is that tow speed and distance are not limited. Once the towed vehicle is loaded, set the parking brake, shift the transmission into Park and install the vehicle tie downs. Tie down attachment points are shown in Figure 1-12.

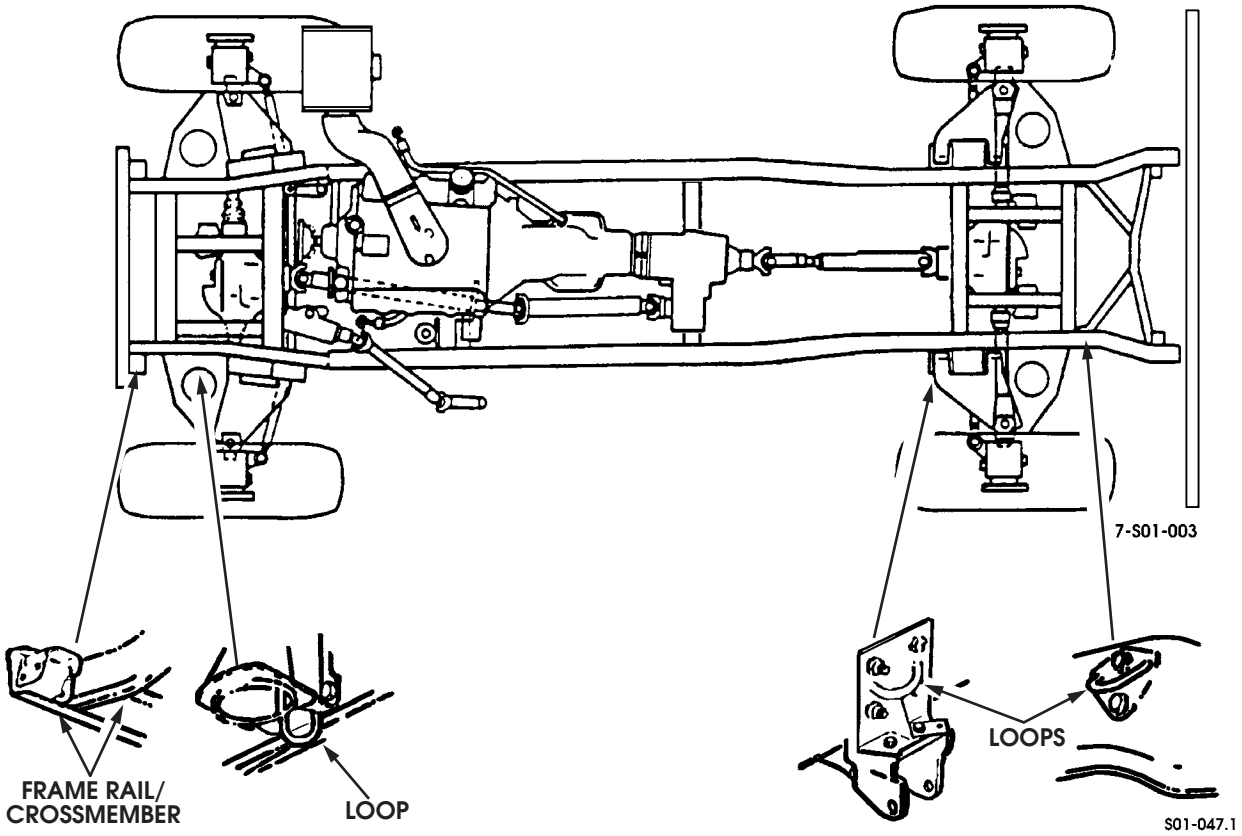


Figure 1-12: Vehicle Tie-Down Points

Conventional Towing Procedures

Front Towing

1. Loop chains around lower control arms and secure to tow sling (Figure-1-13).
2. Insert 4” x 4” x 48” length of wood between bumper and sling chains (Figure-1-13).
3. Raise front end and verify that sling is firmly positioned against front bumper.
4. Release parking brakes.
5. Shift transmission into Park and transfer case into Neutral.
6. Position tow dollies under rear wheels. Proceed with towing operations.

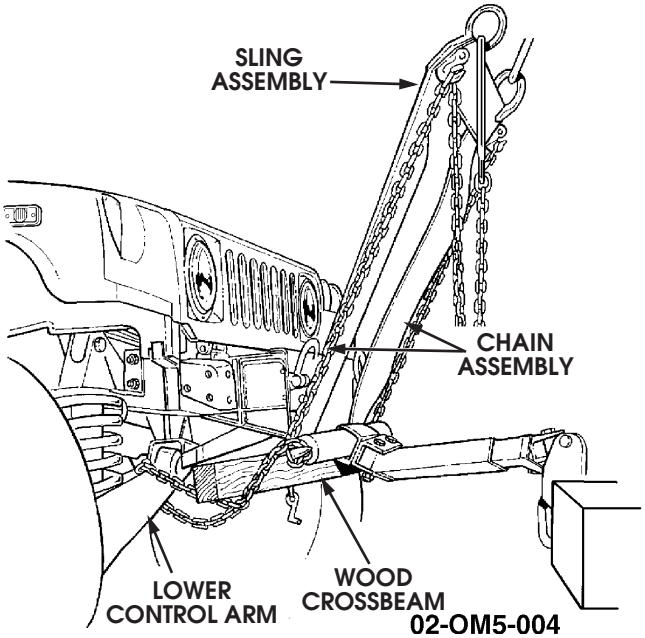


Figure 1-13: Front Towing With Conventional Equipment

Rear Towing

1. Loop sling chain around frame rails adjacent to rear crossmember and secure to tow sling (Figure-1-14).
2. Insert 4” x 4” x 48” length of wood between bumper and sling chains (Figure-1-14).
3. Raise rear end and verify that sling is firmly positioned against rear bumper.
4. Release parking brakes.
5. Shift transmission into Park and transfer case into Neutral.
6. Position tow dollies under front wheels. Proceed with towing operations.

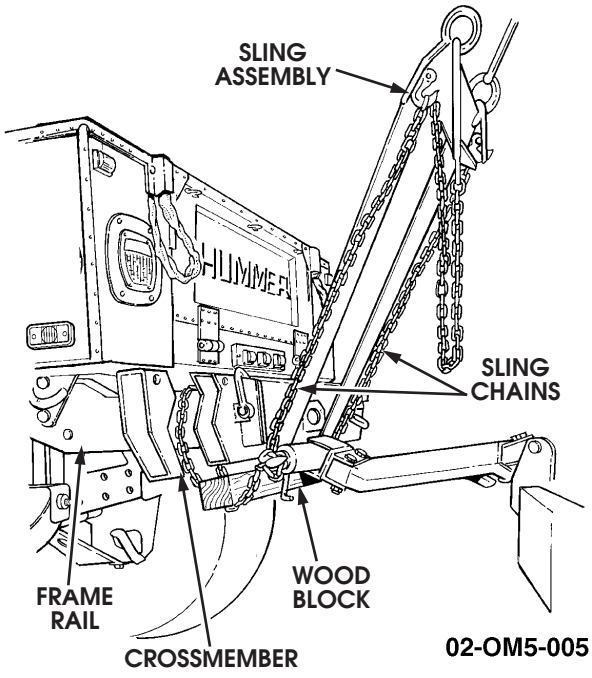


Figure 1-14: Rear Towing with Conventional Equipment

Conventional Towing When Keys are not Available

If the vehicle doors are locked and the keys are not available you cannot determine that the transmission is in Park and the transfer case is in "N" (Neutral). In these situations, you must use one of the following towing methods:

a. Use tow dollies at all wheels and flat tow,

or

b. Raise the vehicle front or rear and use tow dollies under the wheels not raised.

Recreational Towing

HUMMER H1 vehicles can be towed behind an RV if desired. A low-boy style vehicle trailer is best for this purpose. Flat towing is not recommended.

JUMP STARTING

Preparation for Jump Starting

CAUTION: NEVER allow the two vehicles to touch each other when jump starting.

1. Park the vehicle with the booster battery close to the passenger door of your vehicle. Ensure that the vehicles do not touch each other. Place the transmissions of both vehicles in "P" (Park), if applicable, and set all parking brakes.
2. Clean all battery terminals of excess corrosion before connecting jumper cables.

WARNING: ALWAYS remove ALL jewelry BEFORE handling batteries.

CAUTION: NEVER disconnect a vehicle's batteries to jump start.

3. Turn off all electrical switches in both vehicles to prevent possible electrical damage to either vehicle's electrical system.

Jumper Cable Connections

WARNING: NEVER lean over the batteries when connecting the jumper cables or allow the jumper cable clamps to touch each other.

1. Connect one end of the positive jumper cable to the positive (+) terminal on the dead battery. It is best to connect to the positive terminal of the battery closest to the windshield (Figure-1-15).

WARNING: ALWAYS make sure that the positive cable is hooked only to positive terminals and the negative to negative terminals or to a good ground.

2. Connect the other end of the positive cable to the positive (+) terminal on the booster battery.

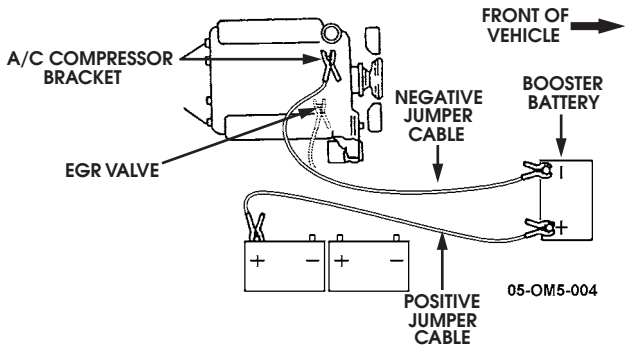


Figure 1-15: Jumper Cable Connections

3. Connect one end of the negative jumper cable to the negative (-) terminal on the booster battery.

WARNING: NEVER connect the other end of the negative jumper cable to the negative (-) terminal on the dead battery.

4. Start the booster vehicle.
5. Connect the other end of the negative cable to a good metallic ground surface on the engine of your vehicle. The best ground point is the A/C compressor bracket on the driver's side of the engine (Figure-1-16).

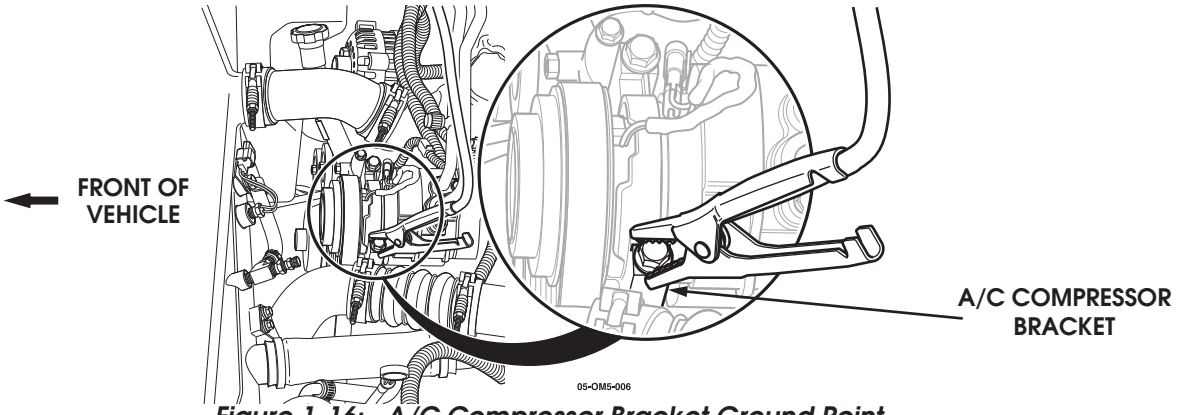


Figure 1-16: A/C Compressor Bracket Ground Point

An alternate ground point is the exhaust gas recirculation (EGR) valve on the passenger side of the engine (Figure-1-17).

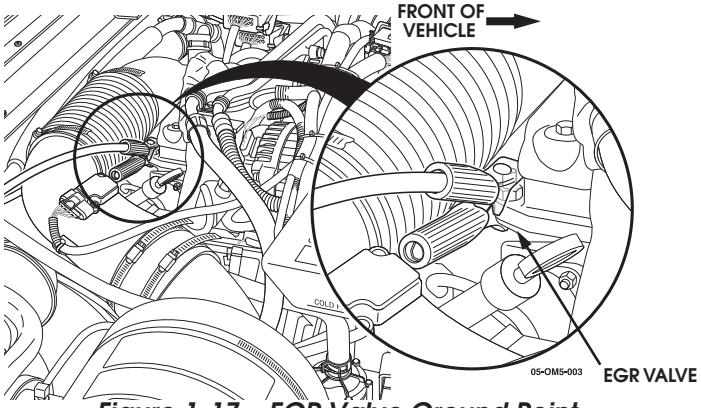


Figure 1-17: EGR Valve Ground Point

Starting the Vehicle

NOTE: Make sure the jumper cables are clear of any moving parts in the engine compartment.

1. With the booster vehicle running with a slightly increased engine speed, allow the dead battery to charge for a few minutes and then start your vehicle. It may take a few tries before your vehicle starts. If your vehicle does not start after cranking for fifteen seconds, stop the procedure. Cranking for more than fifteen seconds at a time seldom starts the engine and could cause damage.
2. Once your vehicle starts, disconnect jumper cables.
3. If the engine stalls, repeat above procedure once, allowing battery to charge for approximately ten minutes. If the engine stalls a second time, have the vehicle transported to an authorized service center.

NOTE: To ensure that the batteries are fully charged, have the batteries charged with proper battery charging equipment.

Disconnecting the Jumper Cables

WARNING: ALWAYS keep your hands away from moving parts in the engine compartment when disconnecting the jumper cables.

1. Remove the negative (-) cable connected to the engine of your vehicle.
2. Remove the other end of the negative (-) cable from the booster battery.

3. Remove the positive (+) cable from the booster battery.
4. Remove the other end of the positive (+) cable from the battery on your vehicle.

After starting, turn off any electrical accessories that were accidentally left on, and allow the engine to run at a high idle speed to recharge the batteries. For a “complete” charge, it may be necessary to use a battery charger to recharge the batteries.

MAINTENANCE SCHEDULE

Recommended Maintenance

Items described in Maintenance Inspection Groups A, B, and C are important to the proper operation, performance, and safety of your vehicle.

It is important that maintenance items outlined in the schedules be performed at suggested intervals. Regular maintenance will greatly improve vehicle reliability and longevity.

Normal Maintenance

The vehicle maintenance schedules reflect services required for normal operation. Normal operation includes city/highway driving on hard surface roads with only minimal operation on unpaved road surfaces.

Maintenance After Severe Operation

Severe operation includes extensive off-road driving, salt water fording, commercial use, sustained operation in high ambient temperatures, and trailer towing. This type of vehicle operation requires additional and more frequent service. If the vehicle is going to be used frequently in severe operating situations, maintenance should be done on an hourly rather than a mileage schedule, as shown in the Scheduled Maintenance Chart on page 1–27 . To keep track of the hours of severe operation, an optional hourmeter can be installed at your HUMMER dealer.

Commercial use involves regular operation as a delivery or service type vehicle. Severe off-road use involves extended operation on rough terrain, stream fording, salt water fording, or sustained operation in sand, mud, snow, or dirt surfaces. Severe operation also includes prolonged daily operation in heavy traffic when ambient temperatures are high.

The additional maintenance required immediately after severe off-road operation is as follows:

- Wash the vehicle underbody, driveline and brake components, and all steering linkage and suspension parts with a low pressure fresh water spray.
- If vehicle was driven over rough terrain, examine the underbody and driveline components for impact damage. Also check for leaks and loose parts.
- If the vehicle was driven through deep water, examine geared hub, axle and vent lines for water contamination. If the lines have become disconnected, these components may become water contaminated. Also inspect the axle and hub vents if required.
- Check the front/rear brake pads for contamination by dirt, mud, sand, etc. Replace the pads if foreign material has become embedded in the lining. However, if the pads are only wet from water, allow them to air dry, or drive the vehicle about a block with the brakes lightly applied to heat and dry the pads.
- Check transmission and transfer case fluid levels and condition. Drain and replace the fluid in either assembly if water contamination is evident. If water contamination proves extensive, it will also be necessary to replace the transmission fluid filter, and flush the transmission fluid cooler and lines.
- Lubricate the steering linkage, ball joints, propeller shaft, and body lubrication points.
- Check the brake and power steering fluid levels and top off as needed.
- Examine the engine air filter. Replace the filter element if necessary and clean the air filter housing and dust unloader.
- Change engine oil and replace engine oil filter.

Maintenance Inspection Groups A-B-C

The inspection groups outline additional components to be checked at stated mileage intervals. The intervals are described in your maintenance booklet. Perform necessary service repair, replacement, or adjustments as each inspection item is checked.

Maintenance Inspection Group A:

- Check fluid levels and condition for power steering pump, cooling system (reservoir and surge tank), brakes, transmission, transfer case, geared hubs, and axles.

- Inspect condition of control arms, springs, and shock absorbers.
- Check tire wear and condition.
- Lubricate all grease fittings and body lubrication points.
- Inspect geared hubs for leaking seals or damage.
- Inspect service brakes and parking brake.
- Check axles for leaks or damage.
- Check torque of wheel lug nuts.
- Inspect condition of geared hub and axle vent lines.
- Inspect condition of transmission and transfer case vent lines.
- Inspect U-joints for wear or missing/damaged grease fittings.
- Inspect condition of engine mounts and insulators.
- Inspect transmission/transfer case shift cables for wear, binding, distortion.
- Check fuel filter and drain/clean if necessary.
- Check CTIS operation. Verify that system inflates/deflates tires.
- Check winch operation and cable condition (if equipped). Free-spool out and pay-in at least 30 feet of cable.
- Check ball joints for wear.
- Test drive vehicle and complete a functional check of all systems.
- Check air cleaner.

Maintenance Inspection Group B:

- Inspect fuel injection pump, lines, and fittings for leaks or damage.
- Check battery voltage and condition.
- Inspect serpentine belt condition.
- Inspect exhaust system and shields.
- Inspect and rotate tires.
- Inspect halfshaft boots and ball joint seals.
- Inspect condition of steering column, U-joints, tie rods, steering arm, center link, and idler arm.
- Check fuel tank vent line filter.
- Inspect condition of frame rails and crossmembers.
- Check A/C system operation.
- Check wheel alignment.

Maintenance Inspection Group C:

- Inspect surge tank, radiator and shroud, A/C condenser, power steering and transmission coolers, charge air cooler, and all hoses and fittings for security of mounting, leaks, obstructions, or damage.
- Inspect fuel tank, lines, and cap.
- Inspect all wiring harnesses for frays, splits, missing insulation, poor connections.
- Inspect power steering pump, power steering gear, hoses, lines, and fittings for leaks or damage.

  NOTE: Clean all dirt from caps and surrounding areas before opening to check fluids.

SCHEDULED MAINTENANCE CHART

6,000 Miles (9,700 km) – 200 hrs normal use or 100 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

12,000 Miles (19,300 km) – 400 hrs normal use or 200 hrs severe operation

❒ Change engine oil and replace filter.



❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.

18,000 Miles (29,000 km) – 600 hrs normal use or 300 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

24,000 Miles (38,600 km) – 800 hrs normal use or 400 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Inspect brake fluid for moisture contamination.

30,000 Miles (48,300 km) – 1,000 hrs normal use or 500 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

36,000 Miles (58,000 km) – 1,200 hrs normal use or 600 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.

42,000 Miles (67,600 km) – 1,400 hrs normal use or 700 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

48,000 Miles (77,200 km) – 1,600 hrs normal use or 800 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Inspect brake fluid for moisture contamination.

54,000 Miles (86,900 km) - 1,800 hrs normal use or 900 hrs severe operation

❒ Change engine oil and replace filter.

❒ Check items in maintenance Groups A and B.

60,000 Miles (96,500 km) - 2,000 hrs normal use or 1,000 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filters.
❒ Replace fuel filter element.
❒ Change engine coolant.
❒ Change transmission and transfer case fluid.
❒ Inspect fuel tank, fuel cap and fuel lines.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Drain & replace brake fluid.

NOTE: Some maintenance requires specialized knowledge or equipment and may be best handled by qualified service technicians at your nearest HUMMER dealer.

NOTE: After your vehicle has been driven for 66,000 miles (106,200 km) repeat the schedule indicated in this section, starting at 6,000 mi (9,700 km).

RECOMMENDED FUEL/FLUIDS/LUBRICANTS/CAPACITIES

Recommended Fuel

Recommended fuel for 6.6L diesel engines is #2 diesel. Do not use any other type fuel.

Engine Oil

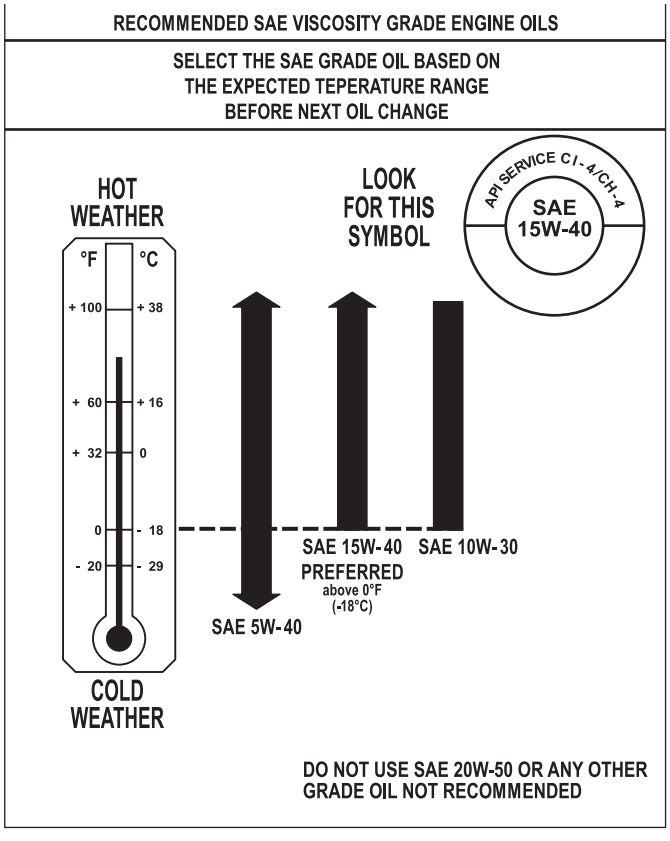


Figure 1-18: Oil Viscosity Chart

Diesel engine oil capacities are:

- 10.5 qts (9.9L) without filter change
- 12.25 qts (11.6L) with filter change
- 2.0 qts (1.9L) for engine oil cooler

Refer to Section 2 for more information regarding engine oil.

Engine Coolant

Recommended engine coolant is a mixture of ethylene glycol antifreeze and water.

Use a mixture containing 50% DEX-COOL and 50% water.

Radiator capacity is 7 qts (6.6L). System capacity is approximately 33 qts (31.2L).

Transmission/Transfer Case/Steering Gear and Pump Fluid

Recommended lubricant for the transmission, transfer case, and steering system is Dexron III automatic transmission fluid.

Approximate fluid capacities are:

- 1 qt (0.95L) for the steering gear and pump
- 3.5 qts (3.3L) for the transfer case
- 14 qts (13.3L) for the transmission, converter, and cooler
- 8.2 qts (7.7L) for the transmission (during fluid drain/refill)

Brake Fluid

Recommended brake fluid for all HUMMER H1 vehicles is DOT 3 brake fluid. Master cylinder approximate capacity is 1.64 pints (0.78L). Brake system approximate capacity is 3.12 pints (1.5L).

Front and Rear Axle Lubricant

Recommended lubricant for axles is HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier. The approximate capacity for one axle is 2 qts (1.9L).

Geared Fan Drive

Recommended lubricant for the GFD is HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier. The approximate capacity is 1.2 pt (0.6L).

Geared Hub Lubricant

Recommended lubricant for hubs is a heavy duty, multipurpose, API GL-5 gear lubricant, with viscosity ratings of 80W-90 or 75W-90.

The 80W-90 is an all purpose lubricant. The 75W-90 lubricant is suggested for use in areas where winter temperatures are consistently below freezing.

Steering Linkage and Suspension Lubricant

Recommended lubricant for steering and driveline components is an NLGI LB, or GC-LB grade multipurpose chassis grease. Use only those lubricants that display the NLGI certification symbol.

Body Lubrication

Door hinges, linkage parts, cables, and other body components can be lubricated with a number of different lubricants. Suggested lubricants and applications are:

- Window regulator mechanisms – spray white grease
- Window slides – silicone spray lube
- Door hinges – engine oil, ATF, or LPS brand spray lube
- Linkage/cables – LPS brand silicone spray lube
- Lock strikers – chassis grease, white grease, or LPS #3.
- Seat track – multipurpose chassis grease (NLGI-LB)
- Lock mechanisms –ATF, silicone spray lube, graphite lube

A/C Refrigerant and Compressor Oil

The only refrigerant that can be used is R-134a. No other refrigerant is recommended.

The only compressor oil recommended is PAG (polyalkylene glycol). It is the only oil compatible with refrigerant R-134a. No other oil is recommended. Any PAG oil used should be compatible with General Motors specifications.

A/C system capacities are:

- 11 fluid ounces (325 ml) of PAG oil
- 3 lb 3 oz (1.45 kg) refrigerant

LUBRICATION AND MAINTENANCE ITEMS

Engine Oil Level

The engine oil dipstick is at the driver side of the engine (Figure-1-19). Correct oil level is to the “F” mark.

Check oil level only when the engine is shut down and the vehicle is on a level surface. Wait one minute after shut down to check.

Never overfill the engine. The excess oil will be churned into foam causing oil film breakdown and consequent engine damage.

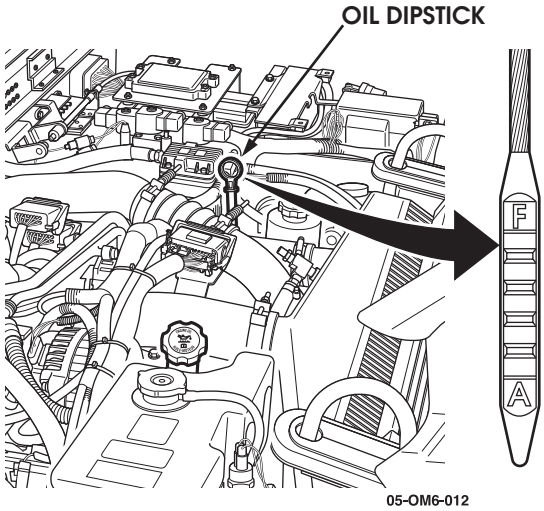


Figure 1-19: Oil Dipstick Location

Engine Oil and Filter Change

The oil filter is located on the driver side of the engine (Figure-1-20). A front mounted fill tube is used.

The spin-on oil filter is only removed with a standard band-type tool. Coat the seal on a new filter with oil and clean the adapter surface before installation. Tighten the filter by hand. Replace filter every 6,000 mi (9,700 km).

The oil pan drain plug has a gasket that should be replaced if cut, cracked, or distorted. Check the gasket seating surface on the oil pan. Burrs or nicks can be smoothed with a fine tooth file. Also replace the drain plug if the threads are worn or damaged. Be sure the plug is tightened to required torque of 16 lb-ft (22 N•m).

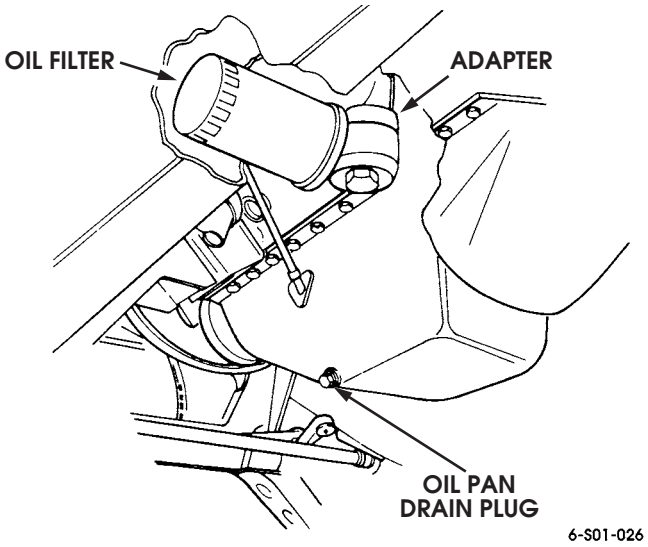


Figure 1-20: Oil Filter/Drain Plug Location

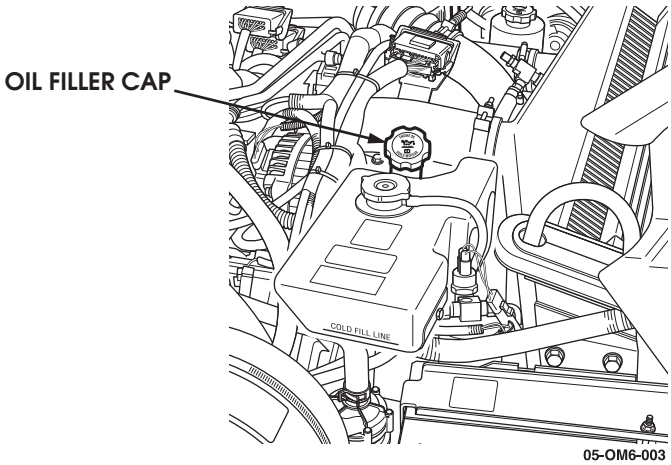


Figure 1-21: Engine Oil Fill Location

Fuel Filter Service

Replace the filter element every 6,000 mi (9,600 km), or annually, whichever occurs first (Figure-1-22). See “Purging Air From Diesel Filter” (Section 3).

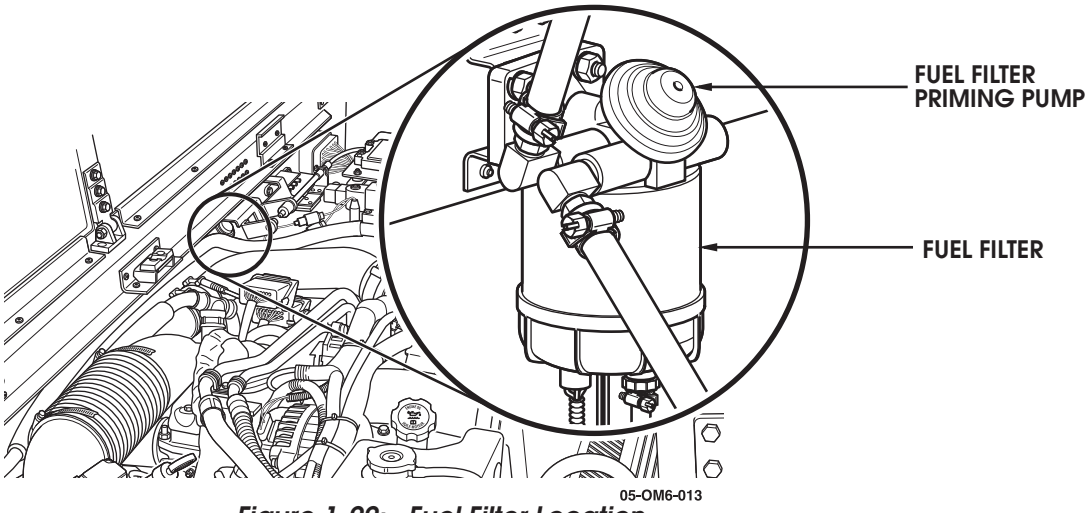


Figure 1-22: Fuel Filter Location

Transmission Fluid

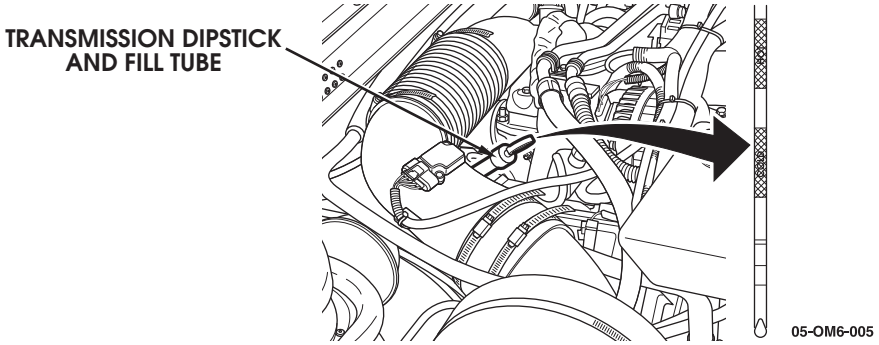


Figure 1-23: Transmission Dipstick Location

Replace the transmission fluid filter each time the fluid is changed. Refill the transmission with Dexron® III afterward.

Check transmission fluid level at least once each month. Procedure is as follows:

1. Drive the vehicle until the transmission fluid is at normal operating temperature. Fluid must be hot to obtain accurate reading.
2. Position the vehicle on a level surface.
3. Shift the transmission into Park.
4. Operate the engine at curb idle speed.
5. Remove the transmission dipstick and check the level (Figure-1-23). Correct level is within the crosshatch marks on the dipstick.
6. If the fluid level is too high, remove the excess through the fill tube using a suction gun and 3/16-in. teflon tubing. If level is low, check for leaks and, if OK, add fluid in 1-2 ounce increments until level is correct.

CAUTION: Do not overfill the transmission. The excess fluid will be churned into foam resulting in overflow from the fill and vent tubes, slip and flare during upshifts, fluid breakdown and eventual clutch failure.

7. Check the fluid color and the condition. Normal color ranges from dark red to light pink. Fluid that is dark brown, black, or orange and full of bubbles indicates a problem that may require overhaul.

Transfer Case Fluid

Check transfer case fluid level every 6,000 mi (9 700 km), or semiannually, whichever comes first. Remove fill plug and gasket. Level should be within 1/2 in. (12.7 mm) of fill plug opening when transfer case is level. Install fill plug and gasket, and tighten to 15-25 lb-ft (20-33 N•m). Change fluid every 12,000 mi (19 000 km) or annually, whichever occurs first (Figure-1-24).

Inspect rubber plug in the shift rail roll pin access passage located near the shift lever for leakage. Replace plug if leakage is present.

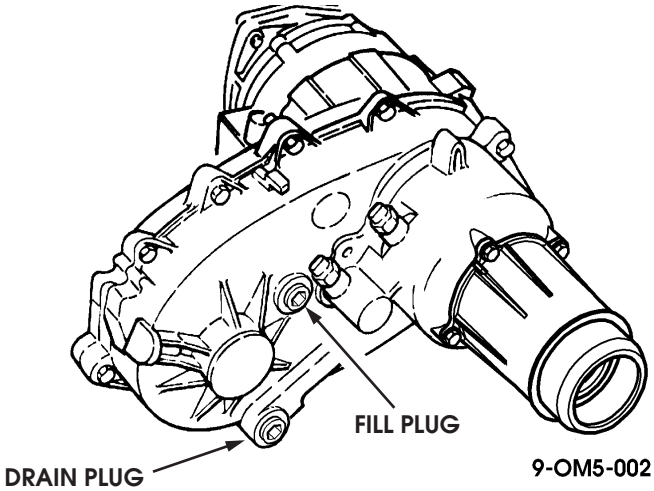


Figure 1-24: Transfer Case Fill/Drain Plug Location

Axle and Geared Hub

Check axle and hub lubricant condition and level every 6,000 mi (9,700 km) or semiannually, whichever occurs first.

Geared hub level should be within 1/2 in. (12.7 mm) of fill plug opening when lubricant is cold, or to plug level when hot.

Axle level should be within 1/4 in. (6.4 mm) of fill plug opening when lubricant is cold, or to plug level when hot (Figures 1-25 and 1-26).

Change axle and hub lubricant when contaminated by water or foreign material.

The geared hubs use GL-5, SAE 80W-90 or 75W-90 gear lubricant only.

For the axles, use only HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier.

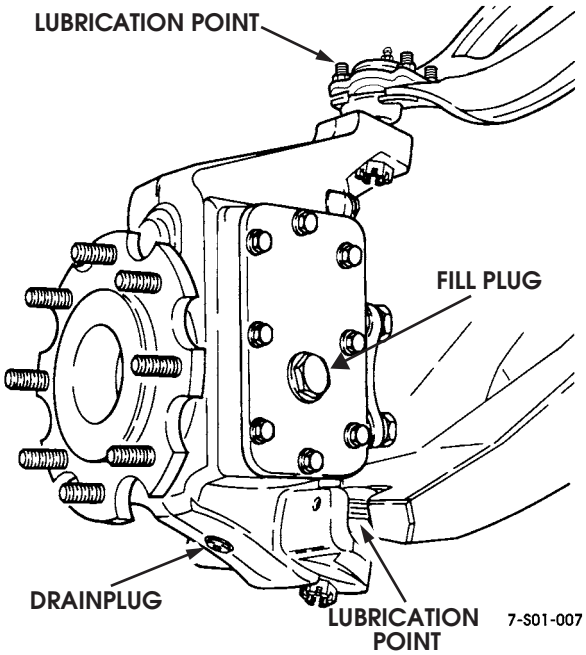


Figure 1-25: Geared Hub Fill/Drain Plug Locations

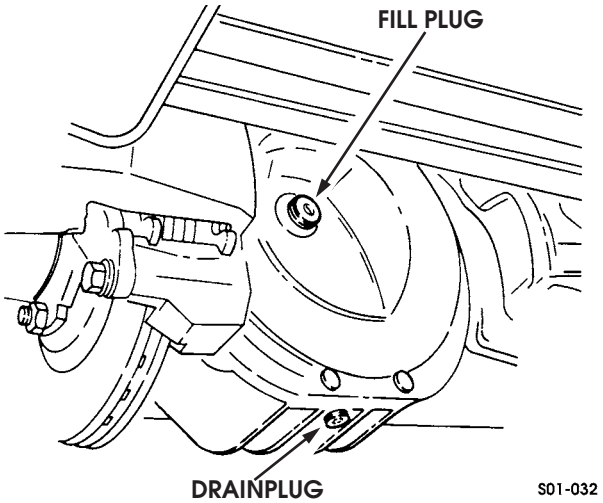


Figure 1-26: Axle Fill/Drain Plug Locations

Geared Fan Drive

CAUTION: If the fluid level is checked when the unit is hot, some of the expanded fluid will run out and create a low fluid condition.

The fluid level in the reservoir must be checked every 6,000 mi (9,700 km) or semiannually, whichever occurs first and topped off using HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier. Remove the fill plug when the unit is cold and ensure that the fluid is even with the bottom of the fill plug hole (Figure-1-27). The coupler shaft CV joints must be greased every 6,000 mi (9,700 km) or semiannually, whichever occurs first with a multipurpose, NLGI-LB grade chassis grease. The coupler shaft has a CV joint at the GFD end and one at the engine crankshaft end. Each CV joint contains two grease zerks, although only one zerk needs to be greased per joint. The second zerk is used to give an optional location depending on the position of the shaft when the engine stopped. This should lessen the need to bar the engine over to gain access to the zerks. Grease should be applied, using a low pressure grease gun, to the joint until old grease can be seen exiting around the sleeve on the shaft. Wipe the excess grease from the shaft when finished (Figure-1-28).

NOTE: It will be normal for some grease to exit the CV joint seals during engine operation, DO NOT replace the CV joints for this condition.

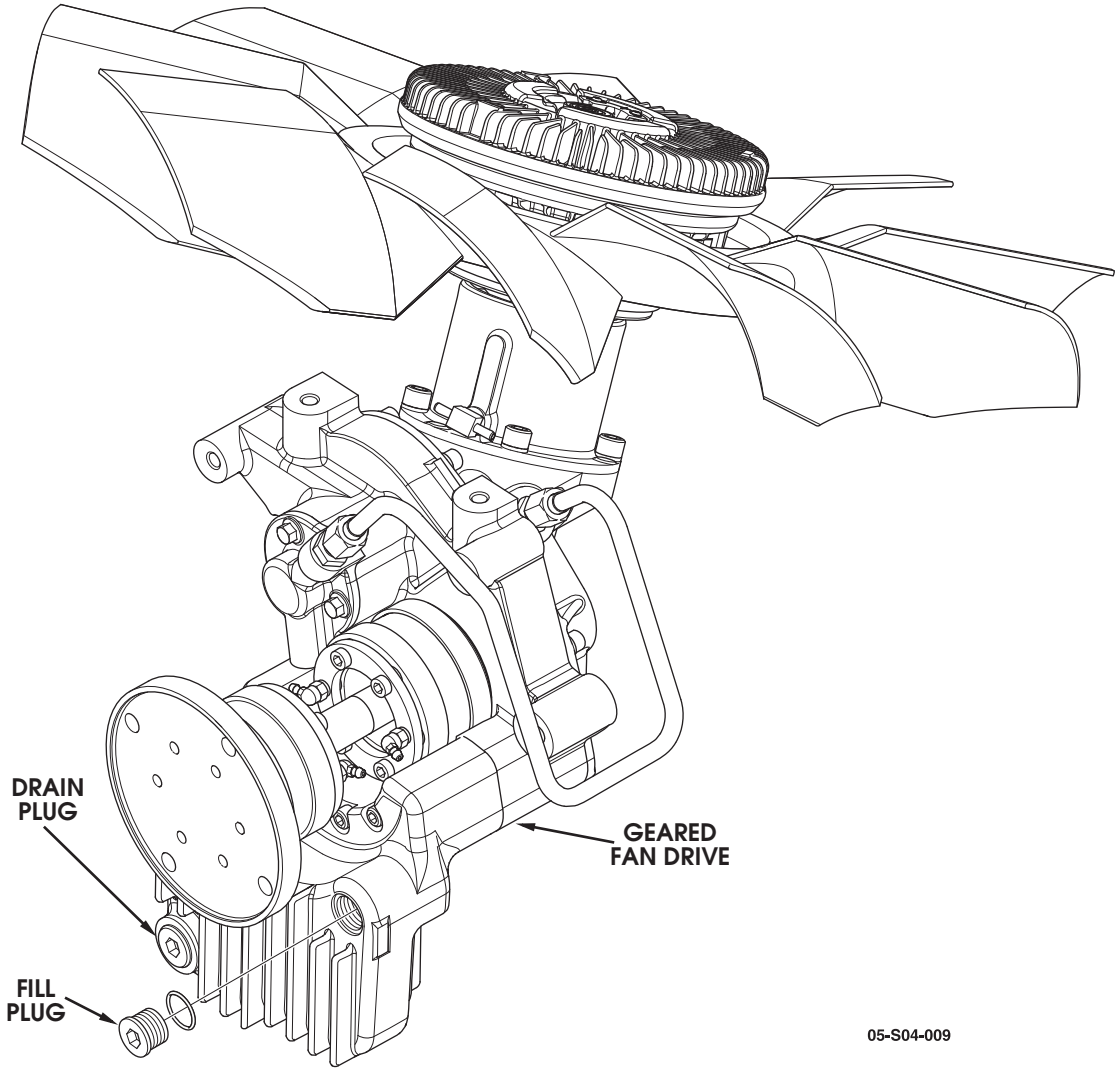


Figure 1-27: GFD Fill and Drain Plug

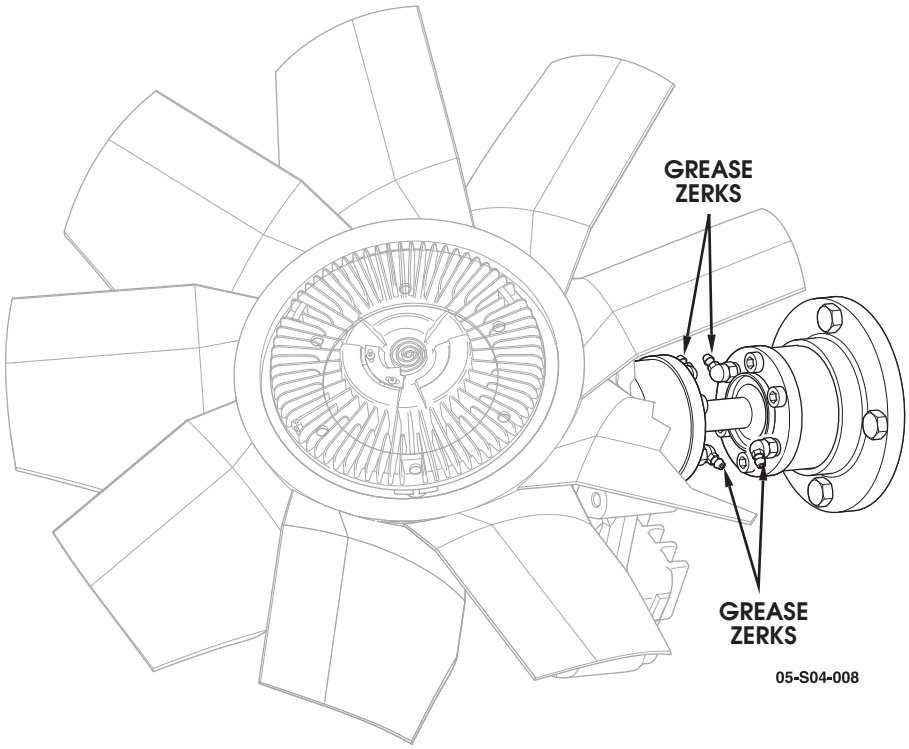


Figure 1-28: Coupler Shaft Grease Points

Universal and Slip Joint Lubrication

Lubricate U-joints with a multipurpose, NLGI-LB grade chassis grease.

Lubricate propeller shaft universal and slip joints every 6,000 mi (9,700 km), or semiannually, whichever occurs first. Use a hand operated or low-pressure air powered lubrication gun. If operating conditions are severe service at 1,000 mi. (1,600 km) intervals.

The rear propeller shaft U-joints have two grease fitting locations (Figure-1-29). The front shaft has four fitting locations (Figure-1-30)

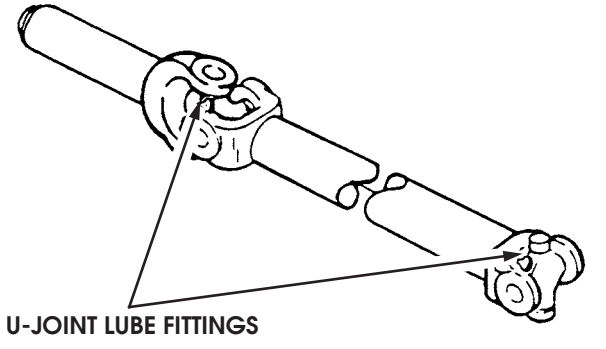


Figure 1-29: Propeller Shaft Lube Points

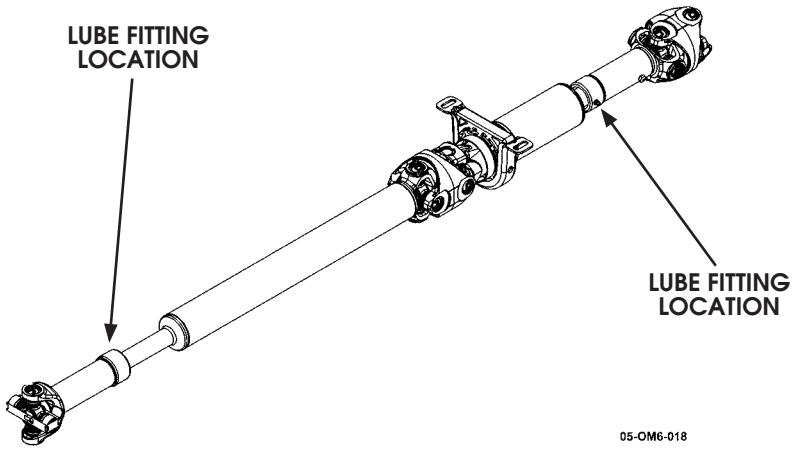


Figure 1-30: Front Propeller Shaft Lube Points

Steering and Suspension Lubrication Points

Lubricate steering and suspension components every 6,000 mi. (9 700 km), or semiannually, whichever occurs first. If operating conditions are severe, service at 1,000 mi. (1 600 km) intervals.

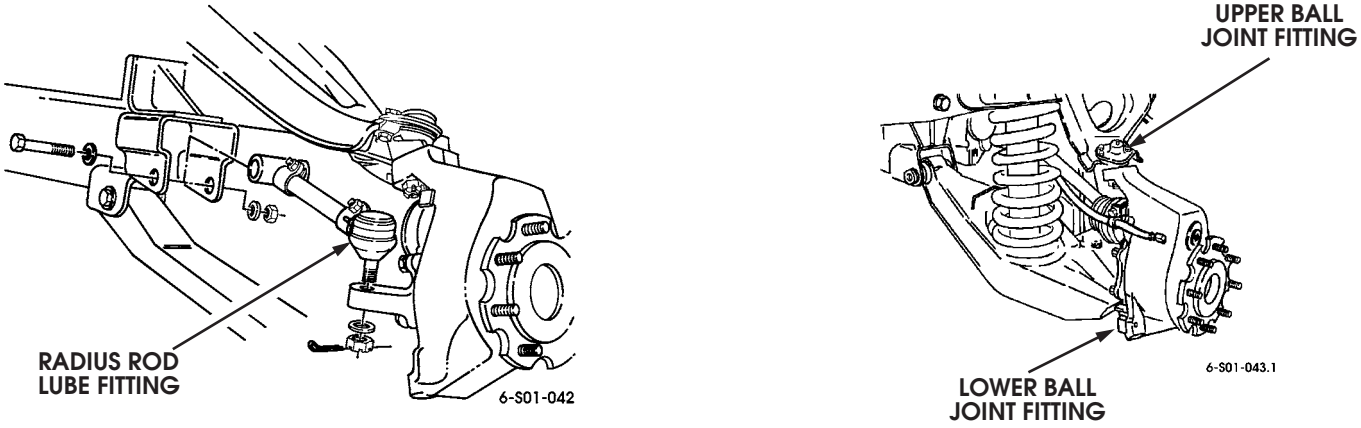


Figure 1-31: Ball Joint/Radius Rod Lube Points

Suspension lube points include the upper and lower ball joints and the rear suspension radius rods (Figure-1-31). Steering lube points include the tie rod ends, idler arm, steering arm, and intermediate steering shaft (Figure 1-32 through Figure 1-34).

Use a hand operated or low pressure air powered lube gun filled with a multipurpose chassis grease. NLGI-LB classification lubricating grease is recommended.

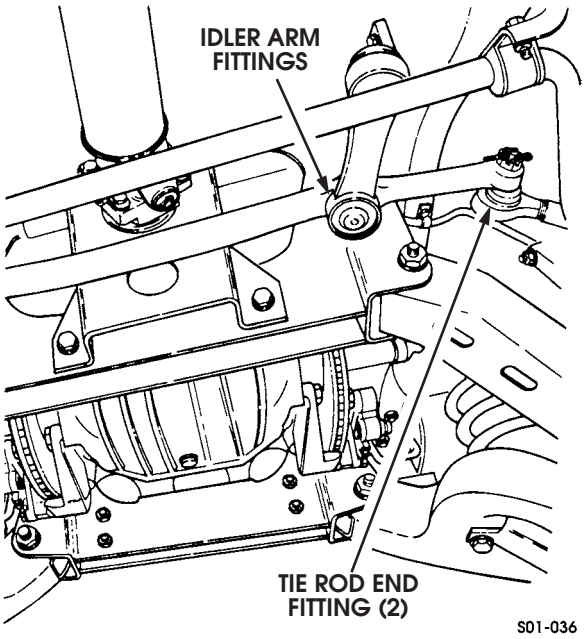


Figure 1-32: Idler Arm and Tie Rod Lube Points

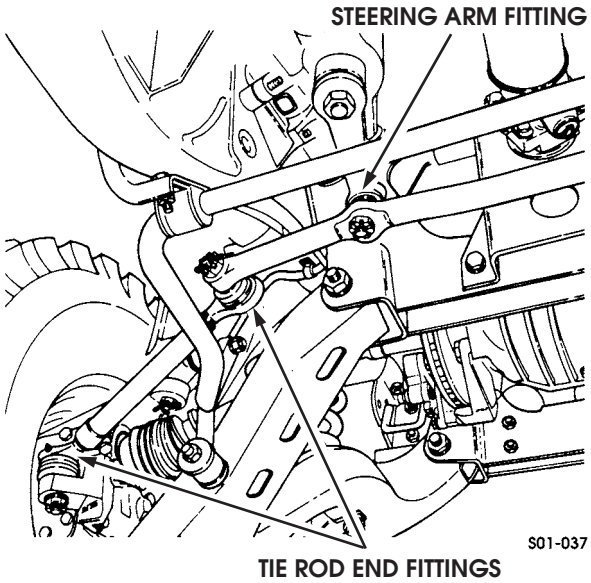


Figure 1-33: Tie Rod and Steering Arm Lube Points

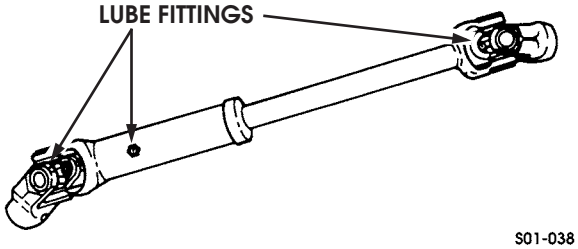


Figure 1-34: Intermediate Steering Shaft Lube Points

Power Steering Fluid

Check the fluid level in the power steering reservoir monthly and adjust level as necessary. If fluid is hot, level should be between "HOT" and "COLD" marks on the cap indicator. If fluid is cool, level should be between "ADD" and "COLD" marks. In either condition, level must be above "ADD" mark.

NOTE: Power steering fluid does not require periodic replacement.

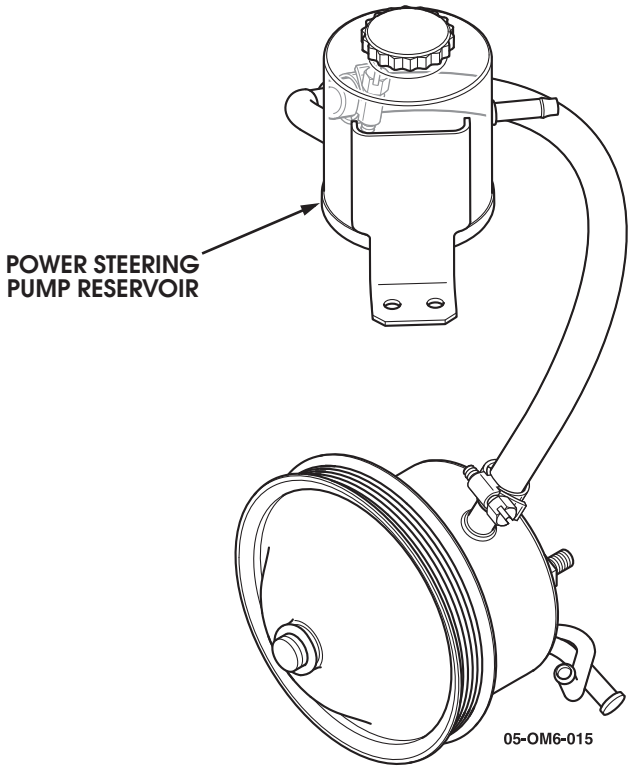


Figure 1-35: Power Steering Pump Reservoir

Cooling System Fluid Level Check

Check coolant level at the surge tank monthly and adjust level as necessary. Level should be at, or above, the cold fill line (Figure-1-36).

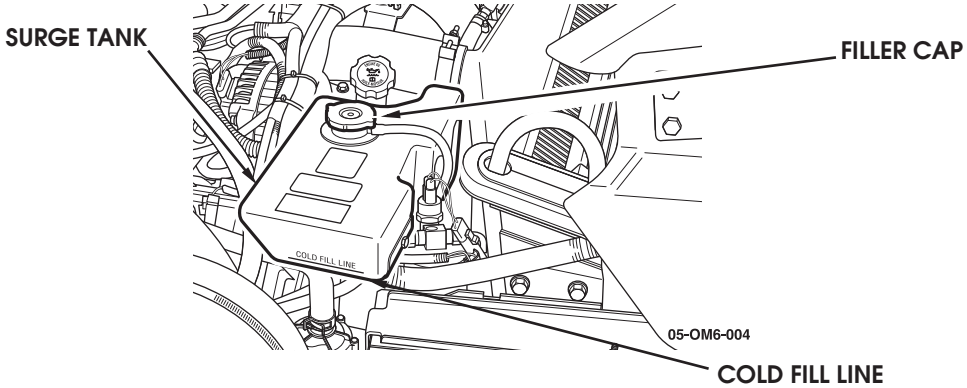


Figure 1-36: Surge Tank Coolant Level Indicator Location

Master Cylinder Fluid Level Check

CAUTION: Use DOT 3 brake fluid only. Failure to use the proper fluid may affect brake performance or damage brake components.

Check master cylinder fluid level monthly. Correct fluid level is to within 1/2 in. (13 mm) from the “MAX” indicator.

Clean the master cylinder cap and exterior before checking fluid level. Dirt on the cap must not be allowed to enter the reservoirs.

Add DOT 3 fluid if necessary and reinstall the cap (Figure-1-37).

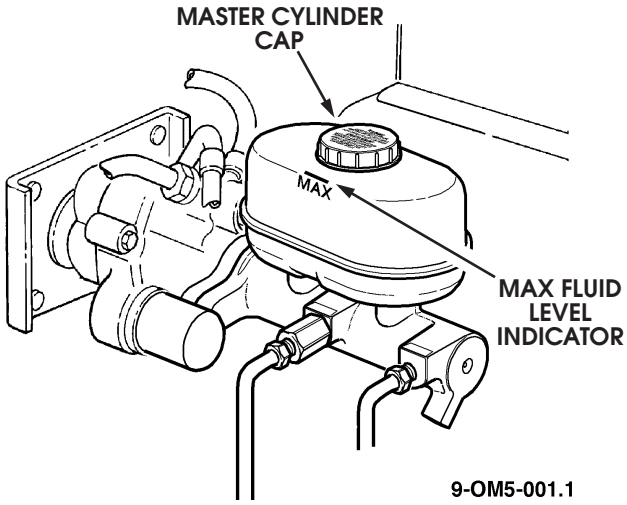


Figure 1-37: Master Cylinder Cap Location

Wheels/Tires/CTIS

Inspect tire and wheel condition. Look for loose wheel nuts and rim stud nuts, or dented, deformed wheel rims. Note tire tread wear and sidewall condition. If the vehicle is used for extensive off road operation, check the sidewalls for bulges, bead damage, cuts, fabric breaks.

If the tire treads are worn, note type of wear. If wear is only on one shoulder, toe setting or camber may be incorrect. If tires are scalloped or worn at crown only, or both shoulders, inflation pressures are probably incorrect.

If the vehicle is equipped with CTIS, cycle the system and check operation. Verify tire inflation pressures with an accurate gauge.

Serpentine Belt

Replace the belt if frayed, cut, or torn. Minor, small surface cracks within the belt grooves are normal. Do not replace the belt unless cracks extend all the way through or across the belt face.

Body Lubrication Points

Every 6 months or 6,000 mi (9,700 km), whichever occurs first, lubricate the: hood hinge, hood stops, tailgate hinges, door hinges, door handles, parking brake lever and service brake pedal push rod stud (Figure-1-38). Suggested lubricants include engine oil or ATF for hinges; LPS silicone lube for linkages, handles, and brake push rod; white grease for seat tracks, window regulators and park brake lever. Door locks should use a graphite based lubricant such as Lock-Eze. Refer to the Recommended Fuel/Fluids/Lubricants/Capacities section for more detailed lube information.

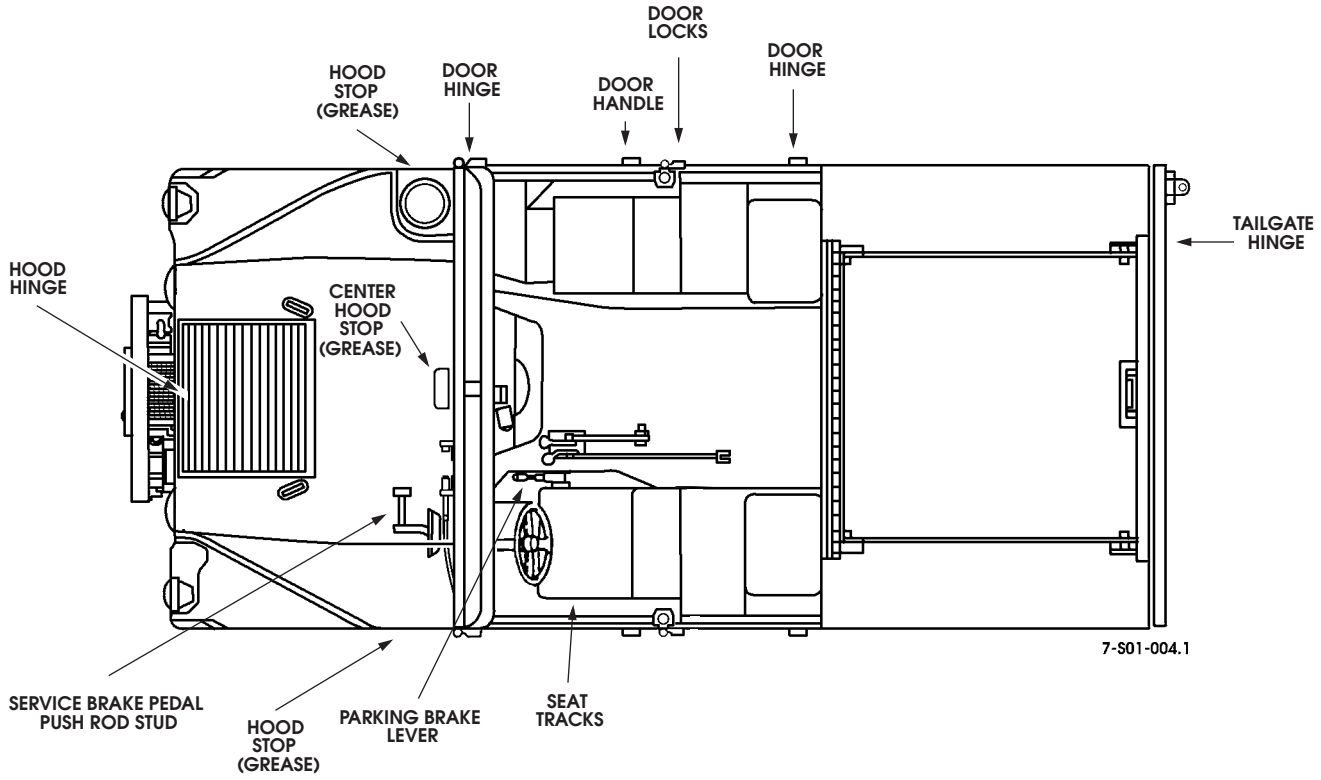


Figure 1-38: Body Lubrication Points

ESSENTIAL TOOLS

NOTE: See page 1-1 of the 2006 Service Parts Catalog for information on ordering Kent-Moore tools.

Engine

Tool No.	Description
EN-47913	Wrench, Belt Tensioner
J–23523-F	Harmonic Balancer Remover/Installer Set
J–23951	Water Manometer
J–26999-10	Compression Gauge Adapter
J–26999-20	Adapter, Compression Gauge
J–26999-30	Compression Gauge Adapter
J–34826	Socket, 36mm 12 Point
J–42000-EU	Digital Battery Tester
J–44640	Installer, Valve Stem Seal
J–44641	Remover, Rear Crankshaft Seal
J–44642	Installer, Rear Crankshaft Seal
J–44643	Flywheel Holder
J–44644	Remover, Front Crankshaft Seal
J–44645	Installer, Front Crankshaft Seal
J–44646	Compressor, Valve Spring (On-Vehicle)
J–44648-A	Storage Case - Duramax 6.6L Tools
J-45059	Angle Meter
J–46594	Tool, Injector Removal

Fuel, Emissions and Exhaust

Tool No.	Description
EN–47589	Test Adapter, Fuel Pressure
J–28552-A	Gauge, Fuel Pressure
J–28552-100	Fuel Pressure/Return Adapter Set
J–29658-D	Fuel Pressure Gauge & Adapter Set
J–29698-A	Injection Line (flare nut) Wrench, 3/4
J–38641-B	Hydrometer, Diesel Fuel
J–44638	Gauge, Vacuum/Pressure
J–45773	Adapters, Fuel Pressure Gauge
J–45873	Test Kit, Fuel Return Volume
J–45873-30	Test Adapters, Fuel Return Volumn

Transmission/Transfer Case

Tool No.	Description
DT–47502	Front Output Seal Installer
J–21366	Torque Converter Retaining Strap
J–25025-B	Oil Pump and Valve Body Pin Set
J–33831-A	Input Gear Seal Installer
J–33835	Pump Housing Seal Installer
J–39700	Break-Out Box
J–41364-A	NSBU Switch Aligner
J–41623-B	Trans Oil Cooler Line Disconnect Tool
J–42497	Extension Housing Seal Installer
J–42543	Selector Shaft Seal Remover/Installer
J–43773	Valve Spring Compressor
J–43799	Break-Out Box Adapter
J–43909	Selector Shaft Seal Installer
J–43911	Selector Shaft Seal Remover
J–44152	Jumper Harness (20 pins)
J–44247	Internal Wiring Harness Installer
J–44257	Wiring Harness Connector Remover
J–44835	Allison Transmission Oil Cooler Flush Adapters
J–44924-A	Storage Case - Allison LCT Tools
J–45053	Pump Remover
J–45056	Oil Pressure Adapter
J–45096	TransFlow Transmission Cooling System Service Tool
J–45096-500	Oil Flush Kit Adapters
J–46409	Torque Converter Alignment Handles

Wheels, Tires and CTIS

Tool No.	Description
CH–47503	Runflat Tire Pry Bar
J–39522	ENG Kit, Socket (5-Point)
J–42452	Runflat Compressor
J–42557	Socket, Cam
J–45760	Rim Separating Jack-Screws
J–45769	Runflat Ratchet Wrench
J–45770	Hutchinson Rim Separator

Brakes

Tool No.	Description
J–35592	ABS Pinout Box
J–42553	Disc Brake Piston Retraction Tool
J–42883	Wheel Speed Sensor Test Cable
J–44237	ABS Blink Code Jumper
J–44238	Master Cylinder Bleed Adapter
J–45405	Brake Line Flaring Kit
J–45761	T-Handle Rachet Wrench (9/16")

Steering

Tool No.	Description
J–33141	Adapter Fittings (used with J–25323)
J–42548	Puller, Pitman Arm
J–44721	Power Steering System Analyzer
J–8092	Universal Driver Handle

Axles/Suspension and Frame

Tool No.	Description
CH–47505	Shock Mounting Pin Socket
DT–47845	Installer, Input Seal
DT–47846	Installer, Spindle Seal
J–08614-A	Pinion Flange Holder
J–08614-5	Bolt Kit Yoke Holding Tool
J–22610	Axle Boot Pliers, Eared Clamp
J–24398-A	Driveshaft Inclinometer
J–35566	Clamp Tool, Axle Boot
J–35910	Axle Boot Crimping Tool
J–38792-A	Electronic Vibration Analyzer (EVA) 2
J–38869	Installer, Pinion Seal
J–42183	Handle, Seal Driver
J–42546	1/4 in. Drive Torque Wrench (Preset)
J–42547	1/2 in. Drive Torque Wrench (Preset)
J–43218	Clamp Plier
J–45762	T-Handle Rachet Wrench (15mm)
J–8092	Universal Driver Handle

HVAC

Tool No.	Description
J–46053	R-134a Refrigerant Leak Detector

Electrical

Tool No.	Description
J–24538-B	Tester, Gauge
J–34513	Terminal Remover
J–35616-B	Connector Test Adapter Set
J–41712	Oil pressure Sending Unit Socket
J–42541	Crimper, 4 pt (field grade)
J–45763	AMP Terminal Release Tool

Electrical Troubleshooting

Tool No.	Description
J–35689-A	Micro-Pack Extract Tool
J–39200-A	Digital Multimeter

SPECIAL TOOLS

Engine

Tool No.	Description
J–02619-A	Slide Hammer
J–05902-A	Cylinder Hone
J–24270	Ridge Reamer
J–24460-A	Cooling System and Cap Pressure Tester
J-26999	Compression Gauge
J–38606	Valve Spring Compressor
J–8037	Ring Compressor
J–8087	Cylinder Bore Gauge
J–9666	Valve Spring Tester

Fuel, Emissions and Exhaust

Tool No.	Description
J–35555	Vacuum Pump (MITY-VAC)
J–42520	Fuel Line Disconnect Tool Set

Transmission/Transfer Case

Tool No.	Description
J–03289-20	Bench-mounted Base
J–21359-A	Oil Pump to Converter Seal Installer
J–21366	Converter Holding Strap
J–21867-A	Pressure and Hose Assembly Kit
J–23456	Clutch Spring Compressor Press
J–36850-A	Transmission Assembly Lubricant
J–6125-1B	Slide Hammer
J–8059	Parallel Jaw Snap Ring Pliers

Wheels, Tires and CTIS

Tool No.	Description
J–39544-18A	Torque Stick (7/8" x 120 lb-ft)

Steering

Tool No.	Description
J–24319-B	Universal Steering Linkage Puller
J–25033-C	Pump Pulley Installer
J–25034-C	Pump Pulley Remover

Brakes

Tool No.	Description
J–29532-A	Diaphragm Brake Bleeder

Axles/Suspension and Frame

Tool No.	Description
J–21465-13	Driver Handle Extension
J–23409	Dial Indicator Extension
J–26900-13	Magnetic Indicator Base
J–39570	Chassis Ear
J–8001	Dial Indicator Set

Body

Tool No.	Description
J–25070	Heat Gun
J–34940	Heavy Duty Rivet Gun

Electrical

Tool No.	Description
J–25300-D	Headlight Aimer
J–39916-A	CD and Cassette Audio Diagnostic Kit

Section 1
General Information, Lubrication and Maintenance

TABLE OF CONTENTS

Abbreviations 1-15
Carbon Monoxide 1-2
Customer Assistance HUMMER H1 Service Hotline 1-3
Fluid Capacities 1-14
Identification Numbers
- Engine Identification Number 1-8
- Transfer Case Identification Number 1-7
- Transmission Identification Number 1-6
- Vehicle Identification Number
  - Decoding Chart 1-9
- Vehicle Identification Number (VIN) 1-8

Information Labels
- Emission Control Information Label 1-4
- EPA Noise Emission Label 1-7
- Safety Certification Label 1-5

Jump Starting 1-24
Keys 1-20
Lubrication and Maintenance Items 1-31
Maintenance Items
- Serpentine Belt 1-40
- Wheels/Tires/CTIS 1-40

Maintenance Schedule 1-26
Metric System and Equivalents 1-19
Paint and Trim Colors 1-20
Safety Summary 1-2
Specifications
- Bolt Identification and Torque Limits (Wet and Dry) 1-17
- Cooling System 1-11
- Cylinders 1-10
- Fluid Capacities 1-14
- Fuel/Air System 1-10
- Generator 1-11
- Governed Speed 1-10
- Lubricating System 1-10
- Starter 1-11
- Vehicle Dimensions 1-15
- Vehicle Weights 1-14

Towing
- Cautions 1-21
- Conventional Towing Procedures 1-22
- Hoisting the Vehicle 1-21
- Recommendations 1-21
- Recreational 1-24
- Vehicle Lifting/Jacking Points 1-20
- When Keys Are Not Available 1-24

Towing, Lifting, Jump Starting 1-20
Transfer Case Identification Number 1-7
Transmission Identification 1-6
Vehicle Identification Number (VIN) 1-8

SAFETY SUMMARY

Individuals who decide to perform their own repairs should have proper training and limit repairs to components which will not affect the safety of the vehicle or its occupants.

When replacement parts are required, it is strongly recommended that they are purchased through an authorized HUMMER dealer. It is essential that replacement parts meet or exceed manufacturer's specifications. Vehicle performance and personal safety may be impaired if other than original factory components are installed.

The installation of nonapproved accessories or conversions is not recommended as they could affect the vehicle's driving characteristics and personal safety. AM General LLC will not be liable for personal injury or damage to property resulting from the installation of nonapproved accessories or conversions to the HUMMER H1.

Following the safety precautions as prescribed throughout this manual may greatly reduce the risks of personal injury and damage to the vehicle. However, it is unlikely that AM General LLC will account for all possibilities.

Warnings, cautions, and notes are used throughout this service manual to assist service personnel in the performance of maintenance actions. These statements are designed as reminders for trained and experienced service personnel.

WARNINGS — Indicate potential safety hazards and must be followed to avoid personal injury. Warnings appear as follows:

> ***WARNING: To avoid injury, do not remove surge tank filler cap before depressurizing cooling system when engine temperature is above 190° F (88° C).***

CAUTIONS — Indicate potential equipment damage, and must be followed to avoid damage to components or systems. An example of a caution is shown below:

> **CAUTION:** To avoid starter damage, do not operate starter continuously for more than 15 seconds. Wait 10 to 15 seconds between periods of operation.

NOTES — Indicate methods or actions that may simplify vehicle maintenance or help maintain vehicle performance. An example of a note is shown below:

> **NOTE:** Clean all components, examine for wear or damage, and replace if necessary.

CARBON MONOXIDE

WARNING: Engine exhaust and a wide variety of automobile components and parts, including components found interior furnishings in a vehicle, contain or emit chemicals known to the State of California to cause cancer and birth defects and reproductive harm. In addition, certain fluids contained in vehicles and certain products of component wear contain or emit chemicals known to the State of California to cause cancer and birth defects or other reproductive harm.

WARNING: Brain damage or death can result from heavy exposure to carbon monoxide. The following precautions must be followed to ensure personal safety.

1. Do not operate vehicle engine in enclosed areas. Do not idle the vehicle engine with vehicle windows closed. Be alert at all times for exhaust odors. Be alert for exhaust poisoning symptoms. They are:
   - Headache
   - Dizziness
   - Sleepiness
   - Loss of muscular control

2. If you see another person with exhaust poisoning symptoms:
   - Remove person from area
   - Expose to open air
   - Keep person warm
   - Do not permit physical exercise
   - Administer artificial respiration, if necessary
   - Notify medical personnel

THE BEST DEFENSE AGAINST EXHAUST POISONING IS ADEQUATE VENTILATION.

This service manual contains instructions for maintaining the 2006 commercial HUMMER H1. Spend some time looking through this manual. Features to improve the usefulness of this manual and increase your efficiency are:

Accessing Information - These include: tabulated sections for quick reference, extensive troubleshooting guides for specific systems, and step-by-step directions for service repairs.

Illustrations - A variety of methods are used to make locating and repairing components easy. Locator illustrations, exploded views, and cut-away diagrams make the information in this manual easy to understand.

The service manual is the best source available for providing information and data critical to vehicle operation and maintenance. In this manual you will find the following information:

- Safety Summary
- General Information
- General Service Procedures
- Detailed Service Procedures
- Torque Ranges
- Wiring Diagrams and Schematics

HUMMER H1 owners and dealership service personnel can submit service manual suggestions and comments in writing to:

AM General
Commercial Publications Department
408 S. Byrkit St.
P.O. Box 728
Mishawaka, IN 46546-0728

Forms are furnished at the end of this manual.

Service Manual Revisions

In order to receive future revisions to this service manual, please write to:

AM General
Service Parts Logistics Operations
Commercial Publications/Customer Service
408 South Byrkit Avenue
P.O. Box 728
Mishawaka, Indiana 46546-0728

Be sure to specify publication number.

HUMMER H1 SERVICE HOTLINE

On occasion, an unusual service problem can arise that is not covered in the manual. For this reason, AM General has established a service hotline for dealership assistance. The hotline number is: **1-800-638-8303**

Transfer Case Hotline

If you have questions that are not answered in Section 5 of this Service Manual, you can call the Transfer Case Hotline at **1-800-945-4327** (in the U.S.) for more information. International and Canadian customers and dealers should call**1-315-432-4110**.

EMISSION CONTROL INFORMATION LABEL

The vehicle emission control label contains engine information such as curb idle rpm, engine displacement, catalytic converter type, fuel rate, and vacuum hose routing.

This label is affixed to the air cleaner housing (Figure-1-1).

The California Air Resources Board (CARB) label (Figure-1-2) is also affixed to the air cleaner housing and certifies that the vehicle conforms to EPA and California emission standards.

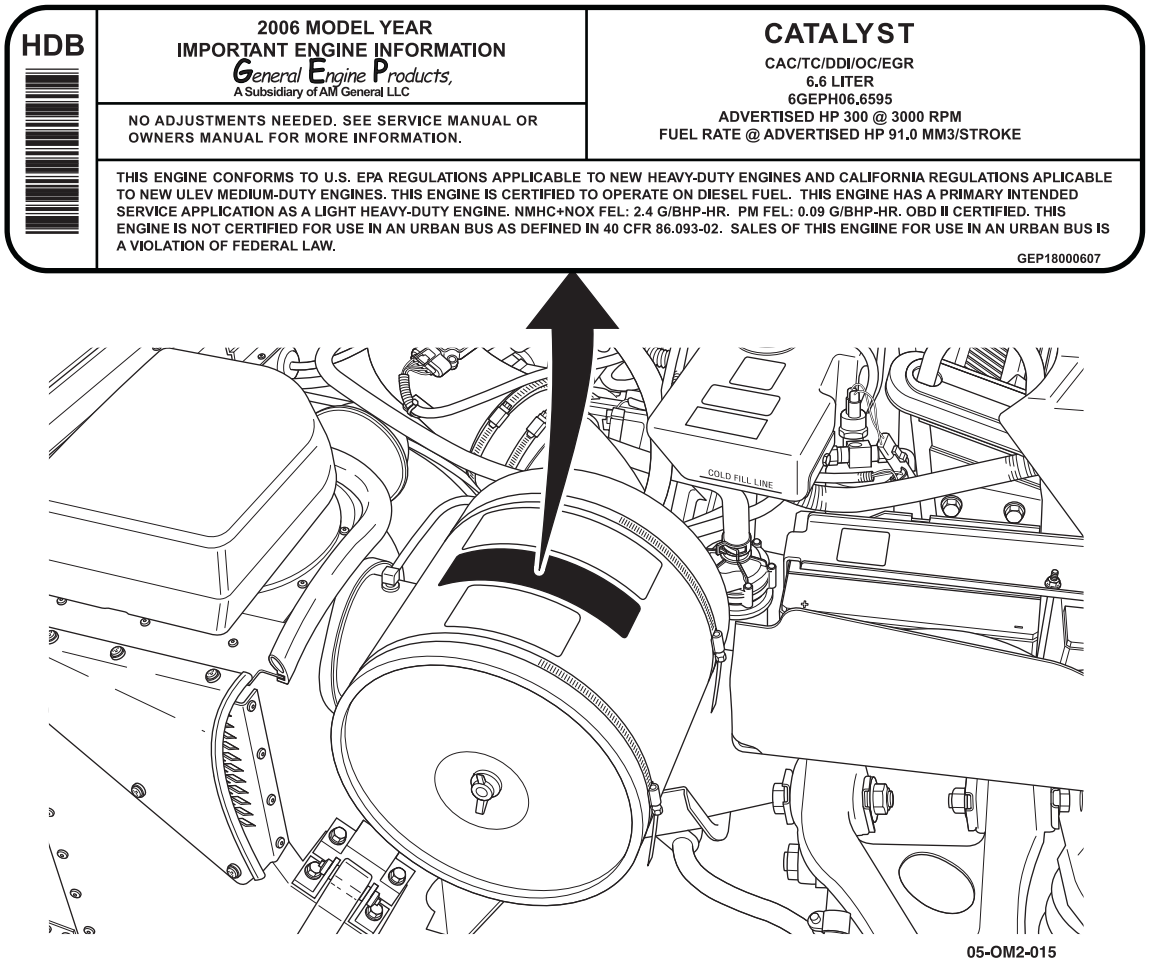


Figure 1-1: Emission Control Information Label

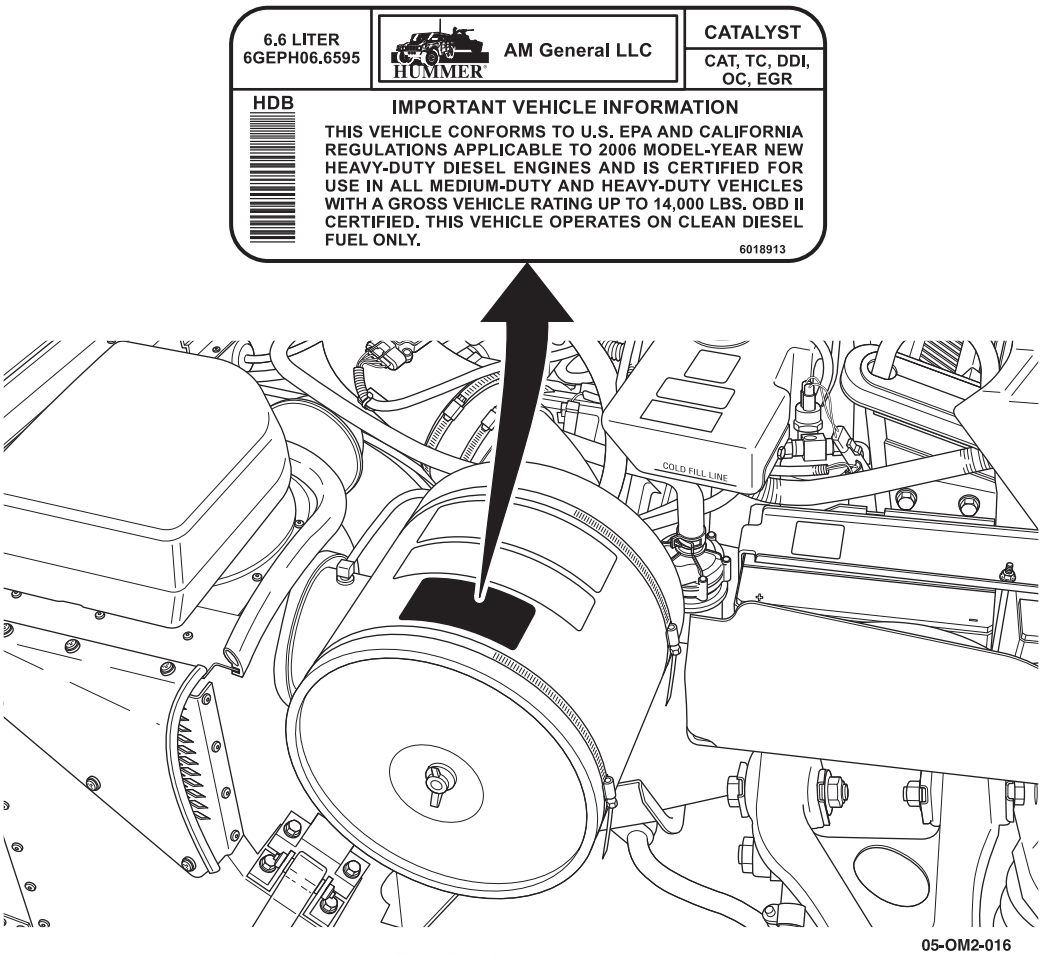


Figure 1-2: California Air Resources Board Label

SAFETY CERTIFICATION LABEL

The safety certification label is located on the driver side B- pillar (door latch post) (Figures 1-3, and 1-4). The label is required by the National Highway Traffic Safety Administration and includes a tamper-proof feature. If the label is tampered with, a void pattern will appear across the label.

The label contains the name of the manufacturer, the month and year the vehicle was manufactured, the certification statement, the vehicle identification number (VIN), and the vehicle model type. It also contains the Gross Vehicle Weight Rating (GVWR), Gross Axle Weight Ratings (GAWR), and wheel and tire information. For more information on the GVWR and GAWR, refer to "VEHICLE LOADING INFORMATION" in the HUMMER H1 Owner's Manual.

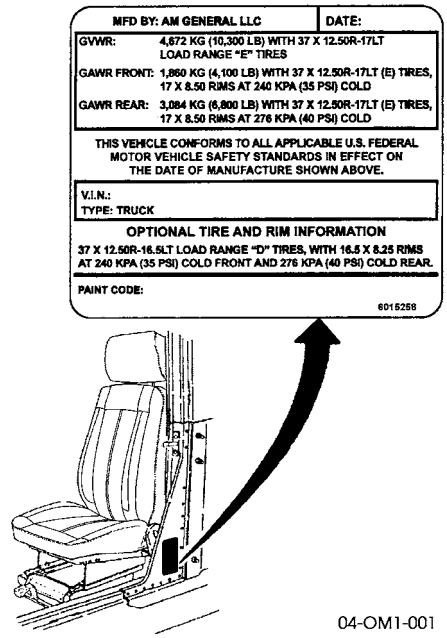


Figure 1-3: Safety Certification Label

TRANSMISSION IDENTIFICATION

An I.D. plate is attached to the passenger side of each Allison Transmission (Figure-1-4). The plate contains the model, date of manufacture, serial number, engineering feature configuration, transmission identification, and the engineering group.

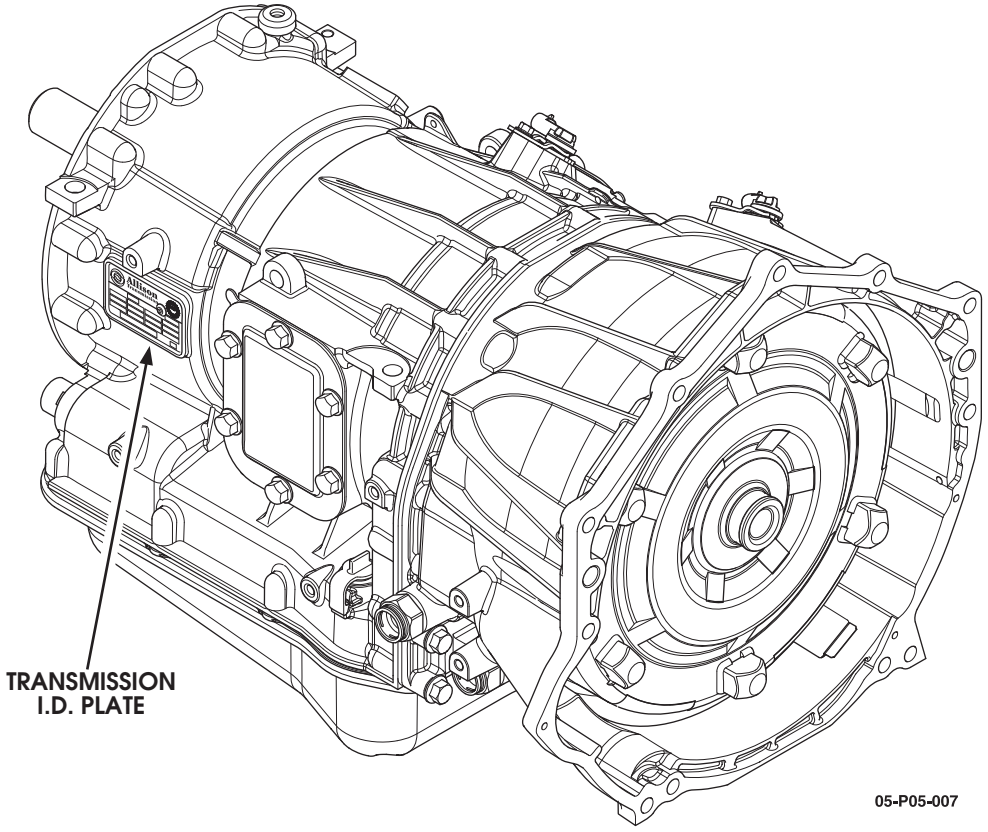


Figure 1-4: Transmission I.D. Plate Location

EPA NOISE EMISSION CONTROL INFORMATION LABEL

The EPA noise emission control information label is located on the passenger side B-pillar (door latch post). The label is required by the EPA and includes a tamper-proof feature. If the label is tampered with, a void pattern will appear across the label. Notify the dealer or the manufacturer if the label is missing or displays a void pattern (Figure-1-5).

The label contains the name of the manufacturer, the month and year the vehicle was manufactured, a statement regarding vehicle conformance to applicable U.S. EPA regulations, and a description of acts prohibited by the Noise Control Act of 1972.

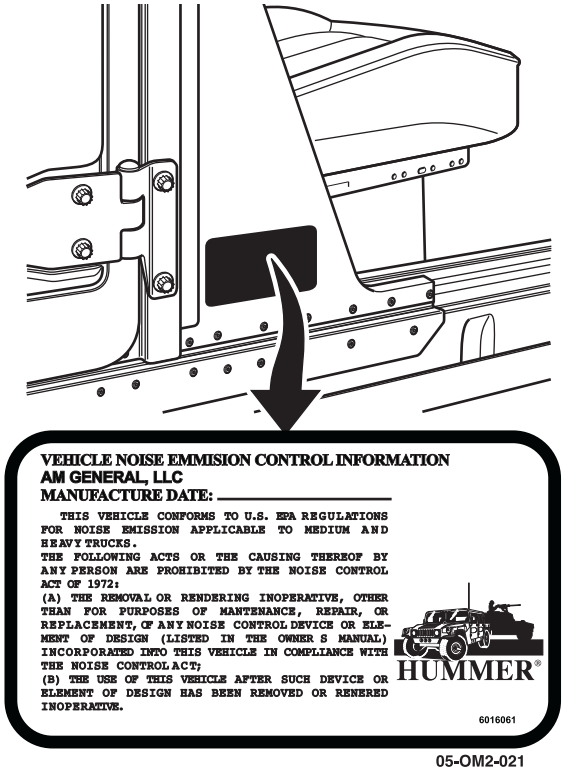


Figure 1-5: EPA Noise Emission Control Information Label Location

TRANSFER CASE IDENTIFICATION

The transfer case serial and assembly numbers are located on a tag attached to the rear case (Figure-1-6).

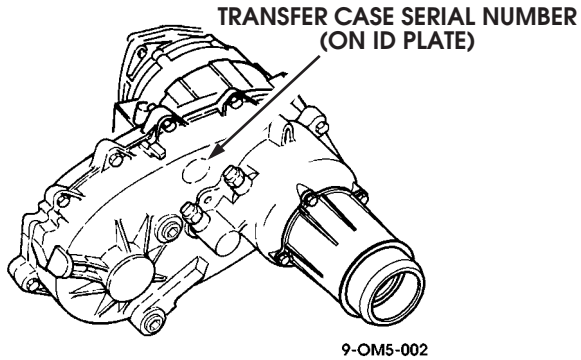


Figure 1-6: Transfer Case I.D. Plate Location

ENGINE IDENTIFICATION

The engine serial number label is located at the rear of the left cylinder head (Figure-1-7).

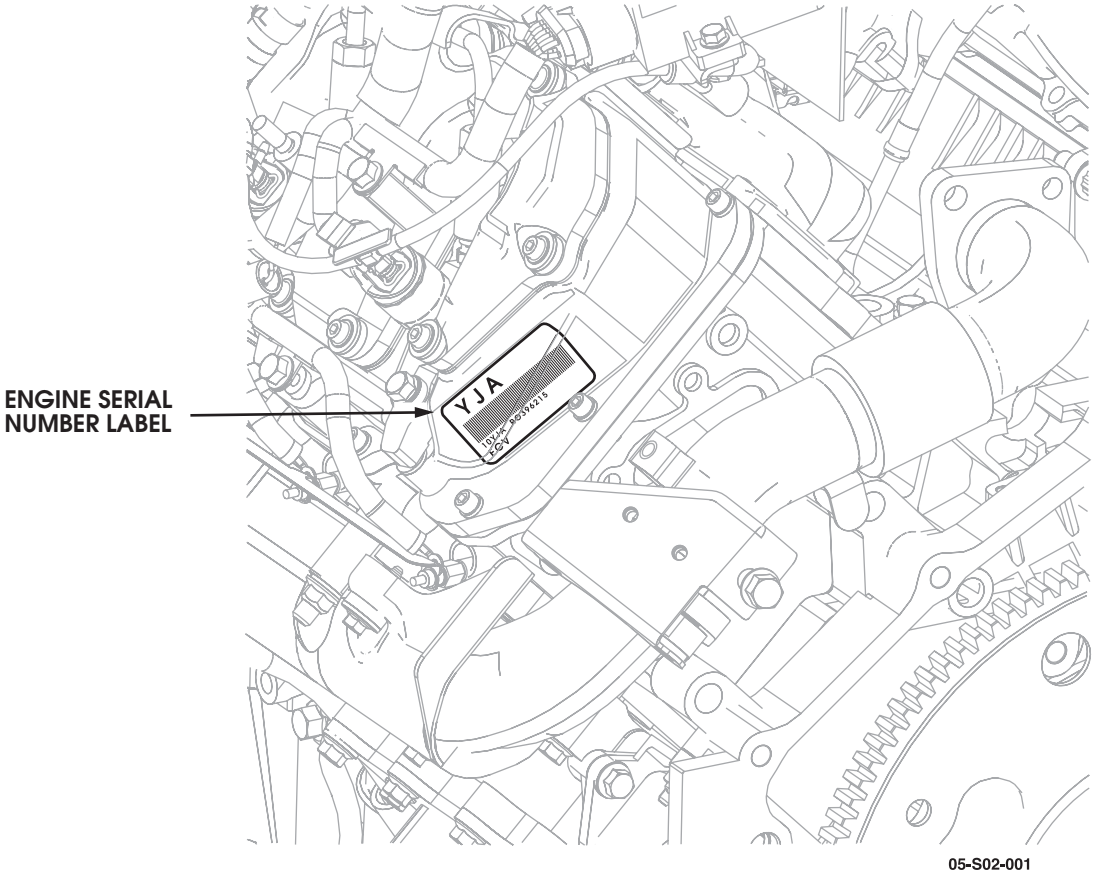


Figure 1-7: Engine I.D. Label Location

VEHICLE IDENTIFICATION NUMBER (VIN)

The VIN plate is located on the driver's side A-pillar. (Figure-1-8).

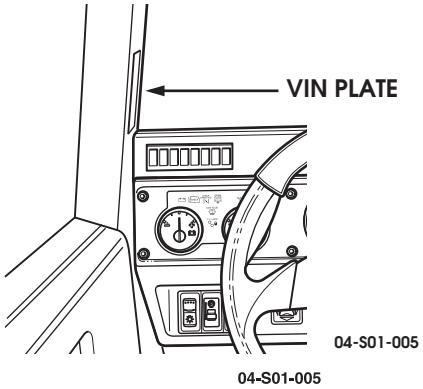
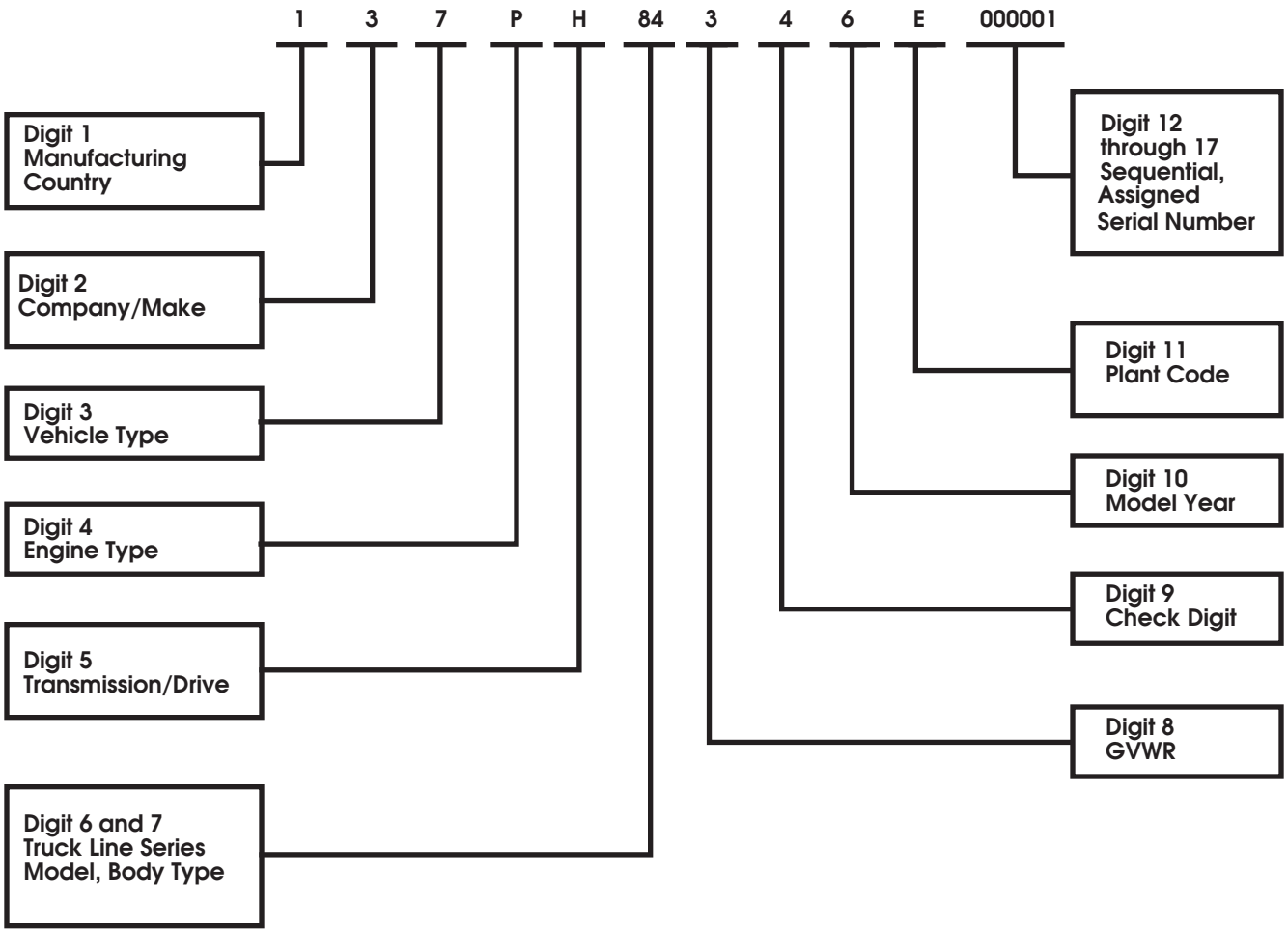


Figure 1-8: VIN Plate Location

The first twelve digits of the seventeen digit VIN are explained in the chart on the following page.



Vehicle Identification Number Decoding Chart

Digit	Code	Code Definition		
1	1	United States		
2	3	AM General LLC		
3	7	Commercial Vehicles		
4	P	6.6L Turbocharged Diesel, GM-Isuzu, 8 cyl., 300 hp		
5	H	5-Speed, Automatic/LHD		
6 & 7	84	1-1/4 ton	Station wagon	Truck, utility - HMDS
	90	1-1/4 ton	Open body w/full hard doors	Truck, utility - HMDO
8	3	Class 3, 10,001 lb - 14,000 lb (4,541 kg - 6,356 kg)		
9	—	Check Digit		
10	6	2006		
11	E	Mishawaka, Indiana		
12-17	—	Sequential Serial Number		

COMPONENT DATA

Engine:)

Manufacturer:	Duramax Inc (GM/ Isuzu)
Model:	6.6 L Turbo Diesel
Type:	Four Cycle, Turbocharged Diesel, with cooled EGR
Configuration:	V8
Turbo Charging:	Variable Nozzel Turbo Charger with Intercooling
Exhaust:	Exhaust Gas Recirculation with Intercooling
Power Output:	300 hp @ 3000 rpm/520 ft lb. Torque @ 1600 rpm
Fuel System:	Common Rail High Presure Direct Injection
Engine control:	Delphi Electronic Control Module
Throttle Control:	Electronic Potentiometer Throttle Pedal
Net Weight:	With fluids 880 lb (400 kg)

Governed Speed:

Full Load:	3,250 RPM
No Load:	3,400 RPM
Idle Speed:	650 RPM

Cylinders:

Number:	8
Arrangement:	90° V
Firing Order:	1-2-7-8-4-5-6-3 (Clockwise)
Bore:	4.055 in. (103. mm)
Stroke:	3.897 in. (9.9 cm)
Displacement:	395 cu. in. (6.6 L)
Compression Ratio:	17:1

Lubricating System:

Type:	Pressure Feed Gear Pump
Operating Pressure:	55 - 60 Psi @ 3250 RPM
(Idle Minimum):	14 psi
System Capacity:	
Crankcase only	10.5 qt
Filter Included	12.25 qt
Filter Capacity:	1.75 qt
Operating Temperature	
(Normal)	180°-250° F (82°-121° C)
Oil Pump	High Output
Filter	Paper Element, Spin On

Fuel System:

Fuel Injection Pump:	Bosch Common Rail
Fuel Filter:	Full Flow, paper element
Glow Plug Type	Fast Start

Starter:

Type:	Torque Reduction
Manufacturer:	Hitachi
Voltage:	12 V

Cooling System:

Type:	Liquid w/Fan and Radiator
Max Operating Temp:	250° F
Min Operating Temp:	-34° F
Filler Cap Pressure:	15 psi (103 kPa)
Radiator Type:	4 Row Core Downflow
Fan Type:	Fan with viscus drive, 23" diameter, Geared Fan Drive 1-1 ratio
Thermostat:	
Starts to Open:	190° F (88° C)
Fully Open:	212° F (100° C)

Generator:

Manufacturer: Delphi	
Output:	145 AMP
Rated Voltage:	13.2 -15.75 V

Batteries:

Manufacturer:	AC Delco
Type:	Low Maintenance
Number:	2
Voltage:	12 V
Amperage:	
@ 0° F	800 Cold Cranking amps Each Battery
32° F	1000 Cold Cranking amps Each Battery
80° F	110 Reserve Capacity (Minutes)

Transmission:

Manufacturer:	Allison Transmission
Mode:	M74 1000 Series
Type:	5-Speed, Automatic
Converter Torque Ratio:	2.0:1
Gear Ratios:	
First:	3.10:1
Second:	1.81:1
Third:	1.41:1
Fourth:	1.00:1
Fifth:	0.71:1
Reverse:	4.49:1
Oil Type:	Dexron® III
Oil Pressure:	130-300 psi

Transfer Case:

Manufacturer:	New Venture Gear
Model:	242
Type:	Full Time Four-Wheel Drive
Gear Ratios:	
High and High Lock:	1:1
Low Range:	2.72:1
Oil Type	Dexron® III

Geared Hub:

Manufacturer:	AM General design, made by Tremec
Type:	Helical Cut
Gear Ratio:	1.92:1
Oil Type:	SAE 80W-90

Axle/Differential:

Manufacturer:	AM General design, made by Dana
Type:	
Axle:	Fixed Mounted Differential W/ Independent Half Shafts
Differential:	Hypoid Torque Biasing (Paired Worm Gears) (Electronic Locking Optional)
Gear Ratio:	2.56:1

Service Brake Caliper (Front):

Manufacturer:	Kelsey-Hayes
Piston Diameter:	2.6 in. (6.6 cm)

Service/Parking Brake Caliper (Rear):

Manufacturer:	Kelsey-Hayes
Piston Diameter:	2.6 in. (6.6 cm)

Service/Parking Brake Rotor:

Manufacturer:	Kelsey-Hayes
Diameter:	12 in. (304.8 mm)
Thickness:	0.87 in. (22 mm)
Minimum Thickness:	0.81 in. (20.7 mm)

Steering System:

Steering Gear	
Manufacturer:	Sheppard
Type:	Recirculating Ball, Worm and Nut
Ratio:	18.3:1
Power Steering Pump	
Manufacturer:	Delphi
Output Pressure: (Max):	1,450
Flow Rate: (Max):	1.7 gpm

Reservoir:	Integral Pump Mounted Tank
Fluid Cooling:	Remote Cooler air to fluid

Frame:

Manufacturer:	AM General design, made by Dana
Type:	Welded Steel Box
No. of Crossmembers:	5

Air Conditioner:

Manufacturer (Compressor):	GM-Harrison
Model	HD-6
Field (Coil)	12 V
Oil Capacity (PAG)	
Main and Auxiliary	8 fl oz (237 ml)
Refrigerant	R-134a
Capacity (system + 2 oz. of oil)	
Main and Auxiliary	2lb 4oz (1.0 kg)

Winch:

Manufacturer	Warn
Model	12,000 lb., 12VDC HUMMER
Type	Electric Drive
Capacity	12,000 lb (5,448 kg)

Wheels and Tires:

Manufacturer	Goodyear Tire Size 37 in. X 12.5R-17
Wheel Type:	
Standard	One-Piece Aluminum
Size	17 x 8.25 in.
Off-Road Adventure Package Option	Two-Piece Aluminum
Size	17 x 8.25 in.

FLUID CAPACITIES

Cooling System	33 qt (31.2 L)
Engine:	
Crankcase (oil pan) only	10.5 qt (9.9 L)
Crankcase and Filter	12.25 qt (11.6 L)
Fuel Tank	27 gal. (102.1 L)
Auxiliary Fuel Tank	24.5gal. (92.7 L)
Axle (front/rear)	2 qt (1.9 L)
Transmission:	
Drain and Refill:	(with Pan Removed) 8.2 qt (7.7 L)
W/Dry Converter:	14 qt (13.3 L)
Transfer Case:	2.5 qt (2.4 L)
Geared Hub:	1 pt (0.47 L)
Steering System	1.75 qt (1.66 L)
Brake Hydraulic System:	(DOT 3)
Master Cylinder:	1.64 pt (0.78 L)
Total System:	3.12 pt. (1.5 L)
Windshield Washer	
Reservoir:	2.5 gal. (9.5 L)
Geared Fan Drive	1.2 pt. (0.6 L)

VEHICLE WEIGHTS

Curb Weight*:	
Four Door Open Top (w/ full doors) (HMDO)	7,847 lb (3,563 kg)
Four-Door Station Wagon (HMDS)	8,114 lb (3,684 kg)
Payload*:	
Four-Door Open Top (w/ full doors) (HMDO)	2,453 lb (1,114 kg)
Four-Door Station Wagon (HMDS)	2,186 lb (992 kg)
Gross Vehicle Weight (GVW)	10,300 lb (4,676 kg)
Gross Axle Weight Rating (GAWR):	
Front	4,100 lb (1,861 kg)
Rear	6,800 lb (3,087 kg)
Gross Combination Weight (GCW)	17,300 lb (7,854 kg)
Maximum Towed Load**:	
Foor-Door Open Top (w/full doors)	9,303 lb (4,224 kg)
Four-Door Station Wagon (HMDS)	9,036 lb (4,102 kg)

*For vehicles equipped with a winch, increase curb weight and reduce payload by 137 lbs (62 kg).

**Maximum trailer ratings are calculated assuming a base vehicle, except for any option(s) necessary to achieve the rating, plus driver (rating is calculated assuming a 150 lb. driver). The weight of other optional equipment, passengers and cargo will reduce the maximum trailer weight the vehicle can tow.

VEHICLE DIMENSIONS

Length:	184.5 in. (468.6 cm) See Note
Height:	77 in. (195.5 cm)
Width (without mirrors):	86.50 in. (219.7 cm)
Ground Clearance:	16 in. (41 cm) (at GVW)
Wheelbase:	130 in (330 cm)
Track Width:	72 in. (183 m)

NOTE: The vehicle weight and dimensions data applies to models without a winch.

ABBREVIATIONS

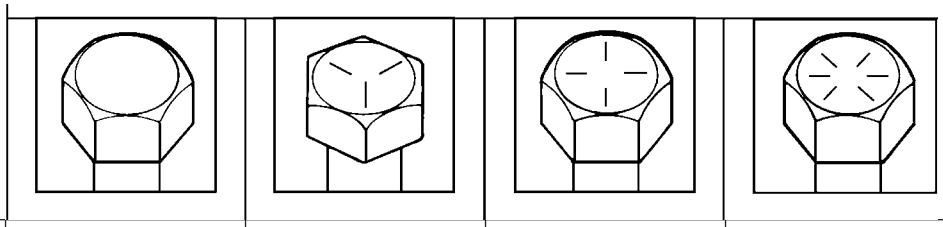
ABS	Antilock Brake System
A/C	Air Conditioning
a.c	Alternating Current
AMP	Ampere
CO	Carbon Monoxide
C	Celsius (centigrade)
cm	Centimeter
CTIS	Central Tire Inflation System
CDR	Crankcase Depression Regulator
cm^3	Cubic Centimeter
$in.^3$	Cubic Inch
cyl	Cylinder
°	Degree (angle or temperature)
DTC	Diagnostic Trouble Code
dia	Diameter
d.c.	Direct Current
EPA	Environmental Protection Agency
F	Fahrenheit
ft	Feet
ft/min	Feet Per Minute
fl oz	Fluid Ounce
gal	Gallon
g	Gram
GAWR	Gross Axle Weight Rating
GVW	Gross Vehicle Weight
GVWR	Gross Vehicle Weight Rating
hp	Horsepower
HVAC	Heat, Ventilation, and Air Conditioning
in	Inch
INC	Include
ID	Identification
I.D	Internal Diameter
kg	Kilograms
km	Kilometer
km/h	Kilometers Per Hour
kPa	Kilopascals

lh	Left Hand
L	Liter
max	Maximum
m	Meter
mpg	Miles Per Gallon
mph	Miles Per Hour
mm	Millimeter
min	Minimum
–	Minus
–	Negative
No	Number
Ohm	Ohms
oz	Ounce
O.D	Outside Diameter
P/N	Part Number
%	Percentage
pt	Pint
+	Plus
+	Positive
lb	Pound
lb-ft	Pound-feet
lb-in	Pound-inch
psi	Pounds Per Square Inch
qt	Quart
:	Ratio
ref.	Reference
RPM	Revolutions Per Minute
rh	Right-Hand
cm^2	Square Centimeters
in^2	Square Inches
TT4	Torque Trac 4
VIN	Vehicle Identification Number
V	Volts
W	Watts
UNC	Unified Coarse
UNF	Unified Fine

BOLT IDENTIFICATION AND TORQUE LIMITS (DRY*)

* A phosphate and oil bolt is considered dry

Bolt Head ID Marks and SAE GRADE

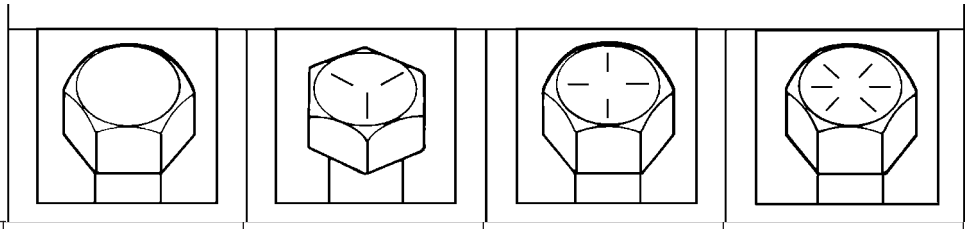


BOLT SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	5(7)	8(11)	10(14)	12(16)
1/4	6	28	6(8)	10(14)	——	14(19)
5/16	8	18	11(15)	17(23)	19(26)	24(33)
5/16	8	24	13(18)	19(26)	——	27(37)
3/8	10	16	18(24)	31(42)	34(46)	44(60)
3/8	10	24	20(27)	35(47)	——	49(66)
7/16	11	14	28(38)	49(66)	55(75)	70(95)
7/16	11	20	30(41)	55(75)	——	78(106)
1/2	13	13	39(53)	75(102)	85(115)	105(142)
1/2	13	20	41(56)	85(115)	——	120(163)
9/16	14	12	51(69)	110(149)	120(163)	155(210)
9/16	14	18	55(75)	120(163)	——	170(231)
5/8	16	11	63(85)	150(203)	167(226)	210(285)
5/8	16	18	95(129)	170(231)	——	240(325)
3/4	19	10	105(142)	270(366)	280(380)	375(509)
3/4	19	16	115(156)	295(400)	——	420(570)
7/8	22	9	160(217)	395(536)	440(597)	605(820)
7/8	22	14	175(237)	435(590)	——	675(915)
1	25	8	235(319)	590(800)	660(895)	910(1234)
1	25	14	250(339)	660(895)	——	990(1342)
1-1/8	29	—	——	800 - 880 (1085 - 1193)	——	1280 - 1440 (1736 - 1953)
1-1/4	32	—	——	—	——	1820 - 2000 (2468 - 2712)
1-3/8	35	—	——	1460 - 1680 (1980 - 2278)	——	2380 - 2720 (3227 - 3688)
1-1/2	38	—	——	1940 - 2200 (2631 - 2983)	——	3160 - 3560 (4285 - 4827)

Bolt Identification and Torque Limits (Wet*)

*A cadmium plated bolt is considered wet.

Bolt Head ID Marks and SAE Grade



BOLT SIZE			SAE GRADE NO. 1 OR 2	SAE GRADE NO. 5	SAE GRADE NO. 6 OR 7	SAE GRADE NO. 8
DIA. INCHES	MILLI-METERS	THREADS PER INCH	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)	POUND FEET (NEWTON-METERS)
1/4	6	20	4(5)	7(10)	9(12)	11(15)
1/4	6	28	5(7)	9(12)	——	13(17)
5/16	8	18	10(14)	15(20)	17(23)	22(30)
5/16	8	24	12(16)	17(23)	——	24(33)
3/8	10	16	16(22)	28(38)	31(42)	40(54)
3/8	10	24	18(24)	32(43)	——	44(60)
7/16	11	14	25(34)	44(60)	50(68)	63(85)
7/16	11	20	27(37)	50(68)	——	70(95)
1/2	13	13	35(48)	68(92)	77(104)	95(129)
1/2	13	20	37(50)	77(104)	——	108(146)
9/16	14	12	46(62)	99(134)	108(146)	140(190)
9/16	14	18	50(67)	108(146)	——	153(207)
5/8	16	11	57(77)	135(183)	150(203)	189(256)
5/8	16	18	85(115)	153(207)	——	216(293)
3/4	19	10	95(129)	243(330)	252(342)	338(458)
3/4	19	16	104(141)	266(361)	——	378(513)
7/8	22	9	144(195)	356(483)	396(537)	545(739)
7/8	22	14	158(214)	392(532)	——	608(824)
1	25	8	212(287)	531(720)	594(805)	819(1111)
1	25	14	225(305)	594(805)	——	891(1208)
1-1/8	29	—	——	720 - 792 (976 - 1074)	——	1152 - 1296 (1562 - 1757)
1-1/4	32	—	——	——	——	1638 - 1800 (2221 - 2441)
1-3/8	35	—	——	1314 - 1512 (1782 - 2050)	——	——
1-1/2	39	—	——	1746 - 1980 (2368 - 2685)	——	2844 - 3204 (3857 - 4345)

U.S./METRIC CONVERSIONS AND EQUIVALENTS

Metric Conversions

MULTIPLY	BY	TO GET
INCHES	2.54	CENTIMETERS
FEET	0.3048	METERS
MILES	1.6093	KILOMETERS
SQUARE INCHES	6.451	SQUARE CENTIMETERS
CUBIC INCHES	16.39	CUBIC CENTIMETERS
FLUID OUNCES	29.573	MILLILITERS
PINTS	0.473	LITERS
QUARTS	0.946	LITERS
GALLON	3.785	LITERS
POUNDS	0.454	KILOGRAMS
SHORT TONS	0.907	METRIC TONS
POUND-INCHES	0.113	NEWTON-METERS
POUND-FEET	1.356	NEWTON-METERS
POUNDS PER SQUARE INCH	6.895	KILOPASCALS
MILES PER GALLON	0.425	KILOMETERS PER LITER
MILES PER HOUR	1.609	KILOMETERS PER HOUR

U.S. Standard Conversions

MULTIPLY	BY	TO GET
MILLIMETERS	0.03937	INCHES
CENTIMETERS	0.3937	INCHES
METERS	3.2808	FEET
KILOMETERS	0.6214	MILES
SQUARE CENTIMETERS	0.155	SQUARE INCHES
CUBIC CENTIMETERS	0.061	CUBIC INCHES
MILLILITERS	0.034	FLUID OUNCES
LITERS	2.113	PINTS
LITERS	1.057	QUARTS
LITERS	0.264	GALLONS
KILOGRAMS	2.205	POUNDS
METRIC TONS	1.102	SHORT TONS
NEWTON-METERS	0.738	POUND-FEET
NEWTON-METERS	8.851	POUND-INCHES
KILOPASCALS	0.145	POUNDS PER SQUARE INCH
KILOMETERS PER LITER	2.352	MILES PER GALLON
KILOMETERS PER HOUR	0.621	MILES PER HOUR

Temperature

32° FAHRENHEIT = 0° CELSIUS 212° FAHRENHEIT = 100° CELSIUS

CELSIUS = 0.556 X (F° -32) FAHRENHEIT = (1.8 X C°) +32

PAINT AND TRIM COLORS

Interior trim colors are tan and gray. Seating materials are available in cloth, vinyl and leather.

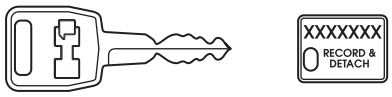
Soft top colors and codes are: Tan (T) and Black (B).

Exterior paint colors and codes are outlined in the following chart.

Top Coat Description	AM General Code
Black Gloss	B25
Bright White	W26
Competition Yellow	Y27
Firehouse Red	R28
Metallic Black	B34
Metallic Diamond Black	B30
Metallic Pewter	P33
Metallic Sand	T32
Summit Silver	S31

REPLACEMENT KEYS

Replacement keys can be cut using Briggs and Stratton or Curtis key cutting tools. Key codes are provided on an identificaion tag included with each key set (Figure-1-9).



03-OM2-005

Figure 1-9: Key Code Location

TOWING, LIFTING, JUMP STARTING

Vehicle Lifting/Jacking Points

Vehicle jacking points are shown in Figure 1-10. The vehicle can be raised with a floor jack at any of the indicated positions. Jacking can be performed at the front, rear, or at any one wheel.

In cases where the entire vehicle must be raised, use jack stands at equidistant points on the frame rails. Use a minimum of four stands to support the vehicle. Suggested capacity for individual jack stands is 3 ton, with a vertical reach of 19 in. (49 cm).

Typical jack stand placement for raising one side of the vehicle is shown in Figure 1-11. Always be sure the jack stand saddle is securely engaged and the stand is level.

Vehicle Hoisting

HUMMER H1 vehicles can be raised on a hoist for service access. Drive-on and swivel arm hoists are both acceptable. Hoist capacity and width are important. The greater width and weight of HUMMER H1 vehicles require a larger hoisting platform. Do not use an under capacity hoist, or modify an existing hoist for use; this practice is neither safe nor recommended.

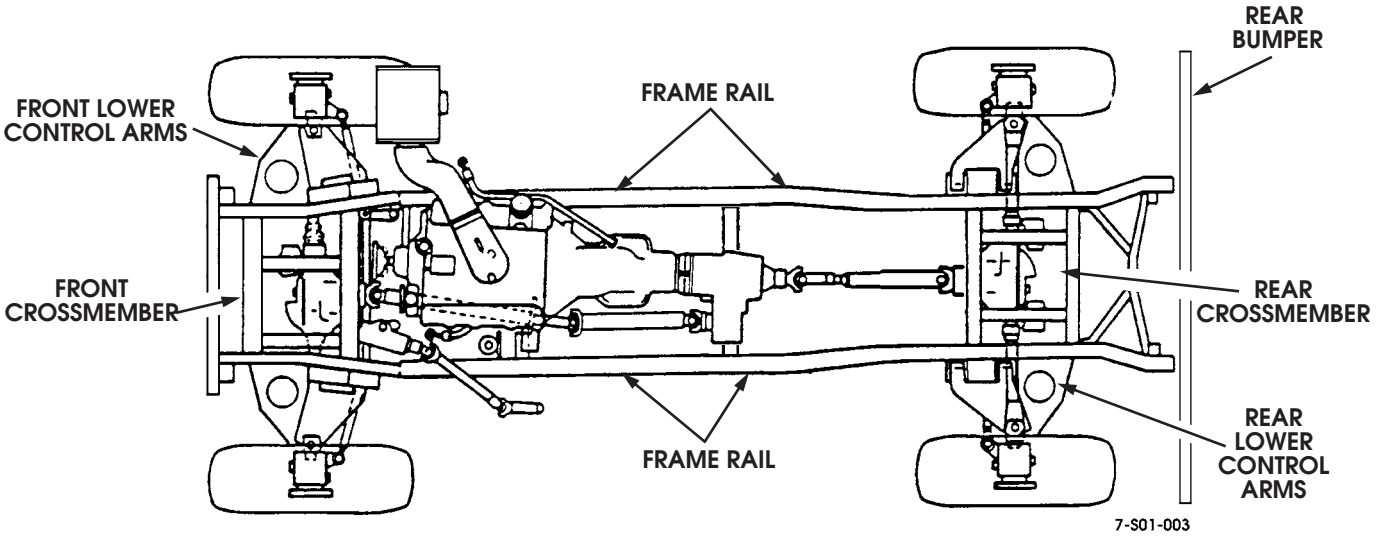


Figure 1-10: Vehicle Jacking Points

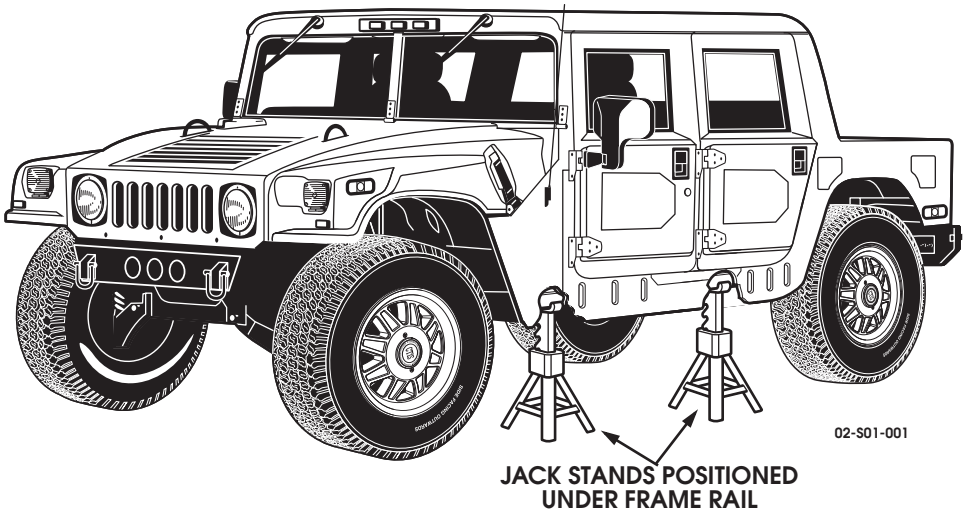


Figure 1-11: Typical Jack Stand Placement

Towing Recommendations

HUMMER H1 vehicles can be towed with wheel lift, sling-type, or flat bed tow equipment.

Flat bed and wheel lift equipment is recommended over sling type or A-frame equipment.

Towing Cautions:

- Remove or secure loads in the towed vehicle
- Never use the shackles on the front bumpers as tie down points
- Always use safety chains on sling towed vehicles
- Always follow the transmission/transfer case shift position recommendations (Transfer Case in N (Neutral); Transmission in P (Park).
- Use a low vehicle trailer for recreational towing (behind an RV or other vehicle) when possible.
- Never put chains, cables or straps on any steering components.

Flat Bed/Wheel Lift Towing Procedures

Flat bed/wheel lift tow vehicles are highly recommended. They keep all of the towed vehicle wheels off the pavement. This is important with full time four wheel drive vehicles.

Loading only requires that the towed vehicle be raised or winched onto the towing platform. A further advantage of this type equipment is that tow speed and distance are not limited. Once the towed vehicle is loaded, set the parking brake, shift the transmission into Park and install the vehicle tie downs. Tie down attachment points are shown in Figure 1-12.

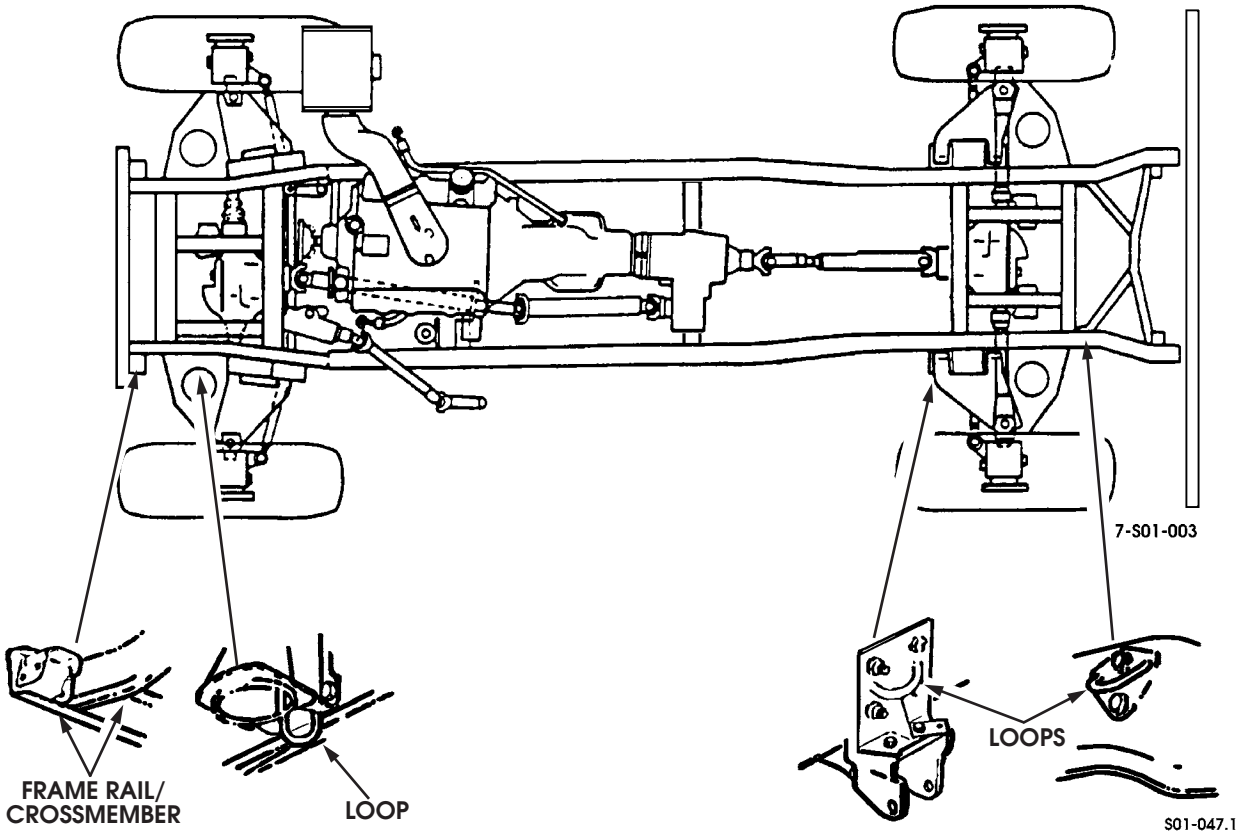


Figure 1-12: Vehicle Tie-Down Points

Conventional Towing Procedures

Front Towing

1. Loop chains around lower control arms and secure to tow sling (Figure-1-13).
2. Insert 4” x 4” x 48” length of wood between bumper and sling chains (Figure-1-13).
3. Raise front end and verify that sling is firmly positioned against front bumper.
4. Release parking brakes.
5. Shift transmission into Park and transfer case into Neutral.
6. Position tow dollies under rear wheels. Proceed with towing operations.

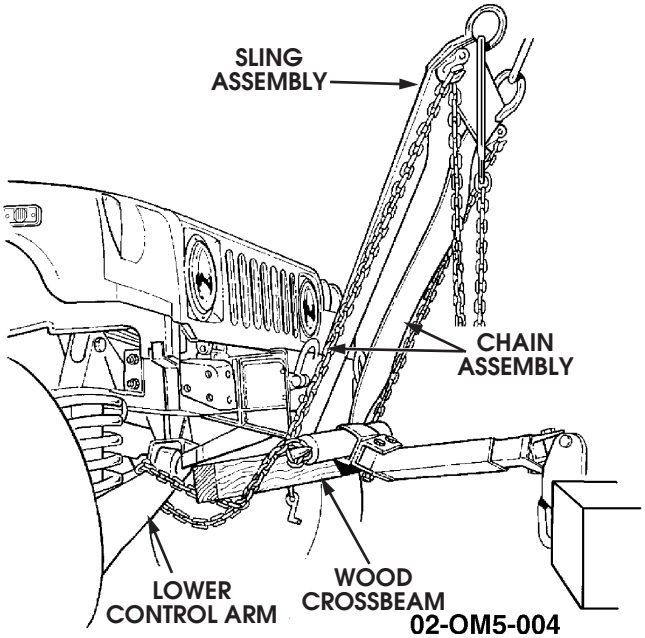


Figure 1-13: Front Towing With Conventional Equipment

Rear Towing

1. Loop sling chain around frame rails adjacent to rear crossmember and secure to tow sling (Figure-1-14).
2. Insert 4” x 4” x 48” length of wood between bumper and sling chains (Figure-1-14).
3. Raise rear end and verify that sling is firmly positioned against rear bumper.
4. Release parking brakes.
5. Shift transmission into Park and transfer case into Neutral.
6. Position tow dollies under front wheels. Proceed with towing operations.

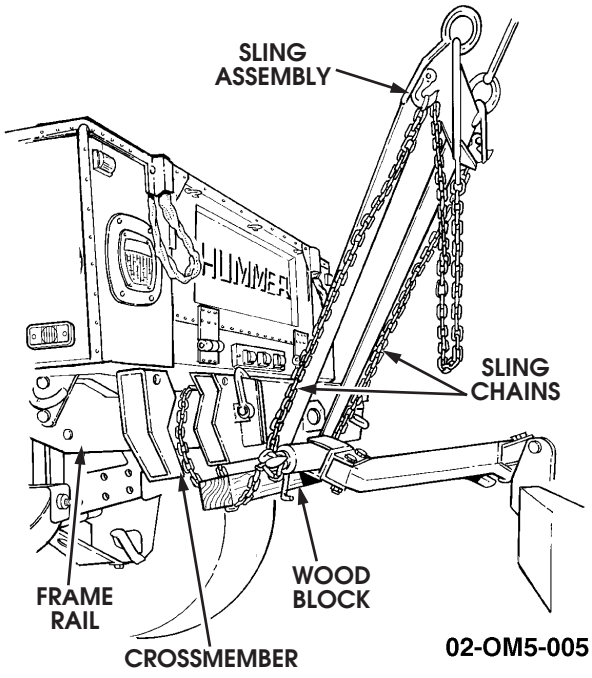


Figure 1-14: Rear Towing with Conventional Equipment

Conventional Towing When Keys are not Available

If the vehicle doors are locked and the keys are not available you cannot determine that the transmission is in Park and the transfer case is in "N" (Neutral). In these situations, you must use one of the following towing methods:

a. Use tow dollies at all wheels and flat tow,

or

b. Raise the vehicle front or rear and use tow dollies under the wheels not raised.

Recreational Towing

HUMMER H1 vehicles can be towed behind an RV if desired. A low-boy style vehicle trailer is best for this purpose. Flat towing is not recommended.

JUMP STARTING

Preparation for Jump Starting

CAUTION: NEVER allow the two vehicles to touch each other when jump starting.

1. Park the vehicle with the booster battery close to the passenger door of your vehicle. Ensure that the vehicles do not touch each other. Place the transmissions of both vehicles in "P" (Park), if applicable, and set all parking brakes.
2. Clean all battery terminals of excess corrosion before connecting jumper cables.

WARNING: ALWAYS remove ALL jewelry BEFORE handling batteries.

CAUTION: NEVER disconnect a vehicle's batteries to jump start.

3. Turn off all electrical switches in both vehicles to prevent possible electrical damage to either vehicle's electrical system.

Jumper Cable Connections

WARNING: NEVER lean over the batteries when connecting the jumper cables or allow the jumper cable clamps to touch each other.

1. Connect one end of the positive jumper cable to the positive (+) terminal on the dead battery. It is best to connect to the positive terminal of the battery closest to the windshield (Figure-1-15).

WARNING: ALWAYS make sure that the positive cable is hooked only to positive terminals and the negative to negative terminals or to a good ground.

2. Connect the other end of the positive cable to the positive (+) terminal on the booster battery.

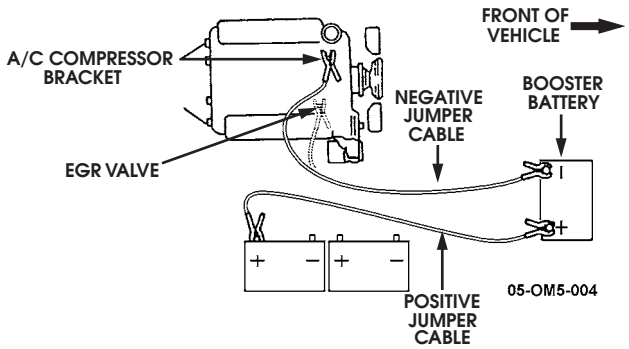


Figure 1-15: Jumper Cable Connections

3. Connect one end of the negative jumper cable to the negative (-) terminal on the booster battery.

WARNING: NEVER connect the other end of the negative jumper cable to the negative (-) terminal on the dead battery.

4. Start the booster vehicle.
5. Connect the other end of the negative cable to a good metallic ground surface on the engine of your vehicle. The best ground point is the A/C compressor bracket on the driver's side of the engine (Figure-1-16).

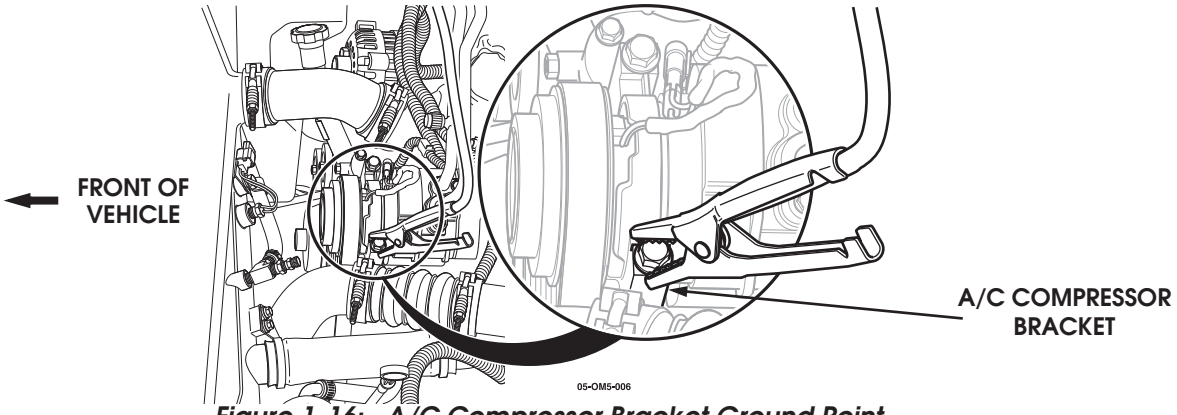


Figure 1-16: A/C Compressor Bracket Ground Point

An alternate ground point is the exhaust gas recirculation (EGR) valve on the passenger side of the engine (Figure-1-17).

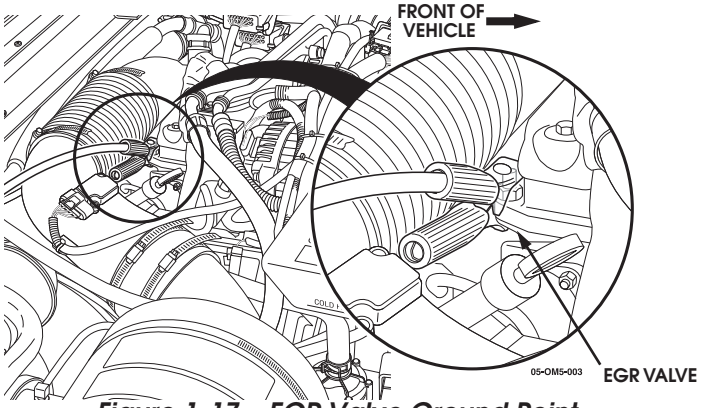


Figure 1-17: EGR Valve Ground Point

Starting the Vehicle

NOTE: Make sure the jumper cables are clear of any moving parts in the engine compartment.

1. With the booster vehicle running with a slightly increased engine speed, allow the dead battery to charge for a few minutes and then start your vehicle. It may take a few tries before your vehicle starts. If your vehicle does not start after cranking for fifteen seconds, stop the procedure. Cranking for more than fifteen seconds at a time seldom starts the engine and could cause damage.
2. Once your vehicle starts, disconnect jumper cables.
3. If the engine stalls, repeat above procedure once, allowing battery to charge for approximately ten minutes. If the engine stalls a second time, have the vehicle transported to an authorized service center.

NOTE: To ensure that the batteries are fully charged, have the batteries charged with proper battery charging equipment.

Disconnecting the Jumper Cables

WARNING: ALWAYS keep your hands away from moving parts in the engine compartment when disconnecting the jumper cables.

1. Remove the negative (-) cable connected to the engine of your vehicle.
2. Remove the other end of the negative (-) cable from the booster battery.

3. Remove the positive (+) cable from the booster battery.
4. Remove the other end of the positive (+) cable from the battery on your vehicle.

After starting, turn off any electrical accessories that were accidentally left on, and allow the engine to run at a high idle speed to recharge the batteries. For a “complete” charge, it may be necessary to use a battery charger to recharge the batteries.

MAINTENANCE SCHEDULE

Recommended Maintenance

Items described in Maintenance Inspection Groups A, B, and C are important to the proper operation, performance, and safety of your vehicle.

It is important that maintenance items outlined in the schedules be performed at suggested intervals. Regular maintenance will greatly improve vehicle reliability and longevity.

Normal Maintenance

The vehicle maintenance schedules reflect services required for normal operation. Normal operation includes city/highway driving on hard surface roads with only minimal operation on unpaved road surfaces.

Maintenance After Severe Operation

Severe operation includes extensive off-road driving, salt water fording, commercial use, sustained operation in high ambient temperatures, and trailer towing. This type of vehicle operation requires additional and more frequent service. If the vehicle is going to be used frequently in severe operating situations, maintenance should be done on an hourly rather than a mileage schedule, as shown in the Scheduled Maintenance Chart on page 1–27 . To keep track of the hours of severe operation, an optional hourmeter can be installed at your HUMMER dealer.

Commercial use involves regular operation as a delivery or service type vehicle. Severe off-road use involves extended operation on rough terrain, stream fording, salt water fording, or sustained operation in sand, mud, snow, or dirt surfaces. Severe operation also includes prolonged daily operation in heavy traffic when ambient temperatures are high.

The additional maintenance required immediately after severe off-road operation is as follows:

- Wash the vehicle underbody, driveline and brake components, and all steering linkage and suspension parts with a low pressure fresh water spray.
- If vehicle was driven over rough terrain, examine the underbody and driveline components for impact damage. Also check for leaks and loose parts.
- If the vehicle was driven through deep water, examine geared hub, axle and vent lines for water contamination. If the lines have become disconnected, these components may become water contaminated. Also inspect the axle and hub vents if required.
- Check the front/rear brake pads for contamination by dirt, mud, sand, etc. Replace the pads if foreign material has become embedded in the lining. However, if the pads are only wet from water, allow them to air dry, or drive the vehicle about a block with the brakes lightly applied to heat and dry the pads.
- Check transmission and transfer case fluid levels and condition. Drain and replace the fluid in either assembly if water contamination is evident. If water contamination proves extensive, it will also be necessary to replace the transmission fluid filter, and flush the transmission fluid cooler and lines.
- Lubricate the steering linkage, ball joints, propeller shaft, and body lubrication points.
- Check the brake and power steering fluid levels and top off as needed.
- Examine the engine air filter. Replace the filter element if necessary and clean the air filter housing and dust unloader.
- Change engine oil and replace engine oil filter.

Maintenance Inspection Groups A-B-C

The inspection groups outline additional components to be checked at stated mileage intervals. The intervals are described in your maintenance booklet. Perform necessary service repair, replacement, or adjustments as each inspection item is checked.

Maintenance Inspection Group A:

- Check fluid levels and condition for power steering pump, cooling system (reservoir and surge tank), brakes, transmission, transfer case, geared hubs, and axles.

- Inspect condition of control arms, springs, and shock absorbers.
- Check tire wear and condition.
- Lubricate all grease fittings and body lubrication points.
- Inspect geared hubs for leaking seals or damage.
- Inspect service brakes and parking brake.
- Check axles for leaks or damage.
- Check torque of wheel lug nuts.
- Inspect condition of geared hub and axle vent lines.
- Inspect condition of transmission and transfer case vent lines.
- Inspect U-joints for wear or missing/damaged grease fittings.
- Inspect condition of engine mounts and insulators.
- Inspect transmission/transfer case shift cables for wear, binding, distortion.
- Check fuel filter and drain/clean if necessary.
- Check CTIS operation. Verify that system inflates/deflates tires.
- Check winch operation and cable condition (if equipped). Free-spool out and pay-in at least 30 feet of cable.
- Check ball joints for wear.
- Test drive vehicle and complete a functional check of all systems.
- Check air cleaner.

Maintenance Inspection Group B:

- Inspect fuel injection pump, lines, and fittings for leaks or damage.
- Check battery voltage and condition.
- Inspect serpentine belt condition.
- Inspect exhaust system and shields.
- Inspect and rotate tires.
- Inspect halfshaft boots and ball joint seals.
- Inspect condition of steering column, U-joints, tie rods, steering arm, center link, and idler arm.
- Check fuel tank vent line filter.
- Inspect condition of frame rails and crossmembers.
- Check A/C system operation.
- Check wheel alignment.

Maintenance Inspection Group C:

- Inspect surge tank, radiator and shroud, A/C condenser, power steering and transmission coolers, charge air cooler, and all hoses and fittings for security of mounting, leaks, obstructions, or damage.
- Inspect fuel tank, lines, and cap.
- Inspect all wiring harnesses for frays, splits, missing insulation, poor connections.
- Inspect power steering pump, power steering gear, hoses, lines, and fittings for leaks or damage.

  NOTE: Clean all dirt from caps and surrounding areas before opening to check fluids.

SCHEDULED MAINTENANCE CHART

6,000 Miles (9,700 km) – 200 hrs normal use or 100 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

12,000 Miles (19,300 km) – 400 hrs normal use or 200 hrs severe operation

❒ Change engine oil and replace filter.



❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.

18,000 Miles (29,000 km) – 600 hrs normal use or 300 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

24,000 Miles (38,600 km) – 800 hrs normal use or 400 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Inspect brake fluid for moisture contamination.

30,000 Miles (48,300 km) – 1,000 hrs normal use or 500 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

36,000 Miles (58,000 km) – 1,200 hrs normal use or 600 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.

42,000 Miles (67,600 km) – 1,400 hrs normal use or 700 hrs severe operation

❒ Change engine oil and replace filter.
❒ Check items in Maintenance Groups A and B.

48,000 Miles (77,200 km) – 1,600 hrs normal use or 800 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filter.
❒ Replace fuel filter element.
❒ Change transmission and transfer case fluid.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Inspect brake fluid for moisture contamination.

54,000 Miles (86,900 km) - 1,800 hrs normal use or 900 hrs severe operation

❒ Change engine oil and replace filter.

❒ Check items in maintenance Groups A and B.

60,000 Miles (96,500 km) - 2,000 hrs normal use or 1,000 hrs severe operation

❒ Change engine oil and replace filter.
❒ Clean or replace air filters.
❒ Replace fuel filter element.
❒ Change engine coolant.
❒ Change transmission and transfer case fluid.
❒ Inspect fuel tank, fuel cap and fuel lines.
❒ Change transmission filter.
❒ Check items in Maintenance Groups A, B, and C.
❒ Change geared hub oil.
❒ Change axle oil.
❒ Drain & replace brake fluid.

NOTE: Some maintenance requires specialized knowledge or equipment and may be best handled by qualified service technicians at your nearest HUMMER dealer.

NOTE: After your vehicle has been driven for 66,000 miles (106,200 km) repeat the schedule indicated in this section, starting at 6,000 mi (9,700 km).

RECOMMENDED FUEL/FLUIDS/LUBRICANTS/CAPACITIES

Recommended Fuel

Recommended fuel for 6.6L diesel engines is #2 diesel. Do not use any other type fuel.

Engine Oil

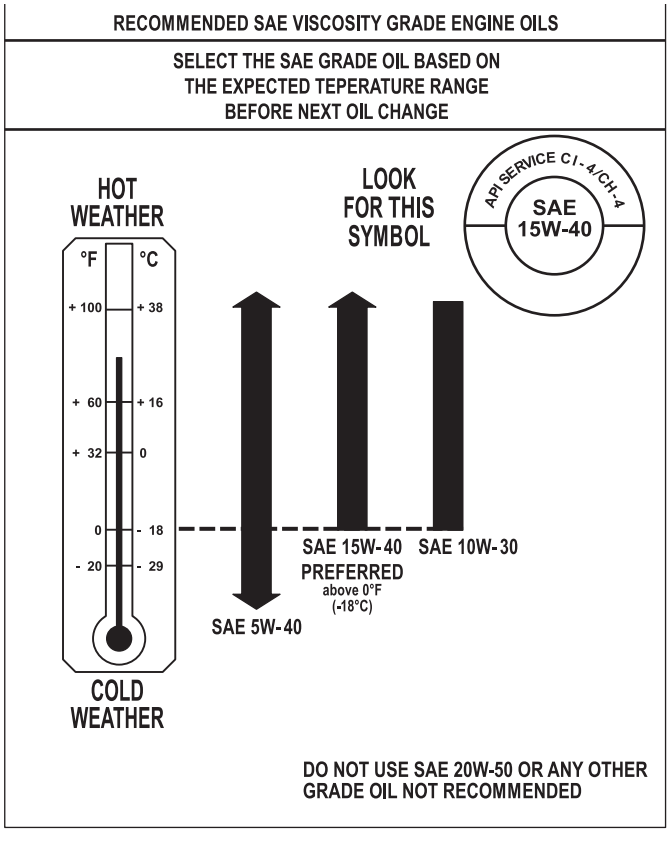


Figure 1-18: Oil Viscosity Chart

Diesel engine oil capacities are:

- 10.5 qts (9.9L) without filter change
- 12.25 qts (11.6L) with filter change
- 2.0 qts (1.9L) for engine oil cooler

Refer to Section 2 for more information regarding engine oil.

Engine Coolant

Recommended engine coolant is a mixture of ethylene glycol antifreeze and water.

Use a mixture containing 50% DEX-COOL and 50% water.

Radiator capacity is 7 qts (6.6L). System capacity is approximately 33 qts (31.2L).

Transmission/Transfer Case/Steering Gear and Pump Fluid

Recommended lubricant for the transmission, transfer case, and steering system is Dexron III automatic transmission fluid.

Approximate fluid capacities are:

- 1 qt (0.95L) for the steering gear and pump
- 3.5 qts (3.3L) for the transfer case
- 14 qts (13.3L) for the transmission, converter, and cooler
- 8.2 qts (7.7L) for the transmission (during fluid drain/refill)

Brake Fluid

Recommended brake fluid for all HUMMER H1 vehicles is DOT 3 brake fluid. Master cylinder approximate capacity is 1.64 pints (0.78L). Brake system approximate capacity is 3.12 pints (1.5L).

Front and Rear Axle Lubricant

Recommended lubricant for axles is HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier. The approximate capacity for one axle is 2 qts (1.9L).

Geared Fan Drive

Recommended lubricant for the GFD is HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier. The approximate capacity is 1.2 pt (0.6L).

Geared Hub Lubricant

Recommended lubricant for hubs is a heavy duty, multipurpose, API GL-5 gear lubricant, with viscosity ratings of 80W-90 or 75W-90.

The 80W-90 is an all purpose lubricant. The 75W-90 lubricant is suggested for use in areas where winter temperatures are consistently below freezing.

Steering Linkage and Suspension Lubricant

Recommended lubricant for steering and driveline components is an NLGI LB, or GC-LB grade multipurpose chassis grease. Use only those lubricants that display the NLGI certification symbol.

Body Lubrication

Door hinges, linkage parts, cables, and other body components can be lubricated with a number of different lubricants. Suggested lubricants and applications are:

- Window regulator mechanisms – spray white grease
- Window slides – silicone spray lube
- Door hinges – engine oil, ATF, or LPS brand spray lube
- Linkage/cables – LPS brand silicone spray lube
- Lock strikers – chassis grease, white grease, or LPS #3.
- Seat track – multipurpose chassis grease (NLGI-LB)
- Lock mechanisms –ATF, silicone spray lube, graphite lube

A/C Refrigerant and Compressor Oil

The only refrigerant that can be used is R-134a. No other refrigerant is recommended.

The only compressor oil recommended is PAG (polyalkylene glycol). It is the only oil compatible with refrigerant R-134a. No other oil is recommended. Any PAG oil used should be compatible with General Motors specifications.

A/C system capacities are:

- 11 fluid ounces (325 ml) of PAG oil
- 3 lb 3 oz (1.45 kg) refrigerant

LUBRICATION AND MAINTENANCE ITEMS

Engine Oil Level

The engine oil dipstick is at the driver side of the engine (Figure-1-19). Correct oil level is to the “F” mark.

Check oil level only when the engine is shut down and the vehicle is on a level surface. Wait one minute after shut down to check.

Never overfill the engine. The excess oil will be churned into foam causing oil film breakdown and consequent engine damage.

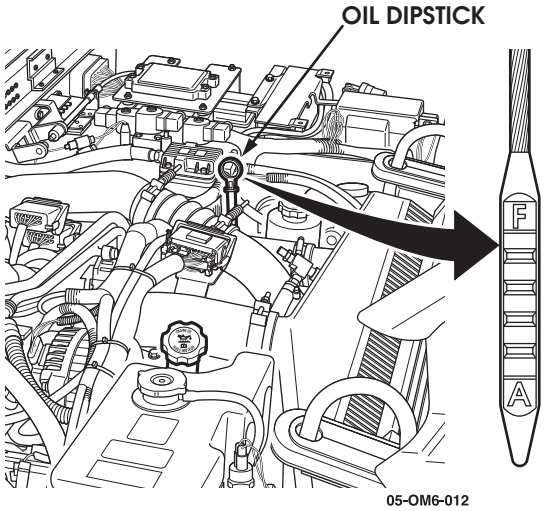


Figure 1-19: Oil Dipstick Location

Engine Oil and Filter Change

The oil filter is located on the driver side of the engine (Figure-1-20). A front mounted fill tube is used.

The spin-on oil filter is only removed with a standard band-type tool. Coat the seal on a new filter with oil and clean the adapter surface before installation. Tighten the filter by hand. Replace filter every 6,000 mi (9,700 km).

The oil pan drain plug has a gasket that should be replaced if cut, cracked, or distorted. Check the gasket seating surface on the oil pan. Burrs or nicks can be smoothed with a fine tooth file. Also replace the drain plug if the threads are worn or damaged. Be sure the plug is tightened to required torque of 16 lb-ft (22 N•m).

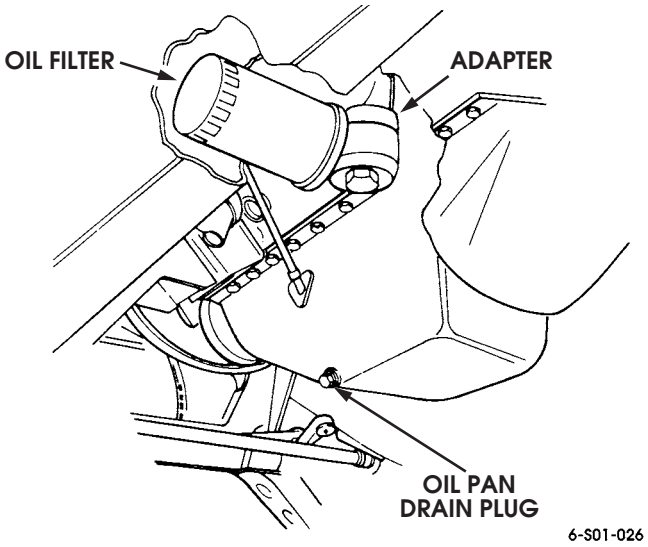


Figure 1-20: Oil Filter/Drain Plug Location

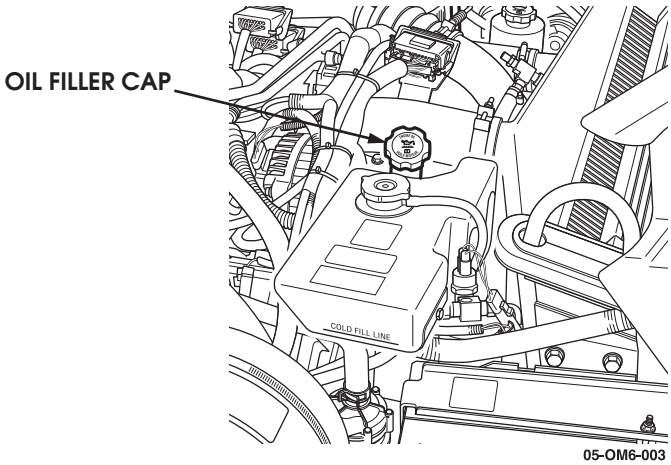


Figure 1-21: Engine Oil Fill Location

Fuel Filter Service

Replace the filter element every 6,000 mi (9,600 km), or annually, whichever occurs first (Figure-1-22). See “Purging Air From Diesel Filter” (Section 3).

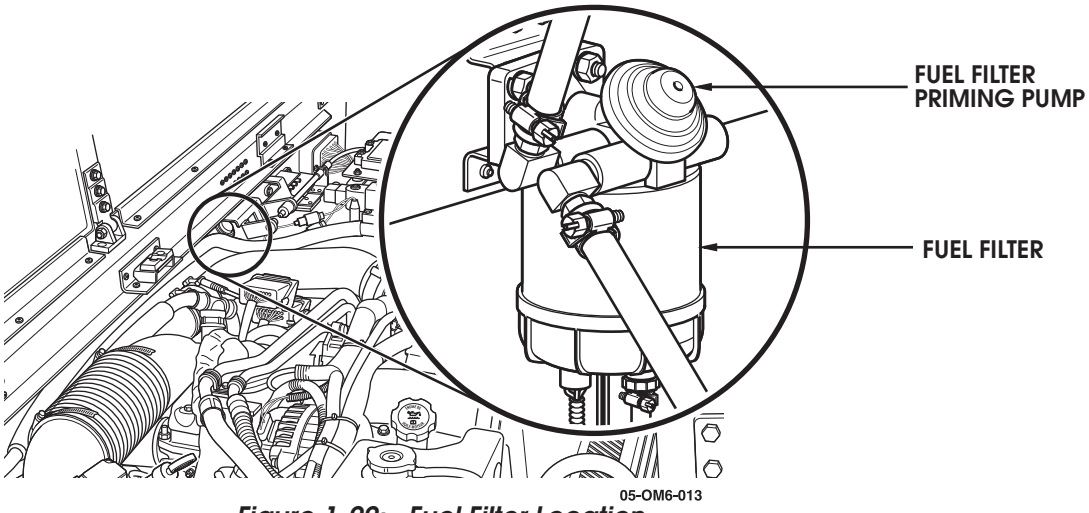


Figure 1-22: Fuel Filter Location

Transmission Fluid

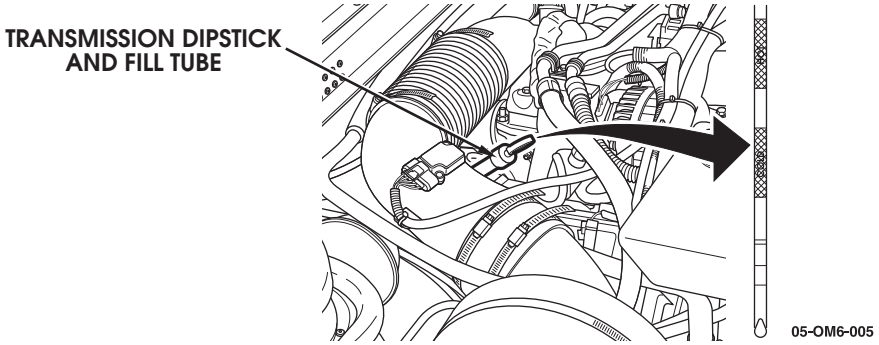


Figure 1-23: Transmission Dipstick Location

Replace the transmission fluid filter each time the fluid is changed. Refill the transmission with Dexron® III afterward.

Check transmission fluid level at least once each month. Procedure is as follows:

1. Drive the vehicle until the transmission fluid is at normal operating temperature. Fluid must be hot to obtain accurate reading.
2. Position the vehicle on a level surface.
3. Shift the transmission into Park.
4. Operate the engine at curb idle speed.
5. Remove the transmission dipstick and check the level (Figure-1-23). Correct level is within the crosshatch marks on the dipstick.
6. If the fluid level is too high, remove the excess through the fill tube using a suction gun and 3/16-in. teflon tubing. If level is low, check for leaks and, if OK, add fluid in 1-2 ounce increments until level is correct.

CAUTION: Do not overfill the transmission. The excess fluid will be churned into foam resulting in overflow from the fill and vent tubes, slip and flare during upshifts, fluid breakdown and eventual clutch failure.

7. Check the fluid color and the condition. Normal color ranges from dark red to light pink. Fluid that is dark brown, black, or orange and full of bubbles indicates a problem that may require overhaul.

Transfer Case Fluid

Check transfer case fluid level every 6,000 mi (9 700 km), or semiannually, whichever comes first. Remove fill plug and gasket. Level should be within 1/2 in. (12.7 mm) of fill plug opening when transfer case is level. Install fill plug and gasket, and tighten to 15-25 lb-ft (20-33 N•m). Change fluid every 12,000 mi (19 000 km) or annually, whichever occurs first (Figure-1-24).

Inspect rubber plug in the shift rail roll pin access passage located near the shift lever for leakage. Replace plug if leakage is present.

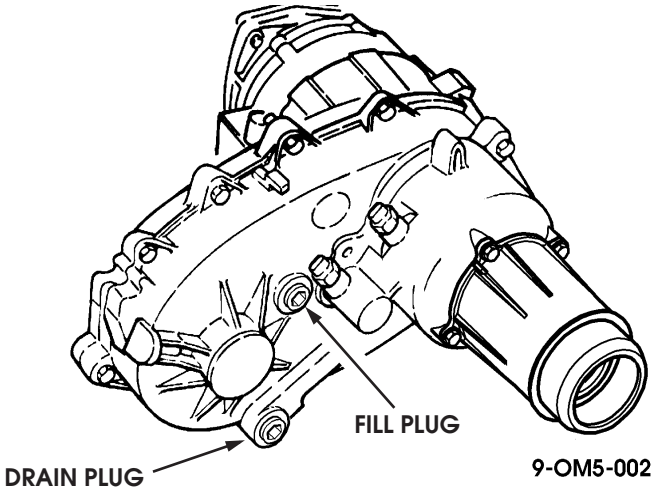


Figure 1-24: Transfer Case Fill/Drain Plug Location

Axle and Geared Hub

Check axle and hub lubricant condition and level every 6,000 mi (9,700 km) or semiannually, whichever occurs first.

Geared hub level should be within 1/2 in. (12.7 mm) of fill plug opening when lubricant is cold, or to plug level when hot.

Axle level should be within 1/4 in. (6.4 mm) of fill plug opening when lubricant is cold, or to plug level when hot (Figures 1-25 and 1-26).

Change axle and hub lubricant when contaminated by water or foreign material.

The geared hubs use GL-5, SAE 80W-90 or 75W-90 gear lubricant only.

For the axles, use only HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier.

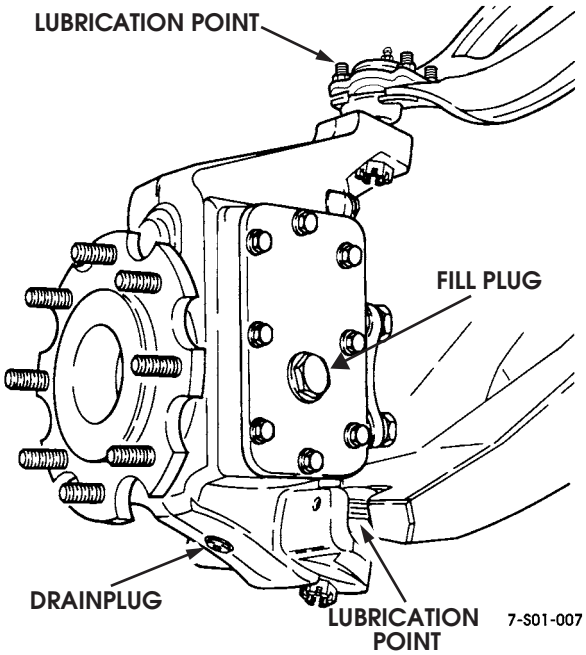


Figure 1-25: Geared Hub Fill/Drain Plug Locations

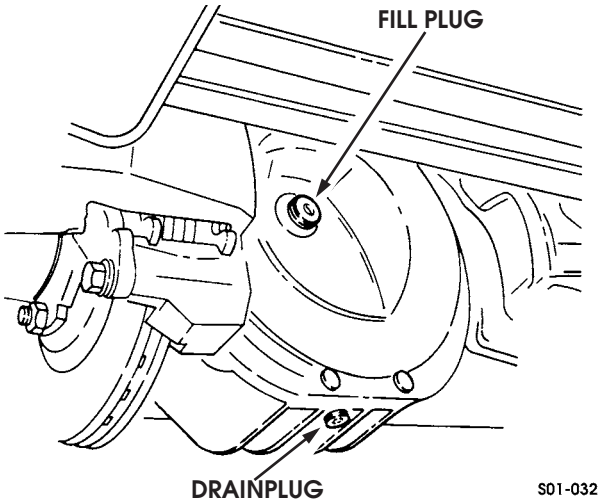


Figure 1-26: Axle Fill/Drain Plug Locations

Geared Fan Drive

CAUTION: If the fluid level is checked when the unit is hot, some of the expanded fluid will run out and create a low fluid condition.

The fluid level in the reservoir must be checked every 6,000 mi (9,700 km) or semiannually, whichever occurs first and topped off using HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier. Remove the fill plug when the unit is cold and ensure that the fluid is even with the bottom of the fill plug hole (Figure-1-27). The coupler shaft CV joints must be greased every 6,000 mi (9,700 km) or semiannually, whichever occurs first with a multipurpose, NLGI-LB grade chassis grease. The coupler shaft has a CV joint at the GFD end and one at the engine crankshaft end. Each CV joint contains two grease zerks, although only one zerk needs to be greased per joint. The second zerk is used to give an optional location depending on the position of the shaft when the engine stopped. This should lessen the need to bar the engine over to gain access to the zerks. Grease should be applied, using a low pressure grease gun, to the joint until old grease can be seen exiting around the sleeve on the shaft. Wipe the excess grease from the shaft when finished (Figure-1-28).

NOTE: It will be normal for some grease to exit the CV joint seals during engine operation, DO NOT replace the CV joints for this condition.

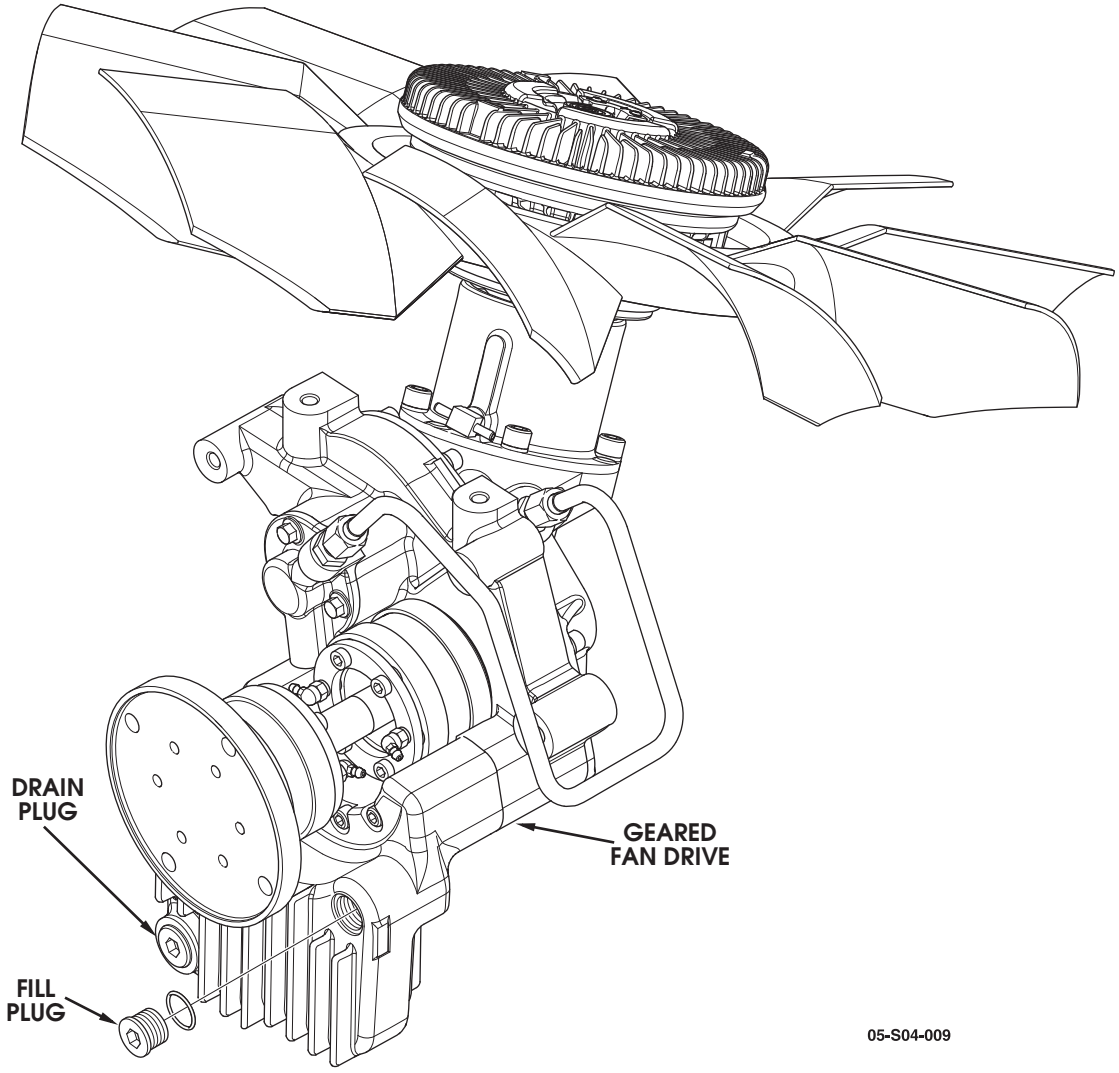


Figure 1-27: GFD Fill and Drain Plug

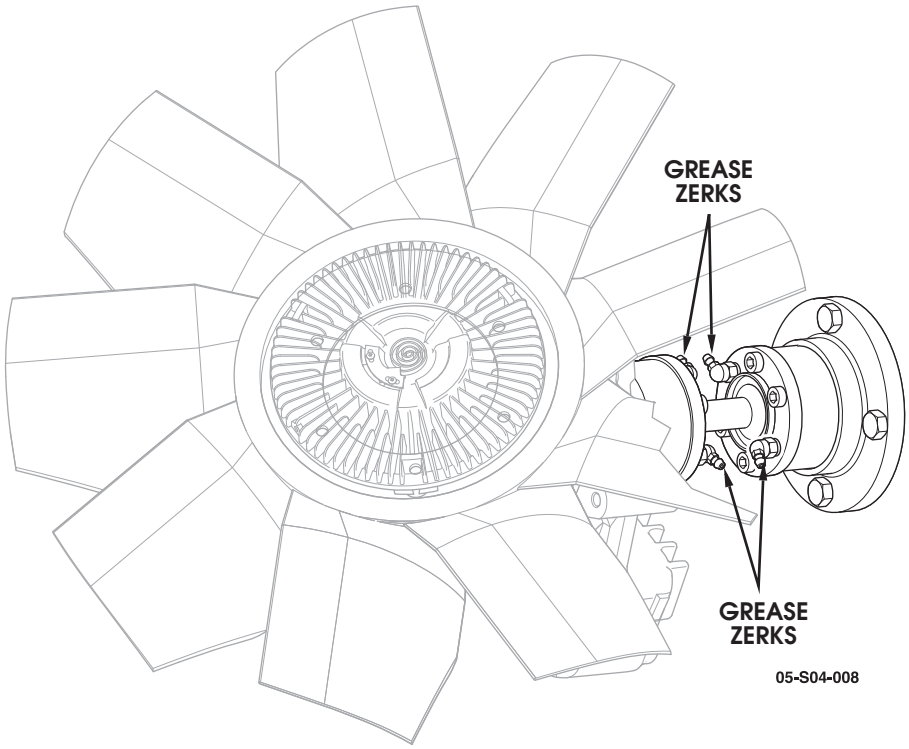


Figure 1-28: Coupler Shaft Grease Points

Universal and Slip Joint Lubrication

Lubricate U-joints with a multipurpose, NLGI-LB grade chassis grease.

Lubricate propeller shaft universal and slip joints every 6,000 mi (9,700 km), or semiannually, whichever occurs first. Use a hand operated or low-pressure air powered lubrication gun. If operating conditions are severe service at 1,000 mi. (1,600 km) intervals.

The rear propeller shaft U-joints have two grease fitting locations (Figure-1-29). The front shaft has four fitting locations (Figure-1-30)

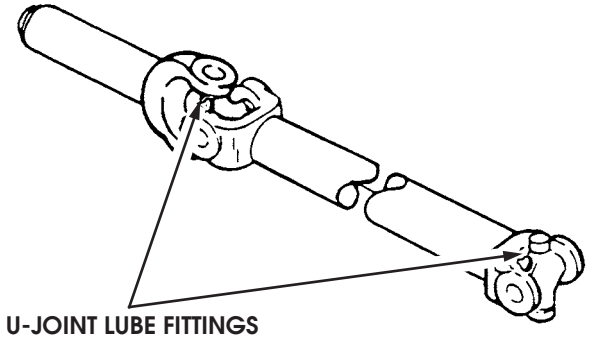


Figure 1-29: Propeller Shaft Lube Points

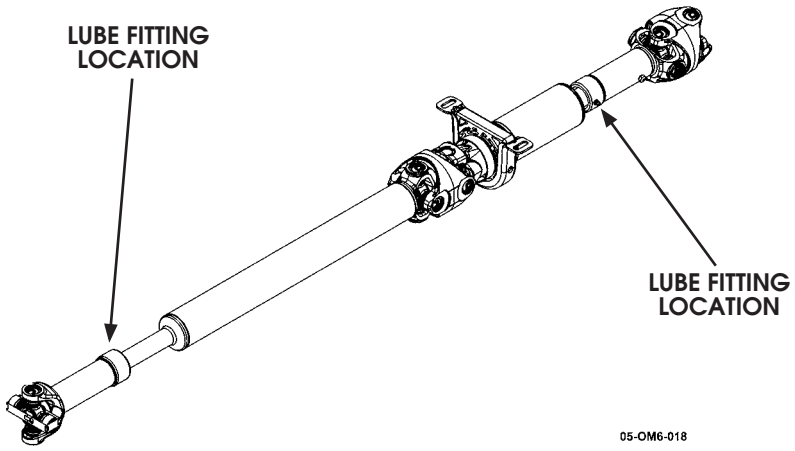


Figure 1-30: Front Propeller Shaft Lube Points

Steering and Suspension Lubrication Points

Lubricate steering and suspension components every 6,000 mi. (9 700 km), or semiannually, whichever occurs first. If operating conditions are severe, service at 1,000 mi. (1 600 km) intervals.

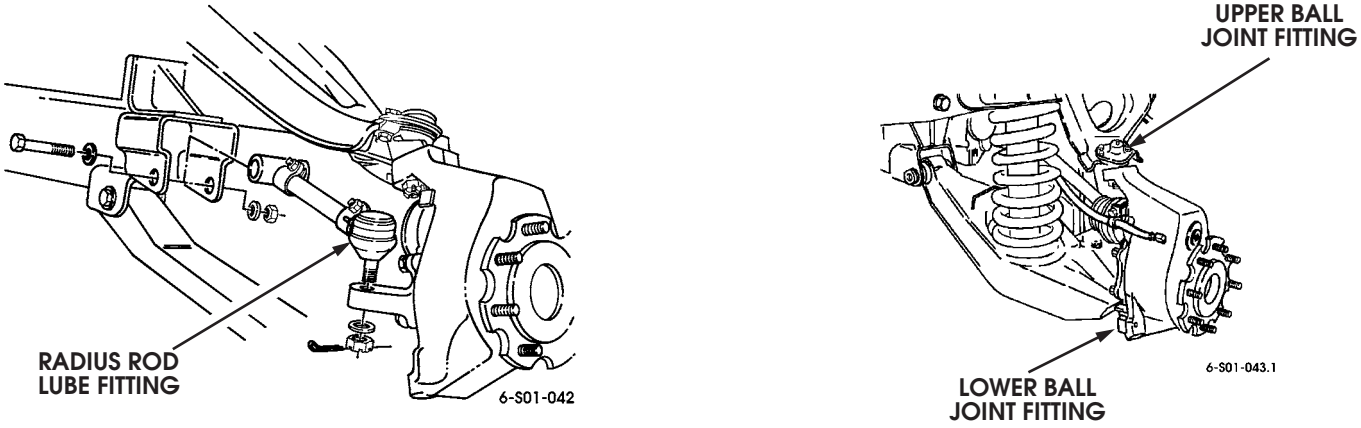


Figure 1-31: Ball Joint/Radius Rod Lube Points

Suspension lube points include the upper and lower ball joints and the rear suspension radius rods (Figure-1-31). Steering lube points include the tie rod ends, idler arm, steering arm, and intermediate steering shaft (Figure 1-32 through Figure 1-34).

Use a hand operated or low pressure air powered lube gun filled with a multipurpose chassis grease. NLGI-LB classification lubricating grease is recommended.

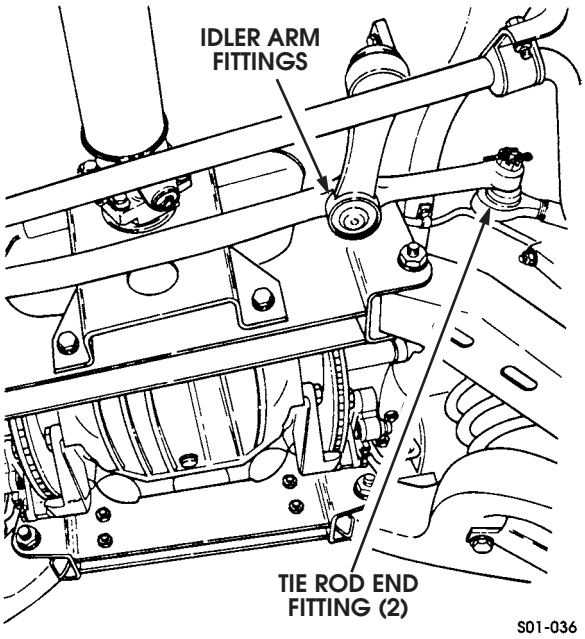


Figure 1-32: Idler Arm and Tie Rod Lube Points

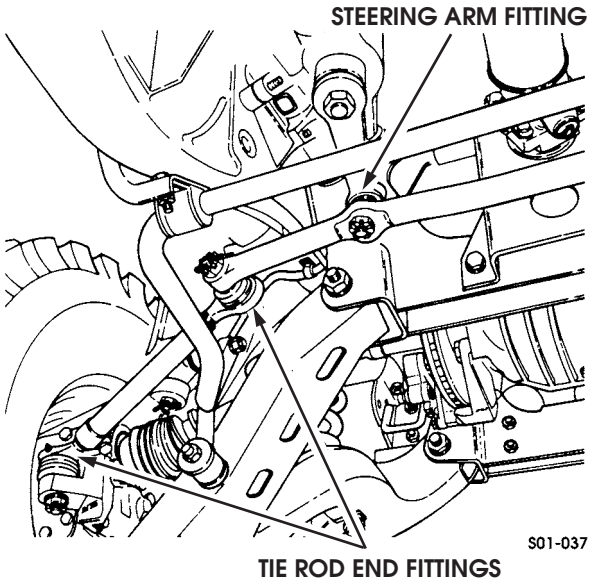


Figure 1-33: Tie Rod and Steering Arm Lube Points

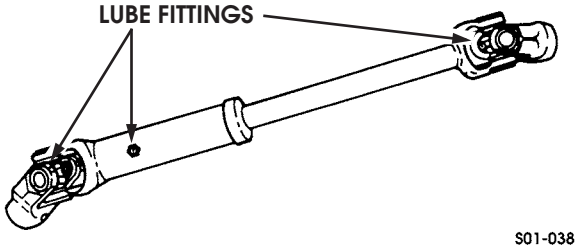


Figure 1-34: Intermediate Steering Shaft Lube Points

Power Steering Fluid

Check the fluid level in the power steering reservoir monthly and adjust level as necessary. If fluid is hot, level should be between "HOT" and "COLD" marks on the cap indicator. If fluid is cool, level should be between "ADD" and "COLD" marks. In either condition, level must be above "ADD" mark.

NOTE: Power steering fluid does not require periodic replacement.

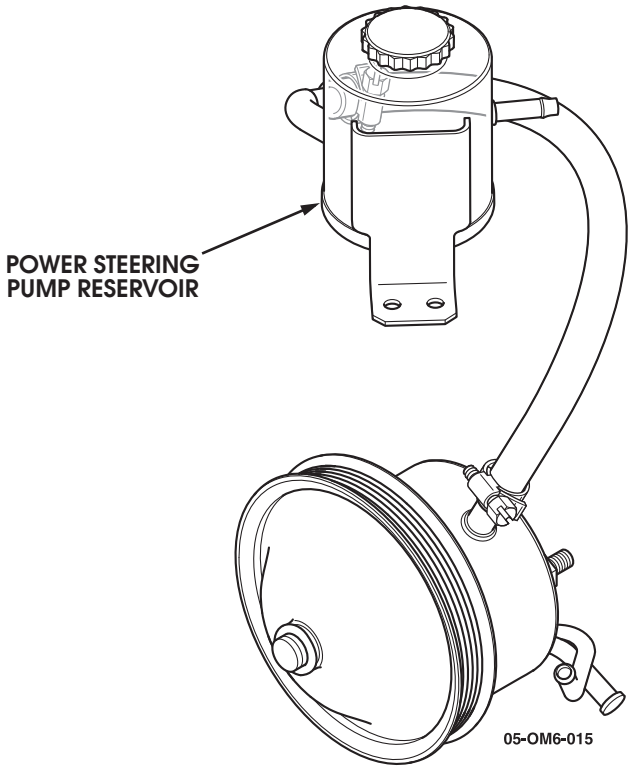


Figure 1-35: Power Steering Pump Reservoir

Cooling System Fluid Level Check

Check coolant level at the surge tank monthly and adjust level as necessary. Level should be at, or above, the cold fill line (Figure-1-36).

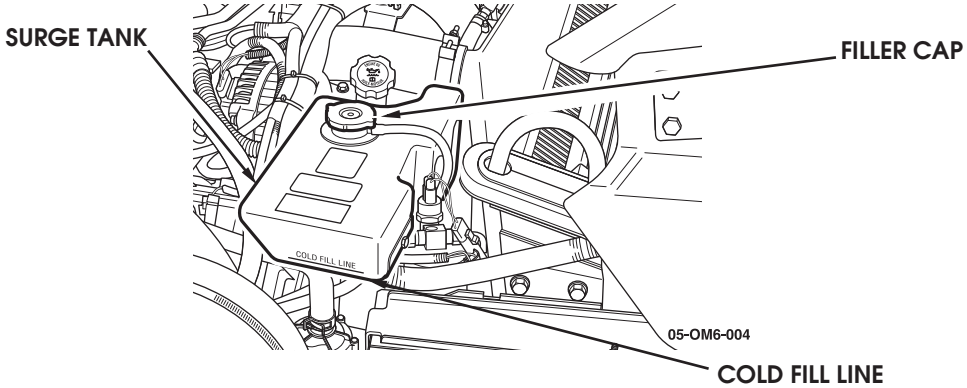


Figure 1-36: Surge Tank Coolant Level Indicator Location

Master Cylinder Fluid Level Check

CAUTION: Use DOT 3 brake fluid only. Failure to use the proper fluid may affect brake performance or damage brake components.

Check master cylinder fluid level monthly. Correct fluid level is to within 1/2 in. (13 mm) from the “MAX” indicator.

Clean the master cylinder cap and exterior before checking fluid level. Dirt on the cap must not be allowed to enter the reservoirs.

Add DOT 3 fluid if necessary and reinstall the cap (Figure-1-37).

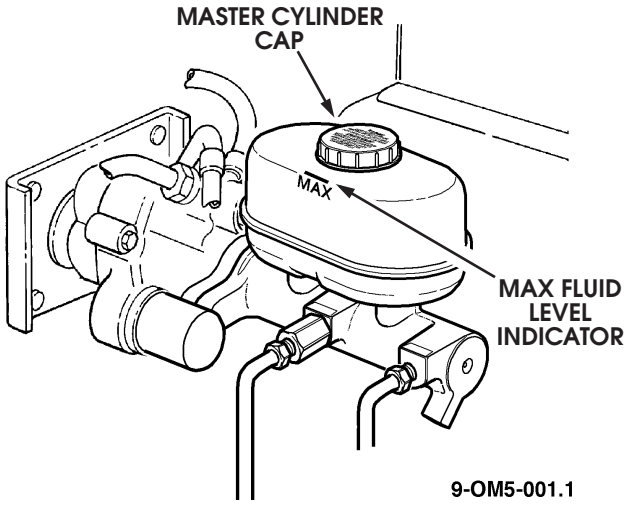


Figure 1-37: Master Cylinder Cap Location

Wheels/Tires/CTIS

Inspect tire and wheel condition. Look for loose wheel nuts and rim stud nuts, or dented, deformed wheel rims. Note tire tread wear and sidewall condition. If the vehicle is used for extensive off road operation, check the sidewalls for bulges, bead damage, cuts, fabric breaks.

If the tire treads are worn, note type of wear. If wear is only on one shoulder, toe setting or camber may be incorrect. If tires are scalloped or worn at crown only, or both shoulders, inflation pressures are probably incorrect.

If the vehicle is equipped with CTIS, cycle the system and check operation. Verify tire inflation pressures with an accurate gauge.

Serpentine Belt

Replace the belt if frayed, cut, or torn. Minor, small surface cracks within the belt grooves are normal. Do not replace the belt unless cracks extend all the way through or across the belt face.

Body Lubrication Points

Every 6 months or 6,000 mi (9,700 km), whichever occurs first, lubricate the: hood hinge, hood stops, tailgate hinges, door hinges, door handles, parking brake lever and service brake pedal push rod stud (Figure-1-38). Suggested lubricants include engine oil or ATF for hinges; LPS silicone lube for linkages, handles, and brake push rod; white grease for seat tracks, window regulators and park brake lever. Door locks should use a graphite based lubricant such as Lock-Eze. Refer to the Recommended Fuel/Fluids/Lubricants/Capacities section for more detailed lube information.

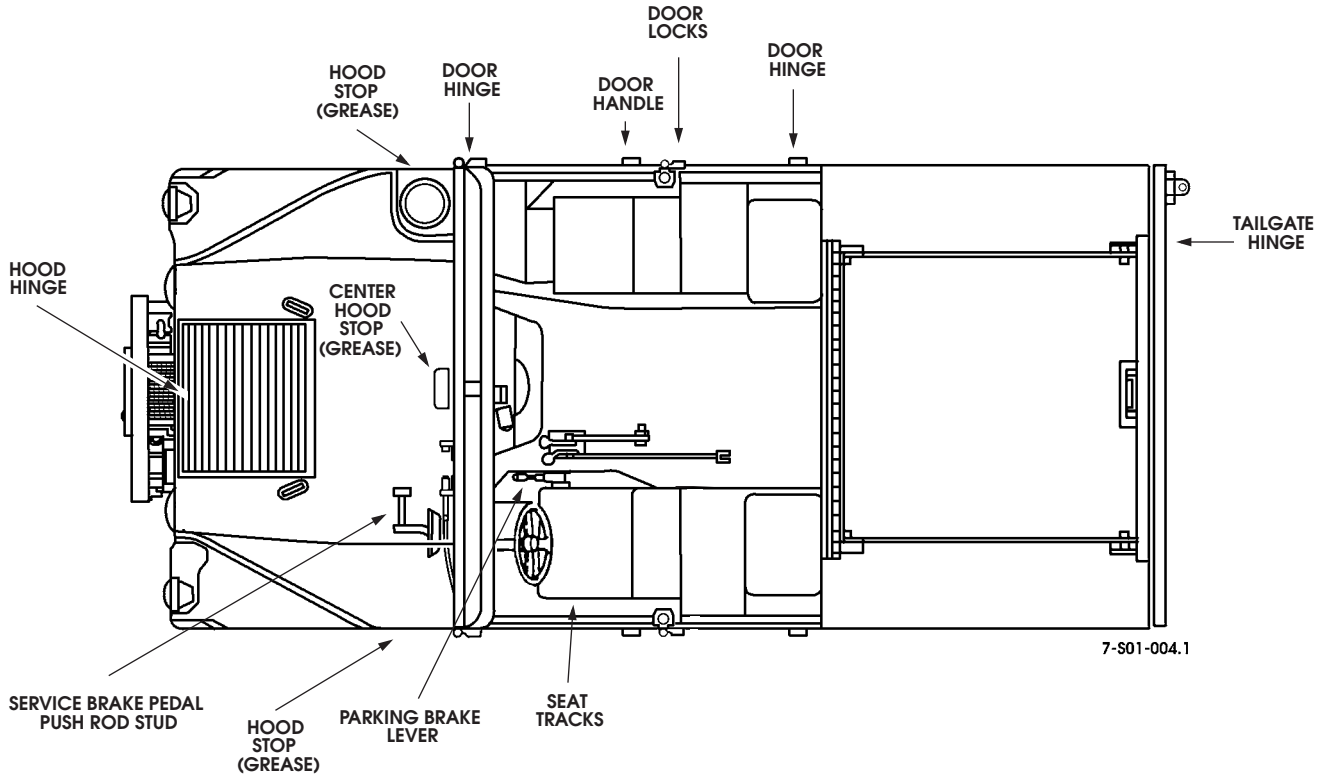


Figure 1-38: Body Lubrication Points

ESSENTIAL TOOLS

NOTE: See page 1-1 of the 2006 Service Parts Catalog for information on ordering Kent-Moore tools.

Engine

Tool No.	Description
EN-47913	Wrench, Belt Tensioner
J–23523-F	Harmonic Balancer Remover/Installer Set
J–23951	Water Manometer
J–26999-10	Compression Gauge Adapter
J–26999-20	Adapter, Compression Gauge
J–26999-30	Compression Gauge Adapter
J–34826	Socket, 36mm 12 Point
J–42000-EU	Digital Battery Tester
J–44640	Installer, Valve Stem Seal
J–44641	Remover, Rear Crankshaft Seal
J–44642	Installer, Rear Crankshaft Seal
J–44643	Flywheel Holder
J–44644	Remover, Front Crankshaft Seal
J–44645	Installer, Front Crankshaft Seal
J–44646	Compressor, Valve Spring (On-Vehicle)
J–44648-A	Storage Case - Duramax 6.6L Tools
J-45059	Angle Meter
J–46594	Tool, Injector Removal

Fuel, Emissions and Exhaust

Tool No.	Description
EN–47589	Test Adapter, Fuel Pressure
J–28552-A	Gauge, Fuel Pressure
J–28552-100	Fuel Pressure/Return Adapter Set
J–29658-D	Fuel Pressure Gauge & Adapter Set
J–29698-A	Injection Line (flare nut) Wrench, 3/4
J–38641-B	Hydrometer, Diesel Fuel
J–44638	Gauge, Vacuum/Pressure
J–45773	Adapters, Fuel Pressure Gauge
J–45873	Test Kit, Fuel Return Volume
J–45873-30	Test Adapters, Fuel Return Volumn

Transmission/Transfer Case

Tool No.	Description
DT–47502	Front Output Seal Installer
J–21366	Torque Converter Retaining Strap
J–25025-B	Oil Pump and Valve Body Pin Set
J–33831-A	Input Gear Seal Installer
J–33835	Pump Housing Seal Installer
J–39700	Break-Out Box
J–41364-A	NSBU Switch Aligner
J–41623-B	Trans Oil Cooler Line Disconnect Tool
J–42497	Extension Housing Seal Installer
J–42543	Selector Shaft Seal Remover/Installer
J–43773	Valve Spring Compressor
J–43799	Break-Out Box Adapter
J–43909	Selector Shaft Seal Installer
J–43911	Selector Shaft Seal Remover
J–44152	Jumper Harness (20 pins)
J–44247	Internal Wiring Harness Installer
J–44257	Wiring Harness Connector Remover
J–44835	Allison Transmission Oil Cooler Flush Adapters
J–44924-A	Storage Case - Allison LCT Tools
J–45053	Pump Remover
J–45056	Oil Pressure Adapter
J–45096	TransFlow Transmission Cooling System Service Tool
J–45096-500	Oil Flush Kit Adapters
J–46409	Torque Converter Alignment Handles

Wheels, Tires and CTIS

Tool No.	Description
CH–47503	Runflat Tire Pry Bar
J–39522	ENG Kit, Socket (5-Point)
J–42452	Runflat Compressor
J–42557	Socket, Cam
J–45760	Rim Separating Jack-Screws
J–45769	Runflat Ratchet Wrench
J–45770	Hutchinson Rim Separator

Brakes

Tool No.	Description
J–35592	ABS Pinout Box
J–42553	Disc Brake Piston Retraction Tool
J–42883	Wheel Speed Sensor Test Cable
J–44237	ABS Blink Code Jumper
J–44238	Master Cylinder Bleed Adapter
J–45405	Brake Line Flaring Kit
J–45761	T-Handle Rachet Wrench (9/16")

Steering

Tool No.	Description
J–33141	Adapter Fittings (used with J–25323)
J–42548	Puller, Pitman Arm
J–44721	Power Steering System Analyzer
J–8092	Universal Driver Handle

Axles/Suspension and Frame

Tool No.	Description
CH–47505	Shock Mounting Pin Socket
DT–47845	Installer, Input Seal
DT–47846	Installer, Spindle Seal
J–08614-A	Pinion Flange Holder
J–08614-5	Bolt Kit Yoke Holding Tool
J–22610	Axle Boot Pliers, Eared Clamp
J–24398-A	Driveshaft Inclinometer
J–35566	Clamp Tool, Axle Boot
J–35910	Axle Boot Crimping Tool
J–38792-A	Electronic Vibration Analyzer (EVA) 2
J–38869	Installer, Pinion Seal
J–42183	Handle, Seal Driver
J–42546	1/4 in. Drive Torque Wrench (Preset)
J–42547	1/2 in. Drive Torque Wrench (Preset)
J–43218	Clamp Plier
J–45762	T-Handle Rachet Wrench (15mm)
J–8092	Universal Driver Handle

HVAC

Tool No.	Description
J–46053	R-134a Refrigerant Leak Detector

Electrical

Tool No.	Description
J–24538-B	Tester, Gauge
J–34513	Terminal Remover
J–35616-B	Connector Test Adapter Set
J–41712	Oil pressure Sending Unit Socket
J–42541	Crimper, 4 pt (field grade)
J–45763	AMP Terminal Release Tool

Electrical Troubleshooting

Tool No.	Description
J–35689-A	Micro-Pack Extract Tool
J–39200-A	Digital Multimeter

SPECIAL TOOLS

Engine

Tool No.	Description
J–02619-A	Slide Hammer
J–05902-A	Cylinder Hone
J–24270	Ridge Reamer
J–24460-A	Cooling System and Cap Pressure Tester
J-26999	Compression Gauge
J–38606	Valve Spring Compressor
J–8037	Ring Compressor
J–8087	Cylinder Bore Gauge
J–9666	Valve Spring Tester

Fuel, Emissions and Exhaust

Tool No.	Description
J–35555	Vacuum Pump (MITY-VAC)
J–42520	Fuel Line Disconnect Tool Set

Transmission/Transfer Case

Tool No.	Description
J–03289-20	Bench-mounted Base
J–21359-A	Oil Pump to Converter Seal Installer
J–21366	Converter Holding Strap
J–21867-A	Pressure and Hose Assembly Kit
J–23456	Clutch Spring Compressor Press
J–36850-A	Transmission Assembly Lubricant
J–6125-1B	Slide Hammer
J–8059	Parallel Jaw Snap Ring Pliers

Wheels, Tires and CTIS

Tool No.	Description
J–39544-18A	Torque Stick (7/8" x 120 lb-ft)

Steering

Tool No.	Description
J–24319-B	Universal Steering Linkage Puller
J–25033-C	Pump Pulley Installer
J–25034-C	Pump Pulley Remover

Brakes

Tool No.	Description
J–29532-A	Diaphragm Brake Bleeder

Axles/Suspension and Frame

Tool No.	Description
J–21465-13	Driver Handle Extension
J–23409	Dial Indicator Extension
J–26900-13	Magnetic Indicator Base
J–39570	Chassis Ear
J–8001	Dial Indicator Set

Body

Tool No.	Description
J–25070	Heat Gun
J–34940	Heavy Duty Rivet Gun

Electrical

Tool No.	Description
J–25300-D	Headlight Aimer
J–39916-A	CD and Cassette Audio Diagnostic Kit

Section 2 Engine

INTRODUCTION

This section contains general information, diesel engine diagnosis, turbocharger service, and diesel engine repair and overhaul. A table of contents is provided that lists the various repair items and the section page number where repair information is located. Use the contents tables to avoid random searches for needed information.

Specifications for diesel engines are located at the end of this section for quick reference. Service tool information can be found at the end of the Engine section.

TABLE OF CONTENTS

Crankshaft Balancer Replacement 2-23
Cylinder Head and Gasket Service 2-39
Engine
- **Cleaning Materials** 2-5
- **Compression Test** 2-5
- **Description** 2-2
- **Diagnosis** 2-10
- **Oil Pump Pressure Test** 2-10
- **Engine Noise Diagnosis Equipment** 2-7
- **Essential Tools** 2-62
- **Identification** 2-3
- **Installation** 2-50
- **Mounting Bracket/Insulator** 2-22
- **Noise Diagnosis** 2-6
- **Removal** 2-45
- **Scan Tool Use** 2-7
- **Special Service Tools** 2-3
- **Specifications** 2-52

Exhaust Manifold Service 2-29
Front Cover Oil Seal Replacement 2-24
Fuel Filter Warning Lamp 2-5
Glow Plug Operation and Testing 2-7
Intake Manifold 2-43
Introduction 2-1
In-Vehicle Service, Diesel Engine 2-22
Lubricants/Sealants/Coolant 2-3
- **Coolant** 2-4
- **Engine Oil** 2-3
- **Sealants** 2-4

Oil Pan Replacement 2-46
Rear Main Oil Seal Replacement 2-25
Road Testing 2-6
Rocker Arm Cover Service 2-26
Torque Specifications 2-51
Turbocharger
- **Description** 2-15
- **Diagnosis** 2-20
- **Installation** 2-18
- **Learn Procedure** 2-16
- **Operation** 2-16
- **Removal** 2-18
- **Service and Diagnosis** 2-15

Valve Lash Adjustment 2-33
Valve Rocker Arm Shaft and Push Rod Replacement 2-30

ENGINE DESCRIPTION

A turbocharged diesel engine is used in the HUMMER H1 vehicles. It is a liquid cooled, four-stroke, 90° – V8 engine with a displacement of 6.6L (402 cu. in.) (Figure 2-1). The engine is manufactured by Duramax Inc. (GM / Isuzu).

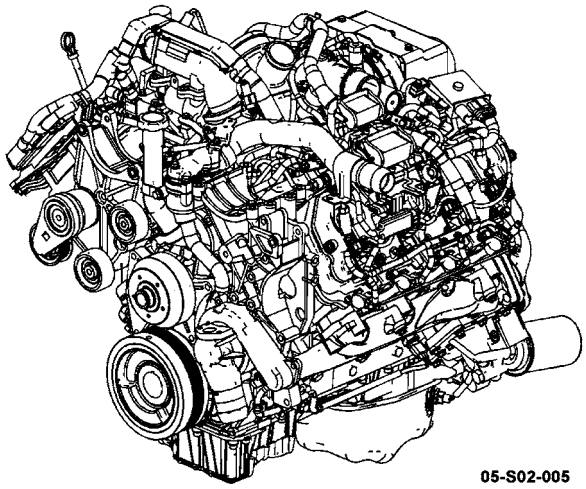


Figure 2-1: 6.6L Turbo Diesel Engine

Engine Components

The engine block is grey iron and the cylinder heads are aluminum. Turbo engines are equipped with a three-piece aluminum intake manifold and cast iron exhaust manifolds.

The oil cooling system for turbo diesel pistons provides for oil spray onto the underside of the piston crown. This is accomplished by additional oil feed orifice tubes and galleries in the block. Oil spray occurs when the piston is approaching bottom dead center on the intake and power strokes. The extra oil pressure and volume needed for piston cooling is provided by a high output oil pump. The pump has a working pressure of 55 to 60 psi at 3250 RPM. Oil feed for piston spray is through galleries and oil tubes located in the main bearing saddles and webs.

The crankshaft is supported by five insert style main bearings. The camshaft is also supported by five bearings; plain type bearings are used.

The engine is equipped with three ring aluminum pistons. Connecting rods are forged steel. The pistons are attached to the rods with hardened steel piston pins. Each piston pin is retained by two snap rings; one at each end of the pin. The pin is a floating fit in the rod and piston.

A gear driven camshaft operates the overhead valve train. Roller lifters and tubular push rods actuate the rocker arms. The arms are mounted on shafts bolted to each cylinder head.

The cylinder heads are equipped with glow plugs for each cylinder and a prechamber for each combustion chamber. One plug and one prechamber are used in each combustion chamber. The glow plugs heat the air entering the prechamber. This aids the combustion process and improves cold weather starting and operation. The glow plugs are activated only when ambient temperatures fall below a pre-set value. On the turbo diesel engine the glow plug relay is mounted on the intake manifold and is controlled by the ECM.

The turbocharged diesel engine is equipped with an IHI turbocharger. Vanes in the turbine housing control the boost. The position of the vanes is variable and controlled by a vain position solenoid based on information sent to the ECM by the boost sensor. The vane position is monitored by the vane position sensor. This allows a proportionate increase in fuel injected into the cylinders. The result is a much denser cylinder charge and greater power output.

The turbocharger turbine and compressor impellers are the mechanisms that pump additional air into the combustion chambers. The impeller wheels are operated by the high speed gas flow through the engine exhaust system.

Engine lubrication is through a conventional mechanical pump located at the rear of the crankcase. The pump is shaft driven by the oil pump drive unit which in turn, is driven off the camshaft. The 6.6L diesel is equipped with a high pressure fuel injection system. The system consists of an electric fuel supply pump, an injection pump, a separate injector nozzle for each cylinder, and the necessary injector feed lines.

The fuel injection pump at the front of the engine valley uses a fuel rail pressure regulator (which is actually a pressure control valve that is controlled by the ECM). The assembly consists of a supply gear pump at the end of the unit. The much larger section is the actual high pressure feed pump. The pump generates peak fuel pressure of approximately 23,000 psi. 5,000 to 6,000 psi is the typical pressure at idle. The pump is engine driven by the camshaft gear.

The fuel passes through the base plate of the Fuel Injection Control Module (FICM) to cool the module. This high voltage unit directly pulses the fuel injectors in the high pressure system when commanded by the ECM.

The fuel cooler on the return line increases fuel handling efficiency. The cooler is mounted on the cool pack.

ENGINE IDENTIFICATION

The diesel engine I.D. decal is located on the back face of the driver side lower rocker arm cover (Figure 2-2).

The decal provides the engine assembly/serial number and a bar code.

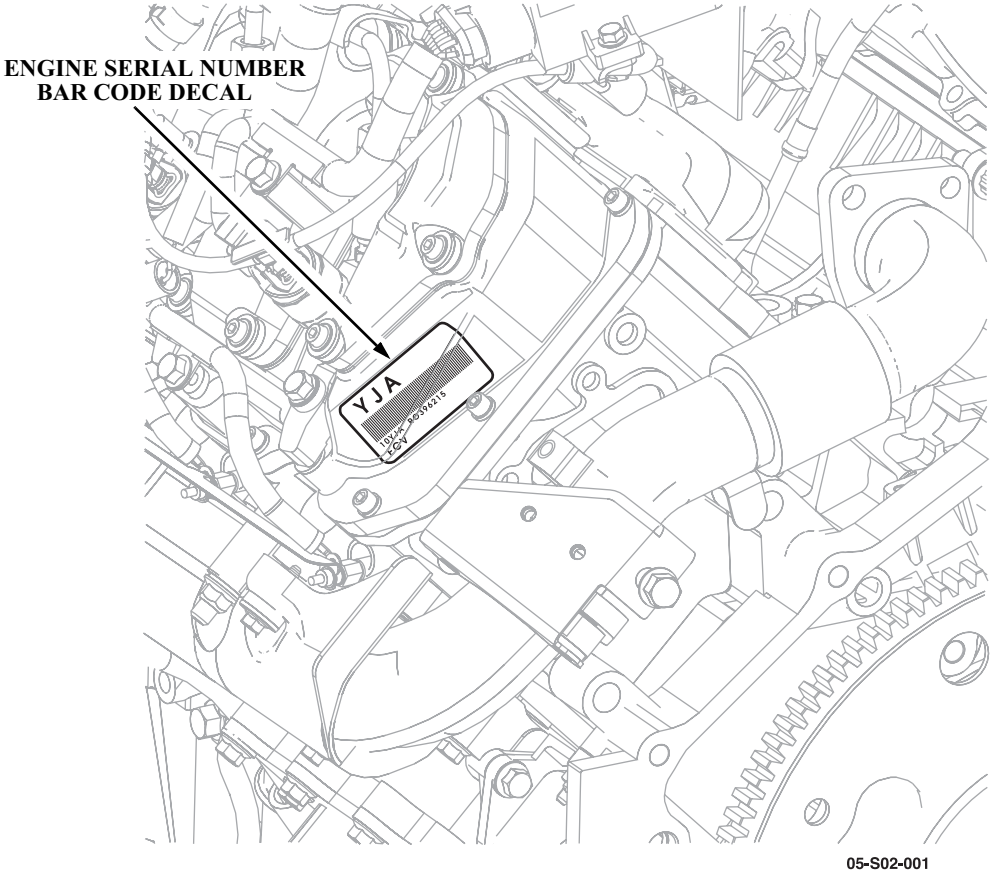


Figure 2-2: Diesel Engine I.D. Tag Location

Service Tools

The special service tools described in this section are available through the dealer tool program.

Specifications

Engine specifications for overhaul, adjustment, inspection and torque requirements are provided at the end of this section.

LUBRICANTS/SEALANTS/COOLANT

Engine Oil

Recommended engine oil for the diesel engines used in HUMMER H1 vehicles, is API classification CG-42-3. Synthetic oils are equally acceptable.

Oil viscosity recommendations are: (Figure 2-3)

SAEþ15W-40 As shown in the viscosity chart, SAEþ15W-40 is best for your vehicle. However, you can use SAEþ10W-30 at temperatures above 0°F (-18°C). When it is very cold, below 0°F (-18°C), you should use SAEþ5W-40 to improve cold starting. These numbers on the oil container show its viscosity or thickness. Do not use other viscosity oils such as SAEþ10W-40 or SAEþ20W-50.

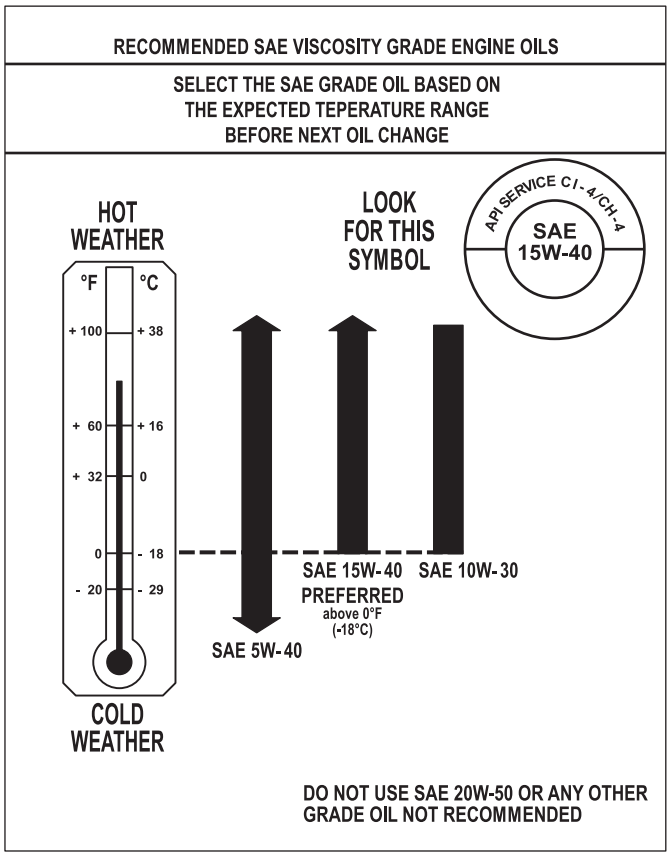


Figure 2-3: Oil Viscosity Chart

Sealants

Anaerobic, RTV (room temperature vulcanizing) and standard sealants are all used for various repairs.

RTV sealers are used when a non-rigid part is attached to a rigid part (e.g. oil pan to engine block).

Typical RTV sealers would be Permatex High Temp, Ultra Copper, Ultra Black, or Loctite 599.

Anaerobic (gasket eliminator) sealants are used where two rigid parts are being assembled. This type of sealant cures in the absence of air. Typical anaerobic sealers are Loctite 510 and 518.

Standard type sealers are used primarily as gasket dressing or thread sealants. Typical examples would be Permatex #2, or Perfect Seal spray sealer.

Thread locking sealants are frequently recommended for fasteners subject to heat and vibration. Recommended products are:

- Loctite 242 for all purpose use
- Loctite “Stud and Bearing Mount” for semi-permanent attachment

Coolant

The cooling system in your vehicle is filled with DEX-COOL® engine coolant. This coolant is designed to remain in your vehicle for 5þyears or 60,000þmiles, whichever occurs first, if you add only DEX-COOL® extended life coolant.

A 50/50þmixture of clean, drinkable water and DEX-COOL® coolant will:

- Give freezing protection down to -34°F (-37°C)
- Give boiling protection up to 265°F (129°C)
- Protect against rust and corrosion
- Help keep the proper engine temperature
- Let the warning lights and gages work as they should

CAUTION: *Using coolant other than DEX-COOL may cause premature engine, heater core or radiator corrosion. In addition, the engine coolant may require changing sooner, at 30,000þmiles (50þ000þkm) or 24þmonths, whichever occurs first. Any repairs would not be covered by your warranty. Always use DEX-COOL (silicate-free) coolant in your vehicle.*

What to Use

Use a mixture of one-half clean, drinkable water and one-half DEX-COOL® coolant which won't damage aluminum parts. If you use this coolant mixture, you don't need to add anything else.

CAUTION: *Adding only plain water to your cooling system can be dangerous. Plain water, or some other liquid such as alcohol, can boil before the proper coolant mixture will. Your vehicle's coolant warning system is set for the proper coolant mixture. With plain water or the wrong mixture, your engine could get too hot but you would not get the overheat warning. Your engine could catch fire and you or others could be burned. Use a 50/50 mixture of clean, drinkable water and DEX-COOL® coolant.*

CLEANING MATERIALS

Normal parts cleaning solvents can be used for most purposes.

Use brake or contact cleaner, to clean surfaces where anaerobic or RTV sealants will be applied. This type of solvent does not leave a residue that interferes with sealer cure or adhesion.

Carbon deposits can be emulsified by some spray type gasket removers. Permatex and 3M both have effective products.

Avoid using diesel fuel, gasoline, paint and lacquer thinners or kerosene for parts cleaning purposes. These products can leave an undesirable residue.

Cylinder and lifter bores should be cleaned with a liquid detergent and warm water mixture after honing or polishing. A bristle brush or cotton towel can be used to wash the bores until clean and free of oil, dirt, and abrasive grit.

COMPRESSION TEST

1. Remove the engine ignition fuse under the hood.
2. Disconnect and remove all the glow plugs.
3. Thread adapter J–26999-20 into the glow plug hole of the first cylinder to be tested. Then attach the compression gauge J–26999 to the adapter.
4. Have a helper crank the engine through six cycles (to generate six compression strokes). Note and record the gauge pressure. Repeat procedure at the remaining cylinders.
5. The minimum compression in any one cylinder is 2069þkPa (300þpsi). There should not be more than 345þkPa (50þpsi) difference between a suspect cylinder and the average compression of all 8þcylinders.

CAUTION: *Never inject oil into the diesel engine cylinders for any reason. This could result in piston and rod damage because of the minimal clearances in a high compression diesel combustion chamber.*

FUEL FILTER WARNING LAMP

All HUMMER H1 models are equipped with a fuel filter warning lamp. The lamp is in circuit with a sensor mounted in the filter. The purpose of the lamp is to alert the driver when water, ice or wax buildup occurs in the filter.

Lamp illumination can be intermittent or continuous depending on the severity of water or wax buildup.

In most cases, continuous illumination of the lamp simply means it is time to drain the filter. However, a continuous lamp plus engine stall or restart problems may indicate a plugged filter or fuel lines. Intermittent illumination of the lamp indicates that water is accumulating in the filter. In this instance, it is only necessary to drain off the water at the wheel house drain cock.

ROAD TESTING

The purpose of road testing is basically to confirm or deny the existence of an engine fault. Procedure is as follows:

1. Note condition of wheels/tires before test. Worn, damaged tires or wheels can cause vibration or noise.
2. Check and adjust lube levels in engine and transmission and top off engine coolant if necessary.
3. Turn off A/C system.
4. Start and run engine at idle speed with transmission in neutral. Record any noise or vibration that may be present. “Rev” engine and note any noise/vibration plus any change in magnitude or frequency.
5. Drive vehicle at legal speed and note any evidence of noise, vibration, low power, miss, etc.
    a. If vibration was noted, drive vehicle above vibration speed. Then shift into neutral and coast down through problem range. If vibration still occurs, problem is with chassis component. However, if vibration ceases, problem is with driveline component.
    b. If noise is noted, shift into neutral at about 35 mph and note if noise changes in pitch, frequency or stops altogether.
6. Operate A/C system and note effect. If noise or vibration begins, problem is related to A/C compressor, clutch, accessory mounting bracket or belt.

ENGINE NOISE DIAGNOSIS

Engine noises are usually sensitive to changes in rpm and load. For example, a collapsed lifter will make an audible “ticking” noise that increases in frequency as rpm goes up.

Engine noises can also be determined according to speed of the related rotating component. For instance, valve train noises will be at a frequency that is one half crankshaft speed.

Accessories

Noise caused by engine accessories such as the vacuum pump alternator, power steering pump, A/C clutch, or drive pulleys is speed sensitive. An increase or decrease in engine rpm will generally change pitch and frequency, or even cause it to stop. A mechanics stethoscope will generally help pinpoint a noise source. Removing the accessory drive belt will also help verify an accessory generated noise.

Bearings

Bearing noise can be differentiated by pitch. A damaged connecting rod bearing makes a higher pitched, metallic knocking sound. This as opposed to the lower pitch thump of a worn or spun main bearing. A failed rod bearing can be confusing as it seems to make a greater frequency noise. This is because the bearing may knock at both ends of piston travel.

Piston and Connecting Rod

Piston slap is usually caused by severely worn cylinder bores and pistons, partially collapsed piston skirts, worn pin bores, severely worn rings or an undersized piston. An incorrectly assembled or installed connecting rod and piston assembly will also produce slap.

Slap always occurs at crankshaft speeds. In severe cases, slap may occur in both directions of piston travel. Although fairly common on high mileage engines, slap can be difficult to hear on low mileage engines. As the term implies, piston slap is appropriate for the sound generated. It occurs when a piston begins to rock within the cylinder as it travels up and down. This action causes the skirt to slap the cylinder wall as it straightens, then rocks away from the direction of thrust.

Valve Train and Camshaft

Rocker arm and hydraulic lifter noise is probably the most easily identifiable. Both make tapping (or clicking) noises that only differ in pitch and volume. Although damaged valve springs or pushrods are more difficult to hear, they usually cause a power loss or rough engine condition and require inspection to locate.

A worn, missing or incorrect thickness camshaft thrust washer will cause excessive cam end play. The most frequent result is an audible knocking sound localized at the rear of the block.

NOTE: Valve train noise can also be the result (or first indicator) of low oil pressure.

Starter Noise

The starter bendix can hang and prevent quick disengagement after startup. The resulting noise can be misdiagnosed as engine related. A mechanics stethoscope is fairly effective at differentiating engine and starter noise.

Knocking Noise At Idle

Knocking noises can be from connecting rod bearings, a cracked flywheel, converter touching the housing or cover, A/C compressor, or loose exhaust component.

Look for exhaust components grounding against the body, frame or driveline component. Remove the converter access cover and visually inspect the flywheel and converter. Check the cover and converter housing for signs of contact. A flywheel cracked at the hub will allow the converter to wobble slightly. Test the A/C system for incorrect charge levels which can produce compressor knock.

Diesel Fuel Knock or Rattle

The rattling sound unique to a diesel engine is normal. It is a function of high compression ratio, injector nozzle spray pattern and pressure and compression ignition. However, low quality fuel or injector nozzle faults can make the normal sound much more pronounced. If the normal rattling is accompanied by or becomes a knocking sound, the fuel injectors, injection pump and fuel quality must all be tested.

DIAGNOSIS EQUIPMENT

Diagnosing engine mechanical problems can be performed with normal shop equipment.

Compression testing with a good quality gauge will reveal condition of the engine rings, pistons, cylinder bores, valves, and guides.

Vacuum diaphragm operation is quickly tested with a hand operated vacuum pump. These pumps are available from companies such as Kent-Moore, Snap-On, RobinAire and Lisle.

A 10 mega-ohm impedance digital multimeter is used for many tasks such as checking wire continuity, shorted-open circuits and components, ground connections, battery condition, glow plug current levels and so on.

An oil pressure gauge is necessary in order to accurately test engine oil pressure. The best gauges are mineral oil filled to avoid indicator needle bounce. The gauge should have a dial range up to 100 psi in 2 psi increments. Necessary adapters to connect the gauge are available from either the gauge manufacturer, or Kent-Moore Tool Corp.

An all purpose dial indicator set such as J–8001, is also needed. Accurate measurement of clearances, component wear, chain deflection and overhaul dimensional settings is only possible with a dial indicator. A good quality vernier caliper and micrometer set are also needed to check part tolerances.

SCAN TOOL USE

The Tech 2 scan tool is primarily designed to test/interrogate ECM/TCM circuits. The tool is extremely useful in locating sensor, switch, or computer faults that affect engine performance. However, the tool is not really designed to replace vacuum gauges, compression testers, multimeters or 12 volt test lamps.

GLOW PLUG OPERATION

In the diesel engine, air alone is compressed in the cylinder. Then, after the air has been compressed, a charge of fuel is sprayed into the cylinder and ignition occurs, due to the heat of compression. Eight glow plugs are used as an aid to starting. Control of the instant start system (ISS) glow plugs is accomplished by an electronic glow plug control unit and 4.7 volt glow plugs, requiring 2þseconds to heat up to 1,000°C (1,832°F). The temperature and the power consumption is controlled between the engine control module (ECM) and the controller within a wide range to suit the engine's pre-heating requirements. Each glow plug is energized individually. This capability yields more optimum heat times for the glow plugs, thus pre-glow times can be kept to a minimum for short wait to crank times and maximum glow plug durability.

A NORMAL FUNCTIONING SYSTEM OPERATES AS FOLLOWS:

- Turn the ignition ON with the engine OFF and at room temperature.

- The glow plugs turn ON and heat up in 2þseconds and then are pulse-width modulated (PWM) for another 2þseconds.
- The glow plug wait lamp is ON for 1þsecond.
- If the engine is cranked during or after the above sequence, the glow plugs may cycle ON and OFF after the ignition switch is returned from the start position, whether the engine starts or not. The engine does not have to be running to terminate the glow plug cycling.

The glow plug initial ON time will vary based on the system voltage and temperature. Lower temperatures cause longer ON times.

The ECM provides glow plug operation after starting a cold engine. This post-start operation is initiated when the ignition switch is returned to Run, from the Start position. This function helps clean up excessive white smoke and/or poor idle quality after starting.

GLOW PLUGS

The glow plugs are 4.7 volt heaters in each of the cylinders that turn ON, then pulse-width modulated when the ignition switch is turned to the RUN position prior to starting the engine. They remain pulsing a short time after starting, then they are turned OFF. A Wait to Start lamp on the instrument panel provides information on engine starting conditions. The Wait to Start lamp will not illuminate during post-start glow plug operation.

GLOW PLUG/CONTROLLER

The glow plug controller is a solid state device which operates the glow plugs. The glow plug controller is connected to the following circuits:

- The fuel heater ignitionþ1 voltage circuit
- The battery voltage circuit
- The CAN communication circuit located between the engine control module (ECM) and the glow plug controller
- The engine ground circuit
- The glow plug supply voltage circuits located between the glow plug controller and the glow plugs.

The glow plug diagnostic circuits are directly monitored individually by using a separate transistor to control current to each glow plug. Individual diagnosis is thus possible for every glow plug (Figure 2-4).

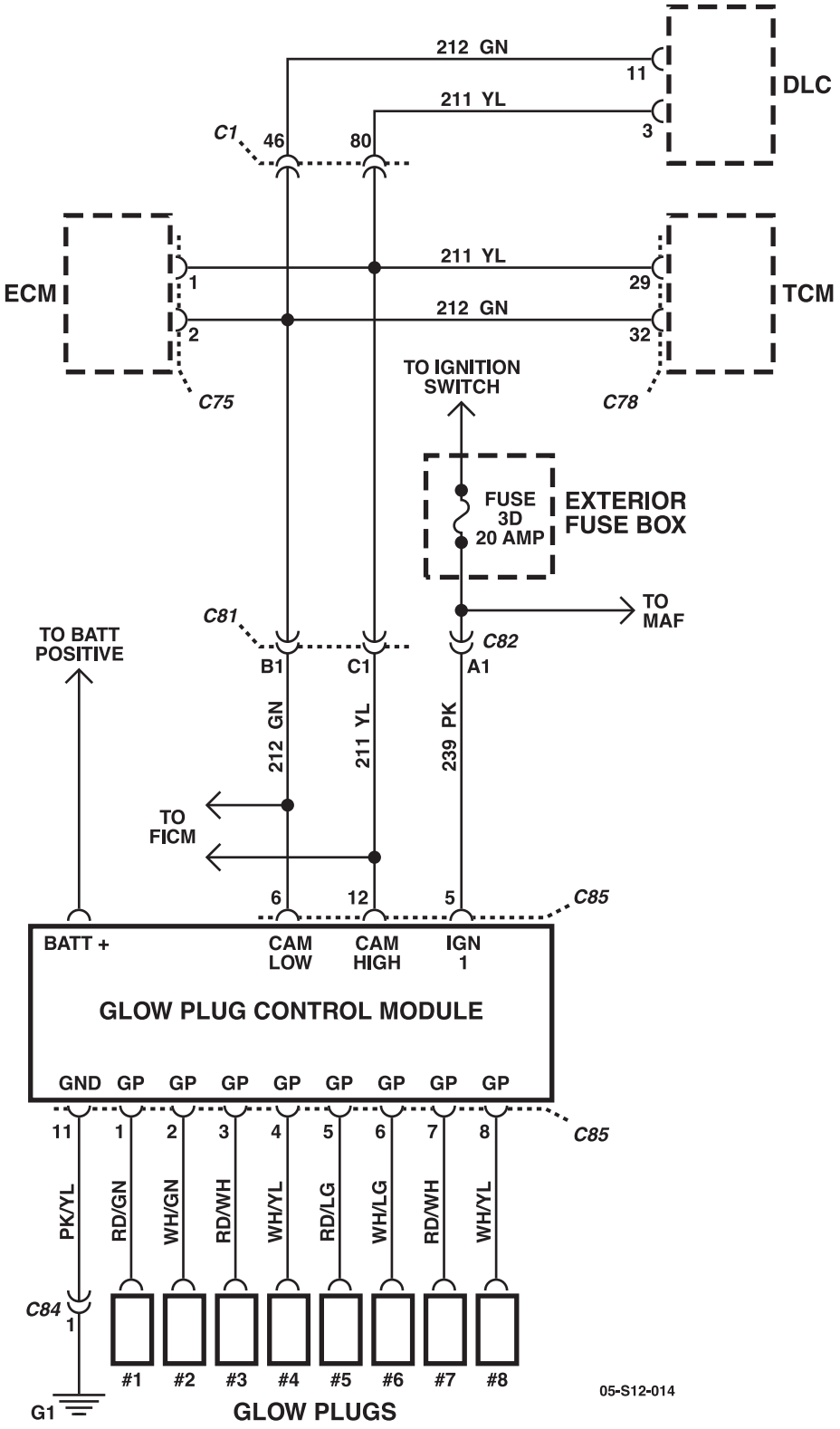


Figure 2-4: Checking Current at Each Glow Plug

ENGINE DIAGNOSIS

Oil Pump Pressure Test

Remove the number one oil gallery plug on the driver side of the engine block. Install J-21876-6. Operate the engine and measure the engine oil pressure. The oil pressure minimum hot at idle is 14psi and 42psi at 1800 RPM.

Possible causes:

- Pump pickup strainer or tube loose
- Pump pressure relief valve or spring problem
- Pump gears worn, chipped
- Pump shaft worn, slipping
- Oil galley plug loose, missing
- Main bearings severely worn
- Cam bearing turned (spun) or misaligned

General Information

The diagnosis charts describe common faults that may occur. Potential causes are listed in order of probability. Although the charts list frequent causes for specific engine related problems, they do not cover every possible cause. The charts are intended to serve as guides only.

The diagnosis information in this section is aimed at solving engine mechanical problems with normal shop diagnostic equipment.

Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Hard Starting	1. Insufficient cranking speed (below 100 rpm cold or 180 rpm hot). Caused by: • Low batteries • Bad cable connections • Serpentine belt or alternator problem	1. Check, repair cables or connections. Recharge batteries if low. Replace batteries if shorted, sulfated or damaged. Replace belt or tensioner if damaged. Test alternator output and repair or replace if low.
	2. Starter problem • Poor connections • Relay • Solenoid • Brushes • Armature • Starter drive damage	2. Check/repair cable and solenoid connections if needed. Check starter draw; overhaul if draw exceeds 450-475 amps. Remove and overhaul starter if brushes, starter drive or armature are faulty.
	3. Insufficient fuel to injectors.	3. Check fuel volume at supply pump and injectors while cranking engine. If volume is low, check for restrictions in lines or at filter. If volume is OK, check pressure at pumps and injectors and repair as needed.
	4. Water in fuel (filter indicator light NOT on).	4. Drain off water at fuel filter drain cock. Then pump the hand primer with drainback open for 5-10 seconds to purge remaining water. If water continues to appear in fuel coming out drain cock, purge fuel tank and lines and refuel vehicle.

Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
	5. Glow plugs inoperative (most noticeable at cold ambient temperatures).	5. Check fuse and wiring harness to plugs. Correct open or short as required. Refer to diagnosis in Section 12 if required.
	6. Air in fuel delivery lines.	6. Check for loose fuel line connections at pump and injectors. Correct if necessary then bleed any remaining air with hand primer.
	7. Fuel return lines restricted or tank vent inoperative.	7. Check return lines (from engine to tank) and correct restrictions, kinks, plugged lines. Make sure tank vent is OK. Repair as necessary.
	8. Air cleaner plugged (after extended off-road operation).	8. Remove and clean air intake components. Replace filter element if plugged or restricted.
	9. Vehicle misfueled.	9. Drain sample at filter drain cock. Replace fuel load if fuel contains gasoline, kerosene, fuel oil or low quality fuel.
Hard Starting When Hot	1. Wrong fuel or poor quality fuel.	1. Drain and refill tank. Purge rest of fuel system and bleed.
	2. Air leaks in fuel supply (suction) lines.	2. Check lines at fuel pump and injectors for leaks or loose fittings. Tighten or replace lines as needed.
	3. Fuel return or vent line restricted.	3. Clear or replace either line if restricted, pinched or damaged.
	4. Low compression due to rings, pistons, valves.	4. Check compression and overhaul engine if necessary.
Hard Starting When Cold	1. Incorrect grade of diesel fuel.	1. Drain and refill fuel tank and filter. Bleed and purge lines as needed.
	2. Water in fuel or wax buildup in filter.	2. Drain water. Remove and clean filter and lines if wax formation has occurred.
	3. Glow plugs inoperative.	3. Repair wiring or replace faulty glow plug(s).
Engine Will Not Crank	1. Shift lever not entirely in Park (or Neutral position).	1. Check and correct linkage adjustment as needed.
	2. Insufficient battery voltage due to: • Low Charge • Corroded connections • Damaged Cables or solenoid wires	2. Check batteries and cable connections. Charge low batteries and check generator and belt. Replace failed battery(s). Clean corrosion from cables connections. Replace or repair cables or terminals as needed.
	3. Blown fuse.	3. Check fuse condition at fuse boxes. If blown fuse is found, check circuit for shorts, grounds.
	4. Park/Neutral position switch problem.	4. Test switch continuity with ohmmeter. Replace switch if open/shorted.

Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
	5. Starter or solenoid problem.	5. Check for bad or loose connections at starter and solenoid. If OK, note if starter surges when current is applied. Problem may be with Bendix or armature.
	6. Hydrostatic lock. Combustion chambers filled with fuel or coolant due to faulty injectors, or blown head gasket. (Remove glow plugs, crank engine and note fluid coming out of plug holes).	6. Test and replace injectors that are stuck open. Replace blown head gasket or replace head if cracked.
	7. Flywheel ring gear teeth or starter Bendix damaged.	7. Remove transmission access cover and inspect ring gear and bendix. Replace flywheel or starter Bendix as necessary.
Engine Stalling	1. Air leaks in fuel lines.	1. Check lines from fuel pump to injectors. Replace lines that leak or have damaged fittings. Tighten loose injectors. Bleed afterward.
	2. Fuel filter partially plugged by wax formation, dirt/sludge or partially water filled.	2. Drain off filter contents at drain cock. Clean out fuel tank and lines if filter contained sludge. Clean out filter if full of wax or dirt.
	3. Misfueled, wrong fuel or low quality fuel.	3. Drain and refill tank. Drain fuel filter and bleed the fuel system.
	4. Restricted air intake due to plugged filter element, air cleaner, intake duct. Generally caused by extended off -road operation in dusty areas.	4. Replace filter if necessary. Remove and clean out air cleaner body, intake duct, cap, hoses and dust unloader.
	5. Fuel drain back or return lines restricted/ damaged.	5. Inspect and repair or replace lines, clamps as needed.
Low Power, Poor Acceleration	1. Vehicle overloaded.	1. Lighten vehicle load.
	2. Low grade diesel fuel.	2. Drain tank and refuel.
	3. Sludge or wax buildup in fuel filter (low fuel supply).	3. Drain and clean filter.
	4. Air in fuel supply system.	4. Check lines from fuel supply pump and to injectors. Replace leaking, damaged lines as needed. Bleed air at hand prime pump.
	5. Restriction in air intake system.	5. Check air intake cap, duct, air cleaner, hoses and air horn. Clean/repair as needed. Replace filter if plugged.
	6. Turbocharger, related wiring fault may have occurred. May also be caused by exhaust gasket failure.	6. Check wiring and ECM with scan tool. Check for intake/exhaust leaks. Replace turbocharger or related components as indicated by diagnosis.
	7. Injection pump or injector failure.	7. Diagnose and replace pump as needed. Replace damaged injectors.

Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
	8. Engine problem: • Piston, ring or valve wear. • Worn cam lobes. • Damaged piston(s).	8. Check compression. Then disassemble engine and repair as needed. Remove engine completely if diagnosis indicates crankshaft, rod or piston problem.
Exhaust Smoke: Blue Smoke	1. Worn piston rings, valve stem seals or valve guides.	1. Remove glow plugs and check compression. Then repair valve train and cylinder heads or perform piston ring replacement.
White Smoke	1. Low quality fuel.	1. Drain and refill tank with better quality fuel.
	2. Engine timing is retarded.	2. Check and correct timing.
	3. Engine coolant entering combustion chamber through blown gasket, cracked head, loose/damaged head bolts. May be accompanied by low coolant level and overheating.	3. Verify problem and repair as necessary. Replace cracked head, block or head gasket.
	4. Low ambient temperatures (below freezing).	4. Normal condition caused primarily by water vapor. Not a concern unless it continues after warm up.
Black Smoke	1. Low grade diesel fuel.	1. Drain and refill tank.
	2. Overrich fuel mixture: • Drain/return lines restricted. • Injector(s) stuck open. • Engine speed or throttle sensor fault.	2. Test, diagnose and repair as required.
	3. Black smoke at wide open throttle.	3. Restriction in air intake system, air leak at intake or exhaust manifold.
Gray Smoke	1. Long idle periods.	1. Try to avoid prolonged idling.
	2. Low grade fuel.	2. Add proper quality fuel. (not necessary to drain and refill tank).
	3. Fuel tank vent restricted.	3. Clear vent and line.
	4. Fuel return line restricted.	4. Clear restriction. Replace line if kinked or pinched.
	5. Engine problem (low compression excessive blowby, worn rings or valve stem seals).	5. Diagnose and repair as indicated.
Excessive Oil Consumption	1. Prolonged high speed, high load or overload operation.	1. Reduce overload or speed as needed.
	2. Incorrect oil grade used for high ambient temperature operation.	2. Switch to C1-4/CH-4 oil with SAE viscosity rating of 15W-40, 10W-30.

Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
	3. Oil leaks at: • Rocker covers • Oil pan • Rear main seal • Oil filter • Timing gear cover or seal • Cooler hoses/lines	3. Locate and correct leaks as needed.
	4. Engine problem: • Worn broken piston rings • Worn valve seats or guides	4. Run compression test to verify ring problem. Overhaul cylinder heads if guides, seals or valves are worn. If wear is premature, check injectors and injection pump. Excessive fuel will wash oil off walls/guides causing ring and valve wear.
Engine Vibration **NOTE**: See road test information in this section.	1. Loose engine accessories: • Alternator • A/C compressor • Power steering pump • Mounting brackets • Pulleys • Belt tensioner • Serpentine belt • Drive pulleys	1. Check and repair as needed. Replace damaged missing bolts and apply Loctite 242 to loose bolt threads. Replace serpentine belt if damaged. Replace bent or broken pulleys.
	2. Torsional damper damaged or loose.	2. Replace damper if damaged, worn or loose.
	3. Flywheel (driveplate) cracked or loose.	3. Replace flywheel and also check for ballooned or damaged converter.
	4. Torque converter imbalance caused by internal damage or missing balance weight.	4. Replace converter.
Overheating	1. Dirt, debris blocking air flow through coolers, condenser and radiator.	1. Remove and clear fins with compressed air, soft bristle brush or water stream.
	2. Low coolant level.	2. Add coolant and check for leaks (hoses, surge tank, hose connections, water pump and radiator).
	3. Serpentine belt loose, worn or tensioner inoperative.	3. Replace belt and/or tensioner if either part has failed or is worn beyond limit.
	4. Prolonged idling/slow speed operation in heavy traffic when ambient temperatures are high.	4. If this type operation cannot be avoided, have driver turn on heater and “rev” engine when stopped in traffic. This will help dissipate some heat and get more air through radiator (from fan).
	5. Failed thermostat or radiator cap.	5. Check thermostat and cap operation. Replace either part if inoperative.
	6. Geared fan drive inoperative.	6. Replace geared fan drive.
	7. Water pump inoperative.	7. Check coolant flow and replace pump if necessary.

Engine Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
	8. Blown head gasket.	8. Verify that coolant is leaking into combustion chamber and replace gasket.
	9. Crack in block or leaking freeze plug.	9. Replace corroded freeze plugs. Replace block if cracked.
	10. Coolant temperature gauge or sensor faulty.	10. Test and replace gauges or sensors as needed.
High Fuel Consumption	1. Prolonged high speed - high load operation.	1. Normal with this type of operation. Have driver reduce speed or load if possible.
	2. Air cleaner/filter partially plugged.	2. Remove and clean air horn, intake hose and air cleaner. Replace filter.
	3. Fuel leaks in lines, hoses at connections.	3. Locate and repair as needed.
	4. Restriction in exhaust system (should also be accompanied by drop in power).	4. Inspect and replace bent, kinked or damaged components.
	5. Decrease in boost on turbocharged models, caused by manifold leak or turbo damage.	5. Correct leaks. Replace turbocharger if inoperative.
	6. Brake drag.	6. Repair stuck/seized calipers.
	7. Converter one way clutch failure.	7. Replace converter.
	8. Injection pump internal problem.	8. Diagnose and replace as necessary.
	9. Power loss due to worn rings, valve guides, cylinder bores, valves, etc.	9. Overhaul engine.

TURBOCHARGER SERVICE AND DIAGNOSIS

Description

The turbocharged diesel engine is equipped with an IHI turbocharger. Vanes in the turbine housing control the boost. The position of the vanes is variable and controlled by a vain position solenoid based on information sent to the ECM by the boost sensor. The vane position is monitored by the vane position sensor. This allows a proportionate increase in fuel injected into the cylinders. The result is a much denser cylinder charge and greater power output.

The turbocharger turbine and compressor impellers are the mechanisms that pump additional air into the combustion chambers. The impeller wheels are operated by the high speed gas flow through the engine exhaust system.

The turbocharger is mounted in the lifter valley at the rear of the engine block. It is positioned between the two halves of the intake manifold.

A turbocharger is fundamentally an air pump used to generate additional engine power. This is accomplished by increasing volume and pressure of air entering the engine combustion chambers. An increase in air volume allows a proportional increase in fuel injected into the cylinders. The net result is a denser fuel/air mixture. A denser mixture produces more power when compressed and burned in the combustion chamber.

A turbocharger feature concerns the method of operation. The turbocharger turbine and compressor impellers are rotated by the flow of engine exhaust gases. As a result, separate drive belts and pulleys are not needed.

The turbocharger used on 6.6L engines consists of a turbine impeller and housing, a compressor impeller and housing, turbocharger vanes, vane position sensor, vane position control solenoid valve, vane position unison ring, hydraulic piston, cam and an impeller connecting shaft (Figure 2-5).

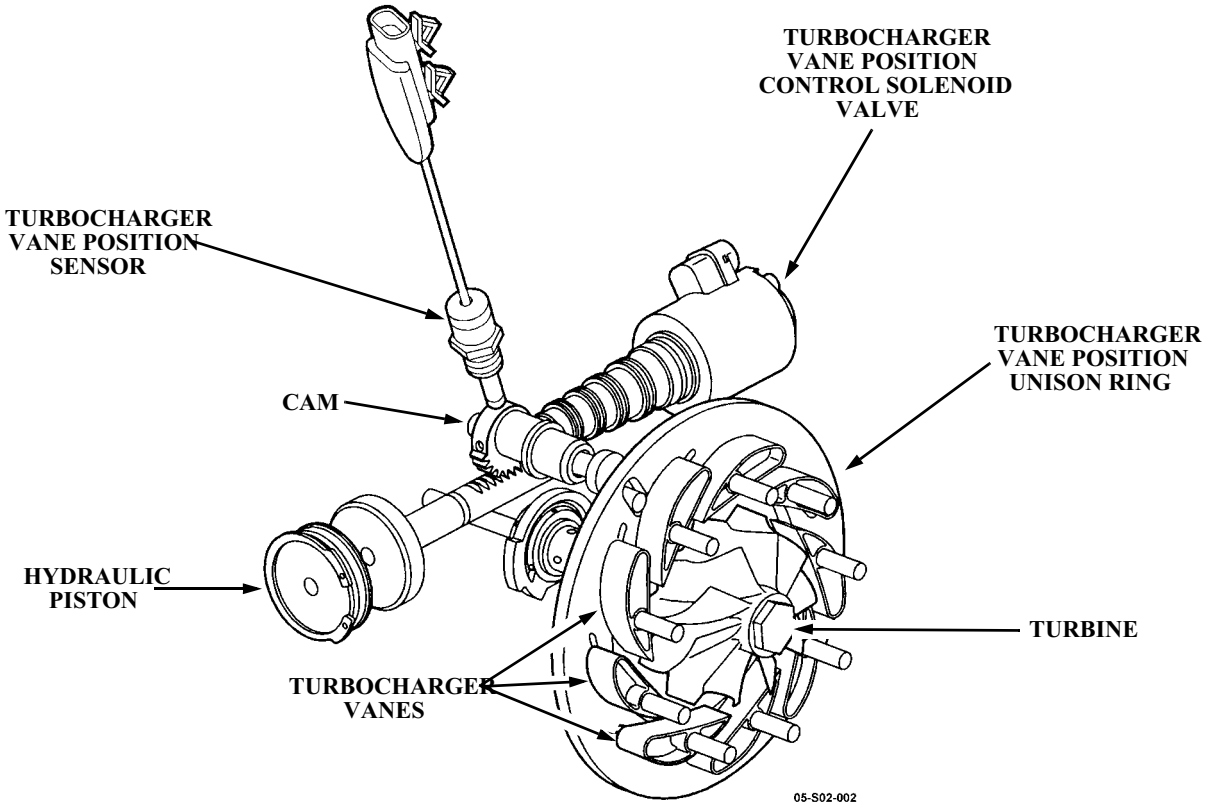


Figure 2-5: Turbocharger Components (Typical)

Turbocharger Operation

The turbocharger increases engine power by pumping compressed air into the combustion chambers, allowing a greater quantity of fuel to combust at the optimal air/fuel ratio. In a conventional turbo, the turbine spins as exhaust gas flows out of the engine and over the turbine blades. This spins the compressor wheel at the other end of the turbine shaft, pumping more air into the intake system. The turbocharger for this system has vane position control by the engine control module (ECM). The vanes can be opened and closed to vary the amount of boost pressure. The boost pressure can be controlled independent of the engine speed. There are controllable vanes in the turbocharger. The vanes mount to a unison ring that can be rotated to change the vane angle. When the engine is not under load, the vanes are open to minimize boost and the exhaust back pressure. To increase boost when the engine load requires it, the vanes are commanded closed. The ECM will vary the boost dependent upon the load requirements of the engine. The turbocharger vanes are normally open when the engine is not under load. However, the ECM will often close the turbocharger vanes to create back pressure to drive the exhaust gas through the exhaust gas recirculation (EGR) valve as required. At extreme cold temperatures, the ECM may close the vanes at a low load conditions in order to accelerate the engine coolant heating.

TURBOCHARGER LEARN PROCEDURE

Description

The turbocharger (TC) learns the vane positions automatically during each ignition cycle. The engine control module (ECM) performs the turbocharger learn procedure automatically when the enable criteria are met. After each ignition cycle, and before the enable criteria ha been met, the ECM will use the previously learned value. If the ECM does not have a previously learn value, it will default to a stored calibrated value. The ECM will use this value until the enable criteria have been met. It will then perform this procedure to learn the new value. If the ECM attempts to perform the learn procedure and fails, DTCsþP0046 or P2563 may set.

The turbocharger learn procedure must be performed manually with a Techþ2 when any turbocharger system service has been performed. Certain enable criteria must be met for the ECM to perform this procedure.

The turbocharger learn procedure is required when the following service procedures have been performed:

- The turbocharger vane position control solenoid valve replacement
- The turbocharger vane position sensor replacement
- The engine control module (ECM) replacement
- The turbocharger replacement
- Any service that disturbs the turbocharger components

Learn Procedure

NOTE: Once the enable conditions have been met the throttle must remain at idle. Do not change the accelerator pedal position (APP) during this procedure.

The following conditions must be met for the ECM to perform the turbocharger learn procedure:

- The A/C is OFF.
- The vehicle is in Park or Neutral.
- Start and idle the engine.
- The engine coolant temperature (ECT) is more than 104°F (40°C).

After the enable conditions have been met and the engine idle is stabilized, enter the TC Learn Output function from the Engine Output Control Menu. Command the TC Vane Position Sensor ON for at least 5þseconds, then command it OFF. The system should have learned the new turbocharger position. The TC Learned parameter should have toggled from No to Yes.

Electronic Accelerator Pedal

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3þindividual sensors within one housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the accelerator pedal sensor assembly with the ECM. Each sensor has a unique functionality to determine pedal position. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle. The APP sensorþ1 voltage should increase as the accelerator pedal is depressed, from below 1.0þvolt at 0þpedal travel to above 2þvolts at 100þpercent pedal travel. APP sensorþ2 voltage should decrease from above 4þvolts at 0þpedal travel to below 3.0þvolts at 100þpercent pedal travel. APP sensorþ3 voltage should decrease from above 3.8þvolts at 0þpercent pedal travel to below 3.3þvolts at 100þpercent pedal travel (Figure 2-6).

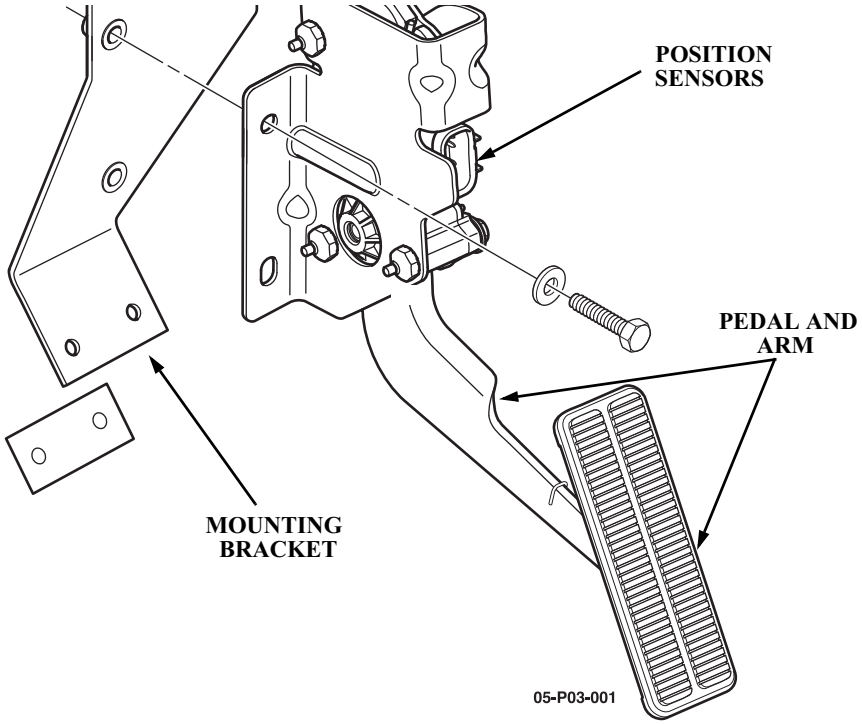


Figure 2-6: Electronic Accelerator Pedal

Turbocharger Removal

1. Remove the center console cover, the upper crash pad, and the engine cover.
2. Disconnect the exhaust down pipe from the turbocharger exhaust housing and remove (Figure 2-7).
3. Remove the turbo pipe heat shields and the turbo pipes (Figure 2-8).
4. Drain the cooling system.
5. Remove the air cleaner outlet duct.
6. Remove the charged air cooler outlet duct from the intake.
7. Remove the charged air cooler inlet duct connector from the turbocharger.
8. Remove the turbocharger inlet coolant hose from the turbocharger coolant bypass valve.
9. Reposition the hose clamp and remove the turbocharger outlet coolant hose from the turbocharger.
10. Remove the turbocharger outlet coolant pipe banjo bolt and washers.
11. Remove the turbocharger upper heat shield bolts and remove the turbocharger upper heat shield (Figure 2-9).
12. Remove the turbocharger oil feed pipe banjo bolt and washer and reposition the oil feed pipe out of the way (Figure 2-10).
13. Remove the turbocharger oil return pipe nuts at the top of the flywheel housing.
14. Unplug the vane control solenoid and the vane position sensor.

CAUTION: *The oil line must be removed before the turbocharger assembly, failure to do so may result in damage to the oil line.*

15. Remove the turbocharger bolts and remove the turbocharger (with the oil return pipe).

WARNING: If a turbocharger failure is thought to be caused due to lack of oil, the camshaft bearing should be checked. The numberþ4 camshaft bearing bore feeds the turbocharger oil supply (feed) pipe. If this camshaft bearing spins in the bore, the turbocharger will be starved for oil. This will cause a failure of the turbocharger. Failure to diagnosis this condition will result in repeat turbocharger failures.

Turbocharger Installation

1. If a turbocharger has failed, clean any turbocharger debris or excessive oil from the charge air cooler system before installing the new turbocharger. Failure to clean debris from the charge air cooler system will cause severe turbocharger and engine damage upon startup. Failure to clean excessive oil from the charge air cooler system may cause an engine runaway condition on startup, resulting in severe engine damage.
2. Install the oil feed pipe, washer, and the bolt, if necessary tighten the bolt to 34þN·m (25þlbþft).
3. Using a new seals, place the turbocharger assembly on the engine block and secure with three bolts. Torque the bolts to 108þN·m (80þlbþft).
4. Install the turbocharger oil return pipe nuts at the top of the flywheel housing tighten the nuts to 25þN·m (18þlbþft).
5. If installing a NEW turbocharger, add about 120-150þcc (4-5þoz) of clean engine oil in the turbocharger oil feed pipe opening while rotating the impeller.
6. Position the oil feed pipe to the turbocharger.
7. Install a NEW turbocharger oil feed pipe washer and the banjo bolt tighten the bolt to 34þN·m (25þlbþft).
8. Install the left exhaust pipe and install the left exhaust pipe to turbocharger bolts tighten the bolt to 53þN·m (39þlbþft).
9. Install the right exhaust pipe and install the right exhaust pipe to turbocharger bolts tighten the bolt to 53þN·m (39þlbþft).
10. Install the exhaust outlet pipe and tighten the clamp to 15þN·m (11þlbþft).
11. Install the exhaust outlet heat shield and install the remaining exhaust heat shield bolts tighten the bolts to 8þN·m (71þlbþin).
12. Install the turbocharger outlet coolant pipe banjo bolt and washers tighten the bolt to 26þN·m (19þlbþft).
13. Install the turbocharger upper heat shield install the turbocharger upper heat shield bolts and tighten the bolt to 9þN·m (80þlbþin).
14. Install the charged air cooler inlet duct connector to the turbocharger tighten the charged air cooler inlet duct connector to the turbocharger clamp tighten the clamp to 6þN·m (53þlbþin).
15. Install the charged air cooler outlet duct to the intake and tighten the charged air cooler outlet duct to intake hose clamp tighten the clamp to 6þN·m (53þlbþin).

16. Install the right turbo pipe and tighten the bolts to 53þN·m (39þlbþft).
17. Install the left turbo pipe and tighten the bolts to 53þN·m (39þlbþft).
18. Install the turbo pipe heat shields and tighten the bolts to 8þN·m (71þlbþin).
19. Install the engine cover, the center console, the right side crash pad, the upper crash pad.
20. Fill the cooling system.
21. Perform the turbocharger learn procedure.

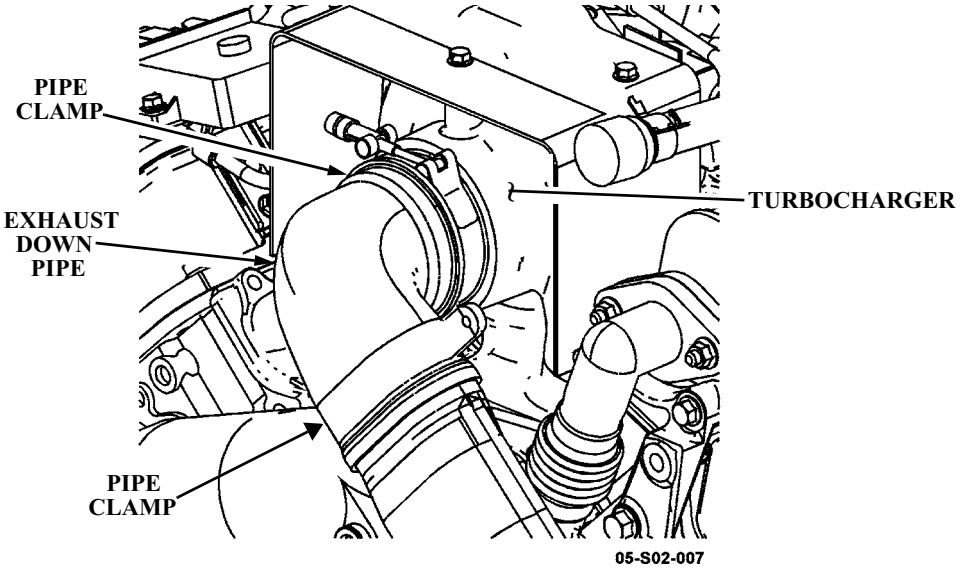


Figure 2-7: Exhaust Down Pipe

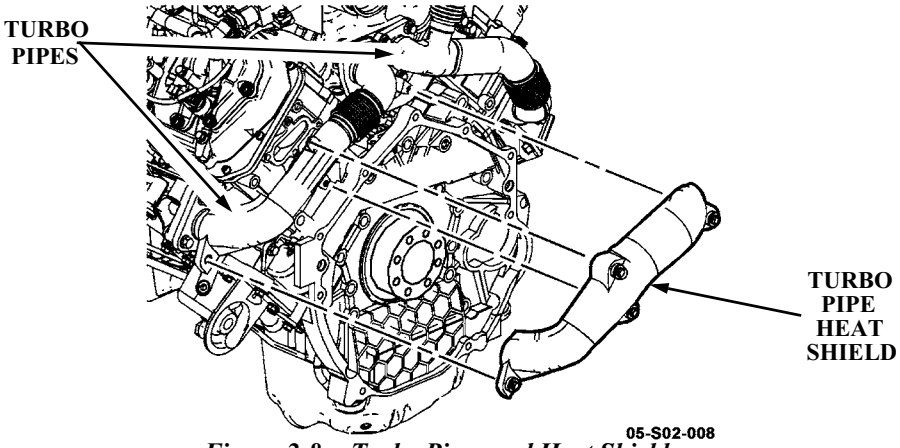


Figure 2-8: Turbo Pipes and Heat Shield

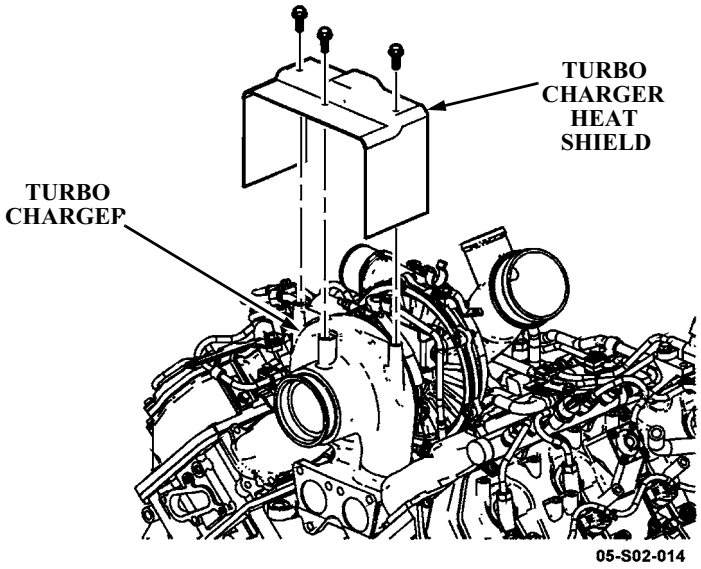


Figure 2-9: Turbo Heat Shield

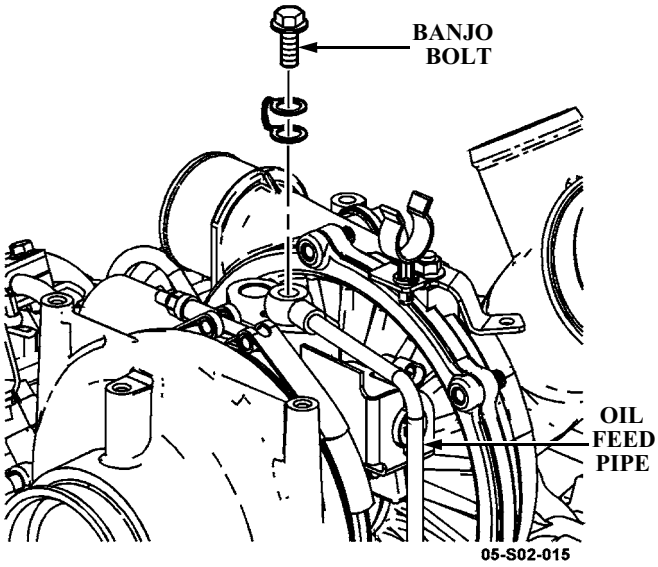


Figure 2-10: Oil Feed Pipe

Turbocharger Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Low Power Poor Acceleration (Black smoke not evident at 1/2 to wide open throttle)	1. Lean fuel mixture caused by insufficient fuel volume or pressure.	1. Problem is in fuel delivery system. Check fuel supply pump pressure, look for leaks in lines and at fittings, plugged fuel filter, accelerator cable problem, injection pump problem. Refer to low power information in guides for standard diagnosis.

Turbocharger Diagnosis

PROBLEM	POTENTIAL CAUSE	CORRECTION
Low Power, Poor Acceleration (Black smoke evident at 3/4 to wide open throttle)	1. Air filter plugged.	1. Replace filter.
	2. Restriction in air intake duct to turbocharger compressor wheel.	2. Remove and inspect duct components. Remove/repair any restrictions.
	3. Air leak in turbocharger compressor inlet and outlet ducts. May be accompanied by high pitch whine indicating system air leak.	3. Disassemble, inspect, repair worn, damaged or loose parts.
	4. Air leak at intake manifold.	4. Tighten loose bolts. Or, remove manifold and replace gaskets if necessary.
	5. Exhaust leak between cylinder head ports and turbine inlet of turbocharger.	5. Check exhaust manifolds pipes and turbocharger connections for leaks. Replace damaged components, tighten loose fasteners.
	6. Turbocharger damaged internally.	6. Remove and inspect turbocharger. Replace if compressor/turbine wheels or other internal components are damaged.
	7. Fuel system problem (over-rich mixture).	7. Refer to low power information in standard diagnosis.
Turbocharger Noise	1. Obstruction in air intake or outlet systems may cause high pitch whine.	1. Disassemble and clear blockage or restriction.
	2. Compressor/turbine impeller contacting housing, or other internal damage. May be accompanied by vibration.	2. Replace turbocharger.
Blue Exhaust Smoke with Warm Engine Only	1. Insufficient intake air volume.	1. Disassemble, inspect and clear any restrictions. Replace damaged, worn ducting parts.
	2. Partially plugged oil drain tube.	2. Remove and clear tube. Replace tube if fully plugged, pinched or kinked.
	3. Oil Leaking past worn compressor or turbine side seals.	3. Replace turbocharger.
	4. Engine problem caused by worn rings or valve seals.	4. Overhaul cylinder heads or engine as needed.

DIESEL ENGINE IN-VEHICLE SERVICE

General Information

The repair procedures described in this section cover engine service that can be performed in the vehicle. Engine removal is not required.

Left/Right Orientation

Left/right orientation throughout this section is from the driver seat. A left side location refers to the driver side of the vehicle and a right side location to the passenger side.

ENGINE MOUNTING BRACKET/INSULATOR LEFT SIDE

Removal

1. Remove the drive line protection.
2. Remove the nuts/bolts attaching the front propeller shaft center bearing to the bracket.
3. Support the engine with a floor jack and a wood block or a safety stand if the vehicle is on a hoist. Position the block or the stand under the oil pan rail at the rear main.
4. Remove the nuts/bolts attaching the insulator bracket to the frame and the insulator from the engine block.
5. Remove the insulator from the vehicle and the bolts securing the insulator to the bracket.

Installation

1. Secure the new engine insulator to the bracket with the bolts and tighten to 48 lb-ft. (65N•m).
2. Start the nuts/bolts attaching the insulator bracket to the frame and the insulator to the engine block.
3. Tighten the nuts/bolts attaching the insulator bracket to the frame to 90 lb-ft. (122N•m).
4. Tighten the nuts/bolts attaching the insulator to the engine block to 43 lb-ft. (58N•m).
5. Tighten the center bearing attaching bolts to 60 lb-ft. (81 N•m).
6. Install the drive line protection.

ENGINE MOUNTING INSULATOR RIGHT SIDE

Removal

1. Remove the drive line protection.
2. Support the engine with a floor jack and a wood block or a safety stand if the vehicle is on a hoist. Position the block or the stand under the oil pan rail at the rear main.
3. Remove the nuts/bolts attaching the insulator to the insulator bracket.
4. Remove the nuts/bolts attaching the insulator to the engine block.
5. Remove the insulator through the opening between the body and the top of the frame.

Installation

1. Position the new engine insulator in to place.
2. Start the nuts/bolts attaching the insulator to the bracket and the insulator to the engine block.
3. Tighten the nuts/bolts attaching the insulator to the bracket to 48 lb-ft. (65 N•m).
4. Tighten the nuts/bolts attaching the insulator to the engine block to 43 lb-ft. (58 N•m).
5. Install the drive line protection.

CRANKSHAFT BALANCER

Removal

1. Disconnect the negative battery cable.
2. Remove the drive line protection.
3. Remove the bolts attaching the geared fan drive (GFD) shaft to the crankshaft balancer.
4. Remove the starter motor bolts. Reposition the starter aside. The wiring to the starter does not require removal.
5. Use essential tool J-44643 in order to hold the flywheel to prevent engine from rotating.
6. Position the GFD shaft out of the way to gain access to the crank shaft balancer bolt.
7. Loosen (but do not remove) the crankshaft balancer bolt (Figure 2-11).
8. Remove the serpentine accessory drive belt as follows:
   a. Loosen the drive belt by rotating the belt tensioner in a counterclockwise direction. Use essential tool EN-47913 to rotate the pulley.
   b. Slide the belt off the tensioner and the other pulleys. Then remove the belt.
9. Remove the crankshaft balancer bolt and the crankshaft balancer.

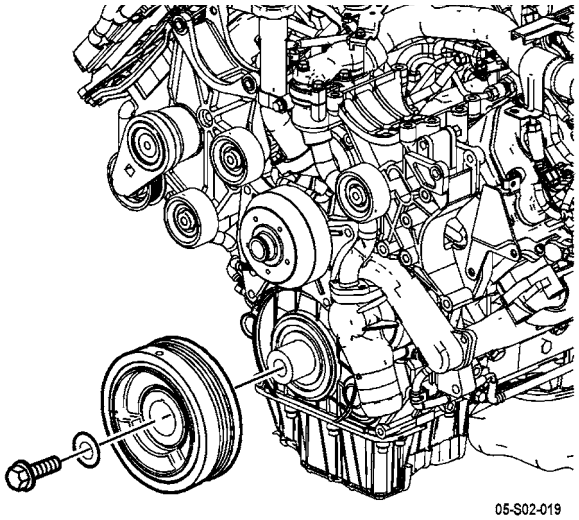


Figure 2-11: Crankshaft Balancer Mounting

Crankshaft Balancer Inspection

1. Clean the crankshaft balancer.
2. Inspect the crankshaft balancer for damage to the belt drive surface and to crankshaft balancer hub.
3. Inspect the balancer hub slot and the keyway for damage or wear.
4. Replace the crankshaft balancer or the keyway if any concerns exist.

Installation

1. Lubricate the crankshaft balancer internal hub with clean engine oil.
2. Install the crankshaft balancer on the crankshaft.
3. Lubricate the crankshaft balancer bolt with clean engine oil.
4. Install the crankshaft balancer bolt and the washer.
5. Tighten the crankshaft balancer bolt to 260 lb-ft. (353þN·m).
6. Remove J 44643 tool from the flywheel.
7. Position the starter motor in place and tighten the starter bolts to 58 lb ft. (78 N•m).
8. Install the serpentine belt on all the pulleys except the belt tensioner (Figure 2-12). Turn the tensioner counterclockwise with essential tool EN-47913 and slide the belt onto the tensioner. Then release essential tool EN-47913 so the tensioner can rotate clockwise to adjust the belt.

9. Install the bolts attaching the geared fan drive (GFD) shaft to the crankshaft balancer and tighten to 37 lb-ft. (50 N•m).
10. Install the drive line protection.
11. Connect the negative battery cable.

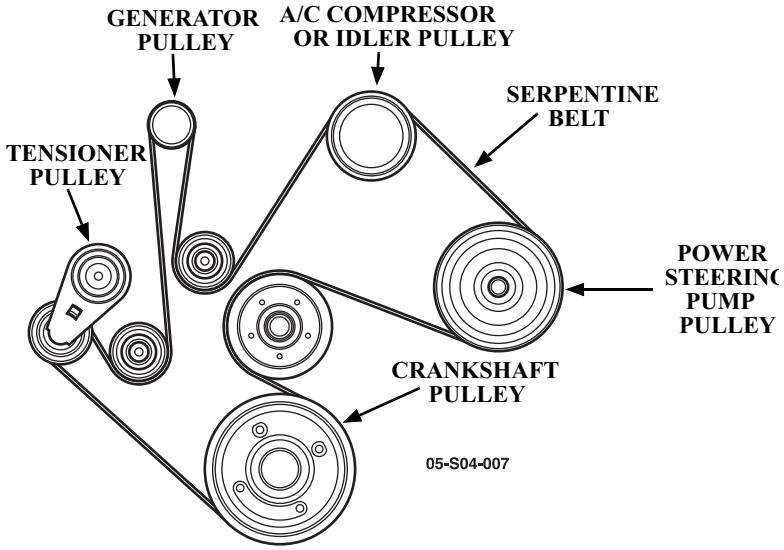


Figure 2-12: Serpentine Belt Installation

FRONT COVER OIL SEAL REPLACEMENT

1. Remove the crankshaft balancer (See "Crankshaft Balancer" on page 2-23) .
2. Remove the oil seal from the front cover with tool J–44644.
3. Clean the front crankshaft seal bore and the crankshaft.
4. Lubricate the crankshaft sealing surface with clean engine oil.
5. Place the crankshaft front oil seal onto the crankshaft.
6. Install tool J–44645 to the crankshaft.
7. Press the crankshaft front oil seal onto the crankshaft using J–44645 until the tool bottoms out (Figure 2-13). Then remove the tool.
8. Install crankshaft balancer and the serpentine belt.

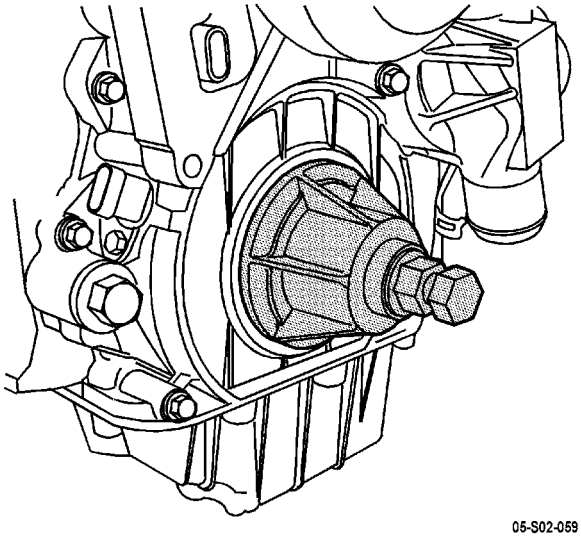


Figure 2-13: Front Cover Crankshaft Seal Installation

REAR MAIN OIL SEAL REPLACEMENT

Removal

1. Remove the transmission and the transfer case assembly.
2. Remove the flywheel.

CAUTION: *Do not nick or scratch the crankshaft seal surface when removing the old seal.*

3. Remove the rear main seal using tools J-44641, J-44641-1 and J-44641-2 (Figure 2-14).

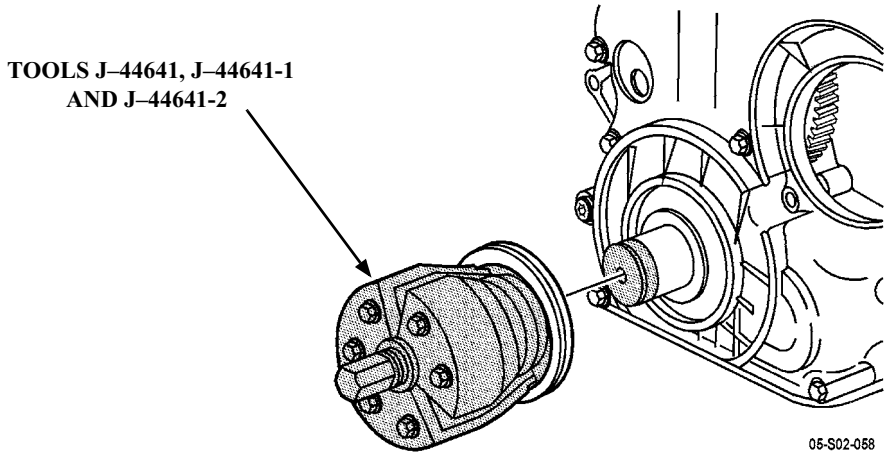


Figure 2-14: Rear Main Oil Seal Removal

Installation

1. Install the new rear main seal using tool J-44642.
2. Install the flywheel.
3. Install the transmission and the transfer case assembly.

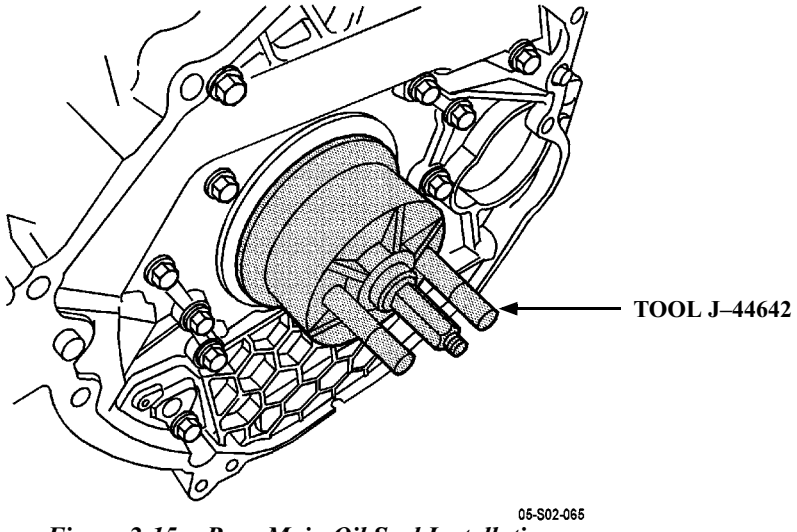


Figure 2-15: Rear Main Oil Seal Installation

ROCKER ARM COVER SERVICE

Right Side Upper & Lower Cover Removal

Upper Cover

1. Disconnect and isolate the negative battery cable.
2. Remove the engine cover.
3. Remove the air horn and the inlet hose.
4. Remove the air cleaner assembly.
5. Remove the charged air cooler outlet duct from the intake.
6. Remove the exhaust gas recirculation (EGR) cooler tube (Refer to section 3).
7. Remove the fuel injection control module (Refer to section 3).
8. Remove the fuel injection control module bracket.

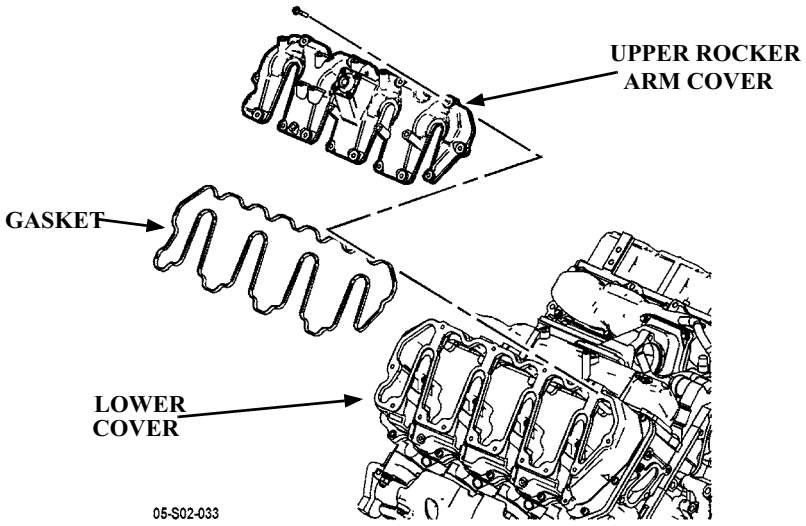


Figure 2-16: Rocker Arm Cover Upper Removal/Installation (Right Side)

9. Remove the transmission dip stick.
10. Remove the transmission harness bracket.
11. Remove the clips securing the injector/glow plug harness to the cover.
12. Remove the fuel injector high pressure lines (Refer to section 3).
13. Remove the right upper valve rocker arm cover bolts and remove the cover (Figure 2-16).

Lower Cover

14. Remove the fuel injectors (Refer to section 3).
15. Remove the bolts securing the lower valve rocker arm cover to the head and remove the cover.

Right Side Cover Upper & Lower Installation

Lower Cover

1. Inspect the lower valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
2. Install the lower valve rocker arm cover and torque the bolts in the sequence shown (Figure 2-18) to 89þlb-in. (10þN·m).
3. Install the fuel injectors.

Upper Cover

4. Inspect the upper valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
5. Install the upper valve rocker arm cover and torque the bolts in the sequence shown (Figure 2-17) to 71þlb-in. (8þN·m).

6. Install the fuel injector pipes (Refer to section 3).
7. Install the clips securing the injector/glow plug harness to the cover.
8. Install the transmission harness bracket.
9. Install the transmission dip stick.
10. Install the fuel injection control module bracket.
11. Install the fuel injection control module (Refer to section 3).
12. Install the exhaust gas recirculation (EGR) cooler tube (Refer to section 3).
13. Install the charged air cooler inlet duct connector to the turbocharger and torque the clamp to 53þlb-in. (6þN·m).
14. Install the air cleaner assembly.
15. Install the air horn and the inlet hose.
16. Install the engine cover.
17. Connect the negative battery cable.

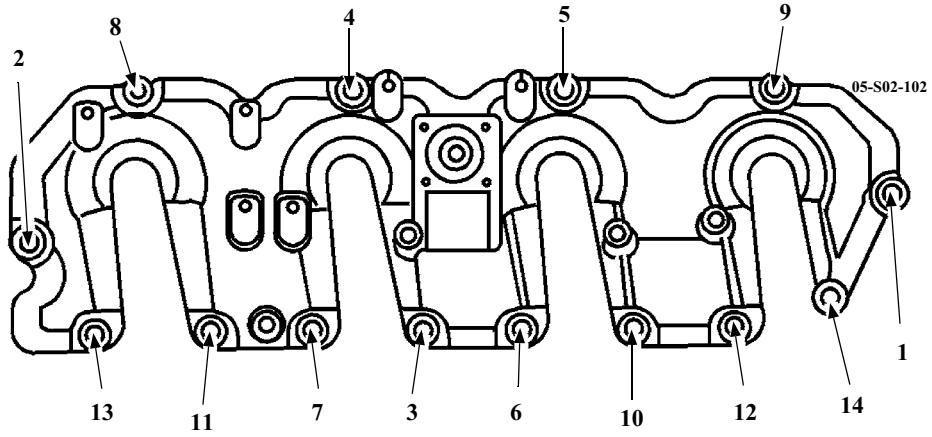


Figure 2-17: Rocker Arm Cover Right Upper Torque Sequence

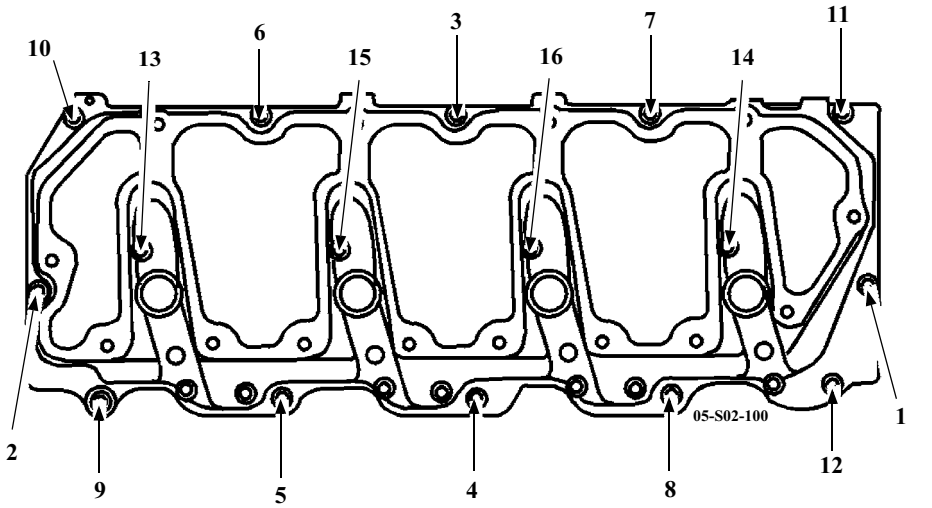


Figure 2-18: Rocker Arm Cover Right Lower Torque Sequence

Left Side Upper & lower Cover Removal

Upper Cover

1. Disconnect and isolate the negative battery cable.
2. Remove the engine cover (Refer to section 10).
3. Remove the charged air cooler inlet duct connector from the turbocharger.

4. Drain the engine coolant.
5. Disconnect the main engine electrical harness connectors.
6. Remove the main engine electrical harness connector hold down bolts.
7. Remove the main electrical connector harness bracket bolts and remove the bracket.
8. Remove the water outlet tube.
9. Remove the positive crankcase ventilation (PCV) hose/pipe.
10. Remove the left fuel injector pipes (Refer to section 3).
11. Remove the upper valve rocker arm cover bolts and remove the cover (Figure 2-19).

Lower Cover

12. Remove the fuel injectors (Refer to section 3).
13. Remove the lower valve rocker arm cover bolts and remove the cover (Figure 2-20).

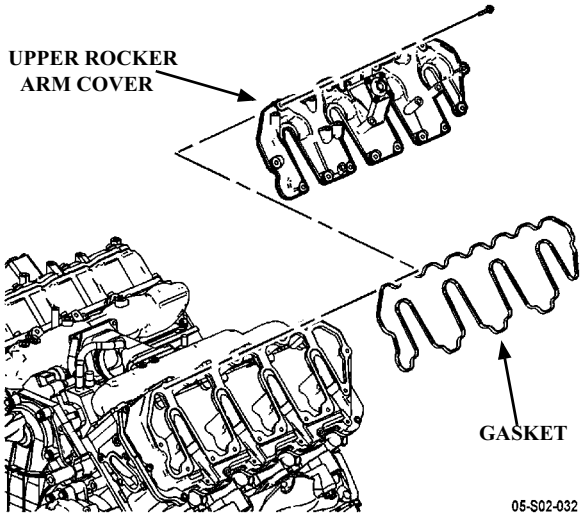


Figure 2-19: Upper Rocker Arm Cover (Left Side)

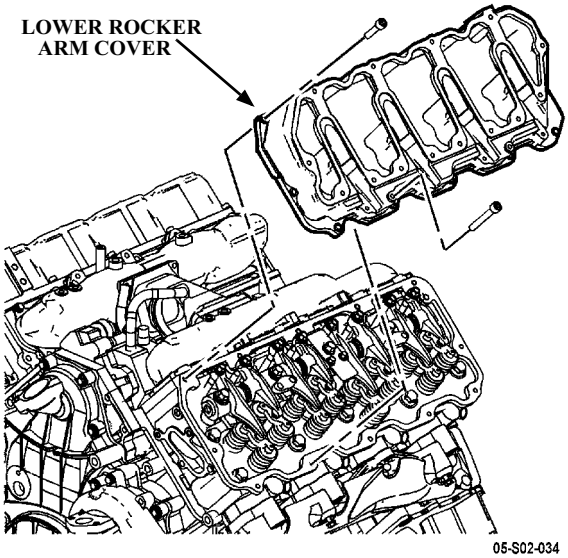


Figure 2-20: Lower Rocker Arm Cover (Left Side)

Left Side Upper & lower Cover Installation

Lower Cover

1. Inspect the lower valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
2. Install the lower valve rocker arm cover and torque the bolts in the sequence shown (Figure 2-21) to 89þlb-in. (10þN·m).
3. Install the fuel injectors (Refer to section 3).

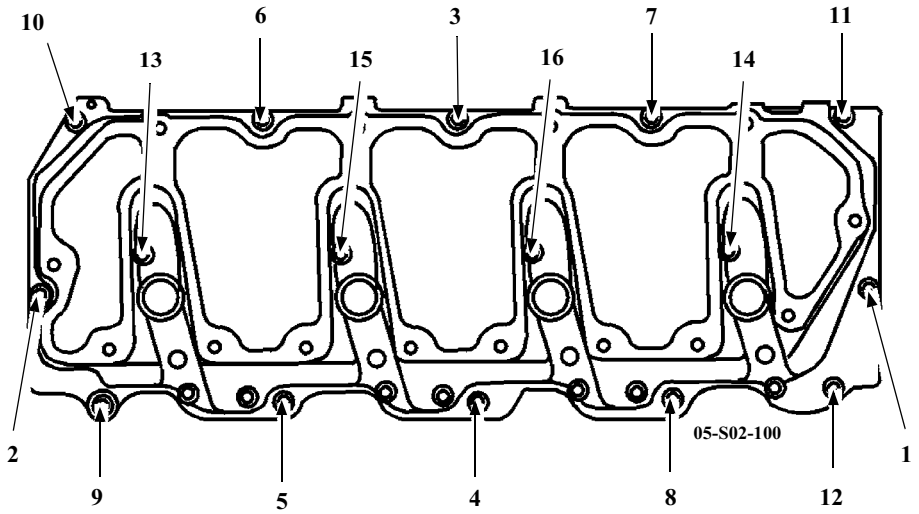


Figure 2-21: Rocker Arm Cover Left Lower Torque Sequence

Upper Cover

4. Inspect the upper valve rocker arm cover gasket for damage, replace if necessary. Otherwise reuse the old gasket.
5. Install the upper valve rocker arm cover and torque the bolts in the sequence shown (Figure 2-22) to 71þlb-in. (8þN·m)
6. Install the fuel injector pipes (Refer to section 3).
7. Install the water outlet tube.
8. Install the PCV hose/pipe.
9. Install the main electrical connector harness bracket and torque the bolts to 15þlb-ft. (21þN·m).
10. Install the main engine electrical harness connector hold down bolts and torque to 89þlb-in. (10þN·m).
11. Connect the main engine electrical harness connectors.
12. Install the charged air cooler inlet duct connector to the turbocharger and torque the clamp to 53þlb-in. (6þN·m).
13. Install the engine cover (Refer to section 10).
14. Fill and bleed the cooling system.
15. Connect the negative battery cable.

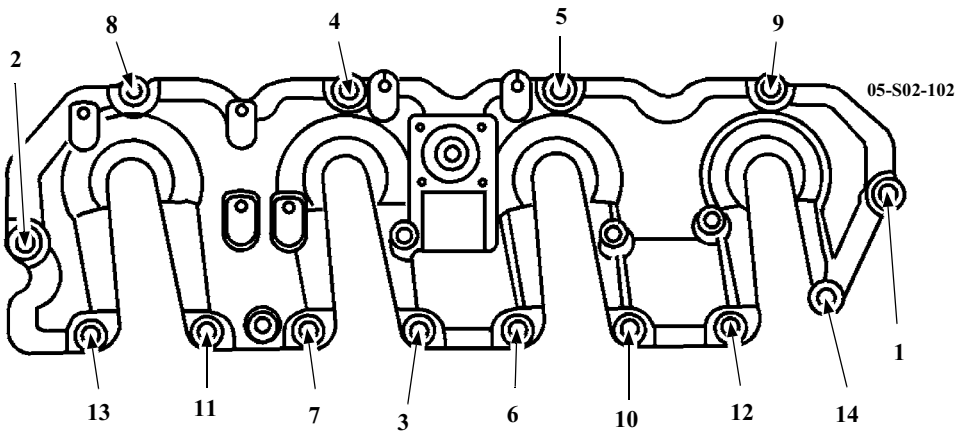


Figure 2-22: Rocker Arm Cover Left Upper Torque Sequence

VALVE ROCKER ARM SHAFT AND PUSH ROD REPLACEMENT

Removal

1. Remove the lower valve rocker arm covers.
2. Loosen the valve clearance lock nuts on each rocker arm.
3. Loosen the valve clearance adjusting screw on each rocker arm in order to relieve tension on the valve train.
4. Remove the rocker arm shaft assembly bolts in the sequence shown (Figure 2-23). Leave the bolts in the rocker arm shaft brackets.

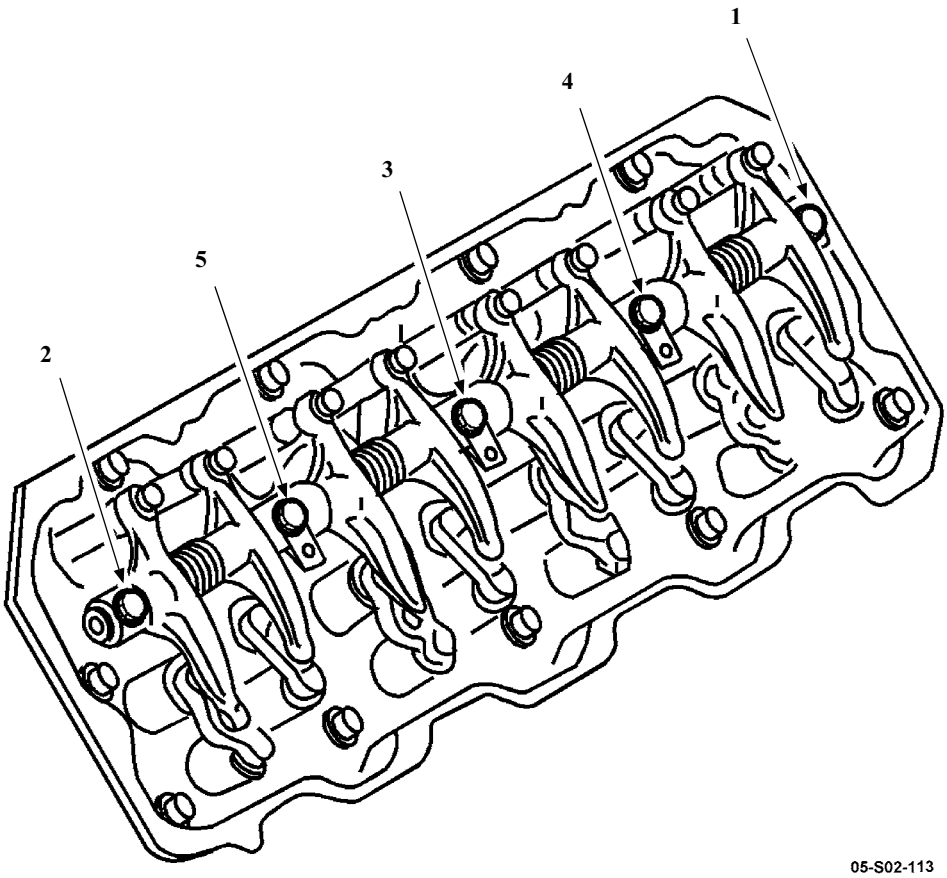


Figure 2-23: Rocker Arm Shaft Removal Sequence

5. Remove the rocker arm shaft assembly from the cylinder head.
6. Remove the valve bridge pins (Figure 2-24).
7. Remove the valve bridges (Figure 2-24).
8. Remove the pushrods (Figure 2-24).

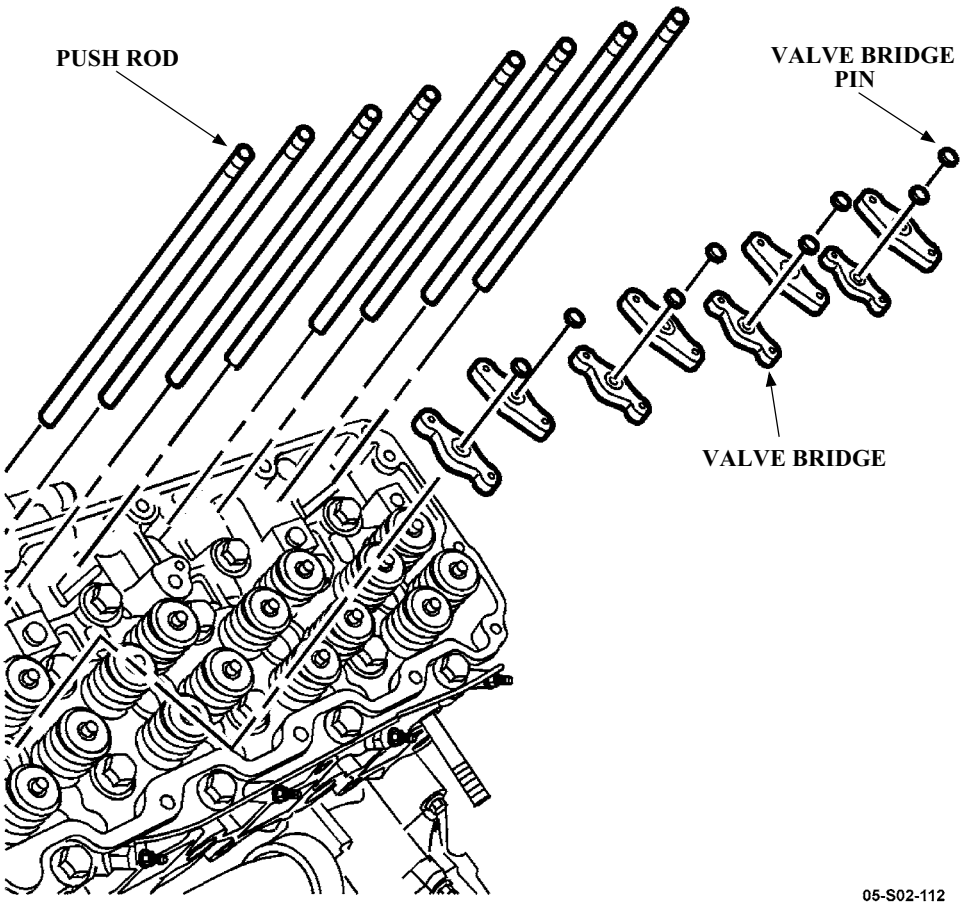


Figure 2-24: Push Rods, Valve Bridge and Valve Bridge Pins

Installation

1. Lubricate the top of the valves, the valve bridge stem, the valve lifter bridge and the valve spring caps with clean engine oil.
2. Install the valve bridge.
3. Install the valve bridge pins.
4. Lubricate the valve lifter end of the pushrod with clean engine oil.
5. Install the pushrods.

NOTE: The pushrods must be correctly seated in the valve lifter and valve rocker arms before the rocker arm shaft assembly is torqued into place. Improper seating of the pushrods can cause damage to the pushrods or the valve rocker arm shaft assembly components.

6. Install the rocker arm shaft assembly.
7. Torque the rocker arm shaft bolts in the sequence shown (Figure 2-25) to 30þlb-ft. (41þN·m).
8. Adjust the valve clearance (Refer to section 2).
9. Install the lower valve rocker arm covers.

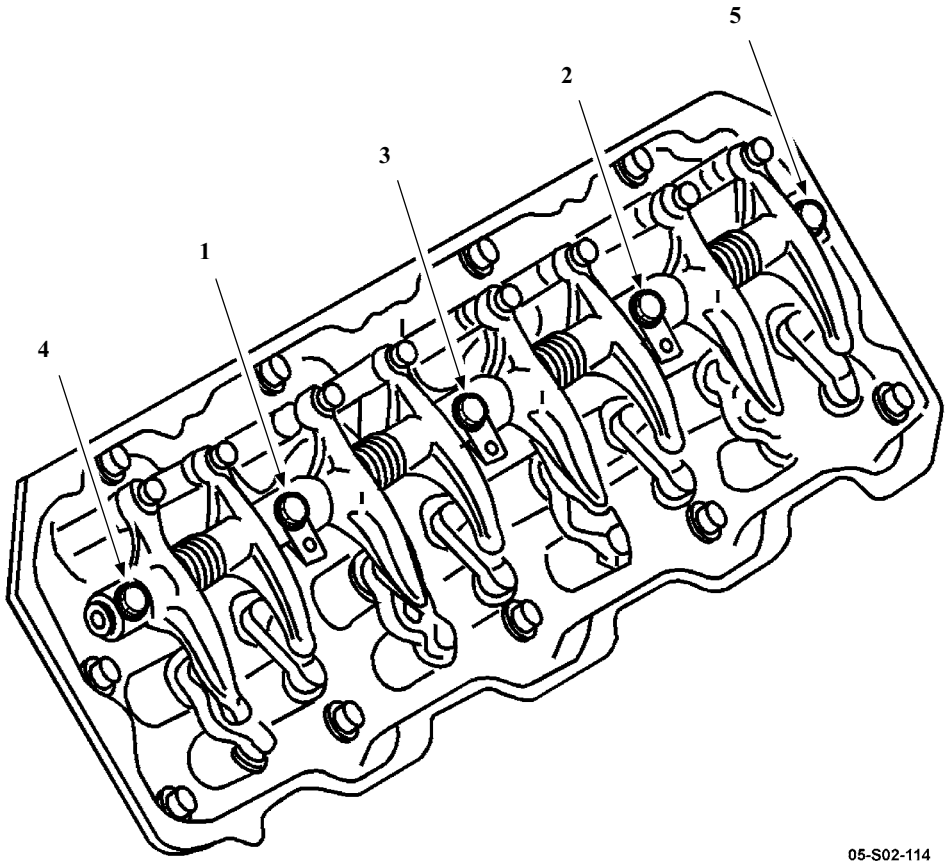


Figure 2-25: Rocker Arm Shaft Torque Sequence

VALVE LASH ADJUSTMENT

1. Rotate the crankshaft to bring the number 1 cylinder at the top dead center of the compression stroke (Figure 2-26). The number 1 cylinder is the front cylinder on the right bank. The mark on the crankshaft balancer should be aligned with the mark on the engine.

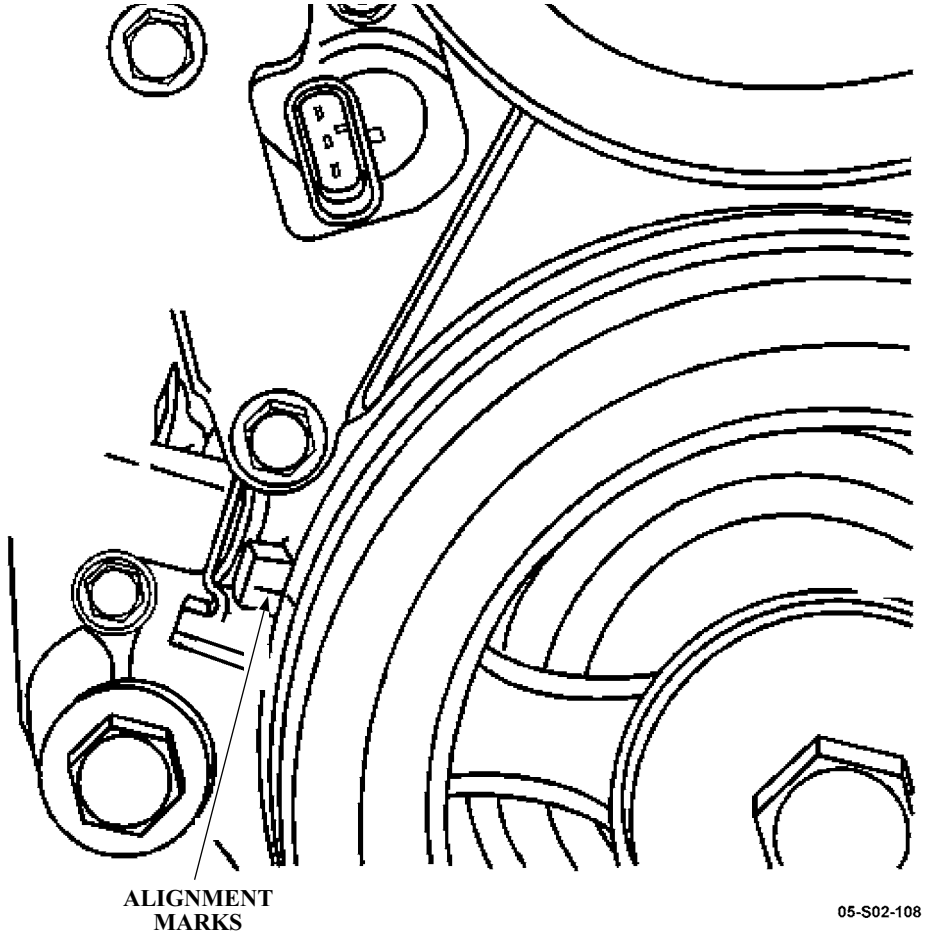


Figure 2-26: Top Dead Center Mark

2. Refer to Figure 2-27 to determine which valves that can be adjusted when the engine is at Top Dead Center.

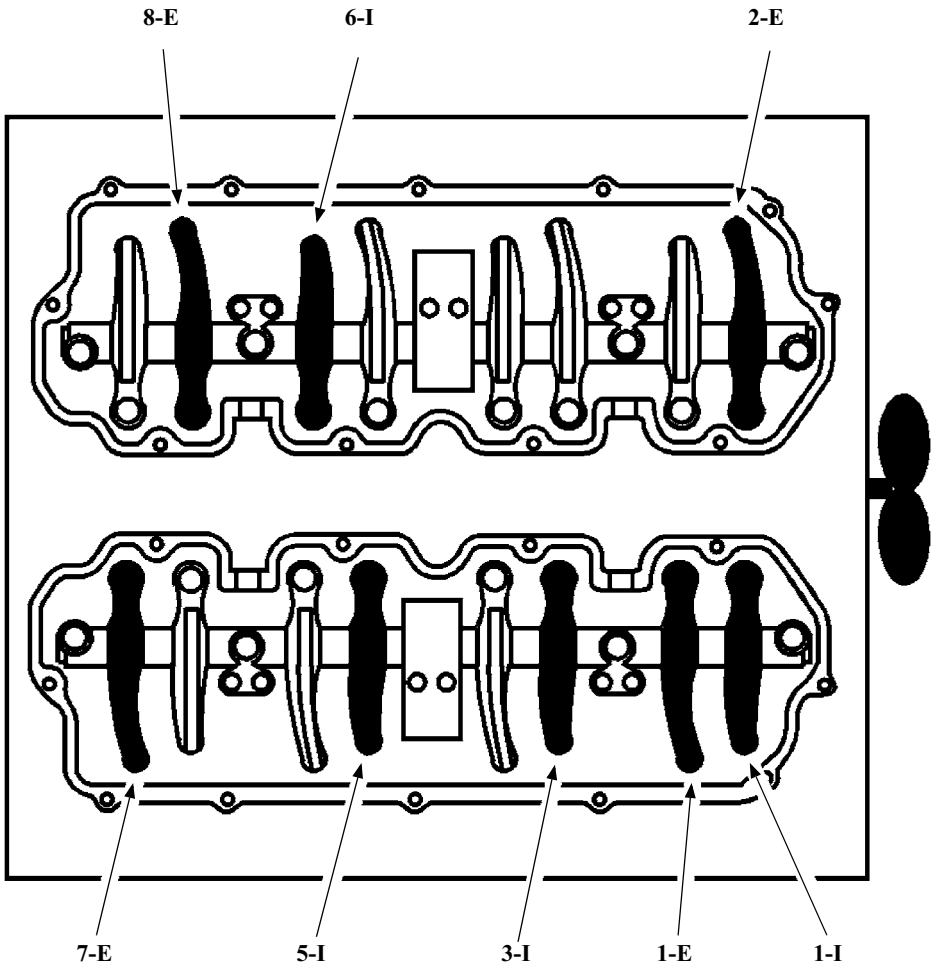


Figure 2-27: Top Dead Center Adjustment Order

3. Loosen the valve adjusting screws.
4. Insert a feeler gauge between the tip of the rocker arm and the valve bridge (Figure 2-28).
5. Adjust the valve lash to 0.012þin. (0.3þmm) and tighten the valve lash lock nut to 16þlb-ft. (22þN·m).

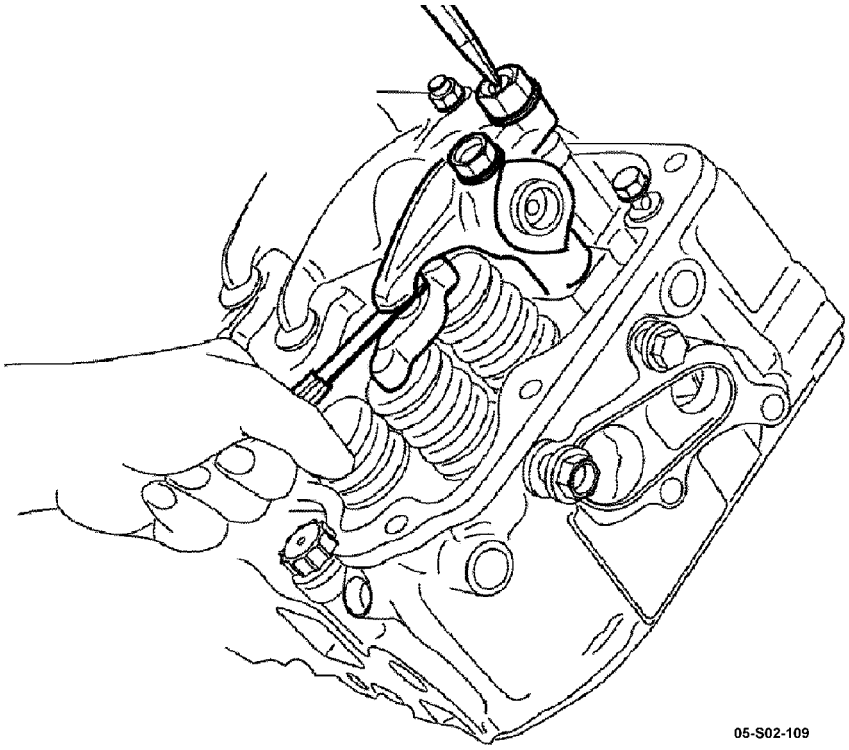


Figure 2-28: Valve Adjusting Screw Adjustment

6. Rotate the crankshaft one revolution to bring the number 1 cylinder at Top Dead Center of the exhaust stroke.
7. Refer to (Figure 2-29) to determine which valves that can be adjusted when the engine is at Top Dead Center of the exhaust stroke.

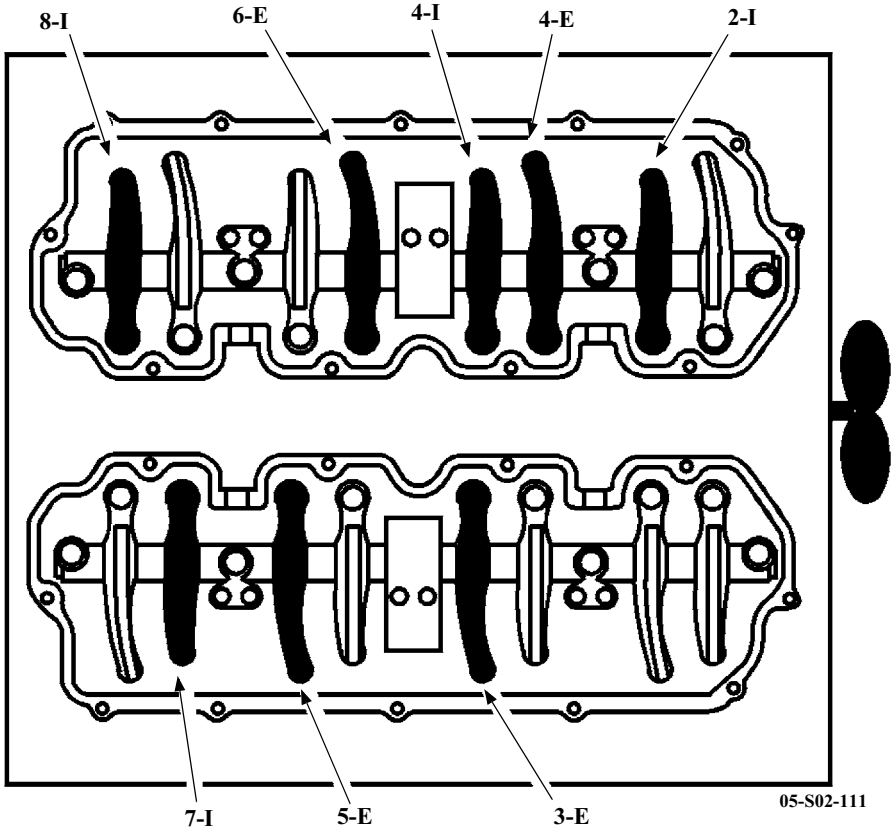


Figure 2-29: Exhaust Top Dead Center Adjustment Order

8. Insert a feeler gauge between the tip of the rocker arm and the valve bridge (Figure 2-28).
9. Adjust the valve lash to 0.012þin. (0.3þmm) and tighten the valve lash lock nut to 16þlbþft (22þN·m).

EXHAUST MANIFOLD SERVICE

The right and left exhaust manifold procedures are very similar in process, this covers the removal of the right side.

Right Exhaust Manifold and Heat Shield Replacement

Removal

1. Remove the engine access cover.
2. Remove the four bolts holding the rear heat shield to the right turbo pipe and remove the shield (Figure 2-33).
3. Remove the four bolts holding the heat shield to the right side exhaust manifold and remove the shield (Figure 2-32).
4. Remove the three bolts holding the turbo pipe to the exhaust manifold.
5. Remove the exhaust manifold bolts and nuts in the proper sequence (Figures 2-30, and 2-31).
6. Remove the exhaust manifold.
7. Clean and inspect the exhaust manifold for cracks and warpage, if damaged, replace the manifold.

Installation

1. Install the exhaust manifold nuts and bolts and the turbo pipe to the exhaust manifold bolts finger tight.
2. Use the sequence shown (Figures 2-30, and 2-31) to properly torque the exhaust manifold bolts/nut to 28þlb-ft. (38þN·m).
3. Torque the turbo pipe to exhaust manifold bolts to 39þlb-ft. (53þN·m).
4. Install the heat shields and torque the bolts to 71þlb-in. (8þN·m).
5. Install the engine access cover.

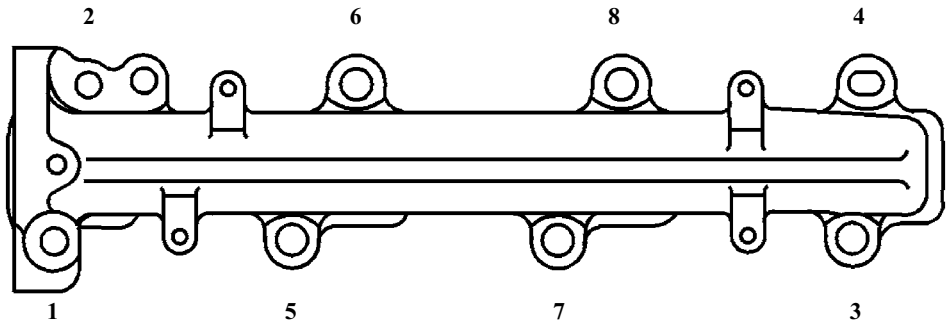


Figure 2-30: Right Exhaust Manifold Removal and Torque Sequence

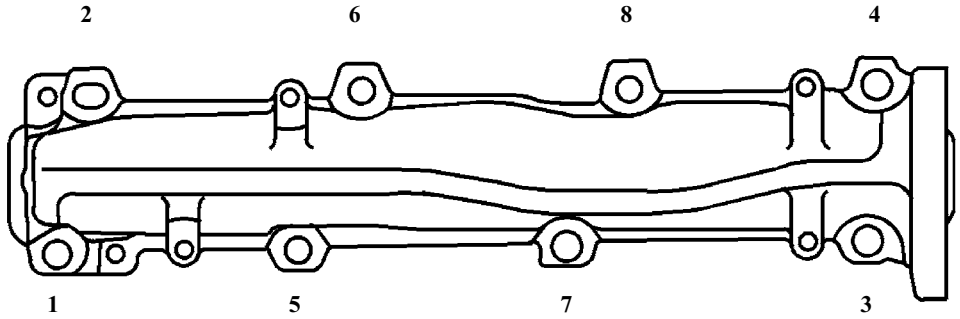


Figure 2-31: Left Exhaust Manifold Removal and Torque Sequence

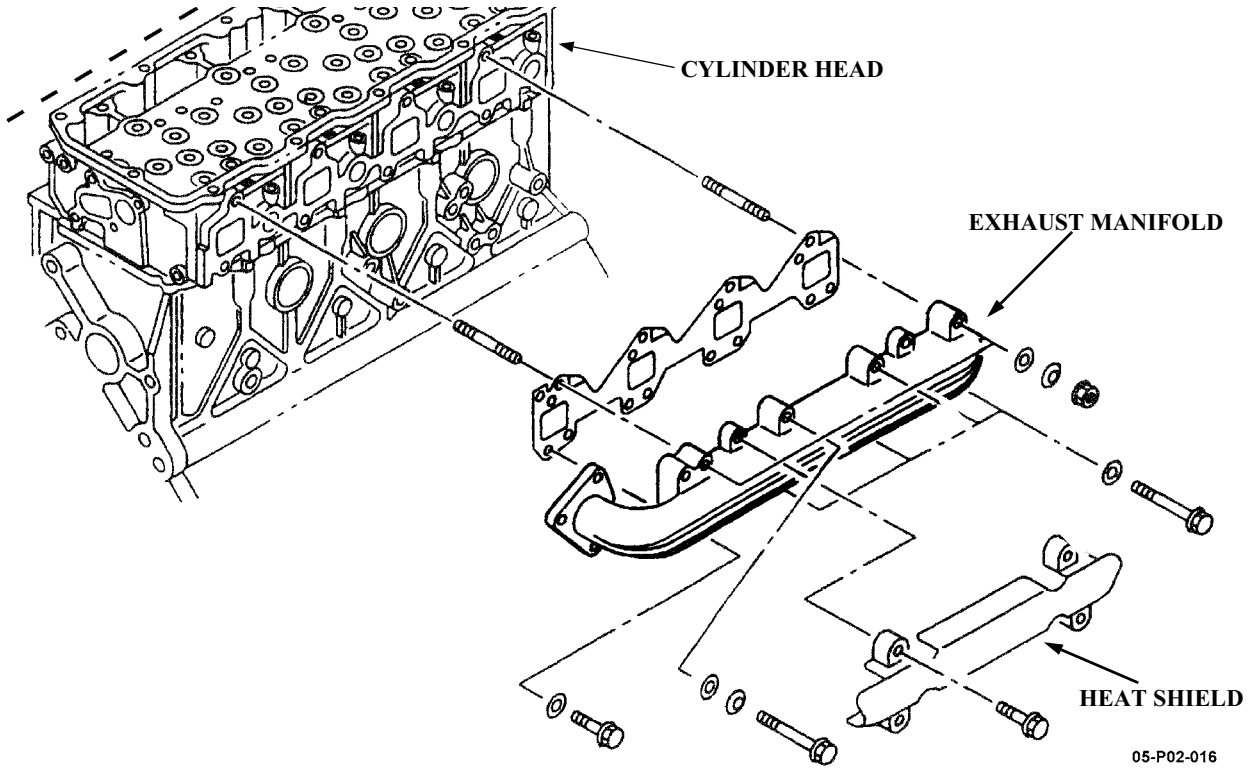


Figure 2-32: Right Heat Shield

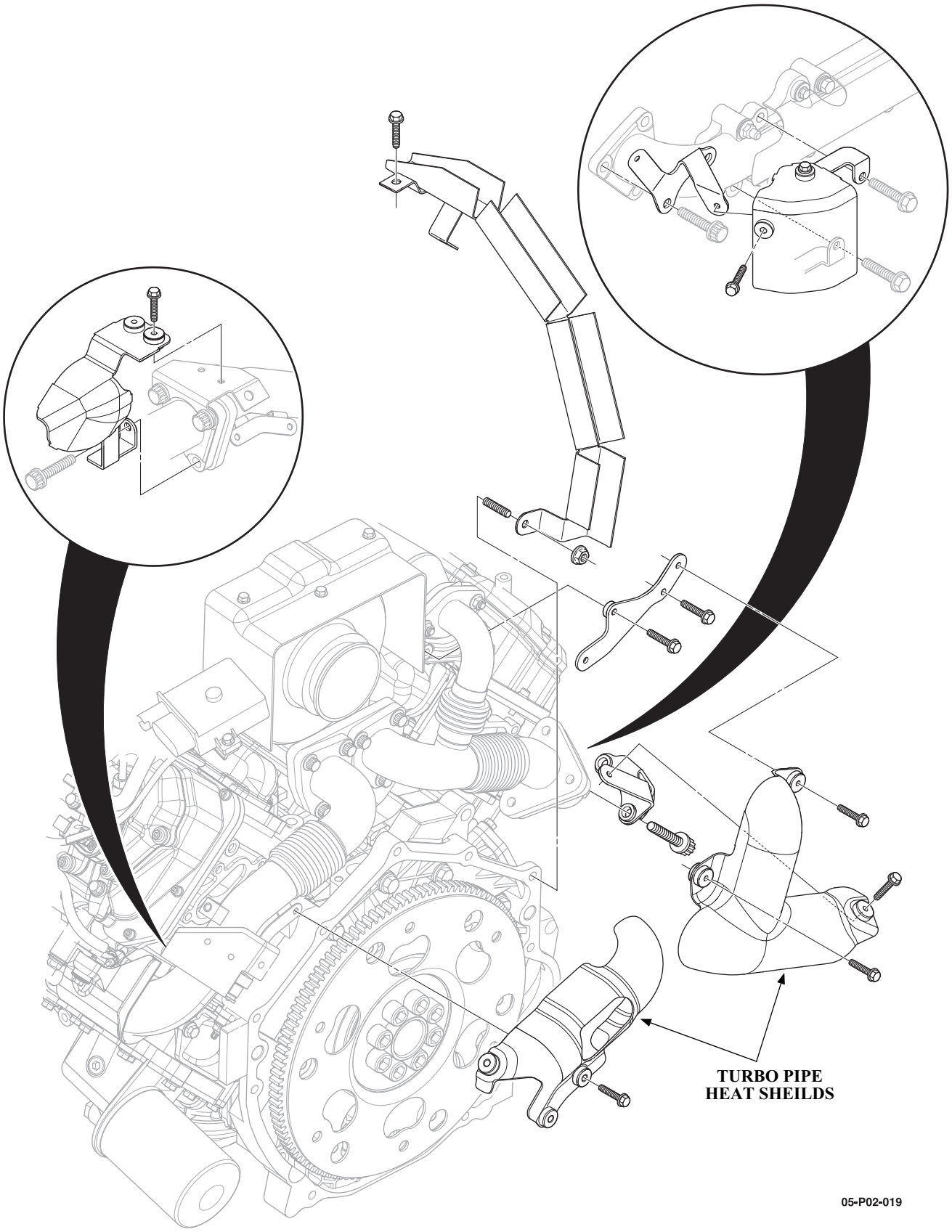


Figure 2-33: Turbo Pipe Heat Shields

CYLINDER HEAD AND GASKET SERVICE

Cylinder Head (Left Side)

Removal

1. Disconnect and isolate the negative battery cable.
2. Drain the cooling system.
3. Remove the thermostat housing crossover (Refer to section 4).
4. Remove the left intake manifold (See “Intake Manifold” on page 2-43) .
5. Remove the left exhaust manifold (See “Exhaust Manifold Service” on page 2-36) .
6. Remove the valve rocker arm shaft, pushrods and valve bridges (See “Valve Rocker Arm Shaft and Push Rod Replacement” on page 2-30) .
7. Remove the glow plugs (Refer to section 12).
8. Remove the cylinder head bolts in the sequence shown (Figure 2-35).
9. Discard the large M12 bolts.
10. Remove the cylinder head (Figure 2-36).
11. Remove the cylinder head gasket note the size of the gasket from the indicators in (Figure 2-34) and from the cylinder head gasket selection chart in (Figure 2-37).

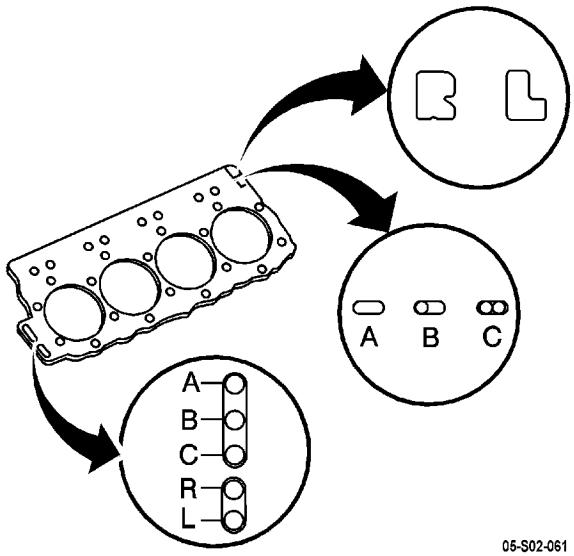


Figure 2-34: Head Gasket Size Indicators

12. Clean the sealing surface of the engine block and the cylinder head.

NOTE: þClean all dirt, debris and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

13. Clean the cylinder head bolt holes in the engine block.

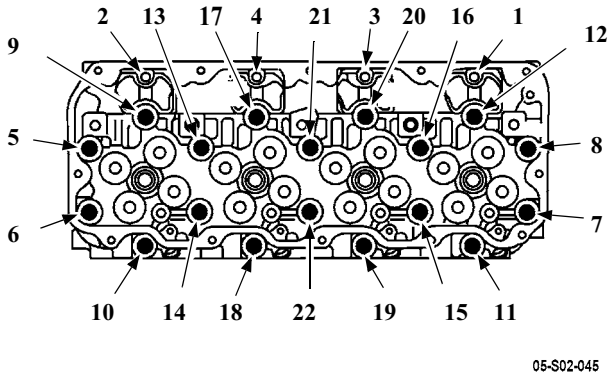


Figure 2-35: Cylinder Head Removal and Torque Sequence

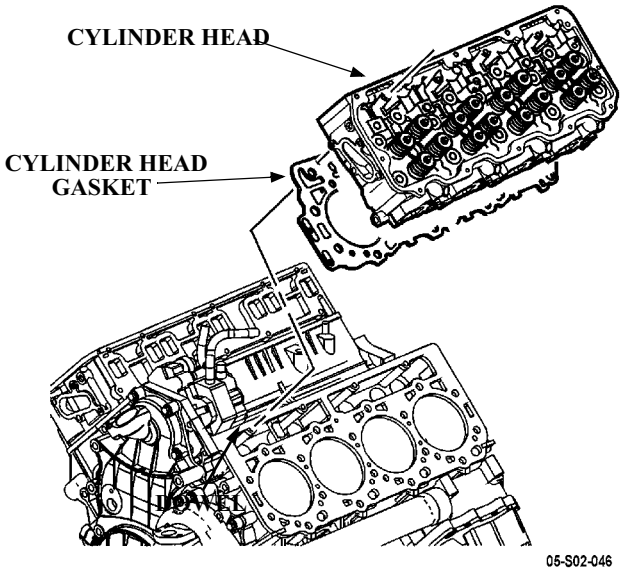


Figure 2-36: Cylinder Head and Gasket Removal/Installation.

Cylinder Head (Left Side)

Installation

NOTE: þThe left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.

1. Install the cylinder head gasket of the correct grade (Figure 2-37).
2. Install the cylinder head.

NOTE: þThis component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

3. Install NEW M12 cylinder head bolts.
4. Reuse the M8 cylinder head bolts.
5. Torque the cylinder head bolts in the following steps using the sequence shown (Figure 2-35).
   a. Tighten the M12 bolts a first pass to 50þN·m (37þlbþft).
   b. Tighten the M12 bolts a second pass to 80þN·m (59þlbþft)

c. Tighten the M12 bolts a third pass to 90þdegrees, using J–45059.
d. Tighten the M12 bolts a final pass to 75þdegrees, using J–45059.
e. Tighten the M8 bolts to 25þN·m (18þlbþft).

6. Install the valve rocker arm shaft, pushrods and valve bridges and adjust the valves.
7. Install the glow plugs.
8. Install the exhaust manifold
9. Install the intake manifold.
10. Install the thermostat housing crossover.
11. Fill and bleed the cooling system.
12. Connect the negative battery cable.
13. Road test the vehicle for normal operation.
14. Inspect for coolant, oil or exhaust leaks.

Cylinder Head Gasket Selection Specifications

	Ti max (Piston Projection)		Gasket Thickness	
Cylinder Head Gasket Grade	**Metric (mm)**	**English (in)**	**Metric (mm)**	**English (in)**
Grade A (No grade hole on the gasket)	Over 0.223 - less than 0.274	Over 0.0088 - less than 0.0108	0.90-1.00	0.0354-0.0394
Grade B (One grade hole on the gasket)	Over 0.274 - less than 0.325	Over 0.0108 - less than 0.0128	0.95-1.05	0.0374-0.0413
Grace C (Two grade holes on the gasket)	Over 0.325 - less than 0.376	Over 0.0128 - less than 0.0148	1.00-1.10	0.0394-0.0433

Figure 2-37: Cylinder Head Gasket Selection Specifications

Cylinder Head (Right Side)

Removal

1. Disconnect and isolate the negative battery cable.
2. Drain the cooling system.
3. Remove the thermostat housing crossover (Refer to section 4).
4. Remove the right intake manifold (Refer to section 2).
5. Remove the right exhaust manifold (Refer to section 2).
6. Remove the valve rocker arm shaft, pushrods and valve bridges (Refer to section 2).
7. Remove the glow plugs (Refer to section 12).
8. Remove the cylinder head bolts in the sequence shown (Figure 2-35).
9. Discard the large M12 bolts.
10. Remove the cylinder head.
11. Remove the cylinder head gasket note the size of the gasket from the indicators in (Figure 2-34) and from the cylinder head gasket selection chart in (Figure 2-37).
12. Clean the sealing surface of the engine block and the cylinder head.

NOTE: þClean all dirt, debris and coolant from the engine block cylinder head bolt holes. Failure to remove all foreign material may result in damaged threads, improperly tightened fasteners or damage to components.

13. Clean the cylinder head bolt holes in the engine block.

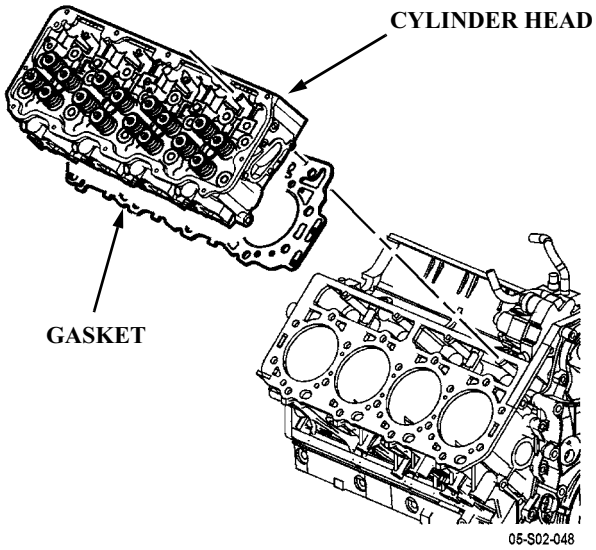


Figure 2-38: Right Side Cylinder Head Removal/Installation

Cylinder Head (Right Side) (Figure 2-38)

Installation

NOTE: þThe left and right cylinder head gaskets are not interchangeable. Improper placement of the cylinder head gasket will block coolant and oil passages. Blocked coolant and oil passages will cause severe engine damage.

1. Install the cylinder head gasket of the correct grade (Figure 2-37).
2. Install the cylinder head.

NOTE: þThis component uses bolts with a preapplied molybdenum disulfide coating for thread lubrication. Do not remove the coating or use any additional lubricant. Improperly lubricated threads will adversely affect the bolt torque and clamp load. Improper bolt torque and clamp load can lead to engine damage.

3. Install NEW M12 cylinder head bolts.
4. Reuse the M8 cylinder head bolts.
5. Torque the cylinder head bolts in the following steps using the sequence shown (Figure 2-35).
    a. Tighten the M12 bolts a first pass to 50þN·m (37þlbþft).
    b. Tighten the M12 bolts a second pass to 80þN·m (59þlbþft)
    c. Tighten the M12 bolts a third pass to 90þdegrees, using J 45059.
    d. Tighten the M12 bolts a final pass to 75þdegrees, using J 45059.
    e. Tighten the M8 bolts to 25þN·m (18þlbþft).
6. Install the valve rocker arm shaft, pushrods and valve bridges and adjust the valves.
7. Install the glow plugs.
8. Install the exhaust manifold
9. Install the intake manifold.
10. Install the thermostat housing crossover.
11. Fill and bleed the cooling system.
12. Connect the negative battery cable.
13. Road test the vehicle for normal operation.

Inspect for coolant, oil or exhaust leaks.

INTAKE MANIFOLD

Service

A three-piece intake manifold and two piece intake pipe is used on the turbocharged diesel engines (Figure 2-39). It consists of left and right manifold halves and a center manifold. The center manifold joins the other manifold halves to the lower inlet pipe which connects to the charged air cooler and the upper inlet pipe, that connects to the EGR pipe.

Center Intake Manifold

Removal

1. Remove the exhaust gas recirculation (EGR) valve cooler tube (Refer to section 3).
2. Remove the intake manifold tube.
3. Remove and discard the 2þintake manifold tube O-ring gaskets.
4. Remove the turbocharger (See “Turbocharger Service and Diagnosis” on page 2-15) .
5. Remove the center intake manifold bolts and nuts.
6. Pull-up the center intake manifold in order to remove.
7. Remove and discard the gaskets.
8. Clean the center intake manifold in cleaning solvent and air dry.

Installation

1. Install the center intake manifold with NEW gaskets torque the nuts and bolts to 89þlb-in. (10þN·m).
2. Install the turbocharger.
3. Install two NEW O-rings onto the intake manifold tube.
4. Lubricate the O-rings with clean engine oil to aid in the installation and install the intake manifold tube.
5. Install the EGR valve cooler tube.
6. Test drive and check for proper operation.

Left Intake Manifold

Removal

1. Remove the center intake manifold (See “Intake Manifold” on page 2-43) .
2. Remove the left fuel rail (Refer to section 3).
3. Remove the intake manifold nuts and bolts.

NOTE: The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surface.

4. Remove the intake manifold.
5. Clean the intake manifold in cleaning solvent and air dry.

Installation

1. Apply a 2-3þmm (1/8þin) wide, by 0.5-1.5þmm (1/16þin) high bead of sealant, GMþP/Nþ97720043 or equivalent to the intake manifold sealing surface.
2. Install the intake manifold, torque the intake manifold nuts and bolts in the sequence shown (Figure 2-40) to 15þlb-ft. (21þN·m).
3. Install the left fuel rail.
4. Install the center intake manifold.
5. Test drive and check for proper operation.

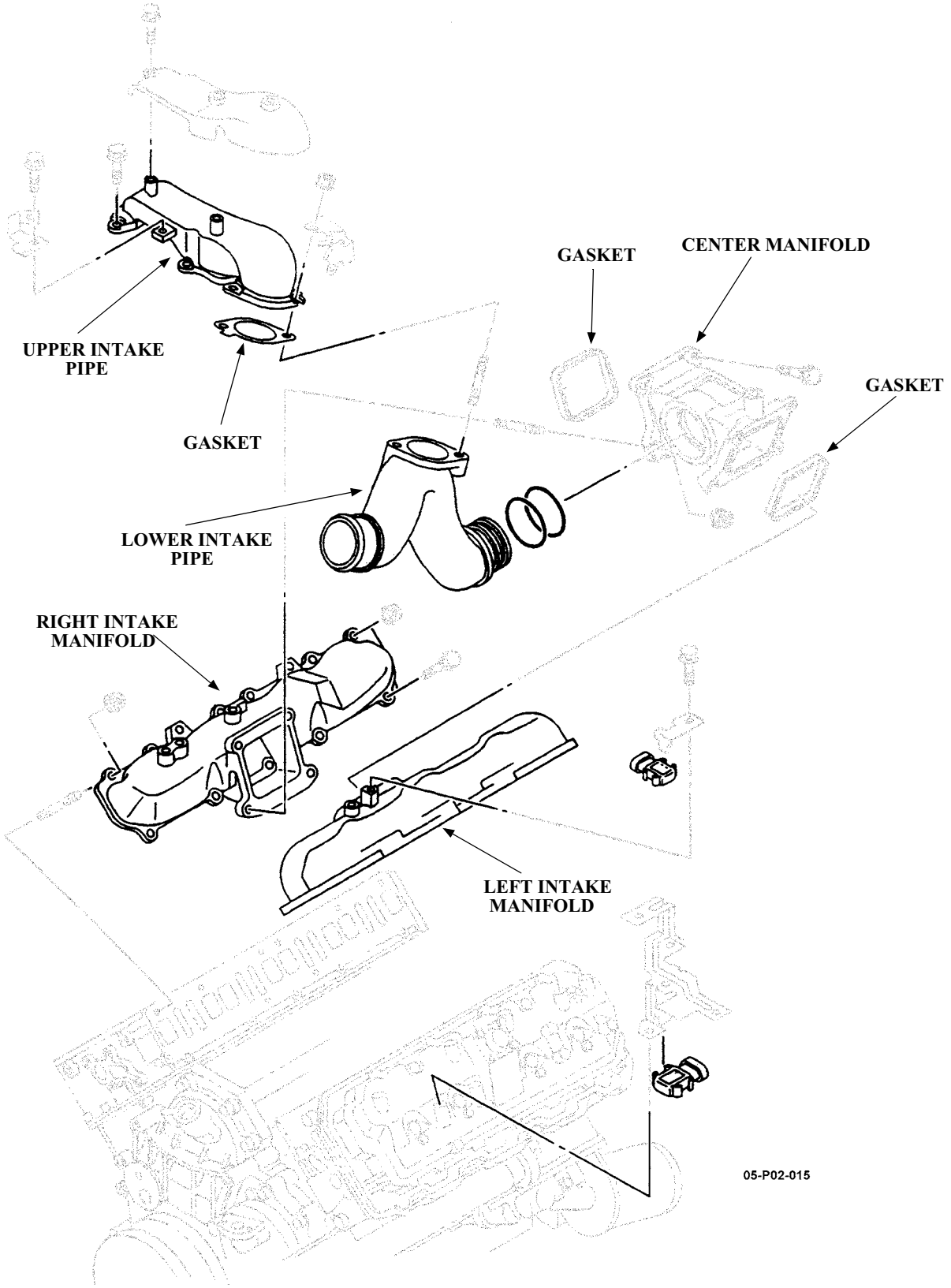


Figure 2-39: Intake Manifold Attachment

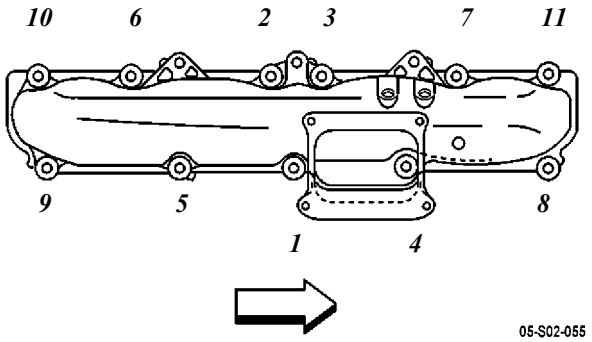


Figure 2-40: Left Intake Manifold Torque Sequence

Right Intake Manifold

Removal

1. Remove the center intake manifold (Refer to section 2).
2. Remove the right fuel rail (Refer to section 3).
3. Remove the intake manifold nuts and bolts.

NOTE: The intake manifold uses sealer. Pry at the area by the fuel rail bolt holes in order to avoid damage to the sealing surface.

4. Remove the intake manifold.
5. Clean the intake manifold in cleaning solvent and air dry.

Installation

1. Apply a 2-3þmm (1/8þin) wide, by 0.5-1.5þmm (1/16þin) high bead of sealant, GMþP/Nþ97720043 or equivalent to the intake manifold sealing surface.
2. Install the intake manifold, torque the intake manifold nuts and bolts in the sequence shown to 15þlb-ft. (21þN·m) (Figure 2-41).
3. Install the right fuel rail.
4. Install the center intake manifold.
5. Test drive and check for proper operation.

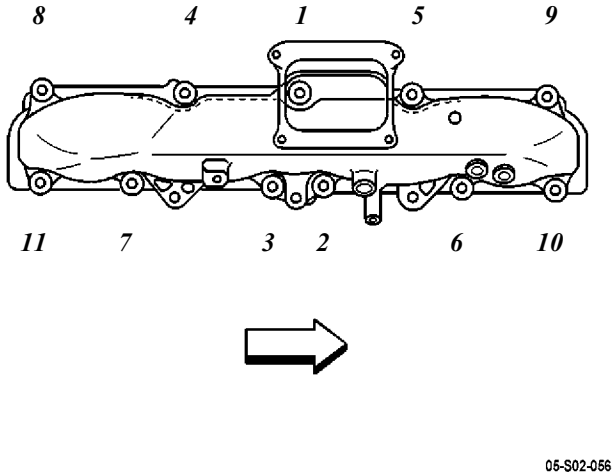


Figure 2-41: Right Intake Manifold Torque Sequence

OIL PAN REPLACEMENT

Lower Oil Pan

Removal

1. Remove the driveline protection (See Section 9).
2. Drain the engine oil.
3. Remove the 18 bolts retaining the lower oil pan to the upper oil pan (Figure 2-42).

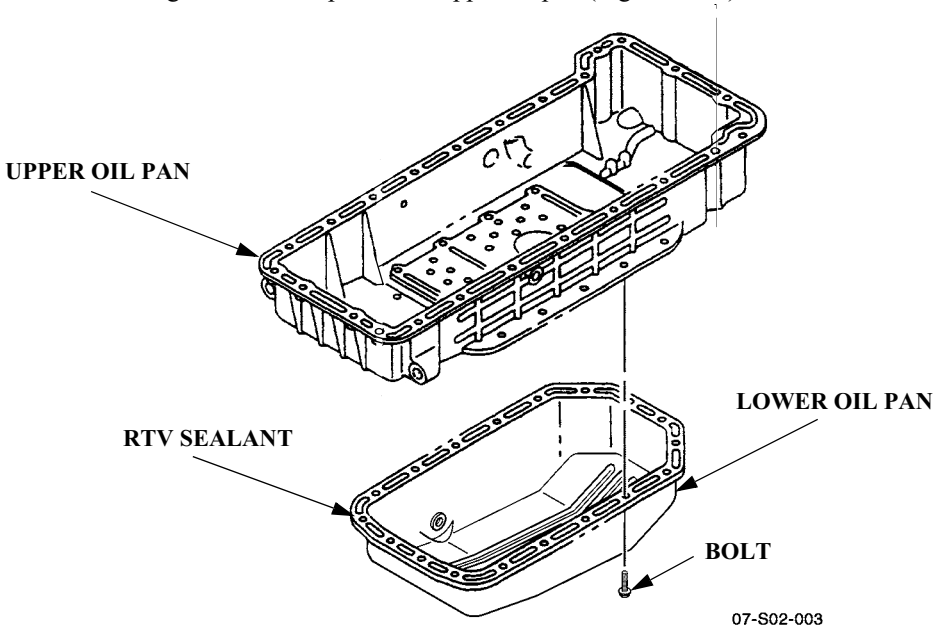


Figure 2-42: Upper and Lower Oil Pan

4. Remove the lower oil pan from the engine.

Installation

1. Clean any residual sealant or gasket material from the upper oil pan and lower oil pan gasket sealing surfaces.
2. Carefully apply a 2-3mm bead of RTV sealant GM PN 12378521 or equivalent on the lower oil pan sealing surface.
3. Place the lower oil pan in position on the upper oil pan and secure with the lower oil pan attachment bolts.
4. Tighten the lower oil pan attachment bolts to 89 in lb. (10 N•m) in a circular sequence starting in the center of the sides and working out to the ends.
5. Install the oil drain plug with a new gasket and tighten the oil drain plug to 62 lb ft. (84 N•m).
6. Refill the engine with fresh oil and replace the oil filter.
7. Install the driveline protection (See Section 9).
8. Operate the engine and check for leaks after normal operating temperature is obtained.

Upper Oil Pan

Removal

1. Remove the driveline protection (See Section 9).
2. Drain the engine oil.
3. Remove the 18 bolts retaining the lower oil pan to the upper oil pan.
4. Remove the lower oil pan from the engine.
5. Removal of the flywheel from the engine is required to provide access to the two bolts retaining the upper oil pan to the flywheel housing (See Section 5).

6. Remove the two bolts retaining the upper oil pan to the flywheel housing(Figure 2-43).

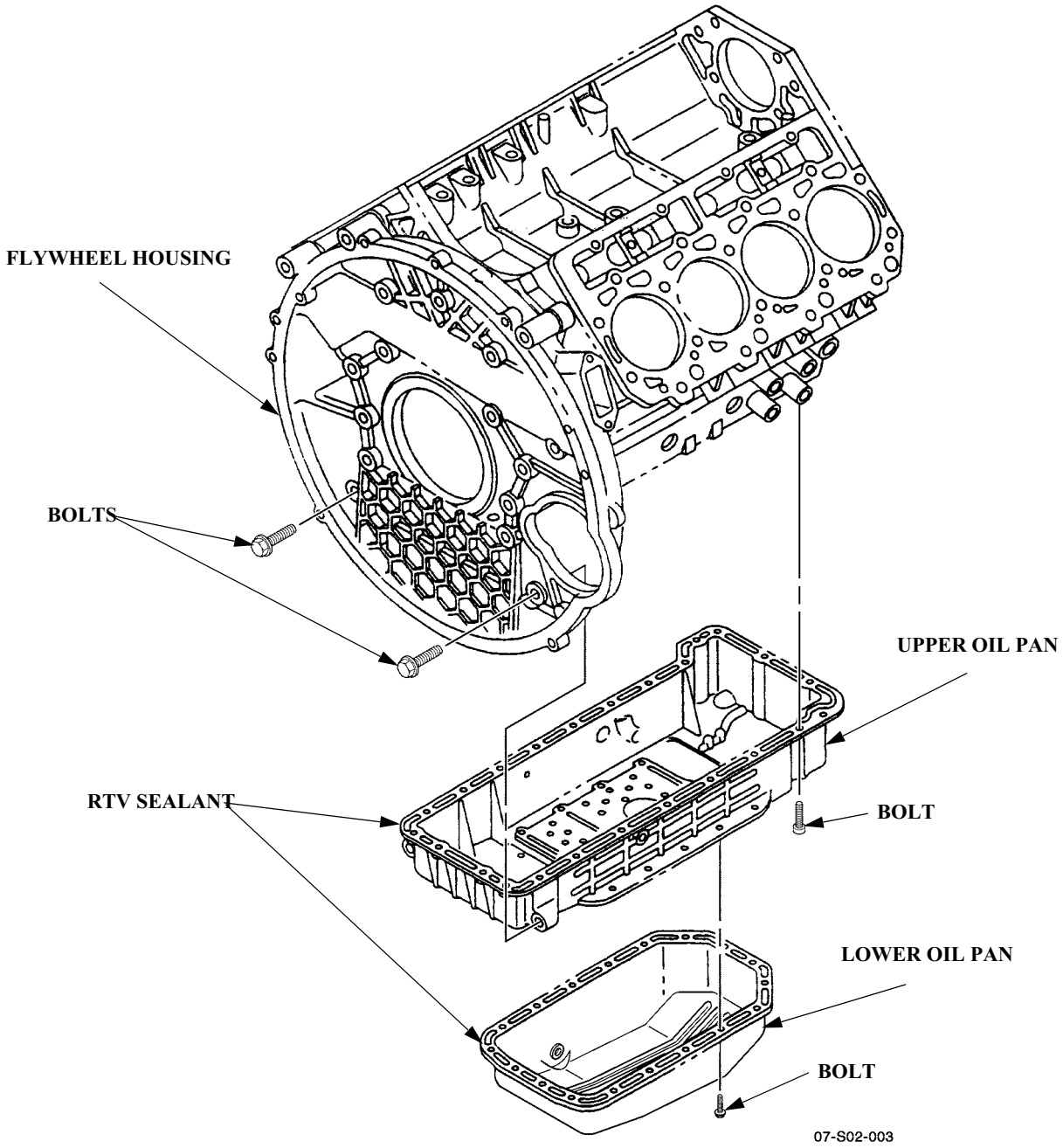


Figure 2-43: Flywheel Housing to Upper Oil Pan Bolt Location

7. Remove the oil pump pickup tube and bracket from the main bearing cap and the oil pump.
8. Remove the bolts retaining the upper oil pan to the block taking care to note the location of the longer bolts and the wiring harness p-clip.
9. Carefully remove the upper oil pan from the block, disconnect the oil dipstick tube from the upper oil pan as it is lowered.

Installation

1. Carefully remove all existing sealant from the block, flywheel housing and upper oil pan sealing surfaces.
2. Replace the o-rings on the engine oil dipstick tube, lubricate the o-rings with clean engine oil.
3. Clean any gasket residue from the oil pump where the oil pickup tube connects.
4. Carefully apply a 2-3mm bead of RTV sealant GM PN 12378521 or equivalent on the upper oil pan to block mating surface. Also apply a similar bead on the flywheel housing to the upper oil pan mating surface.

5. Carefully lift the upper oil pan into position while inserting the oil dipstick tube into the upper oil pan.
6. Place the upper oil pan in position on the block and secure with the bolts previously removed taking care to install the longer bolts and the wiring harness p-clip in the correct locations. Do not fully tighten the bolts at this time.
7. Install the two bolts securing the upper oil pan to the flywheel housing.
8. Tighten the upper oil pan to the block bolts to 15 lb ft. (20 N•m) in a circular clockwise pattern starting at the center of the river's side of the pan.
9. Tighten the two bolts securing the upper oil pan to the flywheel housing to 37 lb ft. (50 N•m).
10. Install the flywheel and other components removed to provide access to the two bolts retaining the upper oil pan to the flywheel housing (See Section 5).
11. Install the oil pickup tube to the oil pump with a new gasket.
12. Secure the pickup tube and bracket to the oil pump and the main bearing cap, tighten the fasteners to 18 lb ft. (25 N•m).
13. Install the lower oil pan to the upper oil pan with a new gasket and the previously removed bolts. Torque the bolts to 89 in lb. (10 N•m) in a circular sequence starting in the center of the sides and working out to the ends.
14. Install the oil drain plug with a new gasket and tighten the oil drain plug to 62 lb ft. (84 N•m).
15. Refill the engine with fresh oil and replace the oil filter.
16. Install the driveline protection (See Section 9).
17. Operate the engine and check for leaks after normal operating temperature is obtained.

ENGINE REMOVAL

1. Remove the hood (Refer to section 10).
2. Shift the transmission into neutral and set the parking brake.
3. Disconnect and remove the batteries (Refer to section 12).
4. Remove the right side splash shield and battery tray (Refer to section 10).
5. Remove the left side splash shield (Refer to section 10).
6. Remove the rubber and sponge pads from the air lift brackets (Refer to section 10).
7. Drain the engine oil.
8. Drain the coolant (See “Engine Cooling System Service” on page 4-8) .
9. Recover the A/C refrigerant (Refer to section 11).
10. Remove the CTIS compressor (Refer to section 6).
11. Disconnect the A/C condenser lines, the transmission cooler lines, the fuel cooler lines, the T-case cooler lines, the coolant hoses and the auxiliary coolant pump thermal switch electrical connector from the cool pack.
12. Remove the charged air hose from the charged air cooler outlet to the intake pipe (Refer to section 3).
13. Remove the charged air hose from turbo outlet and the charged air cooler (Refer to section 3).
14. Remove the coolant hoses from the radiator and lower radiator hose to the surge tank and remove the surge tank form the right air lift bracket (Refer to section 4).
15. Remove the radiator support bracket bolts and remove the lower radiator mount with the help of an assistant, remove the cool pack assembly from the vehicle (Figure 2-44).

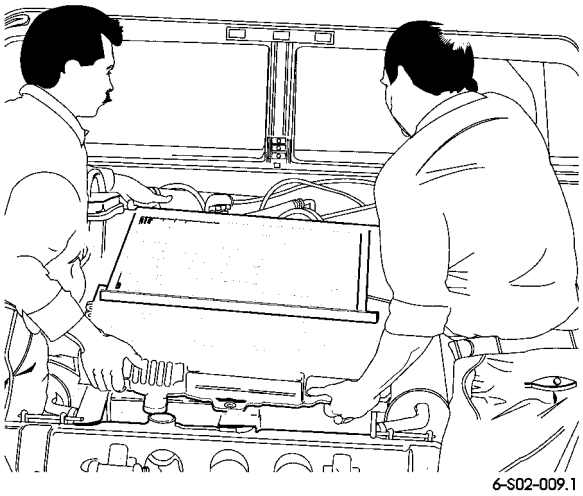


Figure 2-44: Cool Pack Assembly

16. Remove the cooling fan, fan drive assembly and the upper portion of the front, rear crossmember as an assembly (Refer to section 4).
17. Remove the air inlet hose from the air cleaner to the turbo intake tube (Refer to section 4).
18. Remove the engine cover (Refer to section 10).
19. Remove the center driveline protection (Refer to section 9).

CAUTION: *Care must be taken to ensure that the front propeller shaft is not separated at the slip yoke spline. The shaft is balanced at the factory and if separated it will need to be replaced.*

20. Remove the front propeller shaft (Refer to section 9).
21. Remove the vane position sensor from the turbocharger using a Snap-on wrench RX32A or equivalent.
22. Remove the serpentine belt and the serpentine belt tensioner (Refer to section 4).

23. Remove the power steering pump and the mounting bracket, without removing the hoses, tie the pump over to the side (Refer to section 8).
24. Remove the A/C compressor (Refer to section 11).
25. Install lifting bracket EN-47923 on the A/C compressor mounting bracket with the lift eyelet towards the passenger side of the engine.
26. Disconnect the main engine electrical harness connectors (Refer to section 12).
27. Remove the transmission control harness and tray from the engine (Refer to section 12).
28. Remove the starter (Refer to section 12).
29. Remove the six torque convertor bolts through the starter opening and mark the flywheel and torque converter relationship for assembly purposes.
30. Remove the exhaust down pipe from the turbocharger (Refer to section 3).
31. Support the engine and the transmission, disconnect the right and left engine mount to frame bracket bolts.
32. Remove the left engine mount bracket from the frame rail (Refer to section 2).
33. Remove the bolts retaining the engine to the transmission.
34. Raise and remove the engine using a floor jack to keep the rear of the engine at the proper angle to guide it out of the engine bay.

ENGINE INSTALLATION

1. If new engine is being installed, transfer mounting brackets and insulators, generator, drive plate (flywheel), turbocharger and necessary mounting brackets, shields, damper pulleys, sensors and fittings, from the old to the new engine.
2. Attach lifting bracket EN-47923 to the engine.
3. Attach a hoist to the lifting bracket. Raise the engine and guide it into the engine bay with the aid of a helper using a floor jack to keep the rear of the engine at the proper angle to guide it in to the engine bay.

WARNING: Do not draw the engine to the transmission using the transmission bolts. If everything is aligned properly the engine and transmission will come together.

4. Align and seat the engine on the transmission. Be sure the converter pilot hub is seated in the crankshaft and the transmission is seated on the engine block dowels. Install 2-3 transmission attaching bolts (finger tight) to hold the engine and transmission in place.
5. Install the left engine mount bracket to the frame rail and torque to 55þlb-ft. (75þN·m).
6. Install the engine mount to the frame bracket bolts and torque to 50þlb-ft. (65þN·m).
7. Install all the transmission to engine bolts and torque to 37þlb-ft. (50þN·m).
8. Install the torque convertor bolts and torque to 44þlb-ft. (60þN·m).
9. Install the exhaust down pipe to the turbocharger.
10. Install the starter.
11. Install the transmission control harness and tray to the engine.
12. Install the main engine electrical harness connectors.
13. Remove the lifting bracket EN-47923 and install the A/C compressor.
14. Install the power steering pump and the mounting bracket.
15. Install the serpentine belt and the serpentine belt tensioner.
16. Install the vane position sensor to the turbocharger using Snap-on wrench RX32A or equivalent.
17. Install the CTIS compressor.
18. Install the front propeller shaft.
19. Install the center driveline protection.
20. Install the engine cover.
21. Install the air inlet hose from the air cleaner to the turbo intake tube.

22. Install the surge tank to the right air lift bracket and install the coolant hoses from the radiator and lower radiator hose to the surge tank.
23. Install the cooling fan, fan drive assembly and the upper portion of the front, rear crossmember as an assembly.
24. With the help of an assistant, install the cool pack assembly on the vehicle (Figure 2-44). Install the radiator support bracket bolts and the lower radiator mount.
25. Install the charged air hose from the charged air cooler outlet to the intake pipe.
26. Install the charged air hose to the turbo outlet and the charged air cooler.
27. Install the A/C condenser lines, the transmission cooler lines, the fuel cooler lines, the T-case cooler lines, the coolant hoses and the auxiliary coolant pump thermal switch electrical connector to the cooler pack.
28. Evacuate and charge the A/C system.
29. Fill and bleed the cooling system.
30. Fill the engine with the proper weight and level of engine oil.
31. Install the rubber and sponge pads on the air lift brackets.
32. Install the left side splash shield.
33. Install the right side splash shield and battery tray.
34. Install and connect the batteries.
35. Install the hood.
36. Perform the turbocharger learn procedure.
37. Test drive and verify proper operation of all systems affected by engine removal.
38. Inspect for fluid leaks and repair if necessary.

TORQUE SPECIFICATIONS

TORQUE SPECIFICATIONS

Item	Lb-Ft.	Lb-In.	N•m
Camshaft Gear Bolt	173	-	234
Camshaft Thrust Plate Bolt	16	-	22
Crankshaft Balancer Bolt	1st Step 74	-	1st Step 100þ
	2nd Step 90þdegrees	-	2nd Step 90þdegrees
Cylinder Head M12 Bolt - Angular Tightening Method	1st Step 37	-	1st Step 50
	2nd Step 59	-	2nd Step 80
	3rd Step 60þdegrees		
	4th Step 90þdegrees		
Cylinder Head M8 Bolt	18	-	25
Drive Belt Tensioner	37	-	50
Engine Block Coolant Plug	13	-	18
Engine Mount Through Bolt to Frame	55	-	75
Engine Mount to Block Bolts	43	-	58
Engine Mount to Frame Bolt	48	-	65

TORQUE SPECIFICATIONS

Item	Lb-Ft.	Lb-In.	N•m
Flywheel Bolt - Angular Tightening Method	1st Step 58	-	1st Step 79
	2nd Step 60þdegrees		
	3rd Step 60þdegrees		
Front Engine Cover Bolt	18	-	25
Glow Plug	13	-	18
Idle Pulley	37	-	50
Intake Manifold Bolts/Nuts	18	-	25
Oil Drain Plug	62	-	84
Oil Fill Tube Bolt	18	-	25
Oil Filter	18	-	25
Oil Gallery Plugs	39	-	53
Power Steering Pump Bracket Bolt	37	-	50
Power Steering Pump Bolt	37		50
Rocker Arm Shaft Bracket Bolt	30	-	41
Starter Motor Bolt	58	-	78
Thermostat Housing Bolts/Nuts	18	-	25
Thermostat Cover Bolt	18	-	25
Torque Converter Bolt	44	-	60
Turbocharger Bolt	80	-	108
Valve Adjusting Nut	16	-	22
Valve Lifter Hold down Bracket Bolt	-	97	11
Valve Rocker Arm Cover Bolt - Lower	-	89	10
Valve Rocker Arm Cover Bolt - Upper	-	71þlbþin (Two Times)	8þN·m (Two Times)
Water Outlet Bolts	18	-	25
Water Pump Bolt	18	-	25
Water Pump Inlet Pipe Bolts	18	-	25

ENGINE SPECIFICATIONS

General

Engine Type

90þdegree V-8

Displacement

- 6.6þLiter
- 402þcuþin

Bore

- 103þmm
- 4.0551þin

Stroke

- 99þmm
- 3.8976þin

Compression Ratio

- 17.5:1

Engine Compression Test - Minimum

- 2069þKPa
- 300þpsi

Idle Speed

- 680þRPM

Firing Order

- 1-2-7-8-4-5-6-3

Block

Cylinder Bore Diameter - Service Limits

- 103.11þmm
- 4.0594þin

Cylinder Bore Diameter - Production Value

- 103.0-103.014þmm
- 4.0551-4.0557þin

Cylinder Bore Out-of-Round - Production Value

- 0.015þmm
- 0.0006þin

Cylinder Bore Taper - Production Value

- 0.015þmm
- 0.0006þin

Camshaft

Camshaft Bearing Inside Diameter - Service Limit

- 61.07þmm
- 2.4043þin

Camshaft Bearing Inside Diameter - Production Value

- 61.00-61.03þmm
- 2.4016-2.4028þin

Camshaft End Play - Service Limit

- 0.2þmm
- 0.0079þin

Camshaft Journal Diameter - Service Limit

- 60.92þmm
- 2.3984þin

Camshaft Journal Diameter - Production Value

- 60.932-60.962þmm
- 2.3990-2.4001þin

Camshaft Lobe Lift - Exhaust - Production Value

- 5.907þmm
- 0.2326þin

Camshaft Lobe Lift - Intake - Production Value

- 7.273þmm
- 0.2863þin

Camshaft Runout - Service Limit

- 0.05þmm
- 0.0020þin

Cooling System

Capacity @ Engine RPM

- 270þL/min @ 3172þRPM

Thermostat Full Open Temperature

- 110þdegreesþC
- 230þdegreesþF

Turbocharger Coolant Bypass Valve

- 60þdegreesþC
- 140þdegreesþF

Connecting Rod

Connecting Rod Bearing Clearance - Service Limit

- 0.10þmm
- 0.0039þin

Connecting Rod Bearing Clearance - Production Value

- 0.036-0.077þmm
- 0.0014-0.0030þin

Connecting Rod Bore Diameter - Bearing End - Production Value

- 62.958-62.979þmm
- 2.4789-2.4795þin

Connecting Rod Bore Diameter - Pin End - Service Limit

- 34.53þmm
- 1.3594þin

Connecting Rod Bore Diameter - Pin End - Production Value

- 34.512-34.522þmm
- 1.3587-1.3591þin

Connecting Rod Length

- 163.0þmm
- 6.42þin

Connecting Rod Side Clearance - Service Limit

- 0.54þmm
- 0.0213þin

Connecting Rod Side Clearance - Production Value

- 0.31-0.49þmm
- 0.0122-0.0193þin

Crankshaft

Connecting Rod Journal Diameter - Service Limit

- 62.88þmm
- 2.4756þin

Connecting Rod Journal Diameter - Production Value

- 62.902-62.922þmm
- 2.4764-2.4772þin

Crankshaft End Play - Service Limit

- 0.54þmm
- 0.0213þin

Crankshaft End Play - Production Value

- 0.04-0.205þmm
- 0.0016-0.0081þin

Crankshaft Main Bearing Clearance - Service Limit

- 0.014þmm
- 0.0055þin

Crankshaft Main Bearing Clearance - Production Value

- 0.039-0.070þmm
- 0.0015-0.0028þin

Crankshaft Main Journal Diameter - Service Limit

- 79.89þmm
- 3.1453þin

Crankshaft Main Journal Diameter - Production Value

- 79.905-79.925þmm
- 3.1459-3.1466þin

Crankshaft Runout - Service Limit

- 0.44þmm
- 0.0173þin

Crankshaft Runout - Production Value

- 0.05þmm
- 0.0020þin

Cylinder Head

Surface Flatness - Block Deck - Service Limit

- 0.2þmm
- 0.0079þin

Surface Flatness - Block Deck - Production Value

- 0.075þmm
- 0.0030þin

Surface Flatness - Exhaust Manifold Deck - Production Value

- 0.1þmm
- 0.0039þin

Surface Flatness - Intake Manifold Deck - Production Value

- 0.1þmm
- 0.0039þin

Exhaust Manifold

Surface Flatness- Production Value

- 0.3þmm
- 0.0118þin

Intake Manifold

Surface Flatness - Production Value

- 0.3þmm
- 0.0118þin

Lubrication System

Oil Capacity - with Filter

- 12.25þqt
- 11.6þL

Oil Capacity - without Filter

- 10.5þqt
- 9.9þL

Oil Pressure - Minimum- Hot - at idle

- 8þKPa
- 14þpsi

Oil Pressure - Minimum - 1800þRPM

- 294þKPa
- 42þpsi

Oil Relief Valve Opening Pressure

- 441þKPa
- 64þpsi

Piston Cooling Jet Valve Opening Pressure

- 196þKPa
- 29þpsi

Oil Pump

Gear Shaft Outside Diameter - Drive - Service Limit

- 19.86þmm
- 0.7819þin

Gear Shaft Outside Diameter - Drive - Production Value

- 19.947-19.960þmm
- 0.7853-0.7858þin

Gear Shaft Outside Diameter - Driven - Service Limit

- 19.86þmm
- 0.7819þin

Gear Shaft Outside Diameter - Driven - Production Value

- 19.947-19.960þmm
- 0.7853-0.7858þin

Gear Shaft-to-Bushing - Service Limit Clearance

- 0.14þmm
- 0.0055þin

Gear-to-Cover Clearance - Drive/Driven - Service Limit

- 0.109þmm
- 0.0043þin

Gear-to-Cover Clearance - Drive/Driven - Production Value

- 0.064-0.109þmm
- 0.0025-0.0043þin

Gear-to-Housing Clearance - Drive/Driven - Service Limit

- 0.22þmm
- 0.0087þin

Gear-to-Housing Clearance - Drive/Driven - Production Value

- 0.125-0.221þmm
- 0.0049-0.0087þin

Piston Rings

Piston Ring End Gap-First Compression Ring - Service Limit

- 1.37þmm
- 0.0539þin

Piston Ring End Gap-First Compression Ring - Production Value

- 0.3-0.45þmm
- 0.0118-0.0177þin

Piston Ring End Gap-Second Compression Ring - Service Limit

- 1.35þmm
- 0.0531þin

Piston Ring End Gap-Second Compression Ring - Production Value

- 0.50-0.65þmm
- 0.0197-0.0256þin

Piston Ring End Gap-Oil Control Ring - Service Limit

- 1.20þmm
- 0.0472þin

Piston Ring End Gap-Oil Control Ring - Production Value

- 0.15-0.35þmm
- 0.0059-0.0138þin

Piston Ring to Groove Clearance-First Compression Ring - Service Limit

- 0.26þmm
- 0.0102þin

Piston Ring to Groove Clearance-First Compression Ring - Production Value

- 0.08-0.17þmm
- 0.0030-0.0067þin

Piston Ring to Groove Clearance-Second Compression Ring - Service Limit

- 0.10þmm
- 0.0039þin

Piston Ring to Groove Clearance-Second Compression Ring - Production Value

- 0.01-0.03þmm
- 0.0004-0.0012þin

Piston Ring to Groove Clearance-Oil Control Ring - Service Limit

- 0.12þmm
- 0.0047þin

Piston Ring to Groove Clearance-Oil Control Ring - Production Value

- 0.01-0.03þmm
- 0.0004-0.0012þin

Pistons and Pins

Piston Diameter

- 102.948-102.960þmm
- 4.0531-4.0535þin

Piston Pin Bore Diameter

- 34.504-34.512þmm
- 1.3584-1.3587þin

Pin-Piston Pin Clearance to Piston Pin Bore - Service Limit

- 0.017þmm
- 0.0007þin

Pin-Piston Pin Clearance to Piston Pin Bore - Production Value

- 0.004-0.017þmm
- 0.0002-0.0007þin

Pin-Piston Pin Diameter - Service Limit

- 34.45þmm
- 1.3563þin

Pin-Piston Pin Diameter - Production Value

- 34.495-34.5þmm
- 1.3581-1.3583þin

Starter

Rated Output

- 3.5þKW

Turbocharger

Axial Play

- 0.11þmm
- 0.0043þin

Radial Play

- 0.20þmm
- 0.0079þin

Valve System

Valve Face Angle - Production Value

- 45þdegrees

Valves-Valve Face Width - Service Limit

- 2.5þmm
- 0.0984þin

Valve Face Width - Production Value

- 2.1þmm
- 0.0827þin

Valve Head Diameter - Exhaust

- 31.0þmm
- 1.22þin

Valve Head Diameter - Intake

- 33.0þmm
- 1.30þin

Valve Seat Angle

- 45þdegrees

Valve Stem Diameter

- 7.0þmm
- 0.28þin

Valve Stem Oil Seal Installed Height

- 6.05þmm
- 0.2382þin

Valve Stem-to-Guide Clearance - Service Limit

- 0.20þmm
- 0.0079þin

Valve Stem-to-Guide Clearance - Exhaust - Production Value

- 0.038-0.071þmm
- 0.0015-0.0028þin

Valve Stem-to-Guide Clearance - Intake - Production Value

- 0.030-0.063þmm
- 0.0012-0.0025þin

Valve Stem-to-Guide Clearance

- 0.20þmm
- 0.0079þin

Valve Lifters/Push Rods-Push Rod Straightness

- 0.8þmm
- 0.0315þin

Valve Spring Free Length - Production Value

- 56.6þmm
- 2.2283þin

Valve Spring Installed Height - Production Value

- 41þmm
- 1.6142þin

Valve Spring Load - Exhaust - Service Limit

- 275þN at 41þmm
- 61.8þlb at 1.61þin

Valve Spring load - Exhaust - Production Value

- 315-363þN at 41þmm
- 71-81.6þlb at 1.61þin

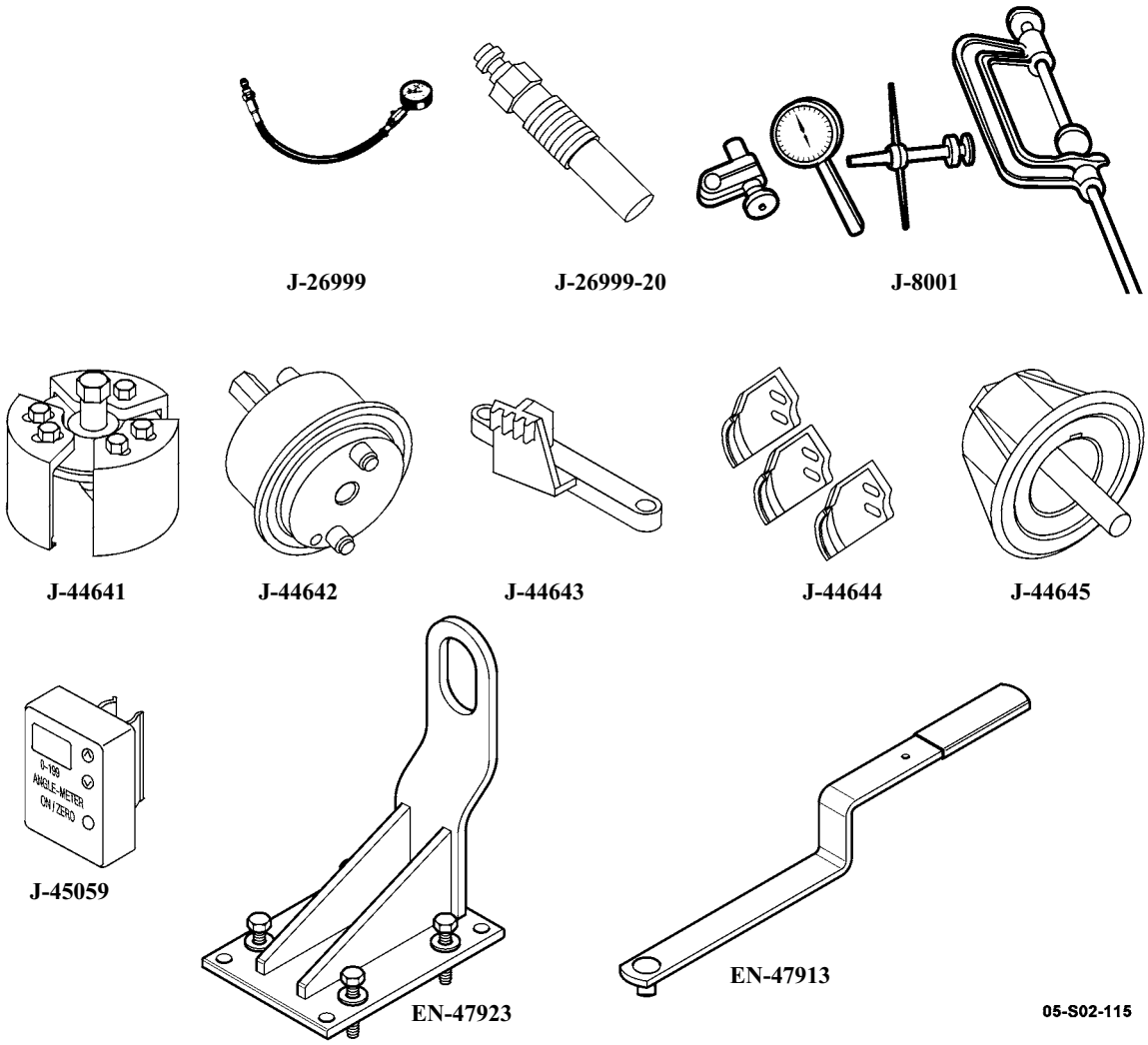
Valve Spring Load - Intake - Service Limit

- 306þN at 41þmm
- 68.8þlb at 1.61þin

Valve Spring Load - Intake - Production Value

- 315-363þN at 41þmm
- 71-81.6þlb at 1.61þin

ESSENTIAL TOOLS



Tool No.	Description
J-26999	Compression Gauge Adapter
J-26999-20	Compression Gauge Adapter
J-8001	Dial Indicator
J-44641, -1, -2	Rear Main Seal Remover
J-44642	Rear Main Seal Installer
J-44643	Flywheel Holder
J-44644	Front Oil Seal Remover
J-44645	Front Oil Seal Installer
J-45059	Torque Angle Meter
EN-47923	Engine Lift Adapter
EN-47913	Belt Tension Wrench

Procure from Kent-Moore.

Section: OBD On-Board Diagnostics

TABLE OF CONTENTS

Basic Symptom Checks OBD-17
- Cuts Out, Misses OBD-25
- Engine Cranks but Does Not Run OBD-19
- Excessive Smoke OBD-26
- Fuel Knock/Combustion Noise OBD-24
- Hard Start OBD-22
- Hesitation, Sag, Stumble OBD-25
- Intermittent Condition OBD-21
- Lack of Power, Sluggishness, or Sponginess OBD-23
- Poor Fuel Economy OBD-26
- Surges/Chugs OBD-23

Connectors
- 102 Way Bulkhead OBD-478
  - C1 ..... OBD-478
- 12 Way Neutral Safety Backup Switch OBD-500
  - C88 Female OBD-500
- 14 way Engine Power harness OBD-493
  - C80 Female OBD-493
- 20 Way Transmission Pass-Through OBD-484
  - C34 Male and Female OBD-484
- 24 way Engine Connector Harness OBD-494
  - C81 Female OBD-494
- 32 way TCM (GRAY) OBD-491
  - C78 Female OBD-491
- 32 way TCM (RED) OBD-492
  - C79 Female OBD-492
- 38 way Engine Connector Harness OBD-495
  - C82 Male and Female OBD-495
- 38 Way Transmission Connector Harness OBD-496
  - C83 Male and Female OBD-496
- 40 Way FICM Connector OBD-499
  - C87 Female OBD-499
- 56 way ECM (GRAY) OBD-489
  - C77 Female OBD-489
- 56 Way ECM J1 (Blue) OBD-485
  - C75 Female OBD-485
- 56 Way Instrument Panel OBD-482
  - C3 Male and Female OBD-482
- 72 way ECM J2 (Black) OBD-487
  - C76 Female OBD-487
- 80 way FICM connector OBD-498
  - C86 Female OBD-498

Diagnostic System Check OBD-8

Diagnostic Trouble Codes
- DTC P0016 Crank Position (CKP) Camshaft Position (CMP) Correlation OBD-48
- DTC P0045 Turbocharger Boost Control Circuit OBD-51
- DTC P0046 Turbocharger Vane Control Position Performance OBD-55
- DTC P0087 Fuel Rail Pressure Too Low OBD-59
- DTC P0088 Rail Pressure too High OBD-63
- DTC P0089 Fuel Rail Pressure Regulator Performance OBD-66

DTC P0090 Fuel Rail Pressure Control Circuit OBD-69
DTC P0101 Mass Air Flow (MAF) Sensor Performance OBD-73
DTC P0102 Mass Air Flow (MAF) Sensor Performance OBD-78
DTC P0103 Mass Air Flow (MAF) Sensor Ckt High Voltage OBD-83
DTC P0112 Intake Air Temperature (IAT) Sensor Circuit Low Voltage OBD-87
DTC P0113 Intake Air Temperature Sensor (IAT) Sensor Circuit High Voltage OBD-90
DTC P0116 Engine Coolant Rationality OBD-93
DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage OBD-98
DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage OBD-101
DTC P01293 Injector Circuit Low to High Current Transition Time Bank 1 ..... OBD-199
DTC P01294 Injector Circuit Low to High Current Transition Time Bank 2 ..... OBD-199
DTC P01295 Injector Circuit High to Low Current Transition Time Bank 1 ..... OBD-199
DTC P01296 Injector Circuit High to Low Current Transition Time Bank 2 ..... OBD-199
DTC P01658 Fuel Injector Control Module (FICM) Driver Performance OBD-199
DTC P0168 Fuel Temperature Sensor Over Temp OBD-104
DTC P01687 Fuel Injector Control Module (FICM) Driver Stuck On OBD-199
DTC P0181 Fuel Temperature Sensor Performance OBD-107
DTC P0182 Fuel Temperature Sensor Circuit Low Voltage OBD-110
DTC P0183 Fuel Temperature Sensor Circuit Low Voltage OBD-113
DTC P0192 Fuel Rail Pressure Sensor Circuit Low Voltage OBD-116
DTC P0193 Fuel Rail Pressure Sensor Circuit Low Voltage OBD-118
DTC P0201-P0208 Injector Control Circuit OBD-121
DTC P0218 Transmission Fluid Over Temperature OBD-127
DTC P0234 Turbo Charger Engine Overboost OBD-129
DTC P0237 Turbocharger Boost Sensor Circuit Low Voltage OBD-132
DTC P0238 Turbo Charger Boost Sensor Circuit High Voltage OBD-135
DTC P0299 Turbocharger Engine Underboost OBD-138
DTC P0300 Engine Misfire Detected OBD-143
DTC P0301-P0308 Cylinder Misfire Detected OBD-144
DTC P0335 Crankshaft Position (CKP) Sensor Circuit OBD-145
DTC P0336 Crankshaft Position (CKP) Sensor Performance OBD-149
DTC P0340 Camshaft Position (CMP) Sensor Circuit OBD-152
DTC P0341 Camshaft Position (CMP) Sensor Performance OBD-156
DTC P0370 & P0374 High Resolution Circuit OBD-159
DTC P0381 Wait To Start Control Circuit OBD-162
DTC P0401 Exhaust Gas Recirculation (EGR) Flow Insufficient OBD-164
DTC P0403 Exhaust Gas Recirculation (EGR) Solenoid Control Circuit OBD-166
DTC P0404 Exhaust Gas Recirculation (EGR) Open Position Performance OBD-169
DTC P0405 Exhaust Gas Recirculation (EGR) Position Sensor Circuit Low Voltage OBD-173
DTC P0406 Exhaust Gas Recirculation (EGR) Position Sensor Circuit High Voltage OBD-176
DTC P0500 Vehicle Speed Sensor (VSS) Circuit OBD-179
DTC P0506 Idle Speed Too Low OBD-182
DTC P0507 Idle Speed Too High OBD-183
DTC P0522 Oil Pressure Circuit Low Voltage OBD-184
DTC P0523 Oil Pressure Sensor High Voltage OBD-187
DTC P0561 System Voltage Performance OBD-190
DTC P0562 System Voltage Low OBD-193
DTC P0563 System Voltage High OBD-195
DTC P0601 Engine Control Module (ECM) Read Only Memory (ROM) OBD-197
DTC P0602 Engine Control Module (ECM) Not Programed OBD-197
DTC P0603 Engine Control Module (ECM) Long Term Memory Reset OBD-197
DTC P0604 Engine Control Module (ECM) Random Access Memory (RAM) OBD-197
DTC P0611 Fuel Injector Control Module (FICM) Performance OBD-199
DTC P0612 Fuel Injector Control Module (FICM) Relay Control Circuit OBD-201
DTC P0642 5 Volt Reference 1 Circuit Low Voltage OBD-203

DTC P0643 5 Volt Reference 1 Circuit High Voltage OBD-205
DTC P0650 Malfunction Indicator Lamp (MIL) Control Circuit OBD-207
DTC P0652 5 Volt Reference 2 Circuit Low Voltage OBD-210
DTC P0653 5 Volt Reference 2 Circuit High Voltage OBD-213
DTC P0670 Glow Plug Control Module Control Circuit OBD-215
DTC P0671-P0678 Glow Plug Control Circuit OBD-218
DTC P0698 5 Volt Reference 3 Circuit Low Voltage OBD-222
DTC P0699 5 Volt Reference 3 Circuit High Voltage OBD-225
DTC P0700 Transmission Control Module (TCM) Request Mill Illumination OBD-227
DTC P0701 Transmission Control System OBD-228
DTC P0703 Brake Switch Circuit OBD-230
DTC P0708 Transmission Range Sensor Circuit High Inpu OBD-232
DTC P0711 Transmission Temperature Sensor Circuit Performance OBD-236
DTC P0712 Transmission Fluid Temperature Sensor Circuit Low Input OBD-240
DTC P0713 Transmission Fluid Temperature Sensor Circuit High Input OBD-244
DTC P0716 Turbine Speed Sensor Circuit Performance OBD-248
DTC P0717 Turbine Speed Sensor Circuit No Signal OBD-251
DTC P0721 Output Speed Sensor Circuit Performance OBD-254
DTC P0722 Output Speed Sensor Circuit No Signal OBD-257
DTC P0726 Engine Speed Sensor Input Circuit Performance OBD-260
DTC P0727 Engine Speed Circuit No Signal OBD-263
DTC P0731 Incorrect First Gear Ratio OBD-266
DTC P0732 Incorrect 2nd Gear ratio OBD-268
DTC P0733 Incorrect 3rd Gear ratio OBD-270
DTC P0734 Incorrect 4th Gear Ratio OBD-272
DTC P0735 Incorrect 5th Gear Ratio OBD-274
DTC P0736 Incorrect Reverse Ratio OBD-276
DTC P0741 Torque Converter Clutch System Stuck Off OBD-279
DTC P0742 Torque Converter Clutch System Stuck On OBD-281
DTC P0743 Torque Converter Clutch OBD-283
DTC P0746 Pressure Control Solenoid Performance OBD-287
DTC P0746 Shift Solenoid C Electrical OBD-298
DTC P0747 Pressure Control Solenoid Stuck On OBD-290
DTC P0748 Pressure Control Solenoid Circuit Electrical OBD-293
DTC P0768 Shift Solenoid D Circuit Electrical OBD-302
DTC P0773 Shift Solenoid E Circuit Electrical OBD-305
DTC P0776 Pressure Solenoid B Controlled Clutch Stuck Off OBD-308
DTC P0777 Pressure Solenoid B Controlled Clutch Stuck On OBD-311
DTC P0778 Pressure Solenoid B Electrical OBD-314
DTC P0802 Transmission Control Module (TCM) MIL Request Circuit OBD-319
DTC P0840 Transmission Pressure Switch Solenoid C Circuit OBD-322
DTC P0841 Transmission Pressure Switch Solenoid C Stuck Off OBD-326
DTC P0842 Transmission Pressure Switch Solenoid C Circuit Stuck Closed OBD-330
DTC P0843 Transmission Pressure Switch Solenoid C Circuit High OBD-334
DTC P0845 Transmission Pressure Switch Solenoid D Circuit OBD-338
DTC P0846 Transmission Pressure Switch Solenoid D Circuit Stuck Open OBD-342
DTC P0847 Transmission Pressure Switch Solenoid D Circuit Stuck Closed OBD-346
DTC P0848 Transmission Pressure Switch Solenoid D Circuit High OBD-350
DTC P0870 Transmission Pressure Switch Solenoid E Circuit OBD-354
DTC P0871 Transmission Pressure Switch Solenoid E Circuit Stuck Open OBD-358
DTC P0872 Transmission Pressure Switch Solenoid E Circuit Stuck Closed OBD-362
DTC P0873 Transmission Pressure Switch Solenoid E Circuit High OBD-366
DTC P0875 Transmission Pressure Switch Reverse Circuit OBD-370
DTC P0876 Transmission Pressure Switch Reverse Circuit Stuck Open OBD-374
DTC P0880 TCM Power Input Signal OBD-378

DTC P1093 Fuel Rail Pressure Low During Power Enrichment OBD-381
DTC P1094 Fuel Rail Pressure Low During Idle or Decel Fuel Cut-Off (DFCO) OBD-385
DTC P1123, P1226, P1229, P1232, P1235, P1238, P1241, P1244 Injector Output Circuit OBD-391
DTC P1125 Accelerator Pedal Position (APP) System OBD-388
DTC P1404 Exhaust Gas Recirculation (EGR) Closed Position Performance OBD-395
DTC P1550 Fuel Injector Control Module (FICM) System Voltage OBD-398
DTC P1621 Engine Control Module (ECM) Long Term Memory Performance OBD-197
DTC P2122 Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage OBD-401
DTC P2123 Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage OBD-405
DTC P2127 Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage OBD-409
DTC P2128 Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage OBD-413
DTC P2132 Accelerator Pedal Position (APP) Sensor 3 Circuit Low Voltage OBD-417
DTC P2133 Accelerator Pedal Position (APP) Sensor 3 Circuit High Voltage OBD-421
DTC P2138 Accelerator Pedal Position (APP) Sensor 1-2 Correlation OBD-425
DTC P2139 Accelerator Pedal Position (APP) Sensor 1-3 Correlation OBD-430
DTC P2140 Accelerator Pedal Position (APP) Sensor 2-3 Correlation OBD-434
DTC P2146 Injector Positive Voltage Control Circuit Group1 ..... OBD-436
DTC P2149 Injector Positive Voltage Control Circuit Group 2 ..... OBD-437
DTC P2227 Barometric Pressure (BARO) Sensor Performance OBD-438
DTC P2228 Barometric Pressure (BARO) Sensor Circuit Low Voltage OBD-443
DTC P2229 Barometric Pressure (BARO) Sensor Circuit High Voltage OBD-447
DTC P2563 Turbocharger Boost Control Position Sensor Performance OBD-450
DTC P2564 Turbocharger Boost Control Position Sensor Circuit Low Voltage OBD-455
DTC P2565 Turbocharger Boost Control Position Sensor Circuit High Voltage OBD-458
DTC P2610 Engine Control Module (ECM) Ignition Of Timer Performance OBD-197
DTC P2636 Fuel Transfer Pump Flow Insufficient OBD-462
DTC P2771 Four Wheel Drive (4WD) Low Switch Circuit OBD-466
DTC P2810 Solenoid G Electrical OBD-468
DTC U0073 High Speed CAN Communication Bus OBD-471
DTC U0100-U299 Lost Communication With Engine Control Module (ECM) OBD-475
Engine Control Module (ECM)
Repair OBD-5
Replacement OBD-5
Reprogramming OBD-5
Schematics OBD-35
Verifying Vehicle Repair OBD-5
Tech 2
Data List OBD-9
Diagnosis OBD-6
Information OBD-6

ENGINE CONTROL MODULE (ECM)

The Engine Control Module (ECM) is located in the passenger compartment under the center console. It is the control center for the fuel and emissions system.

The ECM constantly looks at the information from various sensors, and controls the systems that affect vehicle performance. Through periodic system checks the ECM can recognize operational problems and alert the driver through the Malfunction Indicator Light (MIL). Problems are stored as Diagnostic Trouble Codes (DTCs), which identify the problem areas to aid the technician in making repairs.

The engine control Module, monitors a number of engine and vehicle functions and controls the following operations:

- Fuel control
- Fuel injection timing
- Speed Control
- Turbocharger Boost
- Transmission shift and shift quality functions. Specific transmission control diagnostics are covered in Section 5 of this service manual.

ECM Repair

The only accepted repair to the ECM is replacement.

If the diagnostic procedures call for the ECM to be replaced, it will be necessary to program the new ECM.

Important

- When replacing the production ECM with a service ECM, a DTC P1214 will be stored. It is important to program "TDC Offset" into the service ECM. Refer to "ECM Programming (TDC Offset)."
- When a ECM has been replaced, a short glow plug duration will exist during the first ignition cycle (less than 2 seconds). After the first ignition cycle, the glow plug system will operate properly.
- When replacing the production ECM with a service ECM, it is important to transfer the broadcast code and production ECM number to the service ECM label (**do not record on ECM case**). This will allow positive identification of ECM parts throughout the service life of the vehicle.
- To prevent internal ECM damage, the ignition must be "OFF" when disconnecting or reconnecting power to the ECM (for example, battery cable, ECM pigtail, ECM fuse, etc.). The ignition should be "OFF" for at least 30 seconds before disconnecting power to the ECM.

ECM Replacement

Removal

1. Allow 30 seconds to elapse, after the ignition is turned to the "off" position, before disconnecting the battery cables.
2. Disconnect the negative battery cables.
3. Gain access to the ECM from the center console.
4. Unplug the connectors from the ECM.
5. Remove the ECM mounting hardware and the ECM.

Installation

1. Install the mounting hardware to the new ECM.
2. Secure the connectors to ECM.
3. Relocate the ECM in the center console and tighten hardware.
4. Reconnect the negative battery cables.

NOTE: The MIL, and Check Throttle lamp will continue to be enabled until the ECM is programmed. Once the programming is complete, the lamps will be turned "OFF" and normal operation will resume.

5. Reprogram the new ECM.

Verifying Vehicle Repair

Verification of vehicle repair is more comprehensive for vehicles with OBD II system diagnostics. Following a repair, the technician should perform the following steps:

1. Review and record the failure records and/or Freeze Frame data for the DTC which has been diagnosed (Freeze Frame data will only be stored for an A or B type diagnostic and only if the MIL has been illuminated).
2. Clear DTC(s).
3. Operate the vehicle within conditions noted in the failure records and/or Freeze Frame data.

4. Monitor the DTC status information for the specific DTC which has been diagnosed until the diagnostic test associated with that DTC runs and passes.

Following these steps is very important in verifying repairs on OBD II systems. Failure to follow these steps could result in unnecessary repairs.

Reprogramming of the ECM

The ECM can be reprogrammed with the use of the Tech 2 and the GM Technical Information System (TIS). Follow the steps outlined on the TIS.

TECH 2 INFORMATION

The "On-Board diagnostic (OBD) System Check" is an organized approach to identifying a problem created by a control module system malfunction. It must be the starting point for any driveability complaint diagnosis, this will direct the service technician to the next logical step in diagnosing the complaint. Understanding the chart and using it properly will reduce diagnostic time and prevent the unnecessary replacement of good parts.

Tech 2 Diagnosis

The Tech 2(Figure OBD-1) checks function of the solenoids, sensors, and ECM. The Tech 2 connector is attached to the vehicle data link connector(Figure OBD-2). The Tech 2 provides data on individual circuits, or on all the related electrical components in snap shot mode.

The ECM memory and circuits are interrogated by the Tech 2. The tool reads diagnostic trouble codes (DTC) and displays fault and performance parameters.

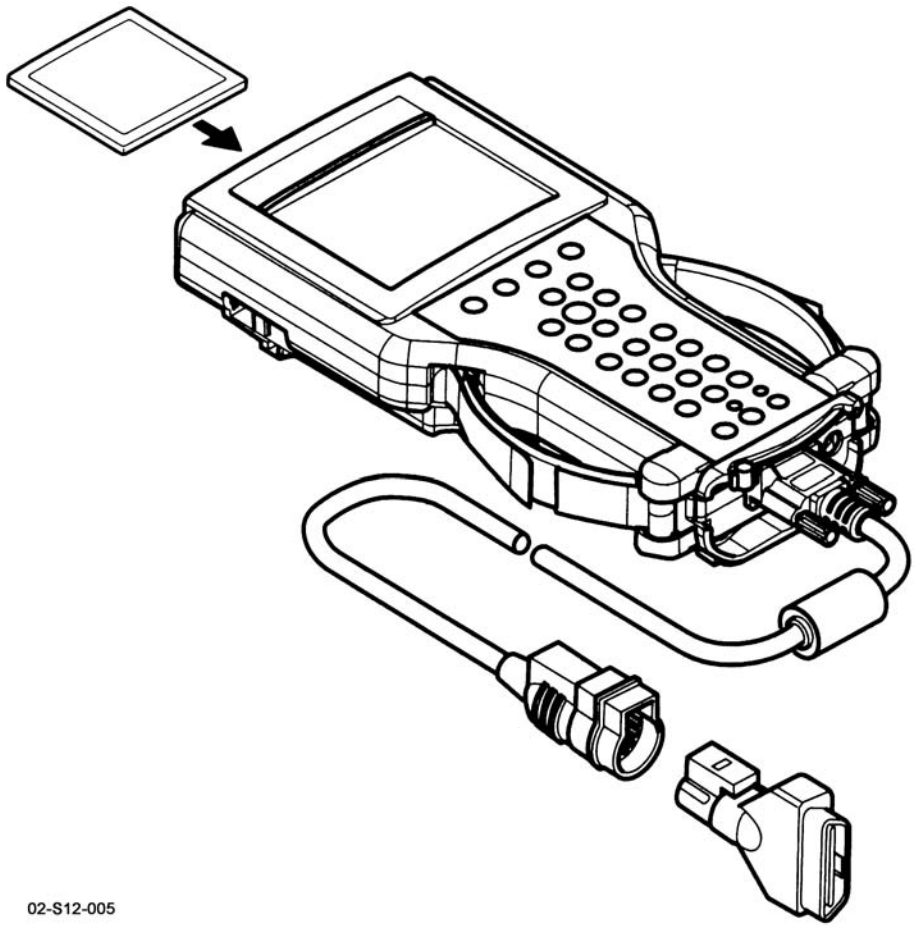


Figure OBD-1: TECH 2

The recommended method for reading DTC(s) stored in memory is by using a Tech 2 plugged into the DLC (Figure OBD-1).

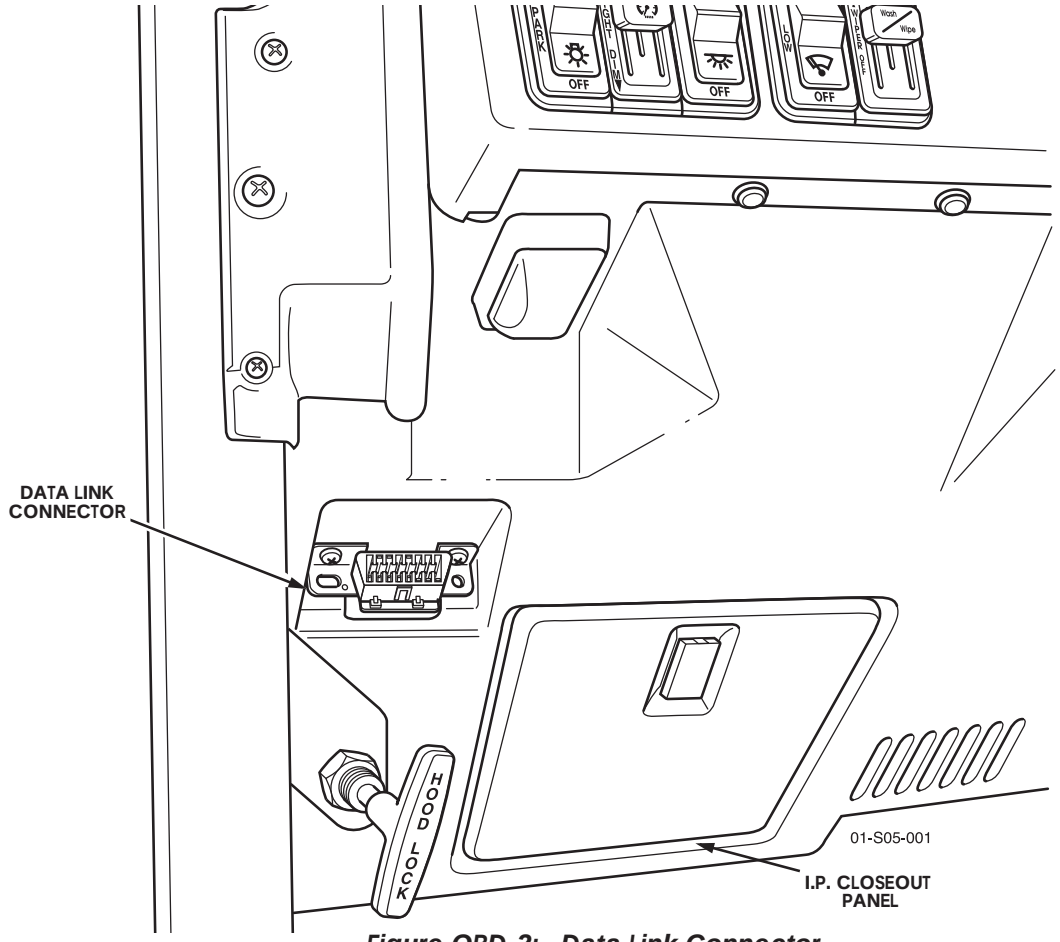


Figure OBD-2: Data Link Connector

Malfunction Indicator Lamp (MIL) "Check Engine"

This light is on the instrument panel and has the following functions.

- It informs the driver that a problem has occurred and that the vehicle should be taken in for service as soon as reasonably possible.

As a bulb and system check, the light will come "ON" with the key "ON" and the engine not running. When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a DTC will remain stored in the ECM.

When the light remains "ON" while the engine is running, or when a malfunction is suspected due to a driveability or emissions problem, an "On-Board Diagnostic (OBD) System Check" must be performed. This check will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

"Check Throttle" Lamp

This light is on the instrument panel and has the following functions:

- It informs the driver that a problem has occurred in the Accelerator Pedal Position (APP) circuit and the vehicle should be taken in for service as soon as reasonably possible.

As a bulb and system check, the light will come "ON" with the key "ON" for 2 seconds. If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a DTC will remain stored in the ECM.

When the light remains "ON" while the engine is running, or when a malfunction is suspected, an "On-Board Diagnostic (OBD) System Check" must be performed. This check will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

DIAGNOSTIC SYSTEM CHECK

Circuit Description

The Diagnostic System Check is an organized approach to identifying a condition that is created by a malfunction in the engine control system. The Diagnostic system check must be the starting point for any driveability concern. Understanding and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

Test Description

The numbers below refer to the step number in the diagnostic table.

3. This step stores the engine control module (ECM) diagnostic trouble code (DTC) information into the Tech 2 memory. After you complete the diagnostic procedure, review the captured information in order to catch the next DTC if the control module stores multiple DTCs. Review the Freeze Frame data and the Failure Records data. Use this information in order to determine how frequently and how recently the DTC set. This information may help diagnose an intermittent condition. Information about the operating conditions at the time that the DTC set may also help diagnose an intermittent condition. Capturing the stored information saves the data that the ECM loses during the following conditions:

- When a diagnostic procedure instructs you to clear the DTCs.
- When a diagnostic procedure instructs you to disconnect the ECM connectors.
- When a diagnostic procedure instructs you to replace the ECM.

Diagnostic System Check

Step	Action	Value(s)	Yes	No
1	Connect the Tech 2 to the vehicle data link connector (DLC) and turn on. Does the Tech 2 Power up?	—	Go to step 2.	Go to “No Scan Tool Data”.
2	Attempt to start the engine. Does the engine Start and Idle?	—	Go to step 3.	Go to Engine Cranks but Does Not Run.
3	Select the DTC display function for the ECM. Does the Tech 2 display any DTCs?	—	Go to step 4.	Go to step 6
4	With a Tech 2, select Captured Info in order to store the engine DTC information. Did you complete the action?	—	Go to step 5.	—
5	Does the Tech 2 display DTC P0601, P0602, P0604, P0606 P1621 or P1627.	—	Go to DTC P0601, P0602, P0604, P0606, P01621 or P01627.	Go to diagnostic trouble code (DTC) list.
6	Is the customer’s concern with the automatic transmission?	—	Refer to section 5 for the appropriate repair procedures.	Go to step 7.

Diagnostic System Check

Step	Action	Value(s)	Yes	No
7	Review the following symptoms. Refer to the application symptom diagnostic table: • Hard Start. • Surges/Chugs. • Lack of Power, Sluggishness, or sponginess. • Hesitation, Sag, Stumble. • Cuts Out, Misses. • Poor Fuel Economy. • Excessive Smoke.	—	System OK	Go to the Intermittent Conditions.

Tech 2 Data List

Use the Tech 2 data listed in this table for comparison after the Diagnostic System Check and finding the on-board Diagnostics function properly with no diagnostic codes displayed.

The Typical Data Values are an average of display values recorded from normally operating vehicles. The Typical Data Values are intended to represent what a normally functioning system would display. The values you get may vary due to a low battery charge or other reasons, but they should be very close.

Do not use a Tech 2 that displays incorrect data. Report the problem to the manufacturer. The use of an improperly functioning Tech 2 can result in misdiagnosis and unnecessary parts replacement.

Use only the parameters listed in the tables for diagnosis. If the Tech 2 reads other parameters, the values are not recommended by AM General for use in diagnosis. If all values are within the range illustrated, refer to Symptoms Diagnostic Charts.

Typical Engine Data Values
Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / A/C "OFF"

Tech 2 Parameter	Units Displayed	Typical Data Value
A/C Compressor	Engaged/Disengaged	Disengaged
A/C Relay	On/Off	Off
A/C Request	Yes/No	no
APP 1	Volts	.45 - .95 volts
APP 2	Volts	3.9-4.5 volts
APP 3	Volts	3.6 - 4.1 volts
Act. Inj. Timing	Degrees	3.5-6°
APP Angle	%	0%
Baro	kPa/Volts	3-5 volts (varies with altitude and baro pressure)
Boost Pressure	kPa	60 - 170 kPa varies with altitude
Brake Switch	Open/Closed	Open
Calc. A/C Load	lb-ft	0 lb-ft

Typical Engine Data Values
Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / A/C "OFF"

Tech 2 Parameter	Units Displayed	Typical Data Value
Crank Ref Missed	#	0 (missed)
Cruise Active	On/Off	Off
Cruise Brake Sw.	Open/Closed	Closed
Cruise Switch	On/Off	Off
Desired Idle	RPM	630-650
Des. Inj Timing	Degrees	3.5 - 6.0°
DTC Set This Ign.	Yes/No	No
ECT	C°/F°	85°C - 105°C (185°F - 221°F) varies with coolant temp.
ECT Sensor	Volts	1.7-2.2 volts (varies with coolant temp.)
Engine Load	%	4 - 6%
Engine Run Time	Hours/Minutes/Seconds	Varies
Engine Speed	RPM	±100 RPM from desired
Engine Torque	ft-lb	7 - 10 ft-lb
ESO Solenoid	On/Off	On
Fuel Rate	Millimeters cubed	7 - 12 mm3
Fuel Temp	C°/F°	60°C - 80°C (140°F - 176°F) Varies with fuel temp.
Glow Plug	Volts	0 volts
Glow Plug System Type	Federal/California	Enabled/Disable
IAT	C°/F°	60°C - 80°C (140°F - 177°F) Varies with incoming air
Ignition Volts	Volts	12 - 14 volts
Inj. Pump Cam Reference Missed	#	0 (missed)
Inj. Pump Sol. Closure Time	Milliseconds	1.70 - 1.90 ms
Lift Pump	Volts	12 - 15 volts
Lift Pump System	Disabled/Enabled	Enabled
MIL Lamp	On/Off	Off
# of Current DTC's	#	0
Resume Switch	On/Off	Off

Typical Engine Data Values
Idle / Upper Radiator Hose Hot / Closed Throttle / Park or Neutral / A/C "OFF"

Tech 2 Parameter	Units Displayed	Typical Data Value
Service Throttle Soon Lamp	On/Off	Off
Set Switch	On/Off	Off
Start Up ECT	C°/F°	Varies (depends on start up ECT)
TDC Offset	Degrees	-.25 to -.75
TFT	C°/F°	50°C - 70°C (122°F - 158°F) varies
TR Switch	Park-Neutral, Reverse, Drive Ranges	Park
Vehicle Speed	MPH kp/h	0 0
*VTD Auto Learn	Active/Inactive	Inactive
*VTD Fuel Disable	Active/Inactive	Inactive
*VTD Fuel Disable Until Ignition Off	Yes/No	No
Wastegate Solenoid	%	50-70%
1-2 Sol	On/Off	On/Off
2-3 Sol.	On/Off	On/Off

Scan Tool Data Definitions

A list of each data message display on the scan tool will be explained in two groups: engine or transmission. This information will assist in emission or driveability problems. The displays can be viewed while the vehicle is being driven. Always perform the Engine Controls Diagnostic System Check first The Diagnostic System Check will confirm proper system operation.

A/C Compressor -Range Engaged/Disengaged

Indicates weather or not the air conditioning (A/C) compressor is engaged. The output test function in the scan tool can only be activated with the key "ON" and the engine "OFF".

A/C Relay - Range Disabled/Enabled

Represents the commanded state of the air conditioning (A/C) clutch control relay. The A/C clutch should be engaged with "ON" displayed.

A/C Request - Range ON/OFF

Represents the state of the air conditioning (A/C) request input from the control head.

Act. Inj. Timing - Range 0 - 25˚

Current actual injection timing.

APP Angle - Range 0 - 100 Percent

Computed by the engine control module (ECM) from accelerator pedal position (APP) module voltage, or the throttle position, and should display 0 percent at idle and 100 percent at wide open throttle (WOT).

APP 1 - Range 0-5 Volts

The engine control module (ECM) uses the accelerator pedal position (APP) sensors to control fuel delivery as requested by the driver. Three APP sensors are located in a module at the base of the accelerator pedal. The ECM only requires information from one sensor, the other two serve as fail-safes. APP 1 should read approximately 0.35-0.95 volts at idle to above 4 volts at WOT.

APP 2 - Range 0-5 Volts

The engine control module (ECM) uses the accelerator pedal position (APP) sensors to control fuel delivery as requested by the driver. Three APP sensors are located in a module at the base of the accelerator pedal. APP 2 should read approximately 4.5 volts at idle and should steadily decrease to approximately 1 volts at WOT.

APP 3 - Range 0-5 Volts

The engine control module (ECM) used the accelerator pedal position sensor in order to control the fuel delivery as requested by the driver. Three APP sensors are located in a module at the base of the accelerator pedal. APP 3 should read approximately 2.5 volts at WOT.

BARO - Range 10-105 kPa

The barometric pressure reading is determined form the boost sensor at ignition “ON”, engine “OFF”. The BARO reading display represents barometric pressure and it is used to compensate for altitude differences.

Brake switch - Range Open/Closed

Is used for stop light and a redundant cruise control disengagement switch.

Boost Pressure - Range Open/Closed

The amount of turbo boost pressure in the intake manifold.This is measured in kPa and volts. True boost pressure is determined by subtracting the barometric pressure from the actual reading.

Crank Reference Missed - Range 0-8

The scan tool will display the numbers of crank pulses missed. At idle, the crank reference missed range should be 0.

Cruise Active - Range ON/OFF

Indicates if the vehicle is in cruise control.

Cruise Brake Switch _ Range Open/Closed

When the brake pedal is applied, the switch sends a signal to the engine control module to disengage the cruise.

Cruise Switch - Range ON/OFF

Indicates if the cruise switch on the turn signal lever is in the “ON” position.

Desired Idle - Range 0-3187 RPM

The idle speed that is requested by the ECM. The ECM will compensate for various engine loads based on engine coolant temperature to keep the engine at the desired speed.

Des. Inj Timing - Range 0-25˚

The amount of injection timing requested by the ECM.

DTC Sent this ignition – Range #

Indicates the total number of current DTCs set this ignition cycle.

ECT - Range -40 to +151˚C (-40 to 304˚F)

The engine coolant temperature (ECT) sensor sends a signal to the ECM relative to the engine coolant temperature. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold and the internal resistance is high, the ECM monitors and interprets a high signal voltage as a cold engine. As the sensor warms and the internal resistance decreases, the voltage signal will decrease and the ECM will interpret the lower voltage as a warm engine.

Engine Load _ Range 0-100 Percent

The amount of load on the engine.

Engine Run Time - Range 00:00:00 (HRS/MIN/SEC)

A measure of how long the engine has been operating. When the ignition is cycled to “OFF”, the value is reset to zero.

Engine Shut-Off Solenoid - Range ON/OFF

The engine shout-off solenoid (ESO) is located on the fuel injecting pump. When the ignition switch is “OFF”, the ESO is in the NO FUEL position. The ESO prevents fuel from entering the fuel injection pump.

Engine Torque - Range 0-999 lb-ft

The amount of engine torque.

Engine Speed - Range 0-9999 RPM

The engine speed is computed by the ECM from the crankshaft position sensor (CKP). If the CKP is inoperative, an RPM reading is taken from the injection pump cam signal. The RPM reading should remain closed to the desired idle during various engine loads with engine idling. The engine speed value is very accurate.

Fuel Rate - Range 0-80 mm3

This reading is displayed in millimeters cubed (MM3). This is the amount of fuel the ECM is requesting.

Fuel Temperature - Range -28 to +140˚C (-18 to +285˚F)

There is a thermistor located in the optical sensor that determines fuel temperature. When the sensor is cold and the internal resistance is high, the ECM will interpret the low voltage as warm fuel.

Glow Plug - Range 0-25.5 volts

The amount of voltage applied to the glow plug system. The scan tool can be used to indicate if the glow plugs actually turn on by monitoring the voltage drop. Also, a good functional check of the glow plug relay.

Glow Plug System - Range Enabled/Disabled

Indicates whether or not the ECM has requested the glow plugs be turned on.

IAT - Range -40 to +151˚C (-40 to +304˚)

The intake air temperature sensor sends a signal to the ECM relative to the incoming air. The IAT is used by the ECM to adjust the fuel delivery.

Ignition volts - Range 0-25.5 Volts

This represents the system voltage measured by the ECM at its ignition feed circuit Ignition voltage is only present when the vehicle is running.

Inj. Pump Cam Reference Missed - 0-8

The Tech 2 will display the number of cam pulses missed. At idle, the inj. pump cam reference missed. At idle, the inj.pump cam reference Missed range should read 0.

Inj. Pump Sol. Closure Time - Range 0.0-4.0 milliseconds.

Indicates the amount of time the fuel solenoid takes to close. When engine lode is increased, the closure time will fluctuate.

Lift Pump - Range 0.0-25.5 Volts

The amount of voltage the lift pump system is drawing. Also, a good functional check of the lift pump relay and the oil pressure switch.

MIL - Range ON/OFF

Represents the commanded state of the Service Engine Soon Light

Number or DTCs - Range #

Indicates the total number of current DTCs set, but does not necessarily mean that the MIL is illuminated.

Resume Switch - Range ON/OFF

Indicates if the cruise control resume switch is activated. The scan tool may be used in order to determine if the cruise control resume set switch is functioning properly.

Service Throttle Soon Lamp - Range ON/OFF

Represents the commanded state of the service throttle soon lamp.

Set Switch - Range ON/OFF

Indicates if the cruise control set switch is activated. The scan tool may be used to dete4rmine if the cruise control set switch is functioning properly.

Startup Cooling - Range -40 to +151˚C (-40 to +304˚F)

A reading of the vehicles coolant temperature at start-up. This will change with every key cycle.

TDC Offset - Range -2.50 to +2.50˚

The ECM has the ability to determine the amount of offset that is needed to bring the engine to top dead center.This is used by the ECM in order to determine the proper injection timing and the fuel delivery. This value may be displayed as a positive or negative number.

Trans. Fluid Temp. - Range -40 to 151˚C (-40 to 304˚F)

This value represents the input signal of the transmission fluid temperature sensor.

Vehicle Speed - Range 0-98

Vehicle speed is a ECM internal parameter. The vehicle speed is computed by timing pulses coming from the vehicle speed sensor. Vehicle speed is used to check the torque converter clutch lock-up speed or speedometer accuracy. the speed is displayed in both kilometers per hour and miles per hour.

Wastegate Solenoid - Range 0-100 Percent

The ECM cycles the boost solenoid ON and OFF. The on time, or duty cycle, of the solenoid valve is expressed as a percent. The boost solenoid meters the vacuum level at the wastegate valve actuator as commanded by the ECM.

No Malfunction Indicator Lamp (MIL) "Check Engine"

Step	Action	Value(s)	Yes	No
8	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2.	Go to OBD system check.
9	Attempt to start the engine. Does the engine start?	—	Go to step 3.	Go to step 6.
10	Check the fuse number 4B of the interior fuse box. Is the fuse OK?	—	Go to step 4.	Go to step 14.
11	Turn the ignition "ON," probe the ignition feed circuit at the cluster connector with a test light to ground. Is the test light "ON?"	—	Go to step 5.	Go to step 11.
12	1. Turn the ignition "OFF." 2. Disconnect the black ECM connector. 3. Turn the ignition "ON." 4. Connect a fused jumper to the MIL control circuit at the ECM connector. 5. Observe the MIL. Is the MIL "ON?"	—	Go to step 9.	Go to step 10.
13	Check the ECM ignition Feed and Battery Feed fuses. Are both of the fuses OK?	—	Go to step 7.	Go to step 13.
14	1. Turn the ignition "OFF." 2. Disconnect the ECM connectors. 3. Turn the ignition "ON." 4. Probe the ECM harness ignition and battery feed circuits with a test light to ground. Is the test light "ON" both circuit?	—	Go to step 8.	Go to step 12.
15	1. Check for a faulty ECM ground or a poor ECM ground connection. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to step 18.	Go to step 9.
16	1. Check for a poor connection at the ECM. 2. If a poor connection is found, repair as necessary. Was a problem found?	—	Go to step 18.	Go to step 15.
17	1. Check the MIL control circuit for an open. 2. If the MIL control circuit is open, repair as necessary. Was a problem found?	—	Go to step 18.	Go to step 16.
18	Repair open in the ignition feed circuit to connector C3. Is the action complete?	—	Go to step 18.	—
19	Locate and repair open in the ECM battery feed circuit or the ECM ignition feed circuit as necessary. Is the action complete?	—	Go to step 18.	—

No Malfunction Indicator Lamp (MIL) "Check Engine"

Step	Action	Value(s)	Yes	No
20	Locate and repair short to ground in the ECM Ignition Feed circuit or the ECM Battery Feed circuit as necessary. Is the action complete?	—	Go to step 18.	—
21	Locate and repair short to ground in the volt/oil module Ignition Feed circuit. Is the action complete?	—	Go to step 18.	—
22	Replace the ECM. **NOTE:** If the ECM is faulty, then ECM must be programmed. Go to ECM Replacement and Programming Procedures. Is the action complete?	—	Go to step 18.	—
23	1. Check the MIL control circuit for a poor connection at the volt/oil module connector. 2. If a problem is found, repair as necessary. Was a problem found?	—	Go to step 18.	Go to step 17.
24	Replace the Volt/Oil module. Is the action complete?	—	Go to step 18.	—
25	1. Using the Scan Tool, select "DTC," "Clear Info." 2. Attempt to start the engine. Does the engine start and continue to run?	—	Go to Step 19	Go to step 2.
26	1. Allow engine to idle until normal operating temperature is reached. 2. Select "DTC," "Failed This Ign." Are any DTCs displayed?	—	Go to Applicable DTC Table	Go to step 20.
27	Using the Scan Tool, select "Capture Info," "Review Info." Are any DTCs displayed that have not been diagnosed?	—	Go to Applicable DTC Table	System OK

No Scan Tool Data

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic (OBD) System Check" performed?	—	Go to step 2.	Go to OBD system check.
2	1. Ignition "OFF" for 30 seconds. 5. Ignition "ON," Engine "OFF." Is the MIL "ON"?	—	Go to step 3.	Go to Chart A-1.
3	Can the Scan Tool communicate with the ECM?	—	Go to step 4.	Go to step 7.
4	With the Scan Tool, command the MIL "ON" and "OFF."	—	Go to step 17.	Go to step 5.

No Scan Tool Data

Step	Action	Value(s)	Yes	No
5	1. Ignition "OFF." 2. Disconnect the ECM connectors. 3. Ignition "ON." Is the MIL "OFF"?	—	Go to step 6.	Go to step 18.
6	With the Scan Tool, check Engine Cal ID. Is the proper CAL ID present?	—	Go to step 28.	Go to step 19.
7	With a test light to ground, probe the DLC connector (pin 16). Is the test light "ON"?	—	Go to step 8.	Go to step 20.
8	With a test light to B+, probe the DLC connector (pins 4 and 5). Is the test light "ON" for both circuits?	—	Go to step 9.	Go to step 21.
9	Check for proper operation of the cigar lighter. Does the cigar lighter operate properly?	—	Go to step 10.	Go to step 22.
10	Verify proper operation of the Scan Tool with a known good vehicle with the same equipment/controller. Does the Scan Tool communicate with known good vehicle?	—	Go to step 11.	Go to step 23.
11	1. Disconnect the Scan Tool. 2. With the DVM connected to ground, check the ECM serial data line at the DLC connector (pin 2). Is voltage on the serial data line less than the specified value?	7v	Go to step 12.	Go to step 15.
12	With the DVM connected to ground, again check the ECM serial data line at the DLC connector (pin 2). Is voltage on the serial data line less than the specified value?	1v	Go to step 13.	Go to step 16.
13	1. Ignition "OFF." 2. With the DVM connected to ground, check resistance of the serial data line at the DLC connector (pin 2). Is resistance less than the specified value?	10 Ohms	Go to step 14.	Go to step 27.
14	1. Disconnect the ECM connectors. 2. With the DVM connected to ground check resistance of the serial data line at the DLC connector (pin 2). Is resistance less than the specified value?	10 Ohms	Go to step 24.	Go to step 28.
15	1. Ignition "OFF." 2. Disconnect the ECM Connectors. 3. Ignition "ON." 4. Check voltage on the DLC connector (pin 2). Is voltage at the specified value?	0v	Go to step 28.	Go to step 25.
16	Reprogram the EEPROM and retest. Is serial data present?	—	Go to step 26.	Go to step 28.

No Scan Tool Data

Step	Action	Value(s)	Yes	No
17	System OK.	—	—	—
18	Repair short to ground on the MIL control circuit.	—	—	—
19	Reprogram the EEPROM and retest.	—	—	—
20	1. Check fuse number 1H or the interior fuse box. 2. If fuse is blown, repair short to ground in the battery feed circuit to the DLC connector (pin 16). 3. If the fuse is OK, repair open in the battery feed circuit to the DLC connector (pin 16).	—	—	—
21	Repair open in circuit that did not light the test light. Refer to Section 12 for ground distribution.	—	—	—
22	Refer to Section 12 for cigar lighter repair.	—	—	—
23	Faulty Scan Tool and/or cable.	—	—	—
24	Repair short to ground in the serial data line.	—	—	—
25	Repair short to voltage in the serial data line.	—	—	—
26	System OK.	—	—	—
27	1. Check serial data line for an open. 2. If OK, check ECM and DLC connections. 3. If OK, replace the ECM. **NOTE:** If the ECM is faulty, the new ECM must be programmed. Go to ECM replacement and programming procedures. Is the action complete?	—	Go to OBD system check.	—
28	Replace the faulty ECM. **NOTE:** If the ECM is faulty, the new ECM must be programmed. Go the ECM replacement and programming procedures. Is the action complete?	—	Go to OBD system check.	—

BASIC SYMPTOM CHECKS

Before using this section, you should perform the Diagnostic System Check that determines that:

- The control module and the malfunction indicator lamp (MIL) are operating correctly.
- There are no diagnostic trouble codes (DTCs) stored, or a DTC exists but without a MIL.

Several of the following symptom procedures call for a careful visual and physical check. The visual and physical checks are very important. The checks can lead to correcting a problem without further checks which may save valuable time.

Visual and Physical Checks

- Check to ensure that the control module grounds are clean, tight, and in their proper location.
- Check the vacuum hose for splits, kinks, and proper connections, as shown on the Vehicle Emission Control Information label.
- Check thoroughly for any type of leak or restriction.
- Check for air leaks at all of the mounting areas of the intake manifold sealing surfaces.
- Check the wiring for the following conditions:
  - Proper connections
  - Pinches
  - Cuts
- The following symptom tables contain groups of possible causes for each symptom. The order of these procedures is not important. If the scan tool readings do not indicate the conditions, then proceed in a logical order, easiest to check or most likely to cause first.

"On-Board Diagnostic (OBD) System Check"

After the visual/physical under hood inspection, the "On-Board Diagnostic (OBD) "System Check" is the starting point for all diagnostic procedures and for locating the cause of an emissions test failure.

The correct procedure to diagnose a fault is to follow three basic steps.

1. Are the on-board diagnostics working? This is determined by performing the "On-Board Diagnostic (OBD) System Check." If the on-board diagnostics are not working, refer to diagnostic charts in this section. If the on-board diagnostics are working properly, the next step will be:
2. Is there a DTC stored? If a DTC is stored, go directly to the numbered DTC chart in this section. This will determine if the fault is still present. If no DTC is stored, the next step will be:
3. Scan Tool serial data transmitted by the control module. This involves displaying the information available on the serial data stream with a Scan Tool or one of the tools available for that purpose. Information on these tools and the meaning of the various displays can be found in this section. Normal readings under a particular operating condition can be found below the chart "On-Board Diagnostic (OBD) System Check."

Tech 2 Use With Intermittents

In some situations the Tech 2 data update rate makes the tool less effective than a voltmeter, such as when trying to detect an intermittent problem which lasts for a very short time. However, the Tech 2 allows manipulation of wiring harnesses or components under the hood with the engine not running, while observing the Tech 2 readout.

The Tech 2 can be plugged in and observed while driving the vehicle under the condition when the MIL "Service Engine Soon" light turns "ON" momentarily or when the engine driveability is momentarily poor. If the problem seems to be related to certain parameters that can be checked on the Tech 2, they should be checked while driving the vehicle. If there does not seem to be any correlation between the problem and any specific circuit, the Tech 2 can be checked on each position, watching for a period of time to see if there is any change in the reading that indicates intermittent operation.

The Tech 2 is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a DTC. Comparing the sensor's readings with those of a known good vehicle may uncover the problem.

The Tech 2 has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the Tech 2 successfully for diagnosis lies in the technician's ability to understand the system he is trying to diagnose as well as understanding of the Tech 2 operation and limitations.

Symptoms

Verify the customer complaint. Locate the correct symptom table. Check the items indicated under that symptom from the following symptom tables:

- Engine Cranks but Does Not Run
- Intermittent Conditions
- Hard Start
- Surges/Chugs
- Lack of Power, Sluggishness, or Sponginess
- Fuel Knock/Combustion Noise
- Hesitation, Sag, Stumble
- Cuts Out, Misses
- Poor Fuel Economy
- Excessive Smoke

Symptom – Engine Cranks But Does Not Run

Circuit Description

This table verifies that all the basic engine systems are operating properly. This includes the battery condition, the engine cranking speed, the glow plugs, and the fuel delivery system.

Diagnostic Aids

If the cause of an engine cranks but will not run condition has not been found, inspect for the following conditions:

- Hard starting only in cold ambient temperatures. These may cause an intermittent condition that may not occur in the service bay:
  - Fuel heater inoperative.
  - Ice blockage at the fuel pickup in the fuel tank--This will be a high vacuum in the supply lines while cranking, and the problem will disappear after the vehicle is brought in the service bay. It may also exhibit a start and stall condition or a starting condition with no acceleration.
- The correct cranking speed is 100 RPM cold and 180 RPM hot.
- Water or foreign material in fuel system.
- A basic engine problem.
- More than 1 ohm of resistance in the ignition voltage circuit to the fuel injection control module may cause a crank but no start condition.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

5. This step tests for an ignition 1 voltage supply to the engine control module (ECM).

6. If there is fuel in the engine oil, fuel may be leaking from the fuel injector or fuel injection pump into the crankcase.

7. If the fuel system will not even briefly prime to 10 psi and will not start, the check valve in the fuel filter/heater element housing is stuck open.

8. This step determines if the fuel system is bleeding down causing a no start. The fuel pressure will slowly drop to 0 psi, but should still be above 8 psi 10 seconds after pressurizing the fuel system.

9. In some cases, no compression, possibly with excessive fuel, in a single cylinder can cause a no start.

10. This step determines if the problem is a stuck open or broken fuel injector. If fuel vapors come out of any of the glow plug holes, excessive fuel is being sent into a cylinder, and not being distributed to all of the fuel injectors.

11. The engine will not run without an actual fuel rail pressure more than 10 MPa (1,450 psi).

Engine Cranks But Does Not Run

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the Scan Tool "Capture Info" to record Freeze Frame and Failure Record for reference, as data will be lost when "Clear Info" function is used. Was the "On-Board Diagnostic System Check" performed?	—	Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the DTC Information with a scan tool. Does the scan tool display DTC P0090, P0193, P0335, P0336, P0340, P0370, P0374, P0601, P0602, P0603, P0604, P0611, P0612, P0642, P0643, P0670, P0698, P0699, P1621, P1626, P1631, P1683, P1687, or U0105?	—	Go to the Diagnostic trouble code test.	Go to step 3.
3	Is the customer's concern with a fuel smell or fuel leak?	—	Go to Fuel Leaks.	Go to step 4.
4	Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the pressure within the specified range?	145-261 psi 1-1.8 MPa	Go to step 5.	Go to step 15.
5	Observe the Ignition 1 signal parameter with a scan tool. Is the Ignition 1 signal parameter at the specified value?	B+	Go to step 6.	Go to step 18.
6	Inspect for the following conditions: • Excessive fuel in the engine oil. • Fuel specific gravity. Did you find and correct the condition?	—	Go to step 26.	Go to step 7.
7	1. Install the J-44638 Vacuum Gage to the fuel system service port on the right front side of the engine. 2. Attempt to hand prime the fuel manager 30 times or until the specified pressure is reached. Can you prime the system to the specified value?	8 psi	Go to step 8.	Go to step 23.
8	Does the pressure measure more than the specified value for more than 2 minutes?	2 psi	Go to step 9.	Go to step 12.
9	Perform the Engine Compression Test. Repair the engine as necessary. Did you find and correct the condition?		Go to step 27.	Go to step 10.
10	Did any of the cylinders emit any fuel vapor during the Engine Compression Test?	—	Go to step 22.	Go to step 11.
11	1. Crank the engine for 15 seconds. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure parameter more than the specified value?	1,450 psi (10 MPa)	Go to step 13	Go to step 12.

Engine Cranks But Does Not Run

Step	Action	Value(s)	Yes	No
12	1. Prime the fuel manager to 10 psi. 2. Attempt to start the engine while the prime is still above 8 psi.	—	Go to Fuel System Diagnosis.	Go to Fuel System Diagnosis High Pressure Side.
13	**NOTE:** If there is high resistance in the signal or low reference circuits of the crankshaft position (CKP) sensor the Engine Speed parameter of the scan tool will display a value more than 0. It will not be an accurate measure of engine speed, and can cause an Engine Cranks but does Not Run condition. Test the CKP sensor signal and low reference circuits for high resistance. Did you find and correct the condition?	—	Go to step 26.	Go to step 14.
14	Inspect for the following conditions: • A plugged air filter. • A collapsed air intake duct • The fuel heater is inoperative. If the customer concern is that the engine will not start when ambient temperatures are less than 2-4˚C (35-40˚F). • A restricted exhaust system. Did you find and correct the condition?	—	Go to step 26.	Go to Diagnostic Aids.
15	1. Disconnect the fuel rail pressure sensor. 2. Observe the Actual Fuel Rail Pressure parameter on the scan tool. Does the Actual Fuel Rail Pressure parameter measure more than the specified value?	25,380 psi (175 MPa)	Go to step 17.	Go to step 16.
16	Test the fuel rail pressure sensor signal circuit for a short to ground. Did you find and correct the condition?	—	Go to step 26.	go to step 21.
17	Test the fuel rail pressure sensor circuits for high resistance. Did you find and correct the condition?	—	go to step 26.	Go to step 19.
18	1. Test the ignition 1 voltage circuit of the engine control module (ECM) for a short to ground, a high resistance or an open. 2. Replace the fuse, if necessary. **(Refer to section 12 Figure 12-108 Fuel Injection Wiring Schematic)** Did you find and correct the condition?	—	Go to step 26.	Go to step 20.
19	Test for an intermittent or for a poor connection at the fuel rail pressure sensor. Did you find and correct the condition?	—	Go to step 26.	Go to step 24.
20	1. Clean and tighten the ECM shared ground located on the lower right side of the engine. 2. Attempt to start the engine. Does the engine start?	—	Go to step 26.	go to step 21.

Engine Cranks But Does Not Run

Step	Action	Value(s)	Yes	No
21	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?	—	Go to step 26.	Go to step 25.
22	**NOTE:** When the fuel injector pressure lines are removed, debris will fall on the fuel injector inlet fitting. Vacuum the debris from the area to prevent the debris from falling in the fuel injector. Replace the fuel injectors on the affected cylinders. Did you complete the replacement?	—	Go to step 26.	—
23	Before replacing the fuel filter/heater element housing, inspect the fuel vent screw for damage or cross threading. Replace the vent screw w/O-ring if either condition is found. Replace the fuel filter/heater element. Did you complete the replacement?	—	Go to step 26.	—
24	Replace the fuel rail pressure sensor. Refer to section 3 Did you complete the replacement?	—	Go to step 26.	—
25	Replace the ECM. Refer to section 12 for replacement, setup and programming	—	Go to step 26.	—
26	1. Clear any DTCs with a scan tool. 2. Attempt to start the engine. Does the engine start and continue to run?	—	Go to step 27.	Go to step 2.
27	1. Allow the engine to idle until normal operating temperature is reached. 2. Observe the DTC Information with a scan tool. Are any DTCs displayed?	—	Go to the Diagnostic Trouble Code Test.	System OK

Symptom – Intermittent Condition

NOTE: Definition: The problem may or may not turn the MIL on or store a diagnostic trouble code.

Checks	Actions
Preliminary Checks	Refer to Basic Symptom Checks (page Section: OBD–17).
Electrical Connections or Wiring.	Poor electrical connections or wiring can cause most intermittent problems. Perform a careful check of the suspected circuit for the following conditions. • Poor mating of the connector halves • Backed out terminals - Terminals not fully seated in the connector body. • Improperly formed or damaged terminals - Carefully reform or replace all the connector terminals in the problem circuit to ensure the proper contact tension. • Poor terminal to wire contact - Check for poor terminal to wire connections by removing the terminal from the connector body and inspecting the terminals.
Road Test.	If a visual and physical check does not locate the cause of the problem, drive the vehicle with a DVOM connected to the suspected circuit, or use a scan tool. An abnormal voltage or scan reading, when the problem occurs, indicates the problem.

NOTE: Definition: The problem may or may not turn the MIL on or store a diagnostic trouble code.

Checks	Actions
Intermittent Malfunction Indicator Lamp (MIL).	The following can cause an intermittent MIL and no DTCs: • Electrical system interference caused by a malfunctioning relay, engine control module (ECM) driven solenoid, or switch - All of these can cause a sharp electrical surge. Normally, the problem will occur when the malfunctioning component is operating. • The improper installation of electrical devices, such as lights, 2-way radios, cell phones, etc. • The malfunction indicator lamp (MIL) circuit intermittently shorted to ground. • Poor ECM grounds.
Loss of DTC Memory.	Check for loss of DTC memory by disconnecting the engine coolant temperature (ECT) sensor and idling the engine until the MIL turns “ON”. An engine coolant temperature (ECT) DTC should store and remain in memory when turning “OFF” the ignition for at least 10 seconds. If not, the ECM is malfunctioning.
Additional checks	Check for an open diode across the A/C compressor clutch and for other open diodes.

Symptom – Hard Start

NOTE: Definition: the engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately die.

Checks	Action
Preliminary checks.	• Refer to Basic Symptom Checks (page Section: OBD–17). • Make sure that the driver is using the correct starting procedure.
Sensor checks.	Check the engine coolant temperature sensor. Use the scan tool in order to compare the engine coolant temperature with the Ambient Air Temperature on a cold engine. If the coolant temperature reading is more than 5˚ more or less than the Ambient Air Temperature on a cold engine, check for a high resistance in the coolant sensor circuit or the sensor itself.
Fuel system checks.	• Check the supply to the injection pump. • Check for air in the fuel system. • Check the fuel return from the injection pump. • Check the engine shut-off solenoid operation. • Check the fuel injection nozzles. • Check the fuel tank cap vent. • Check for an internal injection pump problem.
Electrical system check.	• Check the glow plug operation. • Check for a slow cranking speed.
Air intake system checks.	• Check the air cleaner and the air intake ducts for a restriction. • Check For a restriction in the turbo charger inlet duct. • Check for a restriction in the intake manifold.
Exhaust system check.	Check the exhaust system for a possible restriction.

NOTE: Definition: the engine cranks OK, but does not start for a long time. The engine does eventually run, or may start but immediately die.

Checks	Action
Engine mechanical checks.	Check the engine for the following conditions: • Improper valve timing. • Low compression. • Worn rocker arms. • Broken or weak valve springs. • Worn camshaft lobes.
Additional checks.	• Check for a no crank signal. • Check the service bulletins for a control module software update.

Symptom – Surges/Chugs

NOTE: Definition: The engine has a power variation under a steady throttle or cruise. the vehicle seems to speed up and slow down without a change in pressure on the accelerator.

Checks	Action
Preliminary checks.	• Refer to Basic Symptom Checks (page Section: OBD–17). • Be sure the driver understands the torque converter clutch operation. • Be sure the driver understands the A/C compressor operation. • Use the scan tool in order to ensure the reading of VSS matches the vehicle speedometer.
Fuel system checks.	Check the fuel pressure while the condition exists.
Additional checks.	• Check the control module grounds for being clean, tight, and in their proper locations. • Check the generator output voltage. Repair if less than 9 or more than 16 volts. • Check the vacuum lines for kinks or links. • Check the TCC operation.

Symptom – Lack of Power, Sluggishness, or Sponginess

NOTE: Definition: The engine delivers less than the expected power. There is less on no increase in speed when partially applying the accelerator pedal.

Checks	Actions
Preliminary checks.	• Refer to Basic Symptom Checks (page Section: OBD–17). • Compare the vehicle with a similar unit. make sure that the vehicle has an actual problem. • Remove the air filter. • Check for dirt, or for air ducts being plugged. Clean and replace if necessary. • Inspect the transmission shift pattern and the down shift operation. • Check the fuel quality. • Check the engine oil level and quality.
Fuel systems checks.	• Check the fuel supply to the injection pump and the fuel return from the injection pump. • Check the fuel pump operation. • Check for malfunction fuel injection nozzles.
Exhaust system checks.	• Check the exhaust system for a possible restriction. • Inspect the exhaust system for damaged or collapsed pipes.

NOTE: Definition: The engine delivers less than the expected power. There is less on no increase in speed when partially applying the accelerator pedal.

Checks	Actions
Air intake system checks.	• Check for an air leakage or a restriction in the air inlet ducts or the intake manifold. • Check for a worn or a damaged turbo charger turbine wheel, shaft, or compressor wheel.
Engine mechanical check	Check the engine for the following: • Low compression. • Improper valve timing. • Improper or worn camshaft.
Additional checks.	• Check the control module grounds for being clean, tight, and in their proper location. • Check the torque converter clutch operation. • Check the A/C operation. • Check the generator output voltage. Repair if voltage is less than 9v and more than 16v.

Symptom - Fuel Knock/Combustion Noise

NOTE: Definition: A mild to severe ping which is usually worse upon acceleration. The engine makes sharp metallic knocks which change with the throttle opening.

Checks	Action
Preliminary checks.	• Refer to Basic Symptom Checks (page Section: OBD–17). • Make sure that the vehicle has an actual problem. • Check the fuel quality.
Cooling system checks.	• Check fro obvious overheating problems. • Check for a low engine coolant level. • Check for a loose water pump belt. • Check for restricted air flow through the radiator, or restricted coolant flow. • Check for a malfunctioning or incorrect thermostat. • Check for a correct coolant solution. The solution should be a 50/50 mix of anti-freeze and water.
Sensor check.	Check the engine coolant temperature sensor. use the scan tool in order to compare the engine coolant temperature with the Ambient Air Temperature on a cold engine. If the coolant temperature reading is more than 5˚ more or less than the Ambient Air Temperature on a cold engine, check for a high resistance in the coolant sensor circuit or the sensor itself.
Fuel system checks.	• Check for air leaks in the fuel supply to the injection pump. • Check the injection pump static timing. • Check the injection nozzles.
Engine mechanical checks.	• Check for incorrect basic engine parts such as the cam, the heads, the pistons, etc. • Check for an excessive oil entering the combustion chamber.
Additional checks.	Check the service bulletins for control module software updates.

Symptom - Hesitation, Sag, Stumble

NOTE: Definition: The vehicle has a momentary lack of response when pushing down on the accelerator. The condition can occur at any vehicle speed. The condition is usually most severe when trying to make the vehicle move from a stop. The condition may cause the engine to stall, if severe enough.

Checks	Action
Preliminary check.	Refer to Basic Symptom Checks (page Section: OBD–17).
Fuel system checks.	• Check the fuel pressure. • Check for water contamination in the fuel. • Perform the injector balance test. • Check for a low fuel pressure after a cold start or during a moderate or a full throttle acceleration. If the fuel pressure drops below specification, there is possibly a malfunctioning fuel pump or a restriction in the fuel system.
Additional checks.	• Check the service bulletins for any control module software updates. • Check the generator output voltage.

Symptom - Cuts Out, Misses

NOTE: Definition: A steady jerking that follows the engine speed, usually more pronounced as the engine load increased. The vibration is not normally felt above 1500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound during idle, low speed, or hard acceleration due to the fuel starvation that can cause the engine to cut-out.

Checks	Action
Preliminary check.	Refer to Basic Symptom Checks (page Section: OBD–17).
Ignition system checks.	Check for a cylinder misfire: • Start the engine. • Allow the engine to stabilize. • Perform the injector balance test. • If there is no RPM drop on one or more of the cylinders, or if there is an excessive variation in drop, refer to Engine mechanical checks.
Engine mechanical checks	• Perform a cylinder compression check. • Check the engine for the following conditions: • Improper valve timing. • Bent pushrods. • Worn rocker arms. • Worn camshaft lobes. • Broken or weak valve springs. • Check the intake and exhaust manifold passages for a casting flash.
Fuel system checks.	• Check the fuel system for a plugged fuel filter, low fuel pressure,. etc. • Check for water contamination in the fuel.
Additional checks.	• Check for electromagnetic interference- The EMI on the reference circuit can cause a missing condition. • Monitoring the engine RPM with the Tech 2 can detect an EMI. • A sudden increase in the RPM with little change in the actual engine RPM will indicate that an EMI is present.

Symptom - Poor Fuel Economy

NOTE: Definition: The fuel economy, as measured by an actual road test, is noticeably lower than expected. Also, the economy is noticeably lower than previously shown by an actual road test on this vehicle.

Checks	Action
Preliminary Checks	• Refer to Basic Symptom Checks (page Section: OBD–17). • Check the air cleaner filter for dirt or being plugged. • Visually or physically inspect the vacuum hoses for splits, kinks, and proper connections. • Perform the Diagnostic System Check. • Check the driving habits of the owner. • Is the A/C “ON” full time? Is the defroster mode “ON”? • Are the tires at the correct pressure? • Are any excessively heavy loads being carried? • Is the acceleration too much, too often? • Suggest to the owner to fill the tank and recheck the fuel economy
Fuel system checks.	• Check the fuel type and quality. • Check the fuel pressure.
Cooling system checks.	• Check the engine coolant level. • Check the engine thermostat for the wrong heat range or possible being stuck open.
Additional checks.	• Check the transmission shift pattern. • Check the torque converter clutch operation. When the TCC is commanded “ON”, the Tech 2 should indicate an RPM drop. • Check the service bulletins for any control module software updates. • Check for dragging brakes.

Symptom - Excessive Smoke

NOTE: Definition: White, black, gray or blue smoke under load, idle or start up hot or cold.

Checks	Action
Preliminary check	• Refer to Basic Symptom Checks (page Section: OBD–17). • Make sure the vehicle has an actual problem. • Check the fuel quality.
Fuel system checks.	• Check the injection pump. • Check the injection pump timing. • Check the injection nozzles.
Sensor Check	• Check the engine coolant temperature sensor by using the Tech 2 in order to compare the engine coolant temperature with the Ambient Air Temperature on a cold engine. If the coolant temperature reading is more than 5˚ more or less than Ambient Air Temperature on a cold engine, check for a high resistance in the coolant sensor circuit or the sensor itself. • Check the glow plug system operation.
Air intake system check.	• Check the air cleaner and the air intake ducts for a restriction. • Check for a restriction in the turbo charger inlet duct. • Check for a restriction in the intake manifold.

NOTE: Definition: White, black, gray or blue smoke under load, idle or start up hot or cold.

Checks	Action
Engine mechanical check.	• Check for incorrect basic engine parts such as the cam, the heads, the pistons, etc. • Check for any excessive oil entering the combustion chamber.

OBD II DIAGNOSTIC TROUBLE CODES

DTC Identification

OBD II requires that the automotive industry use a standardized Diagnostic Trouble Code (DTC) structure (Figure OBD-3). This code structure is very different from OBD I DTC structure. The OBD II DTCs contains a letter and a four-digit number. The letter identifies the function of the device that has the fault:

- B = Body
- C = Chassis
- P = Powertrain
- U = Network or data link code

The first digit of the number indicates if the DTC is generic or manufacturer-specific (0=generic, 1=specific). The second number indicates the specific vehicle system that has the fault. Below are the powertrain system identifiers:

- 1 = Fuel and Air Metering
- 2 = Fuel and Air Metering (injector circuit malfunction).
- 3 = Ignition System or Misfire
- 4 = Auxiliary Emission Controls
- 5 = Vehicle Speed Control and Idle Control System
- 6 = Computer Output Circuit
- 7 = Transmission
- 8 = Transmission

The last two digits indicate the component or section of the system that has the fault.

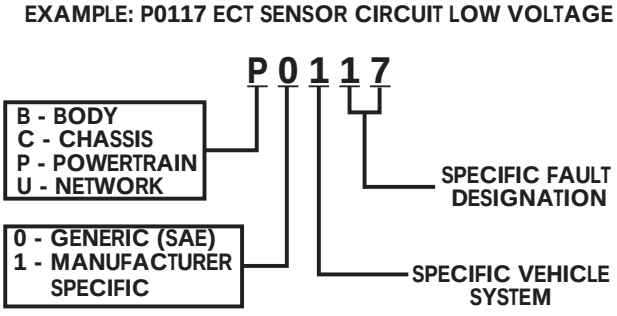


Figure OBD-3: OBD II Code Structure

Code Type

Each DTC is directly related to a diagnostic test. The Diagnostic Management System sets DTCs based on the failure of the tests during a trip or trips. Certain tests must fail two consecutive trips before the DTC is set. The following are the four types of DTCs and the characteristic of those codes:

Type A

- Emissions related.
- Requests illumination of the MIL on the first trip with a failure.
- Stores a HISTORY DTC on the first trip with a failure.
- Stores a Freeze Frame on the first trip with a failure.
- Stores a failure Record.
- Updates the Failure Record the first time the test fails each ignition cycle.

Type B

- Emission related.
- “Armed” after one trip with a failure.
- “Disarmed” after one trip with a pass.
- Requests illumination of the MIL on the second consecutive trip with a failure.
- Stores a HISTORY DTC on the second consecutive trip with a failure (the DTC is “armed” after the first failure).
- Stores a Freeze Frame on the second consecutive trip with a failure.
- Stores a Failure Record when the first test fails (not dependent on consecutive trip fails).
- Updates the Failure Record the first time the test fails each ignition cycle.

Type C

- Non-emission related.
- Request illumination of the service lamp (such as the “CHECK THROTTLE” not the MIL) on the first trip with a failure.
- Stores a HISTORY DTC on the first trip with a failure.
- Does not store a Freeze Frame.
- Stores Failure records when the test fails.
- Updates the Failure Record the first time the test fails each ignition cycle.

Type D

- Non-emission related.
- Does not request illumination of any lamps.
- Stores a History DTC on the first trip with a failure.
- Does not store a Freeze Frame.
- Stores a Failure Record when the test fails.
- Updates the Failure Record the first time the test fails each ignition cycle.

DTC Information

The status of the test and the related DTC messages can be viewed by using the Tech 2. The combination of messages is dependent on the status of the test.The following is a list of DTC information message (some applications do not display all messages listed below):

LAST TEST FAILED:

This message indicates that the last diagnostic test failed. If the DTC is a type A or B this test could have occurred in a previous ignition cycle. This message remains until the test passes or the DTCs are cleared. If the DTC is a type C or D, this message clears when the ignition is turned “OFF”.

TEST FAILED SINCE CODE CLEARED:

This message indicates that the test has failed at least once since the DTCs were cleared.

FAILED THIS IGNITION:

This message indicates that the diagnostic test related to the DTC has failed this ignition cycle.

HISTORY:

This message indicates that the DTC has been stored in memory as a valid fault. Type B DTCs are not stored as history DTCs until the test has failed two consecutive trips.

MIL REQUEST:

This message indicates that the DTC has requested illumination of the MIL. Only type A and B DTCs can request illumination of the MIL.

NOT RAN SINCE CODE CLEARED:

This message indicates that the test related to this DTC has not been run uncertain of the status of the system this ignition cycle. A trip must be completed for the ECM to run the test and know the status of the system.

LAST TEST PASSSED:

This message indicates that the Diagnostic test that failed previously has passed the latest diagnostic test. This does not indicate that the failed is gone. It only indicates that the fault was not present during the latest test.

TEST RAN AND PASSED:

This message indicates that the latest test passed. The test ran and passed this ignition cycle, and ran and passed since DTCs were cleared. The test has not failed since the DTCs were cleared.

FREEZE FRAME:

The Diagnostic Executive in the ECM records certain vehicle operating conditions when a type A or B (emission related) DTC is stored as a history DTC. The ECM only store one Freeze Frame record. Freeze Frame data is stored for the first failed test that sets the DTC and illuminates the MIL.

Freeze Frame is not updated (refreshed) if the test fails a second time. However, fuel trim and misfire DTCs take priority over all other DTCs. Fuel trim and misfire DTCs always overwrite the Freeze Frame record unless a fuel trim or misfire DTC is already stored. Any previous information related to DTCs stored in the Freeze Frame that are overwritten due to a priority DTC setting is lost.

DTC FAIL RECORDS:

Due to the limitations of the Freeze Frame, Failure Records was created. Failure Records assist the technicians when multiple DTCs have been set or when the DTC is non-emission related. Failure Records have similar data parameters to those that are stored in the Freeze Frame. However, the ECM has the ability to store multiple Failure Records.

Failure records are stored any time a diagnostic test fails. Failure Records are only updated (refreshed) the first time the test fails during each ignition cycle. This includes type B DTCs that fail only one trip. Unlike Freeze Frame, Failure Records are not limited to emission DTCs. Type C and D Diagnostic Trouble Codes store Failure Records.

The ECM can store up to Five individual DTC Failure Records. When a diagnostic test fails, Failure Records are stored in the ECM memory and assigned to the first Failure Record position. If a different diagnostic test fails, a second Failure record related to that DTC is stored in memory. Additional failed diagnostic tests for different DTCs also store Failure Records until Fail Record memory is full. If more than the maximum number of DTCs are stored, the failure records are replaced on a “first in, first out” basis.

Diagnostic Trouble Code (DTC) Identification

DTC	Description	Type	Illuminate MIL
P0016	Crankshaft Position (CKP) Camshaft Position (CMP) Sensor Correlation	B	Yes
P0045	Turbocharger Boost Control Circuit	B	Yes
P0046	Turbocharger Boost Control Position Performance	B	Yes
P0087	Fuel Rail Pressure too Low	A	Yes
P0088	Fuel Rail Pressure too High	A	Yes
P0089	Fuel Rail Pressure Regulator Performance	A	Yes
P0090	Fuel Rail Pressure Control Circuit	A	Yes
P0101	Mass Air Flow (MAF) Sensor Performance	B	Yes
P0102	Mass Air Flow (MAF) Sensor Ckt Low Voltage	B	Yes

Diagnostic Trouble Code (DTC) Identification (Continued)

DTC	Description	Type	Illuminate MIL
P0103	Mass Air Flow (MAF) Sensor Ckt High Voltage	B	Yes
P0112	Intake Air Temperature (IAT) Sensor Circuit Low Voltage	B	Yes
P0113	Intake Air Temperature (IAT) Sensor Circuit High Voltage	B	Yes
P0116	Engine Coolant Rationality	B	Yes
P0117	Engine Coolant Temp (ECT) Sensor Circuit Low Voltage	B	Yes
P0118	Engine Coolant Temp (ECT) Sensor Circuit High Voltage	B	Yes
P0168	Fuel Temperature Sensor Over Temp	D	No
P0181	Fuel Temperature Sensor Performance	B	Yes
P0182	Fuel Temperature Sensor Circuit Low Voltage	B	Yes
P0183	Fuel Temperature Sensor Circuit High Voltage	B	Yes
P0192	Fuel Rail Pressure Sensor Circuit Low Voltage	A	Yes
P0193	Fuel Rail Pressure Sensor Circuit High Voltage	A	Yes
P0201	Injector #1 Control Circuit	A	Yes
P0202	Injector #2 Control Circuit	A	Yes
P0203	Injector #3 Control Circuit	A	Yes
P0204	Injector #4 Control Circuit	A	Yes
P0205	Injector #5 Control Circuit	A	Yes
P0206	Injector #6 Control Circuit	A	Yes
P0207	Injector #7 Control Circuit	A	Yes
P0208	Injector #8 Control Circuit	A	Yes
P0218	Transmission Fluid Over temperature	C	No
P0234	Turbo Charger Engine Overboost	B	Yes
P0237	Turbo Charger Boost Sensor Circuit Low Voltage	B	Yes
P0238	Turbo Charger Boost Sensor Circuit High Voltage	B	Yes
P0299	Turbo Charger Engine Underboost	B	Yes
P0300	Engine Misfire Detected	D	Yes
P0301	Cylinder 1 misfire Detected	B	Yes
P0302	Cylinder 2 misfire Detected	B	Yes
P0303	Cylinder 3 misfire Detected	B	Yes
P0304	Cylinder 4 misfire Detected	B	Yes
P0305	Cylinder 5 misfire Detected	B	Yes
P0306	Cylinder 6 misfire Detected	B	Yes

Diagnostic Trouble Code (DTC) Identification (Continued)

DTC	Description	Type	Illuminate MIL
P0307	Cylinder 7 misfire Detected	B	Yes
P0308	Cylinder 8 misfire Detected	B	Yes
P0335	Crankshaft Position (CKP) Sensor Circuit	A	Yes
P0336	Crankshaft Position (CKP) Sensor Performance	B	Yes
P0340	Camshaft Position (CMP) Sensor Circuit	A	Yes
P0341	Camshaft Position (CMP) Sensor Performance	B	Yes
P0370	High Resolution Circuit	A	Yes
P0374	High Resolution System Performance	A	Yes
P0381	Wait To Start Control Circuit	D	No
P0401	Exhaust Gas Recirculation (EGR) Flow Insufficient	D	No
P0403	Exhaust Gas Recirculation (EGR) Solenoid Control Circuit	D	No
P0404	Exhaust Gas Recirculation (EGR) Open Position Performance	D	No
P0405	Exhaust Gas Recirculation (EGR) Position Sensor Circuit Low Voltage	B	Yes
P0406	Exhaust Gas Recirculation (EGR) Position Sensor Circuit High Voltage	B	Yes
P0500	Vehicle Speed Sensor (VSS) Circuit	B	Yes
P0506	Idle Speed Too Low	B	Yes
P0507	Idle Speed Too High	B	Yes
P0522	Oil Pressure Circuit Low Voltage	C	No
P0523	Oil Pressure Circuit High Voltage	C	No
P0561	System Voltage Performance	D	No
P0562	System Voltage Low	D	No
P0563	System Voltage High	D	No
P0601	Engine Control Module (ECM) Read Only Memory (ROM)	A	Yes
P0602	Engine Control Module (ECM) Not Programmed	A	Yes
P0603	Engine Control Module (ECM) Long Term Memory Reset	D	No
P0604	Engine Control Module (ECM) Random Access Memory (RAM)	A	Yes
P0611	Fuel Injector Control Module (FICM) Performance	B	Yes
P0612	Fuel Injector Control Module (FICM) Relay Control Circuit	B	Yes
P0642	5 Volt Reference 1 Circuit Low Voltage	A	Yes
P0643	5 Volt Reference 1 Circuit High Voltage	A	Yes
P0650	Malfunction Indicator Lamp (MIL) Control Circuit	A	Yes
P0652	5 Volt Reference 2 Circuit Low Voltage	A	Yes

Diagnostic Trouble Code (DTC) Identification (Continued)

DTC	Description	Type	Illuminate MIL
P0653	5 Volt Reference 2 Circuit High Voltage	A	Yes
P0670	Glow Plug Control Module Control Circuit	B	Yes
P0671	Glow Plug 1 Control Circuit	B	Yes
P0672	Glow Plug 2 Control Circuit	B	Yes
P0673	Glow Plug 3 Control Circuit	B	Yes
P0674	Glow Plug 4 Control Circuit	B	Yes
P0675	Glow Plug 5 Control Circuit	B	Yes
P0676	Glow Plug 6 Control Circuit	B	Yes
P0677	Glow Plug 7 Control Circuit	B	Yes
P0678	Glow Plug 8 Control Circuit	B	Yes
P0698	5 Volt Reference 3 Circuit Low Voltage	A	Yes
P0699	5 Volt Reference 3 Circuit High Voltage	A	Yes
P0700	Transmission Control Module (TCM) Request MIL Illumination	A	Yes
P0701	Transmission Control System Performance	D	No
P0703	Brake Switch Circuit	D	No
P0708	Transmission Range Sensor Circuit High Input	B	Yes
P0711	Transmission Fluid Temperature Sensor Circuit Performance	B	Yes
P0712	Transmission Fluid Temperature Sensor Circuit Low Input	B	Yes
P0713	Transmission Fluid Temperature Sensor Circuit High Input	B	Yes
P0716	Turbine Speed Sensor Circuit Performance	A	Yes
P0717	Turbine Speed Sensor Circuit No Signal	A	Yes
P0721	Output Speed Sensor Circuit Performance	A	Yes
P0722	Output Speed Sensor Circuit No Signal	A	Yes
P0726	Engine Speed Sensor Input Circuit Performance	B	Yes
P0727	Engine Speed Circuit No Signal	B	Yes
P0731	Incorrect 1st Gear Ratio	A	Yes
P0732	Incorrect 2nd Gear Ratio	A	Yes
P0733	Incorrect 3rd Gear Ratio	A	Yes
P0734	Incorrect 4th Gear Ratio	A	Yes
P0735	Incorrect 5th Gear Ratio	A	Yes
P0736	Incorrect Reverse Ratio	A	Yes
P0741	Torque Converter Clutch System Stuck Off	B	Yes

Diagnostic Trouble Code (DTC) Identification (Continued)

DTC	Description	Type	Illuminate MIL
P0742	Torque Converter Clutch System Stuck On	B	Yes
P0743	Torque Converter Clutch	B	Yes
P0746	Pressure Control Solenoid Performance	A	Yes
P0747	Pressure Control Solenoid A Stuck On	A	Yes
P0748	Pressure Control Solenoid Circuit Electrical	A	Yes
P0763	Shift Solenoid C Circuit Electrical	A	Yes
P0768	Shift Solenoid D Circuit Electrical	A	Yes
P0773	Shift Solenoid E Circuit Electrical	A	Yes
P0776	Pressure Solenoid B Controlled Clutch Stuck Off	A	Yes
P0777	Pressure Solenoid B Controlled Clutch Stuck On	A	Yes
P0778	Pressure Control Solenoid B Electrical	A	Yes
P0802	Transmission Control Module (TCM) MIL Request Circuit	B	Yes
P0840	Transmission Pressure Switch Solenoid C Circuit	A	Yes
P0841	Transmission Pressure Switch Solenoid C Stuck Off	A	Yes
P0842	Transmission Pressure Switch Solenoid C Circuit Stuck Closed	A	Yes
P0843	Transmission Pressure Switch Solenoid C Circuit High	A	Yes
P0845	Transmission Pressure Switch Solenoid D Circuit	A	Yes
P0846	Transmission Pressure Switch Solenoid D Circuit Stuck Open	A	Yes
P0847	Transmission Pressure Switch Solenoid D Circuit Stuck Closed	A	Yes
P0848	Transmission Pressure Switch Solenoid D Circuit High	A	Yes
P0870	Transmission Pressure Switch Solenoid E Circuit	A	Yes
P0871	Transmission Pressure Switch Solenoid E Circuit Stuck Open	A	Yes
P0872	Transmission Pressure Switch Solenoid E Circuit Stuck Closed	A	Yes
P0873	Transmission Pressure Switch Solenoid E Circuit High	A	Yes
P0875	Transmission Pressure Switch Reverse Circuit	A	Yes
P0876	Transmission Pressure Switch Reverse Circuit Stuck Open	A	Yes
P0880	TCM Power Input Signal	D	No
P1093	Fuel Rail Pressure Low During Power Enrichment	A	Yes
P1094	Fuel Rail Pressure Low During Idle or Decel Fuel Cut-Off (DFCO)	D	No
P1125	Accelerator Pedal Position (APP) System	C	No
P1223	Injector 1 Output Circuit	D	No
P1226	Injector 2 Output Circuit	D	No

Diagnostic Trouble Code (DTC) Identification (Continued)

DTC	Description	Type	Illuminate MIL
P1229	Injector 3 Output Circuit	D	No
P1232	Injector 4 Output Circuit	D	No
P1235	Injector 5 Output Circuit	D	No
P1238	Injector 6 Output Circuit	D	No
P1241	Injector 7 Output Circuit	D	No
P1244	Injector 8 Output Circuit	D	No
P1293	Injector Circuit Low to High Current Transition Time Bank 1	A	Yes
P1294	Injector Circuit Low to High Current Transition Time Bank 2	A	Yes
P1295	Injector Circuit High to Low Current Transition Time Bank 1	A	Yes
P1296	Injector Circuit High to Low Current Transition Time Bank 2	A	Yes
P1404	Exhaust Gas Recirculation (EGR) Closed Position Performance	B	Yes
P1550	Fuel Injector Control Module (FICM) System Voltage	D	No
P1621	Engine Control Module Long Term Memory Performance	D	No
P1658	Fuel Injector Control Module Driver Performance	A	Yes
P1687	Fuel Injector Control Module Driver Stuck On	A	Yes
P2122	Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage	C	No
P2123	Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage	C	No
P2127	Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage	C	No
P2128	Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage	C	No
P2132	Accelerator Pedal Position (APP) Sensor 3 Circuit Low Voltage	C	No
P2133	Accelerator Pedal Position (APP) Sensor 3 Circuit High Voltage	C	No
P2138	Accelerator Pedal Position (APP) Sensor 1-2 Correlation	C	No
P2139	Accelerator Pedal Position (APP) Sensor 1-3 Correlation	C	No
P2140	Accelerator Pedal Position (APP) Sensor 2-3 Correlation	C	No
P2146	Injector Positive Voltage Control Circuit Group 1	A	Yes
P2149	Injector Positive Voltage Control Circuit Group 2	A	Yes
P2227	Barometric Pressure (BARO) Sensor Performance	B	Yes
P2228	Barometric Pressure (BARO) Sensor Circuit Low Voltage	B	Yes
P2229	Barometric Pressure (BARO) Sensor Circuit High Voltage	B	Yes
P2563	Turbocharger Boost Control Position Sensor Performance	B	Yes
P2564	Turbocharger Boost Control Position Sensor Circuit Low Voltage	B	Yes
P2565	Turbocharger Boost Control Position Sensor Circuit High Voltage	B	Yes

Diagnostic Trouble Code (DTC) Identification (Continued)

DTC	Description	Type	Illuminate MIL
P2610	Engine Control Module Ignition Off Timer Performance	B	Yes
P2636	Fuel Transfer Pump Flow Insufficient	D	No
P2771	Four Wheel Drive (4WD) Low Switch Circuit	B	Yes
P2810	Solenoid G Electrical	B	Yes
U0073	High Speed CAN Communication Bus	B	Yes
U0100-U0299	Lost Communication	B	Yes

ECM SCHEMATICS

See the following Figures for ECM Schematics on:

- Fuel Selector Valve (Figure OBD-4)
- Accelerator Position Pedal (Figure OBD-5)
- Fuel Injectors (Figure OBD-6)
- Glow Plug Control Module (Figure OBD-7)
- Diagnositc Link Connector (Figure OBD-8)
- EGR Solenoid (Figure OBD-9)
- Camshaft and Cranshaft Sensors (Figure OBD-10)
- Mass Air Flow/Air Intake Temperature Sensors (Figure OBD-11)
- Coolant Temperature, Fuel Temperature and Boost Sensors (Figure OBD-12)
- Oil Pressure Sensor (Figure OBD-13)
- Turbo Vane Postition Sensor (Figure OBD-14)
- Fuel Pressure Sensor (Figure OBD-15)

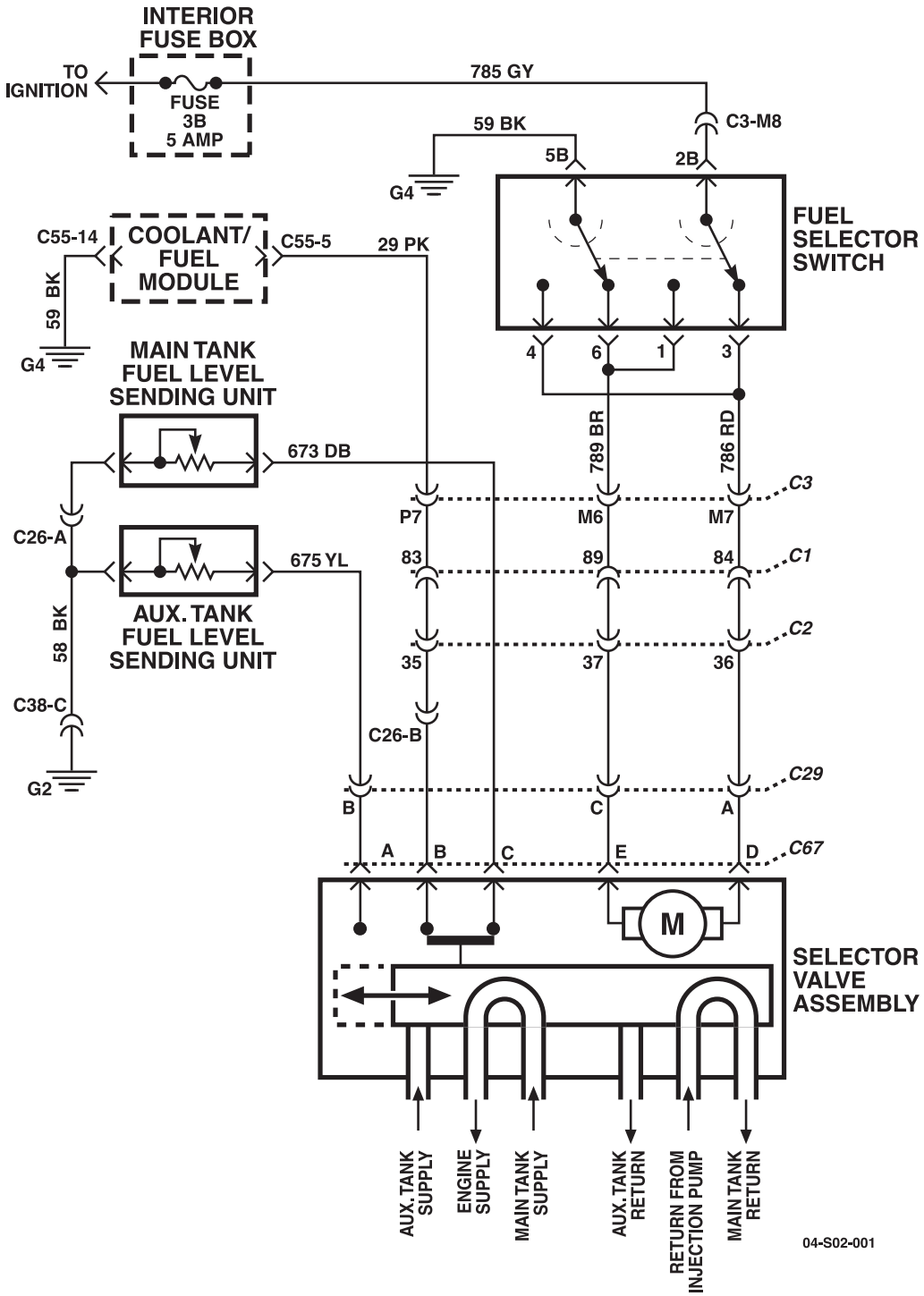


Figure OBD-4: Fuel Selector Valve

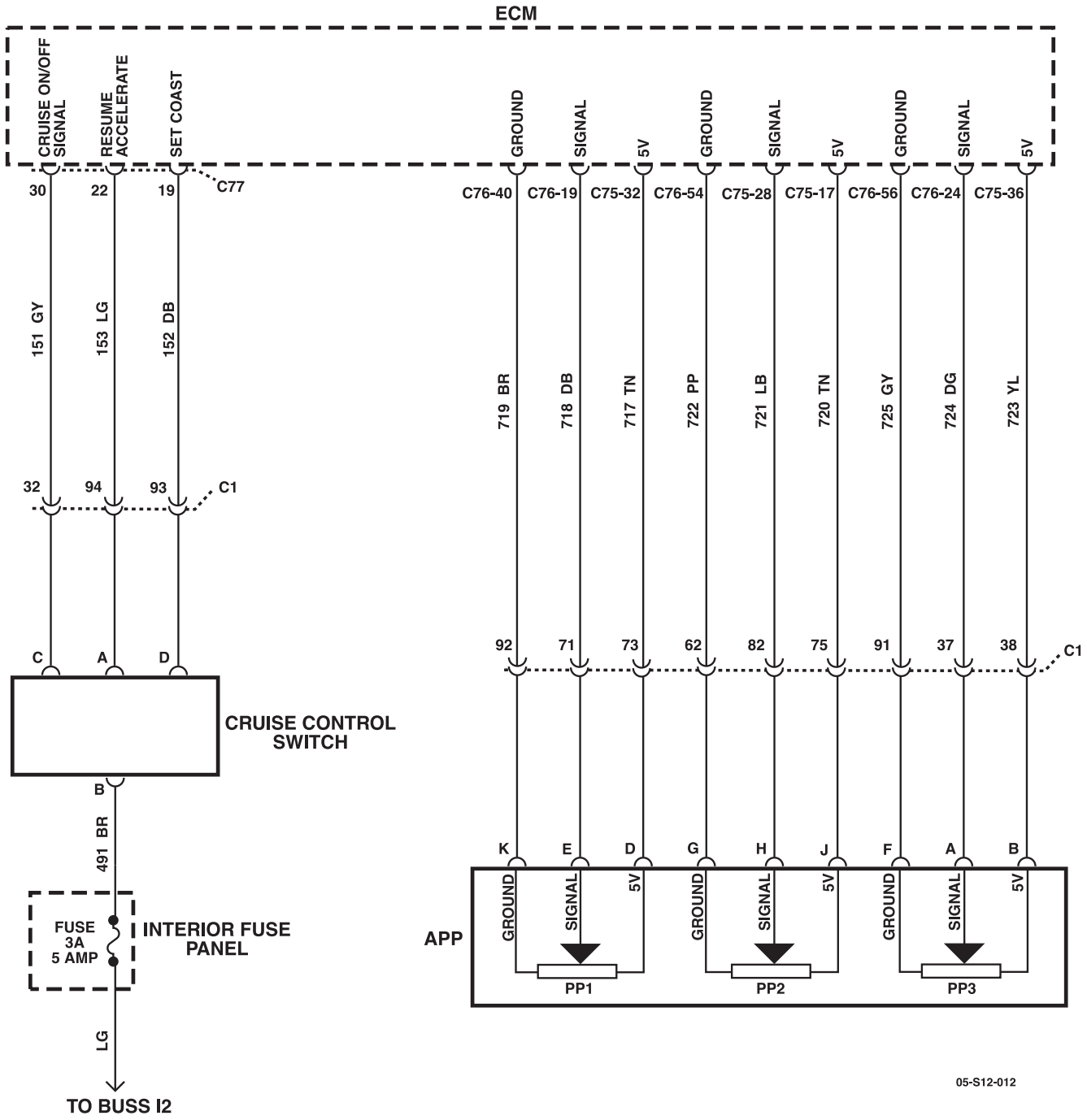


Figure OBD-5: Accelerator Position Pedal

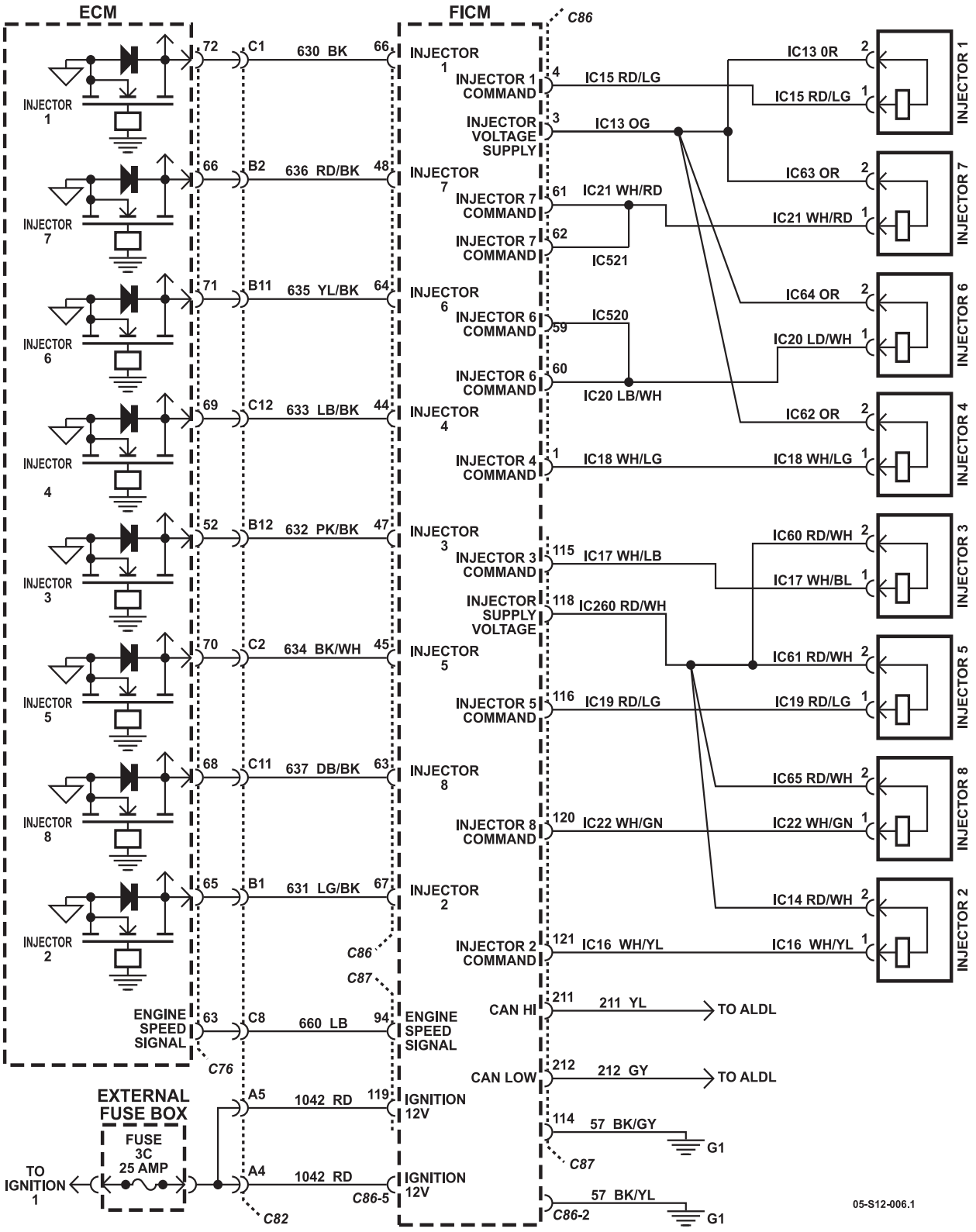


Figure OBD-6: Fuel Injectors

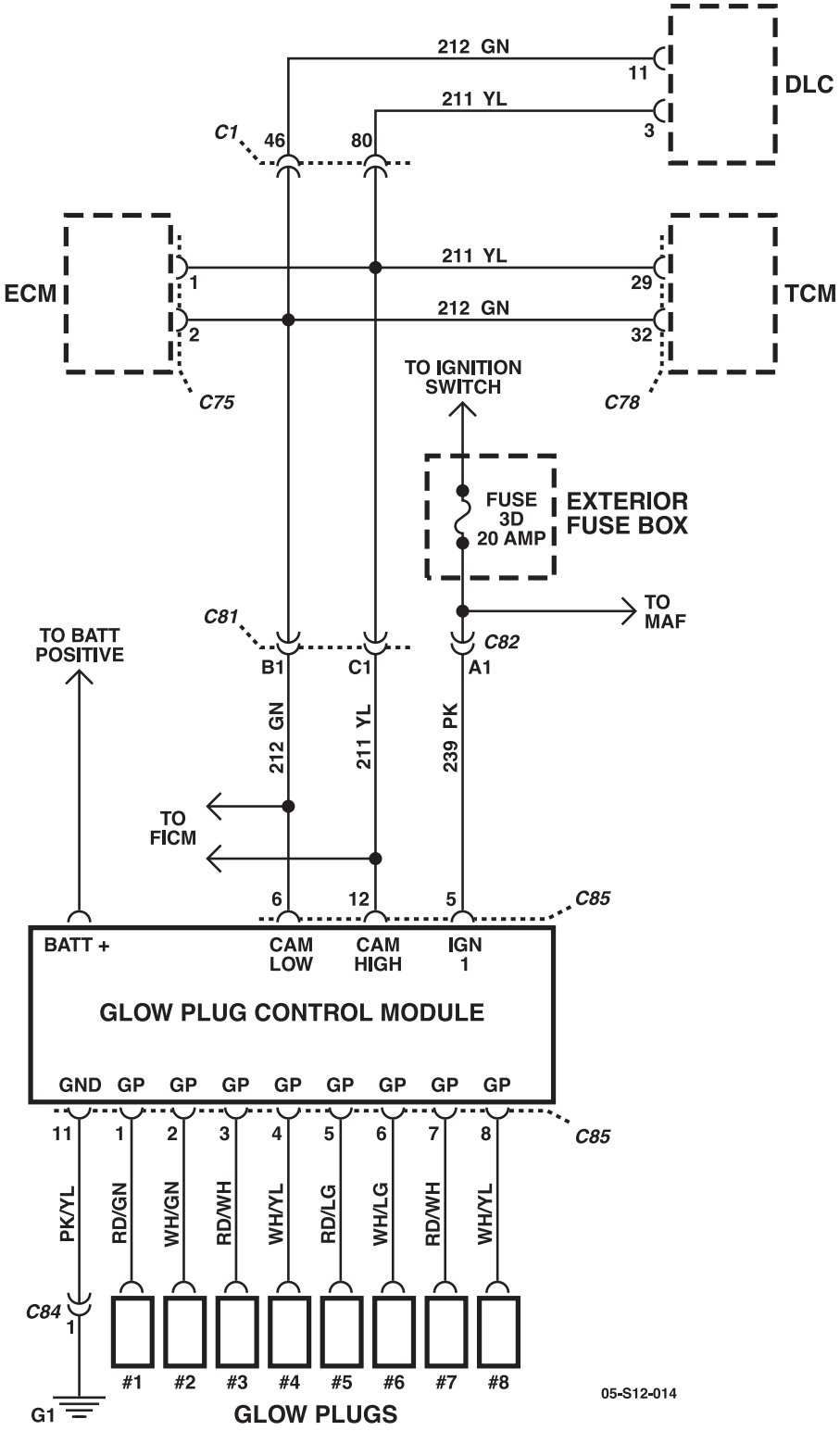


Figure OBD-7: Glow Plug Control Module

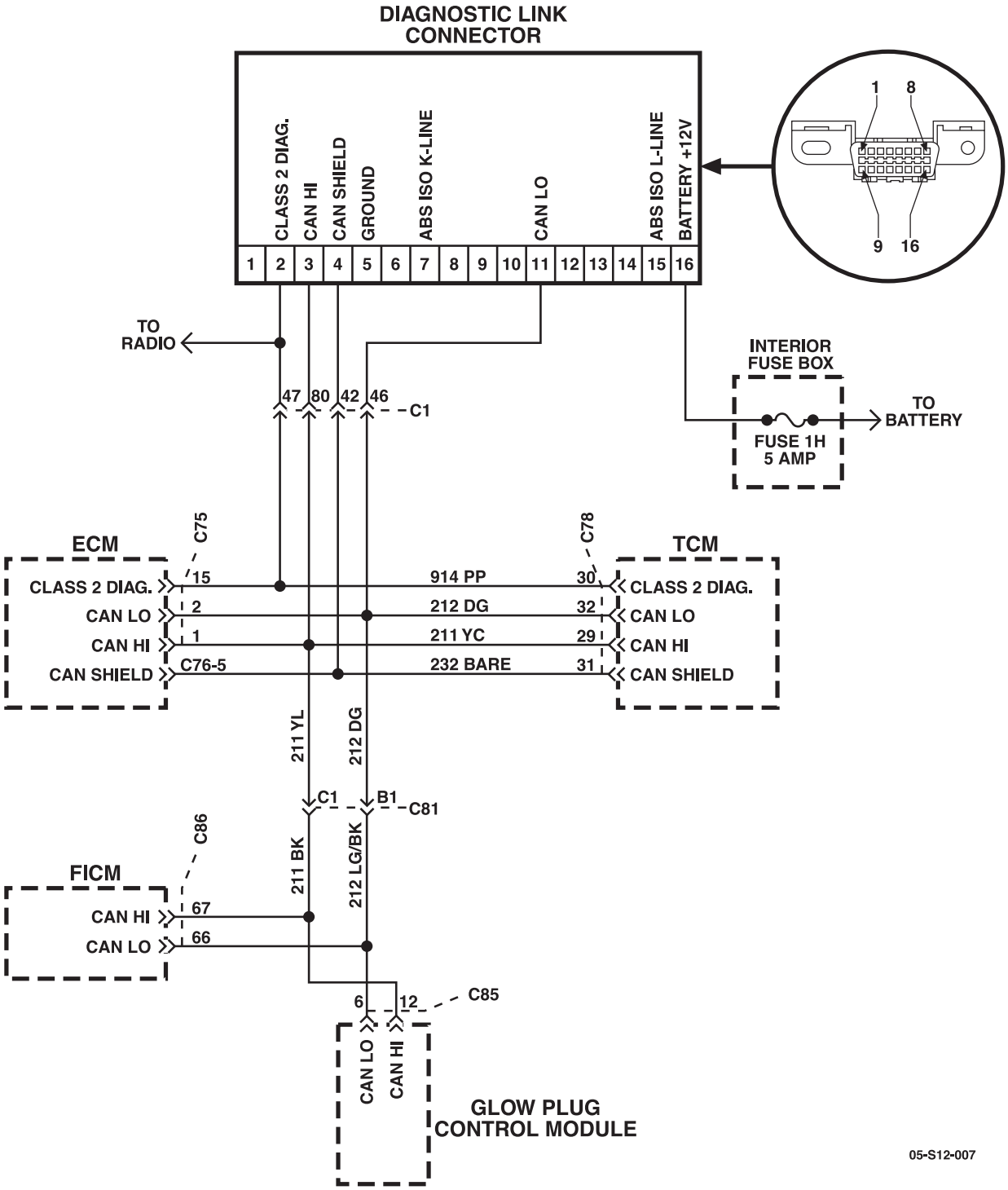


Figure OBD-8: Diagnostic Link Connector

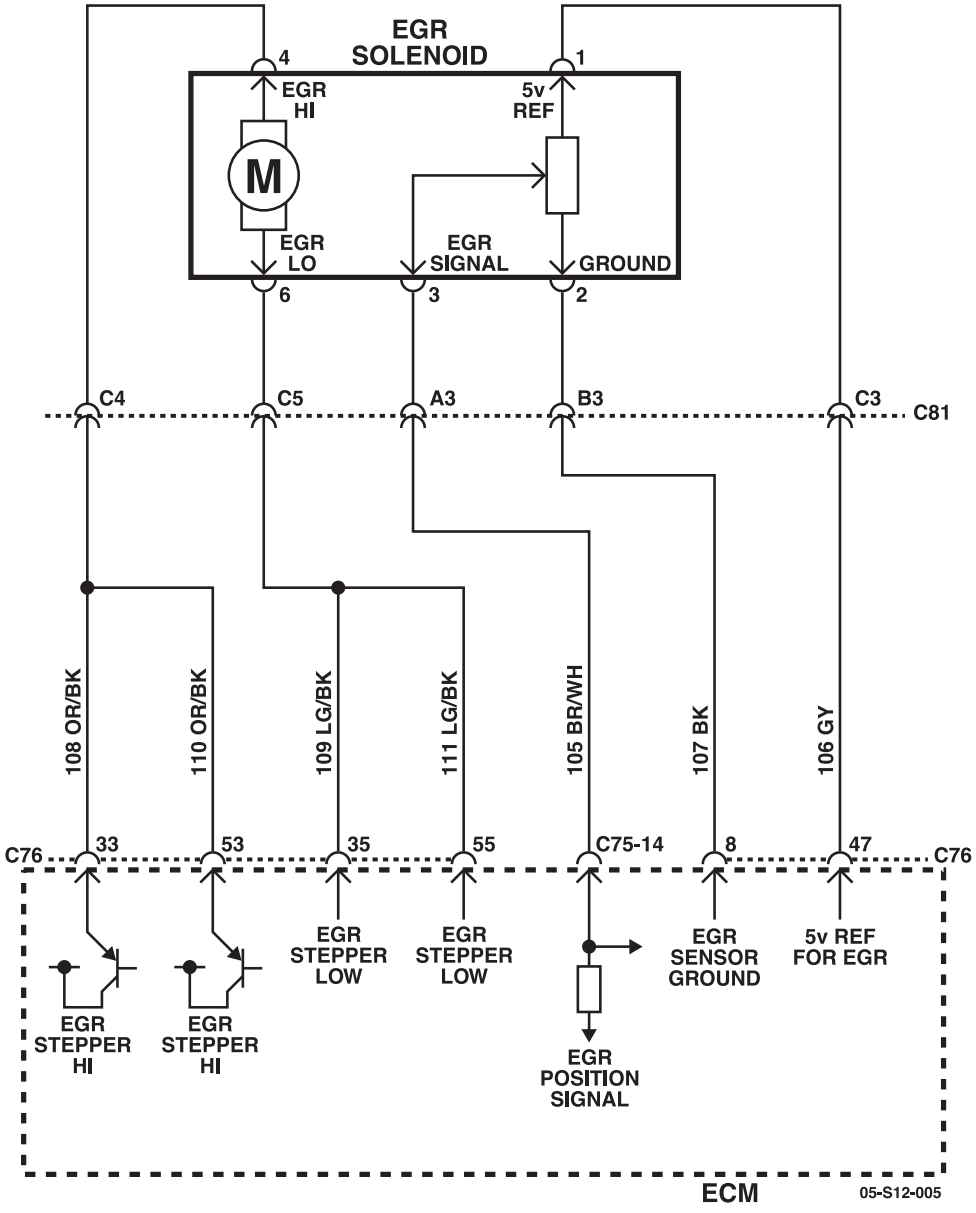


Figure OBD-9: EGR Solenoid

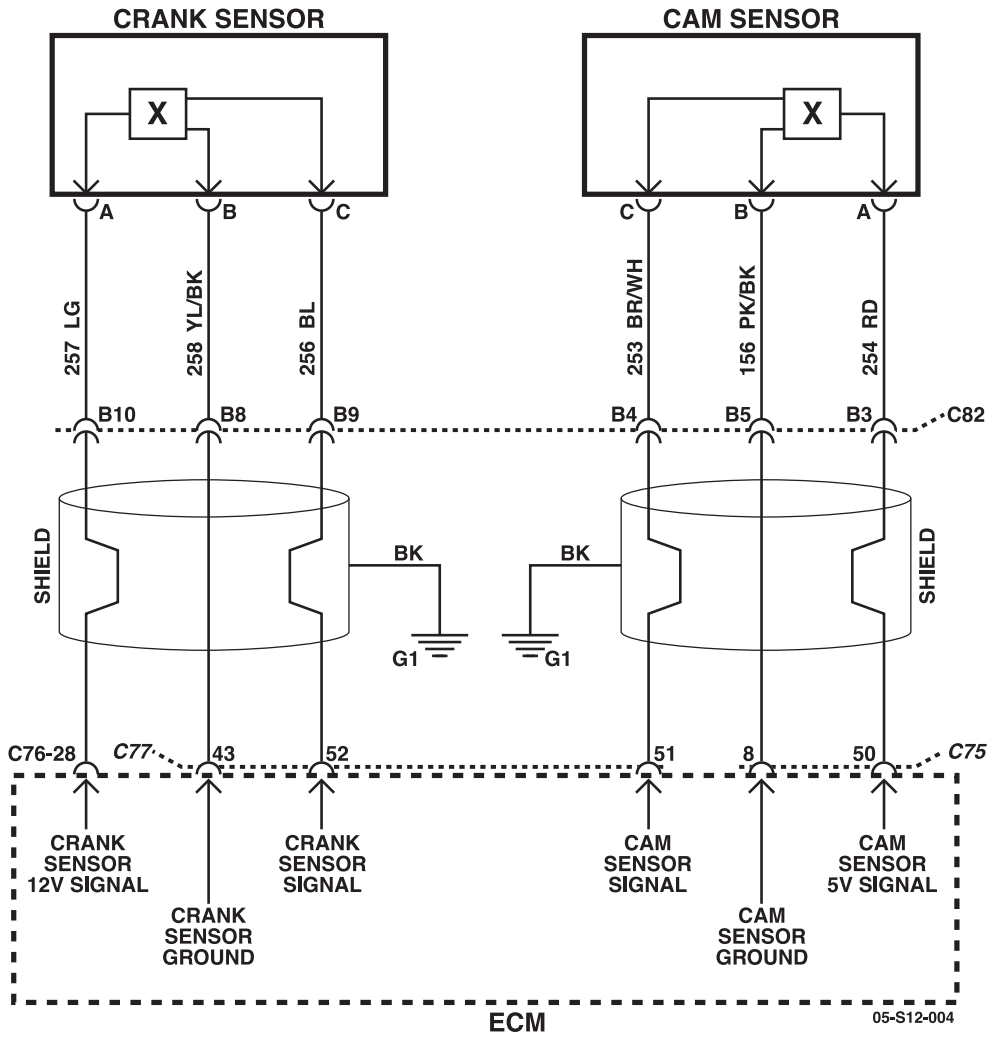


Figure OBD-10: Camshaft and Crankshaft Sensors

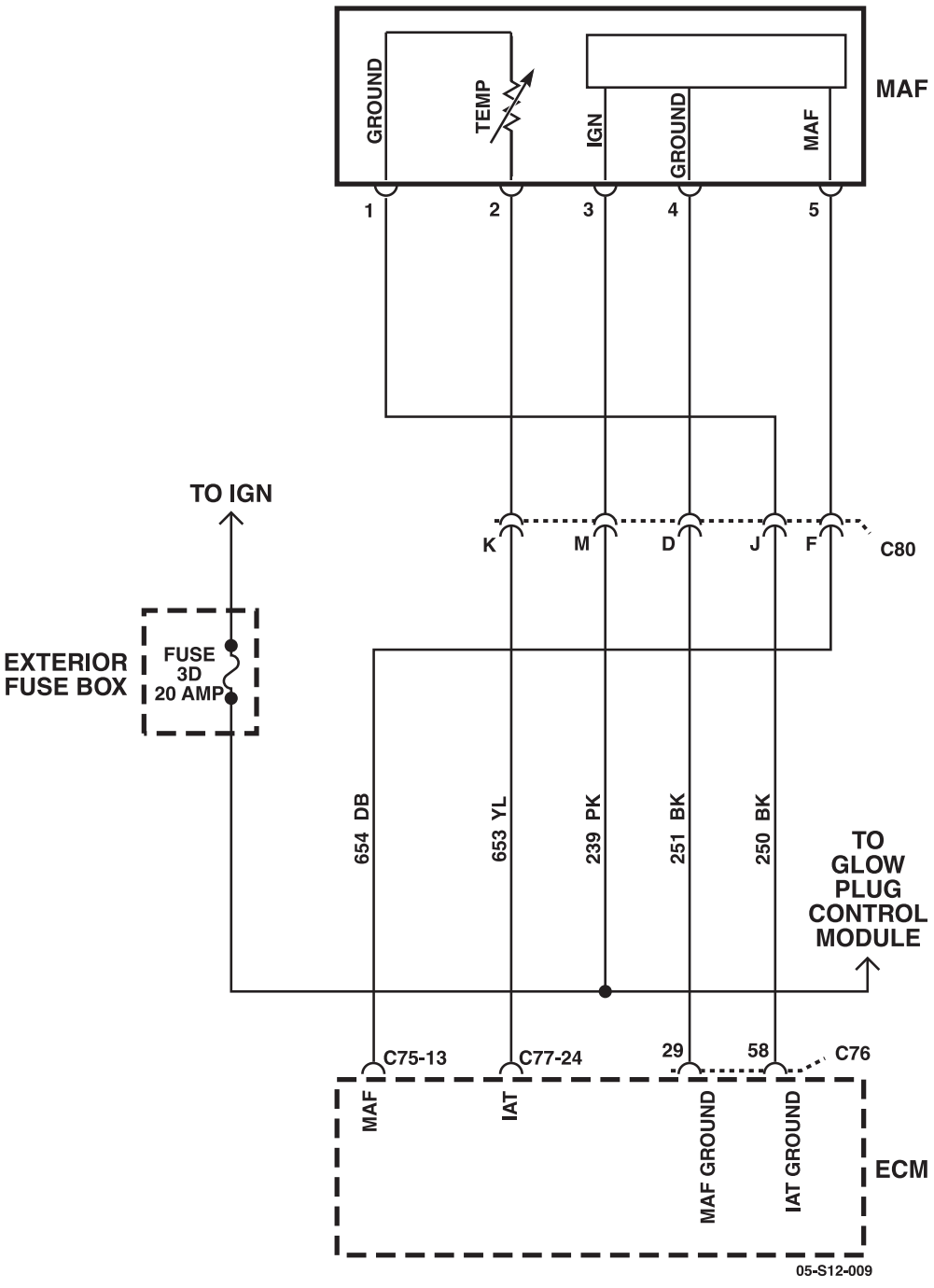


Figure OBD-11: Mass Air Flow/Air Intake Temperature Sensor

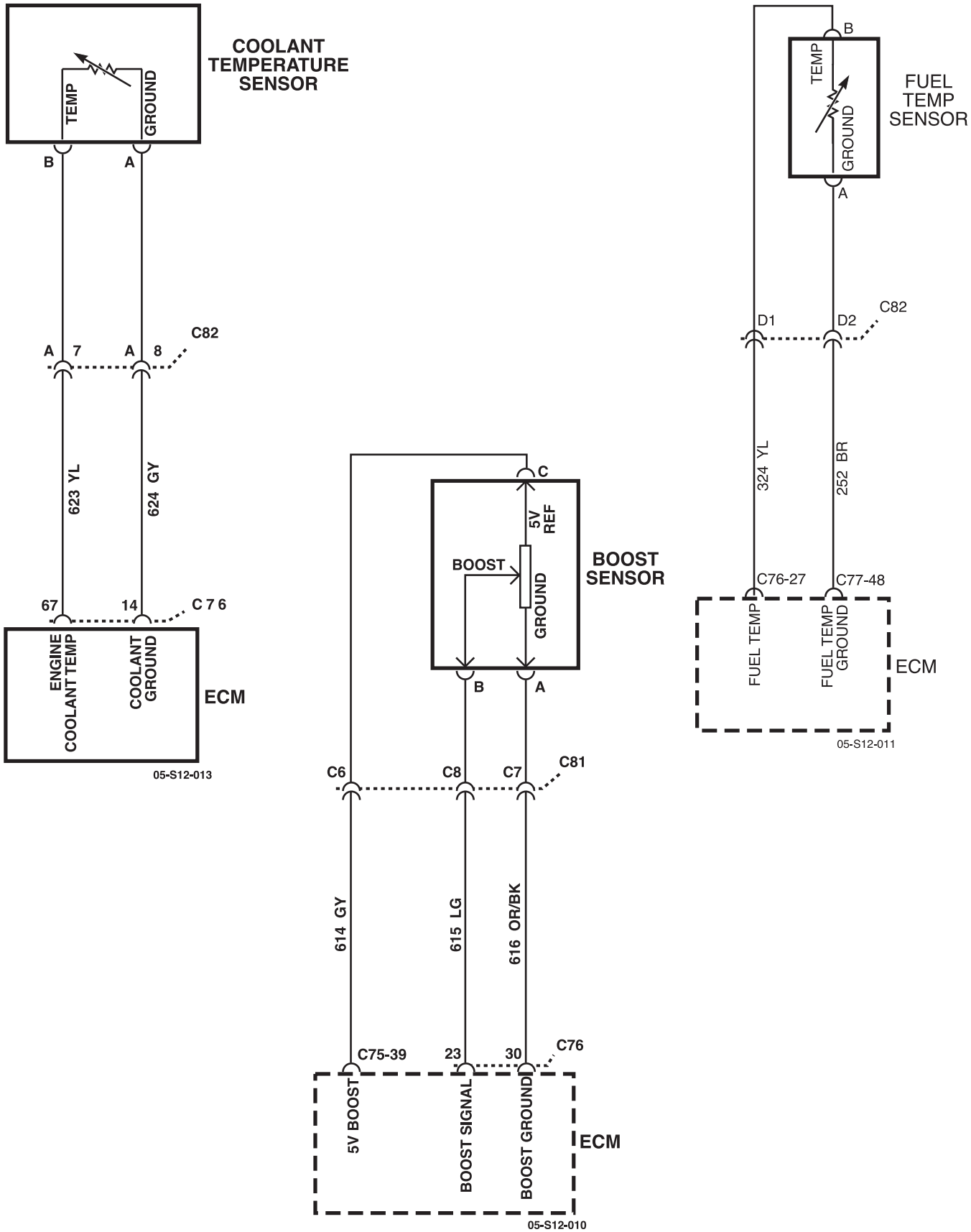


Figure OBD-12: Coolant Temperature, Fuel Temperature and Boost Sensors

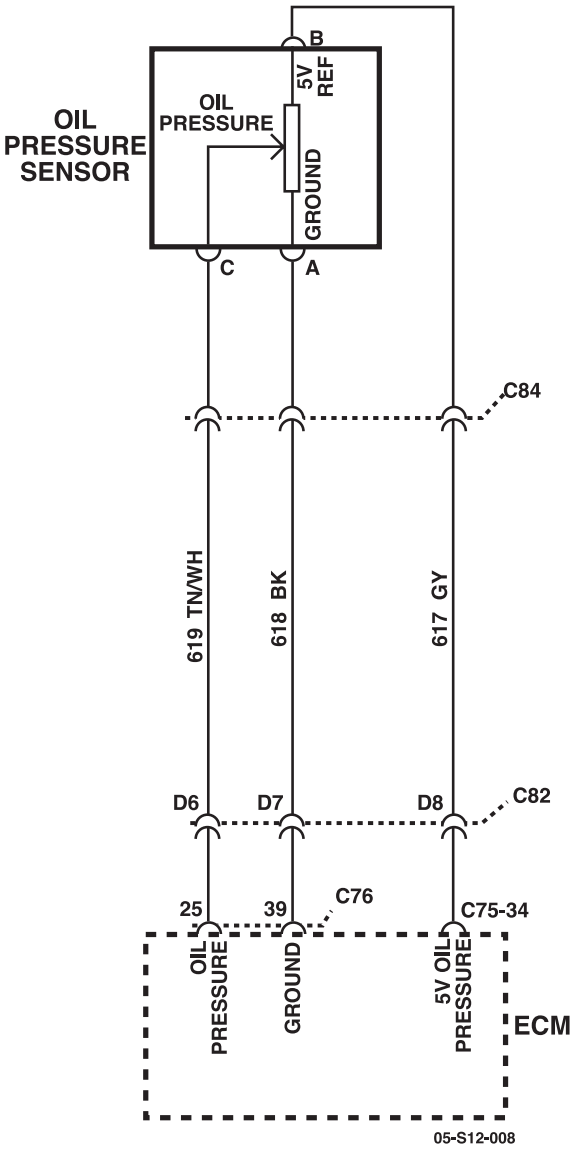


Figure OBD-13: Oil Pressure Sensor

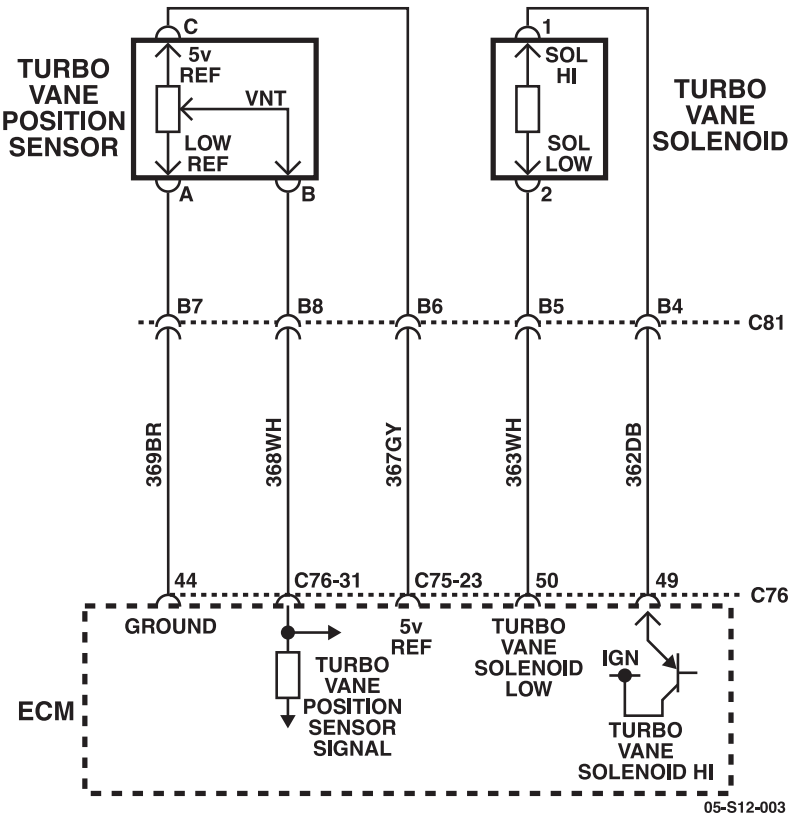


Figure OBD-14: Turbo Vane Position Sensor

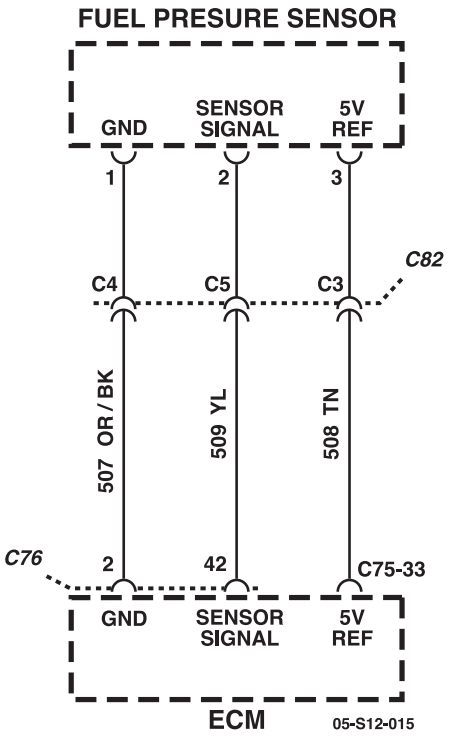


Figure OBD-15: Fuel Pressure Sensor

DTC P0016 Crank Position (CKP) Camshaft Position (CMP) Correlation (Figure OBD-16)

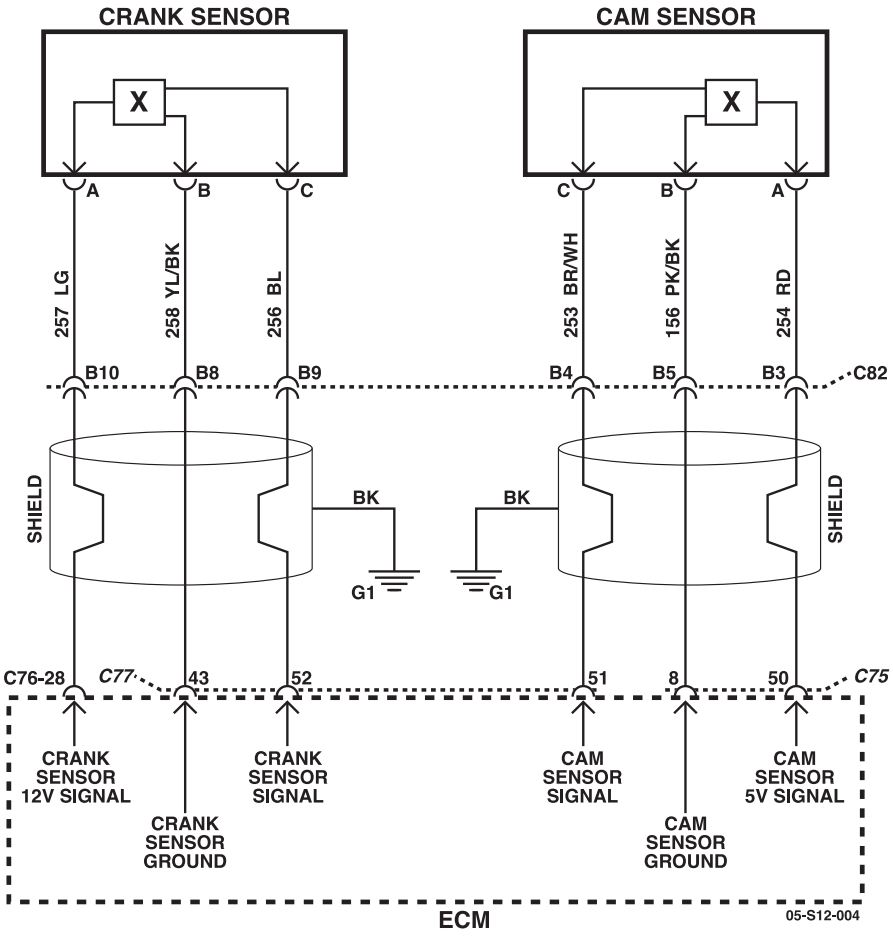


Figure OBD-16: Crank Position (CKP) Camshaft Position (CMP) Sensors

Circuit Description

The engine control module (ECM) monitors the crankshaft position (CKP) and the camshaft position (CMP) signals to determine if they are synchronized. If both signals are not observed by the ECM within a narrow time window, the ECM will determine that an error has occurred and DTC P0016 will set.

Conditions for Setting the DTC

The DTC will set if the following condition is met:

- When the engine is cranking or running, the cam sensor pulses received by the ECM does not equal 3 in one crankshaft revolution.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

Inspect for the following items:

- A loose CMP sensor causing a variance in the sensor signal
- Excessive free play or damage of the timing gears
- The Camshaft Reference Signal Missed parameter will only increment for an intermittent. A constant failure of the CMP sensor will not cause the parameter to increment, but will set DTC P0340.

Step	Action	Value(s)	Yes	No
1	1. Perform the OBD Self-Test. 2. Did you perform the OBD Self-Test?		Go to step 2.	Go to OBD System check.
2	1. Observe the Freeze Frame/Failure Records data for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	Go to Intermittent Conditions
3	If any of the following DTCs are set, go to that DTC first. • DTC P0335 • DTC P0336 • DTC P0340 • DTC P0341 • DTC P0699 Are any of these DTCs set?		Go to the Diagnostic for each Trouble Code in numerical order	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the camshaft position (CMP) Sensor. 3. Test all of the circuits going to the CMP sensor for high resistance. Did you find and correct the condition?		Go to Step 10	Go to Step 5
5	Inspect for a loose CMP sensor. If the sensor is loose and cannot be tightened, the sensor must be replaced. Does the CMP sensor move without being able to be tightened?		Go to Step 8	Go to Step 6
6	1. Remove the CMP sensor. 2. Inspect for a broken CMP sensor casing or a rattle inside when shaken. Does the CMP sensor show any signs of physical damage?		Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Remove the front engine cover. 2. Check for excessive camshaft end-play. 3. Inspect for front engine cover damage. 4. Inspect for timing gear misalignment or damage. 5. Did you find and correct the condition?		Go to Step 10	Go to Step 9
8	1. Replace the faulty CMP sensor. 2. Is the repair complete?		Go to Step 10	
9	1. Replace the faulty ECM. 2. Is the repair complete?		Go to Step 10	
10	1. Using the scan tool, select “DTC,” “Clear info.” 2. Start the engine and idle at normal engine operating temperature. 3. Select “DTC,” “Specific,” then enter the DTC number which was set. 4. Operate the vehicle within the condition for setting this DTC. Does the scan tool indicate that this diagnostic Ran and Passed?		Go to step 11.	Go to step 2.
11	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0045 Turbocharger Boost Control Circuit (Figure OBD-17)

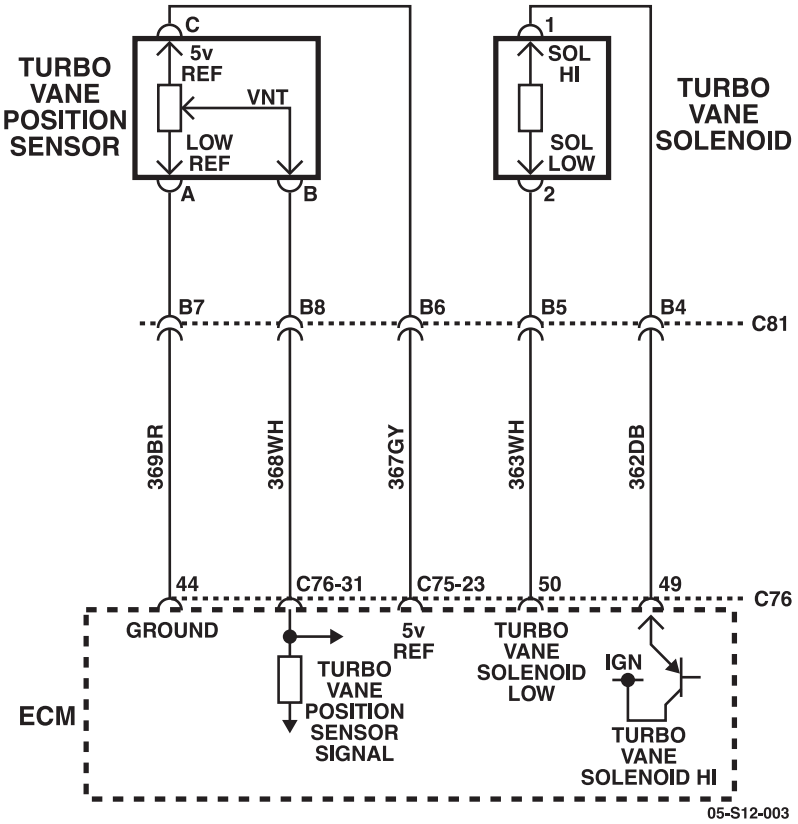


Figure OBD-17: Turbocharger Boost Control Circuit

Circuit Description

The position of the turbocharger vanes is controlled by the engine control module (ECM). The ECM utilizes a turbocharger vane control solenoid valve and a turbocharger vane position sensor to control the turbocharger vanes. When the engine is not under load, the turbocharger vanes are in an open position, or no boost condition. When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger vanes, thus increasing the boost. The ECM will vary the boost dependant upon the load requirements of the engine. The vane control solenoid valve uses 2 circuits, a control circuit and a low reference circuit. The ECM uses a pulse width modulation on the control circuit to open and control the solenoid valve. The ECM provides a ground on the low reference circuit. If the ECM detects any circuit failure, DTC P0045 will set.

Conditions for Setting the DTC

- The control module detects that the commanded state of the driver and the actual state of the control circuit do NOT match.
- The above condition exists for more than 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	If any of the following DTCs are set, go to that DTC first. P0652 P0653 P2564 P2565 Are any of these DTCs set?		Go to the Diagnostic for each Trouble Code in numerical order	Go to Step 3
3	1. Start the engine. 2. Select the turbocharger (TC) vane position control solenoid test in Scan Tool Output Controls. 3. Raise the engine RPM to 2,000 RPM and maintain. 4. Command the turbocharger vane position control solenoid valve to ON and back OFF with a scan tool. 5. Does the engine speed change when the valve is commanded ON?		Go to Step 4	Go to Step 5
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 5	Intermittent, go to Diagnostic Aids.
5	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the TC vane position control solenoid valve. 3. Connect a J 34730-405 Injector Test Lamp between the high control circuit of the solenoid valve and the low reference circuit of the solenoid valve. 4. Turn ON the ignition, with the engine OFF. 5. Select the TC Vane Pos. Ctrl. Solenoid test in scan tool output controls. 6. Command the TC Vane Pos. Ctrl. Solenoid to OFF. Does the test lamp illuminate?		Go to Step 10	Go to Step 6
6	Command the TC Vane Pos. Ctrl. Solenoid to ON with a scan tool. Does the test lamp illuminate?		Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
7	Turn OFF the ignition for 30 seconds. 2.Connect a J 34730-405 between the high control circuit of the solenoid valve and to a good ground. 3.Turn ON the ignition, with the engine OFF. 4.Command the TC Vane Pos. Ctrl. solenoid valve to ON with the scan tool. Does the test lamp illuminate?		Go to Step 11	Go to Step 9
8	Turn OFF the ignition. 2.Ensure the engine control module (ECM) has powered down. 3.Connect a J 34730-405 between the low reference circuit of the solenoid valve and to battery voltage with a fused jumper wire. 4.Ensure that the ignition is OFF. Does the test lamp illuminate?		Go to Step 12	Go to Step 13
9	Test the control circuit of the solenoid valve for the following conditions: • An open • A short to ground • High resistance Did you find and correct the condition?		Go to Step 20	Go to Step 16
10	**NOTE:** Disconnecting the ECM may eliminate the short during testing. Test the control circuit of the solenoid valve for a short to voltage. Did you find and correct the condition?		Go to Step 20	Go to Step 16
11	Test the low reference circuit of the solenoid valve for an open, high resistance, or a short to voltage. Did you find and correct the condition?		Go to Step 20	Go to Step 16
12	Test the low reference circuit of the solenoid valve for a short to ground. Did you find and correct the condition?		Go to Step 20	Go to Step 16
13	1. Disconnect the TC vane position sensor. 2. Test the signal circuit of the position sensor for a high resistance. Did you find and correct the condition?		Go to Step 20	Go to Step 14
14	Test the control circuit and the low reference circuit of the TC vane position control solenoid valve for high resistance. Did you find and correct the condition?		Go to Step 20	Go to Step 15
15	Test for an intermittent and for a poor connection at the vane control solenoid valve. Did you find and correct the condition?		Go to Step 20	Go to Step 17
16	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 20	Go to Step 19
17	1. Inspect the turbocharger for debris, damage, or stuck. 2. If required, replace the turbocharger. 3. Did you find and correct the condition?		Go to Step 20	Go to Step 18

Step	Action	Value(s)	Yes	No
18	Replace the faulty TC vane control solenoid valve. Did you complete the replacement?		Go to Step 20	
19	Replace the faulty ECM. Did you complete the replacement?		Go to Step 20	
20	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Perform the turbocharger learn procedure. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 21
21	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0046 Turbocharger Vane Control Position Performance (Figure OBD-18)

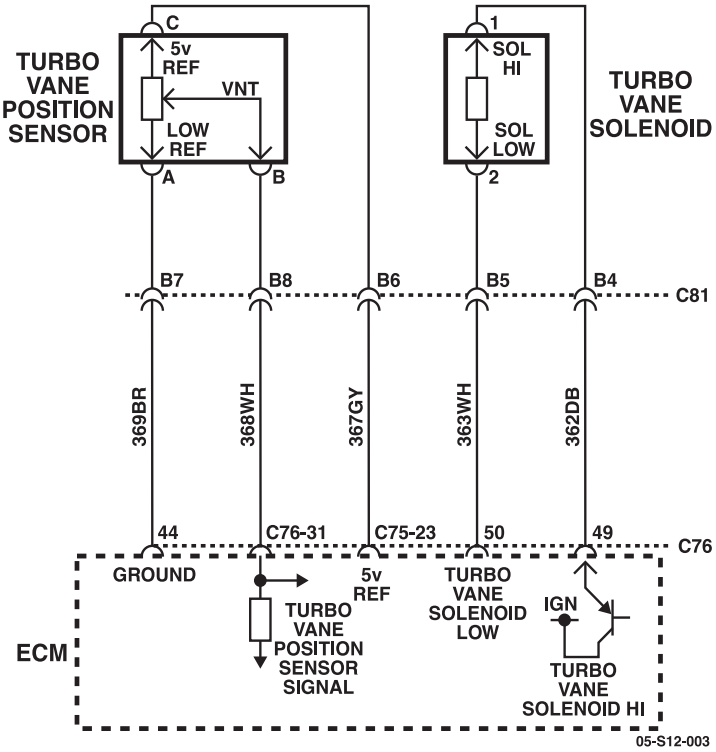


Figure OBD-18: Turbocharger Vane Control Position Circuit

Circuit Description

The position of the turbocharger vanes is controlled by the engine control module (ECM). The ECM utilizes a turbocharger vane control solenoid valve and a turbocharger vane position sensor to control the turbocharger vanes. When the engine is not under load, the turbocharger vanes are in an open position, or no boost condition. When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger vanes, thus increasing the boost. The ECM will vary the boost dependant upon the load requirements of the engine. The vane control solenoid valve uses 2 circuits, a control circuit and a low reference circuit. The ECM uses a pulse width modulation (PWM) on the control circuit to control the solenoid valve. The ECM provides a ground on the low reference circuit. If the ECM detects that the commanded position of the turbocharger vanes does not match the actual position, DTC P0046 will set.

Conditions for Setting the DTC

The ECM detects that the commanded position of the turbocharger vanes does not match the actual position for 1 second.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- If any service has been performed on the turbocharger or on the turbocharger components, a turbocharger relearn must be performed. Failure to perform the turbocharger learn procedure may cause this DTC to set.
- For an intermittent condition, refer to Intermittent Conditions.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	If any of the following DTCs are set, go to that DTC first. P0652 P0653 P2564 P2565 P2563 Are any of these DTCs set?		Go to the Diagnostic for each Trouble Code in numerical order	Go to Step 3
3	1. Perform the Turbocharger Learn Procedure. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Clear the DTCs with the scan tool. Is the procedure complete?		Go to Step 4	
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 5	Intermittent, go to Diagnostic Aids.
5	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the turbocharger vane position sensor. 3. Test for an intermittent and for a poor connection at the vane position sensor. Did you find and correct the condition?		Go to Step 18	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Inspect the ECM connector for corrosion, pushed out pins and correct pin tension. 2. Connect the ECM and the sensor. 3. Key on, engine off. 4. Clear the DTCs. 5. Perform the On-Board Diagnostic (OBD) Self-Test. Did you find and correct the condition?		Go to Step 18	Go to Step 7
7	Measure the resistance of the 5-volt reference circuit 367 (GY) between the vane position sensor pin C harness side and the engine control module (ECM) C75 pin 23 harness side, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 16	Go to Step 8
8	Measure the resistance of the signal circuit 368 (WH) between the vane position sensor pin B harness side and the ECM C76 pin 31 harness side, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 16	Go to Step 9
9	1. Connect the vane position sensor. 2. Disconnect the turbocharger vane position control solenoid valve. 3. Test the turbocharger vane position control solenoid valve high control circuit 362 (DB) pin 1 at the vane position control solenoid for a short to voltage. Did you find and correct the condition?	0 volts	Go to Step 18	Go to Step 10
10	1. Inspect the vane control solenoid valve connector for corrosion, pushed out pins and correct pin tension. 2. Connect vane control solenoid valve sensor. 3. Key on, engine off. 4. Clear the DTCs. 5. Perform the On-Board Diagnostic (OBD) Self-Test. Did you find and correct the condition?		Go to Step 18	Go to Step 11
11	Measure the resistance of the control circuit 362 (DB) between the solenoid valve pin 1 and the ECM C76 pin49, with a DVOM. Is the resistance more than the specified value?	3 ohms	Go to Step 16	Go to Step 12
12	Measure the resistance of the low reference circuit 363 (WH) between the solenoid valve pin 2 and the ECM C76 pin 50, with a DVOM. Is the resistance more than the specified value?	3 ohms	Go to Step 16	Go to Step 13
13	1. Remove the turbocharger vane position control solenoid valve. The solenoid valve may be in 3 different positions: • Open--Light is visible through the slot. • Closed--The surface of the valve in the slot is smooth. • At Rest--The surface of the valve in the slot is serrated. 2. Observe both sets of slots on the side of the valve. A serrated surface, which is part of the sliding piece visible through the slots, should be fully visible in both slots. Is the serrated surface visible through the solenoid valve slots?		Go to Step 14	Go to Step 17

Step	Action	Value(s)	Yes	No
14	1. Connect the ECM. 2. Connect the turbocharger vane control solenoid valve connector. 3. Turn ON the ignition, with the engine OFF. 4. Depress and hold the button at the tip of the control solenoid valve. 5. Command the control solenoid valve ON with the scan tool. 6. Observe the slot closest to the button when commanding the solenoid valve ON. Does the spool valve move and open the slot on the vane control solenoid valve when commanded ON?		Go to Step 15	Go to Step 17
15	1. Inspect the turbocharger for debris, damage, or stuck. 2. If required, replace the turbocharger. 3. Did you find and correct the condition?		Go to Step18	
16	Repair the high resistance in the circuit. Did you complete the repair?		Go to Step18	
17	Replace the faulty turbocharger vane control solenoid valve. Did you complete the replacement?		Go to Step 18	
18	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Perform the turbocharger learn procedure. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 19
19	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0087 Fuel Rail Pressure Too Low (Figure OBD-19)

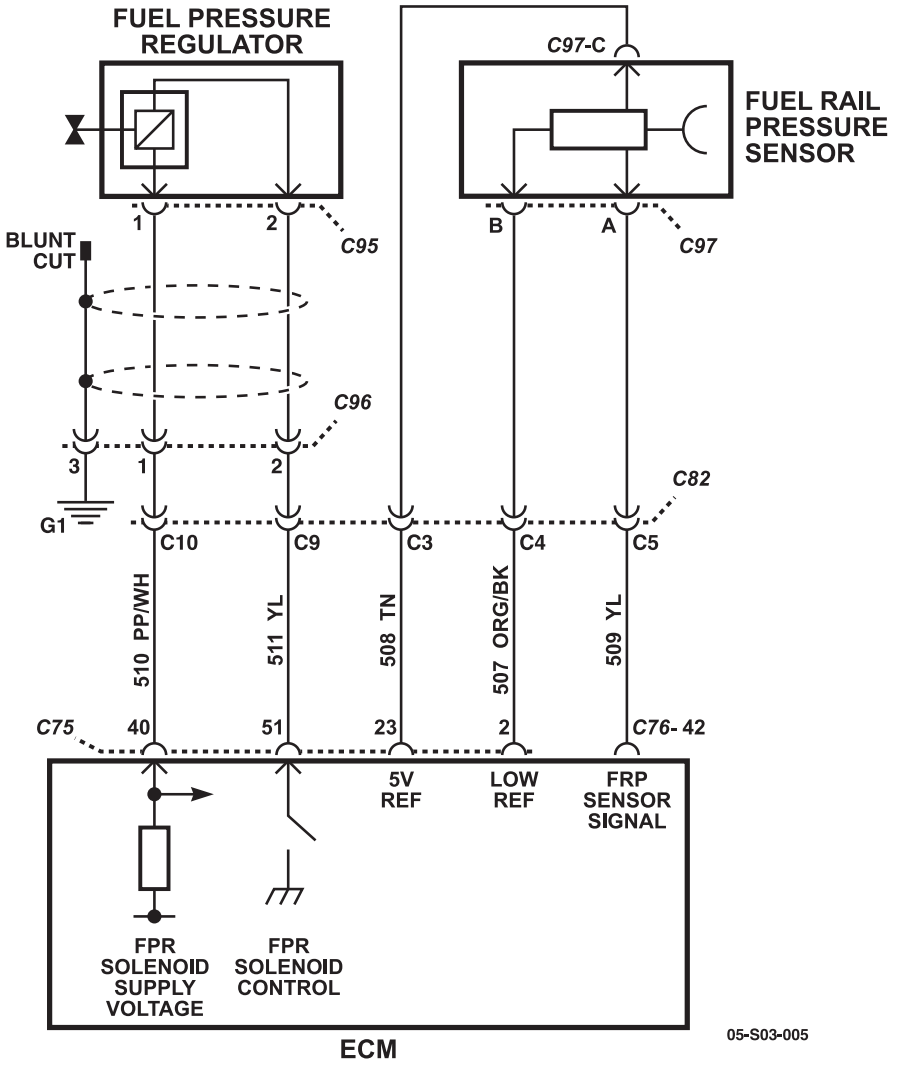


Figure OBD-19: Fuel Pressure Regulator and Fuel Pressure Sensor Circuits

Circuit Description

The engine control module (ECM) monitors fuel rail pressure (FRP) using the FRP sensor. If the sensor indicates a pressure less than the commanded rail pressure plus a possible transitional overshoot, the ECM will set DTC P0087 for fuel rail pressure too low.

Conditions for Setting the DTC

The actual FRP is less than 0.0 MPa at 0-400 RPM. OR The actual FRP is less than 22.5 MPa at more than 600 RPM.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.
- The ECM will limit fuel injection.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- A restricted fuel supply line may cause DTCs P0087 and P1093 to set at the same time. When ambient temperatures are below 0°C (32°F), the fuel tank pickup screen may be iced over from water in the fuel tank.
- If power enhancing devices have been attached to the fuel rail pressure sensor circuits, this DTC may set and adversely effect the fuel system components.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	If any of the following DTCs are set, go to that DTC first. P0168 P0090 Are any of these DTCs set?		Go to the Diagnostic for each Trouble Code in numerical order	Go to Step 3
3	Attempt to start the engine. Does the engine start and idle?		Go to Step 4	Go to Engine Cranks but Does Not Run
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 5	Intermittent Go to Diagnostic Aids
5	1. Turn ON the ignition, with the engine OFF. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure Parameter within the specified range?	1-1.8 MPa	Go to Step 6	Go to Step 10
6	Inspect the engine oil for fuel contamination. Did you find and correct the condition?		Go to Step 17	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Install the J 44638 Vacuum Gage on the fuel fitting located on the right side front of the engine. 2. Start and run the engine at idle. 3. Observe the vacuum gage while increasing RPM slowly to wide open throttle (WOT) in Park or Neutral. Does the vacuum measure less than the specified value through the entire RPM range?	5 in	Go to Step 8	Go to Step 11
8	1. Start and idle the engine until the idle speed drops to 680 RPM. 2. Command the fuel pressure control to 160 MPa with a scan tool. 3. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure parameter more than the specified value?	145 MPa	Go to Step 9	Go to Fuel System Diagnosis - High Pressure Side
9	**NOTE:** If the fuel temperature is near 121°C (250°F) during the duplication of the complaint, or in the Failure Records for this DTC, inspect for a restriction in the fuel cooler air flow or the fuel heater always ON. Operate the vehicle within the conditions for which the customer complaint occurs. Does the vacuum measure less than the specified value through the entire operating range?	12 in	Go to Diagnostic Aids	Go to Step 11
10	1. Disconnect the fuel rail pressure sensor. 2. Observe the Actual Fuel Rail Pressure with a scan tool. Does the Actual Fuel Rail Pressure measure more than the specified value?	175 MPa	Go to Step 15	Go to Step 14
11	Replace the fuel filter. Did you compete the replacement?		Go to Step 12	
12	1. Ensure that the J 44638 is still installed on the engine. 2. Start and run the engine under the conditions for which the high vacuum occurred. Does the vacuum measure less than or equal to the specified value?	5 in at idle or 12 in at high speed	Go to Step 17	Go to Step 13
13	Repair the restriction in the fuel supply lines between the fuel tank and the fuel injection pump. Did you complete the repair?		Go to Step 17	
14	Test the fuel rail pressure sensor signal circuit 509 (YL) for a short to ground. Did you find and correct the condition?		Go to Step 17	Go to Step 16
15	Replace the faulty fuel rail pressure sensor. Did you complete the replacement?		Go to Step 17	
16	Replace the faulty engine control module (ECM). Did you complete the replacement?		Go to Step 17	

Step	Action	Value(s)	Yes	No
17	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Perform the turbocharger learn procedure. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 18
18	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0088 Rail Pressure too High (Figure OBD-20)

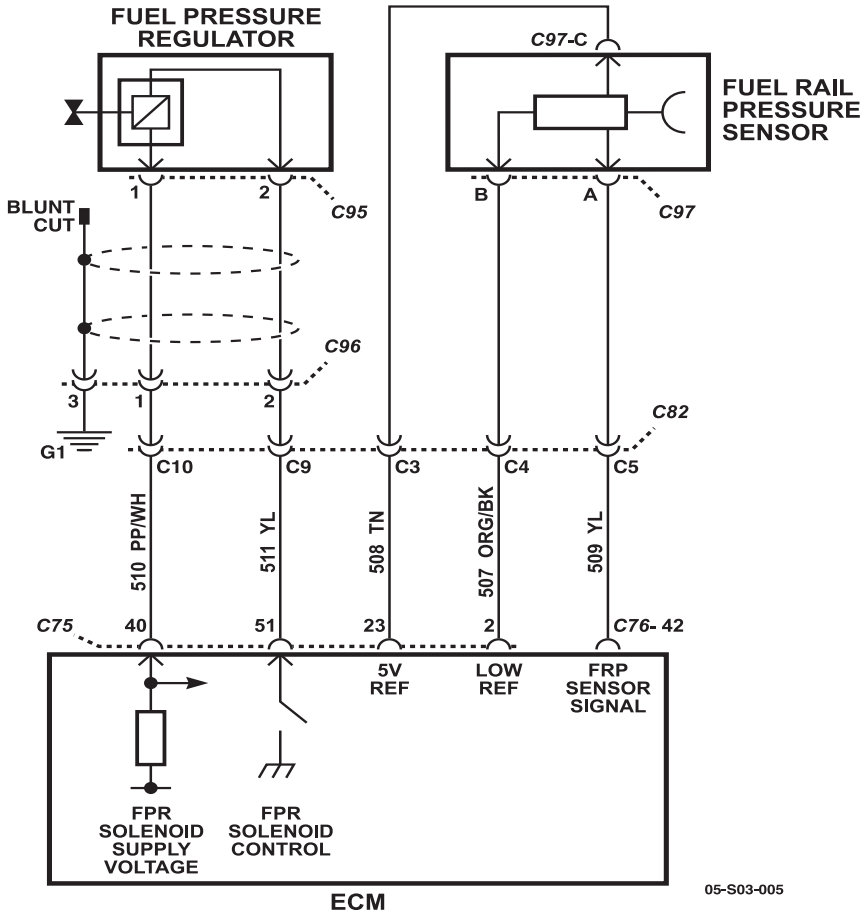


Figure OBD-20: Fuel Pressure Regulator and Fuel Pressure Sensor Circuits

Circuit Description

The engine control module (ECM) monitors fuel rail pressure (FRP) using the FRP sensor. If the sensor indicates a pressure more than the commanded rail pressure plus a possible transitional overshoot, the ECM will set DTC P0088 for FRP too high.

Conditions for Setting the DT

The actual fuel pressure is more than 167 MPa.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.
- The control module will limit fuel injection and FRP.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- There are no driveability concerns associated with the FRP regulator unless a DTC is present. The most likely cause of this DTC is a sticking FRP regulator.
- If the fuel system pressure is actually too high, a fuel knock and smoke condition will exist.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure parameter within the specified range?	1.1-1.4 MPa	Go to Step 3	Go to Step 6
3	Did DTC P0090 also set?		Go to the Diagnostic for P0090	Go to Step 4
4	1. Start the engine. 2. Observe the Actual Fuel Rail Pressure on the scan tool. 3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Is the Actual Fuel Rail Pressure more than the specified value?	167 MPa	Go to Step 11	Go to Step 5
5	1. Start and idle the engine. 2. Perform the following test at idle and at 2,000 RPM: • Change the fuel pressure with a scan tool, incrementing through the entire fuel pressure range. • Observe the actual vs desired fuel pressures at each fuel pressure level. Does the fuel pressure increment and stabilize through the entire fuel pressure range, with actual and desired fuel pressure within 2 MPa of each other at every fuel pressure?		Go to Diagnostic Aids	Go to Step 11
6	1. Disconnect the fuel rail pressure (FRP) sensor. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Does the Actual Fuel Rail Pressure measure more than the specified value?	175 MPa	Go to Step 9	Go to Step 7
7	Test the FRP sensor signal circuit 509 (YL) for a short to ground. Did you find and correct the condition?		Go to Step 12	Go to Step 8

Step	Action	Value(s)	Yes	No
8	Replace the faulty engine control module (ECM). Did you complete the replacement?		Go to Step 12	
9	Test the FRP sensor signal circuit 509 (YL) for high resistance or an open. Did you find and correct the condition?		Go to Step 13	Go to Step 10
10	Replace the faulty FRP sensor. Did you complete the replacement?		Go to Step 12	
11	Replace the FRP regulator. Did you complete the replacement?		Go to Step 12	
12	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
13	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0089 Fuel Rail Pressure Regulator Performance (Figure OBD-21)

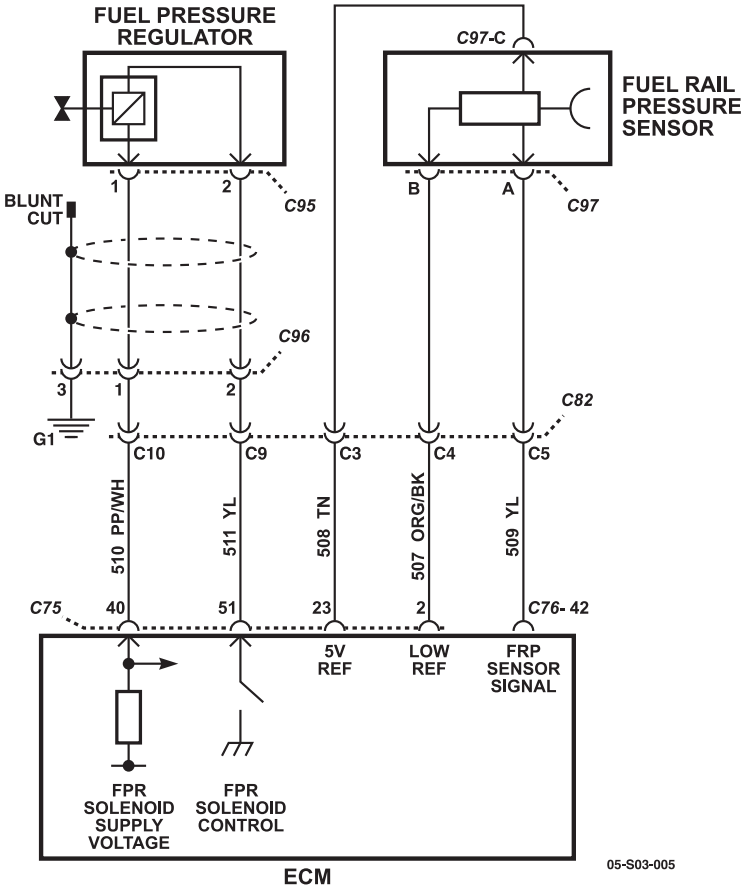


Figure OBD-21: Fuel Pressure Regulator and Fuel Pressure Sensor Circuits

Circuit Description

The engine control module (ECM) uses commanded fuel pump flow to determine a desired fuel rail pressure (FRP). The actual fuel pressure is monitored using the FRP sensor. If the FRP sensor indicates a pressure more than 20 MPa greater than desired, DTC P0089 will set.

Conditions for Setting the DTC

- The difference between the actual FRP and the desired FRP is more than 20 MPa.
- The commanded fuel pump flow is 100 mm©¯/second or less.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Use a scan tool in order to clear the MIL and the DTC.

Diagnostic Aids

- There are no driveability concerns associated with the FRP regulator unless a DTC is present. The most likely cause of this DTC is a sticking FRP regulator.
- If the fuel system pressure is actually too high, a fuel knock and smoke condition will exist.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure parameter within the specified range?	1.1-1.4 MPa	Go to Step 3	Go to Step 6
3	Did DTC P0090 also set?		Go to the Diagnostic for P0090 before diagnosing this code	Go to Step 4
4	Did DTC P1093 also set?		Go to the Diagnostic for P1093 before diagnosing this code	Go to Step 5
5	1. Start and run the engine at 2,000 RPM. 2. Observe the Actual Fuel Rail Pressure parameter and the Desired Fuel Rail Pressure parameter with a scan tool. Does the scan tool display a pressure difference more than the specified value?	167 MPa	Go to Step 11	Go to Step 6
6	1. Start and idle the engine. 2. Perform the following test at idle and at 2,000 RPM: • Change the fuel pressure with a scan tool, incrementing through the entire fuel pressure range. • Observe the actual vs desired fuel pressures at each fuel pressure level. Does the fuel pressure increment and stabilize through the entire fuel pressure range, with actual and desired fuel pressure within 2 MPa of each other at every fuel pressure?		Go to Diagnostic Aids	Go to Step 11
7	1. Disconnect the fuel rail pressure (FRP) sensor. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Does the Actual Fuel Rail Pressure measure more than the specified value?	175 MPa	Go to Step 10	Go to Step 8
8	Test the FRP sensor signal circuit 509 (YL) for a short to ground. Did you find and correct the condition?		Go to Step 12	Go to Step 9

Step	Action	Value(s)	Yes	No
9	Replace the faulty engine control module (ECM). Did you complete the replacement?		Go to Step 12	
10	Replace the faulty FRP sensor. Did you complete the replacement?		Go to Step 12	
11	Replace the FRP regulator. Did you complete the replacement?		Go to Step 12	
12	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
13	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0090 Fuel Rail Pressure Control Circuit (Figure OBD-22)

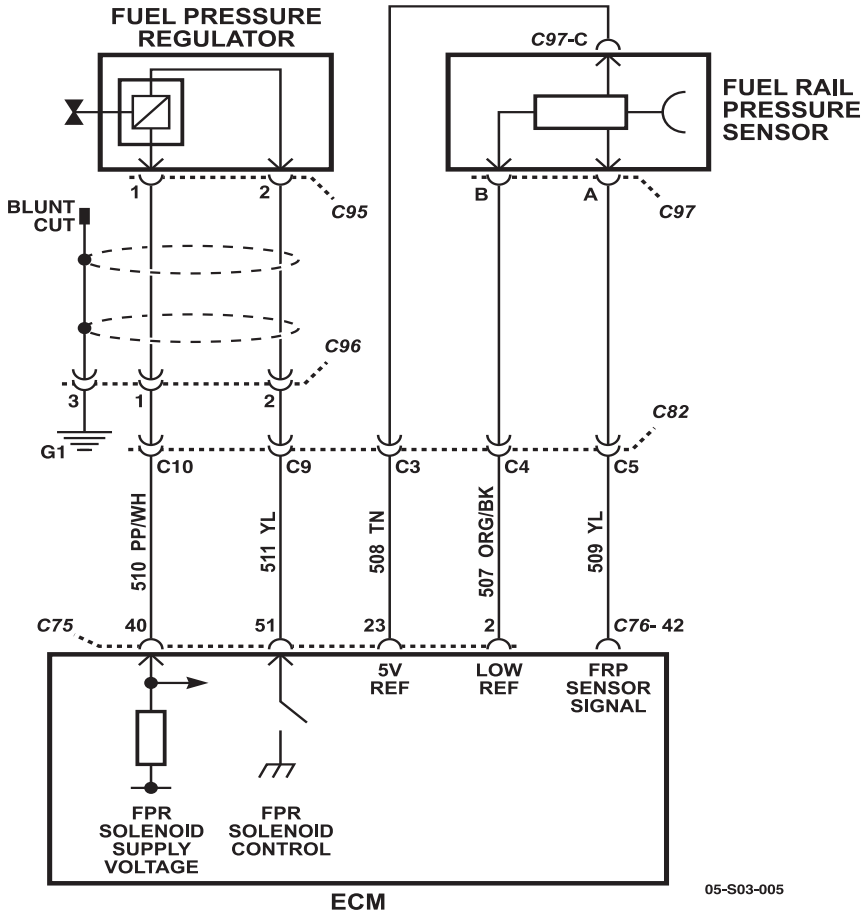


Figure OBD-22: Fuel Pressure Regulator and Fuel Pressure Sensor Circuits

Circuit Description

The engine control module (ECM) supplies power and ground to the fuel rail pressure (FRP) regulator. The ECM monitors current on the circuits to detect a failure. If the current is outside of the expected range, DTC P0090 will set.

Conditions for Setting the DTC

The FRP regulator circuit current is not between 50-1,600 mA.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- There are no driveability concerns associated with the FRP regulator unless a DTC is present. The most likely cause of this DTC is a sticking FRP regulator.
- If the fuel system pressure is actually too high, a fuel knock and smoke condition will exist.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Is DTC U0105 present also?		Go to DTC U0100-U0299 and diagnose first in Computer/ Integrating Systems before diagnosing this code	Go to Step 3
3	**NOTE:** Failure to wait until there is no engine control module (ECM) communications with the scan tool will result in misdiagnosis. 1. Turn OFF the ignition for 30 seconds. 2. Turn ON the ignition, with the engine OFF. 3. Observe the FRP Regulator Command parameter with a scan tool. Is the FRP Regulator Command more than the specified value?	20%	Go to Step 4	Go to Step 20
4	Attempt to start the engine. Does the engine start?		Go to Step 5	Go to Step 6
5	1. Start the engine. 2. Observe the Actual Fuel Rail Pressure and the Desired Fuel Rail Pressure with a scan tool. Does the scan tool display a pressure difference more than the specified value?	5 MPa	Go to Step 7	Go to Diagnostic Aids
6	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) connectors. 3. Disconnect the fuel rail pressure (FRP) regulator connector. 4. Measure the resistance from the control circuit of the FRP regulator to ground with a DVOM. Does the resistance measure at the specified value?		Go to Step 17	Go to Step 14
7	1. Turn OFF the ignition. 2. Disconnect the FRP regulator harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Probe the supply circuit of the fuel rail pressure regulator with a Test Lamp connected to a good ground. Does the test lamp illuminate?		Go to Step 8	Go to Step 10

Step	Action	Value(s)	Yes	No
8	1.Turn OFF the ignition. 2.Verify the FRP regulator harness connector is disconnected. 3.Turn ON the ignition, with the engine OFF. 4.Probe the control circuit 511(YL) of the FRP regulator with a test light connected to battery voltage. Does the test lamp illuminate?		Go to Step 15	Go to Step 9
9	1.Disconnect the ECM C75. 2.Turn ON the ignition, with the engine OFF. 3.Measure the voltage from the FRP regulator control circuit 511 (YL) to a good ground with a DVOM. Does the voltage measure the specified value?	0 Volts	Go to Step 18	Go to Step 13
10	1.Turn OFF the ignition. 2.Disconnect the ECM connector C76. 3.Turn ON the ignition, with the engine OFF. 4.Probe the ignition 1, voltage circuit of the harness connector with a test light that is connected to a good ground. Does the test lamp illuminate?		Go to Step 11	Go to Step 12
11	1. Test for an open in the FRP supply circuit 510 (PP/WH) between the ECM and the FRP regulator. 2. If a condition is found, repair as necessary. Did you find and correct the condition?		Go to Step 21	Go to Step 19
12	Repair the open in the ignition 1 voltage circuit to the ECM. Did you complete the repair?		Go to Step 21	
13	Repair the short to voltage in the control circuit between the ECM and the FRP regulator. Did you complete the repair?		Go to Step 21	
14	Test for a short to ground in the control circuit between the ECM and the FRP regulator. Did you find and correct the condition?		Go to Step 21	Go to Step 20
15	Inspect the fuel pressure regulator connector for corrosion, pushed out pins and correct pin tension. Did you find and correct the condition?		Go to Step 21	Go to Step 16
16	1. Test for an intermittent and for a poor connection at the FRP regulator. 2. Repair the wiring, as necessary. Did you find and correct the condition?		Go to Step 21	Go to Step 17
17	Replace the faulty FRP regulator. Did you complete the replacement?		Go to Step 21	
18	Test for an open in the control circuit 511 (YL) between the ECM C75 pin 51 and the FRP regulator pin 2. Did you find and correct the condition?		Go to Step 21	Go to Step 19

Step	Action	Value(s)	Yes	No
19	1. Inspect the ECM connector for corrosion, pushed out pins and correct pin tension. 2. Connect the ECM and the sensor. 3. Key on, engine off. 4. Clear the DTCs. 5. Perform the On-Board Diagnostic (OBD) Self-Test. Did you find and correct the condition?		Go to Step 21	Go to Step 20
20	Replace the faulty ECM. Did you complete the replacement?		Go to Step 21	
21	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 21
22	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0101 Mass Air Flow (MAF) Sensor Performance (Figure OBD-23)

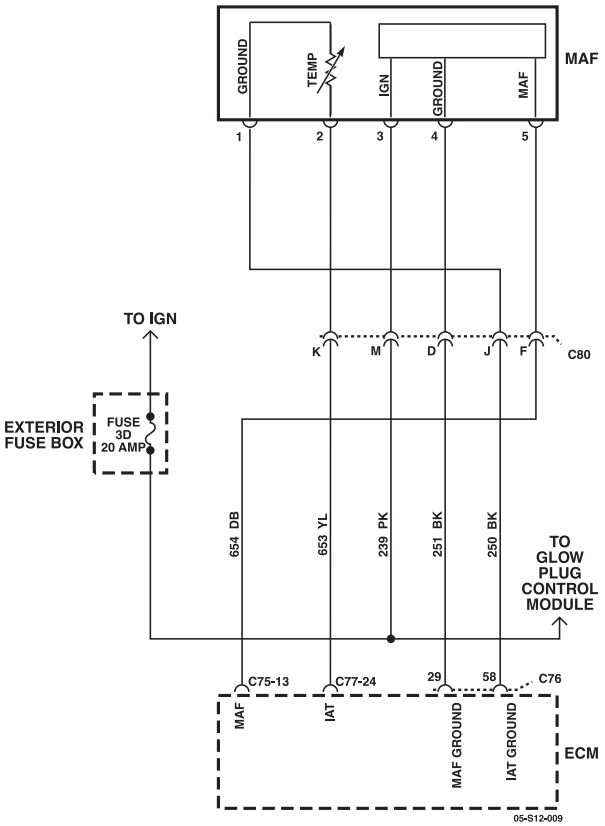


Figure OBD-23: Mass Air Flow (MAF) Sensor Circuit

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air entering the engine. The engine control module (ECM) uses the MAF sensor voltage signal to provide the correct fuel delivery for a reduction in emissions. The ECM uses the MAF sensor signal to control fuel delivery until a calibrated amount of engine air flow is attained. The MAF sensor has an ignition 1 voltage circuit, a signal circuit and a low reference circuit. The MAF sensor produces an output voltage based on the inlet air flow through the air induction system. This output voltage will display on the scan tool as a voltage parameter and as a grams per second (g/s) parameter. The ECM will calculate a predicted MAF value. The ECM compares the actual MAF sensor voltage signal to the predicted MAF value. This comparison will determine if the signal is stuck, or is too low or too high for a given operating condition. If the ECM detects that the actual MAF sensor voltage signal is not within a predetermined range of the calculated MAF value, DTC P0101 sets.

Conditions for Setting the DTC

The ECM detects that the MAF sensor voltage signal is not within a predetermined range of the calculated MAF value for more than 12 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Use a scan tool in order to clear the MIL and the DTC.

Diagnostic Aids

- Any unmetered air that enters the engine downstream of the MAF sensor may cause this DTC to set.
- A short between the signal circuit of the MAF sensor and the signal circuit of the intake air temperature (IAT) sensor will skew the MAF sensor higher than normal at idle and less than normal at higher air flows.
- A malfunctioning MAF sensor can cause excessive engine emissions.
- The MAF display should increase from 24-50 g/s at idle to 320 g/s or more at the 2-3 shift during a wide-open throttle (WOT) acceleration. If not, inspect for a restriction in the induction system or the exhaust system.
- If the vehicle condition is intermittent, refer to Inducing Intermittent Fault Conditions and Intermittent Conditions.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Is DTC P0405 set?		Go to DTC P0405 before diagnosing this code	Go to step 3.
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Go to Diagnostic Aids
4	1. Turn OFF the ignition. 2. Turn ON the ignition, with the engine OFF. 3. Observe the MAF Sensor parameter with a scan tool. Is the MAF Sensor parameter more than the specified value?	0.30 Volts	Go to Step 7	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Inspect for air leaks in the following components: • The air induction system and the turbocharger system • The charge air cooler with a J 46091 Charge Air Cooler Tester • The mass air flow (MAF)/intake air temperature (IAT) sensor O-ring seal • The boost pressure sensor seal • An exhaust gas recirculation (EGR) valve gasket that is missing or damaged 3. Inspect for the following conditions: • A cracked MAF sensor housing • An obstructed intake air duct or a dirty air filter element • Any debris that is blocking the air sensing filaments of the MAF sensor • Any water intrusion in the air induction system • A MAF sensor that is installed backwards • An EGR valve that is stuck open • A restricted exhaust system Did you find and correct the condition?		Go to Step 24	Go to Step 6
6	1. Turn ON the ignition, with the engine OFF. 2. Observe both the BARO parameter and the Boost Pressure Sensor parameter with a scan tool. Is the difference between the sensors equal to or less than the specified value?	5 kPa	Go to Step 8	Go to DTC P2227
7	1. Disconnect the MAF/IAT sensor. 2. Observe the MAF Sensor parameter with a scan tool. Is the MAF Sensor parameter more than the specified value?	0 V	Go to Step 14	Go to Step 8
8	1. Start the engine and allow it to idle. 2. Observe the MAF Sensor parameter with a scan tool. 3. Move the harness and the connector of the MAF/IAT sensor. Does the movement of the harness or the connector affect the MAF Sensor parameter?		Go to Step 21	Go to Step 9
9	1. Turn OFF the engine. 2. Turn ON the ignition, with the engine OFF. 3. Measure the battery voltage with a DVOM. 4. Disconnect the MAF/IAT sensor. 5. Connect a test lamp between the ignition voltage circuit 239 (PK) of the MAF sensor and a good ground. 6. Connect the DVOM to the probe of the test lamp and a good ground. Is the voltage within 1.5 volts of the specified value?	B+	Go to Step 10	Go to Step 18

Step	Action	Value(s)	Yes	No
10	**NOTE:** All electrical components and accessories must be turned OFF. 1. Turn OFF the ignition for 60 seconds to allow the control modules to power down before proceeding. 2. Measure the resistance from the low reference circuit 251 (BK) of the MAF sensor to a good ground with a DVOM. Is the resistance less than the specified value?	5 ohms	Go to Step 11	Go to Step 12
11	1. Turn ON the ignition, with the engine OFF. 2. Connect a 3-amp fused jumper wire between the signal circuit 654 (DB) of the MAF sensor and the signal circuit 653 (YL) of the IAT sensor. 3. Observe the MAF Sensor parameter with a scan tool. Is the MAF Sensor parameter more than the specified value?	445 g/s	Go to Step 16	Go to Step 13
12	1. Disconnect the engine control module (ECM). 2. Test the MAF sensor low reference circuit 251 (BK) between C76 pin 29 and pin 4 of the MAF sensor connector for the following conditions between: • A high resistance • An intermittent open Did you find and correct the condition?		Go to Step 24	Go to Step 17
13	1. Turn OFF the ignition. 2. Disconnect the ECM. 3. Test the MAF sensor signal circuit 654 (DB) between C75 pin 13 and the MAF sensor pin 5 for the following conditions: • A high resistance or an intermittent open • A high resistance short to ground • A high resistance short to the low reference circuit of the MAF sensor or the IAT sensor Did you find and correct the condition?		Go to Step 24	Go to Step 17
14	**NOTE:** Disconnecting the ECM connectors may eliminate the short to voltage if the signal circuit is shorted to another ECM circuit. 1. Turn OFF the ignition. 2. Disconnect the ECM, C75 connector only. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the signal circuit 654 (DB) of the MAF sensor to a good ground with a DVOM. Is the voltage more than the specified value?	0 V	Go to Step 19	Go to Step 15
15	1. Turn OFF the ignition. 2. Disconnect all of the ECM connectors. 3. Measure the resistance from the signal circuit 654 (DB) of the MAF sensor to all other circuits at all ECM connectors with a DVOM. Is the resistance less than the specified value?	∞ ohms	Go to Step 20	Go to Step 17

Step	Action	Value(s)	Yes	No
16	Test for shorted terminals and for an intermittent and for a poor connection at the MAF/IAT sensor. Did you find and correct the condition?		Go to Step 24	Go to Step 22
17	Test for shorted terminals and for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 24	
18	Repair the high resistance or the intermittent open in the MAF sensor ignition voltage circuit 239 (PK). Did you complete the repair?		Go to Step 24	
19	Repair the short to voltage in the MAF sensor signal circuit 654 (DB). Did you complete the repair?		Go to Step 24	
20	Repair the circuits that are shorted together. Did you complete the repair?		Go to Step 24	
21	Repair the harness or the connections as necessary. Did you complete the repair?		Go to Step 24	
22	Replace the faulty MAF/IAT sensor. Did you complete the replacement?		Go to Step 24	
23	Replace the faulty ECM. Did you complete the replacement?		Go to Step 24	
24	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 25
25	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0102 Mass Air Flow (MAF) Sensor Performance (Figure OBD-24)

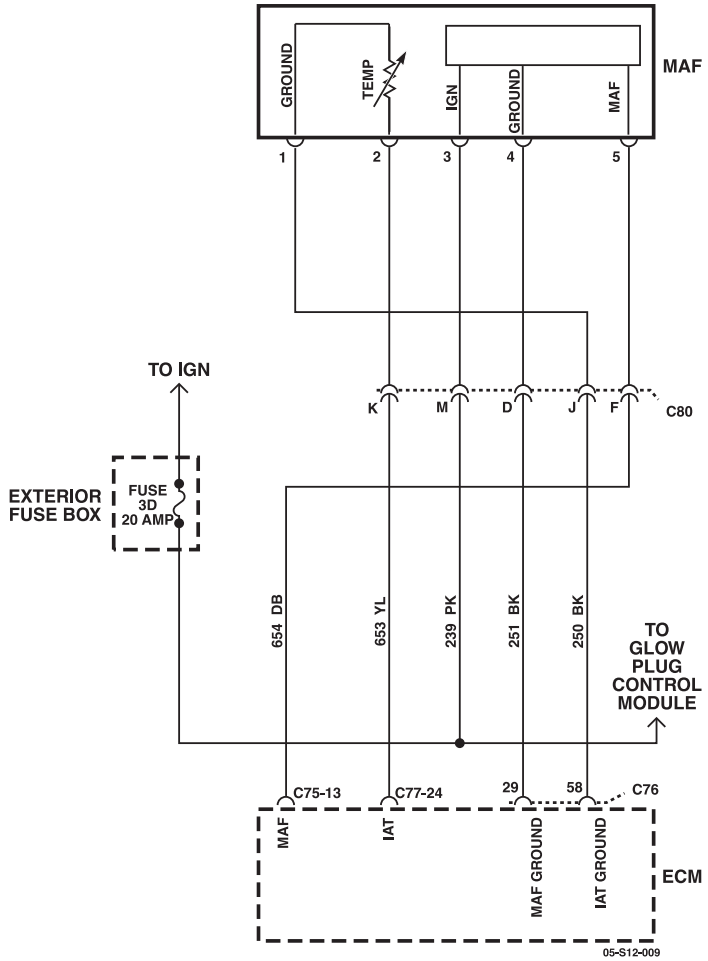


Figure OBD-24: Mass Air Flow (MAF) Sensor Circuit

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air entering the engine. The engine control module (ECM) uses the MAF sensor voltage signal to provide the correct fuel delivery for a reduction in emissions. The ECM uses the MAF sensor signal to control fuel delivery until a calibrated amount of engine air flow is attained. The MAF sensor has an ignition 1 voltage circuit, a signal circuit and a low reference circuit. The MAF sensor produces an output voltage based on the inlet air flow through the air induction system. This output voltage will display on the scan tool as a voltage parameter and as a grams per second (g/s) parameter. If the ECM detects that the actual MAF sensor voltage signal is less than the possible range of a normally operating sensor DTC P0102 sets.

Conditions for Setting the DTC

The ECM detects that the MAF sensor voltage signal is less than 0.42 volt for more than 6 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- The MAF Sensor parameter should increase from 24-50 g/s at idle to 320 g/s or more at the 2-3 shift during a wide-open throttle (WOT) acceleration. If not, inspect for a restriction in the induction system or the exhaust system.
- If the condition is intermittent, refer to Intermittent Conditions and Inducing Intermittent Fault Conditions in Wiring Systems.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Start the engine. Does the engine have fuel knock/combustion noise?		Go to Step 5	Go to Step 3
3	1. Allow the engine to idle. 2. Observe the MAF Sensor parameter with a scan tool. Is the MAF Sensor parameter less than the specified value?	0.42 V	Go to Step 6	Go to Step 4
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 6	Go to Diagnostic Aids
5	With the engine running, disconnect the mass air flow (MAF)/intake air temperature (IAT) sensor. Does the engine have fuel knock/combustion noise?		Go to Step 12	Go to Step 15
6	1. Observe the MAF Sensor parameter with a scan tool. 2. Move the harness and the connector of the MAF/IAT sensor. Does the movement of the harness or the connector affect the MAF Sensor parameter?		Go to Step 19	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the ignition. 2. Inspect for air leaks in the following components: • The air induction system and the turbocharger system • The MAF sensor O-ring seal • The boost pressure sensor seal 3. Inspect for the following conditions: • An obstructed intake air duct or a dirty air filter element • Any debris that is blocking the air sensing filaments of the MAF sensor • Contamination on the air sensing filaments of the MAF sensor • Water intrusion in the air induction system • A MAF sensor that is installed backwards • A restricted exhaust system Did you find and correct the condition?		Go to Step 22	Go to Step 8
8	Inspect the fuse in the ignition voltage circuit 239 (PK) of the MAF sensor. Is the fuse open?		Go to Step 11	Go to Step 9
9	1. Turn ON the ignition, with the engine OFF. 2. Measure the battery voltage with a DVOM. 3. Disconnect the harness connector of the MAF/IAT sensor. 4. Connect a test lamp between the ignition voltage circuit 239 (PK) of the MAF sensor and a good ground. 5. Connect the DVOM to the probe of the test lamp and a good ground. Is the voltage within 1.5 volts of the specified value?	B+	Go to Step 10	Go to Step 17
10	1. Connect a 3-amp fused jumper wire between the ignition voltage circuit 239 (PK) of the MAF sensor and the signal circuit 654 (DB) of the MAF sensor. 2. Observe the MAF Sensor parameter with a scan tool. Is the MAF Sensor parameter more than the specified value?	445 g/s	Go to Step 15	Go to Step 13
11	**NOTE:** The ignition voltage circuit 239 of the MAF sensor is spliced to other components of the vehicle. Test the MAF sensor ignition voltage circuit 239 (PK) for the following conditions: • A short to ground • Any shorted component on the spliced circuit Did you complete the action?		Go to Step 22	

Step	Action	Value(s)	Yes	No
12	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM). 3. Test the MAF sensor ignition voltage circuit 239 (PK) for the following conditions: • A short to the MAF sensor low reference circuit 251 (BK) • A short to the IAT sensor low reference circuit 250 (BK) Did you find and correct the condition?		Go to Step 22	Go to Step 16
13	1. Turn OFF the ignition. 2. Disconnect the fused jumper wire. 3. Disconnect the ECM. 4. Test the MAF sensor signal circuit 654 (DB) for the following conditions: • A high resistance or an open • A short to ground • A short to the IAT sensor low reference circuit • A short to the MAF sensor low reference circuit Did you find and correct the condition?		Go to Step 22	Go to Step 14
14	Measure the resistance from the signal circuit 654 (DB) of the MAF sensor to all the other circuits at all of the ECM connectors with a DVOM. Is the resistance less than the specified value?	∞ ohms	Go to Step 18	Go to Step 16
15	Test for shorted terminals and for an intermittent and for a poor connection at the MAF/IAT sensor. Did you find and correct the condition?		Go to Step 22	Go to Step 20
16	Test for shorted terminals and for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 22	Go to Step 21
17	Repair the high resistance or the open in the MAF sensor ignition voltage circuit 239 (PK). Did you complete the repair?		Go to Step 22	
18	Repair the circuits that are shorted together. Did you complete the repair?		Go to Step 22	
19	Repair the harness or the connections as necessary. Did you complete the repair?		Go to Step 22	
20	Replace the faulty MAF/IAT sensor. Did you complete the replacement?		Go to Step 22	
21	Replace the faulty ECM. Did you complete the replacement?		Go to Step 22	

Step	Action	Value(s)	Yes	No
22	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 23
23	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0103 Mass Air Flow (MAF) Sensor Ckt High Voltage (Figure OBD-25)

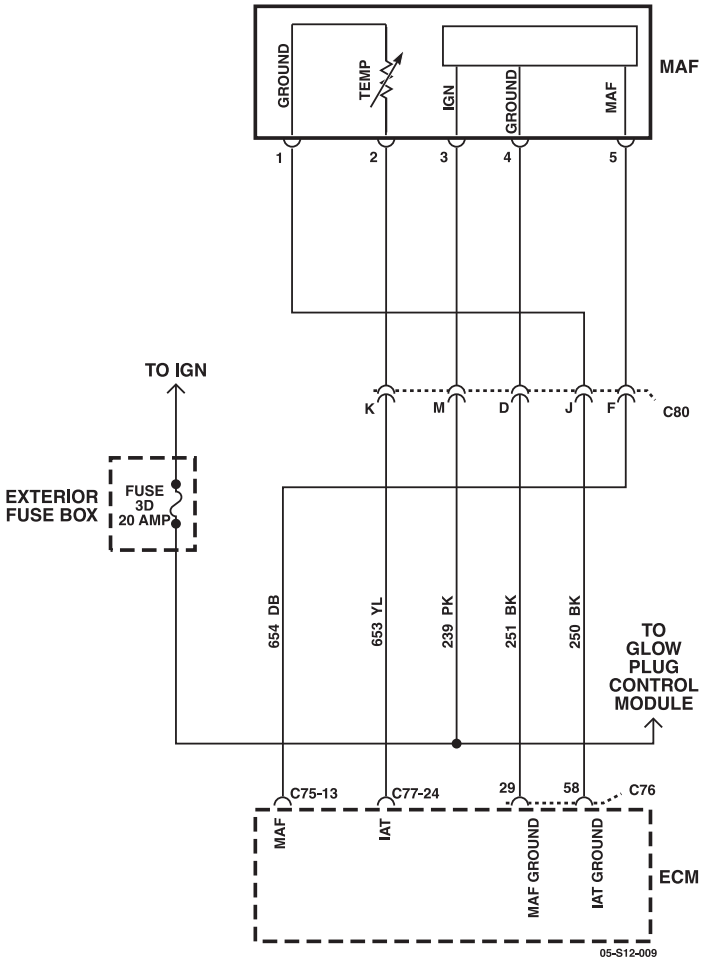


Figure OBD-25: Mass Air Flow (MAF) Sensor Circuit

Circuit Description

The mass air flow (MAF) sensor is an air flow meter that measures the amount of air entering the engine. The engine control module (ECM) uses the MAF sensor voltage signal to provide the correct fuel delivery for a reduction in emissions. The ECM uses the MAF sensor signal to control fuel delivery until a calibrated amount of engine air flow is attained. The MAF sensor has an ignition 1 voltage circuit, a signal circuit and a low reference circuit. The MAF sensor produces an output voltage based on the inlet air flow through the air induction system. This output voltage will display on the scan tool as a voltage parameter and as a grams per second (g/s) parameter. If the ECM detects that the actual MAF sensor voltage signal is more than the possible range of a normally operating sensor DTC P0103 sets.

Conditions for Setting the DTC

The ECM detects that the MAF sensor voltage signal is more than 4.5 volts for more than 6 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecu-

tive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Start the engine. 2. Observe the MAF Sensor parameter with a scan tool. Is the MAF Sensor parameter more than the specified value?	4.5 V	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Go to Diagnostic Aids
4	1. Allow the engine to idle. 2. Observe the MAF Sensor parameter with a scan tool. 3. Move the harness and the connector of the mass air flow (MAF)/intake air temperature (IAT) sensor. Does the movement of the harness or the connector affect the MAF Sensor parameter?		Go to Step 14	Go to Step 5
5	1. Observe the MAF Sensor parameter with a scan tool. 2. Disconnect the MAF sensor. Is the MAF Sensor parameter more than the specified value?	4.5 V	Go to Step 9	Go to Step 6
6	1. Turn OFF the ignition. 2. Inspection the air induction system for any water intrusion. Did you find and correct the condition?		Go to Step 17	Go to Step 7
7	**NOTE:** All electrical components and accessories must be turned OFF. 1. Turn OFF the ignition for 60 seconds to allow the control modules to power down before proceeding. 2. Measure the resistance from the low reference circuit 251 (BK) of the MAF sensor to a good ground with a DVOM. Is the resistance less than the specified value?	5 ohms	Go to Step 11	Go to Step 8

Step	Action	Value(s)	Yes	No
8	**NOTE:** Disconnecting the harness connectors of the ECM may eliminate the short to voltage if the signal circuit is shorted to another ECM circuit. 1. Turn OFF the ignition. 2. Disconnect the ECM connectors. 3. Test the MAF sensor signal circuit 654 (DB) for the following conditions: • A short to voltage. • A short to any 5-volt reference circuit. Did you find and correct the condition?		Go to Step 17	Go to Step 10
9	**NOTE:** Disconnecting the harness connectors of the ECM may eliminate the short to voltage if the signal circuit is shorted to another ECM circuit. 1. Turn OFF the ignition. 2. Disconnect the harness connectors of the ECM. 3. Test the MAF sensor signal circuit 654 (DB) for the following conditions: • A short to voltage • A short to any 5-volt reference circuit. Did you find and correct the condition?		Go to Step 17	Go to Step 10
10	Measure the resistance from the signal circuit 654 (DB) of the MAF sensor to all other circuits at all ECM connectors with a DVOM. Is the resistance less than the specified value?	∞ ohms	Go to Step 13	Go to Step 12
11	Test for an intermittent and for a poor connection at the MAF/IAT sensor. Did you find and correct the condition?		Go to Step 17	Go to Step 15
12	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 17	Go to Step 16
13	Repair the circuits that are shorted together. Did you complete the repair?		Go to Step 17	
14	Repair the harness or the connections as necessary. Did you complete the repair?		Go to Step 17	
15	Replace the faulty MAF/IAT sensor. Did you complete the replacement?		Go to Step 17	
16	Replace the faulty ECM. Did you complete the replacement?		Go to Step 17	

Step	Action	Value(s)	Yes	No
17	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 18
18	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0112 Intake Air Temperature (IAT) Sensor Circuit Low Voltage (Figure OBD-26)

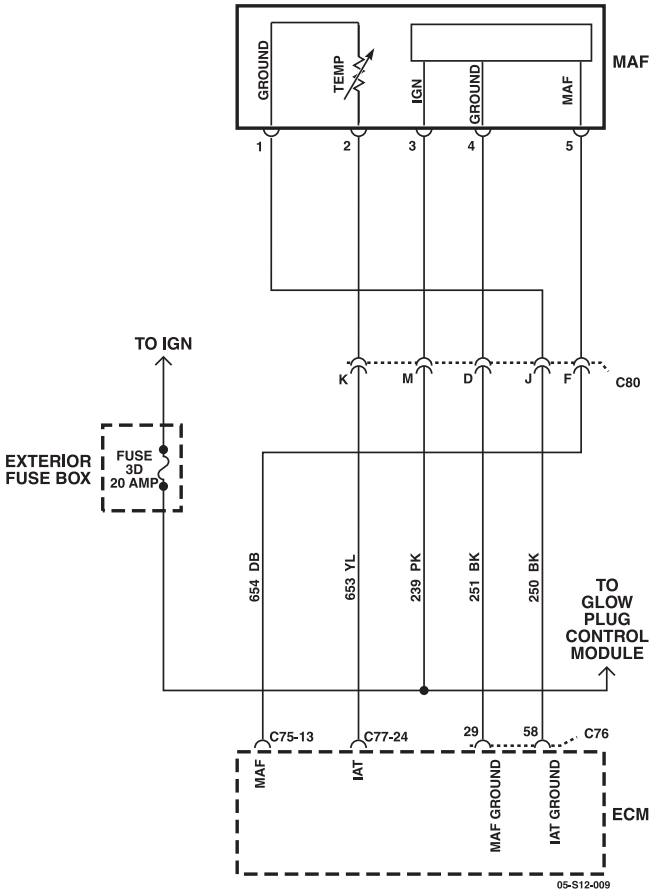


Figure OBD-26: Intake Air Temperature (IAT) Sensor Circuit

Circuit Description

The intake air temperature (IAT) sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit, and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit. If the ECM detects an excessively low IAT signal voltage, indicating a high temperature, DTC P0112 sets.

Conditions for Setting the DTC

The IAT Sensor parameter is more than 148°C (298°F) for more than 10 seconds. This is equal to less than 0.24 volts on the IAT signal circuit as measured by the ECM.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Observe the IAT Sensor parameter with a scan tool. Is the IAT Sensor parameter more than the specified value?	148°C (298°F)	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 60 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go to Diagnostic Aids
4	1. Disconnect the mass air flow (MAF)/intake air temperature (IAT) sensor. 2. Observe the IAT Sensor parameter with a scan tool. Is the IAT Sensor parameter less than the specified value?	-39°C (-38°F)	Go to Step 6	Go to Step 5
5	Test the IAT signal circuit 653 (YL) for the following conditions: • A short to ground • A short to the IAT low reference circuit 250 (BK) • A short to the MAF sensor low reference circuit 251 (BK) Did you find and correct the condition?		Go to Step 10	Go to Step 7
6	Test for shorted terminals and for poor connections at the MAF/IAT sensor. Did you find and correct the condition?		Go to Step 10	Go to Step 8
7	Test for shorted terminals and for poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 10	Go to Step 9
8	Replace the faulty MAF/IAT sensor. Did you complete the replacement?		Go to Step 10	
9	Replace the faulty ECM. Did you complete the replacement?		Go to Step 10	

Step	Action	Value(s)	Yes	No
10	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 11
11	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0113 Intake Air Temperature Sensor (IAT) Sensor Circuit High Voltage (Figure OBD-27)

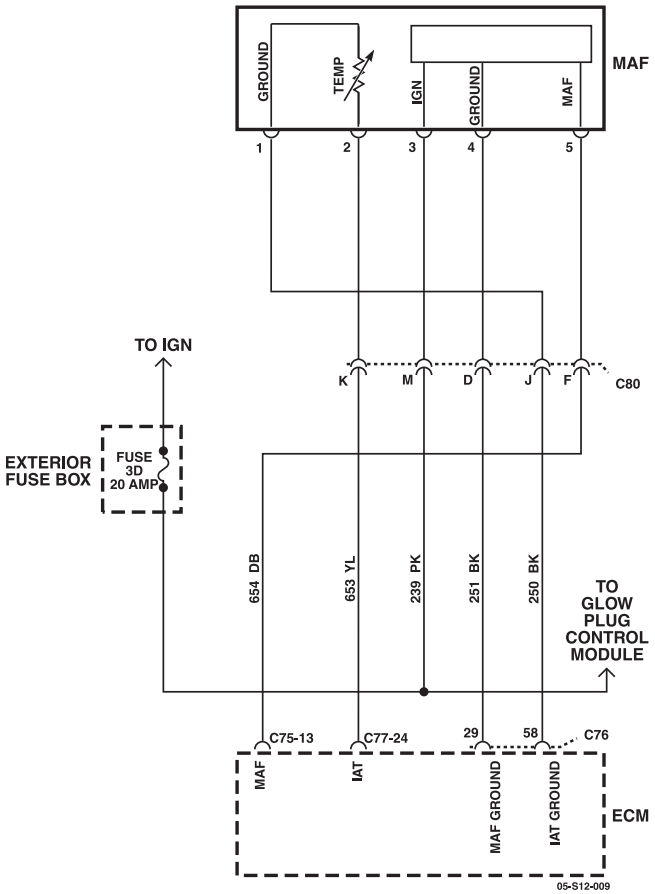


Figure OBD-27: Intake Air Temperature (IAT) Sensor Circuit

Circuit Description

The intake air temperature (IAT) sensor is a variable resistor. The IAT sensor has a signal circuit and a low reference circuit. The IAT sensor measures the temperature of the air entering the engine. The engine control module (ECM) supplies 5 volts to the IAT signal circuit, and a ground for the IAT low reference circuit. When the IAT sensor is cold, the sensor resistance is high. When the air temperature increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the IAT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the IAT signal circuit. If the ECM detects an excessively high IAT signal voltage, indicating a low temperature, DTC P0113 sets.

Conditions for Setting the DTC

The IAT Sensor parameter is less than -39°C (-38°F) for more than 10 seconds. This is equal to more than 4.86 volts on the IAT signal circuit as measured by the ECM.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Observe the IAT Sensor parameter with a scan tool. Is the IAT Sensor parameter less than the specified value?	-39°C (-38°F)	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. Turn OFF the ignition for 60 seconds. 2. Start the engine. 3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go to Diagnostic Aids
4	1. isconnect the mass air flow (MAF)/intake air temperature (IAT) sensor. 2. Measure the voltage from the signal circuit 653 (YL) of the IAT sensor to a good ground with a DVOM. Is the voltage more than the specified value?	5.2 Volts	Go to Step 5	Go to Step 6
5	**NOTE:** If a short to B+ voltage occurs the sensor may be damaged. Test the IAT signal circuit 653 (YL) for a short to voltage. Did you find and correct the condition?		Go to Step 15	Go to Step 12
6	Connect a 3-amp fused jumper wire between the signal circuit 653 (YL) of the IAT sensor and the low reference circuit 250 (BK) of the IAT sensor. Is the IAT Sensor parameter more than the specified value?	148°C (298°F)	Go to Step 10	Go to Step 7
7	Connect a 3-amp fused jumper wire between the signal circuit 653 (YL) of the IAT sensor and a good ground. Is the IAT Sensor parameter more than the specified value?	148°C (298°F)	Go to Step 9	Go to Step 8
8	Test the IAT signal circuit 653 YL) for an open circuit or for high resistance Between C77 pin 24 and pin 2 of the IAT sensor connector. Did you find and correct the condition?		Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
9	Test the IAT low reference circuit 250 (BK) for an open circuit or for high resistance between C76 pin 58 and pin 1 of the IAT sensor connector. Did you find and correct the condition?		Go to Step 15	Go to Step 12
10	Test the IAT signal circuit 650 (YL) for a short to any 5-volt reference circuit. Did you find and correct the condition?		Go to Step 15	Go to Step 11
11	Test for an intermittent and for a poor connection at the MAF/IAT sensor. Did you find and correct the condition?		Go to Step 15	Go to Step 13
12	Test for an intermittent and for a poor connection at the engine control module (ECM). Did you find and correct the condition?		Go to Step 15	Go to Step 14
13	Replace the faulty MAF/IAT sensor. Did you complete the replacement?		Go to Step 15	
14	Replace the faulty ECM. Did you complete the replacement?		Go to Step 15	
15	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 16
16	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0116 Engine Coolant Rationality (Figure OBD-28)

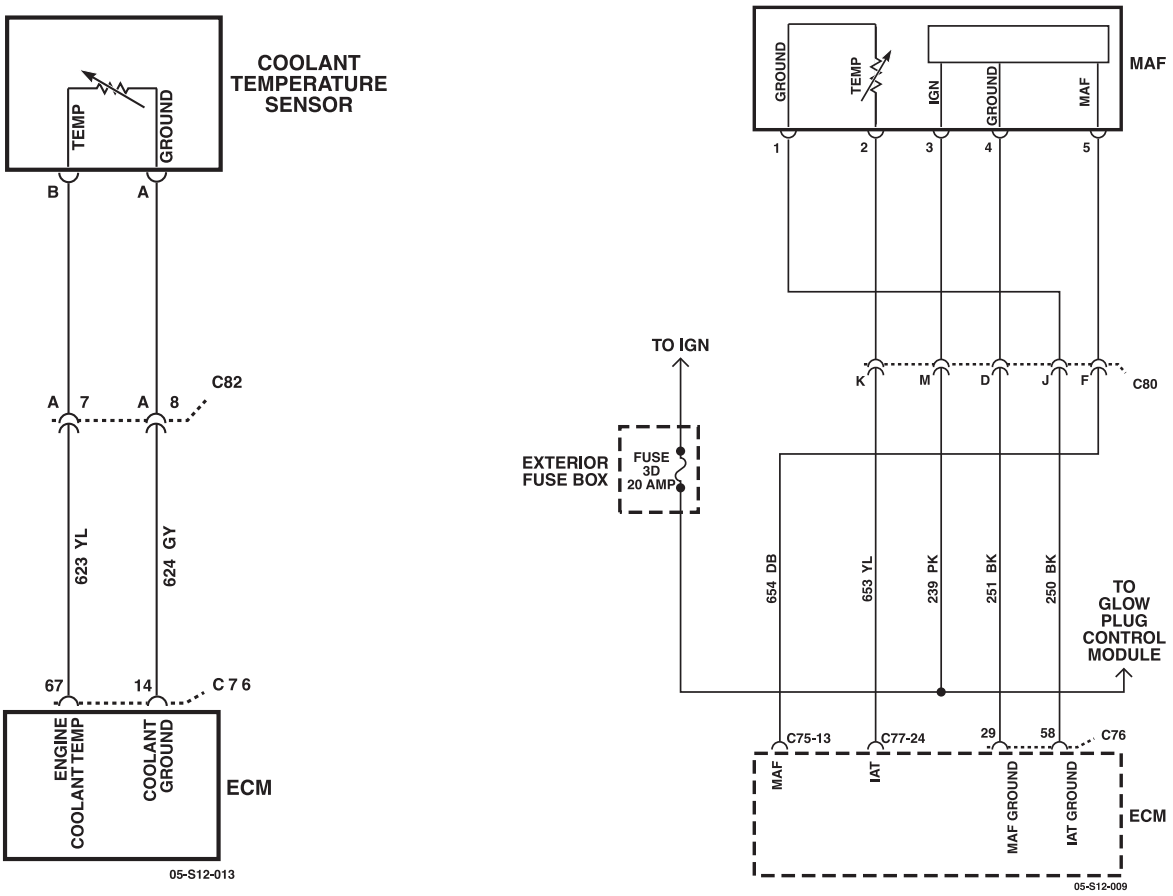


Figure OBD-28: Coolant Temperature/Mass Air Flow and Air Intake Temperature Sensor Circuits

Circuit Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the signal circuit and a ground for the low reference circuit. When the engine coolant temperatures are low, the resistance is high. When the engine coolant temperatures are high the resistance is low. The ECM uses this high side coolant rationality test to determine if the ECT input is skewed high. The ECM will record the amount of time the engine is OFF. At restart the ECM will compare the temperature difference between the ECT and intake air temperature (IAT). Before failing this diagnostic, the ECM will perform the calculation to determine the presence of a block heater. If the temperature difference is not within the calculated range, after the predetermined engine OFF time, DTC P0116 sets.

Conditions for Setting the DTC

If the ECM detects a start-up temperature difference between the ECT sensor and the IAT sensor of more than 5°C (9°F), then the vehicle must be driven for more than 400 seconds over 24 km/h (15 mph) and the engine speed must be more than 600 RPM. If the IAT sensor temperature decreases more than 5°C (9°F) then a block heater is detected and the test is aborted. If the IAT sensor temperature does not decrease, then a block heater was not detected and DTC P0116 sets.

Action Taken When the DTC Sets

The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.

The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle,

the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Inspect the cooling system coolant level. Is the cooling system coolant low?		Fill The Cooling System	Go to Step 3
3	Observe and record the ambient air temperature of the vehicle environment using an accurate thermometer. Did you complete the action?		Go to Step 4	
4	**NOTE:** The engine needs to have been OFF for at least 10 hours for the engine coolant temperature (ECT) and the intake air temperature (IAT) to be at ambient temperature. The vehicle should not have changed environments during this time. Has the engine been OFF for the specified amount of time?	10 hrs	Go to Step 7	Go to Step 5
5	1. Remove the mass air flow/intake air temperature (MAF/IAT) sensor. 2. Remove the ECT sensor. 3. Place the sensors on a work surface away from any heat source. 4. Allow the sensors to reach the ambient air temperature for 30-60 minutes. Are the sensors at the ambient temperature?		Go to Step 6	
6	1. Connect the MAF/IAT sensor to the electrical connector, but DO NOT install it. 2. Insulate the sensor from any engine heat source. 3. Connect the ECT sensor to the electrical connector, but DO NOT install it. 4. Insulate the sensor from any engine heat source. Are the sensors connected?		Go to Step 7	

Step	Action	Value(s)	Yes	No
7	**NOTE:** The IAT sensor will start to warm-up as soon as the ignition is turned ON. 1. Turn ON the ignition. 2. Take a snapshot of the Engine Data List with a scan tool. Review the snapshot data that was taken with the scan tool. Observe the ECT Sensor parameter with a scan tool. 3. Observe the IAT Sensor parameter with a scan tool. Is the difference between the ECT Sensor parameter and the IAT Sensor parameter more than the specified value?	5°C (9°F)	Go to Step 8	Intermittent Go To Diagnostic Aids
8	Observe the recorded IAT Sensor parameter. Is the difference between the IAT Sensor parameter and the ambient air temperature less than the specified value?	5°C (9°F)	Go to Step 9	Go to Step 10
9	Observe the recorded ECT Sensor parameter. Is the difference between the ECT Sensor parameter and the ambient air temperature less than the specified value?	5°C (9°F)	Intermittent Go To Diagnostic Aids	Go to Step 12
10	1.Disconnect the MAF/IAT sensor. 2.Test for an intermittent and for a poor connection at the IAT sensor. Did you find and correct the condition?		Go to Step 24	Go to Step 11
11	1. At the sensor, measure the resistance between the IAT signal pin 2 and pin 1 the IAT low reference terminals with a DVOM and record the value. 2. Compare the resistance measurement of the IAT sensor to the ambient air temperature using the Temperature vs. Resistance table. Is the resistance measurement of the IAT sensor within the specified range?		Go to Step 14	Go to Step 21
12	1. Disconnect the ECT sensor. 2. Inspect for the following conditions: • An ECT sensor leaking engine coolant internally through the sensor • Corrosion on the ECT sensor terminals • Corrosion on the ECT harness connector terminals Did you find and correct the condition?		Go to Step 23	Go to Step 13
13	**NOTE:** Do not hold the ECT sensor by the probe. 1. At the sensor, measure the resistance between the ECT signal and the ECT low reference terminals with a DVOM and record the value. 2. Observe the recorded ambient air temperature. 3. Compare the resistance measurement of the ECT sensor to the ambient air temperature using the Temperature vs. Resistance table. Is the resistance measurement of the ECT sensor within the specified range?		Go to Step 15	Go to Step 22

Step	Action	Value(s)	Yes	No
14	Measure the voltage from the IAT signal circuit 653 (YL) to a good ground with a DVOM. Is the voltage within the specified range?	4.8-5.2 Volts	Go to Step 16	Go to Step 17
15	Measure the voltage from the ECT signal circuit 623 (YL) to a good ground with a DVOM. Is the voltage within the specified range?	4.8-5.2 Volts	Intermittent Go To Diagnostic Aids	Go to Step 19
16	**NOTE:** All electrical components and accessories must be turned OFF. Performing this step will disable the diagnostic for 10 hours. 1. Turn OFF the ignition for 90 seconds to allow the control modules to power down. 2. Measure the resistance from the low reference circuit 250 (BK) of the IAT sensor to a good ground with a DVOM. Is the resistance less than the specified value?	5 ohms	Intermittent Go To Diagnostic Aids	Go to Step 18
17	Test the IAT signal circuit 653 (YL) for a high resistance between C77 pin 24 and pin 2 of the IAT sensor connector. Did you find and correct the condition?		Go to Step 24	Go to Step 20
18	Test the IAT low reference circuit 250 (BK) for a high resistance between C76 pin 58 and pin1 of the IAT sensor connector. Did you find and correct the condition?		Go to Step 24	Go to Step 20
19	Test the ECT signal circuit 623 (YL) for a high resistance short to ground between C76 pin 67 and pin B of the ECT sensor connector. Did you find and correct the condition?		Go to Step 24	Go to Step 20
20	Test for an intermittent and for a poor connection at the engine control module (ECM). Did you find and correct the condition?		Go to Step 24	Go to Step 23
21	Replace the faulty MAF/IAT sensor. Did you complete the replacement?		Go to Step 24	
22	Replace the faulty ECT sensor. Did you complete the replacement?		Go to Step 24	
23	Replace the faulty ECM. Did you complete the replacement?		Go to Step 24	
24	Reassemble the vehicle as necessary. Did you complete the action?		Go to Step 25	

Step	Action	Value(s)	Yes	No
25	**NOTE:** This DTC will not run without the engine being OFF for at least 10 hours. 1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 26
26	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0117 Engine Coolant Temperature (ECT) Sensor Circuit Low Voltage (Figure OBD-29)

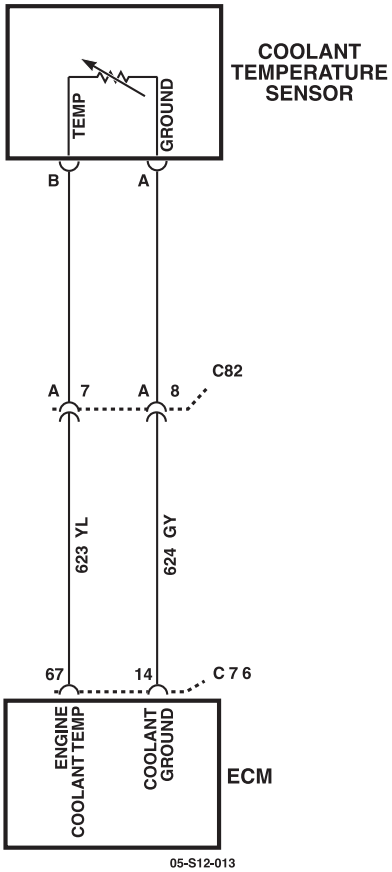


Figure OBD-29: Engine Coolant Temperature (ECT) Sensor Circuit

Circuit Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit, and a ground for the ECT low reference circuit. When the ECT is cold, the sensor resistance is high. When the ECT increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessively low ECT signal voltage, which is a high temperature indication, DTC P0117 sets.

Conditions for Setting the DTC

The ECM detects that the ECT Sensor parameter is more than 148°C (298°F) for more than 10 seconds. This is equal to less than 0.24 volts on the ECT signal circuit as measured by the ECM.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Observe the ECT Sensor parameter. Is the ECT Sensor parameter more than the specified value?	148°C (298°F)	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 60 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go to Diagnostic Aids
4	1. Disconnect the engine coolant temperature (ECT) sensor. 2. Observe the ECT Sensor parameter with a scan tool. Is the ECT Sensor parameter less than the specified value?	-39°C (-38°F)	Go to Step 6	Go to Step 5
5	Test the ECT signal circuit 623 (YL) for a short to ground or for a short to any low reference circuit. Did you find and correct the condition?		Go to Step 10	Go to Step 7
6	Test for shorted terminals and for poor connections at the ECT sensor. Did you find and correct the condition?		Go to Step 10	Go to Step 8
7	Test for shorted terminals and for poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 10	Go to Step 9
8	Replace the faulty ECT sensor. Did you complete the replacement?		Go to Step 10	
9	Replace the faulty ECM. Did you complete the replacement?		Go to Step 10	

Step	Action	Value(s)	Yes	No
10	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 11
11	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0118 Engine Coolant Temperature (ECT) Sensor Circuit High Voltage (Figure OBD-30)

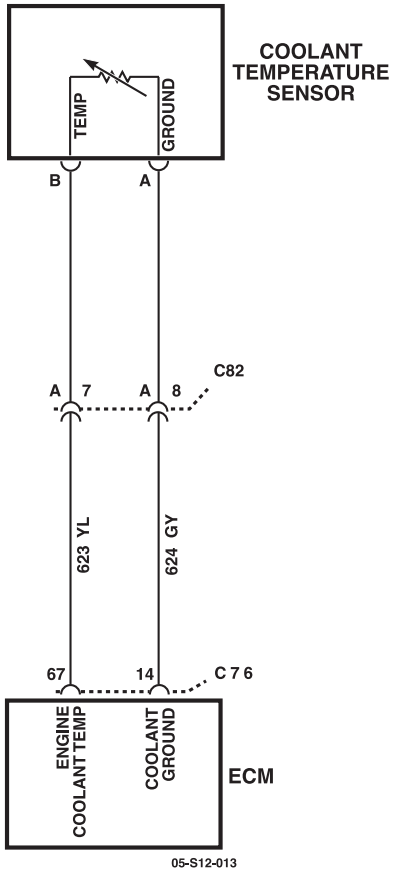


Figure OBD-30: Engine Coolant Temperature (ECT) Sensor Circuit

Circuit Description

The engine coolant temperature (ECT) sensor is a variable resistor that measures the temperature of the engine coolant. The engine control module (ECM) supplies 5 volts to the ECT signal circuit and a ground for the ECT low reference circuit. When the ECT is cold, the sensor resistance is high. When the ECT increases, the sensor resistance decreases. With high sensor resistance, the ECM detects a high voltage on the ECT signal circuit. With lower sensor resistance, the ECM detects a lower voltage on the ECT signal circuit. If the ECM detects an excessively high ECT signal voltage, which is a low temperature indication, DTC P0118 sets.

Conditions for Setting the DTC

The ECT sensor temperature is less than -39°C (-38°F) for more than 10 seconds. This is equal to more than 4.76 volts on the ECT signal circuit as measured by the ECM.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- If a short to a separate 5-volt source occurs, this DTC will set.
- A skewed sensor could result in poor driveability conditions. Refer to Temperature vs Resistance.
- After starting the engine, the ECT should rise steadily, then stabilize when the thermostat opens.
- If the condition is suspected of being intermittent, refer to Intermittent Conditions and Inducing Intermittent Fault Conditions in Wiring Systems.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Observe the ECT Sensor parameter. Is the ECT Sensor parameter more than the specified value?	148°C (298°F)	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 60 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go to Diagnostic Aids
4	1. Disconnect the engine coolant temperature (ECT) sensor. 2. Measure the voltage from the signal circuit of the ECT sensor to a good ground with a DVOM. Is the voltage more than the specified value?	5.2 Volts	Go to Step 5	Go to Step 6
5	**NOTE:** If a short to B+ voltage occurs, the ECT sensor may be damaged. Test the ECT signal circuit for a short to voltage. Did you find and correct the condition?		Go to Step 15	Go to Step 12
6	1. Connect a 3-amp fused jumper between the signal circuit 623 (YL) of the ECT sensor and the low reference circuit 624 (GY). 2. Observe the ECT sensor parameter with the scan tool. Is the ECT sensor parameter more than the specified value?	148°C (298°F)	Go to Step 10	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Connect a 3-amp fused jumper between the signal circuit 623 (YL) of the ECT sensor and a good ground. 2. Observe the ECT sensor parameter with a scan tool. Is the ECT sensor parameter more than the specified value?	148°C (298°F)	Go to Step 9	Go to Step 8
8	Test the signal circuit 623 (YL) of the ECT sensor for a high resistance or an open between C76 pin 67 and pin B of the ECT sensor connector. Did you find and correct the condition?		Go to Step 15	Go to Step 12
9	Test the low reference circuit 624 (GY) of the ECT sensor for a high resistance or an open between C76 pin 14 and pin A of the ECT sensor connector. Did you find and correct the condition?		Go to Step 15	Go to Step 12
10	Test the ECT signal circuit 623 (YL) for a short to any 5-volt reference circuit. Did you find and correct the condition?		Go to Step 15	Go to Step 11
11	Test for an intermittent and for a poor connection at the ECT sensor. Did you find and correct the condition?		Go to Step 15	Go to Step 13
12	Test for an intermittent and for a poor connection at the engine control module (ECM). Did you find and correct the condition?		Go to Step 15	Go to Step 14
13	Replace the faulty ECT sensor. Did you complete the replacement?		Go to Step 15	
14	Replace the faulty ECM. Did you complete the replacement?		Go to Step 15	
15	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 16
16	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0168 Fuel Temperature Sensor Over Temp (Figure OBD-31)

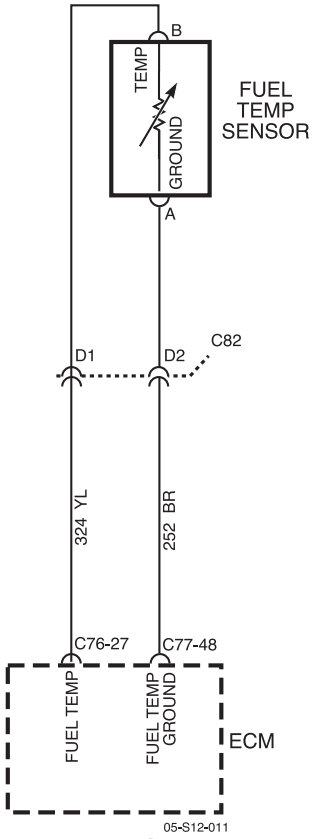


Figure OBD-31: Fuel Temperature Sensor Circuit

Circuit Description

The fuel temperature sensor is a thermistor type sensor. The engine control module (ECM) supplies 5 volts and a ground circuit to the sensor. When the ECM detects a fuel temperature sensor above a pre-determined value, a type D code, no malfunction indicator lamp (MIL) sets. A fuel cooler located in the cool pack is used to help keep the fuel temperature at an acceptable limit.

Conditions for Setting the DTC

The fuel temperature sensor is above 122°C (252°F) for more than 5 seconds.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Inspect the fuel cooler located in the cool pack for debris restricting the airflow or damage to the cooling fins. 2. Inspect the fuel lines for kinks or damage. 3. Clean or replace the above listed components as necessary. Did any of the components require a repair?		Go to Step 11	Go to Step 3
3	1. Disconnect the air filter outlet duct to access the fuel temperature sensor. 2. Disconnect the fuel temperature sensor electrical connector. 3. Turn ON the ignition. 4. Probe the fuel temperature sensor signal circuit 324 (YL) with a DVOM connected to ground. Is the voltage near the specified value?	5 V	Go to Step 4	Go to Step 5
4	1. Connect a test lamp to B+. 2. Probe the low reference circuit 252 (BR) of the fuel temperature sensor connector. Does the test lamp illuminate?		Go to Step 7	Go to Step 6
5	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) connector 76 that contains the fuel temperature sensor signal circuit. 3. Inspect the signal circuit 324 (YL) for an open or short to voltage or ground between C76 pin 27 and pin B of the FTS. Did you find and correct the condition?		Go to Step 11	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect the ECM connector 77 that contains the fuel temperature sensor low reference circuit 252 (BR). 3. Inspect the fuel temperature sensor low reference circuit 252(BR) and connectors for an open or high resistance between C77 pin 48 and pin A of the FTS. Did you complete the repair?		Go to Step 11	
7	Inspect for poor connections at the fuel temperature sensor and repair as necessary. Did you find and correct the condition?		Go to Step 11	Go to Step 9
8	Inspect for poor connections at the ECM and repair as necessary. Did you find and correct the condition?		Go to Step 11	Go to Step 10
9	Replace the faulty fuel temperature sensor. Did you complete the replacement?		Go to Step 11	
10	Replace the faulty ECM. Did you complete the replacement?		Go to Step 11	

Step	Action	Value(s)	Yes	No
11	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 12
12	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0181 Fuel Temperature Sensor Performance (Figure OBD-32)

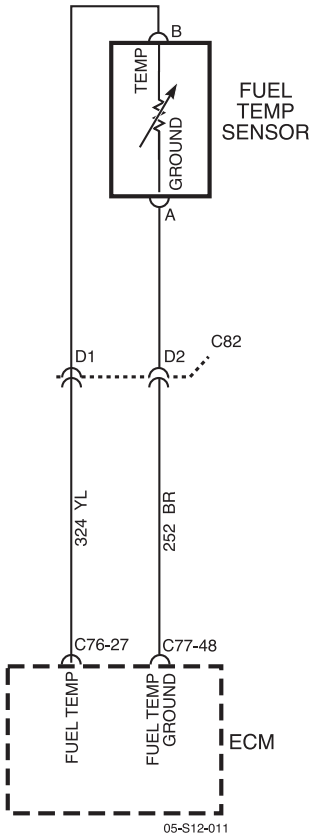


Figure OBD-32: Fuel Temperature Sensor Circuit

Circuit Description

The fuel temperature sensor is a thermistor. The engine control module (ECM) supplies the fuel temperature sensor a reference voltage of 5 volts on the signal circuit and also provides a low reference circuit to the sensor. When the fuel temperature sensor is cold, the resistance is high. The fuel temperature sensor signal voltage remains near the supplied voltage cold and decreases the signal voltage as the sensor warms. The control module monitors the fuel temperature sensor signal circuit in order to calculate the temperature of the fuel entering the engine.

Conditions for Setting the DTC

- The fuel temperature and the ECT are more than 9.75°C (18°F) of each other at start-up.
- The IAT has dropped less than 5.25°C (10°F) after running more than 400 seconds above 24 km/h (15 mph).

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Allow the engine to cool to ambient temperature. 2. Turn ON the ignition. 3. Observe the intake air temperature (IAT) sensor parameter with a scan tool. Does the scan tool indicate a temperature near ambient temperature within the specified range?	10°C (18°F)	Go to Step 3	Go to Step 4
3	1. Start the engine. 2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. Does the DTC fail this ignition?		Go to Step 6	Intermittent Go To Diagnostic Aids
4	1. Disconnect the mass air flow (MAF) sensor connector. 2. Turn ON the ignition, with the engine OFF. 3. Measure the voltage of the IAT signal circuit 654 (DB) at the MAF sensor connector. Does the voltage measure near the specified value?	5 V	Go to Step 5	Go to Step 9
5	1. Connect a test lamp to B+. 2. Probe the low reference circuit 250 (BK) of the IAT. Does the test lamp illuminate?		Go to Step 14	Go to Step 11
6	1. Disconnect the air filter outlet duct to access the fuel temperature sensor. 2. Disconnect the fuel temperature sensor electrical connector. 3. Turn ON the ignition, with the engine OFF. 4. Probe the fuel temperature sensor signal circuit 324 (YL) with a DVOM connected to ground. Does the voltage measure near the specified value?	5 V	Go to Step 8	Go to Step 9
7	Connect a 3-amp fused jumper wire between the fuel temperature sensor signal circuit 324 (YL) and ground. Is the temperature more than the specified value?	140°C (285°F)	Go to Step 8	Go to Step 10
8	1. Connect a test lamp to B+. 2. Probe the low reference circuit 252 (BK) pin A of the fuel temperature sensor connector. Does the test lamp illuminate?		Go to Step 15	Go to Step 11

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM) connectors. 3. Inspect the signal circuit 324 (YL) for an open or for short to ground between C76 pin 27 and pin B of the FT sensor. Did you perform a repair?		Go to Step 16	Go to Step 12
10	Repair the high resistance in the fuel temperature sensor signal circuit 324 (YL). Did you complete the repair?		Go to Step 16	Go to Step 12
11	Repair the open or the high resistance in the sensor low reference circuit 252 (BR). Did you complete the repair?		Go to Step 16	Go to Step 13
12	Inspect the ECM connector terminals for spreading or poor connections. Did you find and correct the condition?		Go to Step 16	Go to Step 13
13	Replace the faulty ECM. Did you complete the replacement?		Go to Step 16	
14	Replace the faulty MAF sensor. Did you complete the replacement?		Go to Step 16	
15	Replace the faulty fuel temperature sensor. Did you complete the replacement?		Go to Step 16	
16	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 17
17	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0182 Fuel Temperature Sensor Circuit Low Voltage (Figure OBD-33)

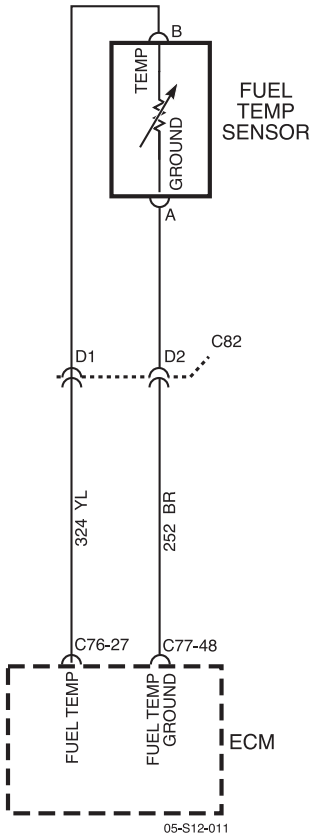


Figure OBD-33: Fuel Temperature Sensor Circuit

Circuit Description

The fuel temperature sensor is a thermistor. The engine control module (ECM) supplies the fuel temperature sensor a reference voltage of 5 volts on the signal circuit and also provides a low reference circuit to the sensor. When the fuel temperature sensor is cold, the resistance is high. The fuel temperature sensor signal voltage remains near the supplied voltage cold and decreases the signal voltage as the sensor warms. The control module monitors the fuel temperature sensor signal circuit in order to calculate the temperature of the fuel entering the engine. If the ECM detects an excessively low fuel temperature signal voltage, a high temperature indication, this DTC will set.

Conditions for Setting the DTC

The fuel temperature sensor is more than 129.75°C (265.55°F) for 2 seconds.

OR

The fuel temperature sensor voltage is less than 0.24 volts for 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- After starting a cold engine, the fuel temperature should be within a few degrees of the intake air temperature (IAT) sensor.
- Use the Temperature vs. Resistance table in order to test the fuel temperature sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor could result in poor driveability concerns.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the fuel temperature sensor parameter with a scan tool. Is the fuel temperature sensor parameter more than the specified value?	130°C (266°F)	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go To Diagnostic Aids
4	1. Remove the air cleaner outlet duct from the air intake pipe. 2. Disconnect the fuel temperature sensor. 3. Turn ON the ignition, with the engine OFF. 4. Observe the fuel temperature sensor parameter with a scan tool. Is the fuel temperature sensor parameter less than the specified value?	-30°C (-86°F)	Go to Step 6	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM). 3. Test the signal circuit 324 (YL) of the fuel temperature sensor for a short to ground or a short to any low reference circuit between C76 pin 27 and pin B of the fuel temp sensor. Did you find and correct the condition?		Go to Step 8	Go to Step 7
6	Replace the faulty fuel temperature sensor. Did you complete the replacement?		Go to Step 8	

Step	Action	Value(s)	Yes	No
7	Replace the faulty ECM. Did you complete the replacement?		Go to Step 8	
8	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 9
9	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0183 Fuel Temperature Sensor Circuit Low Voltage (Figure OBD-34)

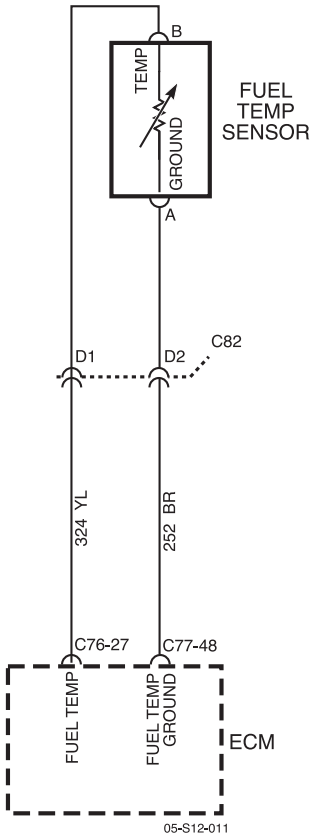


Figure OBD-34: Fuel Temperature Sensor Circuit

Circuit Description

The fuel temperature sensor is a thermistor. The engine control module (ECM) supplies the fuel temperature sensor a reference voltage of 5 volts on the signal circuit, and also provides a ground circuit to the sensor. When the fuel temperature sensor is cold, the resistance is high. The fuel temperature sensor signal voltage remains near the supplied voltage cold, and decreases the signal voltage as the sensor warms. The control module monitors the fuel temperature sensor signal circuit in order to calculate the temperature of the fuel entering the engine. If the ECM detects an excessively high fuel temperature sensor voltage, a low temperature indication, this DTC will set.

Conditions for Setting the DTC

- The fuel temperature sensor is less than -30°C (-22°F) for 2 seconds.
- DTC P0183 runs continuously within the above enabling conditions.
- Action Taken When the DTC Sets
- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- If a short to a separate 5-volt source occurs, this DTC may set. If this is the condition, a continuity test to all other ECM circuits will be necessary in order to diagnose the specific circuit.
- After starting a cold engine, the fuel temperature sensor should be within a few degrees of the intake air temperature (IAT) reading.
- Use the Temperature vs. Resistance table to test the fuel temperature sensor at various temperature levels, and to evaluate the possibility of a skewed sensor.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the Fuel Temperature Sensor parameter with a scan tool. Is the Fuel Temperature Sensor parameter less than the specified value?	-30°C (-22°F)	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go To Diagnostic Aids
4	1. Turn OFF the ignition. 2. Disconnect the fuel temperature sensor. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the signal circuit 324 (YL) of the fuel temperature sensor to a good ground with a DVOM. Is the voltage more than the specified value?	5.2 Volts	Go to Step 5	Go to Step 6
5	**NOTE:** If a short to battery voltage occurs, the fuel temperature sensor may be damaged. Test the fuel temperature sensor signal circuit for a short to voltage. Did you find and correct the condition?		Go to Step 15	Go to Step 12

Step	Action	Value(s)	Yes	No
6	1. Connect a 3-amp fused jumper between the signal circuit 324 (YL) of the fuel temperature sensor and the low reference circuit 252 (BR). 2. Observe the fuel temperature sensor with the scan tool. Is the fuel temperature sensor parameter more than the specified value?	138°C (280°F)	Go to Step 10	Go to Step 7
7	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper between the signal circuit 324 (YL) of the fuel temperature sensor and a good ground. 3. Turn ON the ignition, with the engine OFF. 4. Observe the fuel temperature sensor parameter with a scan tool. Is the fuel temperature sensor parameter more than the specified value?	138°C (280°F)	Go to Step 9	Go to Step 8
8	Test the fuel temperature sensor signal circuit 324 (YL) for an open or high resistance between C76 pin 27 and pin B of the fuel temp sensor. Did you find and correct the condition?		Go to Step 15	Go to Step 12
9	Test the low reference circuit 252 (BR) of the fuel temperature sensor for an open or high resistance between C77 pin 48 and pin A of the fuel temp sensor. Did you find and correct the condition?		Go to Step 15	Go to Step 12
10	Test the signal circuit 324 (YL) of the fuel temperature sensor for a short to any other 5-volt reference circuit. Did you find and correct the condition?		Go to Step 15	Go to Step 11
11	Test for an intermittent and for a poor connection at the fuel temperature sensor. Did you find and correct the condition?		Go to Step 15	Go to Step 13
12	Test for an intermittent and for a poor connection at the engine control module (ECM). Did you find and correct the condition?		Go to Step 15	Go to Step 14
13	Replace the faulty fuel temperature sensor. Did you complete the replacement?		Go to Step 15	
14	Replace the faulty ECM. Did you complete the replacement?		Go to Step 15	
15	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 16
16	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0192 Fuel Rail Pressure Sensor Circuit Low Voltage (Figure OBD-35)

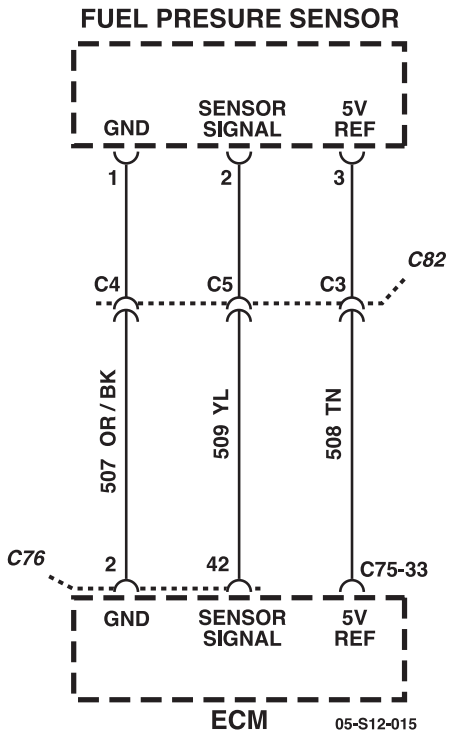


Figure OBD-35: Fuel Rail Pressure Sensor Circuit

Circuit Description

The engine control module (ECM) monitors the fuel rail pressure (FRP) via a FRP sensor. When the fuel rail pressure is high the signal voltage is high. When the FRP is low the signal voltage is low. If the FRP is not above the lower limit for the sensor, DTC P0192 will set.

Conditions for Setting the DTC

The ECM detects the signal circuit is less than 1.2 MPa for more than 1 second.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure parameter within the specified range?	1.2-1.9 MPa	Intermittent Go To Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the fuel rail pressure (FRP) sensor. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure parameter less than the specified value?	175 MPa	Go to Step 4	Go to Step 5
4	Test the signal circuit 509 (YL) of the FRP sensor for a short to ground or high resistance between C76 pin 42 and pin A of the FRP sensor. Did you find and correct the condition?		Go to Step 7	Go to Step 6
5	Replace the faulty FRP sensor. Did you complete the replacement?		Go to Step 7	
6	Replace the faulty engine control module (ECM). Did you complete the replacement?		Go to Step 7	
7	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 8
8	1. Using the Scan Tool select "Capture Info," Review Info." Are any DTC's displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0193 Fuel Rail Pressure Sensor Circuit Low Voltage (Figure OBD-36)

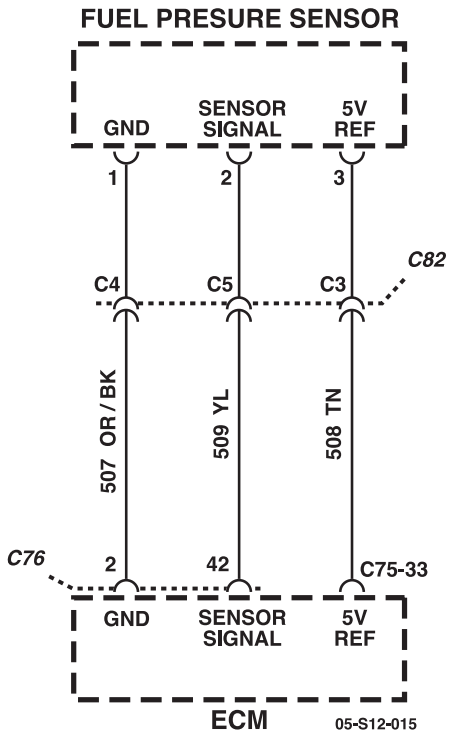


Figure OBD-36: Fuel Rail Pressure Sensor Circuit

Circuit Description

The engine control module (ECM) monitors the fuel rail pressure (FRP) via a FRP sensor. When the FRP is high, the signal voltage is high. When the FRP is low, the signal voltage is low. If the fuel rail pressure is above the upper limit for the sensor, DTC P0193 will set.

Conditions for Setting the DTC

The ECM detects the signal circuit is more than 175 MPa.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.
- The control module limits fuel injection and FRP.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	If any of the following DTCs are set, go to that DTC first. P0642 P0643 Are any of these DTCs set?		Go to the Diagnostic for each Trouble Code in numerical order	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze/Frame Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go To Diagnostic Aids
4	1. Turn ON the ignition, with the engine OFF. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure within the specified range?	1-1.8 MPa	Go to Step 6	Go to Step 5
5	1. Disconnect the fuel rail pressure (FRP) sensor connector. 2. Probe the FRP 5-volt reference circuit 508 (TN) with a DVOM connected to a good ground. Does the voltage measure near the specified value?	5 Volts	Go to Step 7	Go to Step 6
6	1. Test the 5-volt reference circuit 508 (TN) of the FRP sensor for high resistance or an open between C75 pin 23 and pin C of the FRP sensor connector. 2. Repair as necessary. Did you find and correct the condition?		Go to Step 17	Go to Step 14
7	1. Verify that the ignition is ON, with the engine OFF. 2. Verify the FRP sensor harness connector is still disconnected. 3. Measure the voltage between the FRP sensor signal circuit 509 (YL) and a the low reference circuit 507 (OR/BK) PIN B at the FRP harness connector. Is the current more than the specified value?	5 Volts	Go to Step 10	Go to Step 8
8	1. Turn OFF the ignition. 2. Disconnect the negative battery cables. 3. Measure the resistance from the low reference circuit 507 (OR/BK) of the FRP sensor to a good ground. Is the resistance less than the specified value?	5 ohms	Go to Step 9	Go to Step 12

Step	Action	Value(s)	Yes	No
9	1. Turn OFF the ignition. 2. Connect a 3-amp fused jumper wire between the signal circuit 509 (YL) of the FRP sensor and the low reference circuit 507 (OR/BK) of the FRP sensor. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Actual FRP parameter with a scan tool. Is the Actual FRP parameter at the specified value?	0 MPa	Go to Step 13	Go to Step 11
10	Test for a short to voltage in the FRP sensor signal circuit 509 (YL). Did you find and correct the condition?		Go to Step 17	Go to Step 16
11	Test the signal circuit 509 (YL) of the FRP sensor for a high resistance or an open between C76 pin 42 and pin A of the FRP sensor connector. Did you Find and correct the condition?		Go to Step 17	Go to Step 14
12	1. Disconnect the engine control module (ECM). 2. Test the low reference circuit 507 (OR/BK) of the FRP sensor for a high resistance or an open between C75 pin 2 and pin B of the FRP sensor connector. Did you find and correct the condition?		Go to Step 17	Go to Step 14
13	Test for an intermittent and for a poor connection at the FRP sensor. Did you find and correct the condition?		Go to Step 17	Go to Step 15
14	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 17	Go to Step 16
15	Replace the faulty FRP sensor. Did you complete the replacement?		Go to Step 17	
16	Replace the faulty engine control module (ECM). Did you complete the replacement?		Go to Step 17	
17	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 18
18	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0201-P0208 Injector Control Circuit (Figure OBD-37)

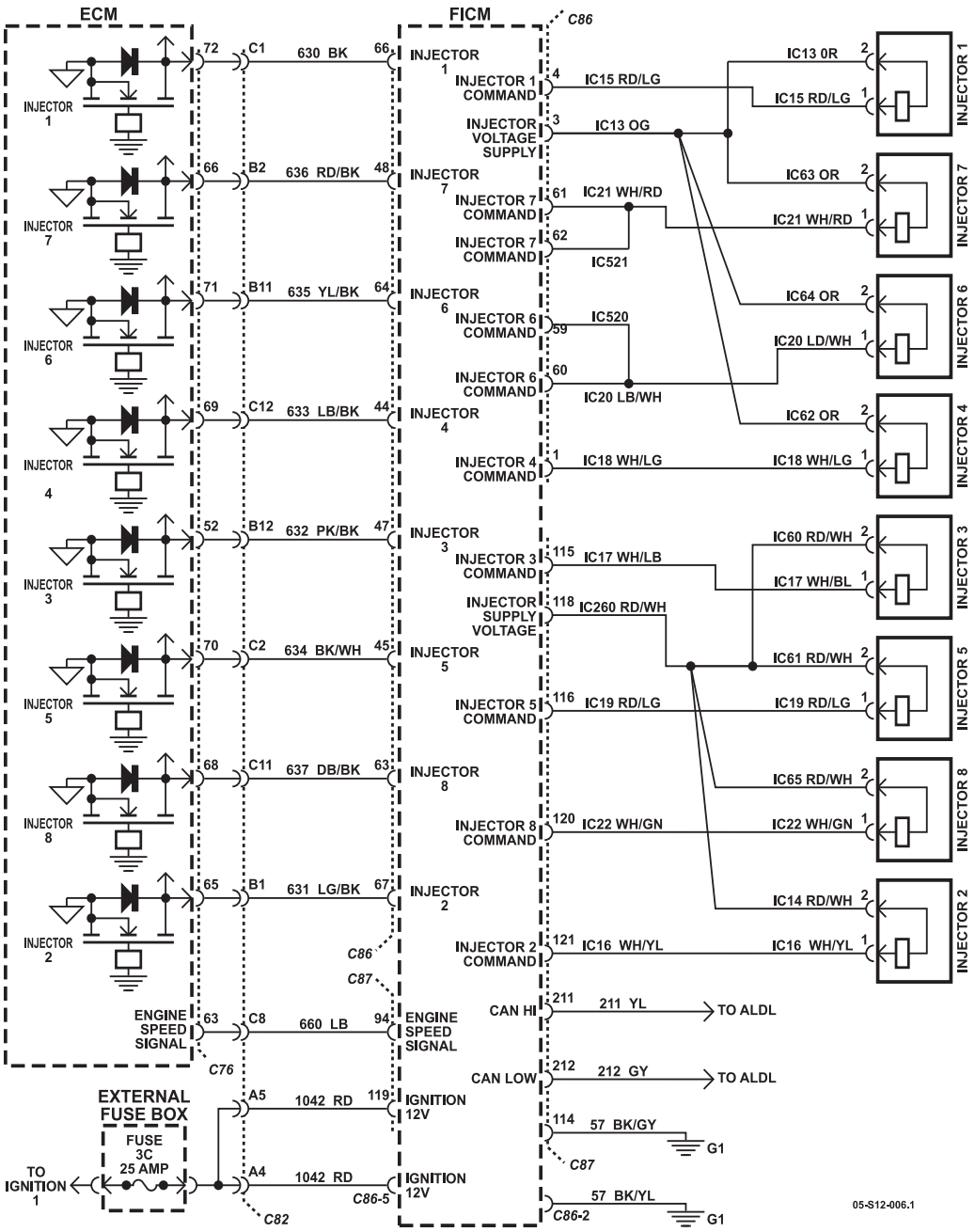


Figure OBD-37: Injector Control Circuit

Circuit Description

The fuel injection control module (FICM) supplies high voltage to each fuel injector on the injector supply voltage circuits. The FICM enables each fuel injector by grounding the command circuit between the FICM and the fuel injector. The FICM monitors the status of the injector supply voltage circuits and the fuel injector command circuits. When a fuel injector circuit condition is detected by the FICM, all of the fuel injectors on the affected injector supply voltage circuit will be disabled. If a circuit condition is detected on a fuel injector circuit for cylinders 1, 4, 6, or 7, DTCs P0201, P0204, P0206, P0207 will set, along with DTC P2146. If a circuit condition is detected on a fuel injector circuit for cylinders 2, 3, 5, or 8, DTCs P0202, P0203, P0205, P0208 will set, along with DTC P2149.

Conditions for Setting the DTC

- The FICM detects an incorrect current on a fuel injector circuit.
- The condition exists for less than 1 second.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.
- The control module disables the set of fuel injectors that have a concern.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Observe the DTC information with a scan tool. Are any of DTCs P0201, P0204, P0206, P0207, P0202, P0203, P0205, or P0208 set?		Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. Turn OFF the ignition for 30 seconds. 2. Start the engine.Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intermittent Go To Diagnostic Aids
4	Is DTC P2146 also set?		Go to Step 13	Go to Step 5

Step	Action	Value(s)	Yes	No
5	***WARNING: This System Uses High Voltage*** **NOTE:** Failure to identify the correct cylinder will result in misdiagnosis. Use the J 35616-94 adapters to probe the fuel injection control module (FICM) connector. 1. Turn OFF the ignition. 2. Disconnect the FICM. 3. Measure the resistance between the injector supply voltage circuit for cylinders 2, 3, 5, and 8 and a known good ground with a DVOM. Does the DVOM display OL?		Go to Step 7	Go to Step 6
6	Disconnect cylinders 2, 3, 5, and 8 harness connectors for each of the fuel injectors one at a time, while monitoring the DVOM. Does the DVOM display OL when any of the fuel injector harness connectors are disconnected?		Go to Step 21	Go to Step 30
7	**NOTE:** • The DVOM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis. Use the DVOM to perform this test. Refer to the DVOM User Manual for calibration procedure. • The temperature of the engine and injectors should be the same as when the DTC set. • Use the J 35616-94 adapters to probe the FICM connector. Measure the resistance between the injector supply voltage circuit and the injector command circuits for cylinders 2, 3, 5, and 8 with a DVOM. Does the DVOM display OL for all of the circuits?		Go to Step 31	Go to Step 8
8	Does the DVOM display OL for any of the circuits?		Go to Step 22	Go to Step 9
9	Does the DVOM display a resistance above the specified value for any fuel injector circuit?	0.8 ohms	Go to Step 24	Go to Step 10
10	Does the DVOM display a resistance below the specified value for any fuel injector circuit?	0.3 ohms	Go to Step 25	Go to Step 11
11	**NOTE:** Use the J 35616-94 adapters to probe the FICM connector. 1. Turn ON the ignition, with the engine OFF.Probe the injector supply voltage circuit for cylinders 2, 3, 5 and 8, with a DVOM connected to ground. Does the DVOM display battery voltage?		Go to Step 12	Go to Step 33
12	Disconnect cylinders 2, 3, 5, and 8 harness connectors for each of the fuel injectors one at a time, while monitoring the DVOM. Does the DVOM display the specified voltage when any of the fuel injector harness connectors are disconnected?	0 Volts	Go to Step 28	Go to Step 27

Step	Action	Value(s)	Yes	No
13	***WARNING: Refer to High Voltage Caution in Cautions and Notices.*** **NOTE:** • Use the J 35616-94 adapters to probe the FICM connector. • Failure to identify the correct cylinder will result in misdiagnosis. 1. Turn OFF the ignition. 2. Disconnect the FICM. 3. Measure the resistance between the injector supply voltage circuit for cylinders 1, 4, 6, and 7 and a known good ground with a DVOM. Does the DVOM display OL?		Go to Step 15	Go to Step 14
14	Disconnect cylinders 1, 4, 6, and 7 harness connectors for each of the fuel injectors one at a time, while monitoring the DVOM. Does the DVOM indicate OL when any of the fuel injector harness connectors are disconnected?		Go to Step 21	Go to Step 30
15	**NOTE:** • Use the J 35616-94 adapters to probe the FICM connector. • The DVOM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis. Refer to the DVOM User Manual for calibration procedure. • The temperature of the engine and injectors should be the same as when the DTC set. Measure the resistance between the injector supply voltage circuit and the injector command circuits for cylinders 1, 4, 6 and 7 with a DVOM. Does the DVOM display OL for all of the circuits?		Go to Step 31	Go to Step 16
16	Does the DVOM display OL for any of the circuits?		Go to Step 22	Go to Step 17
17	Does the DVOM display a resistance above the specified value for any fuel injector circuit?	0.8 ohms	Go to Step 24	Go to Step 18
18	Does the DVOM display a resistance below the specified value for any fuel injector circuit?	0.3 ohms	Go to Step 25	Go to Step 19
19	**NOTE:** Use the J 35616-94 adapters to probe the FICM connector. 1. Turn ON the ignition, with the engine OFF. 2. Probe the injector supply voltage circuit for cylinders 1, 4, 6 and 7, with a DVOM connected to ground. Does the DVOM display battery voltage?		Go to Step 20	Go to Step 33

Step	Action	Value(s)	Yes	No
20	Disconnect cylinders 1, 4, 6, and 7 harness connectors for each of the fuel injectors one at a time, while monitoring the DVOM. Does the DVOM display the specified voltage when any of the fuel injector harness connectors are disconnected?	0 Volts	Go to Step 28	Go to Step 27
21	Measure the resistance from the fuel injector command circuit to ground at the FICM connector for the cylinder that caused the DVOM to display OL. Does the DVOM display continuity?		Go to Step 29	Go to Step 26
22	1. Disconnect the connector of the fuel injector that displayed OL. 2. Test the command circuit of the fuel injector between the FICM and the injector connector, for the following conditions: • An open circuit • A poor connection Did you find and correct the condition?		Go to Step 35	Go to Step 23
23	Test the injector voltage circuit of the fuel injector, between the injector connector and the splice, for the following conditions: • An open circuit • A poor connection Did you find and correct the condition?		Go to Step 35	Go to Step 26
24	1. Disconnect the injector connector for the circuit with high resistance. 2. Test for the following conditions: • Excessive resistance in the fuel injector circuits between the FICM and the injector connector • Poor connections at the injector connector of the fuel injector Did you find and correct the condition?		Go to Step 35	Go to Step 25
25	Test for a short between the injector supply voltage circuit and the fuel injector command circuit. Did you find and correct the condition?		Go to Step 35	Go to Step 26
26	Test for an intermittent and for a poor connection at the harness connector of the fuel injector. Did you find and correct the condition?		Go to Step 35	Go to Step 32
27	Repair the short to voltage in the injector supply voltage circuit. Did you complete the repair?		Go to Step 35	
28	Repair the short to voltage in the fuel injector command circuit that changed to 0 volts on the DVOM. Did you complete the repair?		Go to Step 35	
29	Repair the short to ground in the fuel injector command circuit. Did you complete the repair?		Go to Step 35	

Step	Action	Value(s)	Yes	No
30	Repair the short to ground in the injector supply voltage circuit. Did you complete the repair?		Go to Step 35	
31	Repair the open in the injector supply voltage circuit. Did you complete the repair?		Go to Step 35	
32	Replace the appropriate faulty fuel injector. Did you complete the replacement?		Go to Step 35	
33	Test for an intermittent and for a poor connection at the harness connector of the FICM. Did you find and correct the condition?		Go to Step 35	
34	Replace the faulty FICM. Did you complete the replacement?		Go to Step 35	
35	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 18
36	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0218 Transmission Fluid Over Temperature

Circuit Description

The flow of transmission fluid starts in the transmission pan. The fluid is then drawn through the filter and transmission case and into the oil pump assembly. The oil pump pressurizes the fluid into main pressure that is regulated at the main pressure regulator valve. From this point, fluid is directed to the torque converter clutch pulse width modulated (TCC PWM) solenoid and to the control main regulator and control main relief valve, into the control main filter assembly, and on to all solenoids for use as control pressure. Hot fluid leaving the torque converter is routed through the converter flow valve to cooler lines and into the cooler assembly. The transmission oil cooler is located in the radiator. The vehicle may be equipped with auxiliary oil cooler. The cooled fluid is returned to the transmission through the return cooler line and to the transmission lube circuit. The automatic transmission fluid temperature (TFT) sensor, which is part of pressure switch manifold (PSM) assembly, is located in the oil pan. If the transmission control module (TCM) detects a high TFT for an extended period of time, then DTC P0218 sets.

DTC P0218 is a type C DTC.

Conditions for Setting the DTC

DTC P0218 sets when the TCM detects a transmission sump temperature greater than 126°C (252°F) for 10 seconds.

Action Taken When the DTC Sets

- The TCM does not illuminate the malfunction indicator lamp (MIL).
- The TCM freezes shift adapts from being updated.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as Failure Records.
- The TCM stores DTC P0218 in TCM history.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

- A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.
- The TCM cancels the DTC default actions when the condition no longer exists and the DTC passes the test.

Diagnostic Aids

- Verify the driving habits of the customer, such as trailer towing, etc.
- The scan tool TFT should rise steadily during warm-up cycles, then stabilize.
- DTC P0218 may set after DTC P0711 has set. Follow the diagnostic table for DTC P0711 before proceeding to the diagnostic for DTC P0218.
- Repairing the condition that set DTC P0711 will likely eliminate DTC P0218.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Perform the Transmission Fluid Checking Procedure. Refer to Transmission Fluid Checking Procedure . Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	1. Inspect the engine cooling system for the following conditions: • Air flow restrictions • Air flow blockage • System fluid level and condition • Debris 2. Inspect the transmission cooling system for the following conditions: • Air flow restrictions • Air flow blockage • System fluid level and conditions • Debris • Damaged cooler lines or hoses Did you find and correct the condition?		Go to Step 6	Go to Step 4
4	Perform the Line Pressure Check Procedure. Is the line pressure correct?		Go to Step 6	Go to Step 5
5	Inspect the torque converter stator for damage. Did you find and correct the condition?		Go to Step 6	Go to Symptoms - Automatic Transmission
6	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the TFT. 3. Start the engine. 4. The TFT must be less than 122°C (252°F) for at least 10 seconds. 5. Select Specific DTC. 6. Enter DTC P0218. Has the test run and passed?		System OK	Go to Step 1

DTC P0234 Turbo Charger Engine Overboost (Figure OBD-38)

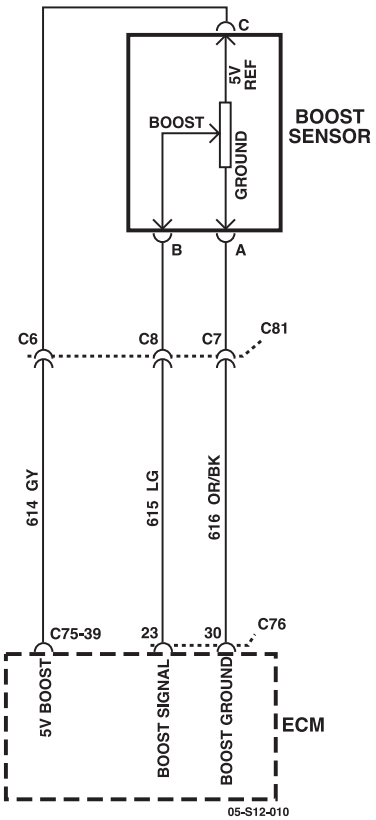


Figure OBD-38: Turbocharger Boost Sensor Circuit

Circuit Description

The boost pressure sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by turbocharger output, engine speed, accelerator pedal input, air temperature, and barometric pressure (BARO). A diaphragm within the boost pressure sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The boost pressure sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The boost pressure sensor provides a signal voltage to the ECM, relative to pressure, on the boost pressure sensor signal circuit. The ECM converts the signal voltage input to a pressure value. Under normal operation the lowest pressure that can exist in the intake manifold is equal to the BARO. This occurs when the vehicle is operated at idle or when the ignition is on while the engine is off. Under these conditions, the ECM uses the boost pressure sensor to aid in diagnosis of the BARO sensor. The highest manifold pressures occur when the turbocharger output is high. Manifold pressure can range from 58 kPa (8 psi) when pressures are low to more than 240 kPa (34 psi) when pressures are high, depending on the BARO. The boost pressure sensor has a range of 33 kPa (4 psi) to 255 kPa (36 psi). The ECM also uses the boost pressure sensor to provide engine overboost protection. The ECM calculates a predicted value for the boost pressure sensor. The ECM then compares the predicted value to the sensor input. If the ECM detects that the boost pressure sensor input is above the predicted range, this DTC will set.

Conditions for Setting the DTC

The measured boost pressure is above the expected range by 35 kPa or more for 12 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- Any changes to the induction system or exhaust system, such as the installation of aftermarket parts, may cause this DTC to set.
- If the condition is intermittent, refer to Intermittent Conditions.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	If any of the following DTCs are set, go to that DTC first. P0045 P0046 P2563 P2564 P2565 Are any of these DTCs set?		Go to the Diagnostic for each Trouble Code in numerical order	Go to Step 3
3	1. Install a scan tool. 2. Start the engine. 3. Monitor the DTC Information with the scan tool. Does the scan tool indicate that DTC P2229 is current?		Go to DTC P2229	Go to Step 4
4	1. Allow the engine to reach operating temperature. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. Does the scan tool indicate that the difference between the boost sensor pressure and the barometric pressure (BARO) sensor pressure is more than the specified value?	10 kPa	Go to Step 5	Go to Step 7

Step	Action	Value(s)	Yes	No
5	1. Turn OFF the ignition. 2. Disconnect the boost sensor harness connector. 3. Connect a jumper wire between each of the terminals in the boost sensor harness connector and the corresponding terminal at the boost sensor. 4. Turn ON the ignition, with the engine OFF. 5. Measure the voltage from the low reference circuit 616 OR/BK of the boost sensor at the jumper wire terminal to a good ground with a DVOM. Is the voltage more than the specified value?	0.2 Volts	Go to Step 6	Go to Step 8
6	Test the boost sensor low reference circuit 616 OR/BK for an open and for high resistance between C76 pin 30 and pin A of the boost sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 9
7	Remove and inspect the turbocharger for wear or damage. Did you find a condition with the turbocharger?		Go to Step 10	Go to Diagnostic Aids
8	Test for an intermittent and for a poor connection at the boost sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 11
9	Test for an intermittent and for poor connection at the engine control module (ECM). Did you find and correct the condition?		Go to Step 13	Go to Step 12
10	Replace the faulty turbocharger. Did you complete the replacement?		Go to Step 13	
11	Replace the faulty boost sensor. Did you complete the replacement?		Go to Step 13	
12	Replace the faulty ECM. Did you complete the replacement?		Go to Step 13	
13	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 14
14	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0237 Turbocharger Boost Sensor Circuit Low Voltage (Figure OBD-39)

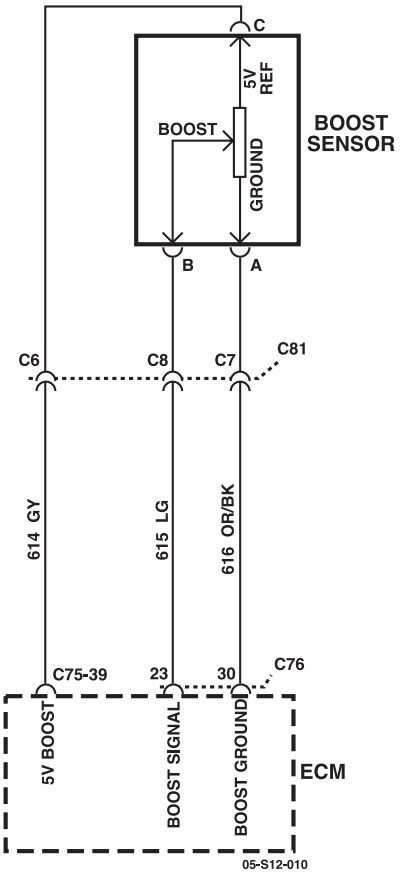


Figure OBD-39: Turbocharger Boost Sensor Circuit

Circuit Description

The boost pressure sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by turbocharger output, engine speed, accelerator pedal input, air temperature, and barometric pressure (BARO). A diaphragm within the boost pressure sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The boost pressure sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The boost pressure sensor provides a signal voltage to the ECM, relative to the pressure changes, on the boost pressure sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation, the lowest pressure that can exist in the intake manifold is equal to the BARO. This occurs when the vehicle is operating at idle or when the ignition is ON, while the engine is OFF. Under these conditions, the ECM uses the boost pressure sensor to aid in diagnosis of the BARO sensor. The highest manifold pressures occur when the turbocharger output is high. Manifold pressure can range from 58 kPa (8 psi) when pressure are low, to more than 240 kPa (34 psi) when pressures are high, depending on the BARO. The boost pressure sensor has a range of 33-255 kPa (4-36 psi). The ECM also uses the boost pressure sensor to provide engine overboost protection. The ECM monitors the boost pressure sensor signal for pressure outside of the normal range. If the ECM detects a boost pressure sensor signal pressure that is excessively low, DTC P0237 sets.

Conditions for Setting the DTC

The boost pressure is less than 37 kPa (5 psi) for 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.
- The ECM limits fuel delivery.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Start the engine. 2. Monitor the DTC Information with the scan tool. Does the scan tool indicate that DTC P0652 is also set		Go to DTC P0652	Go to Step 3
3	Observe the boost pressure sensor parameter with a scan tool. Is the pressure less than the specified value?	37 kPa (5 psi)	Go to Step 5	Go to Step 4
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 5	Intermittent Go To Diagnostic Aids
5	1.Turn OFF the ignition. 2.Disconnect the boost pressure sensor electrical connector. 3.Turn ON the ignition, with the engine OFF. 4.Measure the voltage from the 5-volt reference circuit 614 (GY) pin C of the boost pressure sensor to a good ground with a DVOM. Is the voltage more than the specified value?	4.8 V	Go to Step 6	Go to Step 7

Step	Action	Value(s)	Yes	No
6	Connect a 3-amp fused jumper wire between the 5-volt reference circuit 614 (GY) C75 pin 39 and the signal circuit of the boost pressure sensor pin C. Does the scan tool indicate that the pressure is more than the specified value?	254 kPa (36 psi)	Go to Step 9	Go to Step 8
7	Test the 5-volt reference circuit 614 (GY) of the boost pressure sensor for an open between C75 pin 39 and pin C of the boost sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 10
8	Test the signal circuit 615 (LG) of the boost pressure sensor for a short to ground or an open between C76 pin 23 and pin B of the boost sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 10
9	Inspect for poor connections at the boost pressure sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 11
10	Inspect for poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 13	Go to Step 12
11	Replace the faulty boost pressure sensor. Did you complete the replacement?		Go to Step 13	
12	Replace the faulty ECM. Did you complete the replacement?		Go to Step 13	
13	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 14
14	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0238 Turbo Charger Boost Sensor Circuit High Voltage (Figure OBD-40)

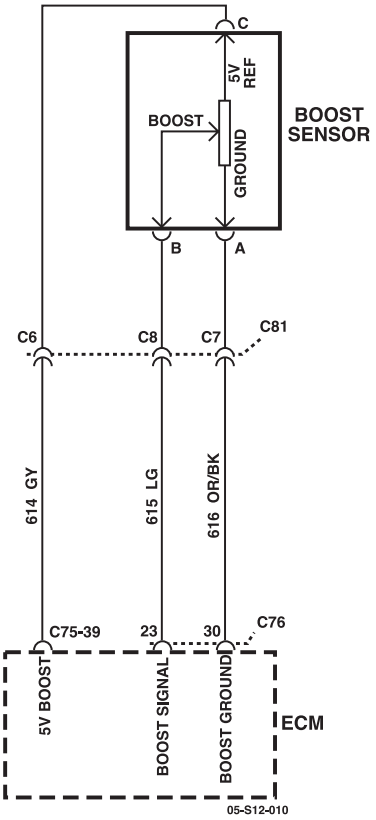


Figure OBD-40: Turbocharger Boost Sensor Circuit

Circuit Description

The boost pressure sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by turbocharger output, engine speed, accelerator pedal input, air temperature, and barometric pressure (BARO). A diaphragm within the boost pressure sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The boost pressure sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The boost pressure sensor provides a signal voltage to the ECM, relative to the pressure changes, on the boost pressure sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Under normal operation the lowest pressure that can exist in the intake manifold is equal to the BARO. This occurs when the vehicle is operated at idle or when the ignition is ON while the engine is OFF. Under these conditions, the ECM uses the boost pressure sensor to aid in the diagnosis of the BARO sensor. The highest manifold pressure occur when the turbo charger output is high. Manifold pressure can range from 58 kPa (8 psi) when pressure are low, to more than 240 kPa (34 psi) when pressure are high, depending on the BARO. The boost pressure sensor has a range of 33-255 kPa (4-36 psi). The ECM also uses the boost pressure sensor to provide engine overboost protection.

The ECM monitors the boost pressure sensor signal for pressure outside of the normal range. If the ECM detects a boost pressure that is excessively high, DTC P0238 sets.

Conditions for Setting the DTC

The ECM detects that the boost pressure is more than 254 kPa (36 psi) for 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Observe the boost pressure sensor parameter with a scan tool. Is the pressure less than the specified value?	254 kPa (36 psi)	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Intemittent Go To Diagnostic Aids
4	Monitor the Diagnostic Trouble Code (DTC) Information with a scan tool. Does the scan tool indicate that DTC P0653 is also set?		Go to Step 7	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the electrical connector of the boost pressure. 3. Turn ON the ignition, with the engine OFF. Does the scan tool indicate that the Boost Pressure Sensor parameter is less than the specified value?	36 kPa (5 psi)	Go to Step 6	Go to Step 8

Step	Action	Value(s)	Yes	No
6	1.Remove the boost pressure sensor. 2.Connect a jumper wire between each of the terminals in the boost pressure sensor harness connector and the corresponding terminal at the boost pressure sensor. 3.Measure the voltage from the low reference circuit 616 (OR/BK) of the boost pressure sensor at the jumper wire terminal to a good ground with a DVOM. Is the voltage more than the specified value?	0.2 Volts	Go to Step 9	Go to Step 10
7	1.Turn OFF the ignition. 2.Disconnect the electrical connector of the boost pressure sensor. 3.Turn ON the ignition, with the engine OFF. Does the scan tool indicate that the Boost Pressure Sensor parameter is less than the specified value?	36 kPa (5 psi)	Go to DTC P0653	Go to Step 8
8	Test the signal circuit 615 (LG) of the boost pressure sensor for a short to voltage. Did you find and correct the condition?		Go to Step 14	Go to Step 13
9	Test the low reference circuit 616 (OR/BK) of the boost pressure sensor for high resistance or an open between C76 pin 30 and pin A of the boost sensor. Did you find and correct the condition?		Go to Step 14	Go to Step 11
10	Inspect for poor connections at the boost pressure sensor. Did you find and correct the condition?		Go to Step 14	Go to Step 12
11	Inspect for poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 14	Go to Step 13
12	Replace the faulty boost pressure sensor. Did you complete the replacement?		Go to Step 14	
13	Replace the faulty ECM. Did you complete the replacement?		Go to Step 14	
14	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 15
15	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0299 Turbocharger Engine Underboost (Figure OBD-41)

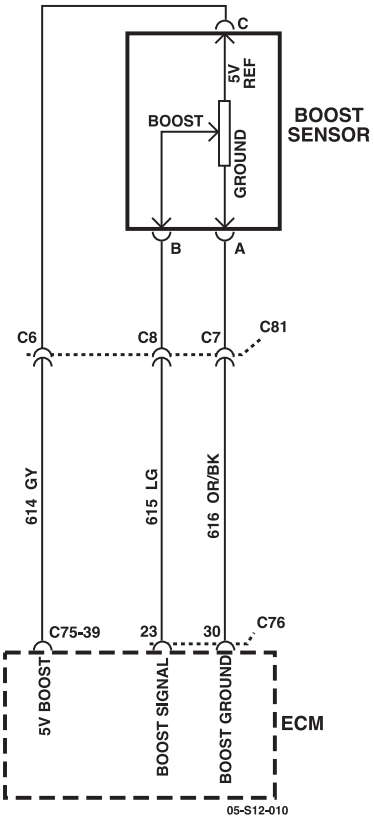


Figure OBD-41: Turbocharger Boost Sensor Circuit

Circuit Description

The boost pressure sensor measures the pressure inside the intake manifold. Pressure in the intake manifold is affected by turbocharger output, engine speed, accelerator pedal input, air temperature, and barometric pressure (BARO). A diaphragm within the boost pressure sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The sensor translates this action into electrical resistance. The boost pressure sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The boost pressure sensor provides a signal voltage to the ECM, relative to pressure, on the boost pressure sensor signal circuit. The ECM converts the signal voltage input to a pressure value. Under normal operation the lowest pressure that can exist in the intake manifold is equal to the BARO. This occurs when the vehicle is operated at idle, or when the ignition is ON while the engine is OFF. Under these conditions, the ECM uses the boost pressure sensor to aid in diagnosis of the BARO sensor. The highest manifold pressures occur when the turbocharger output is high. Manifold pressure can range from 58 kPa (8 psi) when pressures are low to more than 240 kPa (34 psi) when pressures are high, depending on the BARO. The boost pressure sensor has a range of 33 kPa (4 psi) to 255 kPa (36 psi). The ECM also uses the boost pressure sensor to provide engine overboost protection. The ECM calculates a predicted value for the boost pressure sensor. The ECM then compares the predicted value to the sensor input. If the ECM detects that the boost pressure sensor input is below the predicted range, this DTC will set.

Conditions for Setting the DTC

- The ECM detects that the boost pressure input is 35 kPa below the calibrated value.
- To obtain the desired boost, the ECM must command the turbocharger vanes closed further than expected.
- One of the above conditions exist for more than 12 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	If any of the following DTCs are set, go to that DTC first. P0045 P0046 P0652 P2563 P2564 P2565 Are any of these DTCs set?		Go to the Diagnostic for each Trouble Code in numerical order	Go to Step 3
3	Observe the Boost Pressure Sensor parameter and the BARO parameter with a scan tool. Is the difference between the values more than the specified value?	3 kPa	Go to Step 12	Go to Step 4
4	1. Turn OFF the ignition. 2. Remove the boost sensor from the intake manifold. 3. Inspect for the following conditions: • A plugged sensor port • A damaged or leaking seal Did you find and correct the condition?		Go to Step 23	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Connect the electrical connector to the boost sensor. 2. Connect a J 23738-A vacuum pump to the sensor port. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Boost Pressure Sensor parameter with a scan tool. 5. Slowly apply vacuum with the J 23738-A to the sensor until 10 inches Hg is reached. Does the Boost Pressure Sensor parameter decrease?		Go to Step 6	Go to Step 19
6	1. Observe the Boost Pressure Sensor parameter with a scan tool. 2. Remove the vacuum from the sensor port. Does the Boost Pressure Sensor parameter return to the value observed in Step 3?		Go to Step 7	Go to Step 19
7	Inspect the following components: • Inspect the air cleaner element for the following conditions: • Excessive dirt • Debris • Water saturation • Inspect the air intake duct for a leak or restriction. Did you find and correct the condition?		Go to Step 23	Go to Step 8
8	Test the charge air cooler and connecting pipes and hoses for air leaks using the J 46091 Charge Air Cooler Tester. Did you find and correct the condition?		Go to Step 23	Go to Step 9
9	Inspect the exhaust system for the following conditions: • Leaks between the exhaust manifolds and the turbocharger • Restrictions • Aftermarket parts Did you find and correct the condition?		Go to Step 23	Go to Step 10
10	Remove and inspect the turbocharger for wear or damage. Did you find a condition with the turbocharger?		Go to Step 22	Go to Step 11
11	1. Test for the following conditions: • Charge air leaks between the following components: • Air inlet tube • Intake manifold tube • Center intake manifold • Left and right intake manifolds • Left and right cylinder heads • Head gasket failure--Refer to Engine Compression Test. • Worn piston rings--Refer to Engine Compression Test. 2. Repair as necessary. Did you find and correct the condition?		Go to Step 23	Intermittent Go To Diagnostic Aids

Step	Action	Value(s)	Yes	No
12	Test for an intermittent and for a poor connection at the boost pressure sensor connector. Did you find and correct the condition?		Go to Step 23	Go to Step 13
13	1. Disconnect the boost pressure sensor. 2. Measure the amperage between the 5-volt reference circuit 614 (GY) and the low reference circuit 616 (OR/BK), at the boost pressure sensor connector, with a DVOM. Is the amperage more than the specified value?	220 mA	Go to Step 14	Go to Step 15
14	1. Connect a jumper wire between the 5-volt reference circuit 614 (GY) pin C and the signal circuit 615 pin B of the boost pressure sensor at the connector. 2. Observe the Boost Pressure Sensor parameter with the scan tool. Is the pressure more than the specified value?	254 kPa (36 psi)	Go to Step 20	Go to Step 17
15	1. Disconnect the engine control module (ECM). 2. Measure the resistance of the 5-volt reference circuit 614 (GY) between the boost pressure sensor pin C and C75 pin 39 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 19	Go to Step 16
16	Measure the resistance of the low reference circuit 616 (OR/BK) between the boost pressure sensor pin A and C76 pin 30 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 19	Go to Step 21
17	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 23	Go to Step 18
18	1. Disconnect the ECM. 2. Measure the resistance of the boost pressure sensor signal circuit 615 (LG) between the boost pressure sensor pin B and C76 pin 23 of the ECM with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 19	Go to Step 21
19	Repair the high resistance in the circuit. Did you complete the repair?		Go to Step 23	
20	Replace the faulty boost pressure sensor. Did you complete the replacement?		Go to Step 23	
21	Replace the faulty ECM. Did you complete the replacement?		Go to Step 23	
22	Replace the faulty turbocharger. Did you complete the replacement?		Go to Step 23	

Step	Action	Value(s)	Yes	No
23	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 15
24	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0300 Engine Misfire Detected

Circuit Description

The engine control module (ECM) adjusts the fuel delivery to each cylinder in order to minimize crankshaft speed changes. If the ECM identifies a cylinder or cylinders requiring an excessive amount of fuel in order to maintain the correct crankshaft speed, DTC P0300 will set.

Conditions for Setting the DTC

The fuel rate adjustment for more than one cylinder exceeds an acceptable value for more than 30 seconds.

Action Taken When the DTC Sets

The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.

The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Use a scan tool in order to clear the MIL and the DTC.

Diagnostic Aids

A misfire with no other DTCs will be caused by an engine mechanical or fuel injector problem.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Are any other DTCs set?		Go to the applicable DTC table.	Intermittent Go To Diagnostic Aids

DTC P0301-P0308 Cylinder Misfire Detected

Circuit Description

The engine control module (ECM) monitors changes in crankshaft speed using inputs from the crankshaft position (CKP) sensor and the fuel injection control module (FICM). The ECM adjusts the fuel delivery to each cylinder in order to minimize crankshaft speed changes. This DTC will set when the ECM identifies a cylinder or cylinders requiring an excessive amount of fuel in order to maintain the correct crankshaft speed.

Conditions for Setting the DTC

The fuel rate adjustment for a cylinder exceeds an acceptable value for more than 30 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Use a scan tool in order to clear the MIL and the DTC.

Diagnostic Aids

A misfire with no other DTCs will be caused by an engine mechanical or fuel injector problem.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Are there any other DTCs set?		Go to the applicable DTC table.	Intermittent Go To Diagnostic Aids

DTC P0335 Crankshaft Position (CKP) Sensor Circuit (Figure OBD-42)

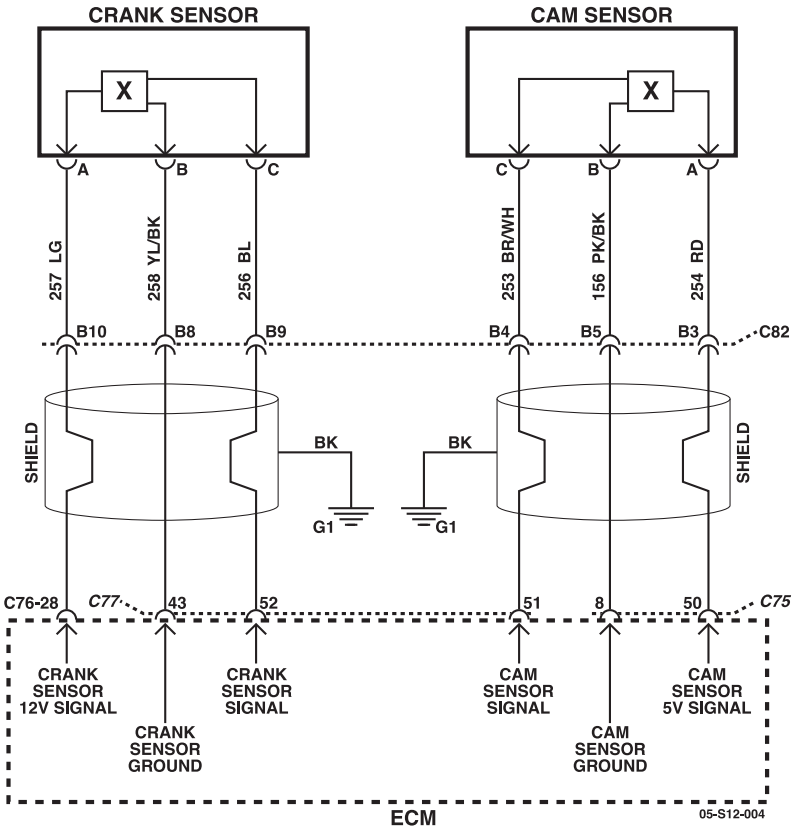


Figure OBD-42: Crankshaft Position (CKP) Sensor Circuit

Circuit Description

The hall effect crankshaft position (CKP) sensor signal indicates the crankshaft speed and position. There are 57 teeth on the front of the crankshaft sprocket, plus a sync gap. The CKP sensor will output an ON-OFF pulse as each window passes the sensing element. The CKP sensor is connected directly to the engine control module (ECM) by the following circuits:

- The 12-volt reference circuit
- The low reference circuit
- The CKP sensor signal circuit

Conditions for Setting the DTC

The ECM determines no signal from the CKP sensor for less than 8 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Attempt to start the engine. Does the engine start and run?		Intermittent Go To Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the crankshaft position (CKP) sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Connect a test lamp between the 12-volt reference circuit 257 (LG) pin A of the CKP harness connector and a good ground. Does the test lamp illuminate?	B+	Go to Step 4	Go to Step 7
4	1. Turn OFF the ignition. 2. Connect a jumper wire between each of the terminals in the CKP sensor harness connector and the corresponding terminal at the CKP sensor. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the low reference circuit 258 (YL/BK) pin B of the CKP sensor at the jumper wire terminal to a good ground with a DVOM. Is the voltage more than the specified value?	0.2 Volts	Go to Step 6	Go to Step 5
5	1. Turn OFF the ignition. 2. Remove the jumper wires from the CKP sensor harness connector. 3. Turn ON the ignition, with the engine OFF. 4. Observe the crank signal present parameter with a scan tool. 5. With a fused jumper wire connected to the signal circuit 256 (BL) pin C of the CKP sensor harness connector, momentarily and repeatedly probe B+. Does the crank signal present parameter change when the jumper wire contacts B+ repeatedly?		Go to Step 9	Go to Step 8
6	Test the low reference circuit 258 (YL/BK) for an open or high resistance between C77 pin 43 and pin B of the CKP sensor connector. Did you find and correct the condition?		Go to Step 16	Go to Step 11

Step	Action	Value(s)	Yes	No
7	Test the 12-volt reference circuit 257 (LG) for an open, high resistance or a short to ground between C76 28 and pin A of the CKP. Did you find and correct the condition?		Go to Step 16	Go to Step 11
8	Test the CKP signal circuit 256 (BL) for an open, short to ground or a short to voltage between C77 pin 52 and pin C of the CKP sensor connector. Did you find and correct the condition?		Go to Step 16	Go to Step 14
9	Test the CKP signal circuit 256 (BL) for high resistance between C77 pin 52 and pin C of the CKP sensor connector. Did you find and correct the condition?		Go to Step 16	Go to Step 10
10	Inspect for poor connections at the CKP sensor. Did you find and correct the condition?		Go to Step 16	Go to Step 12
11	Inspect for a poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 16	Go to Step 14
12	1. Remove the CKP sensor. 2. Visually inspect the CKP sensor for the following conditions: • Physical damage • Loose or improper installation • Wiring routed too closely to secondary ignition components 3. The following conditions may cause this DTC to set: • Electromagnetic interference in the CKP sensor circuits • Foreign material passing between the CKP sensor and the reluctor wheel • Insufficient fuel Did you find and correct the condition?		Go to Step 16	Go to Step 13
13	Inspect the CKP reluctor wheel for the following conditions: • Physical damage • Improper installation • Excessive endplay or looseness Did you find and correct the condition?		Go to Step 16	Go to Step 15
14	Replace the faulty ECM. Did you complete the replacement?		Go to Step 16	
15	Replace the faulty CKP sensor. Did you complete the replacement?		Go to Step 16	

Step	Action	Value(s)	Yes	No
16	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 17
17	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0336 Crankshaft Position (CKP) Sensor Performance (Figure OBD-43)

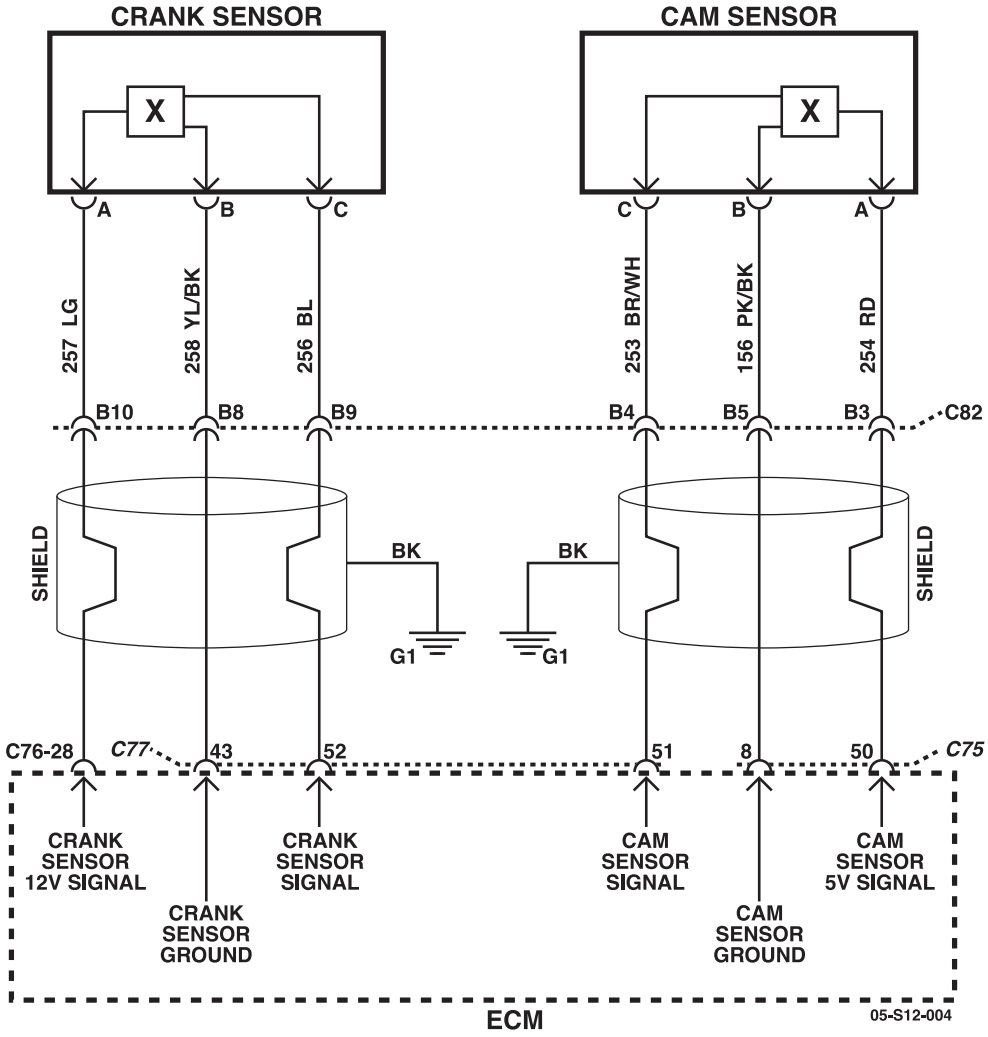


Figure OBD-43: Crankshaft Position (CKP) Sensor Circuit

Circuit Description

The hall effect crankshaft position (CKP) sensor signal indicates the crankshaft speed and position. There are 57 teeth on the front of the crankshaft sprocket, plus a sync gap. The CKP sensor will output an ON-OFF pulse as each window passes the sensing element. The CKP sensor is connected directly to the engine control module (ECM) by the following circuits:

- The 12-volt reference circuit
- The low reference circuit
- The CKP sensor signal circuit

Conditions for Setting the DTC

The ECM determines that the CKP sensor signal is out of range for less than 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

An intermittent CKP sensor signal may cause DTC P0336 to set. Wiggle the wiring harness with the engine running and observe the CKP Signal Missed parameter of the scan tool. If the parameter indicates anything other than 0, there is an intermittent condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure Records data for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	Intermittent Go To Diagnostic Aids
3	1. Inspect all of the circuits going to the crankshaft position (CKP) sensor for the following: • Routed too closely to fuel injection wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids, relays, and motors 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?		Go to Step 10	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the CKP sensor. 3. Test the CKP sensor signal circuit for high resistance. Did you find and correct the condition?		Go to Step 10	Go to Step 5
5	Test for an intermittent and for a poor connection at the CKP sensor. Did you find and correct the condition?		Go to Step 10	Go to Step 6
6	Test for an intermittent and for a poor connection of the CKP sensor circuits at the engine control module (ECM). Did you find and correct the condition?		Go to Step 10	Go to Step 7
7	1. Remove the CKP sensor. 2. Visually inspect the CKP sensor for the following conditions: • Physical damage • Loose or improper installation • Wiring routed too closely to secondary ignition components 3. The following conditions may cause this DTC to set: • Excessive air gap between the CKP sensor and the reluctor wheel • Electromagnetic interference in the CKP sensor circuits • Foreign material passing between the CKP sensor and the reluctor wheel • Insufficient fuel Did you find and correct the condition?		Go to Step 10	Go to Step 8
8	Inspect the CKP reluctor wheel for the following conditions: • Physical damage • Improper installation • Excessive endplay or looseness Did you find and correct the condition?		Go to Step 10	Go to Step 9
9	Replace the faulty CKP sensor. Did you complete the replacement?		Go to Step 10	
10	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 11
11	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0340 Camshaft Position (CMP) Sensor Circuit (Figure OBD-44)

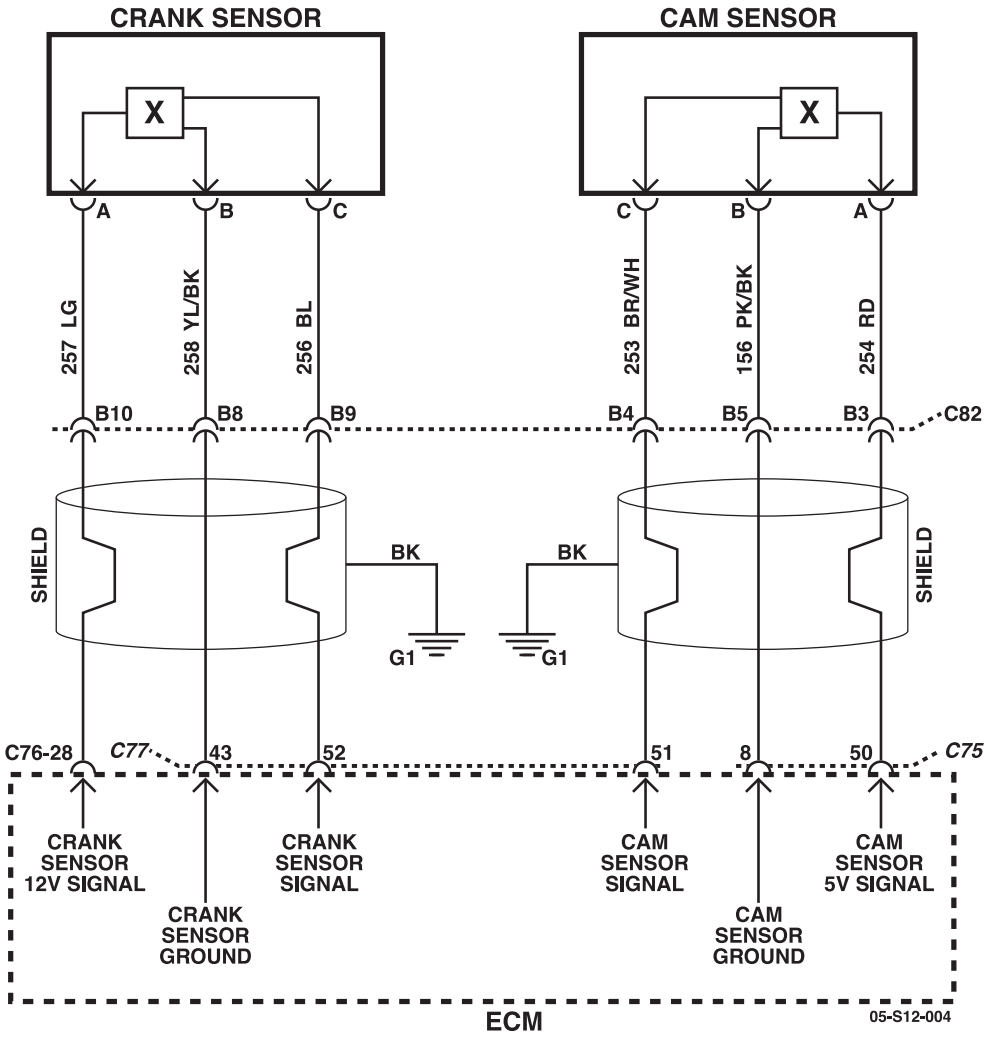


Figure OBD-44: Camshaft Position (CMP) Sensor Circuit

Circuit Description

The hall effect camshaft position (CMP) sensor produces 3 ON-OFF pulses for each revolution of the camshaft. The CMP output is pulse width encoded. The engine control module (ECM) uses the CMP and crankshaft position (CKP) output pulses to determine the engine speed and position. The CMP is connected directly to the ECM by the following circuits:

- 5-volt reference
- Low reference
- CMP sensor signal

If the ECM does not see a CMP signal for more than 2 seconds, DTC P0340 will set.

Conditions for Setting the DTC

The ECM does not see a CMP sensor signal for more than 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- An intermittent CMP sensor signal may cause DTC P0340 to set. Wiggle the wiring harness with the engine running and observe the Cam Signal Missed parameter of the scan tool. If the parameter indicates anything other than 0, there is an intermittent condition.
- If the CMP sensor signal is lost while running, the engine will operate normally. If the CMP sensor signal is not present on start-up, the engine will not start.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Attempt to start the engine. Does the engine start and run?		Intermittent Go To Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the camshaft position (CMP) sensor. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the 5-volt reference circuit 254 (RD) of the CMP sensor to a good ground with a DVOM. Does the DVOM display a reading within the specified range?	4.8-5.2 Volts	Go to Step 5	Go to Step 4
4	Does the DVOM display a reading above the specified value?	5.2 Volts	Go to Step 9	Go to Step 8
5	1. Turn OFF the ignition. 2. Disconnect the engine control module (ECM). 3. Measure the resistance of the 5-volt reference circuit 254 (RD) between C75 pin 50 and pin A of the CMP sensor with a DVOM. Is the resistance above the specified value?	5 ohms	Go to Step 10	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Connect the ECM. 2. Connect a jumper wire between each of the terminals in the CMP sensor harness connector and the corresponding terminals at the CMP sensor. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the low reference circuit 156 (PK/BK) of the CMP sensor at the jumper wire terminal to a good ground with a DVOM. is the voltage more than the specified value?	0.2 Volts	Go to Step 11	Go to Step 7
7	1. Turn OFF the ignition. 2. Remove the jumper wires from the CMP sensor. 3. Turn ON the ignition, with the engine OFF. 4. Observe the Cam Signal Present parameter with a scan tool. 5. Momentarily and repeatedly probe the signal circuit 253 (BR/WH) of the CMP sensor with a test lamp that is connected to battery voltage. Does the Cam Signal Present parameter change when the test lamp contracts the signal circuit?		Go to Step 12	Go to Step 13
8	Test the CMP sensor 5-volt reference circuit 254 (RD) for an open or a short to ground between C75 pin 50 and pin A of the cam sensor connector. Did you find and correct the condition?		Go to Step 18	Go to Step 15
9	Test the CMP sensor 5-volt reference circuit 254 (RD) for a short to voltage between C75 pin 50 and pin A of the cam sensor connector. Did you find and correct the condition?		Go to Step 18	Go to Step 15
10	Repair the high resistance in the CMP sensor 5-volt reference circuit 254 (RD). Did you complete the repair?		Go to Step 18	
11	Test the CMP sensor low reference circuit 156 (PK/BK) for an open or for high resistance between C75 pin 8 and pin B of the cam sensor connector. Did you find and correct the condition?		Go to Step 18	Go to Step 15
12	Test the CMP sensor signal circuit 253 (BR/WH) for high resistance between C77 pin 51 and pin C of the cam sensor connector. Did you find and correct the condition?		Go to Step 18	Go to Step 14
13	Test the CMP sensor signal for the following conditions: • An open • A short to ground • A short to voltage • High resistance Did you find and correct the condition?		Go to Step 18	Go to Step 15
14	Inspect for poor connections at the CMP sensor. Did you find and correct the condition?		Go to Step 18	Go to Step 16

Step	Action	Value(s)	Yes	No
15	Inspect for poor connections at the ECM. Did you find and correct the condition?		Go to Step 18	Go to Step 17
16	**NOTE:** Inspect the CMP sensor for physical damage before replacing. Replace the faulty CMP sensor. Did you complete the replacement?		Go to Step 18	
17	Replace the faulty ECM. Did you complete the replacement?		Go to Step 18	
18	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 19
19	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0341 Camshaft Position (CMP) Sensor Performance (Figure OBD-45)

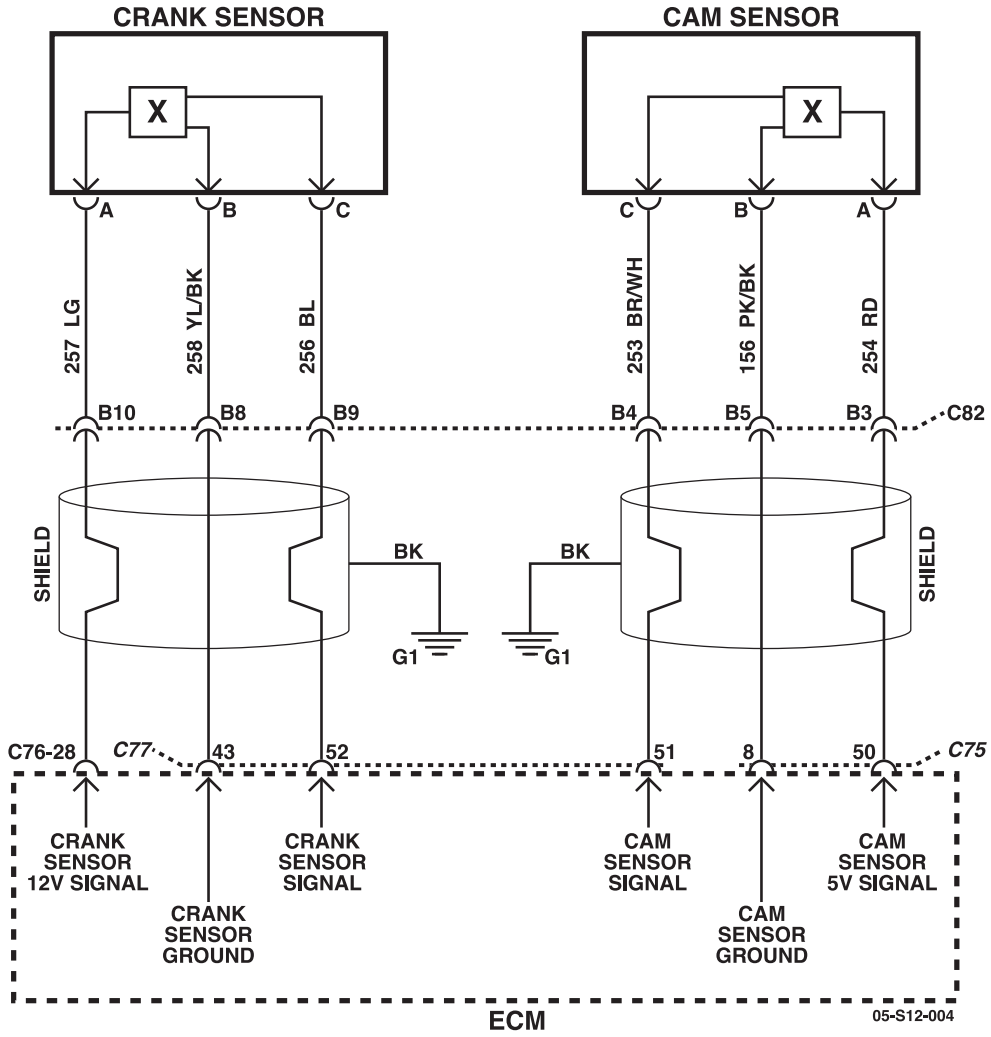


Figure OBD-45: Camshaft Position (CMP) Sensor Circuit

Circuit Description

The hall effect camshaft position (CMP) sensor produces 3 ON-OFF pulses for each revolution of the camshaft. The CMP output is pulse width encoded. The engine control module (ECM) uses the CMP and crankshaft position (CKP) output pulses to determine the engine speed and position. The CMP is connected directly to the ECM by the following circuits:

- 5-volt reference
- Low reference
- CMP sensor signal

If the ECM determines that the CMP sensor signal is out of range for less than 2 seconds, DTC P0341 will set.

Conditions for Setting the DTC

The ECM determines that the CMP sensor signal is out of range for less than 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Use a scan tool in order to clear the MIL and the DTC.

Diagnostic Aids

- An intermittent CMP sensor signal may cause DTC P0341 to set. Wiggle the wiring harness with the engine running and observe the Cam Signal Missed parameter of the scan tool. If the parameter indicates anything other than 0, there is an intermittent condition.
- If the CMP sensor signal is lost while running, the engine will operate normally. If the CMP sensor signal is not present on start-up, the engine will not start.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure Records data for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	Intermittent Go to Diagnostic Aids
3	Test the 5-volt reference circuit 254 (RD) for high resistance between C75 pin 50 and pin A of the cam sensor connector. Is the resistance above the specified value? Did you find and correct the condition?	5ohms	Go to Step 10	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Inspect all of the circuits going to the camshaft position (CMP) sensor for the following conditions: • Routed too closely to fuel injection wiring or components • Routed too closely to after-market add-on electrical equipment • Routed too closely to solenoids, relays, and motors 2. If you find incorrect routing, correct the harness routing. Did you find and correct the condition?		Go to Step 10	Go to Step 5
5	Test for an intermittent and for a poor connection at the CMP sensor. Did you find and correct the condition?		Go to Step 10	Go to Step 6
6	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 10	Go to Step 7
7	1. Remove the CMP sensor. 2. Inspect the CMP sensor for signs of damage. 3. Replace if damaged. Did you find and correct the condition?		Go to Step 10	Go to Step 8
8	1. Inspect the CMP reluctor wheel for damage. 2. If the CMP reluctor wheel is damaged. 3. Replace if damaged. Did you find and correct the condition?		Go to Step 10	Go to Step 9
9	Replace the faulty CMP sensor. Did you complete the replacement?		Go to Step 10	
10	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 11
11	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0370 & P0374 High Resolution Circuit (Figure OBD-46)

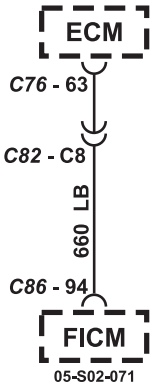


Figure OBD-46: High Resolution Circuit

Circuit Description

The engine control module (ECM) replicates the signal received from the crankshaft position (CKP) sensor. This signal is sent to the fuel injection control module (FICM) through the engine speed signal circuit. The FICM uses this replicated signal to generate injection current and control the recharge of the fuel injection high voltage circuits. When cranking, the FICM has full control of the fuel injectors. The only input the FICM uses at this time is the engine speed signal from the ECM. The FICM monitors the signal along with the injection request signals from the ECM after the engine is running. If there is a problem with this signal, a DTC could set.

Conditions for Setting the DTC

- The FICM does not receive a crank signal, but does receive injection requests from the ECM. OR
- The FICM receives an invalid crank signal from the ECM.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

A missing high resolution signal will cause a no-start condition. High resistance in the position sensor low reference circuit may cause this DTC to set. If the condition is intermittent, refer to Intermittent Conditions .

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Crank the engine. 2. Observe the Specific DTC information with the scan tool for the DTC that was set. Does the scan tool display Last Test Failed?		Go to Step 3	Intermittent Go To Diagnostic Aids
3	**NOTE:** Use the proper terminal from J 35616-B Connector Test Adapter Kit. 1. Turn OFF the ignition. 2. Disconnect the fuel injection control module (FICM) harness C76 containing the engine speed signal circuit 660 (LB). 3. Connect a DVOM between the engine speed signal circuit 660 (LB) and a good ground. 4. Measure the voltage while cranking the engine. Does the voltage measure within the specified range?	5.5-6.3 Volts	Go to Step 5	Go to Step 4
4	Does the voltage measure above the specified range?	5.5-6.3 Volts	Go to Step 6	Go to Step 7
5	Test for a short to reference voltage on the engine speed signal circuit 660 (LB) between C76 pin 63 and C86 pin 94. Did you find and correct the condition?		Go to Step 12	Go to Step 8
6	1. Test for a short to voltage in the engine speed signal circuit 660 (LB) between C76 pin 63 and C86 pin 94. 2. Repair as necessary. Did you find and correct the condition?		Go to Step 12	Go to Step 10
7	1. Test the engine speed signal circuit 660 (LB) and for an open or a short to ground between C76 pin 63 and C86 pin 94 of the FICM. 2. Repair as necessary. Did you find and correct the condition?		Go to Step 12	Go to Step 10
8	Test for a poor connection at the FICM. Did you find and correct the condition?		Go to Step 12	Go to Step 9
9	Replace the faulty FICM. Did you complete the replacement?		Go to Step 12	
10	Test for a poor connection at the engine control module (ECM). Did you find and correct the condition?		Go to Step 12	
11	Replace the faulty ECM. Did you complete the replacement?		Go to Step 12	

Step	Action	Value(s)	Yes	No
12	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
13	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0381 Wait To Start Control Circuit (Figure OBD-47)

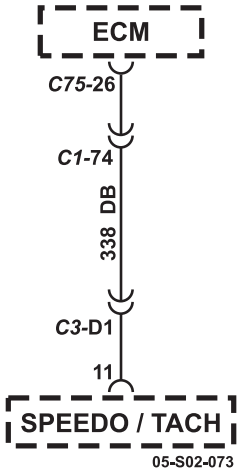


Figure OBD-47: Wait To Start Control Circuit

Circuit Description

Ignition voltage is supplied directly to the wait to start indicator. The engine control module (ECM) controls the lamp by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the component being controlled. Each driver has a fault line which is monitored by the ECM. When the ECM is commanding a component ON, the voltage of the control circuit should be low, near 0 volts. When the ECM is commanding the control circuit to a component OFF, the voltage potential of the circuit should be high, near battery voltage. If the fault detection circuit senses a voltage other than what is expected, the fault line status will change causing the DTC to set.

Conditions for Setting the DTC

- The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match.
- The condition must be present for a minimum of 5 seconds.

Action Taken When the DTC Sets

- The ECM stores the DTC information in memory.
- The ECM records the operating conditions at the time the DTC sets. The ECM displays the failure information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The history DTC clears after 40 malfunction free warm-up cycles.
- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The ECM receives the clear code command from the scan tool.

Diagnostic Aids

NOTE: Remove any debris from the ECM connector surfaces before servicing the ECM. Inspect the ECM connector gaskets when diagnosing/replacing the ECM. Ensure that the gaskets are installed correctly. The gaskets prevent water intrusion into the ECM.

Using Freeze Frame and/or Failure Records data may aid in locating an intermittent condition. If you cannot duplicate the DTC, the information included in the Freeze Frame and/or Failure Records data can aid in determining how many miles since the DTC set. The Fail Counter and Pass Counter can also aid determining how many ignition cycles the diagnostic reported a pass and/or a fail. Operate the vehicle within the same freeze frame conditions (RPM, load, vehicle speed, temperature etc.) that you observed. This will isolate when the DTC failed.

The wait to start indicator illuminates only with the ignition ON and the engine OFF. The wait to start indicator will not illuminate during post-start glow plug operation.

The wait to start indicator will not stay ON for long at higher engine temperatures.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Turn the ignition ON, with the engine OFF. Does the wait to start indicator illuminate and then turn OFF?		Intermittent Go To Diagnostic Aids	Go to Step 3
3	1. Turn the ignition OFF. 2. Disconnect the engine control module (ECM) connector 76. 3. Turn the ignition ON, with the engine OFF. 4. Measure the voltage from the wait to start signal circuit 338 (DB) of the ECM to a good ground. Does the voltage measure greater than the specified value?	9.5 Volts	Go to Step 4	Go to Step 6
4	Test the wait to start signal circuit 338 (DB) for a short to voltage. Did you find and correct the condition?		Go to Step 8	Go to Step 5
5	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 8	Go to Step 7
6	Repair the short to ground in the wait to start signal circuit 338 (DB. Did you complete the repair?		Go to Step 8	
7	Replace the faulty ECM. Did you complete the replacement?		Go to Step 8	
8	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 9
9	1. Using the Scan Tool select "Capture Info," Review Info." Are any DTC's displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0401 Exhaust Gas Recirculation (EGR) Flow Insufficient

Circuit Description

The engine control module (ECM) tests the exhaust gas recirculation (EGR) flow once per ignition cycle. When the proper enabling conditions are met, the ECM will close the EGR valve and then open the EGR valve while monitoring the mass air flow (MAF) signal. An expected MAF difference should be detected between the open and closed positions. If the ECM does not see the expected MAF difference, DTC P0401 sets.

Conditions for Setting the DTC

The MAF difference monitored by the ECM during the EGR flow test indicates an insufficient amount of EGR flow for 10 seconds.

Action Taken When the DTC Sets - California

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. **NOTE:** Attaching the shop exhaust system to the vehicle may cause false exhaust gas recirculation (EGR) DTCs to set. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition cycle?		Go to Step 3	Go to Intermittent Conditions
3	Is DTC P0101 also set?		Go to Step 8	Go to Step 4

Step	Action	Value(s)	Yes	No
4	Is DTC P0404 or P1404 also set?		Go to P0404 P1404	Go to Step 5
5	Is DTC P0403, P0405, or P0406 also set?		Go to P0403 P0405 P0406	Go to Step 6
6	Inspect for engine vacuum leaks. Did you find and correct the condition?		Go to Step 9	Go to Step 7
7	Inspect the exhaust system for leaks, for restrictions, and for a modification of the original equipment manufacture (OEM) parts. Did you find and correct the condition?		Go to Step 9	Go to Step 8
8	1. Remove the exhaust gas recirculation (EGR) valve. 2. Inspect for the following conditions: • A stuck open EGR valve • Leaks in the EGR valve and EGR passages • Restrictions in the EGR valve and EGR passages • Debris or damage that can cause the EGR valve to stick partially open or partially closed If the EGR valve is sticking or damaged and can not be cleaned, replace the EGR valve. Did you complete the repair?		Go to Step 9	
9	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 10
10	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0403 Exhaust Gas Recirculation (EGR) Solenoid Control Circuit (Figure OBD-48)

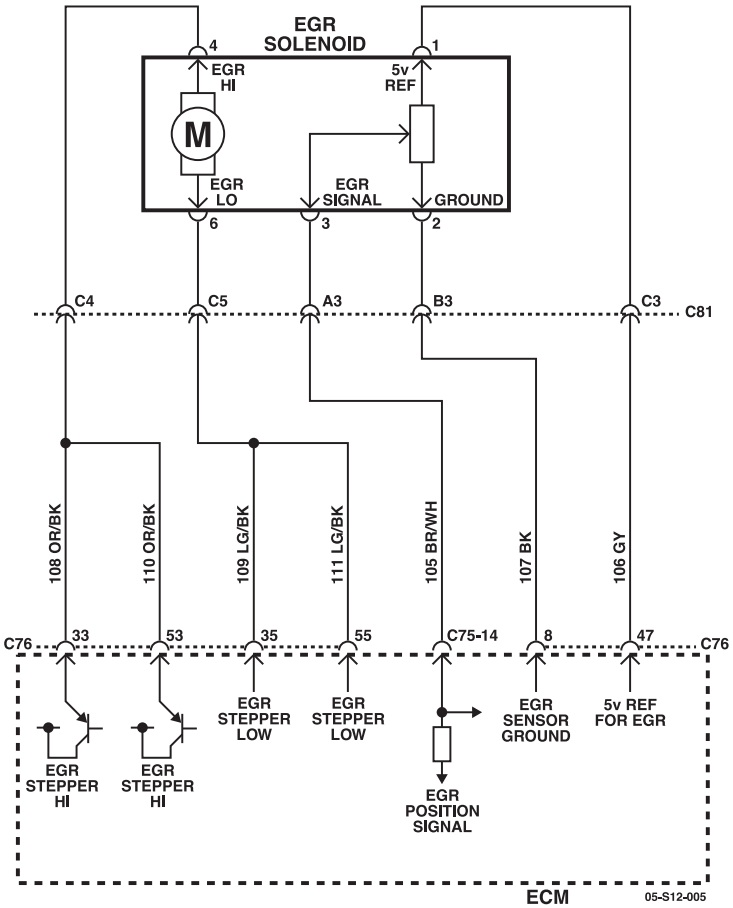


Figure OBD-48: Exhaust Gas Recirculation (EGR) Solenoid Control Circuit

Circuit Description

The exhaust gas recirculation (EGR) valve is controlled by the engine control module (ECM) through the EGR motor high control and the EGR motor low control circuits. The ECM supplies voltage that is near ignition voltage to the high and low control circuits at all times. The ECM will pulse width modulation (PWM) the low control circuit to ground when EGR is desired. The lower the pulse width, the more the valve will open. The ECM will PWM the high control circuit to ground when the EGR valve is desired closed. If the ECM detects an electrical malfunction on the control circuits, DTC P0403 will set.

Conditions for Setting the DTC

- The ECM detects an electrical malfunction on an EGR motor control circuit.
- The above condition is present for more than 10 seconds.

Action Taken When the DTC Sets - California

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition cycle?		Go to Step 3	Go to Intermittent Conditions
3	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the exhaust gas recirculation (EGR) valve. 3. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did DTC P0403 fail this ignition?		Go to Step 4	Go to Step 6
4	**NOTE:** The low control circuit of the EGR valve normally has near ignition voltage present. Test the low control circuit for a short to all other voltage circuits from the engine control module (ECM). Test the low control circuit of the EGR valve for a short to voltage. Did you find and correct the condition?		Go to Step 10	Go to Step 7
5	Test the EGR motor high control circuits 108/110 (OR/BK and low control circuits 109/111 (LG/BK) for a short to ground. Did you find and correct the condition?		Go to Step 10	Go to Step 7
6	Test for shorted terminals and poor connections at the EGR valve. Did you find and correct the condition?		Go to Step 10	Go to Step 8
7	Test for shorted terminals and poor connections at the ECM. Did you find and correct the condition?		Go to Step 10	Go to Step 9
8	Replace the faulty EGR valve. Did you complete the replacement?		Go to Step 10	

Step	Action	Value(s)	Yes	No
9	Replace the faulty ECM. Did you complete the replacement?		Go to Step 10	
10	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 11
11	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0404 Exhaust Gas Recirculation (EGR) Open Position Performance (Figure OBD-49)

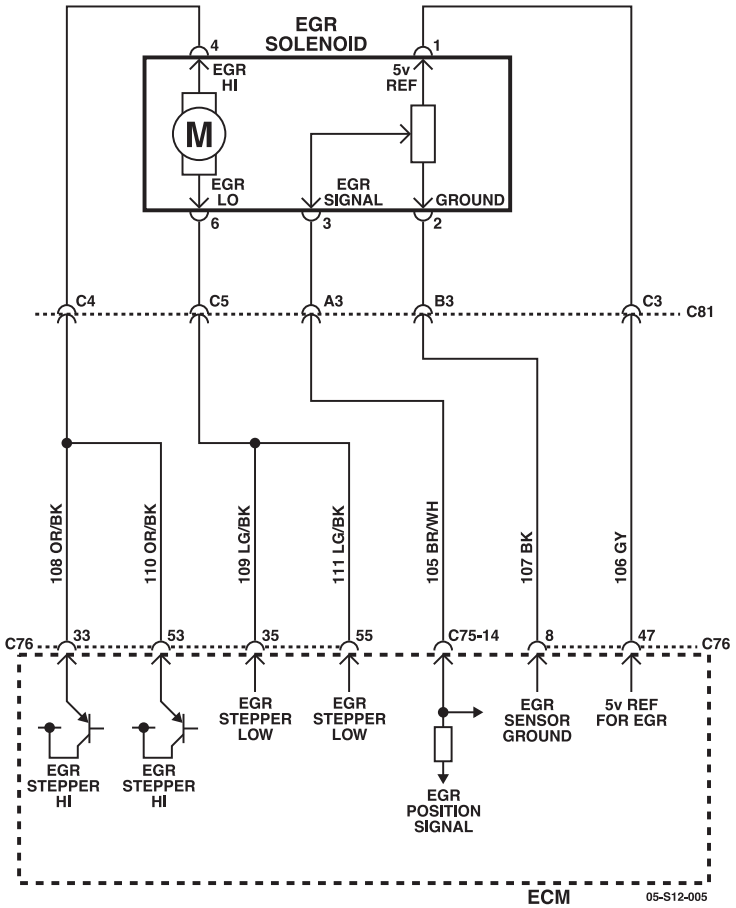


Figure OBD-49: Exhaust Gas Recirculation (EGR) Position Sensor Circuit

Circuit Description

The engine control module (ECM) uses the exhaust gas recirculation (EGR) position sensor to determine the position of the EGR valve. The ECM sends a reference voltage through the 5-volt reference circuit to the EGR position sensor. The ECM provides a voltage return path for the sensor through the low reference circuit. A variable voltage signal, based on the EGR valve position, is sent from the sensor to the ECM through the EGR position sensor signal circuit. The ECM compares the actual EGR position with the desired EGR position when the EGR valve is commanded open or closed. If the ECM detects a variance between the actual EGR position and desired EGR position for a calibrated amount of time while the EGR valve is commanded open, DTC P0404 sets.

Conditions for Setting the DTC

- The difference between the actual EGR position and the desired EGR position is more than 6 percent.
- The above condition is present for more than 5 seconds

Action Taken When the DTC Sets - California

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	**NOTE:** Attaching the shop exhaust system to the vehicle may cause false exhaust gas recirculation (EGR) DTCs to set. **NOTE:** Performing the EGR Solenoid output control function may result in setting exhaust gas recirculation (EGR) system DTCs. 1. Start the engine. 2. .Observe the EGR Position Variance parameter while commanding the exhaust gas recirculation (EGR) valve from 0-30 percent with a scan tool. 3. Exit the EGR output control function. Did the EGR Position Variance parameter read more than the specified value when commanded with a scan tool?	6%	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition cycle?		Go to Step 4	Intermittent Go To Diagnostic Aids
4	Is DTC P0403, P0405, or P0406 also set?		Go to P0403 Go to P0405 Go to P0406	Go to Step 5
5	Test for shorted terminals and poor connections at the EGR valve. Did you find and correct the condition?		Go to Step 16	Go to Step 6

Step	Action	Value(s)	Yes	No
6	**NOTE:** Failure to perform the following procedure can result in inaccurate test results. **NOTE:** Direct battery voltage to the EGR valve motor is not to exceed 5 seconds. 1. Disconnect the EGR valve. 2. Start the engine. 3. Measure the ignition voltage at the battery and note as supply voltage. 4. Connect a 5-amp fused jumper between the battery positive terminal and the high control circuits 108/110 (OR/BK) terminal on the EGR valve. 5. Set up the DVOM to measure amperage. 6. Connect a DVOM between the battery negative terminal and the low control circuits 109/111 (LG/BK) terminal on the EGR valve. 7. Measure the amperage and note as current draw. 8. Remove the DVOM and the 5-amp fused jumper wire. 9. Divide the supply voltage by the current draw in order to calculate the resistance of the EGR valve motor coil. Is the calculated resistance within the specified value for the specified EGR coil case temperature?	-40°C (-40°F) 1.42-2.88 ohms 25°C (77°F) 1.62-3.28 ohms 90°C (194°F) 1.75-3.66 ohms 150°C (302°F) 1.89-4.05 ohms	Go to Step 7	Go to Step 14
7	1. Measure the voltage from the 5-volt reference circuit 106 (GY) of the EGR position sensor to a good ground with a DVOM and note as "supply voltage." 2. Connect a test lamp and a DVOM in series between the 5-volt reference circuit 106 (GY) of the EGR position sensor and the low reference circuit 107 (BK) of the EGR position sensor. 3. Measure the amperage and note as "current draw." 4. Remove the DVOM and connect the test lamp between the 5-volt reference circuit 106 (GY) of the EGR position sensor and the low reference circuit 107 (BK) of the EGR position sensor. 5. Connect a DVOM in parallel between the 5-volt reference circuit 106 (GY) of the EGR position sensor and a good ground. 6. Measure the voltage and note as "load voltage drop." 7. Subtract the "load voltage drop" from the "supply voltage" and divide your answer by the "current draw" in order to calculate the resistance in the 5-volt reference circuit 106 (GY). Is the calculated resistance more than the specified value?	300 ohms	Go to Step 10	Go to Step 8
8	1. With the test lamp still connected, connect a DVOM in parallel between the low reference circuit 107 (BK) of the EGR position sensor and a good ground. 2. Measure and note the "low reference voltage drop." 3. Divide the "low reference voltage drop" by the "current draw" measured in the previous step in order to calculate the resistance in the low reference circuit 107 (BK). Is the calculated resistance more than the specified value?	5 ohms	Go to Step 10	Go to Step 9

Step	Action	Value(s)	Yes	No
9	1. Remove the test lamp and the DVOM. 2. Connect a jumper wire between the 5-volt reference circuit 106 (GY) of the EGR position sensor and the signal circuit 105 (BR/WH) of the EGR position sensor. 3. Observe the EGR Sensor parameter with a scan tool. Is the voltage more than the specified value?	4.9 Volts	Go to Step 11	Go to Step 10
10	Test for shorted terminals and poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 16	Go to Step 12
11	1. Turn OFF the ignition. 2. Disconnect the ECM. 3. Test the EGR motor high control circuits 108/110 OR/BK) and low control circuits 109/111 (LG/BK) for high resistance. Is the resistance more than the specified value?	High Control Circuit = -7 ohms Low Control Circuit = -9 ohms	Go to Step 12	Go to Step 13
12	Repair the high resistance in the affected circuit. Did you find and correct the condition?		Go to Step 16	Go to Step 15
13	1. Remove the EGR valve. 2. Inspect for debris that will cause the EGR valve to stick. Clean if necessary. Did you find and correct the condition?		Go to Step 16	Go to Step 14
14	Replace the faulty EGR valve. Did you complete the replacement?		Go to Step 16	
15	Replace the faulty ECM. Did you complete the replacement?		Go to Step 16	
16	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 17
17	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0405 Exhaust Gas Recirculation (EGR) Position Sensor Circuit Low Voltage (Figure OBD-50)

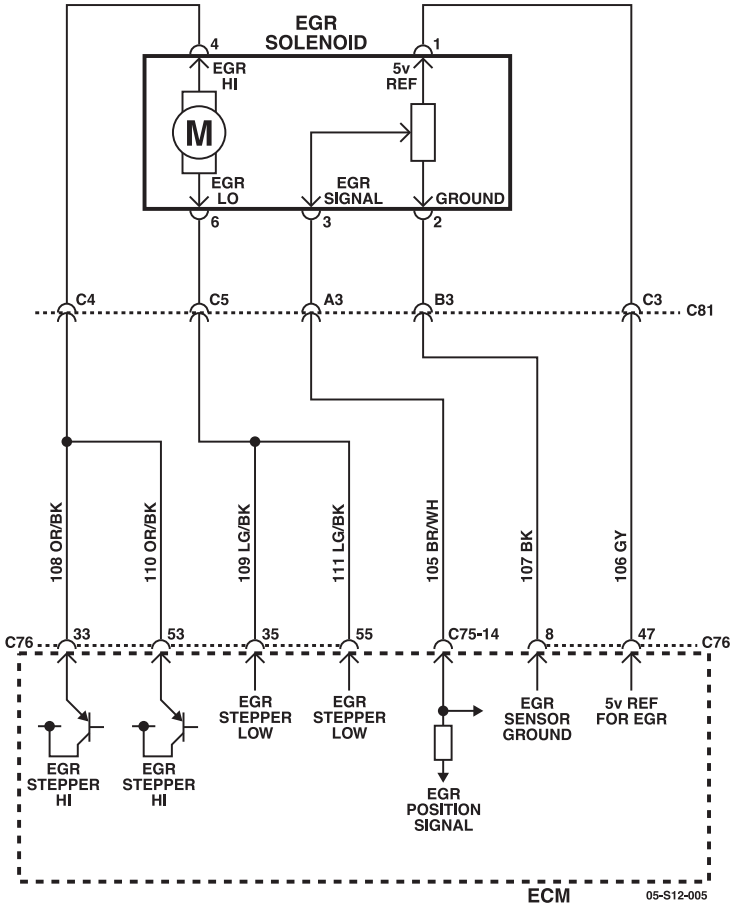


Figure OBD-50: Exhaust Gas Recirculation (EGR) Position Sensor Circuit

Circuit Description

The engine control module (ECM) uses the exhaust gas recirculation (EGR) position sensor to determine the position of the EGR valve. The ECM sends a reference voltage through the 5-volt reference circuit to the EGR position sensor. The ECM provides a voltage return path for the sensor through the low reference circuit. A variable voltage signal, based on the EGR valve position, is sent from the sensor to the ECM through the EGR position sensor signal circuit. If the ECM detects an EGR position sensor voltage that is less than the normal operating range, DTC P0405 sets.

Conditions for Setting the DTC

- The EGR position sensor voltage is less than 0.25 volts.
- The above condition is present for more than 10 seconds.

Action Taken When the DTC Sets - California

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition. 2. Observe the EGR Position Sensor parameter. Is the voltage less than the specified value?	0.26 V	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition cycle?		Go to Step 4	Go To Intermittent Conditions
4	Test for shorted terminals and poor connections at the exhaust gas recirculation (EGR) valve. Did you find and correct the condition?		Go to Step 12	Go to Step 5
5	1. Disconnect the EGR valve. 2. Turn ON the ignition. 3. Measure the voltage from the 5-volt reference circuit 106 (GY) of the EGR valve to a good ground with a DVOM. Is the voltage less than the specified value?	5 Volts	Go to Step 7	Go to Step 6
6	1. Connect a jumper wire between the 5-volt reference circuit 106 (CY) of the EGR valve and the signal circuit of the EGR valve. 2. Observe the EGR Position Sensor parameter with a scan tool. Is the voltage less than the specified value?	5 Volts	Go to Step 8	Go to Step 10
7	Repair the open or high resistance in the 5-volt reference circuit 106 (GY) of the EGR valve. Did you find and correct the condition?		Go to Step 12	Go to Step 9
8	Repair the open or short to ground in the signal circuit 105 (BR/WH) of the EGR valve. Did you complete the repair?		Go to Step 12	Go to Step 9

Step	Action	Value(s)	Yes	No
9	Test for shorted terminals and poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 12	Go to Step 11
10	Replace the faulty EGR valve. Did you complete the replacement?		Go to Step 12	
11	Replace the faulty ECM. Did you complete the replacement?		Go to Step 12	
12	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
13	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0406 Exhaust Gas Recirculation (EGR) Position Sensor Circuit High Voltage (Figure OBD-51)

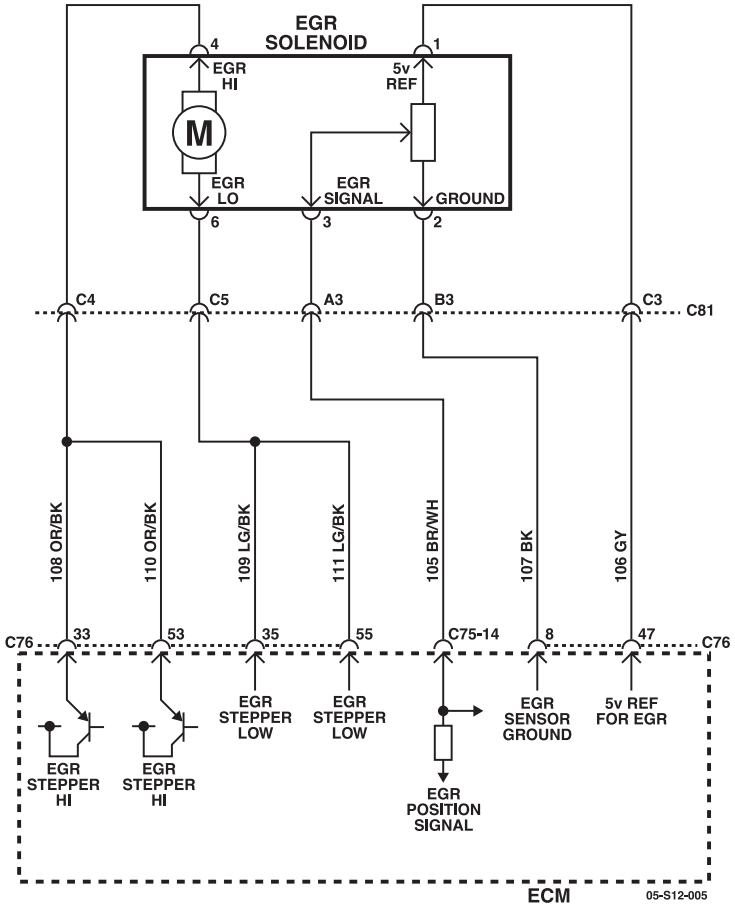


Figure OBD-51: Exhaust Gas Recirculation (EGR) Position Sensor Circuit

Circuit Description

The engine control module (ECM) uses the exhaust gas recirculation (EGR) position sensor to determine the position of the EGR valve. The ECM sends a reference voltage through the 5-volt reference circuit to the EGR position sensor. The ECM provides a voltage return path for the sensor through the low reference circuit. A variable voltage signal, based on the EGR valve position, is sent from the sensor to the ECM through the EGR position sensor signal circuit. If the ECM detects an EGR position sensor voltage that is more than the normal operating range, DTC P0406 sets.

Conditions for Setting the DTC

- The EGR position sensor voltage is more than 4.75 volts.
- The above condition is present for more than 10 seconds.

Action Taken When the DTC Sets - California

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition. 2. Observe the EGR Position Sensor parameter. Is the voltage more than the specified value?	4.75 Volts	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition cycle?		Go to Step 4	Intermittent Go to Diagnostic Aids
4	Test for shorted terminals and poor connections at the exhaust gas recirculation (EGR) valve. Did you find and correct the condition?		Go to Step 12	Go to Step 5
5	1. Disconnect the EGR valve. 2. Observe the EGR Position parameter on the scan tool. Is the voltage more than the specified value.	0 Volts	Go to Step 8	Go to Step 6
6	Measure the voltage between the 5-volt reference circuit 106 (GY) of the EGR valve and the low reference circuit 107(BK) of the EGR valve with a DVOM. Is the voltage less than the specified value.	5 Volts	Go to Step 7	Go to Step 10
7	Repair the open in the low reference circuit 107 (BK) of the EGR valve. Did you find and correct the condition?		Go to Step 12	Go to Step 9
8	Repair the short to voltage in the signal circuit 105 (BR) of the EGR valve. Did you complete the repair?		Go to Step 12	Go to Step 9
9	Test for shorted terminals and poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 12	Go to Step 11

Step	Action	Value(s)	Yes	No
10	Replace the faulty EGR valve. Did you complete the replacement?		Go to Step 12	
11	Replace the faulty ECM. Did you complete the replacement?		Go to Step 12	
12	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
13	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0500 Vehicle Speed Sensor (VSS) Circuit (Figure OBD-52)

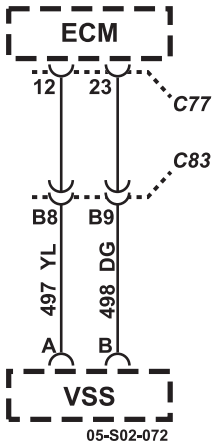


Figure OBD-52: Vehicle Speed Sensor (VSS) Circuit

Circuit Description

The vehicle speed sensor (VSS) monitors the rotation speed of the transmission output shaft. The VSS assembly is a permanent magnet generator. It produces an AC voltage as the rotor teeth on the output shaft of the transmission, 2WD, or transfer case, 4WD, pass through the magnetic field of the sensor. The AC voltage frequency and amplitude increase as the vehicle speed increases. The engine control module (ECM) that operates in a range of -4.5 volts or +5.0 volts. The ECM converts this signal into vehicle speed. As vehicle speed increases, the frequency of the duty cycle will increase.

Conditions for Setting the DTC

If the ECM detects a difference in vehicle speed with the VSS of greater than 8 km/h (5 mph), then DTC P0500 is set.

Action Taken When the DTC Sets

- The ECM illuminates the malfunction indicator lamp (MIL) on the second consecutive drive trip that the diagnostic runs.
- The ECM disables cruise control.
- The ECM records the operating conditions when the Conditions for Setting the DTC are met. The ECM stores this information as Freeze Frame and Failure Records.
- The ECM stores DTC P0500 in ECM history.

Conditions for Clearing the MIL/DTC

- The ECM turns OFF the MIL during the third consecutive trip in which the diagnostic test runs and passes.
- A scan tool can clear the MIL/DTC.
- The ECM clears the DTC from ECM history if the vehicle completes 40 warm-up cycles without an emission related diagnostic fault occurring.
- The ECM cancels the DTC default actions when the ignition switch is OFF long enough in order to power down the ECM.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records from the TCM. **NOTE:** Using the Clear Info function erases stored DTCs in both the TCM and ECM. 3. Record the DTC Freeze Frame and Failure Records. Is there a DTC P0721 or P0722 present?		Go to P0721 P0722	Go to Step 3
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records from the ECM. **NOTE:** Using the Clear Info function erases stored DTCs in both the ECM and TCM. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. ***WARNING: To avoid any vehicle damage, serious personal injury or death when major components are removed from the vehicle and the vehicle is supported by a hoist, support the vehicle with jack stands at the opposite end from which the components are being removed.*** 5. Raise and support the vehicle. 6. Start and idle the engine. 7. Turn off the traction control system, if equipped. 8. Select and monitor Engine Data 1/Vehicle Speed on the scan tool. 9. Place the transmission into DRIVE. With the drive wheels rotating, slowly increase the engine speed. Does Vehicle Speed on the scan tool increase with wheel speed?		Go to Intermittent Conditions	Go to Step 4
4	1. Turn OFF the engine. 2. Disconnect connector C76 at the ECM. 3. Turn the ignition to the ON position. 4. Using the DVOM and the J 35616 GM terminal test kit, test the signal circuit for voltage between pin 21 and ground. Is the circuit voltage within the specified range?			

Step	Action	Value(s)	Yes	No
5	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
6	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0506 Idle Speed Too Low

Circuit Description

The engine control module (ECM) adjusts the fuel delivery in order to control crankshaft speed at idle. If the ECM detects the engine speed is incorrect for the amount of fuel that is delivered, DTC P0506 sets.

Conditions for Setting the DTC

The actual idle speed is more than 100 RPM under the target idle speed.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Are any other DTCs set?		Go to the DTC in order	

DTC P0507 Idle Speed Too High

Circuit Description

The engine control module (ECM) adjusts the fuel delivery in order to control crankshaft speed at idle. If the ECM detects the engine speed is incorrect for the amount of fuel that is delivered, DTC P0507 sets.

Conditions for Setting the DTC

The actual idle speed is more than 100 RPM over the target idle speed.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

Inspect for one of the following:

- A crankcase overfill causing oil to be forced through the positive crankcase ventilation (PCV) system
- An aftermarket performance kit using an external fuel source
- An engine mechanical condition

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Are any other DTCs set?		Go to the DTC in order	Go to Step 3
3	Attempt to start the engine. Does the engine crank?		Go to Step 4	Go to Engine Will Not Crank
4	Does the engine start?		Go to Diagnostic Aids	Go to Engine Cranks but Does Not Run

DTC P0522 Oil Pressure Circuit Low Voltage (Figure OBD-53)

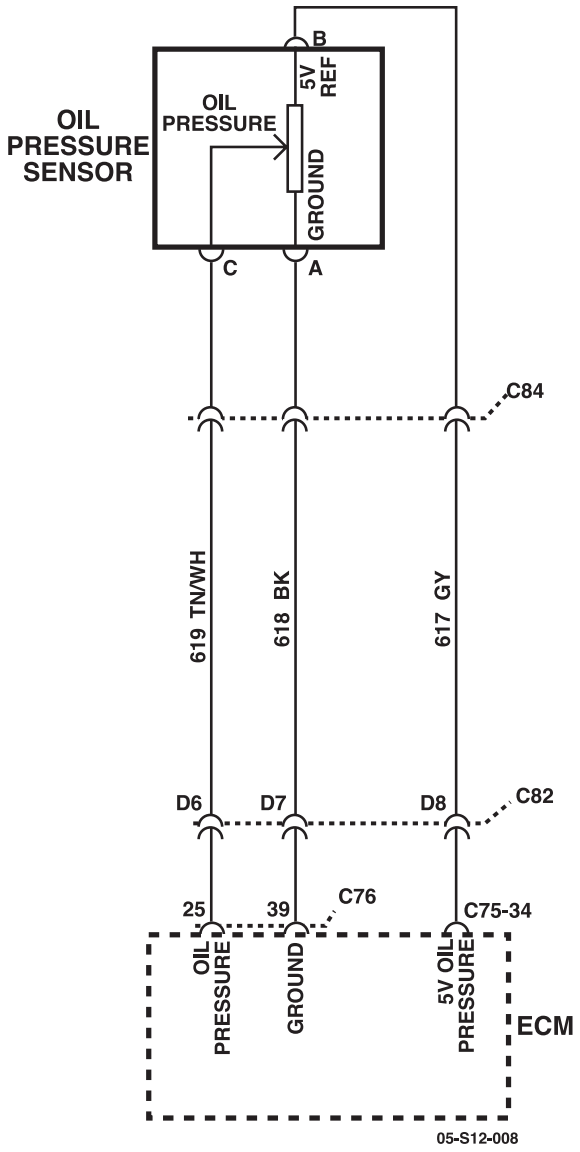


Figure OBD-53: Oil Pressure Sensor Circuit

Circuit Description

The engine oil pressure (EOP) sensor changes resistance based on engine oil pressure. The Engine control module (ECM) monitors the signal circuit of the EOP sensor. When the oil pressure is high, the sensor resistance is high, and the ECM senses a high signal voltage. When the oil pressure is low, the sensor resistance is low, and the ECM senses a low signal voltage. The ECM sends the engine oil pressure information to the instrument panel cluster (IPC) via the class 2 serial data circuit.

Conditions for Setting the DTC

- The ECM detects that the EOP sensor signal circuit is less than 0.4 volts.
- The above condition is present for greater than 9 seconds.

Action Taken When the DTC Sets

- The ECM records the operating conditions at the time the diagnostic test fails. The ECM displays this information in the Failure Records on the scan tool.
- The IPC illuminates the engine oil pressure indicator.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC clears after 40 malfunction free warm-up cycles.
- The ECM receives a clear code command from the scan tool.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help determine how many miles since the DTC set. The Fail Counter and Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Install a scan tool. 2. Turn the ignition ON, with the engine OFF. 3. With the scan tool, observe one of the following engine oil pressure parameters: • Monitored Oil Pressure parameter in the IPC Data 1 data list-6.6L diesel only. • Engine Oil Pressure Sensor parameter in the ECM Engine Data 2 data list. Does the scan tool indicate that the Engine Oil Pressure parameter is at or less than the specified value?	0 kPa (0 psi) 0.4 Volts	Go to Step 3	Go to Diagnostic Aids
3	Is DTC P0641 current in the engine control module (ECM)?		Go to P0641	Go to Step 4
4	1. Turn the ignition OFF. 2. Disconnect the engine oil pressure (EOP) sensor. 3. Connect a 3-ampere fused jumper between the EOP sensor signal circuit 619 (TN/WH) and the 5-volt reference circuit 617 (GY) of the EOP sensor. 4. With the scan tool, observe one of the following engine oil pressure parameters: • Monitored Oil Pressure parameter in the IPC Data 1 data list-6.6L diesel only. • Engine Oil Pressure Sensor parameter in the ECM Engine Data 2 data list. Does the scan tool indicate that the Engine Oil Pressure parameter is at or greater than the specified value?	550 kPa (80 psi) 4.6 Volts	Go to Step 8	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Disconnect the fused jumper. 2. Measure the voltage between the 5-volt reference circuit 617 (GY) of the EOP sensor and the low reference circuit 618 (BK) of the EOP sensor. Does the voltage measure greater than the specified value?	4.6 Volts	Go to Step 7	Go to Step 6
6	Test the 5 volt reference circuit 617 (GY) of the EOP sensor for an open or for a high resistance between C75 pin 34 and pin B of the EOP sensor. Did you find and correct the condition?		Go to Step 12	Go to Step 9
7	Test the EOP sensor signal circuit 619 (TN/WH) for an open, for a short to ground, or for a high resistance between C76 pin 25 and pin C of the EOP sensor. Did you find and correct the condition?		Go to Step 12	Go to Step 9
8	Inspect for poor connections at the harness connector of the EOP sensor. Did you find and correct the condition?		Go to Step 12	Go to Step 10
9	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 12	Go to Step 11
10	Replace the faulty engine oil pressure sensor. Did you complete the replacement?		Go to Step 12	
11	Replace the faulty ECM. Did you complete the replacement?		Go to Step 12	
12	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
13	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0523 Oil Pressure Sensor High Voltage (Figure OBD-54)

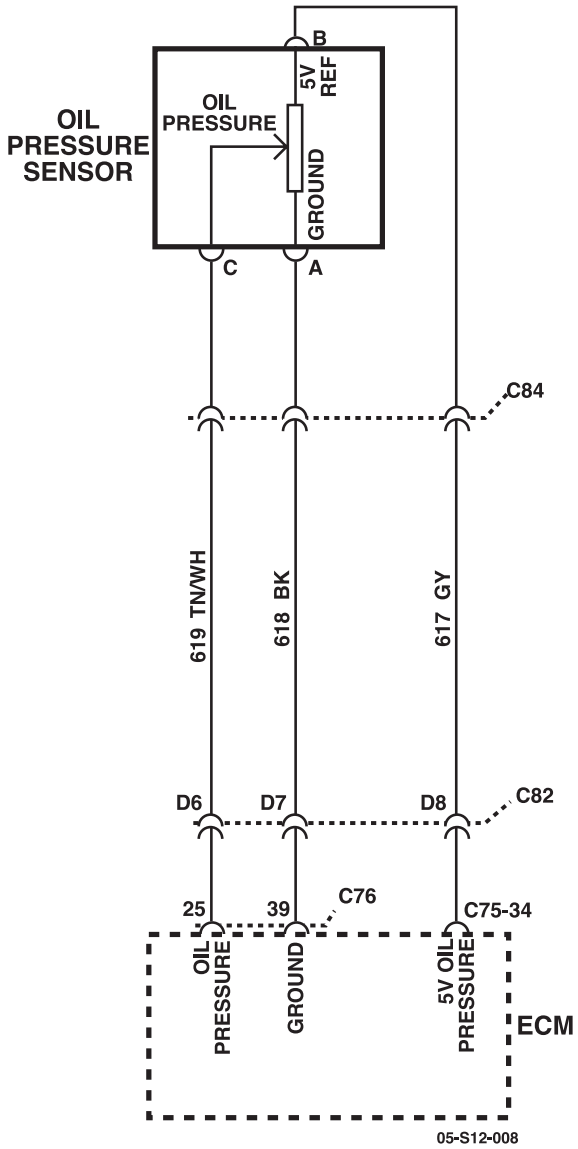


Figure OBD-54: Oil Pressure Sensor Circuit

Circuit Description

The engine oil pressure (EOP) sensor changes resistance based on engine oil pressure. The engine control module (ECM) monitors the signal circuit of the EOP sensor. When the oil pressure is high, the sensor resistance is high, and the ECM senses a high signal voltage. When the oil pressure is low, the sensor resistance is low, and the ECM senses a low signal voltage. The ECM sends the engine oil pressure information to the instrument panel cluster (IPC) via the class 2 serial data circuit.

Conditions for Setting the DTC

- The ECM detects that the EOP sensor signal circuit is greater than 4.6 volts.
- The above condition is present for greater than 9 seconds.

Action Taken When the DTC Sets

The ECM records the operating conditions at the time that the diagnostic test fails. The ECM displays this information in the Failure Records on the scan tool.

Conditions for Clearing the DTC

- The DTC becomes history when the conditions for setting the DTC are no longer present.
- The history DTC is cleared after 40 malfunction free warm-up cycles.
- The ECM receives the clear code command from the scan tool.

Diagnostic Aids

Using the Failure Records data may help locate an intermittent condition. If you cannot duplicate the DTC, the information in the Failure Records can help in determining how many miles since the DTC set. The Fail Counter and the Pass Counter can help determine how many ignition cycles that the diagnostic test reported a pass and/or a fail.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Install a scan tool. 2. Turn the ignition ON, with the engine OFF. 3. With the scan tool, observe the Engine Oil Pressure Sensor parameter in the ECM Engine Data 2 data list. Does the scan tool indicate that the Engine Oil Pressure parameter is at or greater than the specified value	550 kPa (80 psi) 4.6 Volts	Go to Step 3	Intermittent Go to Diagnostic Aids
3	1. Turn the ignition OFF. 2. Disconnect the engine oil pressure (EOP) sensor. 3. With the scan tool, observe the Engine Oil Pressure Sensor parameter in the ECM Engine Data 2 data list. Does the scan tool indicate that the Engine Oil Pressure parameter is at or less than the specified value?	0 kPa (0 psi) 0.4 V	Go to Step 4	Go to Step 5
4	1. Turn the ignition OFF. 2. Disconnect the negative battery cable. 3. Measure the resistance from the low reference circuit 618 (BK) of the EOP sensor to a good ground. Is the resistance less than the specified value?	5 ohms	Go to Step 7	Go to Step 6
5	Test the EOP sensor signal circuit 619(TN/WH) for a short to voltage. Did you find and correct the condition?		Go to Step 11	Go to Step 8
6	1. Disconnect the engine control module (ECM). 2. Test the low reference circuit 618 (BK) of the EOP sensor for an open or for a high resistance between C76 pin 39 and pin A of the EOP sensor connector. Did you find and correct the condition?		Go to Step 11	Go to Step 8

Step	Action	Value(s)	Yes	No
7	Inspect for poor connections at the harness connector of the EOP sensor. Did you find and correct the condition?		Go to Step 11	Go to Step 9
8	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 11	Go to Step 10
9	Replace the faulty engine oil pressure sensor. Did you complete the replacement?		Go to Step 12	
10	Replace the faulty ECM. Did you complete the replacement?		Go to Step 12	
11	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 12
12	1. Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0561 System Voltage Performance (Figure OBD-55)

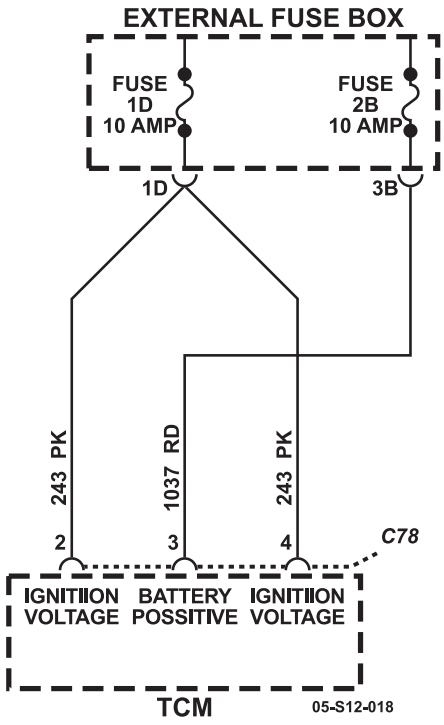


Figure OBD-55: External Fuse Box Circuit

Circuit Description

The transmission control module (TCM) requires a switched ignition voltage input and a direct battery voltage input.

DTC P0561 is a type C DTC.

Conditions for Setting the DTC

DTC P0561 sets when the TCM detects a large variation in ignition voltage or battery direct voltage. When an ignition or battery direct voltage variation of 4.0 volts or greater is detected for 0.5 second, a fault pending is reported. After 1.0 second of 4.0 volts or greater variation, a DTC is set with a failure response.

Action Taken When the DTC Sets

- The TCM does not illuminate the malfunction indicator lamp (MIL).
- The transmission fails to hydraulic default.
- DTC P0561 will be stored in TCM history.
- The TCM inhibits torque converter clutch (TCC) engagement.
- The TCM freezes shift adapts

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect for aftermarket devices that could affect the operation of the starting and charging systems.
- Inspect for the presence of aftermarket accessories, such as a remote starter, etc. Depending on how these aftermarket accessories are installed, they may interfere with the required voltage for proper operation of the transmission.
- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine and observe the charge indicator on the instrument panel cluster (IPC). Does the charge indicator illuminate or the driver information center (DIC) display a charging system message?		Go to Charging System Test in Engine Electrical	Go to Step 3
3	1. Turn the ignition OFF. 2. Disconnect the TCM C78 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at the C78. 4. Using a DVOM, measure voltage at the +12v Battery input CKT 1037 (RD) between C78 pin 3, and a good ground. Is voltage within the specified value?	B+	Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	Using a DVOM, in sequence, measure the voltage from the 12 volt ignition voltage circuits 243 (PK) at C78 pin 2, and C78 pin 4, and a good ground. 2.Turn ON the ignition, with the engine OFF. Is voltage within the specified value?	B+	Go to Step 7	Go to Step 6
5	Test the battery positive voltage circuit 1037 (RD) for an open or short to ground between C78 pin 3 and fuse 2B in the external fuse box. Did you find and correct the condition?		Go to Step 10	Go to Diagnostic Aids
6	Test the ignition feed circuit 1037 (RD) for an open or short to ground between C78 pin 2 and fuse 1D and also between C78 pin 4 and fuse 1Din the external fuse box. Did you find and correct the condition?		Go to Step 10	Go to Step 9
7	1. Start the engine. 2. Operate all accessories. Did voltage fluctuate by the specified value?	4 Volts	Go to Step 8	Go to Step 9
8	Determine the cause of the accessory voltage drop. Did you find and correct the condition?		Go to Step 10	Go to Diagnostic Aids
9	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 10	
10	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor TCM voltage. 3. Select Specific DTC. 4. Enter DTC P0561. Has the test run and passed?		System OK	Go to Step 1

DTC P0562 System Voltage Low

Circuit Description

The transmission control module (TCM) requires a switched ignition voltage to operate. The voltage signal should be direct from the ignition switch to avoid any interference.

DTC P0562 is a type C DTC.

Conditions for Setting the DTC

DTC P0562 sets when the TCM detects ignition voltage below 8.0 volts at 0°C (32°F) for a total of 5 out of 7 seconds. The voltage threshold is temperature dependant, varying from 5.0 volts at -60°C (-76°F) to 9.0 volts at 20°C (68°F).

Action Taken When the DTC Sets

- The TCM does not illuminate the malfunction indicator lamp (MIL).
- The transmission fails to hydraulic default.
- DTC P0562 will be stored in TCM history.
- The TCM inhibits torque converter clutch (TCC) engagement.
- The TCM freezes shift adapts.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect for the presence of aftermarket accessories, such as a remote starter, etc. Depending on how these aftermarket accessories are installed, they may interfere with the required voltage for proper operation of the transmission.
- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using a DVOM, measure and record voltage at the battery terminals. Is voltage within the specified value?	B+	Go to Step 3	Go to Step 4
3	Start the engine and observe the charge indicator on the instrument cluster. Does the charge indicator illuminate?		Go to Step 5	Go to Step 6
4	Replace the battery or resolve the battery condition. Did you resolve the condition or complete the replacement?		Go to Step 6	
5	Repair the charging system. Did you complete the repair?		Go to Step 6	
6	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor TCM voltage. 3. Select Specific DTC. 4. Enter DTC P0562. Has the test run and passed?		System OK	Go to Step 1

DTC P0563 System Voltage High

Circuit Description

The transmission control module (TCM) requires ignition voltage to operate correctly. The voltage signal should be direct from the ignition switch to avoid any interference.

DTC P0563 is a type C DTC.

Conditions for Setting the DTC

DTC P0563 sets when the TCM detects a voltage greater than 18 volts for 6 out of 10 seconds.

Action Taken When the DTC Sets

- The TCM does not illuminate the malfunction indicator lamp (MIL).
- The transmission fails to hydraulic default.
- DTC P0563 will be stored in TCM history.
- The TCM inhibits torque converter clutch (TCC) engagement.
- The TCM freezes shift adapts.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect for the presence of aftermarket accessories, such as a remote starter, etc. Depending on how these aftermarket accessories are installed, they may interfere with the required voltage for proper operation of the transmission.
- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using a DVOM, measure and record voltage at the battery terminals. Is voltage within the specified value?	B+	Go to Step 3	Go to Step 4
3	Start the engine and observe the charge indicator on the instrument cluster. Does the charge indicator display voltage higher than specified value?	18 Volts	Go to Step 5	Go to Step 6
4	Replace the battery, or resolve the battery condition. Did you resolve the battery condition or replace the battery?		Go to Step 6	
5	Repair the charging system. Did you complete the repair?		Go to Step 6	
6	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor TCM voltage. 3. Select Specific DTC. 4. Enter DTC P0563. Has the test run and passed?		System OK	Go to Step 1

DTC P0601 Engine Control Module (ECM) Read Only Memory (ROM)

DTC P0602 Engine Control Module (ECM) Not Programed

DTC P0603 Engine Control Module (ECM) Long Term Memory Reset

DTC P0604 Engine Control Module (ECM) Random Access Memory (RAM)

DTC P1621 Engine Control Module (ECM) Long Term Memory Performance

DTC P2610 Engine Control Module (ECM) Ignition Of Timer Performance

Description

This diagnostic applies to internal microprocessor integrity conditions within the engine control module (ECM). This diagnostic also addresses if the ECM is not programmed.

Conditions for Setting the DTC

These codes will set when there is incomplete programming or an internal failure within the ECM within 15 seconds.

Action Taken When the DTC Sets

DTC P0601, P0602, and P0604

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

DTC P0603 and P1621

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center (DIC), if equipped, may display a message.

DTC P2610

- The control module illuminates the MIL on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

DTC P0601, P0602, P0604, and P2610

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

DTC P0603 and P1621

- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	**NOTE:** P0602 indicates the ECM is not programmed. Is DTC P0602 set?		Go to Step 3	Go to Step 5
3	Program the engine control module (ECM). Does DTC P0602 reset?		Go to Step 4	Go to Step 6
4	1. Ensure that all tool connections are secure. 2. Ensure that the programming equipment is operating correctly. 3. Ensure that the correct software/calibration package is used. 4. Attempt to program the ECM. Does DTC P0602 reset?		Go to Step 5	Go to Step 6
5	Replace the faulty ECM. Did you complete the replacement?		Go to Step 6	
6	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 7
7	Using the Scan Tool select "Capture Info," Review Info." Are any DTC's displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0611 Fuel Injector Control Module (FICM) Performance

DTC P01293 Injector Circuit Low to High Current Transition Time Bank 1

DTC P01294 Injector Circuit Low to High Current Transition Time Bank 2

DTC P01295 Injector Circuit High to Low Current Transition Time Bank 1

DTC P01296 Injector Circuit High to Low Current Transition Time Bank 2

DTC P01658 Fuel Injector Control Module (FICM) Driver Performance

DTC P01687 Fuel Injector Control Module (FICM) Driver Stuck On

Circuit Description

This diagnostic applies to internal microprocessor integrity conditions within the fuel injection control module (FICM).

Conditions for Setting the DTC

These codes will set when there is an internal failure in the FICM for less than 1 second.

Action Taken When DTC P1293, P1294, P1295, P1296, P1658, or P1687 Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Action Taken When the DTC P0611 Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	Replace the faulty fuel injection control module (FICM). Did you complete the replacement?		Go to Step 3	
3	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 4
4	Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0612 Fuel Injector Control Module (FICM) Relay Control Circuit

Circuit Description

The engine control module (ECM) monitors the condition of the ignition relay control circuit. If the ECM senses excessive voltage on this circuit, DTC P0612 will set.

Conditions for Setting the DTC

The feedback voltage does not match the output state for more than 1 second.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

If the engine starts, the ignition relay control circuit is shorted to power intermittently.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Attempt to start the engine. Does the engine start?		Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Remove the relay that supplies ignition voltage to the fuel injection control module (FICM) 3. Disconnect the engine control module (ECM) C75 containing the relay control circuit 516 (GY/BK). 4. Turn ON the ignition. 5. Probe the relay control circuit 516 (GY/BK) pin 52 with a test lamp connected to a good ground. Does the test lamp illuminate?		Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	Measure the resistance of the coil circuit of the relay with a DVOM. Does the resistance measure within the specified range?	60-80 ohms	Go to Step 7	Go to Step 6
5	Repair the short to battery or ignition voltage on the relay control circuit. Did you complete the repair?		Go to Step 8	
6	Replace the faulty relay. Did you complete the replacement?		Go to Step 8	
7	Replace the faulty ECM. Did you complete the replacement?		Go to Step 8	
8	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 9
9	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0642 5 Volt Reference 1 Circuit Low Voltage (Figure OBD-56)

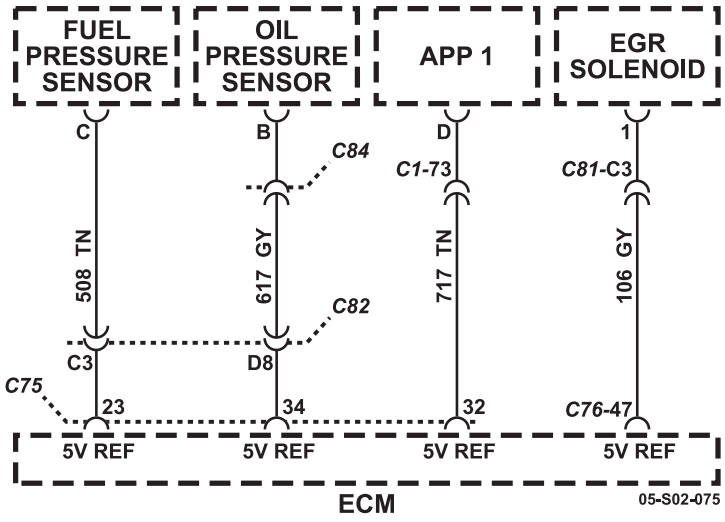


Figure OBD-56: 5 Volt Refernce 1 Circuit

The Engine Control Module (ECM) Provides 5 volts To The Following Sensors:

- The oil pressure sensor
- The exhaust gas recirculation (EGR) valve
- The accelerator pedal position (APP) 1 sensor
- The rail pressure sensor

These 5-volt reference circuits are independent of each other outside the ECM, but are bussed together inside the ECM. Therefore, a circuit condition on one sensor 5-volt reference circuit may affect the other sensor 5-volt reference circuits. The ECM monitors the voltage on the 5-volt reference circuit. If the ECM detects a low voltage condition, DTC P0642 sets.

Conditions for Setting the DTC

- The ECM detects the 5-volt reference 1 circuit voltage is less than 4.7 volts.
- The above condition is present for 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	Go to Intermittent Conditions
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor. 3. Turn ON the ignition, with engine OFF. 4. Measure the voltage from the 5-volt reference circuit 717 (TN) of the APP 1 sensor to a good ground with a DVOM. Is the voltage within the specified range?	4.7-5.2 Volts	Go to Step 7	Go to Step 4
4	1. Observe the DVOM while disconnecting all other components connected to the 5-volt reference, one at a time. 2. If voltage changes when one of the above components are disconnected, replace the component. • Engine Oil Pressure Sensor and/or Switch Replacement • Exhaust Gas Recirculation (EGR) Valve Replacement • Fuel Rail Pressure (FRP) Sensor Replacement Was a component replaced?		Go to Step 8	Go to Step 5
5	Test each 5-volt reference 1 circuits 508 (TN), 717 (TN), 617 (GY), and 106 (GY) for a short to ground. Did you find and correct the condition?		Go to Step 8	Go to Step 6
6	Replace the faulty ECM. Did you complete the replacement?		Go to Step 8	
7	Replace the faulty APP sensor. Did you complete the replacement?		Go to Step 8	
8	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 9
9	Using the Scan Tool select "Capture Info," Review Info." Are any DTC's displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0643 5 Volt Reference 1 Circuit High Voltage (Figure OBD-57)

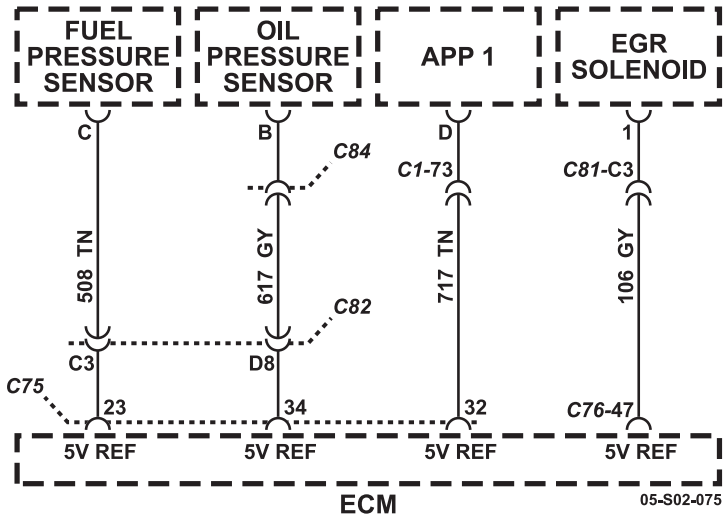


Figure OBD-57: 5 Volt Reference 1 Circuit

Circuit Description

The engine control module (ECM) provides 5 volts to the following sensors:

- The oil pressure sensor
- The exhaust gas recirculation (EGR) valve
- The accelerator pedal position (APP) 1 sensor
- The rail pressure sensor

These 5-volt reference circuits are independent of each other outside the ECM, but are bussed together inside the ECM. Therefore, a circuit condition on one sensor 5-volt reference circuit may affect the other sensor 5-volt reference circuits. The ECM monitors the voltage on the 5-volt reference circuit. If the ECM detects a high voltage condition, DTC P0643 sets.

Conditions for Setting the DTC

- The ECM detects the 5-volt reference 1 circuit voltage is more than 5.2 volts.
- The above condition is present for longer than 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the 5-Volt Reference 1 parameter with a scan tool. Is the 5-Volt Reference 1 parameter more than the specified value?	5.2 Volts	Go to Step 3	Go to Intermittent Conditions
3	Test each 5-volt reference 1 circuits 508 (TN), 717 (TN), 617 (GY), 106 (GY) for a short to voltage. Did you find and correct the condition?		Go to Step 6	Go to Step 4
4	Replace the faulty ECM. Did you complete the replacement?		Go to Step 8	
5	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 6
6	Using the Scan Tool select "Capture Info," Review Info." Are any DTC's displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0650 Malfunction Indicator Lamp (MIL) Control Circuit (Figure OBD-58)

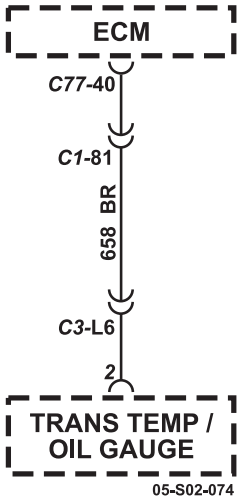


Figure OBD-58: Malfunction Indicator Lamp (MIL) Control Circuit

Circuit Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL informs the driver that an emission system fault has occurred and that the engine control system requires service. The control module monitors the MIL control circuit for conditions that are incorrect for the commanded state of the MIL. For example, a failure condition exists if the control module detects low voltage when the MIL is commanded OFF, or high voltage when the MIL is commanded ON. If the control module detects an improper voltage on the MIL control circuit, DTC P0650 will set.

Conditions for Setting the DTC

- The control module detects that the commanded state of the MIL driver and the actual state of the control circuit do not match.
- The conditions are present for a minimum of 30 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Verify whether the instrument cluster is operational. 2. Command the MIL ON and OFF with a scan tool. Does the malfunction indicator lamp (MIL) turn ON and OFF when commanded with a scan tool?		Go to Step 3	Go to Step 4
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Intermittent Conditions
4	Turn OFF the ignition. 5. Disconnect the engine control module (ECM). 6. Turn ON the ignition, with the engine OFF. Is the MIL OFF?		Go to Step 5	Go to Step 10
5	1. Remove fuse 4B that supplies voltage to the instrument panel cluster (IPC). 2. Measure the voltage from the MIL control circuit 658 (BR) in the ECM harness C77 pin 40 to a good ground. Is the voltage less than the specified value?	1 Volt	Go to Step 6	Go to Step 11
6	1. Turn OFF the ignition. 2. Install the fuse that supplies ignition voltage to the MIL. 3. Turn ON the ignition, with the engine OFF. 4. Connect a 3-amp fused jumper wire between the MIL control circuit 658 (BR) of the ECM harness connector and a good ground. Is the MIL illuminated?		Go to Step 9	Go to Step 7
7	Test the MIL control circuit 658 (BR) for an open or high resistance between C77 pin 40 and pin 2 of the trans temp/oil gauge. Did you find and correct a condition?		Go to Step 14	Go to Step 8
8	Test for an intermittent and for a poor connection at the IPC. Did you find and correct the condition?		Go to Step 14	Go to Step 12
9	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 14	Go to Step 13
10	Test for a short to ground in the MIL control circuit 658 (BR) between C77 pin 40 and pin 2 of the trans temp/oil gauge. Did you find and correct the condition?		Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	Repair the short to voltage in the MIL control circuit 658 (BR) between C77 pin 40 and pin 2 of the trans temp/oil gauge. Did you complete the repair?		Go to Step 14	
12	Replace the faulty IPC. Did you complete the replacement?		Go to Step 14	
13	Replace the faulty ECM. Did you complete the replacement?		Go to Step 14	
14	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 5
15	Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0652 5 Volt Reference 2 Circuit Low Voltage (Figure OBD-59)

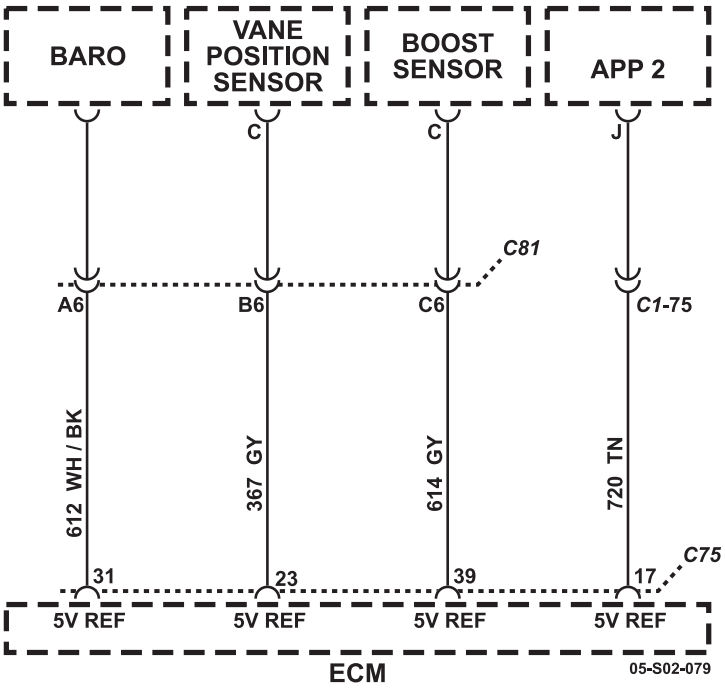


Figure OBD-59: 5 Volt Reference 2 Circuit

Circuit Description

The engine control module (ECM) provides 5 volts to the following sensors:

- The boost sensor
- The accelerator pedal position (APP) 2 sensor
- The turbocharger vane position sensor
- The A/C refrigerant pressure sensor
- The barometric pressure (BARO) sensor

These 5-volt reference circuits are independent of each other outside the ECM, but are bussed together inside the ECM. Therefore, a circuit condition on one sensor 5-volt reference circuit may affect the other sensor 5-volt reference circuits. The ECM monitors the voltage on the 5-volt reference circuit. If the ECM detects a low voltage condition, DTC P0652 sets.

Conditions for Setting the DTC

- The ECM detects the 5-volt reference circuit 2 voltage is less than 4.7 volts.
- The above condition is present for 2 seconds.

Action Taken When the DTC Sets

- *The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- *The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	Go to Intermittent Conditions
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the 5-volt reference circuit 720 (TN) of the APP 2 sensor to a good ground with a DVOM. Is the voltage within the specified range?	4.7-5.2 Volts	Go to Step 7	Go to Step 4
4	1. Observe the DVOM while disconnecting all other components connected to the 5-volt reference, one at a time. 2. If voltage changes when one of the above components are disconnected, replace the component. Was a component replaced?		Go to Step 8	Go to Step 5
5	Test each 5-volt reference 2 circuit for a short to ground. Did you find and correct the condition?		Go to Step 8	Go to Step 6
6	Replace the faulty ECM. Did you complete the replacement?		Go to Step 8	
7	Replace the faulty APP sensor. Did you complete the replacement?		Go to Step 8	
8	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 9

Step	Action	Value(s)	Yes	No
9	Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0653 5 Volt Reference 2 Circuit High Voltage (Figure OBD-60)

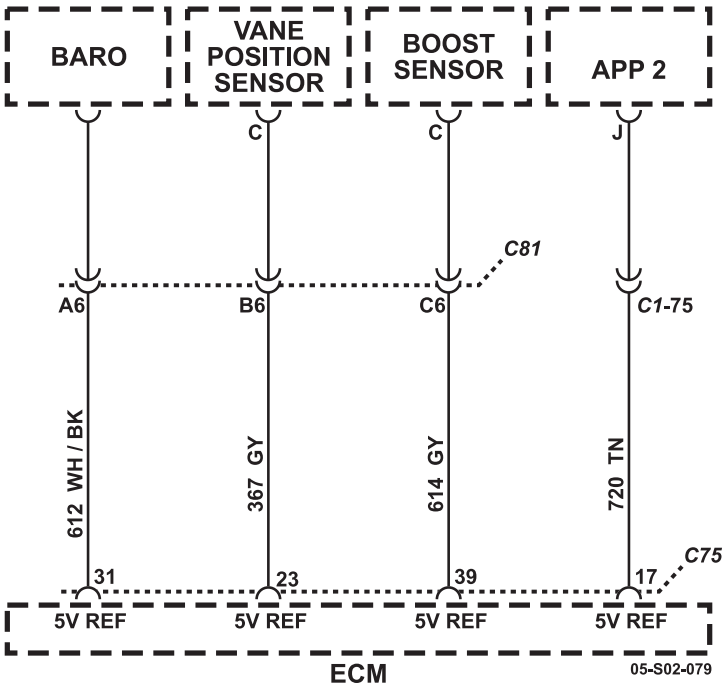


Figure OBD-60: 5 Volt Reference 2 Circuit

Circuit Description

The engine control module (ECM) provides 5 volts to the following sensors:

- The boost sensor
- The accelerator pedal position (APP) sensor 2
- The turbocharger vane position sensor
- The A/C refrigerant pressure sensor
- The barometric pressure (BARO) sensor

These 5-volt reference circuits are independent of each other outside the ECM, but are bussed together inside the ECM. Therefore, a circuit condition on one sensor 5-volt reference circuit may affect the other sensor 5-volt reference circuits. The ECM monitors the voltage on the 5-volt reference circuit. If the ECM detects a high voltage condition, DTC P0653 sets.

Conditions for Setting the DTC

- The ECM detects the 5-volt reference circuit 2 voltage is more than 5.2 volts.
- The above condition is present for 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the 5-Volt Reference 2 parameter with a scan tool. Is the 5-Volt Reference 2 parameter more than the specified value?	5.2 Volts	Go to Step 3	Go to Intermittent Conditions
3	Test each 5-volt reference 2 circuit for a short to voltage. Did you find and correct the condition?		Go to Step 6	Go to Step 4
4	Test the following sensor signal circuits for a short to voltage: • The boost sensor signal circuit • The A/C pressure sensor signal circuit • The barometric pressure (BARO) sensor signal circuit • The turbocharger vane position sensor signal circuit Did you find and correct the condition?		Go to Step 6	Go to Step 5
5	Replace the faulty ECM. Did you complete the replacement?		Go to Step 6	
6	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 7
7	Using the Scan Tool select "Capture Info," Review Info." Are any DTC's displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0670 Glow Plug Control Module Control Circuit (Figure OBD-61)

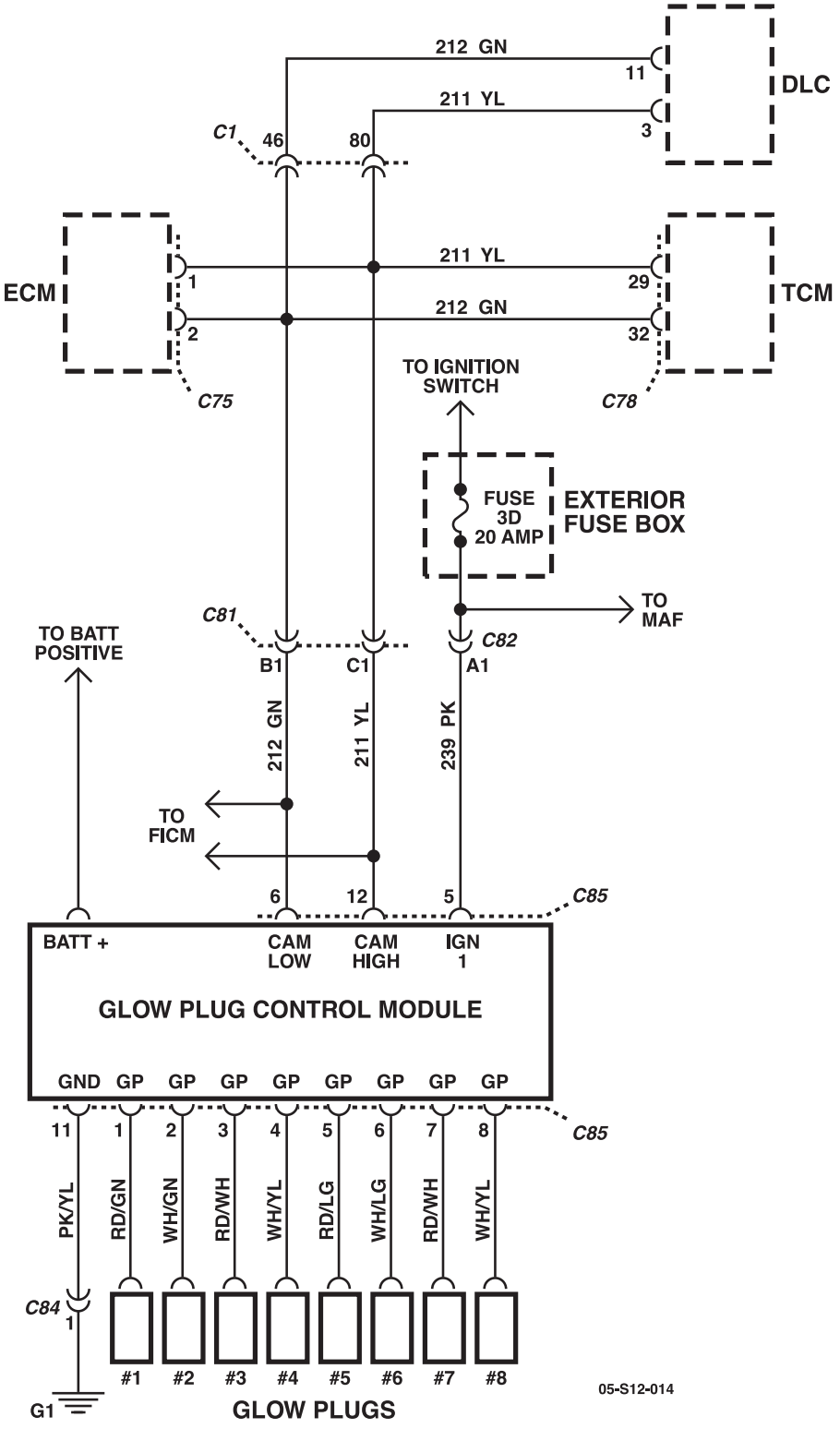


Figure OBD-61: Glow Plug Control Module Circuit

Circuit Description

The glow plug controller has the ability to perform internal diagnostics for voltage and output state of the glow plugs. If the glow plug controller senses an open in the main battery supply to the glow plug controller, or a condition with any of the glow plug driver circuits, the glow plug controller will send an error message to the engine control module (ECM).

Conditions for Setting the DTC

The glow plug controller detects an open to the main battery supply for the glow plugs, or an open in all 8 glow plug circuits for less than 1 second.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	Go to Intermittent Conditions
3	Is DTC P0671-P0678 set?		Go to Step 4	Go to Step 5

Step	Action	Value(s)	Yes	No
4	**NOTE:** The DVOM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis. Perform this test with the DVOM. Refer to the DVOM User Manual for calibration procedure. 1. Turn OFF the ignition. 2. Disconnect the glow plug controller harness connector. 3. Measure the resistance from the ground circuit PK/YL at the glow plug controller harness C85 pin 11 and a good ground on the engine with a DVOM. Does the DVOM display a resistance below the specified value?	1 ohms	Go to Step 6	Go to Step 7
5	1. Turn OFF the ignition. 2. Disconnect the main battery circuit from the glow plug controller. 3. Probe the main battery + circuit with a test lamp that is connected to a good ground. Does the test lamp illuminate?		Go to Step 6	Go to Step 8
6	Test for an intermittent and for a poor connection at the harness connector of the glow plug controller. Did you find and correct the condition?		Go to Step 11	Go to Step 10
7	Repair the ground circuit (PK/YL) of the glow plug harness between the glow plug controller C85 pin 11 and the engine ground G1 for high resistance. Did you complete the repair?		Go to Step 9	
8	Repair the open or the short to ground in the battery positive voltage circuit between the glow plug controller and the battery. Did you complete the repair?		Go to Step 11	
9	Replace the faulty glow plugs. Did you complete the replacement?		Go to Step 11	
10	Replace the faulty glow plug controller. Did you complete the replacement?		Go to Step 11	
11	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 12
12	Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0671-P0678 Glow Plug Control Circuit (Figure OBD-62)

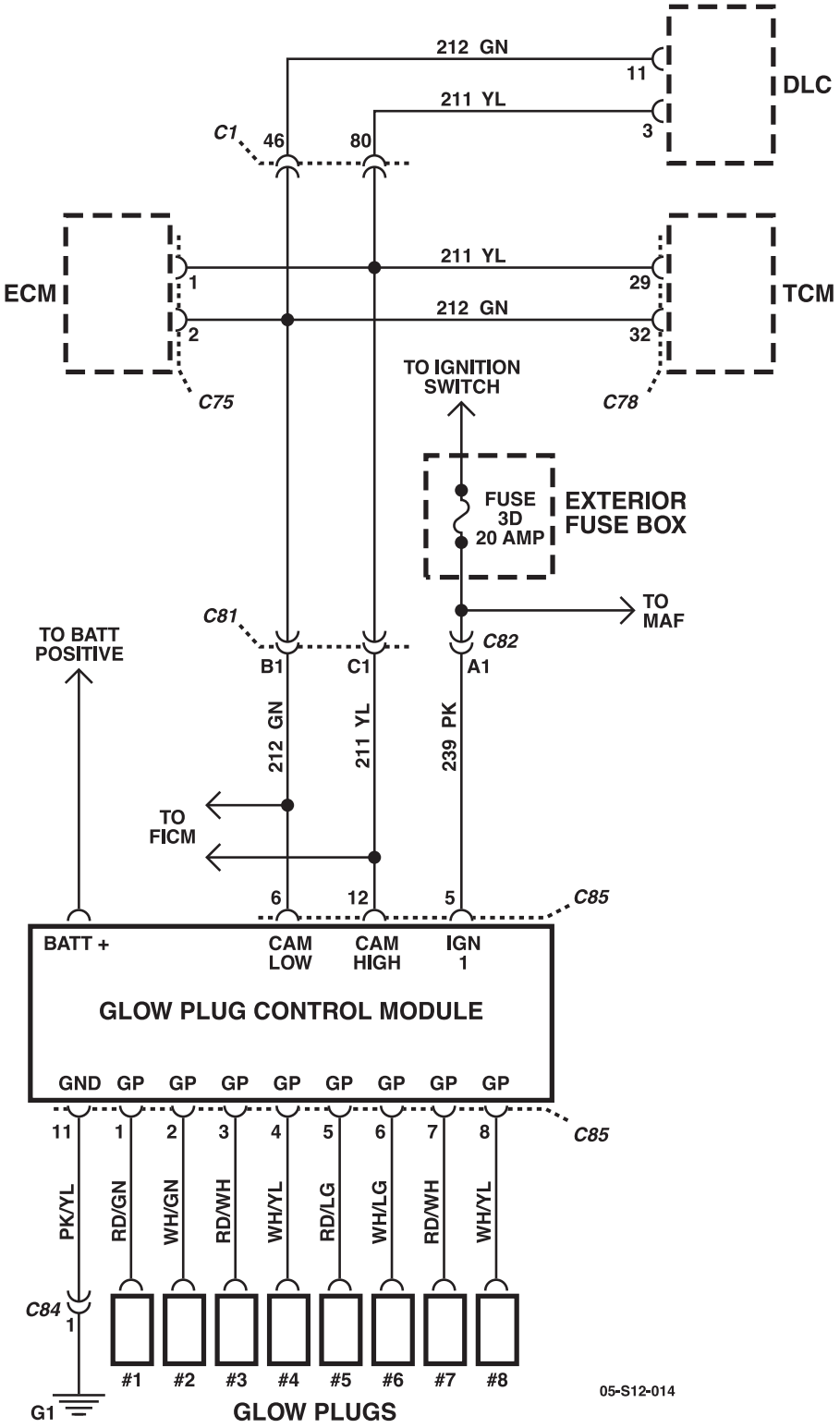


Figure OBD-62: Glow Plug Control Circuit

Circuit Description

The glow plug controller has the ability to perform internal checks, an open or a short to ground on each of the glow plug circuits. If the glow plug controller senses a problem in a glow plug circuit, the glow plug on the affected cylinder will be disabled and the glow plug controller will send an error message to the engine control module (ECM). If this condition exists, the DTC will set.

Conditions for Setting the DTC

The glow plug controller detects an open or a short to ground in the glow plug circuit for less than 1 second.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Is DTC P0670 set?		Go to DTC P0670	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition. 3. Turn ON the ignition, with the engine OFF. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze/Frame Failure Records. Did the DTC fail this ignition?		Go to Step 4	Go to Intermittent Conditions

Step	Action	Value(s)	Yes	No
4	1. Turn ON the ignition, with the engine OFF. 2. Probe the terminal on the affected glow plug, with an unpowered test lamp connected to the ground. **NOTE:** The glow plugs can only be commanded ON once per ignition cycle. Turn the ignition OFF and ON to command the glow plugs ON each time with a scan tool. 3. Command the glow plugs ON, with a scan tool. Does the test lamp illuminate with the glow plugs commanded ON?		Go to Step 5	Go to Step 6
5	1. Turn OFF the ignition. 2. Disconnect the glow plug connector at the affected glow plugs. 3. Probe the terminal on the glow plug with an unpowered test lamp connected to battery voltage. Does the test lamp illuminate?		Go to Step 8	Go to Step 11
6	Test the affected glow plug harness between the glow plug controller and the glow plug for the following conditions: • An open • A short to ground • A short to voltage Refer to Circuit Testing and Wiring Repairs in Wiring Systems. Did you find and correct the condition?		Go to Step 13	Go to Step 7
7	Test for an intermittent and for a poor connection at the harness connector of the glow plug controller. Did you find and correct the condition?		Go to Step 13	Go to Step 12
8	**NOTE:** The DVOM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis. Use the DVOM to perform this test. Refer to the DVOM User Manual for calibration procedure. Measure the resistance between the affected glow plug terminal of the glow plug and a good ground on the engine with a DVOM. Does the DVOM display a resistance below the specified value?	1 ohm	Go to Step 9	Go to Step 11
9	**NOTE:** The DVOM and test leads must be calibrated to 0 ohms in order to prevent misdiagnosis. Use the DVOM to perform this test. Refer to the DVOM User Manual for calibration procedure. 1. Disconnect the glow plug controller harness connector. 2. Measure the resistance from the affected glow plug supply voltage circuit between the glow plug harness connector and the glow plug controller harness connector with a DVOM. Does the DVOM display a resistance below the specified value?	1 ohm	Go to Step 12	Go to Step 10
10	Repair or replace the glow plug harness. Is the action complete?		Go to Step 13	
11	Replace the faulty glow plug. Did you complete the replacement?		Go to Step 13	

Step	Action	Value(s)	Yes	No
12	Replace the faulty glow plug controller. Did you complete the replacement?		Go to Step 13	
13	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 14
14	Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0698 5 Volt Reference 3 Circuit Low Voltage (Figure OBD-63)

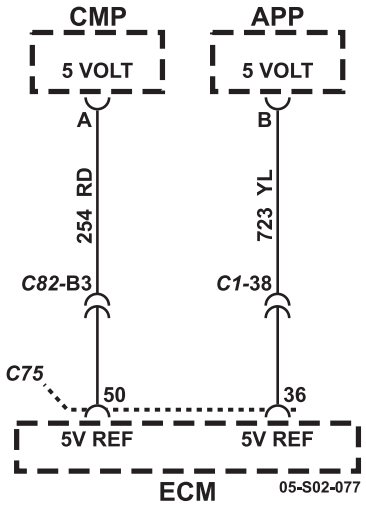


Figure OBD-63: 5 Volt Reference 3 Circuit

Circuit Description

The engine control module (ECM) provides 5 volts to the following sensors:

- The accelerator pedal position (APP) sensor 3
- The camshaft position (CMP) sensor

These 5-volt reference circuits are independent of each other outside the ECM, but are bussed together inside the ECM. Therefore, a circuit condition on one sensor 5-volt reference circuit may affect the other sensor 5-volt reference circuits. The ECM monitors the voltage on the 5-volt reference circuit. If the ECM detects a low voltage condition, DTC P0698 sets.

Conditions for Setting the DTC

- The ECM detects the 5-volt reference 3 circuit voltage is less than 4.7 volts.
- The above condition is present for 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Observe the Freeze Frame/Failure records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	Go to Intermittent Conditions
3	1. Turn OFF the ignition. 2. Disconnect the accelerator pedal position (APP) sensor. 3. Turn ON the ignition, with the engine OFF. 4. Observe the 5-Volt Reference 3 parameter with a scan tool. Is the 5-Volt Reference 3 parameter within the specified range?	4.7-5.2 Volts	Go to Step 8	Go to Step 4
4	1. Disconnect the camshaft position (CMP) sensor. 2. Turn ON the ignition, with the engine OFF. 3. Observe the 5-Volt Reference 3 parameter with a scan tool. Is the 5-Volt Reference 3 parameter within the specified range?	4.7-5.2 Volts	Go to Step 9	Go to Step 5
5	Test the 5-volt reference circuit 254 (RD) of the CMP sensor for a short to ground. Did you find and correct the condition?		Go to Step 10	Go to Step 6
6	Test the 5-volt reference circuit 723 (YL) of the APP sensor 3 for a short to ground. Did you find and correct the condition?		Go to Step 10	Go to Step 7
7	Replace the faulty engine control module (ECM). Did you complete the replacement?		Go to Step 10	
8	Replace the faulty APP sensor. Did you complete the replacement?		Go to Step 10	
9	Replace the faulty CMP sensor. Did you complete the replacement?		Go to Step 10	
10	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 11

Step	Action	Value(s)	Yes	No
11	Using the Scan Tool select “Capture Info,” Review Info.” Are any DTC’s displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0699 5 Volt Reference 3 Circuit High Voltage (Figure OBD-64)

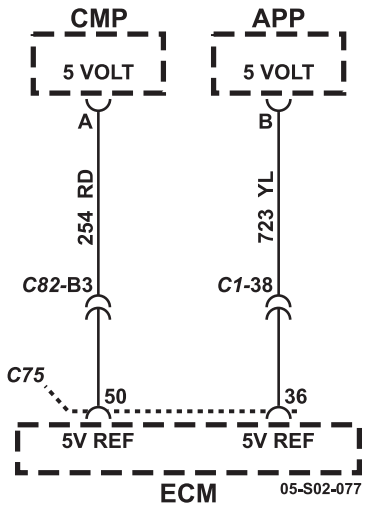


Figure OBD-64: 5 Volt Reference 3 Circuit

Circuit Description

The engine control module (ECM) provides 5 volts to the following sensors:

- The accelerator pedal position (APP) sensor 3
- The camshaft position (CMP) sensor

These 5-volt reference circuits are independent of each other outside the ECM, but are bussed together inside the ECM. Therefore, a circuit condition on one sensor 5-volt reference circuit may affect the other sensor 5-volt reference circuits. The ECM monitors the voltage on the 5-volt reference circuit. If the ECM detects a high voltage condition, DTC P0699 sets.

Conditions for Setting the DTC

- The ECM detects the 5-volt reference 3 circuit voltage is more than 5.2 volts.
- The above condition is present for 2 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the 5-Volt Reference 3 parameter with a scan tool. Is the 5-Volt Reference 3 parameter more than the specified value?	5.2 Volts	Go to Step 3	Go to Intermittent Conditions
3	Test the accelerator pedal position (APP) 3 sensor 5-volt reference circuit 723 (YL) for a short to voltage. Did yo find and correct the condition?		Go to Step 6	Go to Step 4
4	Test the camshaft position (CMP) sensor 5-volt reference circuit 254 (RD) for a short to voltage. Did yo find and correct the condition?		Go to Step 6	Go to Step 5
5	Replace the faulty engine control module (ECM). Did you complete the replacement?		Go to Step 10	
6	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 1	Go to Step 11
7	Using the Scan Tool select "Capture Info," Review Info." Are any DTC's displayed that have not been diagnosed?		Go to the applicable DTC table.	System OK.

DTC P0700 Transmission Control Module (TCM) Request Mill Illumination

Circuit Description

This diagnostic trouble code (DTC) indicates that a related transmission DTC set in the transmission control module (TCM). The engine control module (ECM) receives the TCM DTC information over the serial data circuit. The ECM turns ON the malfunction indicator lamp (MIL) when the TCM sends a message over the serial data circuit requesting MIL illumination.

DTC P0700 is a type A DTC.

Conditions for Setting the DTC

The ECM receives a serial data message from the TCM, in order to illuminate the MIL.

Action Taken When the DTC Sets

- The control module illuminates the MIL when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the DTC

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	1. Install the scan tool. **NOTE:** • Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. • DTC P0700 is set by the ECM. DTC P0700 allows a technician to be alerted from the engine diagnostic side that the TCM is setting a DTC and is requesting the MIL. • If the TCM has DTC's set that are requesting MIL illumination, those DTC's must be diagnosed first. Refer to Obtaining Diagnostic Trouble Codes. 2. Turn ON the ignition, with the engine OFF. Does the scan tool display any DTC's other than DTC P0700?		Go to Diagnostic Trouble Code (DTC) List/Type	Go to Diagnostic System Check - Vehicle in Vehicle DTC Information

DTC P0701 Transmission Control System

Circuit Description

The transmission control module (TCM) monitors the status of the pressure switches at start-up to detect the presence of hydraulic pressure.

DTC P0701 is a type C DTC.

Conditions for Setting the DTC

DTC P0701 sets when the TCM detects the following conditions:

- Transmission fluid temperature is above -25°C (-13°F).
- All pressure switches do not indicate pressure at startup.
- Engine speed is above 500 RPM for 6 seconds or 400 RPM for 15 seconds.
- Forward or REVERSE range is selected.

Action Taken When the DTC Sets

- he TCM does not illuminate the malfunction indicator lamp (MIL).
- DTC P0701 will be stored in TCM history.
- TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- DTC P0701 may be logged if a forward or REVERSE range is selected immediately after the engine is started, and before the TCM detects pressure at the switches, 2-6 seconds after engine start.
- A plugged control main filter may cause this code to set.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine and measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Step 4
3	This DTC can be set after performing fluid service and filter change, after replacement of the pressure switch manifold (PSM), or after a long period of storage. Have any of these conditions occurred?		Go to Step 7	Go to Step 5
4	Add fluid to the proper level. Is the fluid at the appropriate level?		Go to Step 5	
5	Measure line pressure. Is the pressure within the specified value?		Go to Step 7	Go to Step 6
6	No main pressure at idle may be an indication of the following conditions: • Stuck or sticking lube regulator valve • Stuck or sticking main regulator valve • Loose or damaged suction filter • Defective suction filter seal Did you find the reason for a no line pressure condition and was it repaired?		Go to Step 7	Go to Symptoms - Automatic Transmission
7	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Select Specific DTC. 4. Enter DTC P0701. Has the test run and passed?		System OK	Go to Step 1

DTC P0703 Brake Switch Circuit

Circuit Description

A mechanical switch attached to the brake pedal sends a signal to the transmission control module (TCM) indicating the service brake has been applied.

DTC P0703 is a type C DTC.

Conditions for Setting the DTC

DTC P0703 sets when the vehicle accelerates 10 times with the brake switch in the ON position, or decelerates 10 times with the brake switch in the OFF position.

Action Taken When the DTC Sets

- The TCM does not illuminate the malfunction indicator lamp (MIL).
- The TCM uses default assumption that brake is off.
- DTC P0703 will be stored in TCM history.
- TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

DTC P0703 indicates that the TCM did not see the proper input signal for service brake status during an acceleration or deceleration cycle. This may indicate an open or short in the TCC brake switch/cruise control release circuit or a faulty stop lamp switch.

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Apply and release the service brake. Does the scan tool indicate that the brake switch is toggling off and on?		Go to Diagnostic Aids	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the C78 connector at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Turn ON the ignition. 5. Using a DOMM, measure voltage at C78 pin 7 and a good ground. 6. Apply and release the service brake. Is voltage within the specified value?	Brakes applied 0.0 Volts Brakes released 12.0 Volts	Go to Diagnostic Aids	Go to Step 4
4	Using the DVOM, measure voltage at terminal C of the stop lamp switch and a good ground. Is voltage within the specified value?	B+	Go to Step 5	Go to Step 6
5	Using a DVOM, measure voltage at terminal D of the stop lamp switch. Is voltage available?	B+	Go to Step 8	Go to Step 7
6	1. Remove the brake fuse. 2. Inspect the brake fuse for an open. Did you find and correct the condition?		Go to Step 9	
7	Repair or replace the stop lamp switch. Did you complete the repair or replacement?		Go to Step 9	
8	Inspect the engine wiring harness for an open or short to ground. Did you find and correct the condition?		Go to Step 9	
9	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the brake switch. 3. Operate the vehicle under the Conditions for Setting the DTC. 4. Select Specific DTC. 5. Enter DTC P0703. Has the test run and passed?		System OK	Go to Step 1

DTC P0708 Transmission Range Sensor Circuit High Input (Figure OBD-65)

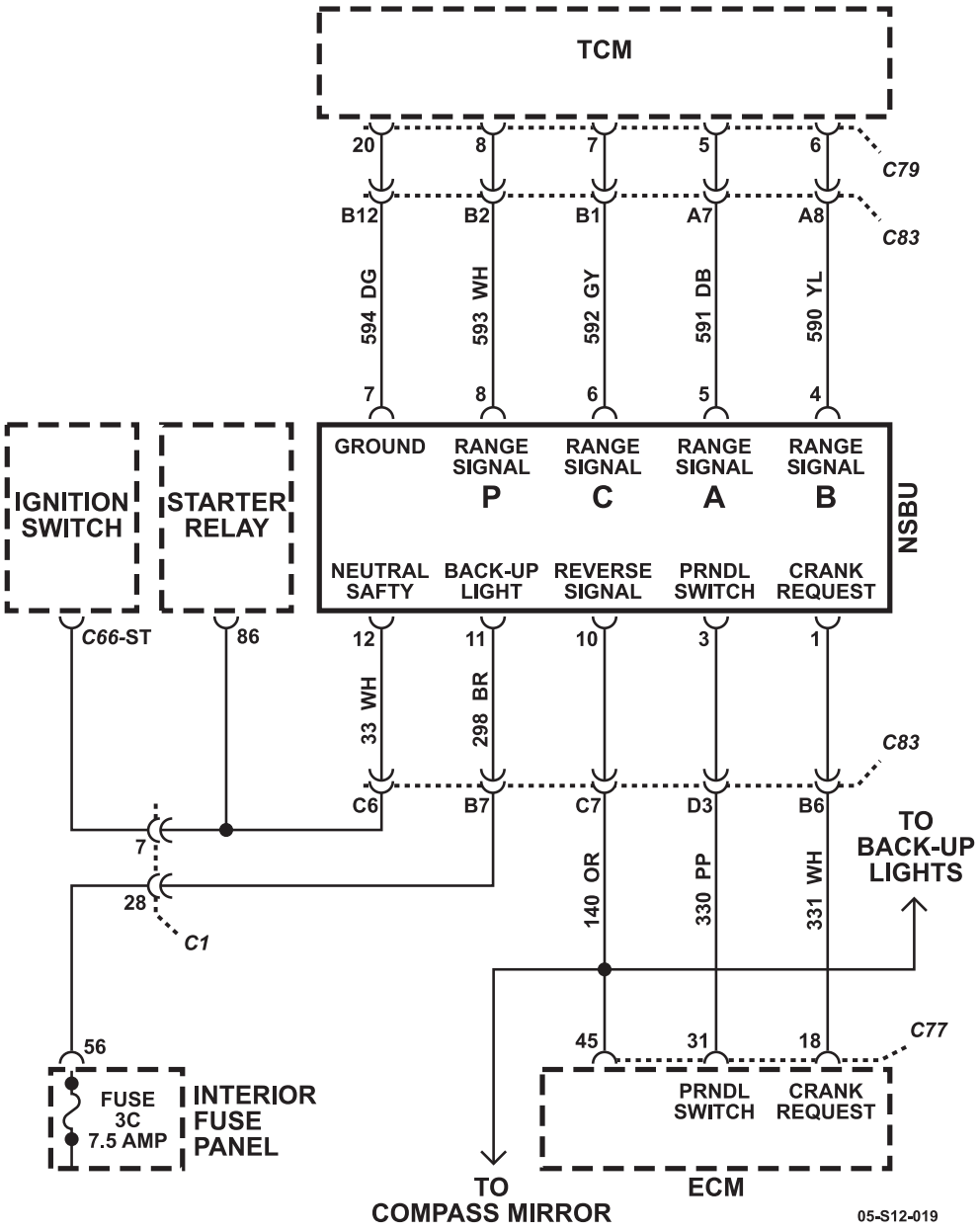


Figure OBD-65: Transmission Range Sensor Circuit

Circuit Description

The installation of a transmission mounted neutral start back up (NSBU) switch is required. This switch mounts directly onto the transmission housing from the outside, and detects the angular position of the shift selector shaft. This position is communicated to the transmission control module (TCM) so that certain vehicle control functions can be coordinated with the position of the shift controls. The NSBU switch has redundant circuitry to alert the TCM in the event of a single wire or switch failure.

The neutral signal output of the NSBU switch is typically used as confirmation that the transmission is in NEUTRAL before the engine starter is engaged. The NSBU switch is interfaced to the starter circuit with weatherproof electrical connectors. The reverse signal provision may be used to activate vehicle back-up lights and/or reverse warning devices.

DTC P0708 is a type A DTC.

Conditions for Setting the DTC

DTC P0708 sets when the TCM detects an invalid condition and parity error occurring over consecutive ignition cycles.

Action Taken When the DTC Sets

While diagnostic response is active, one of the following conditions can occur:

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission fails to hydraulic default.
- DTC P0708 will be stored in TCM history.
- The TCM freezes shift adapts.
- TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool must be used to clear the code from TCM history. This DTC does not automatically clear from TCM history after 40 ignition cycles.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM and the ECM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- If a P0875, previously a P1713, is shown in failure records as being set first on the failure list followed by a P0872, previously a P1711, combined with P0708, this generally indicates a PNP internal switch failure. Often when the DTCs are cleared they do not return, this may be due to moisture that was present at the time the DTC was set, causing a short internally.
- Inspect the NSBU switch linkage carefully for proper adjustment. Also, inspect the switch for signs of damage.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Inspect for proper adjustment of the NSBU switch. Is the NSBU switch and shift linkage properly adjusted?		Go to Step 3	

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. With the scan tool, observe the TR Sw. display while selecting each transmission range: P, R, N, D4, D3, D2, and D1. Does each selected transmission range match the scan tool TR Sw. display?		Go to Diagnostic Aids	Go to Step 4
4	1. Turn the ignition OFF. 2. Disconnect the 12-way connector at the NSBU switch. 3. Turn the ignition ON. 4. In sequence, connect terminals 4, 5, 6, and 8 to terminal 7 in the 12-way NSBU connector. 5. Using the scan tool, monitor transmission range switch status. Does each selected transmission range match the scan tool NSBU Sw. display?	PARK = 5 and 8 REVERE = 5 and 4 NETRAL = 8 and 4 DRIVE 4 = 6 and 4 DRIVE 3 = 4, 5, 6, 8 DRIVE 2 = 5 and 6 DRIVE 1 = 6 and 8	Go to Step 8	Go to Step 5
5	Using the DVOM and the J 35616-C GM terminal test kit measure the following: 1. Measure the voltage from pin 5 of the NSBU switch 12-way connector to ground. 2. Measure the voltage from pin 6 of the NSBU switch 12-way connector to ground. 3. Measure the voltage from pin 8 of the NSBU switch 12-way connector to ground. 4. Measure the voltage from pin 4 of the NSBU switch 12-way connector to ground. Does the voltage measure within the specified value at all four terminals?	B+	Go to Step 6	Go to Step 7

Step	Action	Value(s)	Yes	No
6	1.Turn the ignition OFF. 2.Disconnect TCM C79. 3.Using the DVOM and the J 35616-C, in sequence, test the signal circuits 591 (DB), 592 (GY), 594 (DG), and 593 (WH) between C79 of the TCM and 591 (DB), 592 (GY), 594 (DG), and 593 (WH) of the NSBU switch 12-way connector for a short to voltage condition. Did you find and correct the condition?		Go to Step 10	Go to Step 9
7	Test the signal circuits of the NSBU switch that did not indicate proper voltage for an open or short to ground. Did you find and correct the condition?		Go to Step 10	Go to Step 9
8	**NOTE:** A scan tool must be used in order to clear the code from the TCM history. Replace the faulty NSBU switch. Did you complete the replacement?		Go to Step 10	
9	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 10	
10	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the TR Sw. display while selecting each transmission range, P, R, N, D4, D3, D2, and D1. 3. Select Specific DTC. 4. Enter DTC P0708. Has the test run and passed?		System OK	Go to Step 1

DTC P0711 Transmission Temperature Sensor Circuit Performance (Figure OBD-66)

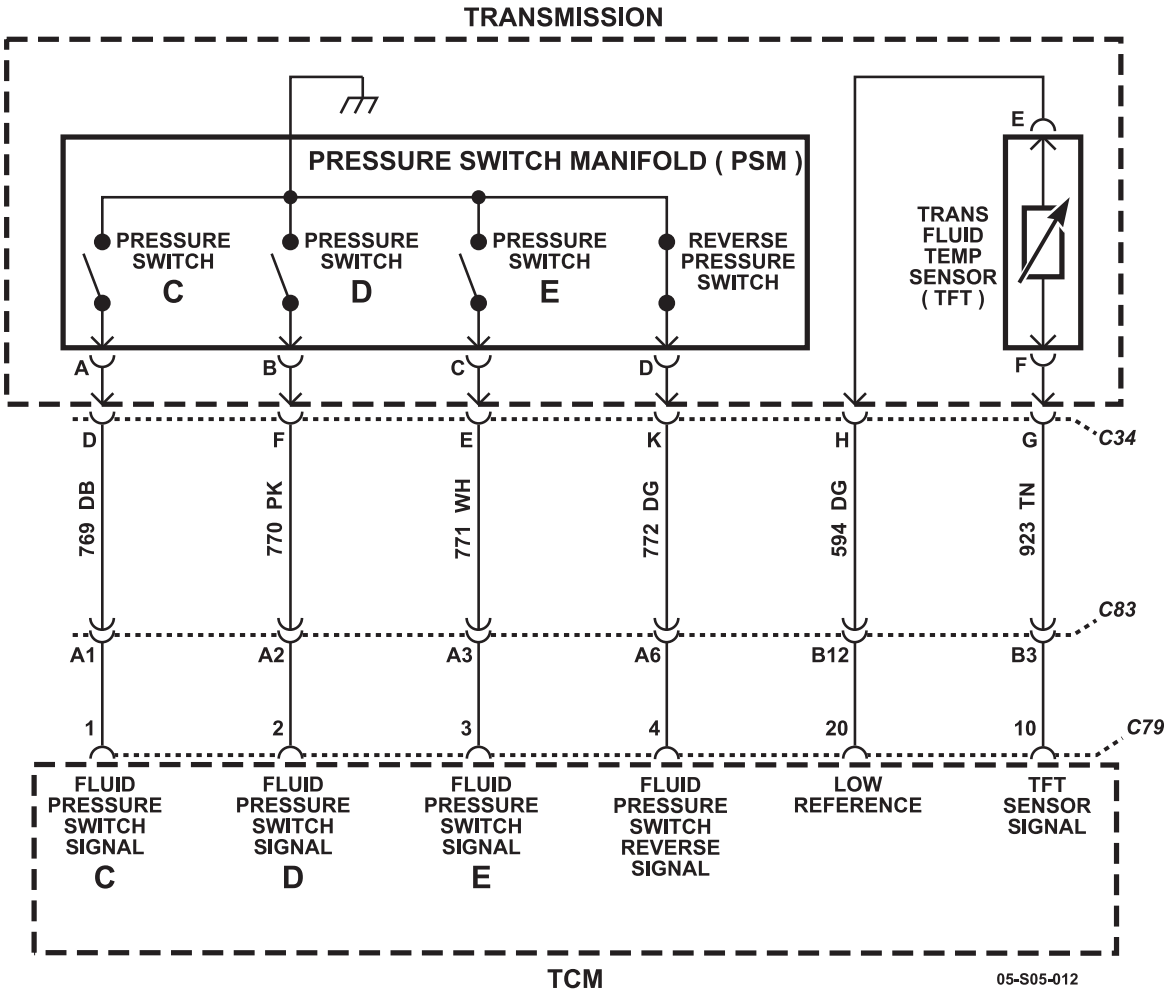


Figure OBD-66: Transmission Temperature Sensor Circuit

Circuit Description

The transmission fluid temperature (TFT) sensor is a part of the pressure switch manifold (PSM) assembly, and is located in the transmission oil pan. The TFT sensor is a thermistor, which changes value based on the temperature of the transmission fluid. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, as the temperature decreases the resistance increases. The transmission control module (TCM) supplies a 5 volt reference voltage signal to the TFT sensor and measures the voltage drop in the circuit. When the transmission is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature warms to a normal operating temperature, the resistance becomes less and the signal voltage decreases. The TCM uses this information to control shift quality and torque converter clutch (TCC) apply.

DTC P0711 is a type B DTC.

Conditions for Setting the DTC

DTC P0711 sets when the TCM detects one of the following conditions:

- The TCM detects a temperature change that is below a set limit when compared to samples of the minimum and maximum temperature values.
- The TFT has an unrealistic temperature change of greater than 10°C (50°F) for 10 occurrences.
- The temperature from startup decreases 40°C (104°F) or greater within a duration of 6 seconds or greater.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM freezes shift adapts.
- The TCM records the operating conditions when the Conditions for Setting the DTC are met. The TCM stores this information as Failure Records.
- The TCM stores DTC P0711 in TCM history.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- The TFT should rise steadily during warm-up cycles, then stabilize.
- DTC P0218 may set after DTC P0711 has set. Follow the diagnostic table for DTC P0711 before proceeding to the diagnostic for DTC P0218.
- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- An open condition at circuit 2762 may allow a ground path internally through circuit 2471. If this occurs, the TCM sees a temperature that appears to be within normal operation, approximately -22°C (-7.6°F), and initially a code will not be set. However, the transmission will still inhibit shift adapts and TCC operation. It may take several minutes before P0711 code is set to indicate a failure.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select TFT on the scan tool. 6. Drive the vehicle and look for an unrealistic TFT reading. Is the TFT reading at or below the specified value?	1.5°C (2.7°F)	Go to Step 4	Go to Diagnostic Aids
4	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Turn ON the ignition, with the engine OFF. 5. Use a DVOM, measure voltage at C79 terminal 10 and terminal 20. Is the voltage within the specified value?	5 Volts	Go to Step 5	Go to Step 11
5	1. Turn the ignition OFF. 2. Using a DVOM, measure resistance at C79 terminal 10 and terminal 20. Is the resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Diagnostic Aids	Go to Step 6
6	1. Turn the ignition OFF. 2. Disconnect the transmission 20-way C34. 3. Using a DVOM, measure resistance at the transmission side of the 20-way connector between terminals G and H. Is the resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Remove the transmission oil pan. 2. Disconnect the pressure switch manifold (PSM) from the internal wiring harness. 3. Using a DVOM, measure the PSM resistance at terminals C and B. Is resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Step 9	Go to Step 10
8	Repair the engine wiring harness. Did you complete the repair?		Go to Step 12	
9	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 12	
10	Replace the PSM. Did you complete the replacement?		Go to Step 12	
11	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 12	
12	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the TFT. 3. Drive the vehicle under normal operating conditions. Watch for significant changes in TFT. 4. Select Specific DTC. 5. Enter DTC P0711. Has the test run and passed?		System OK	Go to Step 1

DTC P0712 Transmission Fluid Temperature Sensor Circuit Low Input (Figure OBD-67)

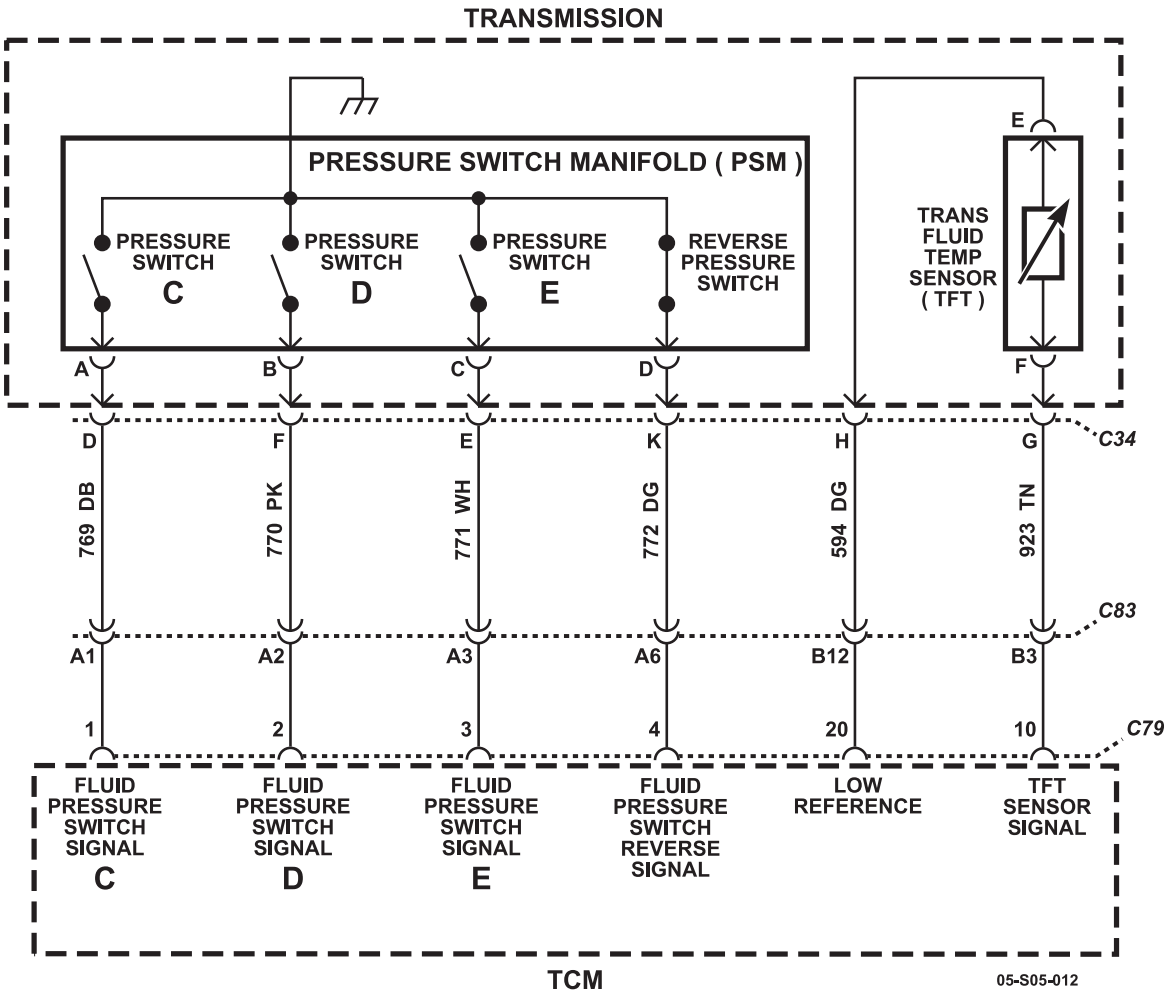


Figure OBD-67: Transmission Fluid Temperature Sensor Circuit

Circuit Description

The transmission fluid temperature (TFT) sensor is a part of the pressure switch manifold (PSM) assembly, and is located in the transmission oil pan. The TFT sensor is a thermistor, which changes value based on the temperature of the transmission fluid. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, as the temperature decreases the resistance increases. The transmission control module (TCM) supplies a 5 volt reference voltage signal to the TFT sensor and measures the voltage drop in the circuit. When the transmission is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature warms to a normal operating temperature, the resistance becomes less and the signal voltage decreases. The TCM uses this information to control shift quality and torque converter clutch (TCC) apply.

DTC P0712 is a type B DTC.

Conditions for Setting the DTC

DTC P0712 sets when the TCM detects a temperature greater than 150°C (302°F) for 2.5 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM uses a TFT default value.
- The TCM freezes shift adapts.
- The TCM stores this information as Failure Records.
- The TCM stores DTC P0218 in TCM history.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- A short to ground on circuit 1227 will allow a code P0712 to set.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select TFT on the scan tool. 6. Drive the vehicle and inspect for an unrealistic TFT reading. Is the TFT reading at or below the specified value?	-36°C (-32°F)	Go to Step 4	Go to Diagnostic Aids
4	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Turn ON the ignition, with the engine OFF. 5. Using a DVOM, measure voltage at C79 terminal 10 and terminal 20. Is voltage within the specified value?	5 Volts	Go to Step 5	Go to Step 11
5	1. Turn the ignition OFF. 2. Using a DVOM, measure the resistance at C79 terminal 10 and terminal 20. Is the resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Diagnostic Aids	Go to Step 6
6	1. Turn the ignition OFF. 2. Disconnect the transmission 20-way C34. 3. Using a DVOM, measure resistance at the transmission side 20-way connector terminals G and H. Is the resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Remove the transmission oil pan. 2. Disconnect the PSM from the internal wiring harness. 3. Using a DVOM, measure the PSM resistance at terminals E and F. Is resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Step 9	Go to Step 10
8	Repair the engine wiring harness. Did you complete the repair?		Go to Step 12	
9	Replace the faulty automatic transmission internal harness. Did you complete the replacement?		Go to Step 12	
10	Replace the faulty PSM. Did you complete the replacement?		Go to Step 12	
11	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 12	
12	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the transmission fluid temperature. 3. Drive the vehicle under normal operating conditions. Watch for significant changes in TFT. 4. Select Specific DTC. 5. Enter DTC P0712. Has the test run and passed?		System OK	Go to Step 1

DTC P0713 Transmission Fluid Temperature Sensor Circuit High Input (Figure OBD-68)

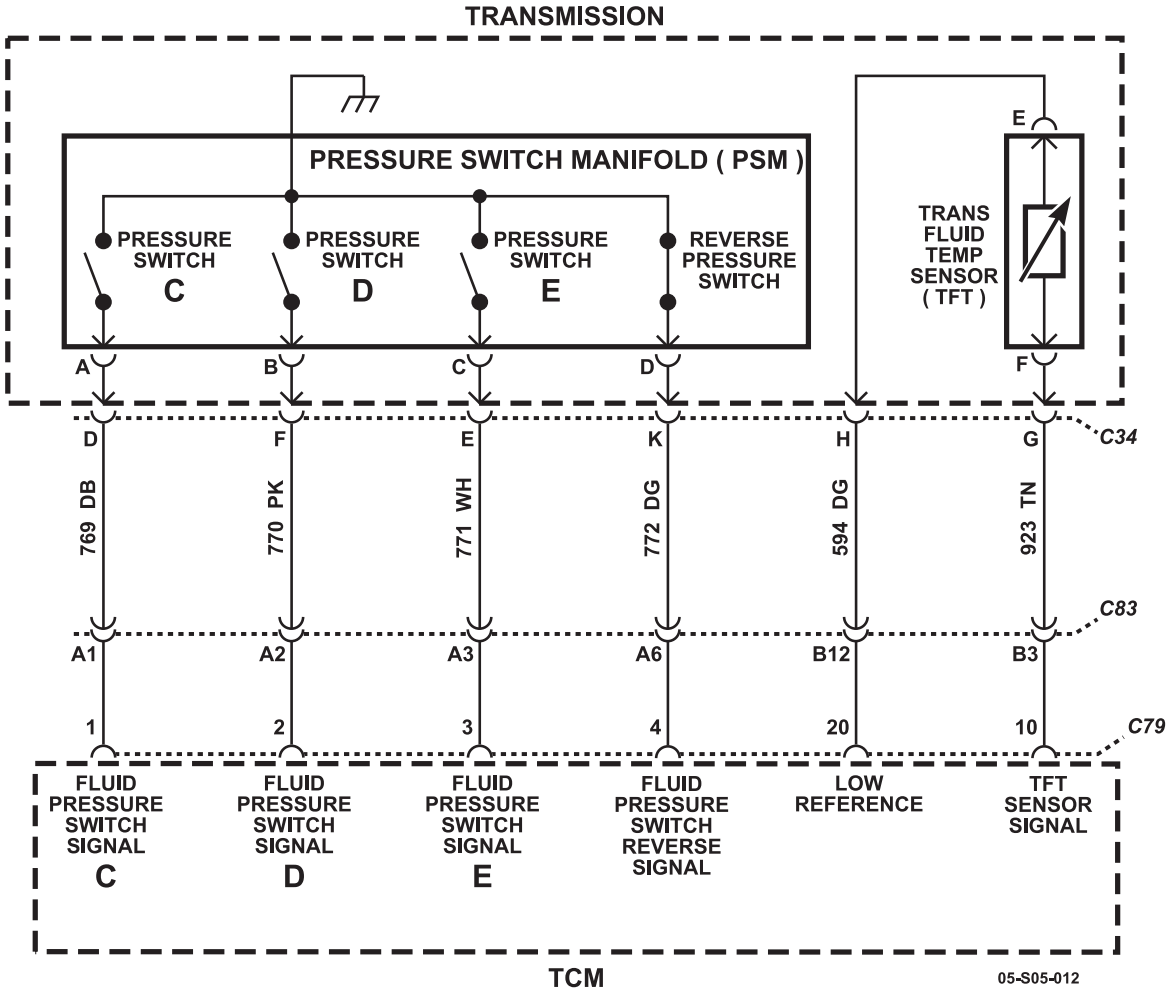


Figure OBD-68: Transmission Fluid Temperature Sensor Circuit

Circuit Description

The transmission fluid temperature (TFT) sensor is part of the pressure switch manifold (PSM) assembly, and is located in the transmission oil pan. The TFT sensor is a thermistor, which changes value based on the temperature of the transmission fluid. The sensor has a negative-temperature coefficient. This means that as the temperature increases, the resistance decreases, as the temperature decreases the resistance increases. The transmission control module (TCM) supplies a 5 volt reference voltage signal to the TFT sensor and measures the voltage drop in the circuit. When the transmission is cold, the sensor resistance is high and the TCM detects high signal voltage. As the fluid temperature warms to a normal operating temperature, the resistance becomes less and the signal voltage decreases. The TCM uses this information to control shift quality and torque converter clutch (TCC) apply.

DTC P0713 is a type B DTC.

Conditions for Setting the DTC

DTC P0713 sets when the TCM detects a voltage greater than 4.84 volts for 2.5 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The TCM uses a TFT default value.
- The TCM freezes shift adapts.
- The TCM stores this information as Failure Records.
- The TCM stores DTC P0218 in TCM history.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- A short to power on circuit 2762 will allow P0713 to set.
- A short to power may also damage the TFT sensor.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Select TFT on the scan tool. 6. Drive the vehicle and inspect for an unrealistic TFT reading. Is the TFT reading at or below the specified value?	-36°C (-32°F)	Go to Step 4	Go to Diagnostic Aids
4	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Turn ON the ignition, with the engine OFF. 5. Using a DVOM, measure voltage at C79 terminal 10 and terminal 20. Is voltage within the specified value?	5 Volts	Go to Step 5	Go to Step 11
5	1. Turn the ignition OFF. 2. Using a DVOM, measure the resistance at C79 terminal 10 and terminal 20. Is the resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Diagnostic Aids	Go to Step 6
6	1. Turn the ignition OFF. 2. Disconnect the transmission 20-way C34. 3. Using a DVOM, measure resistance at the transmission side 20-way connector terminals G and H. Is the resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Step 8	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Remove the transmission oil pan. 2. Disconnect the PSM from the internal wiring harness. 3. Using a DVOM, measure the PSM resistance at terminals E and F. Is resistance within the specified value?	3,490 ohms [commat] 20°C (68°F) 177.9 ohms [commat] 100°C (212°F)	Go to Step 9	Go to Step 10
8	Repair the engine wiring harness. Did you complete the repair?		Go to Step 12	
9	Replace the faulty automatic transmission internal harness. Did you complete the replacement?		Go to Step 12	
10	Replace the faulty PSM. Did you complete the replacement?		Go to Step 12	
11	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 12	
12	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the transmission fluid temperature. 3. Drive the vehicle under normal operating conditions. Watch for significant changes in TFT. 4. Select Specific DTC. 5. Enter DTC P0712. Has the test run and passed?		System OK	Go to Step 1

DTC P0716 Turbine Speed Sensor Circuit Performance (Figure OBD-69)

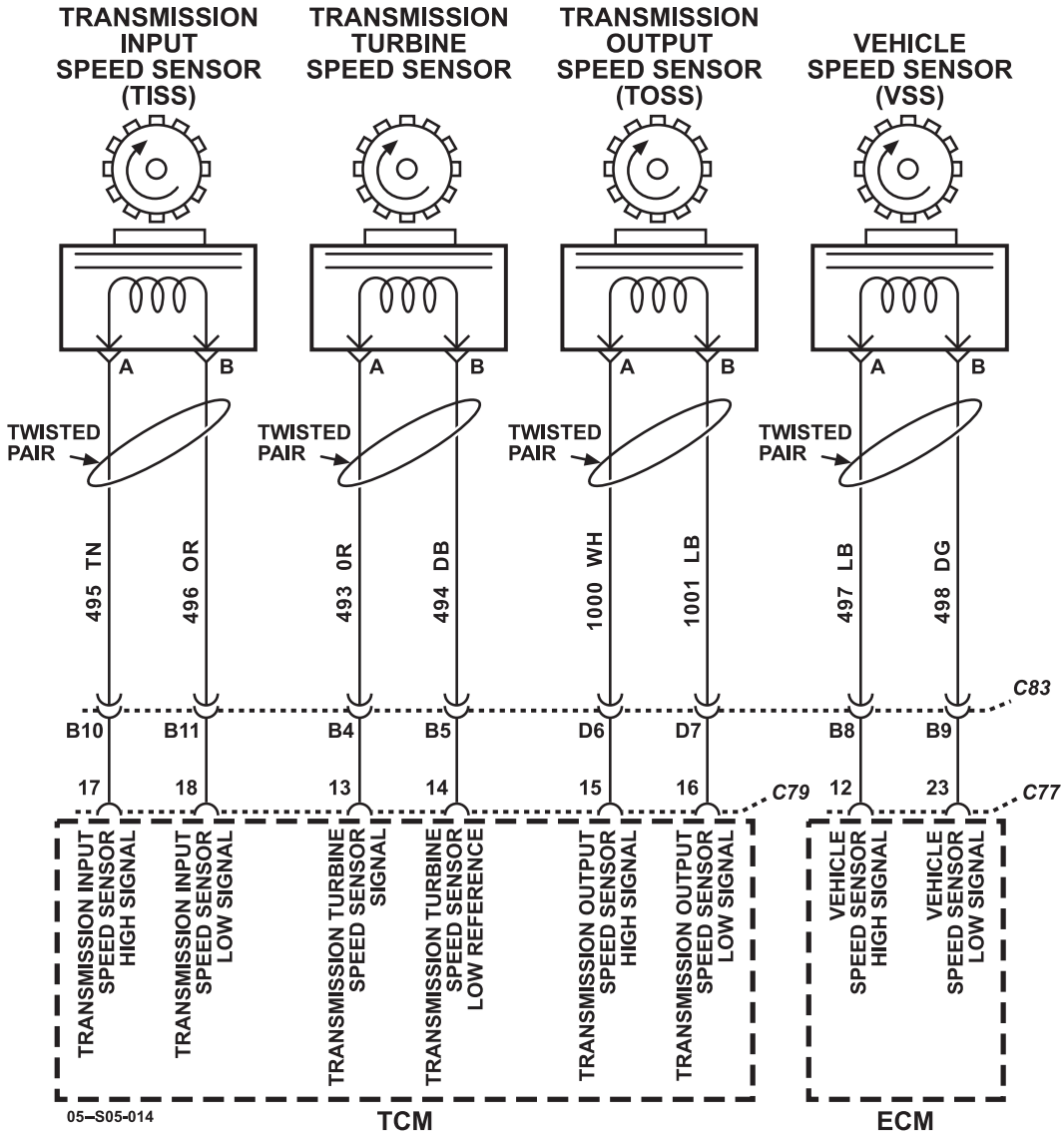


Figure OBD-69: Turbine Speed Sensor Circuit

Circuit Description

The speed sensors are variable reluctance devices that convert mechanical motion to an AC voltage. Each sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member, such as a gear tooth. Two signal wires extend from one end of the housing, and an exposed end of the pole piece is at the opposite end of the housing. The permanent magnet produces lines of flux around the pole piece. As a ferrous object, such as a gear tooth, approaches and passes through the gap at the end of the pole piece, an AC voltage pulse is induced in the wire coil. The transmission control module (TCM) calculates the frequency of these AC pulses and converts it to a speed value. The AC voltage generated varies from 150 millivolt at low speed to 15 volts at high speed. The signal wires from the sensor are formed as twisted pairs to cancel magnetically induced fields. The cable is also shielded to protect from voltage-related fields. Using two-wire differential inputs at the TCM eliminates noise from other sources.

DTC P0716 is a type A DTC.

Conditions for Setting the DTC

DTC P0716 sets when the TCM detects a large unrealistic change in turbine speed or if excessive noise is present in the turbine speed sensor circuit.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When failure occurs in a forward range and shifting is complete, the transmission remains in the current range. When failure occurs while in a forward range and the shift is in process, the transmission returns to the previous range, except in post-shift state, where the transmission will continue the commanded range. When failure occurs in other conditions, the transmission shifts to 1st, 3rd or 5th. While diagnostic response is active, if the shift selector is moved to NEUTRAL or REVERSE or is selecting DRIVE again, then the transmission will lock in NEUTRAL.
- DTC P0716 will be stored in TCM history.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- If the condition is intermittent, connect the scan tool and select the speed sensor indicated by the code. If the signal is erratic, investigate and eliminate the following:
  - Intermittent wiring connection
  - Excessive vibration, such as driveline or engine torsionals
  - Irregular sensor gap, such as a loose sensor, a loose tone wheel or a damaged tone wheel
  - Inspect that the speed sensor wiring consists of twisted pairs at the rate of 12-16 twists per 300 mm (12 in). These twists must extend the entire length of the wiring harness to within at least 50 mm (2 in) of the speed sensor connector.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 from the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at the C79. 4. Using a DVOM, measure the resistance between connector C79 pin 13 and 14. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Diagnostic Aids	Go to Step 4
4	1. Disconnect the wiring harness from the turbine speed sensor. 2. Using a DVOM, measure the resistance between the speed sensor terminals. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Step 5	Go to Step 6
5	Repair the engine wiring harness. Did you complete the repair?		Go to Step 7	
6	**NOTE:** Do not rotate the speed sensor in the retaining bracket. Orientation is fixed, and if changed, may cause improper operation. Replace the faulty turbine speed sensor. Did you complete the replacement?		Go to Step 7	Go to Diagnostic Aids
7	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the turbine speed sensor operation. 3. Select Specific DTC. 4. Enter DTC P0716. Has the test run and passed?		System OK	Go to Step 1

DTC P0717 Turbine Speed Sensor Circuit No Signal (Figure OBD-70)

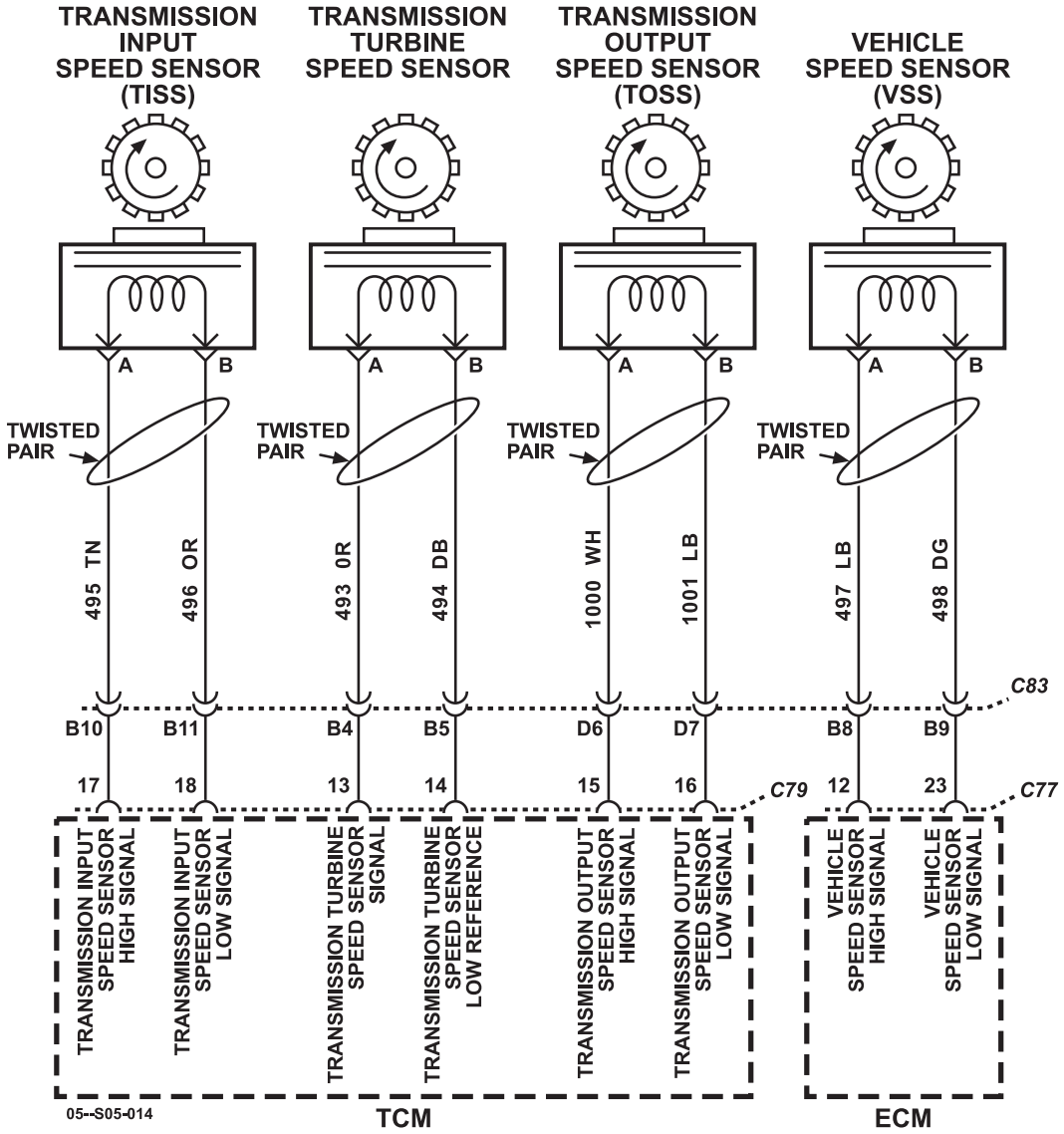


Figure OBD-70: Turbine Speed Sensor Circuit

Circuit Description

The speed sensors are variable reluctance devices that convert mechanical motion to an AC voltage. Each sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member, such as a gear tooth. Two signal wires extend from one end of the housing and an exposed end of the pole piece is at the opposite end of the housing. The permanent magnet produces lines of flux around the pole piece. As a ferrous object, such as a gear tooth, approaches and passes through the gap at the end of the pole piece, an AC voltage pulse is induced in the wire coil. The transmission control module (TCM) calculates the frequency of these AC pulses and converts it to a speed value. The AC voltage generated varies from 150 millivolt at low speed to 15 volts at high speed. The signal wires from the sensor are formed as twisted pairs to cancel magnetically induced fields. The cable is also shielded to protect from voltage-related fields. Using two-wire differential inputs at the TCM eliminates noise from other sources.

DTC P0717 is a type A DTC.

Conditions for Setting the DTC

DTC P0717 sets when the TCM detects one of the following conditions:

- An unrealistically large change in turbine speed
- An unrealistically low turbine speed

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When failure occurs in a forward range and shifting is complete, the transmission remains in the current range. When failure occurs while in a forward range and the shift is in process, the transmission returns to the previous range, except in post-shift state, where the transmission will continue to the commanded range. When failure occurs in other conditions, the transmission shifts to 1st, 3rd or 5th. While diagnostic response is active, if the shift selector is moved to NEUTRAL or REVERSE or selecting DRIVE again, then the transmission will lock in NEUTRAL.
- DTC P0717 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- If the condition is intermittent, connect the scan tool and select the speed sensor indicated by the code. If the signal is erratic, investigate and eliminate the following:
  - Intermittent wiring connection
  - Excessive vibration, such as driveline or engine torsionals
  - Irregular sensor gap, such as a loose sensor, a loose tone wheel or a damaged tone wheel
  - Inspect that the speed sensor wiring consists of twisted pairs at the rate of 12-16 twists per 300 mm (12 in). These twists must extend the entire length of the wiring harness to within at least 50 mm (2 in) of the speed sensor connector.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 from the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at the C79. 4. Using a DVOM, measure the resistance between connector C79 pin 13 and 14. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Diagnostic Aids	Go to Step 4
4	1. Disconnect the wiring harness from the turbine speed sensor. 2. Using a DVOM, measure the resistance between the speed sensor terminals. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Step 5	Go to Step 6
5	Repair the engine wiring harness. Did you complete the repair?		Go to Step 7	
6	**NOTE:** Do not rotate the speed sensor in the retaining bracket. Orientation is fixed, and if changed, may cause improper operation. Replace the faulty turbine speed sensor. Did you complete the replacement?		Go to Step 7	Go to Diagnostic Aids
7	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the turbine speed sensor operation. 3. Select Specific DTC. 4. Enter DTC P0717. Has the test run and passed?		System OK	Go to Step 1

DTC P0721 Output Speed Sensor Circuit Performance (Figure OBD-71)

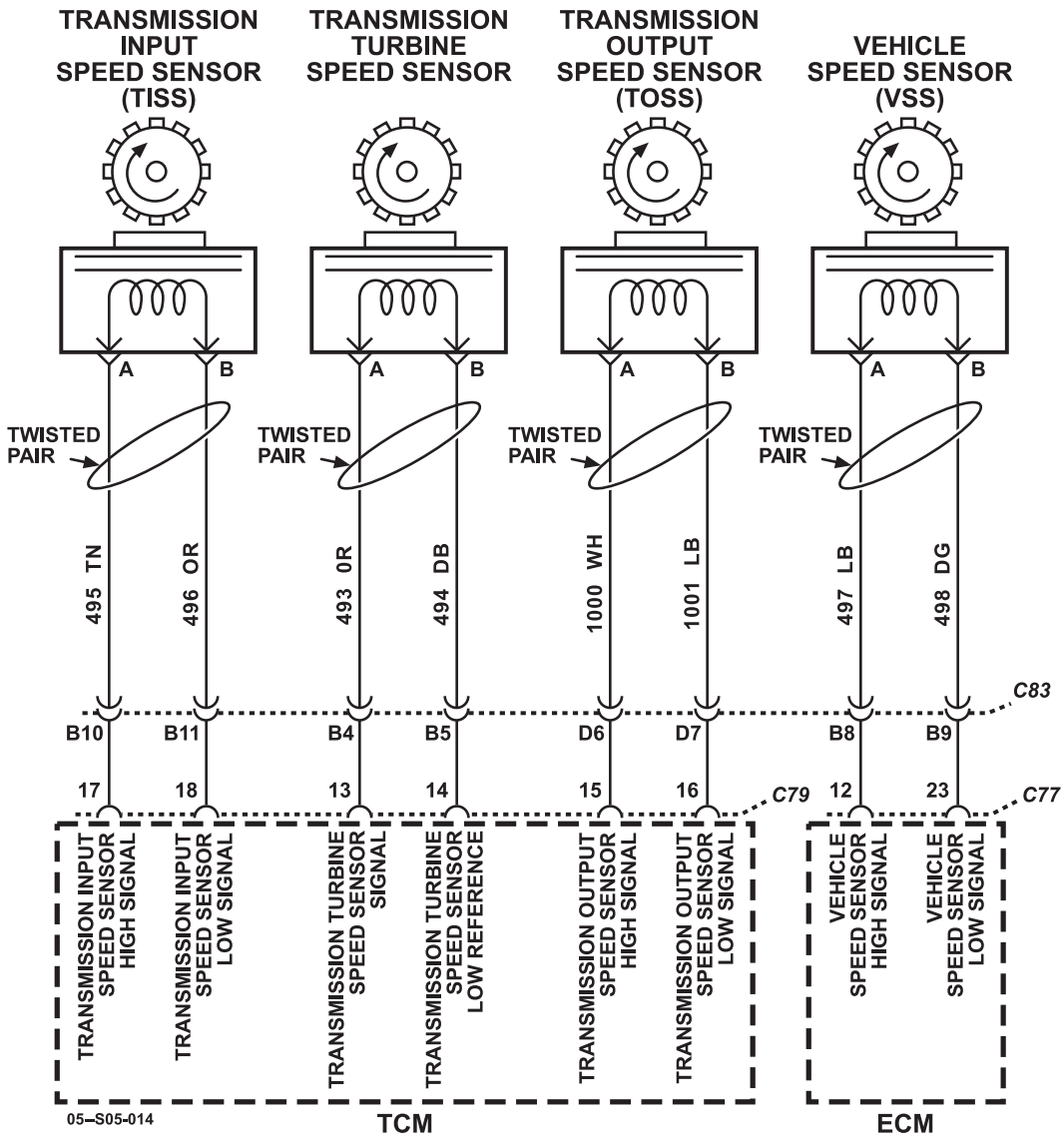


Figure OBD-71: Output Speed Sensor Circuit

Circuit Description

The speed sensors are variable reluctance devices that convert mechanical motion to an AC voltage. Each sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member. Two signal wires extend from one end of the housing and an exposed end of the pole piece is at the opposite end of the housing. The permanent magnet produces lines of flux around the pole piece. As a ferrous object, such as a gear tooth, approaches and passes through the gap at the end of the pole piece, an AC voltage pulse is induced in the wire coil. The transmission control module (TCM) calculates the frequency of these AC pulses and converts it to a speed value. The AC voltage generated varies from 150 millivolt at low speed to 15 volts at high speed. The signal wires from the sensor are formed as twisted pairs to cancel magnetically induced fields. The cable is also shielded to protect from voltage-related fields. Using two-wire differential inputs at the TCM eliminates noise from other sources.

Conditions for Setting the DTC

DTC P0721 sets when the TCM detects an unrealistically large change in output speed or if excessive noise is present in the output speed sensor circuit.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When failure occurs in a forward range and shifting is complete, the transmission remains in the current range. When failure occurs while in a forward range and the shift is in process, the transmission returns to the previous range, except in post-shift state, where the transmission will continue to the commanded range. When failure occurs in other conditions, the transmission shifts to 1st, 3rd or 5th. While diagnostic response is active, if the shift selector is moved to NEUTRAL or REVERSE or any other forward range, then the transmission will lock in NEUTRAL.
- DTC P0721 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- If the condition is intermittent, connect the scan tool and select the speed sensor indicated by the code. If the signal is erratic, investigate and eliminate the following:
  - Intermittent wiring connection
  - Excessive vibration, such as driveline or engine torsionals
  - Irregular sensor gap, such as a loose sensor, a loose tone wheel or a damaged tone wheel
  - Inspect that the speed sensor wiring consists of twisted pairs at the rate of 12-16 twists per 300 mm (12 in). These twists must extend the entire length of the wiring harness to within at least 50 mm (2 in) of the speed sensor connector.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 from the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at the C79. 4. Using a DVOM, measure the resistance between connector C79 pin 15 and 16. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Diagnostic Aids	Go to Step 4
4	1. Disconnect the wiring harness from the turbine speed sensor. 2. Using a DVOM, measure the resistance between the speed sensor terminals. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Step 5	Go to Step 6
5	Repair the engine wiring harness. Did you complete the repair?		Go to Step 7	
6	**NOTE:** Do not rotate the speed sensor in the retaining bracket. Orientation is fixed, and if changed, may cause improper operation. Replace the faulty output speed sensor. Did you complete the replacement?		Go to Step 7	Go to Diagnostic Aids
7	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the turbine speed sensor operation. 3. Select Specific DTC. 4. Enter DTC P0721. Has the test run and passed?		System OK	Go to Step 1

DTC P0722 Output Speed Sensor Circuit No Signal (Figure OBD-72)

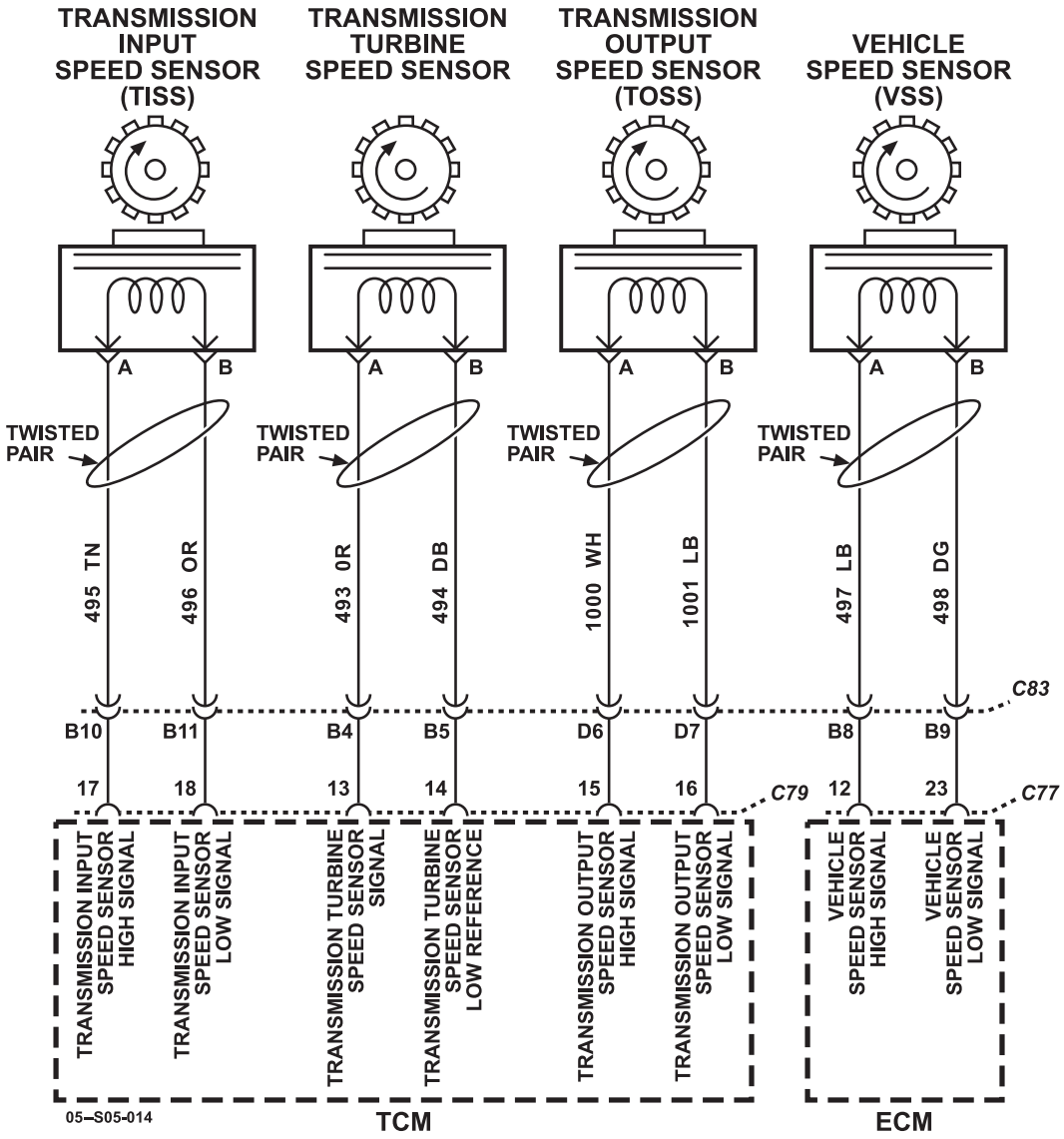


Figure OBD-72: Output Speed Sensor Circuit

Circuit Description

The speed sensors are variable reluctance devices that convert mechanical motion to an AC voltage. Each sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member. Two signal wires extend from one end of the housing and an exposed end of the pole piece is at the opposite end of the housing. The permanent magnet produces lines of flux around the pole piece. As a ferrous object, such as a gear tooth, approaches and passes through the gap at the end of the pole piece, an AC voltage pulse is induced in the wire coil. The transmission control module (TCM) calculates the frequency of these AC pulses and converts it to a speed value. The AC voltage generated varies from 150 millivolt at low speed to 15 volts at high speed. The signal wires from the sensor are formed as twisted pairs to cancel magnetically induced fields. The cable is also shielded to protect from voltage-related fields. Using two-wire differential inputs at the TCM eliminates noise from other sources.

DTC P0722 is a type A DTC.

Conditions for Setting the DTC

DTC P0722 sets when the TCM detects one of the following conditions:

- An unrealistically large change in output speed
- An unrealistically low output speed

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When failure occurs in a forward range and shifting is complete, the transmission remains in the current range. When failure occurs while in a forward range and the shift is in process, the transmission returns to the previous range, except in post-shift state, where the transmission will continue to the commanded range. When failure occurs in other conditions, the transmission shifts to 1st, 3rd or 5th. While diagnostic response is active, if the shift selector is moved to NEUTRAL or REVERSE or any other forward range, then the transmission will lock in NEUTRAL.
- DTC P0722 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  -
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- If the condition is intermittent, connect the scan tool and select the speed sensor indicated by the code. If the signal is erratic, investigate and eliminate the following:
  - Intermittent wiring connection
  - Excessive vibration, such as driveline or engine torsionals
  - Irregular sensor gap, such as a loose sensor, a loose tone wheel or a damaged tone wheel
  - Inspect that the speed sensor wiring consists of twisted pairs at the rate of 12-16 twists per 300 mm (12 in). These twists must extend the entire length of the wiring harness to within at least 50 mm (2 in) of the speed sensor connector.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 from the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at the C79. 4. Using a DVOM, measure the resistance between connector C79 pin 15 and 16. Is the speed sensor resistance within the specified values?	1,420-2,140 ohms	Go to Diagnostic Aids	Go to Step 4
4	1. Disconnect the wiring harness from the turbine speed sensor. 2. Using a DVOM, measure the resistance between the speed sensor terminals. Is the speed sensor resistance within the specified values?	1,420-2,140 ohms	Go to Step 5	Go to Step 6
5	Repair the engine wiring harness. Did you complete the repair?		Go to Step 7	
6	**NOTE:** Do not rotate the speed sensor in the retaining bracket. Orientation is fixed, and if changed, may cause improper operation. Replace the faulty output speed sensor. Did you complete the replacement?		Go to Step 7	Go to Diagnostic Aids
7	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the turbine speed sensor operation. 3. Select Specific DTC. 4. Enter DTC P0721. Has the test run and passed?		System OK	Go to Step 1

DTC P0726 Engine Speed Sensor Input Circuit Performance (Figure OBD-73)

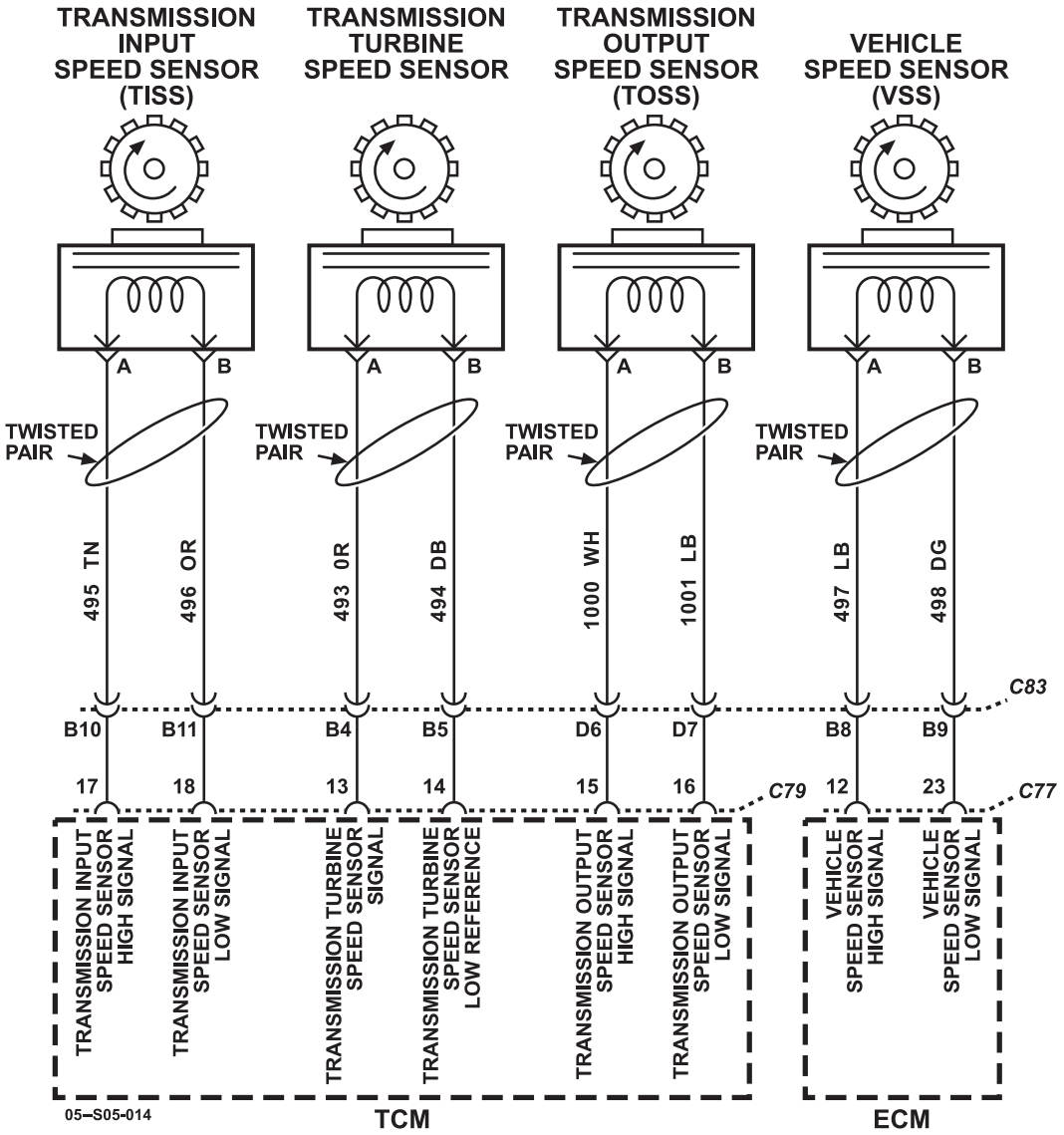


Figure OBD-73: Engine Speed Sensor Input Circuit

Circuit Description

The speed sensors are variable reluctance devices that convert mechanical motion to an AC voltage. Each sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member. Two signal wires extend from one end of the housing and an exposed end of the pole piece is at the opposite end of the housing. The permanent magnet produces lines of flux around the pole piece. As a ferrous object, such as a gear tooth, approaches and passes through the gap at the end of the pole piece, an AC voltage pulse is induced in the wire coil. The transmission control module (TCM) calculates the frequency of these AC pulses and converts it to a speed value. The AC voltage generated varies from 150 millivolt at low speed to 15 volts at high speed. The signal wires from the sensor are formed as twisted pairs to cancel magnetically induced fields. The cable is also shielded to protect from voltage-related fields. Using two-wire differential inputs at the TCM eliminates noise from other sources.

DTC P0726 is a type B DTC.

Conditions for Setting the DTC

DTC P0726 sets when the TCM detects a large unrealistic engine speed or if excessive noise is present in the engine speed sensor circuit.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- DTC P0726 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- If the condition is intermittent, connect the scan tool and select the speed sensor indicated by the code. If the signal is erratic, investigate and eliminate the following:
  - Intermittent wiring connection
  - Excessive vibration, such as driveline or engine torsionals
  - Irregular sensor gap, such as a loose sensor, a loose tone wheel or a damaged tone wheel
  - Inspect that the speed sensor wiring consists of twisted pairs at the rate of 12-16 twists per 300 mm (12 in). These twists must extend the entire length of the wiring harness to within at least 50 mm (2 in) of the speed sensor connector.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 from the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at the C79. 4. Using a DVOM, measure the resistance between connector C79 pin 17 and 18. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Diagnostic Aids	Go to Step 4
4	1. Disconnect the wiring harness from the turbine speed sensor. 2. Using a DVOM, measure the resistance between the speed sensor terminals. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Step 5	Go to Step 6
5	Repair the engine wiring harness. Did you complete the repair?		Go to Step 7	
6	**NOTE:** Do not rotate the speed sensor in the retaining bracket. Orientation is fixed, and if changed, may cause improper operation. Replace the faulty transmission input speed sensor. Did you complete the replacement?		Go to Step 7	Go to Diagnostic Aids
7	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the turbine speed sensor operation. 3. Select Specific DTC. 4. Enter DTC P0726. Has the test run and passed?		System OK	Go to Step 1

DTC P0727 Engine Speed Circuit No Signal (Figure OBD-74)

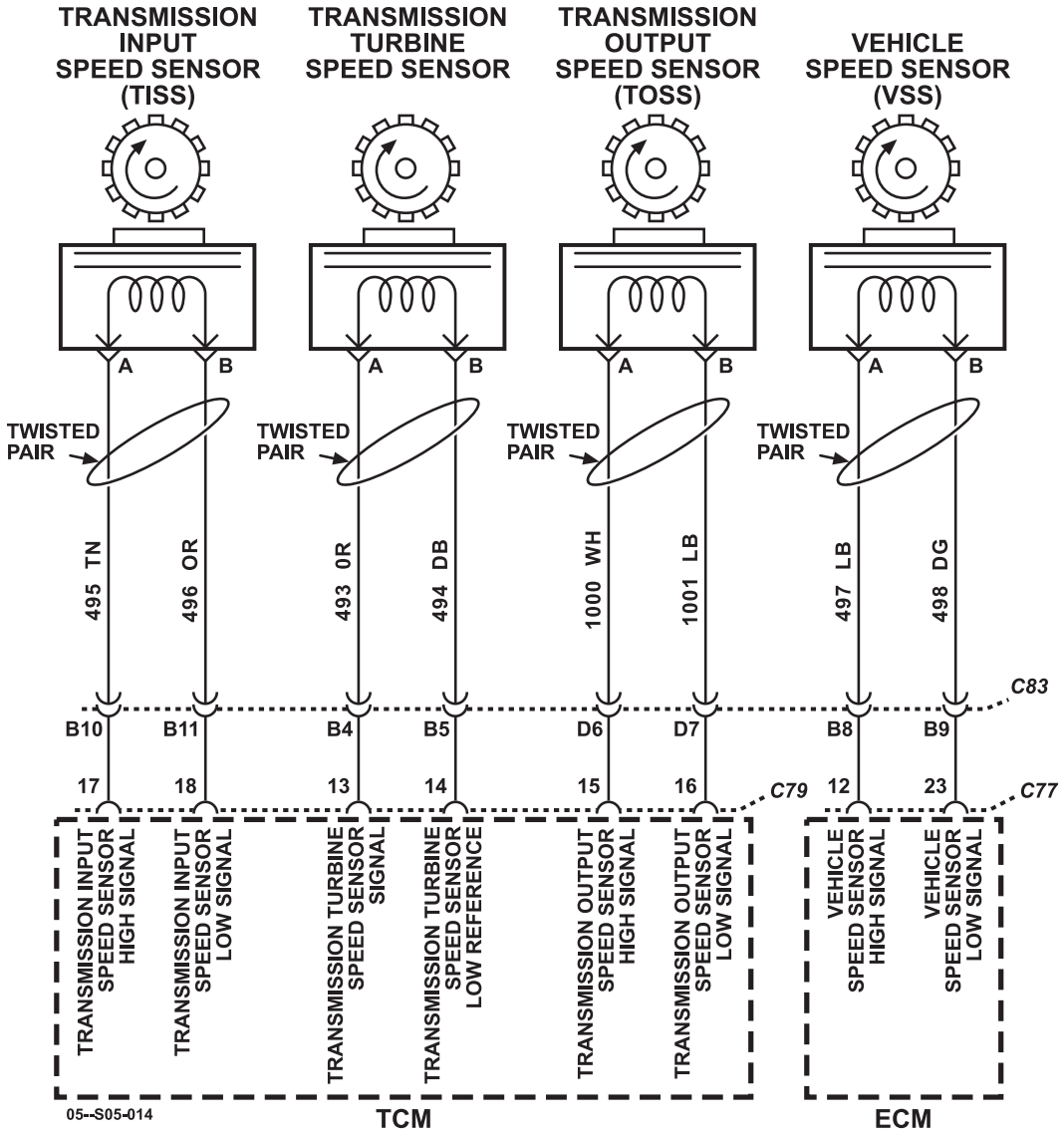


Figure OBD-74: Engine Speed Circuit

Circuit Description

The speed sensors are variable reluctance devices that convert mechanical motion to an AC voltage. Each sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member. Two signal wires extend from one end of the housing and an exposed end of the pole piece is at the opposite end of the housing. The permanent magnet produces lines of flux around the pole piece. As a ferrous object, such as a gear tooth, approaches and passes through the gap at the end of the pole piece, an AC voltage pulse is induced in the wire coil. The transmission control module (TCM) calculates the frequency of these AC pulses and converts it to a speed value. The AC voltage generated varies from 150 millivolt at low speed to 15 volts at high speed. The signal wires from the sensor are formed as twisted pairs to cancel magnetically induced fields. The cable is also shielded to protect from voltage-related fields. Using two-wire differential inputs at the TCM eliminates noise from other sources.

DTC P0727 is a type B DTC.

Conditions for Setting the DTC

DTC P0727 sets if engine speed is detected less than 61 RPM for 4 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- DTC P0727 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- If the condition is intermittent, connect the scan tool and select the speed sensor indicated by the code. If the signal is erratic, investigate and eliminate the following:
  - Intermittent wiring connection
  - Excessive vibration, such as driveline or engine torsionals
  - Irregular sensor gap, such as a loose sensor, a loose tone wheel or a damaged tone wheel
  - Inspect that the speed sensor wiring consists of twisted pairs at the rate of 12-16 twists per 300 mm (12 in). These twists must extend the entire length of the wiring harness to within at least 50 mm (2 in) of the speed sensor connector.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 from the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at the C79. 4. Using a DVOM, measure the resistance between connector C79 pin 17 and 18. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Diagnostic Aids	Go to Step 4
4	1. Disconnect the wiring harness from the turbine speed sensor. 2. Using a DVOM, measure the resistance between the speed sensor terminals. Is the speed sensor resistance within the specified values?	2,600 ohms [commat] 25°C (77°F)	Go to Step 5	Go to Step 6
5	Repair the engine wiring harness. Did you complete the repair?		Go to Step 7	
6	**NOTE:** Do not rotate the speed sensor in the retaining bracket. Orientation is fixed, and if changed, may cause improper operation. Replace the faulty transmission input speed sensor. Did you complete the replacement?		Go to Step 7	Go to Diagnostic Aids
7	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor the turbine speed sensor operation. 3. Select Specific DTC. 4. Enter DTC P0727. Has the test run and passed?		System OK	Go to Step 1

DTC P0731 Incorrect First Gear Ratio

Circuit Description

The transmission control module (TCM) uses input from the turbine speed sensor and the output speed sensor to determine gear ratios. The TCM then compares the known gear ratio to the calculated gear ratio for the current range.

DTC P0731 is a type A DTC.

Conditions for Setting the DTC

DTC P0731 sets when the calculated first range ratio, steady state, differs from the known first range ratio.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission defaults to 2nd or 5th range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will either lock in NEUTRAL or shift to REVERSE, unless the transmission is compromised by over speeding or direction change. If this occurs, the transmission will lock in NEUTRAL.
- DTC P0731 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Incorrect ratio codes typically indicate mechanical conditions with specific clutches, such as C1 or C5 for first range.
- Incorrect ratio code could indicate a hydraulically failed solenoid. Observe DTC information for the specific solenoid.
- Clutch test mode can be used to measure stall speed.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Start the engine. 2. Using the scan tool, observe the gear ratio. Is the correct first range ratio shown?	3.10:1	Go to Step 5	Go to Diagnostic Aids
5	1. Drive the vehicle under normal operating conditions. 2. Using the scan tool, monitor engine, turbine and output speed readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 6
6	Conduct a clutch test for first range. Refer to Clutch Test. Did turbine speed remain at zero?		Go to Diagnostic Aids	Go to Step 7
7	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for contaminated fluid and excessive material in the pan. Is the fluid contaminated or excessive material found in the pan?		Go to Step 8	Go to Step 9
8	Remove the transmission for overhaul or replacement. Did you complete the replacement?		Go to Step 11	
9	Inspect for a stuck or sticking trim valve. Did you find and correct a condition?		Go to Step 11	Go to Step 10
10	Replace the faulty pressure control (PC) solenoid A. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor first gear ratio and operate vehicle under normal operating conditions. 4. Select Specific DTC. 5. Enter DTC P0731. Has the test run and passed?		System OK	Go to Step 1

DTC P0732 Incorrect 2nd Gear ratio

Circuit Description

The transmission control module (TCM) uses input from the turbine speed sensor and output speed sensor (OSS) to determine gear ratios. The TCM then compares the known gear ratio to the calculated gear ratio for the current range.

DTC P0732 is a type A DTC.

Conditions for Setting the DTC

DTC P0732 sets when the calculated second range ratio, steady state, differs from the known second range ratio.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission defaults to 3rd range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE, unless the transmission is compromised by over speeding or direction change. If this occurs, the transmission will lock in NEUTRAL.
- DTC P0732 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Incorrect ratio codes typically indicate mechanical conditions with specific clutches, such as 1-2-3-4 clutch and 2nd clutch for 2nd range.
- Incorrect ratio code could indicate a hydraulically failed solenoid. Observe DTC information for specific solenoid.
- Clutch test mode can be used to observe stall speed.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Drive the vehicle under normal operating conditions. 2. Using the scan tool, monitor engine, turbine and output speed readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	Conduct a clutch test for second range. Did the turbine speed remain at zero?		Go to Diagnostic Aids	Go to Step 6
6	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for contaminated fluid and excessive material in the pan. Is the fluid contaminated or excessive material found in the pan?		Go to Step 7	Go to Step 8
7	Remove the transmission for overhaul or replacement. Did you complete the replacement?		Go to Step 10	
8	Inspect for a stuck or sticking trim valve. Did you find and correct a condition?		Go to Step 10	Go to Step 9
9	Replace the faulty pressure control (PC) solenoid A. Did you complete the replacement?		Go to Step 10	
10	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor first gear ratio and operate vehicle under normal operating conditions. 4. Select Specific DTC. 5. Enter DTC P0732. Has the test run and passed?		System OK	Go to Step 1

DTC P0733 Incorrect 3rd Gear ratio

Circuit Description

The transmission control module (TCM) uses input from the input speed sensor and output speed sensor to determine gear ratios. The TCM then compares the known gear ratio to the calculated gear ratio for the current range.

DTC P0733 is a type A DTC.

Conditions for Setting the DTC

DTC P0733 sets when the calculated third range ratio, steady state, differs from the known third range ratio.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission defaults to 4th range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0733 will be stored in TCM history.
- The TCM freezes shift adapts.
- TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Incorrect ratio codes typically indicate mechanical conditions with specific clutches, such as 1-2-3-4 clutch and 3rd, 5th, and Reverse clutch, for 3rd range.
- Incorrect ratio code could indicate hydraulically failed solenoid. Observe DTC information for specific solenoid.
- Clutch test mode can be used to observe stall speed.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Drive the vehicle under normal operating conditions. 2. Using the scan tool, monitor engine, turbine and output speed readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	Conduct a clutch test for third range. Did the turbine speed remain at zero?		Go to Diagnostic Aids	Go to Step 6
6	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for contaminated fluid and excessive material in the pan. Is the fluid contaminated or excessive material found in the pan?		Go to Step 7	Go to Step 8
7	Remove the transmission for overhaul or replacement. Did you complete the replacement?		Go to Step 10	
8	Inspect for a stuck or sticking trim valve. Did you find and correct a condition?		Go to Step 10	Go to Step 9
9	Replace the faulty pressure control (PC) solenoid A. Did you complete the replacement?		Go to Step 10	
10	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor first gear ratio and operate vehicle under normal operating conditions. 4. Select Specific DTC. 5. Enter DTC P0733. Has the test run and passed?		System OK	Go to Step 1

DTC P0734 Incorrect 4th Gear Ratio

Circuit Description

The transmission control module (TCM) uses input from the input speed sensor and output speed sensor to determine gear ratios. The TCM then compares the known gear ratio to the calculated gear ratio for the current range.

DTC P0734 is a type A DTC.

Conditions for Setting the DTC

DTC P0734 sets when the calculated 4th range ratio, steady state, differs from the known 4th range ratio.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission defaults to 5th range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE, unless the transmission is compromised by a direction change. In that case, the transmission will shift to NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0734 will be stored in TCM history.
- The TCM freezes shift adapts.
- TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Incorrect ratio codes typically indicate mechanical conditions with specific clutches, such as 1-2-3-4 clutch and 4th and 5th clutch, for 4th range.
- Incorrect ratio code could indicate a hydraulically failed solenoid. Observe DTC information for specific solenoid.
- Clutch test mode can be used to observe stall speed.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Drive the vehicle under normal operating conditions. 2. Using the scan tool, monitor engine, turbine and output speed readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	Conduct a clutch test for fourth range. Did the turbine speed remain at zero?		Go to Diagnostic Aids	Go to Step 6
6	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for contaminated fluid and excessive material in the pan. Is the fluid contaminated or excessive material found in the pan?		Go to Step 7	Go to Step 8
7	Remove the transmission for overhaul or replacement. Did you complete the replacement?		Go to Step 10	
8	Inspect for a stuck or sticking trim valve. Did you find and correct a condition?		Go to Step 10	Go to Step 9
9	Replace the faulty pressure control (PC) solenoid A. Did you complete the replacement?		Go to Step 10	
10	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor first gear ratio and operate vehicle under normal operating conditions. 4. Select Specific DTC. 5. Enter DTC P0734. Has the test run and passed?		System OK	Go to Step 1

DTC P0735 Incorrect 5th Gear Ratio

Circuit Description

The transmission control module (TCM) uses input from the input speed sensor and output speed sensor (OSS) to determine gear ratios. The TCM then compares the known gear ratio to the calculated gear ratio for the current range.

DTC P0735 is a type A DTC.

Conditions for Setting the DTC

DTC P0735 sets when the calculated fifth range ratio, steady state, differs from the known fifth range ratio.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission defaults to 4th range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE, unless the transmission is compromised by a direction change. In that case, the transmission will shift to NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0735 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Incorrect ratio codes typically indicate mechanical conditions with specific clutches, such as 4th and 5th clutch and 3rd, 5th, and Reverse clutch, for 5th range.
- Incorrect ratio code could indicate a hydraulically failed solenoid. Observe DTC information for specific solenoid.
- Clutch test mode can be used to observe stall speed.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Drive the vehicle under normal operating conditions. 2. Using the scan tool, monitor engine, turbine and output speed readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	Conduct a clutch test for fifth range. Did the turbine speed remain at zero?		Go to Diagnostic Aids	Go to Step 6
6	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for contaminated fluid and excessive material in the pan. Is the fluid contaminated or excessive material found in the pan?		Go to Step 7	Go to Step 8
7	Remove the transmission for overhaul or replacement. Did you complete the replacement?		Go to Step 10	
8	Inspect for a stuck or sticking trim valve. Did you find and correct a condition?		Go to Step 10	Go to Step 9
9	Replace the faulty pressure control (PC) solenoid A. Did you complete the replacement?		Go to Step 10	
10	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor first gear ratio and operate vehicle under normal operating conditions. 4. Select Specific DTC. 5. Enter DTC P0735. Has the test run and passed?		System OK	Go to Step 1

DTC P0736 Incorrect Reverse Ratio

Circuit Description

The transmission control module (TCM) uses input from the input speed sensor and output speed sensor to determine gear ratios. The TCM then compares the known gear ratio to the calculated gear ratio for the current gear.

DTC P0736 is a type A DTC.

Conditions for Setting the DTC

DTC P0736 sets when the calculated REVERSE range ratio, steady state, detected by the TCM differs from the known REVERSE range ratio.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission will lock in NEUTRAL.
- DTC P0736 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Incorrect ratio codes typically indicate mechanical conditions with specific clutches, such as 3rd, 5th, and Reverse clutch and Low and Reverse clutch for REVERSE range.
- Incorrect ratio code could indicate a hydraulically failed solenoid. Observe DTC information for specific solenoid.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure

Step	Action	Value(s)	Yes	No
3	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Start the engine. 2. Select REVERSE range. 3. Using the scan tool, observe the gear ratio. Is the correct REVERSE range ratio shown?	4.49:1	Go to Step 5	Go to Diagnostic Aids
5	1. Turn the ignition ON. 2. Start the engine and run at idle. 3. Using the scan tool, monitor engine, turbine, and output speed readings in REVERSE range with the vehicle brakes applied. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 6
6	**NOTE:** Do not perform a full RPM stall test in reverse range, or vehicle damage may occur. 1. Apply vehicle brakes and select REVERSE. 2. With the engine at idle and REVERSE range attained, turbine speed should go to zero. 3. Using the scan tool, monitor turbine speed while increasing engine speed to 1,000 RPM. Did turbine speed remain at zero?		Go to Diagnostic Aids	Go to Step 7
7	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for contaminated fluid and excessive material in the pan. Is the fluid contaminated or excessive material found in the pan?		Go to Step 8	Go to Step 9
8	Remove the transmission for overhaul or replacement. Did you complete the replacement?		Go to Step 11	
9	Inspect for a stuck or sticking trim valve. Did you find and correct a condition?		Go to Step 11	Go to Step 10
10	Replace pressure control (PC) solenoid B. Did you complete the replacement?		Go to Step 11	

Step	Action	Value(s)	Yes	No
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor REVERSE gear ratio and operate the vehicle under normal operating conditions. 4. Select Specific DTC. 5. Enter DTC P0736. Has test run and passed?		System OK	Go to Step 1

DTC P0741 Torque Converter Clutch System Stuck Off

Circuit Description

The transmission control module (TCM) uses data from the engine speed sensor and the input speed sensor (ISS) to calculate torque converter slip value. The TCM then compares this calculated slip value to a preset value in the TCM calibration.

DTC P0741 is a type B DTC.

Conditions for Setting the DTC

DTC P0741 sets when the TCM detects one of the following conditions:

- A TCC slip value greater than 80 RPM for 15 seconds.
- The TCC slip speed values indicate a stuck off state.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- DTC P0741 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Drive the vehicle under normal operating conditions. 2. Using the scan tool, monitor converter slip speed indicated when a range is attained where the TCC should be applied. Is the slip speed value at or greater than the specified value when the TCC should be applied?	80 RPM	Go to Step 4	Go to Diagnostic Aids
4	This condition indicates the TCC is mechanically stuck OFF. Inspect for the following conditions: • Worn TCC clutch • Faulty torque converter clutch pulse width modulated (TCC PWM) solenoid • Debris in the TCC valve bore • Clogged converter relief passage Did you find and repair a condition?		Go to Step 5	
5	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, operate the vehicle under normal operating conditions. 4. Select Specific DTC. 5. Enter DTC P0741. Has the test run and passed?		System OK	Go to Step 1

DTC P0742 Torque Converter Clutch System Stuck On

Circuit Description

The transmission control module (TCM) uses data from the engine speed sensor and the input speed sensor (ISS) to calculate the torque converter slip value. The TCM then compares this calculated slip value to a preset value in the TCM calibration.

DTC P0742 is a type B DTC.

Conditions for Setting the DTC

DTC P0742 sets when the TCM detects TCC slip speed values indicating a stuck on or locked condition for 2.5 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- If failure occurs before shifting is completed, the transmission will shift to NEUTRAL. If failure occurs while shifting is being completed, the transmission will shift to NEUTRAL or 1st range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to NEUTRAL or REVERSE.
- If the shift selector is returned to DRIVE, the transmission will shift to NEUTRAL or 1st range.
- DTC P0742 will be stored in TCM history.
- The TCM inhibits TCC engagement.
- The TCM freezes shift adapts.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:

A bent terminal

A backed-out terminal

A damaged terminal

Poor terminal tension

A chafed wire

A broken wire inside the insulation

When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.

You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool “Capture info” to record Freeze Frame and Failure Records for reference, as data will be lost when “Clear Info” function is used Was the “On-Board Diagnostic (OBD) System Check” performed?		Go to step 2.	Go to OBD System Check.

Step	Action	Value(s)	Yes	No
2	1. Install the scan tool. 2. Set the parking brake and block the wheels to prevent vehicle movement. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failures Records. 4. Clear the DTC. 5. Start the engine. 6. Apply the vehicle brakes and select DRIVE. Did the engine stall?		Go to Step 3	Go to Diagnostic Aids
3	1. Remove the transmission oil pan. 2. Inspect for contaminated fluid and/or excessive material in the pan. Is the fluid contaminated or excessive material found in the pan?		Go to Step 5	Go to Step 4
4	This condition indicates the TCC is mechanically stuck ON. Inspect for the following conditions: 1. Faulty torque converter clutch pulse width modulated (TCC PWM) solenoid 2. Stuck or sticking TCC valve 3. Restricted transmission cooler lines Did you find and repair a condition?		Go to Step 6	
5	Remove the transmission for overhaul or replacement. Did you complete the repair or replacement?		Go to Step 6	
6	Preform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Using the scan tool, monitor TCC slip speed. The TCC must engage/disengage when commanded. 4. Select Specific DTC. 5. Enter DTC P0742. Has the test run and passed?		System OK	Go to Step 1

DTC P0743 Torque Converter Clutch (Figure OBD-75)

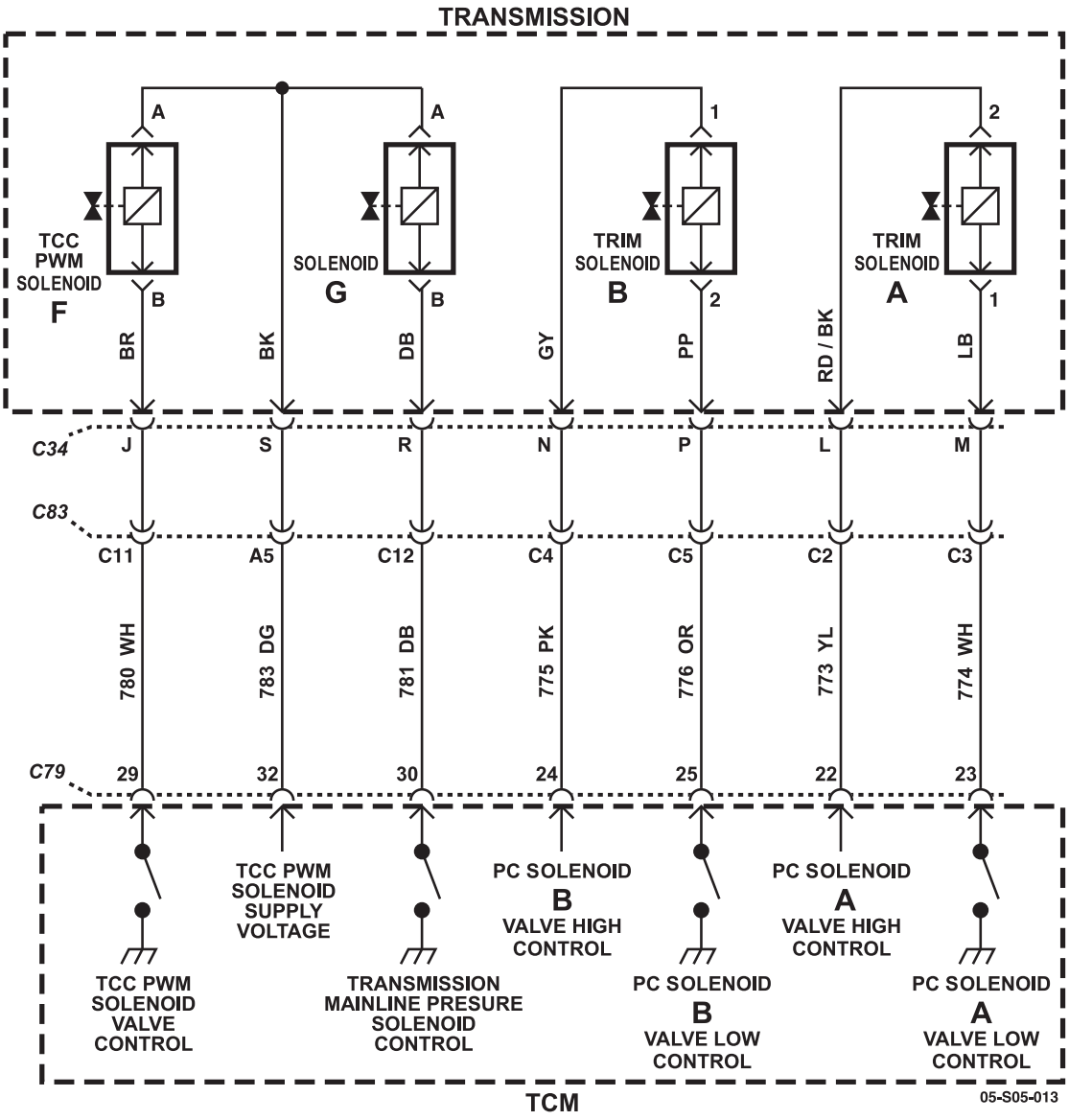


Figure OBD-75: Torque Converter Clutch Circuit

Circuit Description

The torque converter clutch (TCC) solenoid is a pulse width modulated (PWM) solenoid. Pulse width modulation occurs when the signal from the transmission control module (TCM) to a solenoid is modulated at an established frequency, causing the steel check ball in the solenoid to rapidly open and close the solenoid passage. This serves to vary the output fluid pressure.

DTC P0743 is a type B DTC.

Conditions for Setting the DTC

DTC P0743 sets when the TCM detects an open circuit, a short to power, or a short to ground in the TCC PWM solenoid circuit for 1.5 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- DTC P0743 will be stored in TCM history.
- The TCM inhibits TCC engagement.
- The TCM freezes shift adapts.
- REVERSE operation is disabled.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change. Refer to Testing for Intermittent Conditions and Poor Connections in Wiring Systems.
- You may have to drive the vehicle in order to experience a condition.
- Solenoids are sensitive to battery voltage spikes and poor ground connections.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Install the scan tool. 2. Start the engine. **NOTE:** • Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. • This diagnostic table should only be used if the DTC is currently failing. If the DTC is not active, refer to Testing for Intermittent Conditions and Poor Connections in Wiring Systems until the DTC becomes active. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage

Step	Action	Value(s)	Yes	No
3	1. Turn the ignition OFF. 2. Disconnect the C79 connector at the TCM. 3. Using a DVOM, measure the resistance between connector C79 terminal 29 and connector C79 terminal 32. Is the resistance reading within the specified value?	10.5 ohms [commat] 20° (68°F)	Go to Step 4	Go to Step 5
4	1. Turn the ignition OFF. 2. Disconnect the TCM connector C79. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. Do not connect the vehicle side C79 connector to the J 43799. 4. Using a 12-volt unpowered test light, place the leads on terminals 29 and 32 of the J 39700. 5. Turn the ignition ON, with the engine OFF. 6. Use the scan tool in Solenoid Test Mode to command the TCC PWM solenoid ON and OFF. Does the test lamp turn ON and OFF when commanded?		Go to Diagnostic Aids	Go to Step 11
5	1. Turn the ignition OFF. 2. Connect the C79 connector to the TCM. 3. Disconnect the transmission 20-way connector. 4. Turn the ignition ON, with the engine OFF. Additional DTCs may set. 5. Using a 12-volt unpowered test light, place the leads at C34 harness side terminals J and S. 6. Use the scan tool in Solenoid Test Mode to command the TCC PWM solenoid ON and OFF. Does the test lamp turn ON and OFF when commanded?		Go to Step 6	Go to Step 8
6	1. Turn the ignition OFF. 2. Using a DVOM, measure the resistance between terminals J and S of C34. Is the solenoid resistance within the specified value?	10.5 ohms [commat] 20°C (68°F)	Go to Diagnostic Aids	Go to Step 7
7	1. Remove the oil pan. Refer to Oil Pan Replacement. 2. Remove the internal wiring harness at the TCC PWM solenoid connector. 3. Using a DVOM, measure the resistance of the TCC PWM solenoid between pins B and A. Is the solenoid resistance within the specified value?	10.5 ohms [commat] 20°C (68°F)	Go to Step 9	Go to Step 10
8	Repair the engine wiring harness. Did you complete the repair		Go to Step 12	
9	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 12	
10	Replace the faulty TCC PWM solenoid. Did you complete the replacement?		Go to Step 12	

Step	Action	Value(s)	Yes	No
11	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 12	
12	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Using the scan tool, monitor TCC slip speed. The TCC must engage/disengage when commanded. 4. Select Specific DTC. 5. Enter DTC P0743. Has the test run and passed?		System OK	Go to Step 1

DTC P0746 Pressure Control Solenoid Performance

Circuit Description

Pressure control (PC) solenoid A is used to control oncoming, off-going, and holding pressure in any one of five clutches. This solenoid is referred to as a pressure proportional to current (PPC) solenoid since the output hydraulic pressure supplied by this solenoid is proportional to the controlled current command.

The transmission control module (TCM) uses information from the turbine speed sensor and output speed sensor (OSS) to detect if a clutch is slipping. The clutch being controlled by the PC solenoid A will vary depending on the shift that was being completed.

DTC P0746 is a type A DTC.

Conditions for Setting the DTC

DTC P0746 sets when the TCM detects an incorrect oncoming ratio, for an accumulated number of occurrences during a forward range shift.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When failure occurs in a forward range, the transmission will go to the previous range. If failure occurs in NEUTRAL or REVERSE, the transmission will lock in NEUTRAL while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL and in some cases may lock in NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE or NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will shift to NEUTRAL.
- DTC P0746 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC indicates the oncoming clutch being controlled by the PC solenoid A, not applied or applied too slowly. This could indicate a leak or obstruction in a specific clutch apply circuit. Observe scan tool failure record data for previous or current range information when the DTC was set, to determine specific shift when the DTC was set. Refer to the Solenoid and Clutch Chart to determine which clutch circuit is suspect.

NOTE: Clutch failure due to installation of an engine power upgrade is not covered under the manufacturers warranty.

- Inspect for the presence of an add-on engine power package. When engine horsepower or torque is increased over factory rating. A shift flare condition may occur.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	1. Install the scan tool. 2. Start the engine. **NOTE:** • Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. • This diagnostic table should only be used if the DTC is currently failing. If the DTC is not active, refer to Testing for Intermittent Conditions and Poor Connections in Wiring Systems until the DTC becomes active. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Start the engine. 2. Drive the vehicle under normal operating conditions. 3. Using the scan tool, monitor engine, turbine and output speed sensor readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	1. Connect a 2,000 kPa (300 psi) pressure gage to the line pressure tap. Refer to Line Pressure Check Procedure. 2. Use the scan tool in clutch test mode, to cycle through all transmission ranges with the engine at idle and vehicle brakes applied. Record line pressure in each range. Was the line pressure low in a specific range or in ranges where the same clutch was applied?		Go to Low Main Line Pressure in All Ranges	Go to Step 6
6	Conduct a clutch test for all forward ranges. Refer to Clutch Test Did turbine speed remain at zero in all ranges?		Go to Diagnostic Aids	Go to Step 7

Step	Action	Value(s)	Yes	No
7	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for signs of clutch failure. Are there signs of a clutch failure?		Go to Step 8	Go to Step 9
8	Remove the transmission for overhaul or replacement. Refer to Transmission Replacement. Did you complete the repair or replacement?		Go to Step 11	
9	Inspect for a stuck or sticking PC valve. Did you find and repair a valve condition?		Go to Step 11	Go to Step 10
10	Replace faulty PC solenoid A. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Use the scan tool to reset adaptive values for all shifts. 4. Operate the vehicle in all ranges under normal driving conditions. 5. Select Specific DTC. 6. Enter DTC P0746. Has the test run and passed?		System OK	Go to Step 1

DTC P0747 Pressure Control Solenoid Stuck On

Circuit Description

Pressure control (PC) solenoid A is used to control oncoming, off-going, and holding pressure to any one of the five clutches. This solenoid is referred to as a pressure proportional to current (PPC) solenoid since the output hydraulic pressure supplied by this solenoid is proportional to the controlled current command.

The transmission control module (TCM) uses information from the turbine and output speed sensors to detect if a clutch is in a tie-up condition or 3 clutches are applied. The clutch being controlled by PC solenoid A will vary depending on the shift being made.

DTC P0747 is a type A DTC.

Conditions for Setting the DTC

DTC P0747 sets if the TCM determines off-going clutch controlled by PC solenoid A remains engaged during a forward range shift.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When failure occurs in a forward range, the transmission will go to the previous range. If failure occurs in NEUTRAL or REVERSE, the transmission will lock in NEUTRAL while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE or NEUTRAL, or in some cases may lock in NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will shift to NEUTRAL.
- DTC P0747 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC indicates the off-going clutch being controlled by PC solenoid A, is not releasing or is slow to release. This could indicate a leak or obstruction in a specific clutch apply circuit. Observe scan tool failure record data for previous or current range information when the DTC was set, to determine the specific shift when the DTC was set. Refer to Solenoid and Clutch Chart to determine which clutch circuit is suspect.

NOTE: Clutch failure due to installation of an engine power upgrade is not covered under the manufacturers warranty.

Inspect for the presence of an add-on engine power package. When engine horsepower or torque is increased over factory rating, a shift flare condition may occur.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	1. Install the scan tool. 2. Start the engine. **NOTE:** • Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. • This diagnostic table should only be used if the DTC is currently failing. If the DTC is not active, refer to Testing for Intermittent Conditions and Poor Connections in Wiring Systems until the DTC becomes active. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Start the engine. 2. Drive the vehicle under normal operating conditions. 3. Using the scan tool, monitor engine, turbine and output speed sensor readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	1. Connect a 2,000 kPa (300 psi) pressure gage to the line pressure tap. 2. Use the scan tool in clutch test mode, to cycle through all transmission ranges with the engine at idle and vehicle brakes applied. Record line pressure in each range. Was the line pressure low in a specific range or in ranges where the same clutch was applied?		Go to Low Main Line Pressure in All Ranges	Go to Step 6
6	Conduct a clutch test for all forward ranges. Refer to Clutch Test Did turbine speed remain at zero in all ranges?		Go to Diagnostic Aids	Go to Step 7
7	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for signs of clutch failure. Are there signs of a clutch failure?		Go to Step 8	Go to Step 9

Step	Action	Value(s)	Yes	No
8	Remove the transmission for overhaul or replacement. Refer to Transmission Replacement. Did you complete the repair or replacement?		Go to Step 11	
9	Inspect for a stuck or sticking PC valve. Did you find and repair a valve condition?		Go to Step 11	Go to Step 10
10	Replace faulty PC solenoid A. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Use the scan tool to reset adaptive values for all shifts. 4. Operate the vehicle in all ranges under normal driving conditions. 5. Select Specific DTC. 6. Enter DTC P0746. Has the test run and passed?		System OK	Go to Step 1

DTC P0748 Pressure Control Solenoid Circuit Electrical (Figures OBD-76, and 77)

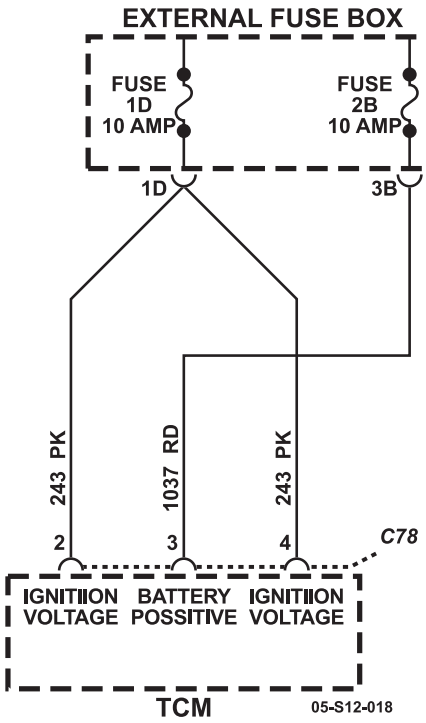


Figure OBD-76: External Fuse Box Circuit

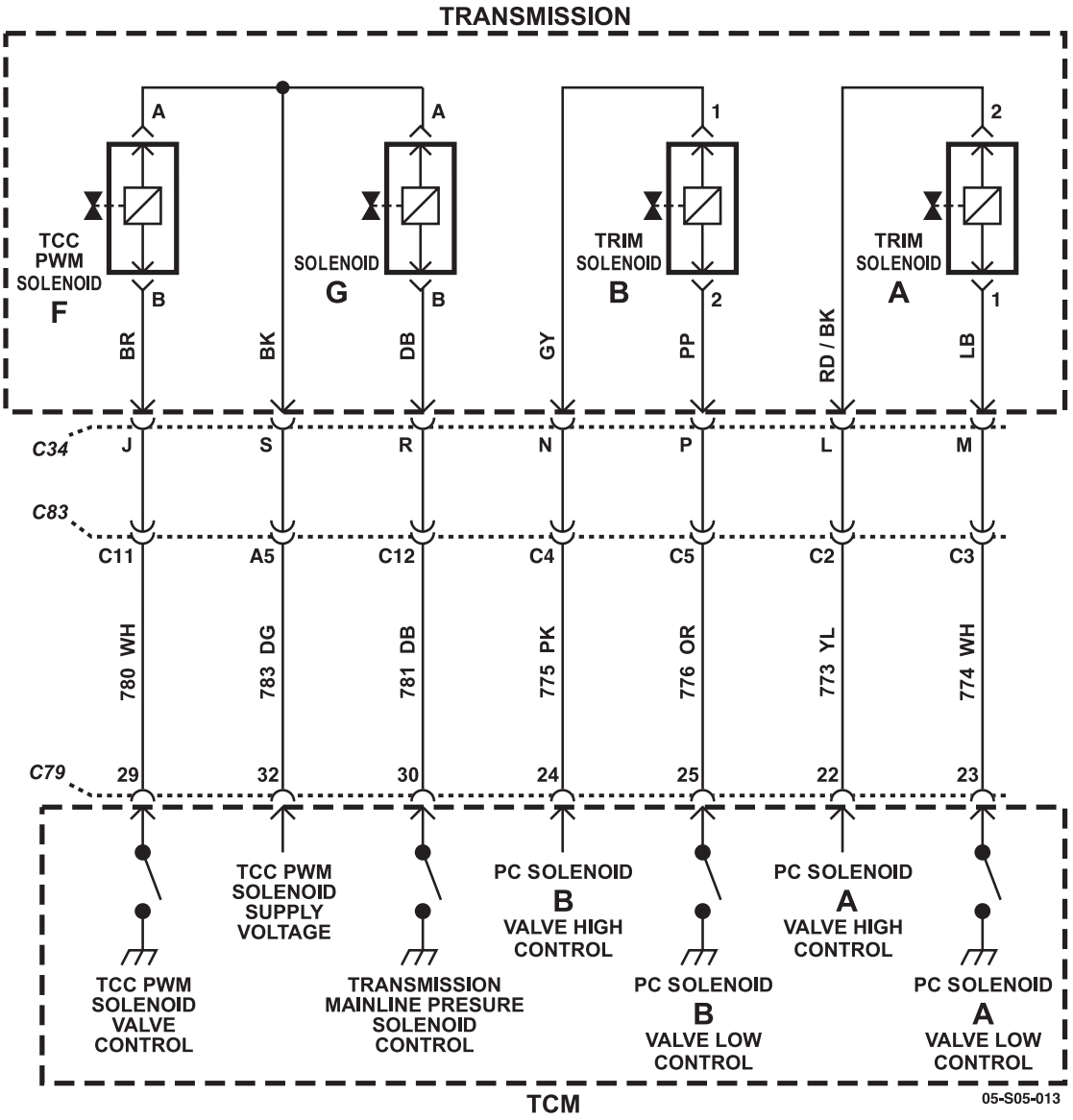


Figure OBD-77: Pressure Control Solenoid Circuit

Circuit Description

Pressure control (PC) solenoid A is used to control oncoming, off-going, and holding pressure to any one of the five clutches. This solenoid is referred to as a pressure proportional to current (PPC) solenoid since the output hydraulic pressure supplied by this solenoid is proportional to the controlled current command.

The solenoid operates using a very high frequency pulse width modulation signal of 1,000 Hz. Unlike the torque converter clutch pulse width modulated (TCC PWM) solenoid, where the ball follows the pulse width square wave, the PPC ball remains stationary. The ball clearance is balanced between a coil current force on one side of the ball and the clutch trim pressure force on the other side of the ball. The ball-to-seat clearance adjusts the bleed-off rate in the signal pocket. At high bleed levels, the resulting flow across the feed orifice results in a high pressure drop. This produces the desired signal pressure level used to trim the clutch.

DTC P0748 is a type A DTC.

Conditions for Setting the DTC

DTC P0748 sets when the transmission control module (TCM) detects one of the following conditions:

- A short to power
- A short to ground
- High or low resistance in PC solenoid A
- High or low resistance in PC solenoid A wiring

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range, the transmission fails to 1st, 3rd, or 5th range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE, unless the transmission is compromised by a direction change, then the transmission will shift to or lock in NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0748 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- Solenoids are sensitive to battery voltage spikes and poor ground connections. This condition may not be indicated with your scan tool, or with a DVOM.
- The installation of aftermarket devices such as remote starters may interfere with proper TCM voltage supply.
- A faulty ignition switch may cause improper voltage supply to the TCM.
- Power or ground corrosion may cause voltage variation.
- Voltage may vary by 0.5 volts based on the state of charge in the battery.
- PC solenoid A operates on 1,000 Hz and can be measured using a DVOM.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to step 2.	Go to OBD System Check.
2	1. Install the scan tool. 2. Start the engine. **NOTE:** • Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. • This diagnostic table should only be used if the DTC is currently failing. If the DTC is not active, refer to Testing for Intermittent Conditions and Poor Connections in Wiring Systems until the DTC becomes active. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect C78 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Turn ON the ignition, with the engine OFF. 5. Using a DVOM, measure voltage at C78 terminals 2, 4, and 3 to a known good ground. Is the voltage within the specified value?	B+	Go to Step 4	Go to Diagnostic Aids
4	1. Turn the ignition OFF. 2. Disconnect the C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Using a DVOM, measure voltage between connector C79 terminal 22 and terminal 23. 5. Turn ON the ignition, with the engine OFF. 6. Using the scan tool, command PC solenoid A ON. Is the voltage within the range specified when PC solenoid A is commanded ON?	7-7.5 Volts	Go to Step 5	Go to Step 11
5	1. Turn the ignition OFF. 2. Using a DVOM measure the resistance between connector C79 terminal 22 and terminal 23. Is the resistance within the specified value?	5.5 ohms [commat] 20°C (68°F)	Go to Diagnostic Aids	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Connect the C79 to the TCM. 2. Disconnect the transmission 20-way connector C34. 3. Using a DVOM, measure the resistance between terminals L and M of the transmission side of the 20-way connector. Is resistance within the specified value?	5.5 ohms [commat] 20°C (68°F)	Go to Step 9	Go to Step 7
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Remove the internal wiring harness at the PC Trim solenoid A connector. 3. Using the DVOM, measure the resistance of the PC solenoid A. Is the solenoid resistance within the specified value?	5.5 ohms [commat] 20°C (68°F)	Go to Step 8	Go to Step 10
8	Replace the internal wiring harness. Did you complete the replacement?		Go to Step 12	
9	Inspect the cowl top harness for an open or short to ground on circuits 773 (YL) and 774 (WH) between C79 and C83. Did you find and correct a condition?		Go to Step 12	
10	Replace PC solenoid A. Did you complete the replacement?		Go to Step 12	
11	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 12	
12	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Select Specific DTC. 4. Enter DTC P0748. Has the test run and passed?		System OK	Go to Step 1

DTC P0746 Shift Solenoid C Electrical (Figure OBD-78)

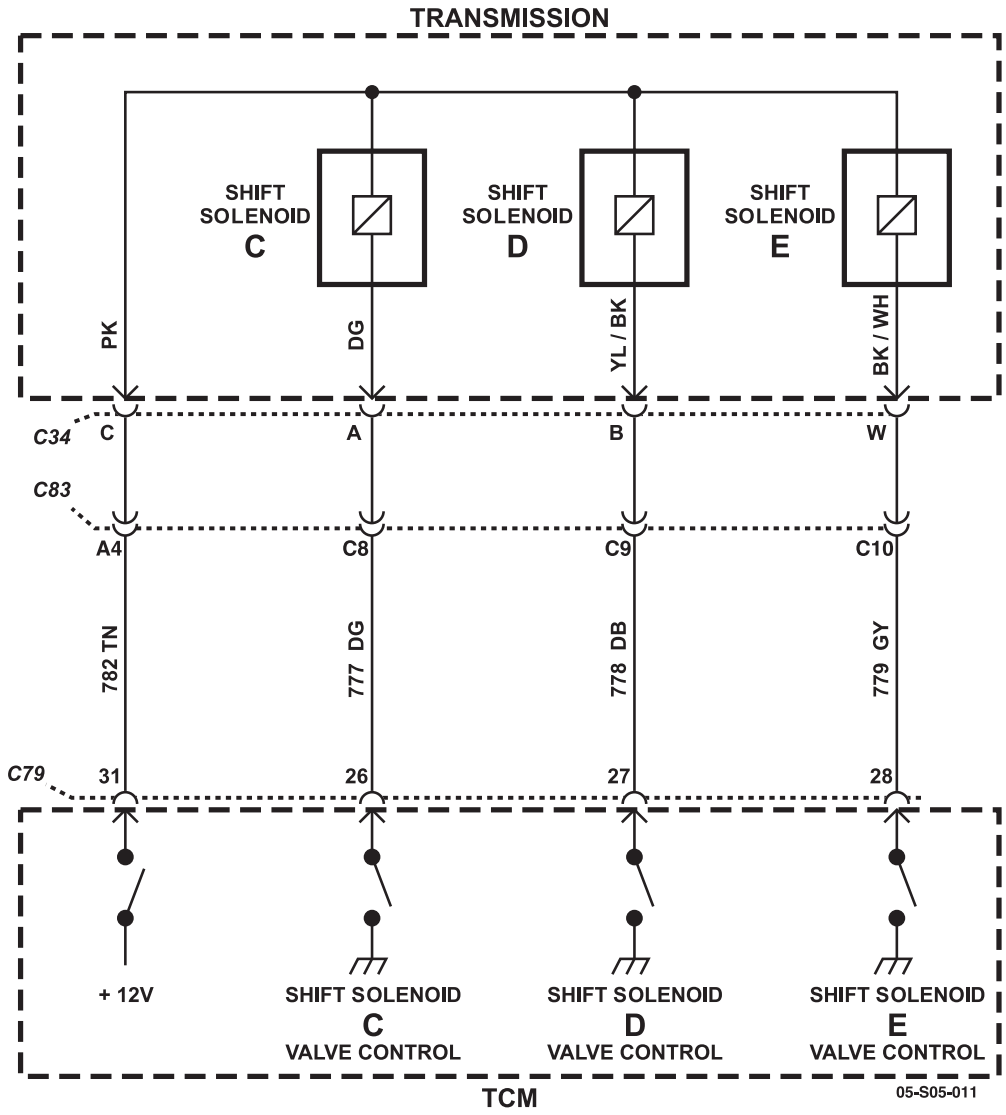


Figure OBD-78: Shift Solenoid C Circuit

Circuit Description

Pressure control (PC) solenoid A is used to control oncoming, off-going, and holding pressure to any one of the five clutches. This solenoid is referred to as a pressure proportional to current (PPC) solenoid since the output hydraulic pressure supplied by this solenoid is proportional to the controlled current command.

The solenoid operates using a very high frequency pulse width modulation signal of 1,000 Hz. Unlike the torque converter clutch pulse width modulated (TCC PWM) solenoid, where the ball follows the pulse width square wave, the PPC ball remains stationary. The ball clearance is balanced between a coil current force on one side of the ball and the clutch trim pressure force on the other side of the ball. The ball-to-seat clearance adjusts the bleed-off rate in the signal pocket. At high bleed levels, the resulting flow across the feed orifice results in a high pressure drop. This produces the desired signal pressure level used to trim the clutch.

DTC P0748 is a type A DTC.

Conditions for Setting the DTC

DTC P0748 sets when the transmission control module (TCM) detects one of the following conditions:

- A short to power
- A short to ground
- High or low resistance in PC solenoid A
- High or low resistance in PC solenoid A wiring

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range, the transmission fails to 1st, 3rd, or 5th range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE, unless the transmission is compromised by a direction change, then the transmission will shift to or lock in NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0748 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- Solenoids are sensitive to battery voltage spikes and poor ground connections. This condition may not be indicated with your scan tool, or with a DVOM.
- The installation of aftermarket devices such as remote starters may interfere with proper TCM voltage supply.
- A faulty ignition switch may cause improper voltage supply to the TCM.
- Power or ground corrosion may cause voltage variation.
- Voltage may vary by 0.5 volts based on the state of charge in the battery.
- PC solenoid A operates on 1,000 Hz and can be measured using a DVOM.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to Step 2	Go to OBD System Check.
2	1. Install the scan tool. 2. Start the engine. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Using a DVOM, measure voltage between connector C79 terminal 26 and terminal 31. 5. Turn ON the ignition, with the engine OFF. 6. Using the scan tool, command C solenoid to ON. Is voltage within the value specified when C solenoid is commanded ON?	B+	Go to Step 4	Go to Step 10
4	1. Turn the ignition OFF. 2. Using the DVOM, measure the resistance between connector C79 terminal 26 and terminal 31. Is the resistance reading within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Connect C79 at the TCM. 3. Disconnect the wiring harness from the transmission 20-way connector C34. 4. Install a DVOM and measure the resistance on the transmission side of the 20-way connector terminals A and C. Is resistance within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Step 6	Go to Step 7
6	Inspect the harness for an open or short to ground on circuits 782 (TN) and 777(DG) between C79 and C34. Did you find and correct the condition?		Go to Step 11	
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Remove the AT internal wiring harness at the shift solenoid C connector. 3. Using the DVOM, measure the resistance of shift solenoid C. Is the solenoid resistance within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Step 8	Go to Step 9

Step	Action	Value(s)	Yes	No
8	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 11	
9	Replace the faulty shift solenoid C. Did you complete the replacement?		Go to Step 11	
10	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Select Specific DTC. 4. Enter DTC P0763. Has the test run and passed?		System OK	Go to Step 1

DTC P0768 Shift Solenoid D Circuit Electrical (Figure OBD-79)

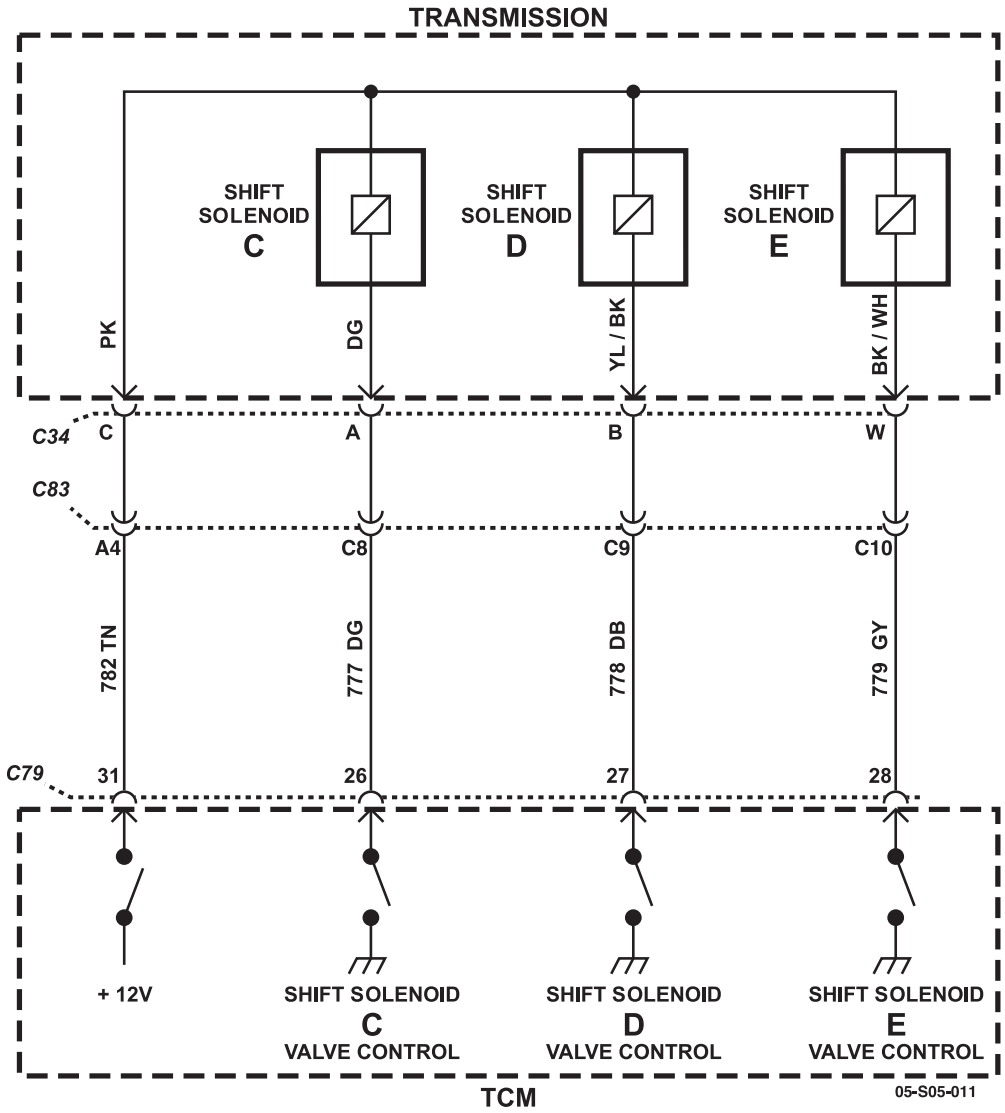


Figure OBD-79: Shift Solenoid D Circuit

Circuit Description

Shift D solenoid is a normally closed (N/C) solenoid that provides control main pressure to stroke the D shift valve. The transmission control module (TCM) determines the proper solenoid command logic to move the D shift valve to attain a particular range.

Since the valve state, stroked or unstroked, is critical to providing the correct transmission range, the shift valve has a pressure switch, located in the pressure switch manifold, to provide feedback to the TCM as to the position of the valve.

DTC P0768 is a type A DTC.

Conditions for Setting the DTC

DTC P0768 sets when the TCM detects one of the following conditions for greater than 100 milliseconds:

- An open circuit or short to ground is detected when D solenoid is commanded OFF.
- A short to power is detected when D solenoid is commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range, the transmission will shift to another forward range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to NEUTRAL or REVERSE.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0768 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- Solenoids are sensitive to battery voltage spikes and poor ground connections. This condition may not be indicated with your scan tool, or with a DVOM.

Step	Action	Value(s)	Yes	No
1	**NOTE:** Before clearing DTC(s) use the scan tool "Capture info" to record Freeze Frame and Failure Records for reference, as data will be lost when "Clear Info" function is used Was the "On-Board Diagnostic (OBD) System Check" performed?		Go to Step 2	Go to OBD System Check.
2	1. Install the scan tool. 2. Start the engine. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage

Step	Action	Value(s)	Yes	No
3	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Using a DVOM, measure voltage between connector C79 terminal 27 and terminal 31. 5. Turn ON the ignition, with the engine OFF. 6. Using the scan tool, command shift solenoid D to ON. Is the voltage within the specified value when shift solenoid D is commanded ON?	B+	Go to Step 4	Go to Step 10
4	1. Turn the ignition OFF. 2. Using a DVOM, measure the resistance between connector C79 terminal 27 and terminal 31. Is the resistance reading within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Connect C79 at the TCM. 3. Disconnect the wiring harness from the transmission 20-way connector C34. 4. Using a DVOM, measure the resistance on the transmission side of the 20-way connector between terminals B and C. Is resistance within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Step 6	Go to Step 7
6	Inspect the harness Between C34 and C79 on circuits 782 (TN) and 778 (DB) for an open or short to ground on. Did you find and correct a condition?		Go to Step 11	
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Remove the AT internal wiring harness at shift solenoid D connector. 3. Using a DVOM, measure the resistance of D solenoid. Is the solenoid resistance within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Step 8	Go to Step 9
8	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 11	
9	Replace shift solenoid D. Did you complete the replacement?		Go to Step 11	
10	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Select Specific DTC. 4. Enter DTC P0768. Has the test run and passed?		System OK	Go to Step 1

DTC P0773 Shift Solenoid E Circuit Electrical (Figure OBD-80)

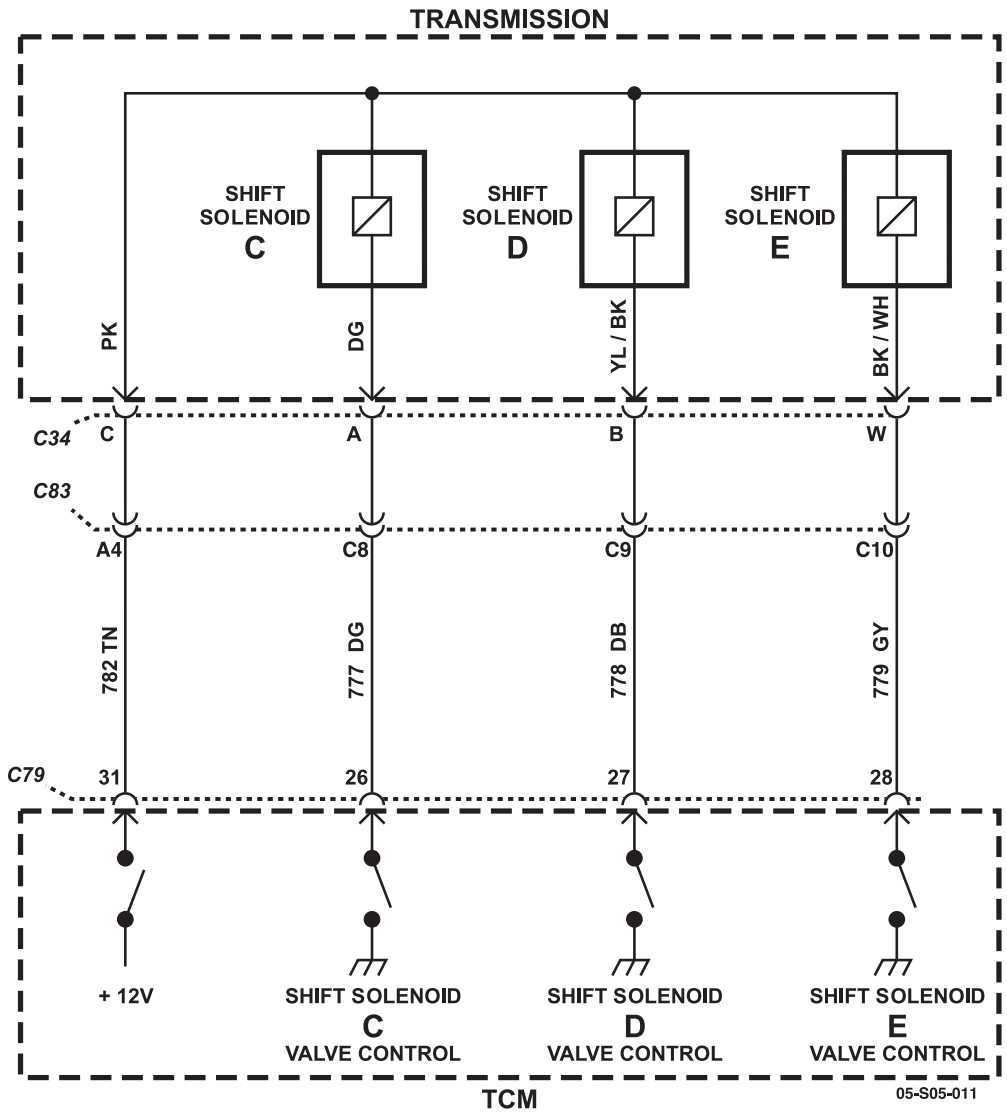


Figure OBD-80: Shift Solenoid E Circuit

Circuit Description

Shift E solenoid is a normally closed (N/C) solenoid that provides control main pressure to stroke the E shift valve. The transmission control module (TCM) determines the proper solenoid command logic to move the E shift valve to attain a particular range.

Since the valve state, stroked or unstroked, is critical to providing the correct transmission range, the shift valve has a pressure switch, located in the pressure switch manifold, to provide feedback to the TCM as to the position of the valve.

DTC P0773 is a type A DTC.

Conditions for Setting the DTC

DTC P0773 sets when the TCM detects any one of the following conditions for greater than 100 milliseconds:

- An open circuit or a short to ground is detected when E solenoid is commanded OFF.
- A short to power is detected when E solenoid is commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range, the transmission will shift to another forward range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to NEUTRAL or REVERSE.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0773 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.

Solenoids are sensitive to battery voltage spikes and poor ground connections. This condition may not be indicated with your scan tool, or with a DVOM.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Install the scan tool. 2. Start the engine. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage

Step	Action	Value(s)	Yes	No
3	1. Turn the ignition OFF. 2. Disconnect the C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Using a DVOM, measure voltage between connector C79 terminal 28 and terminal 31. 5. Turn ON the ignition, with the engine OFF. 6. Using the scan tool, command E solenoid to ON. Is the voltage within the value specified when E solenoid is commanded ON?	B+	Go to Step 4	Go to Step 10
4	1. Turn the ignition OFF. 2. Using a DVOM, measure the resistance between connector C79 terminal 28 and terminal 31 harness side. Is the resistance reading within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Connect the C79 at the TCM. 3. Disconnect the wiring harness from the transmission 20-way connector C34. 4. Install a DVOM and measure resistance on the transmission side of C34 terminals W and C. Is the resistance within the value specified?	22.0 ohms [commat] 20°C (68°F)	Go to Step 6	Go to Step 7
6	Inspect the wiring harness from C34 to C79 circuits 782 (TN) and 779 (GY) for an open or short to ground. Did you find and correct the condition?		Go to Step 11	
7	1. Remove the transmission oil pan. 2. Remove the AT internal wiring harness at the shift solenoid E connector. 3. Using the DVOM, measure the resistance of shift solenoid E. Is the solenoid resistance within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Step 8	Go to Step 9
8	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 11	
9	Replace the faulty shift solenoid E. Did you complete the replacement?		Go to Step 11	
10	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Select Specific DTC. 4. Enter DTC P0773. Has the test run and passed?		System OK	Go to Step 1

DTC P0776 Pressure Solenoid B Controlled Clutch Stuck Off

Circuit Description

Pressure control (PC) solenoid B is used to control oncoming, off-going, and holding pressure in any one of five clutches. This solenoid is referred to as a pressure proportional to current (PPC) solenoid since the output hydraulic pressure supplied by this solenoid is proportional to the controlled current command.

The transmission control module (TCM) uses information from the turbine and output speed sensors to detect if a clutch is slipping. The clutch being controlled by PC solenoid B will vary depending on the shift that was being completed.

DTC P0776 is a type A DTC.

Conditions for Setting the DTC

DTC P0776 sets when the TCM detects an incorrect oncoming ratio, during a forward range shift, for an accumulated number of occurrences.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL)
- When failure occurs in a forward range, the transmission will go to the previous range. If failure occurs in NEUTRAL or REVERSE, the transmission will lock in NEUTRAL while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL and in some cases, may lock in NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE or NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will shift to NEUTRAL.
- DTC P0776 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC indicates the oncoming clutch, being controlled by PC solenoid B, is not applied or applied too slowly. This could indicate a leak or obstruction in a specific clutch apply circuit. Observe scan tool failure record data for previous or current range information when the DTC was set, to determine specific shift when the DTC was set. Refer to Solenoid and Clutch Chart to determine which clutch circuit is suspect.

NOTE: Important: Clutch failure due to installation of an engine power upgrade is not covered under the transmission manufacturers warranty.

Inspect for the presence of an add-on engine power package. When engine horsepower or torque is increased over factory rating, a shift flare condition may occur.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	1. Install the scan tool. 2. Start the engine. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Start the engine. 2. Drive the vehicle under normal operating conditions. 3. Using the scan tool, monitor engine, turbine and output speed sensor readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	1. Connect a 2,000 kPa (300 psi) pressure gage to the line pressure tap. 2. Use the scan tool, in Clutch Test Mode, to cycle through all transmission ranges with the engine at idle and vehicle brakes applied. Record line pressure in each range. Was the line pressure low in a specific range or in ranges where the same clutch was applied?		Go to Low Main Line Pressure in All Ranges	Go to Step 6
6	Refer to Transmission Stall Test. Conduct a clutch test for all forward ranges. Did the turbine speed remain at zero in all ranges?		Go to Diagnostic Aids	Go to Step 7
7	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for signs of clutch failure. Are there signs of clutch failure?		Go to Step 8	Go to Step 9
8	Remove the transmission for overhaul or replacement. Refer to Transmission Replacement. Did you complete the repair or replacement?		Go to Step 11	

Step	Action	Value(s)	Yes	No
9	Inspect for a stuck or sticking PC valve B. Did you find and correct a condition?		Go to Step 11	Go to Step 10
10	Replace the faulty PC solenoid B. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Use the scan tool to reset adaptive values for all shifts. 4. Operate the vehicle in all ranges under normal driving conditions. 5. Select Specific DTC. 6. Enter DTC P0776. Has test run and passed?		System OK	Go to Step 1

DTC P0777 Pressure Solenoid B Controlled Clutch Stuck On

Circuit Description

Pressure control (PC) solenoid B is used to control oncoming, off-going, and holding pressure to any one of the five clutches. This solenoid is referred to as a pressure proportional to current (PPC) solenoid since the output hydraulic pressure supplied by this solenoid is proportional to the controlled current command.

The transmission control module (TCM) uses information from the turbine speed sensor and output speed sensor (OSS) to detect if a clutch is in a tie-up condition or 3 clutches are applied. The clutch being controlled by PC solenoid B will vary depending on the shift being made.

DTC P0777 is a type A DTC

Conditions for Setting the DTC

DTC P0777 sets when the TCM detects the off-going clutch, controlled by PC solenoid B, remains engaged during a forward range shift.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When failure occurs in a forward range, the transmission will go to the previous range. If failure occurs in NEUTRAL or REVERSE, the transmission will lock in NEUTRAL while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE or NEUTRAL or in some cases may lock in NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will shift to NEUTRAL.
- DTC P0777 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC indicates the off-going clutch, being controlled by PC solenoid B, is not releasing or is slow to release. This could indicate a leak or obstruction in a specific clutch apply circuit. Observe scan tool failure record data for previous or current range information when the DTC was set, to determine the specific shift when the DTC was set. Refer to the Solenoid and Clutch Chart to determine which clutch circuit is suspect.

NOTE: Clutch failure due to installation of an engine power upgrade is not covered under the transmission manufacturers warranty.

Inspect for the presence of an add-on engine power package. When engine horsepower or torque is increased over factory rating, a shift flare condition may occur.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	1. Install the scan tool. 2. Start the engine. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 4	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
4	1. Start the engine. 2. Drive the vehicle under normal operating conditions. 3. Using the scan tool, monitor engine, turbine and output speed sensor readings. Is speed sensor data erratic?		Go to the appropriate speed sensor DTC	Go to Step 5
5	1. Connect a 2,000 kPa (300 psi) pressure gage to the line pressure tap. 2. Use the scan tool, in Clutch Test Mode, to cycle through all transmission ranges with the engine at idle and vehicle brakes applied. Record line pressure in each range. Was the line pressure low in a specific range or in ranges where the same clutch was applied?		Go to Low Main Line Pressure in All Ranges	Go to Step 6
6	Refer to Transmission Stall Test. Conduct a clutch test for all forward ranges. Did turbine speed remain at zero in all ranges?		Go to Diagnostic Aids	Go to Step 7
7	1. Remove the transmission oil pan. Refer to Automatic Transmission Fluid/Filter Replacement. 2. Inspect for signs of clutch failure. Are there signs of a clutch failure?		Go to Step 8	Go to Step 9
8	Remove the transmission for overhaul or replacement. Refer to Transmission Replacement. Did you complete the repair or replacement?		Go to Step 11	

Step	Action	Value(s)	Yes	No
9	Inspect for a stuck or sticking PC valve B. Did you find and correct a condition?		Go to Step 11	Go to Step 10
10	Replace the faulty PC solenoid B. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Use the scan tool to reset adaptive values for all shifts. 4. Operate the vehicle in all ranges under normal driving conditions. 5. Select Specific DTC. 6. Enter DTC P0777. Has test run and passed?		System OK	Go to Step 1

DTC P0778 Pressure Solenoid B Electrical (Figures OBD-81, and 82)

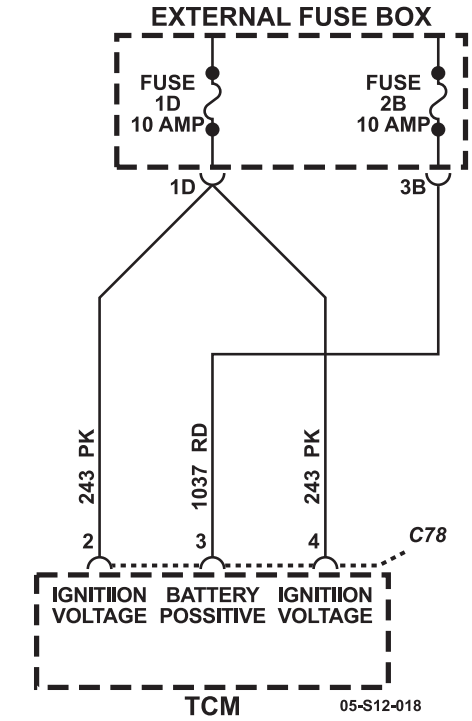


Figure OBD-81: External Fuse Box Circuit

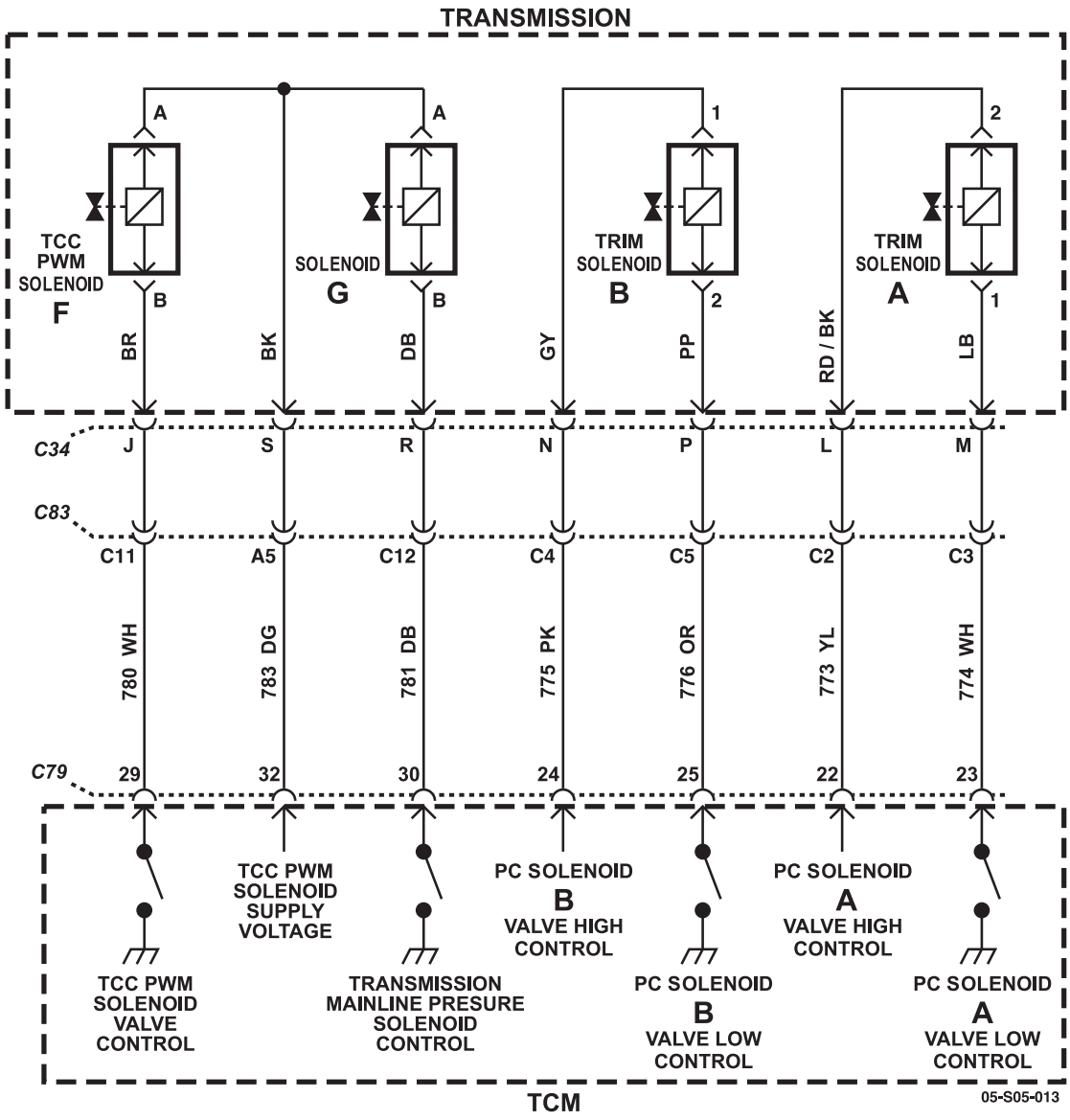


Figure OBD-82: Pressure Control Solenoid Circuit

Circuit Description

Pressure control (PC) solenoid B is used to control oncoming, off-going, and holding pressure to any one of the five clutches. This solenoid is referred to as a pressure proportional to current (PPC) solenoid since the output hydraulic pressure supplied by this solenoid is proportional to the controlled current command.

The solenoid operates using a very high frequency pulse width modulation signal of 1,000 Hz. Unlike the torque converter clutch pulse width modulated (TCC PWM) solenoid, where the ball follows the pulse width square wave, the PPC ball remains stationary. The ball clearance is balanced between a coil current force on one side of the ball and the clutch trim pressure force on the other side of the ball. The ball-to-seat clearance adjusts the bleed-off rate in the signal pocket. At high bleed levels, the resulting flow across the feed orifice results in a high pressure drop. This produces the desired signal pressure level used to trim the clutch.

DTC P0778 is a type A DTC.

Conditions for Setting the DTC

DTC P0778 sets when the transmission control module (TCM) detects one of the following conditions:

- A short to power
- A short to ground
- A high or low resistance in PC solenoid B
- A high or low resistance in PC solenoid B wiring

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range, the transmission fails to 1st, 3rd, or 5th range while diagnostic response is active.
- If the shift selector is moved to NEUTRAL, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE, unless the transmission is compromised by a direction change, then the transmission will shift to or lock in NEUTRAL.
- If the shift selector is returned to a forward range and the transmission is compromised by over speeding or direction change, the transmission will lock in NEUTRAL.
- DTC P0778 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits TCC engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- Solenoids are sensitive to battery voltage spikes and poor ground connections. This condition may not be indicated with your scan tool, or with a DVOM.
- The installation of aftermarket devices such as remote starters may interfere with proper TCM voltage supply.
- A faulty ignition switch may cause improper voltage supply to the TCM.
- Power or ground corrosion may cause voltage variation.
- Voltage may vary by 0.5 volts based on the state of charge in the battery.
- PC solenoid B operates on 1,000 Hz and can be measured using a DVOM.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Install the scan tool. 2. Start the engine. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, measure ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C78 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Turn ON the ignition, with the engine OFF. 5. Using a DVOM, measure the voltage at connector C78 terminals 2, 4, and 3 to a known good ground. Is the voltage within specified value?	B+	Go to Step 4	Go to Diagnostic Aids
4	1. Turn the ignition OFF. 2. Disconnect the C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Using a DVOM, measure the voltage between C79 terminal 24 and terminal 25. 5. Turn ON the ignition, with the engine OFF. 6. Using the scan tool, command PC solenoid B to ON. Is voltage within the range specified when PC solenoid B is commanded ON?	7-7.5 Volts	Go to Step 5	Go to Step 11
5	1. Turn the ignition OFF. 2. Using a DVOM, measure the resistance between C79 terminal 24 and terminal 25. Is the resistance reading within the specified value?	5.5 ohms [commat] 20°C (68°F)	Go to Diagnostic Aids	Go to Step 6
6	1. Connect the C79 to the TCM. 2. Disconnect the transmission 20-way connector C34. 3. Using a DVOM, measure the resistance between terminals N and P of the transmission side of C34. Is the resistance within the specified value?	5.5 ohms [commat] 20°C (68°F)	Go to Step 9	Go to Step 7
7	1. Remove the oil pan. Refer to Oil Pan Replacement. 2. Remove the internal wiring harness at the PC solenoid B connector. 3. Using a DVOM, measure the resistance of trim solenoid B. Is the solenoid resistance within the specified value?	5.5 ohms [commat] 20°C (68°F)	Go to Step 8	Go to Step 10

Step	Action	Value(s)	Yes	No
8	Replace the internal wiring harness. Did you complete the replacement?		Go to Step 12	
9	Inspect the wiring harness between C79 and C34 circuits 755 (PK) and 776 (OR) for an open or short to ground. Did you find and correct a condition?		Go to Step 12	
10	Replace the faulty trim solenoid B. Did you complete the replacement?		Go to Step 12	
11	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 12	
12	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Select Specific DTC. 4. Enter DTC P0778. Has the test run and passed?		System OK	Go to Step 1

DTC P0802 Transmission Control Module (TCM) MIL Request Circuit (Figure OBD-83)

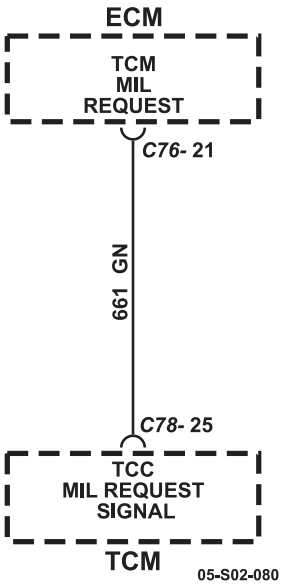


Figure OBD-83: Transmission Control Module (TCM) MIL Request Circuit

Circuit Description

The transmission control module (TCM) malfunction indicator lamp (MIL) request circuit signals the engine control module (ECM) that the TCM is requesting MIL illumination.

Conditions for Setting the DTC

The ECM is detecting an improper voltage level on the TCM MIL request circuit within 7 seconds of the key ON.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Observe the Freeze Frame/Failure Records data for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text or as close to the Freeze Frame/Failure Records data that you observed. Does the DTC fail this ignition?		Go to Step 3	Go to Intermittent Conditions
3	1. Turn OFF the ignition. 2. Disconnect the TCM C78. 3. Connect a DVOM from the TCM malfunction indicator lamp (MIL) request circuit 661 (GN) at the TCM harness C78 to a good ground. 4. Turn ON the ignition, with the engine OFF. Does the voltage measure near the specified value?	B+	Go to Step 4	Go to Step 5
4	Test the TCM MIL request circuit 661 (GN) for a short to voltage between C78 pin 25 and C76 pin 21. Did you find and correct the condition?		Go to Step 11	Go to Step 6
5	Test the TCM MIL request circuit 661 (GN) for an open between C78 pin 25 and C76 pin 21 and repair. Did you find and correct the condition?		Go to Step 11	Go to Step 6
6	1. Leave the TCM disconnected. 2. Connect a fused jumper wire from the TCM MIL request circuit 661 (GN) C78 pin 25 to a good ground. 3. Clear the DTCs with a scan tool. Does DTC P0700 set, but not DTC P0802?		Go to Step 7	Go to Step 9
7	Perform the following procedures: • Check the battery and powers and grounds of the TCM for high resistance or corrosion. • Test the TCM connectors for a poor connection. Did you find and correct the condition?		Go to Step 11	Go to Step 8
8	Replace the faulty TCM. Did you complete the action?		Go to Step 11	
9	Test the engine control module (ECM) connectors for a poor connection. Did you find and correct the condition?		Go to Step 11	
10	Replace the faulty ECM. Did you complete the replacement?		Go to Step 11	

Step	Action	Value(s)	Yes	No
11	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 12
12	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code (DTC) List	System OK

DTC P0840 Transmission Pressure Switch Solenoid C Circuit (Figure OBD-84)

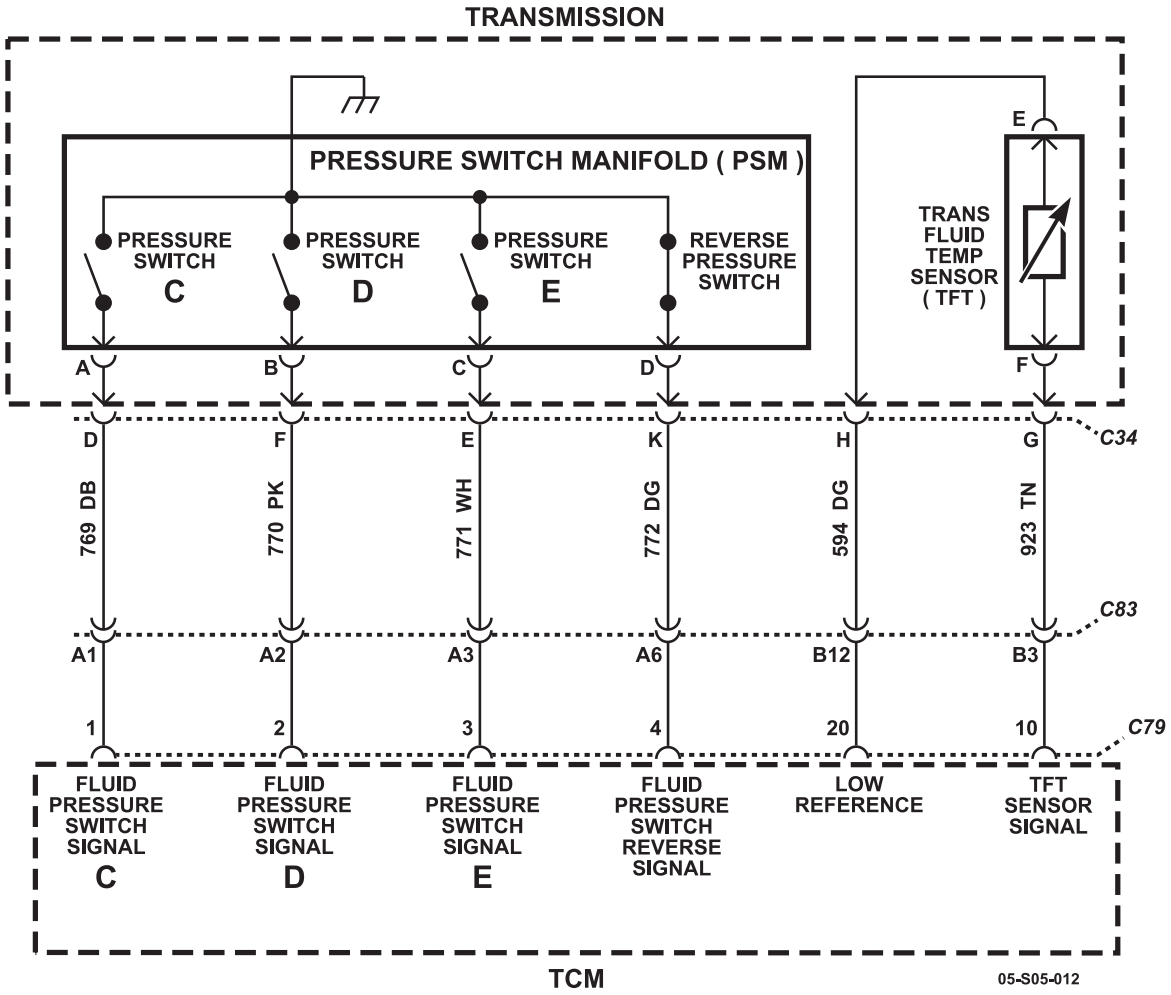


Figure OBD-84: Transmission Pressure Switch Solenoid C Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The C pressure switch monitors C shift valve positioning and relays it to the transmission control module (TCM). When the C pressure switch is in the open state, the C shift valve should be in the unstroked position.

DTC P0840 is a type A DTC.

Conditions for Setting the DTC

DTC P0840 sets during steady state operation when pressure switch C indicates ON for 125 milliseconds after C solenoid has been commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL while diagnostic response is active.
- If the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE if it is not compromised by over speeding or a direction change. If compromised, the transmission will shift to NEUTRAL.
- DTC P0840 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that C solenoid is mechanically defective or the shift valve is stuck in the stroked state.
- When a P0840 and P0842 are set in combination, this may indicate a short to ground at the pressure switch circuit or the shift valve is stuck in the stroked state.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. C status. Does the scan tool indicate TFP SW. C status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect terminal 1 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal D to a known good ground. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 11
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Disconnect the AT internal wiring harness from the PSM and ground terminal A. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 10
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch C membrane. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Diagnostic Aids	Go to Step 9
9	Replace the faulty PSM. Did you complete the replacement?		Go to Step 13	
10	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 13	
11	Repair engine wiring harness circuit for an open or short. Did you complete the repair?		Go to Step 13	

Step	Action	Value(s)	Yes	No
12	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 13	
13	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP Sw. C status. 4. Select Specific DTC. 5. Enter DTC P0840. Has the test run and passed?		System OK	Go to Step 1

DTC P0841 Transmission Pressure Switch Solenoid C Stuck Off (Figure OBD-85)

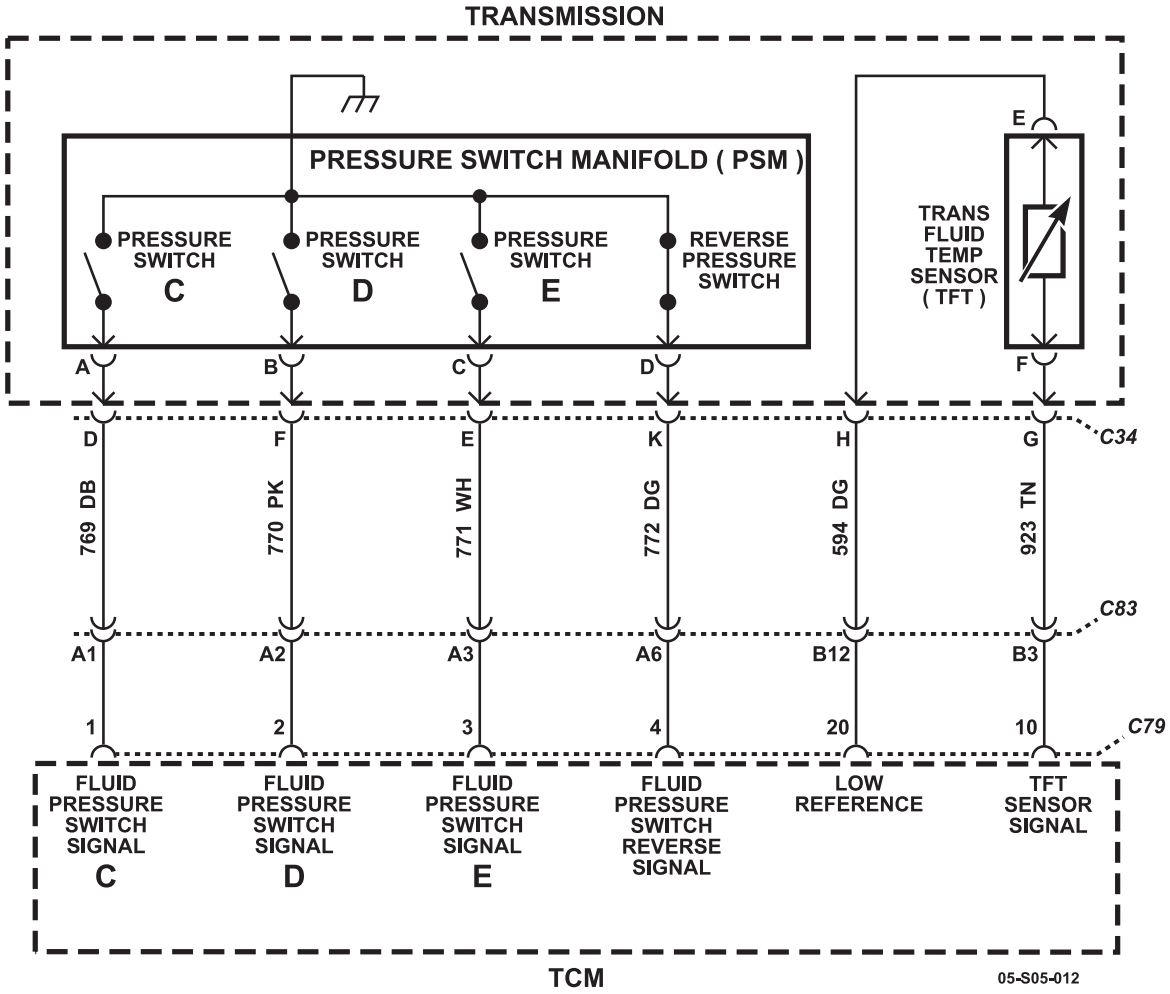


Figure OBD-85: Transmission Pressure Switch Solenoid C Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The C pressure switch monitors C shift valve positioning and relays it to the transmission control module (TCM). When C pressure switch is in the open state, C shift valve should be in the unstroked position.

DTC P0841 is a type A DTC.

Conditions for Setting the DTC

DTC P0841 sets when C solenoid is commanded ON and pressure switch C status remains OFF for 5 seconds depending on fluid temperature.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts where the shifts will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0841 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that C solenoid is mechanically defective or the shift valve is stuck in the stroked state.
- When a P0841 and P0843 are set in combination, this may indicate an open circuit condition is present at the pressure switch circuit or the shift valve is stuck in the unstroked position.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. C status. Does the scan tool indicate TFP SW. C status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 1 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 15
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal D to a known good ground. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Disconnect the AT internal wiring harness from the PSM and ground terminal A. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch C membrane. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking C shift valve. Was the C shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the C shift solenoid and install the control valve body. Did you complete the replacement of the C shift solenoid and the installation of the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Clean and inspect the related valves, bores and the valve body for debris or contamination. Did you complete the repair?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the engine wiring harness circuit for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. C status. 4. Select Specific DTC. 5. Enter DTC P0841. Has the test run and passed?		System OK	Go to Step 1

DTC P0842 Transmission Pressure Switch Solenoid C Circuit Stuck Closed (Figure OBD-86)

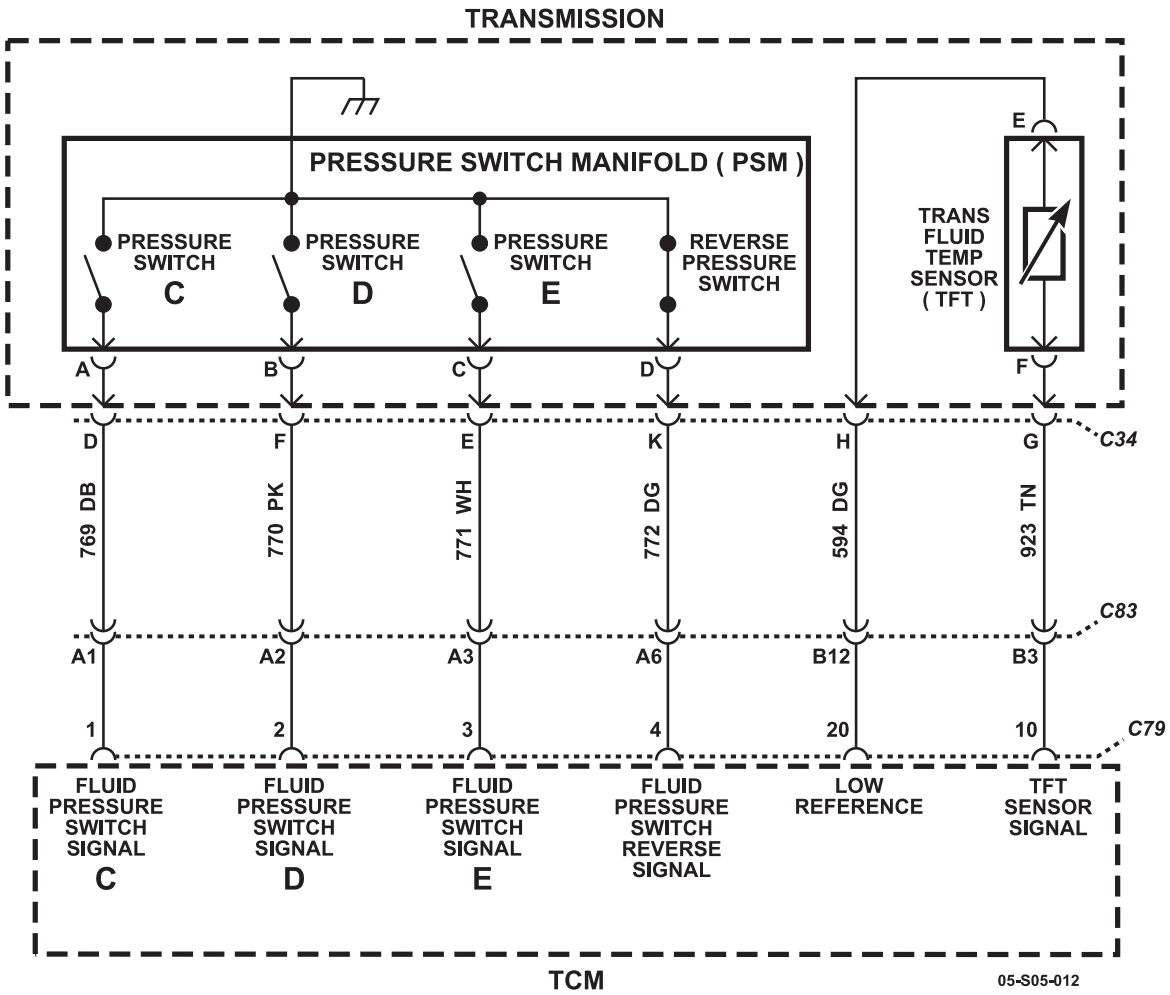


Figure OBD-86: Transmission Pressure Switch Solenoid C Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The C pressure switch monitors C shift valve positioning and relays it to the transmission control module (TCM). When the C pressure switch is in the open state, C shift valve should be in the unstroked position.

DTC P0842 is a type A DTC.

Conditions for Setting the DTC

DTC P0842 sets when C solenoid is commanded OFF and pressure switch C status remains ON for 2-6 seconds, depending on fluid temperature.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL)
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts which will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0842 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that C solenoid is mechanically defective or the shift valve is stuck in the stroked state.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. C status. Does the scan tool indicate TFP SW. C status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect terminal 1 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 15
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal D to a known good ground. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Disconnect the AT internal wiring harness from the PSM and ground terminal A. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch C membrane. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking C shift valve. Was the C shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the faulty C shift solenoid and install the control valve body. Did you replace the solenoid and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Replace the control valve body assembly. Did you complete the replacement?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 769 (DB) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Use the scan tool, monitor TFP SW. C status. 4. Select Specific DTC. 5. Enter DTC P0842. Has the test run and passed?		System OK	Go to Step 1

DTC P0843 Transmission Pressure Switch Solenoid C Circuit High (Figure OBD-87)

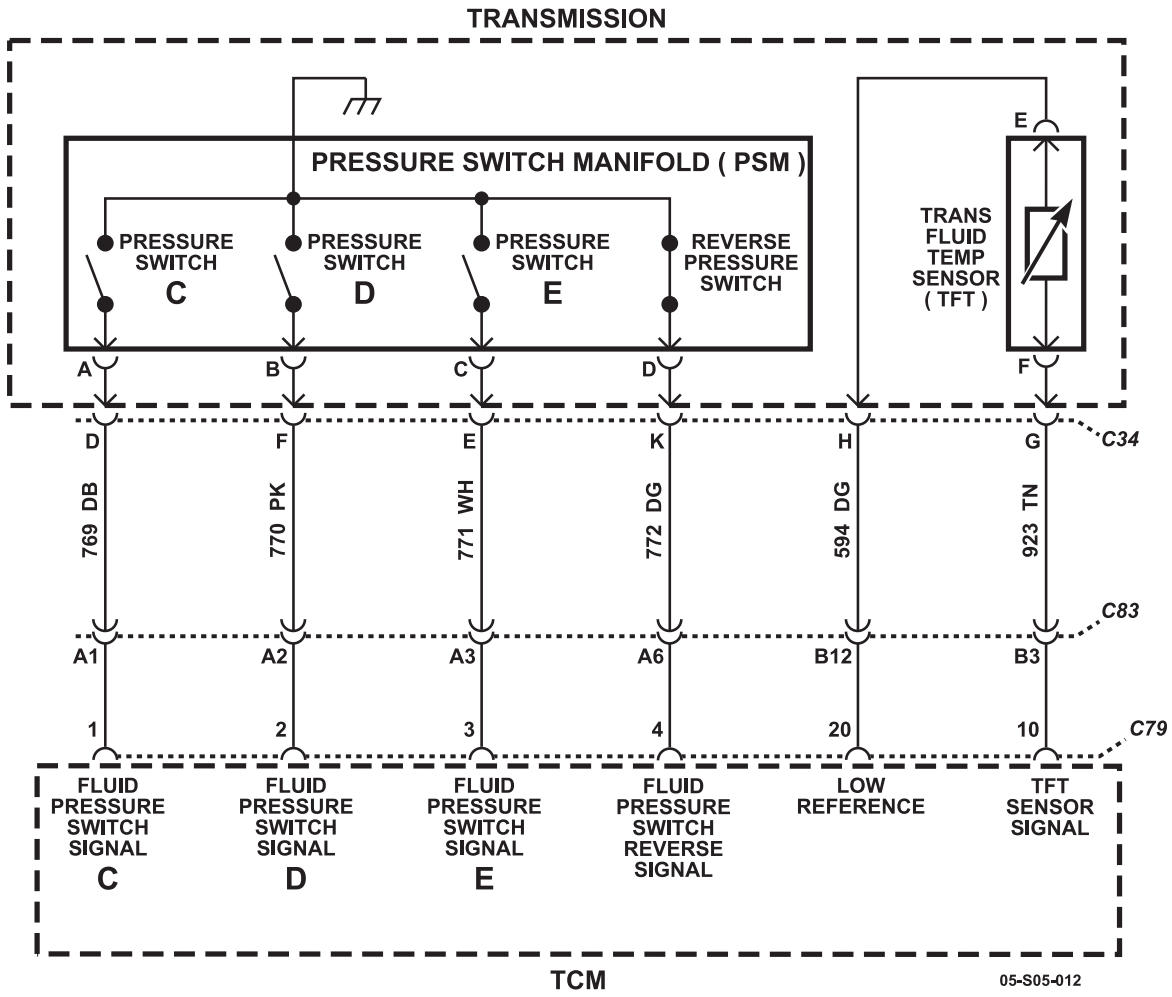


Figure OBD-87: Transmission Pressure Switch Solenoid C Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The C pressure switch monitors C shift valve positioning and relays it to the transmission control module (TCM). When C pressure switch is in the open state, C shift valve should be in the unstroked position.

DTC P0843 is a type A DTC.

Conditions for Setting the DTC

DTC P0843 sets during steady state operation when C solenoid is commanded ON and C pressure switch indicates OFF for 0.1 second.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts which will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0843 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate C solenoid is mechanically defective.
- When a P0843 and P0841 are set in combination, this may indicate an open circuit condition is present at the pressure switch circuit or the shift valve is stuck in the unstroked position.
- This DTC can be caused by a loss of prime.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. C status. Does the scan tool indicate TFP SW. C status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect terminal 1 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 15
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal D to a known good ground. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Disconnect the AT internal wiring harness from the PSM and ground terminal A. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch C membrane. Does the scan tool indicate TFP SW. C status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking C shift valve. Was the C shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the faulty C shift solenoid and install the control valve body. Did you replace the solenoid and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Replace the control valve body assembly. Did you complete the replacement?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 769 (DB) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Use the scan tool, monitor TFP SW. C status. 4. Select Specific DTC. 5. Enter DTC P0843. Has the test run and passed?		System OK	Go to Step 1

DTC P0845 Transmission Pressure Switch Solenoid D Circuit (Figure OBD-88)

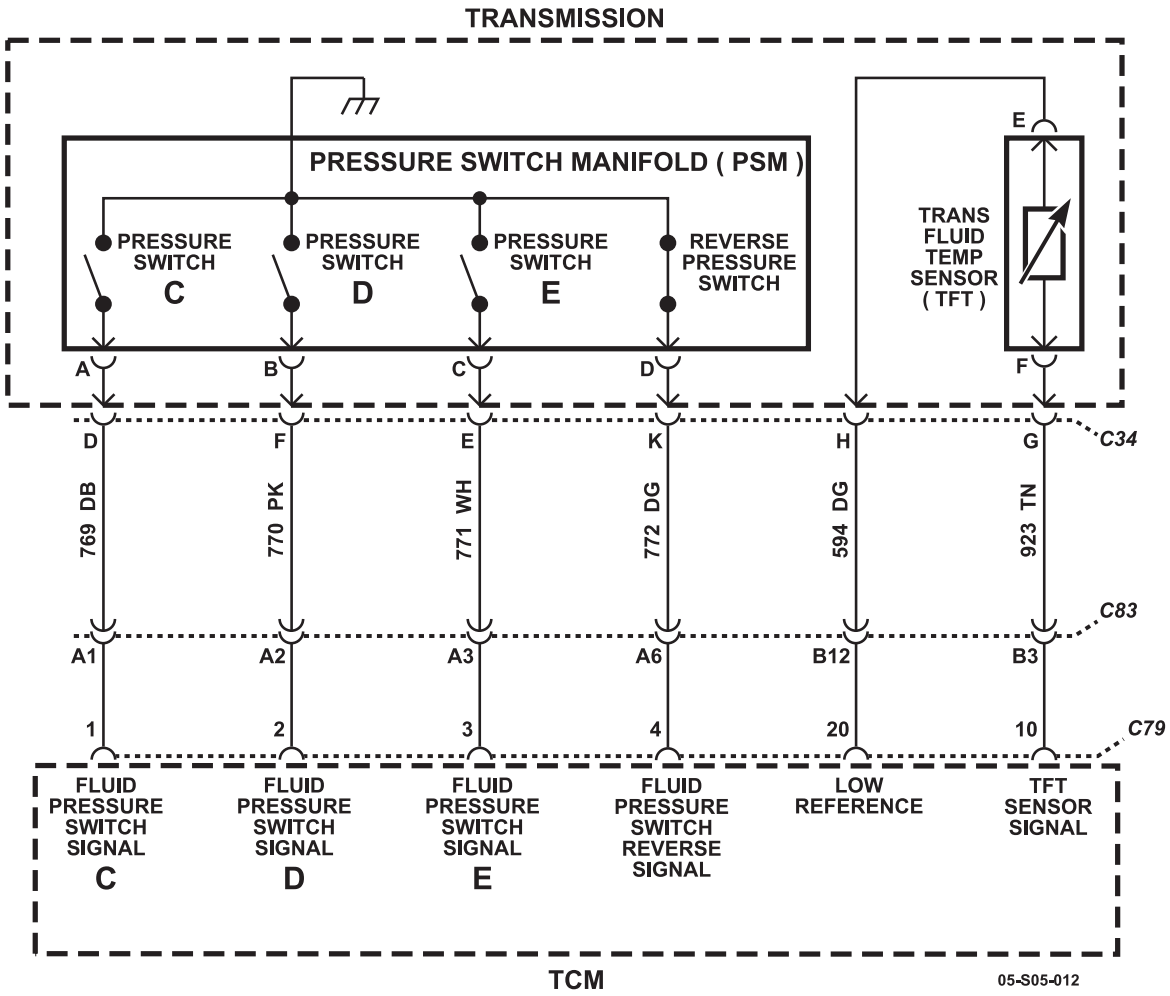


Figure OBD-88: Transmission Pressure Switch Solenoid D Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The D pressure switch monitors D shift valve positioning and relays it to the transmission control module (TCM). When D pressure switch is in the open state, D shift valve should be in the unstroked position.

DTC P0845 is a type A DTC.

Conditions for Setting the DTC

DTC P0845 sets during steady state operation when pressure switch D indicates ON for 40 milliseconds after D solenoid has been commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range when engine speed is reasonable.
- When in NEUTRAL or REVERSE, the transmission fails to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL and a forward range cannot be attained again.
- DTC P0845 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC can be set by a loss of prime.
- When a P0845 and P0847 are set in combination, this may indicate a short to ground is present at the pressure switch circuit or the shift valve is stuck in the stroked state.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. D status. Does the scan tool indicate TFP SW. D status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 2 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect terminal F to a known good ground. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 11
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 2. Disconnect the AT internal wiring harness from the PSM and ground terminal B. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 10
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch D membrane. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Diagnostic Aids	Go to Step 9
9	Replace the faulty PSM. Did you complete the replacement?		Go to Step 13	
10	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 13	
11	Repair wiring harness circuit 770 (PK) for an open or short. Did you complete the repair?		Go to Step 13	

Step	Action	Value(s)	Yes	No
12	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 13	
13	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. D status. 4. Select Specific DTC. 5. Enter DTC P0845. Has the test run and passed?		System OK	Go to Step 1

DTC P0846 Transmission Pressure Switch Solenoid D Circuit Stuck Open (Figure OBD-89)

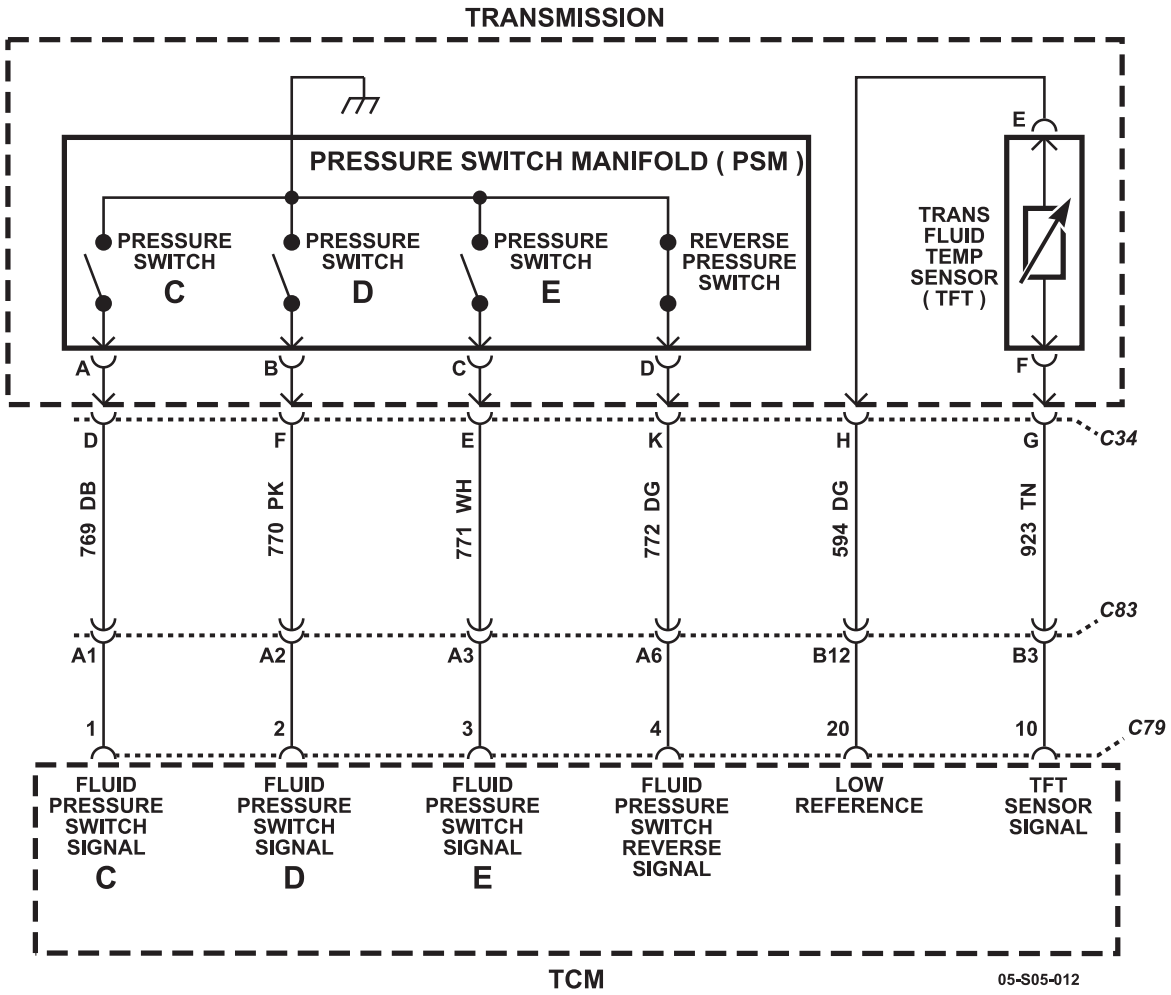


Figure OBD-89: Transmission Pressure Switch Solenoid D Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The D pressure switch monitors D shift valve positioning and relays it to the transmission control module (TCM). When D pressure switch is in the open state, D shift valve should be in the unstroked position.

DTC P0846 is a type A DTC.

Conditions for Setting the DTC

DTC P0846 sets when D solenoid is commanded ON and pressure switch D remains OFF for 5 seconds, depending on fluid temperature.

Action Taken When the DTC Sets

- The TCM Illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts where the shifts will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0846 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate D solenoid is mechanically defective.
- When a P0846 and P0848 are set in combination, this may indicate an open circuit condition is present at the pressure switch circuit or the shift valve is stuck in the unstroked position

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. D status. Does the scan tool indicate TFP SW. D status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 2 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal F to a known good ground. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Connect the transmission C34. 2. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 3. Disconnect the AT internal wiring harness from the PSM and ground terminal B. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. Refer to Pressure Switch Manifold Replacement. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch D membrane. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking D shift valve. Was the D shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the D shift solenoid and install the control valve body. Did you complete the replacement and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Clean and/or polish the sticking valve to restore free movement, or replace the control valve body assembly. Did you restore free movement or replace the valve body?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 770 (PK) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. D status. 4. Select Specific DTC. 5. Enter DTC P0846. Has the test run and passed?		System OK	Go to Step 1

DTC P0847 Transmission Pressure Switch Solenoid D Circuit Stuck Closed (Figure OBD-90)

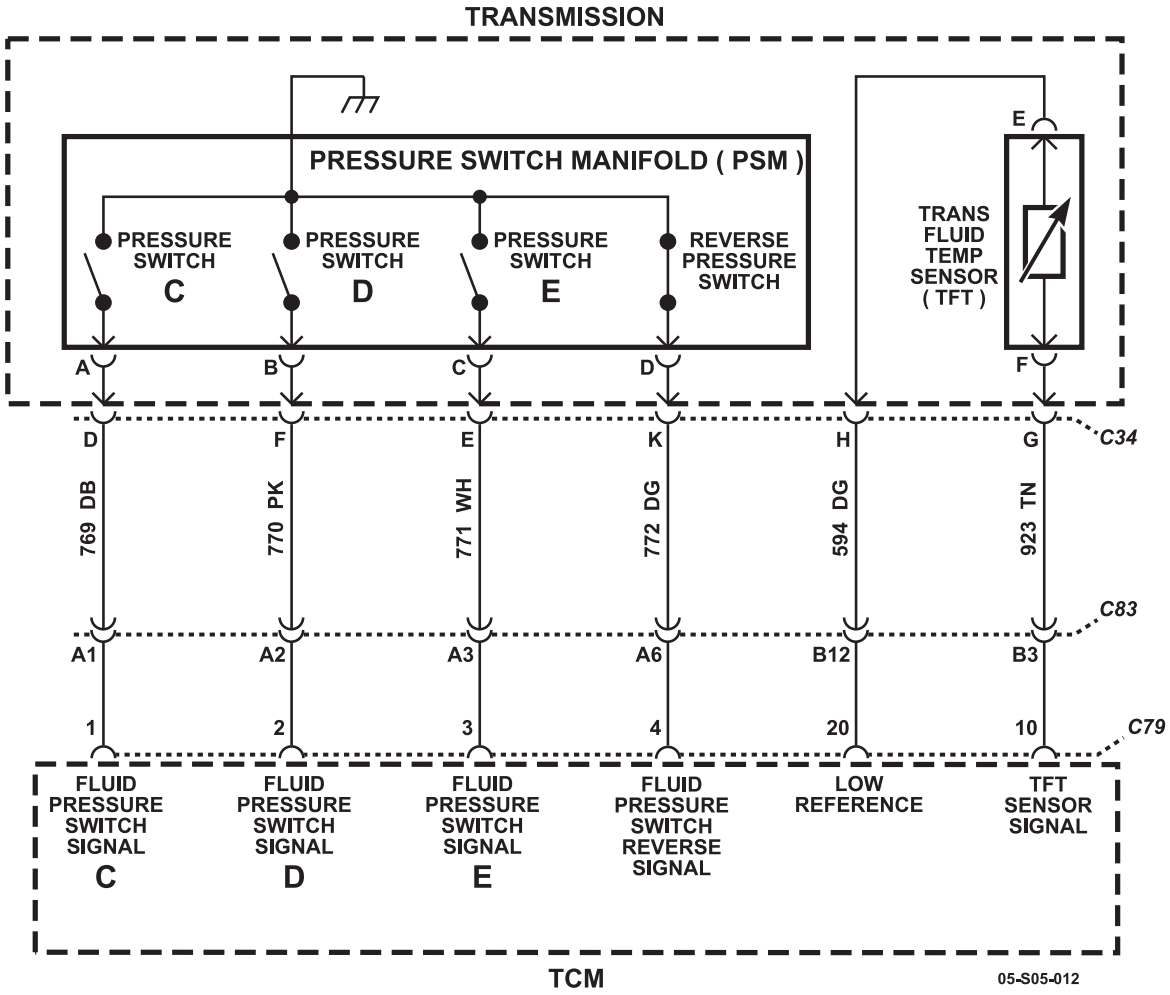


Figure OBD-90: Transmission Pressure Switch Solenoid D Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The D pressure switch monitors D shift valve positioning and relays it to the transmission control module (TCM). When D pressure switch is in the open state, D shift valve should be in the unstroked position.

DTC P0847 is a type A DTC.

Conditions for Setting the DTC

DTC P0847 sets when D solenoid is commanded OFF and pressure switch D status remains ON for 2-16 seconds, depending on fluid temperature.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts which will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0847 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that D solenoid is mechanically defective or the shift valve is stuck in the stroked state.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. D status. Does the scan tool indicate TFP SW. D status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 2 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal F to a known good ground. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Connect the transmission C34. 2. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 3. Disconnect the AT internal wiring harness from the PSM and ground terminal B. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. Refer to Pressure Switch Manifold Replacement. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch D membrane. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking D shift valve. Was the D shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the D shift solenoid and install the control valve body. Did you complete the replacement and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Clean and/or polish the sticking valve to restore free movement, or replace the control valve body assembly. Did you restore free movement or replace the valve body?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 770 (PK) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. D status. 4. Select Specific DTC. 5. Enter DTC P0847. Has the test run and passed?		System OK	Go to Step 1

DTC P0848 Transmission Pressure Switch Solenoid D Circuit High (Figure OBD-91)

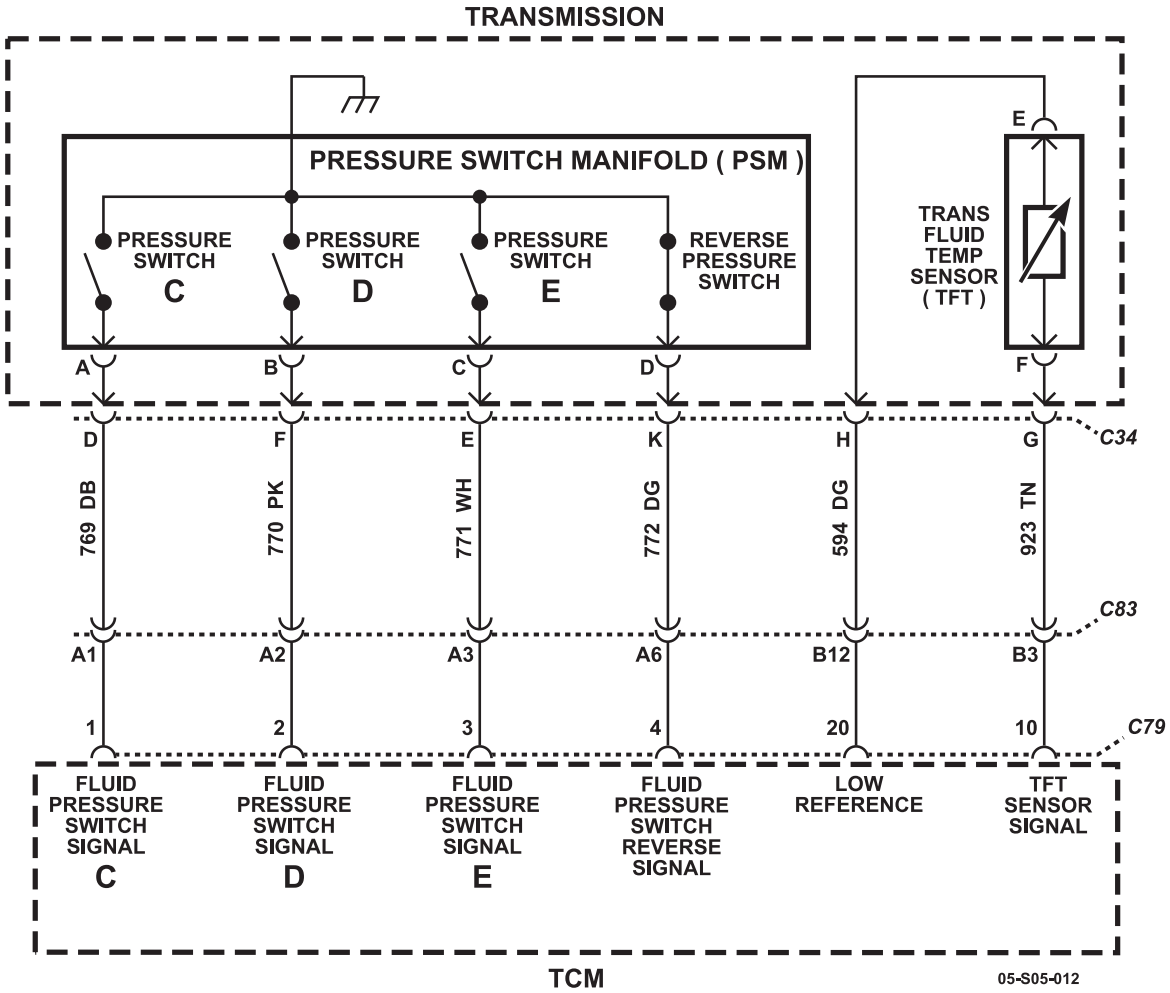


Figure OBD-91: Transmission Pressure Switch Solenoid D Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The D pressure switch monitors D shift valve positioning and relays it to the transmission control module (TCM). When D pressure switch is in the open state, D shift valve should be in the unstroked position.

DTC P0848 is a type A DTC.

Conditions for Setting the DTC

DTC P0848 sets during steady state operation, when pressure switch D indicates OFF for 125 milliseconds of D solenoid being commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts which will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0848 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that D solenoid is mechanically defective.
- When a P0848 and P0846 are set in combination, this may indicate an open circuit is present at the pressure switch circuit or the shift valve is stuck in the unstroked position.
- This DTC can be caused by a loss of prime.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. D status. Does the scan tool indicate TFP SW. D status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 2 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal F to a known good ground. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Connect the transmission C34. 2. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 3. Disconnect the AT internal wiring harness from the PSM and ground terminal B. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. Refer to Pressure Switch Manifold Replacement. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch D membrane. Does the scan tool indicate TFP SW. D status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking D shift valve. Was the D shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the D shift solenoid and install the control valve body. Did you complete the replacement and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Clean and/or polish the sticking valve to restore free movement, or replace the control valve body assembly. Did you restore free movement or replace the valve body?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 770 (PK) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. D status. 4. Select Specific DTC. 5. Enter DTC P0847. Has the test run and passed?		System OK	Go to Step 1

DTC P0870 Transmission Pressure Switch Solenoid E Circuit (Figure OBD-92)

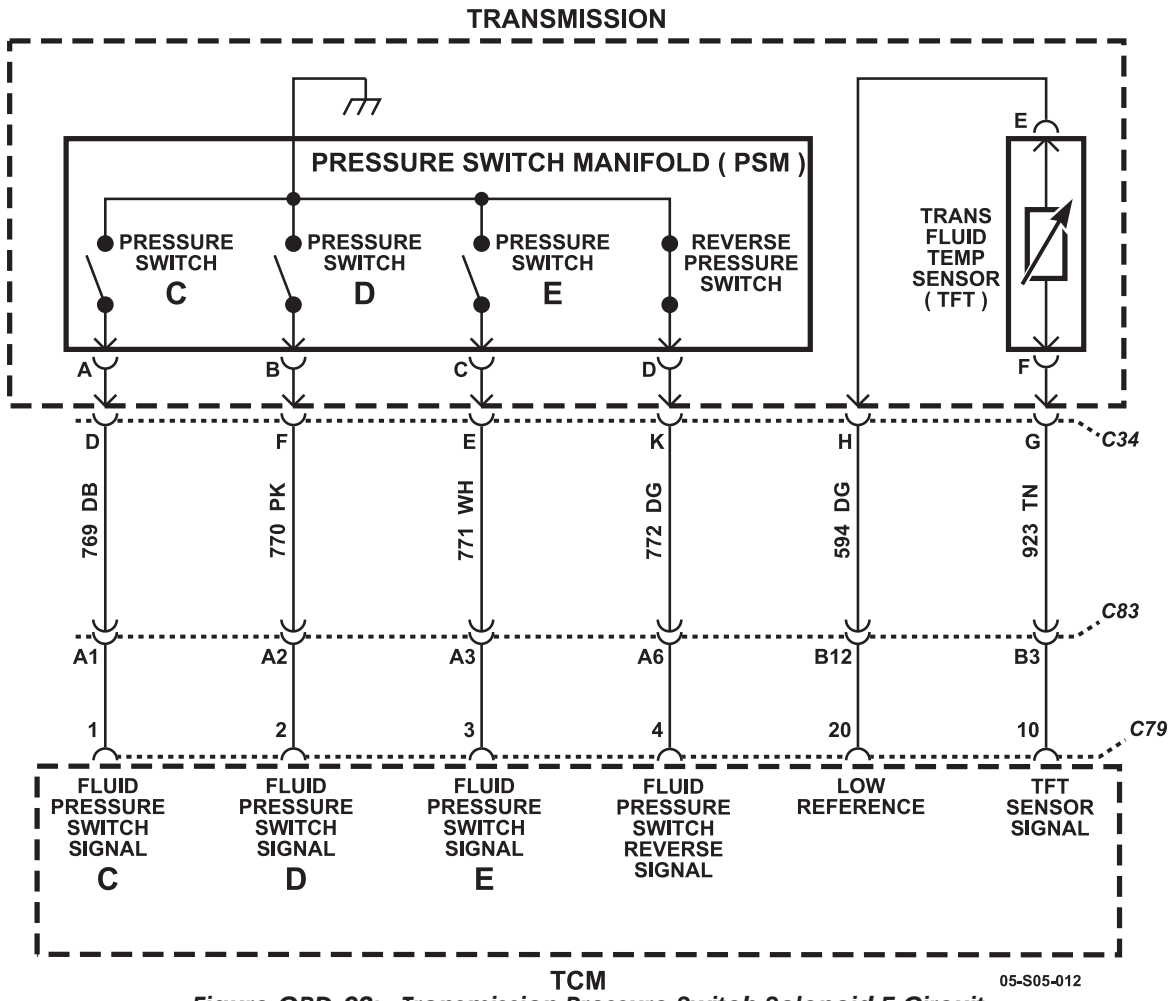


Figure OBD-92: Transmission Pressure Switch Solenoid E Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The E pressure switch monitors E shift valve positioning and relays it to the transmission control module (TCM). When E pressure switch is in the open state, E shift valve should be in the unstroked position.

DTC P0870 is a type A DTC.

Conditions for Setting the DTC

DTC P0870 sets during steady state operation when pressure switch E indicates ON for 20 milliseconds after E solenoid has been commanded OFF.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL while diagnostic response is active.
- If the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, the transmission will shift to NEUTRAL.
- If the shift selector is moved to REVERSE, the transmission will shift to REVERSE if it is not compromised by over speeding or a direction change. If compromised, the transmission will shift to NEUTRAL.
- DTC P0870 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- When a P0870 and 0872 are set in combination, this may indicate a short to ground is present at the pressure switch circuit.
- This DTC can be set by a loss of prime.
- This DTC may indicate that E solenoid is mechanically defective.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. E status. Does the scan tool indicate TFP SW. E status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 3 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal E to a known good ground. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 11
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement . 2. Disconnect the AT internal wiring harness from the PSM and ground terminal C. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 10
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch E membrane. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Diagnostic Aids	Go to Step 9
9	Replace the faulty PSM. Did you complete the replacement?		Go to Step 13	
10	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 13	
11	Repair the wiring harness circuit 771 (WH) for an open or short. Did you complete the repair?		Go to Step 13	

Step	Action	Value(s)	Yes	No
12	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 13	
13	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. E status. 4. Select Specific DTC. 5. Enter DTC P0870. Has test run and passed?		System OK	Go to Step 1

DTC P0871 Transmission Pressure Switch Solenoid E Circuit Stuck Open (Figure OBD-93)

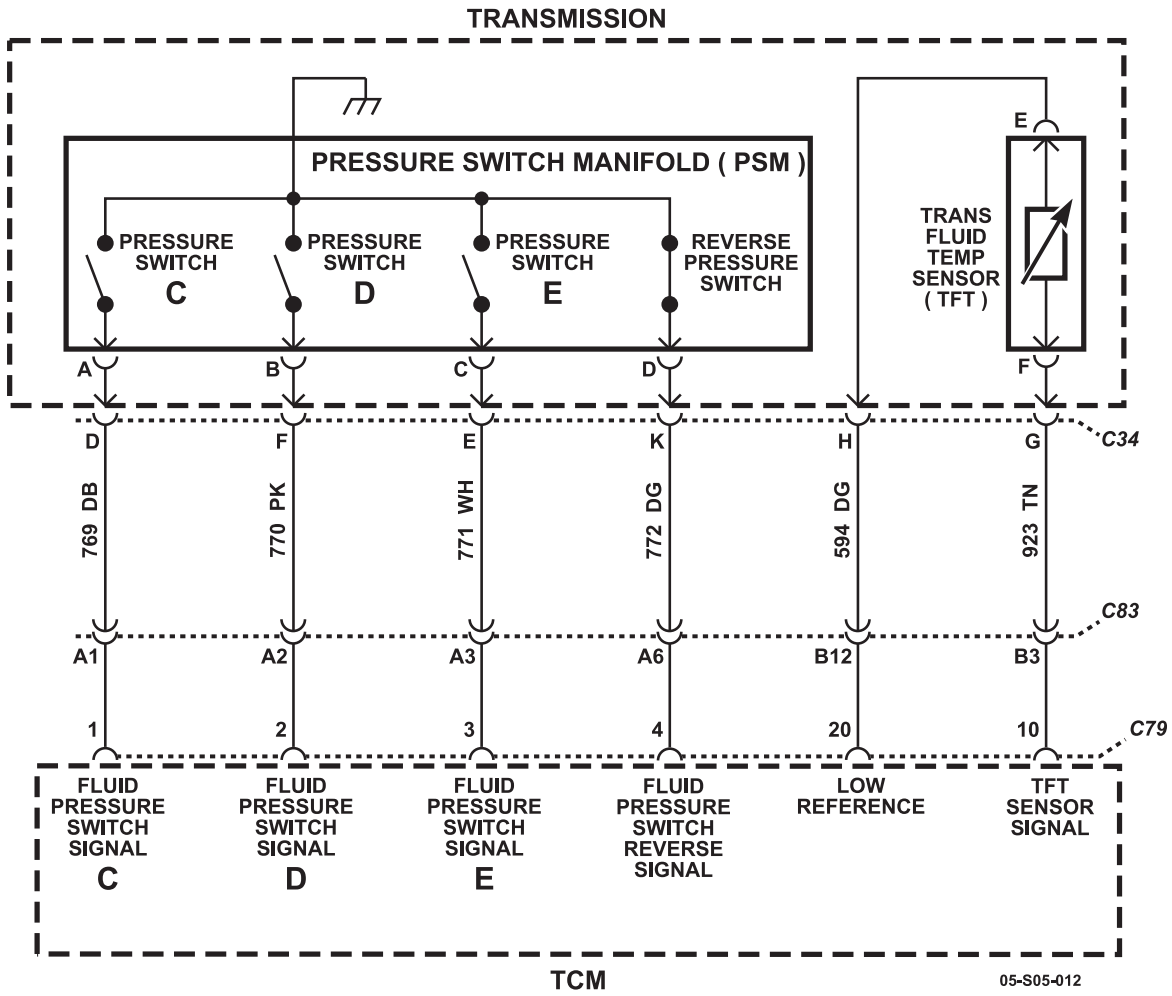


Figure OBD-93: Transmission Pressure Switch Solenoid E Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The E pressure switch monitors E shift valve positioning and relays it to the transmission control module (TCM). When E pressure switch is in the open state, E shift valve should be in the unstroked position.

DTC P0871 is a type A DTC.

Conditions for Setting the DTC

DTC P0871 sets when E solenoid is commanded ON and pressure switch E status remains OFF for 5 seconds, depending on fluid temperature.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts where the shifts will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0871 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that E solenoid is mechanically defective.
- When a P0871 and P0873 are set in combination, this may indicate an open circuit condition is present at the pressure switch circuit or the shift valve is stuck in the unstroked position.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. E status. Does the scan tool indicate TFP SW. E status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 3 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal E to a known good ground. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Connect the transmission C34. 2. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 3. Disconnect the AT internal wiring harness from the PSM and ground terminal C. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. Refer to Pressure Switch Manifold Replacement. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch E membrane. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking E shift valve. Was the E shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the E shift solenoid and install the control valve body. Did you complete the replacement and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Clean and/or polish the sticking valve to restore free movement, or replace the control valve body assembly. Did you restore free movement or replace the valve body?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 771 (WH) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. E status. 4. Select Specific DTC. 5. Enter DTC P0871. Has the test run and passed?		System OK	Go to Step 1

DTC P0872 Transmission Pressure Switch Solenoid E Circuit Stuck Closed (Figure OBD-94)

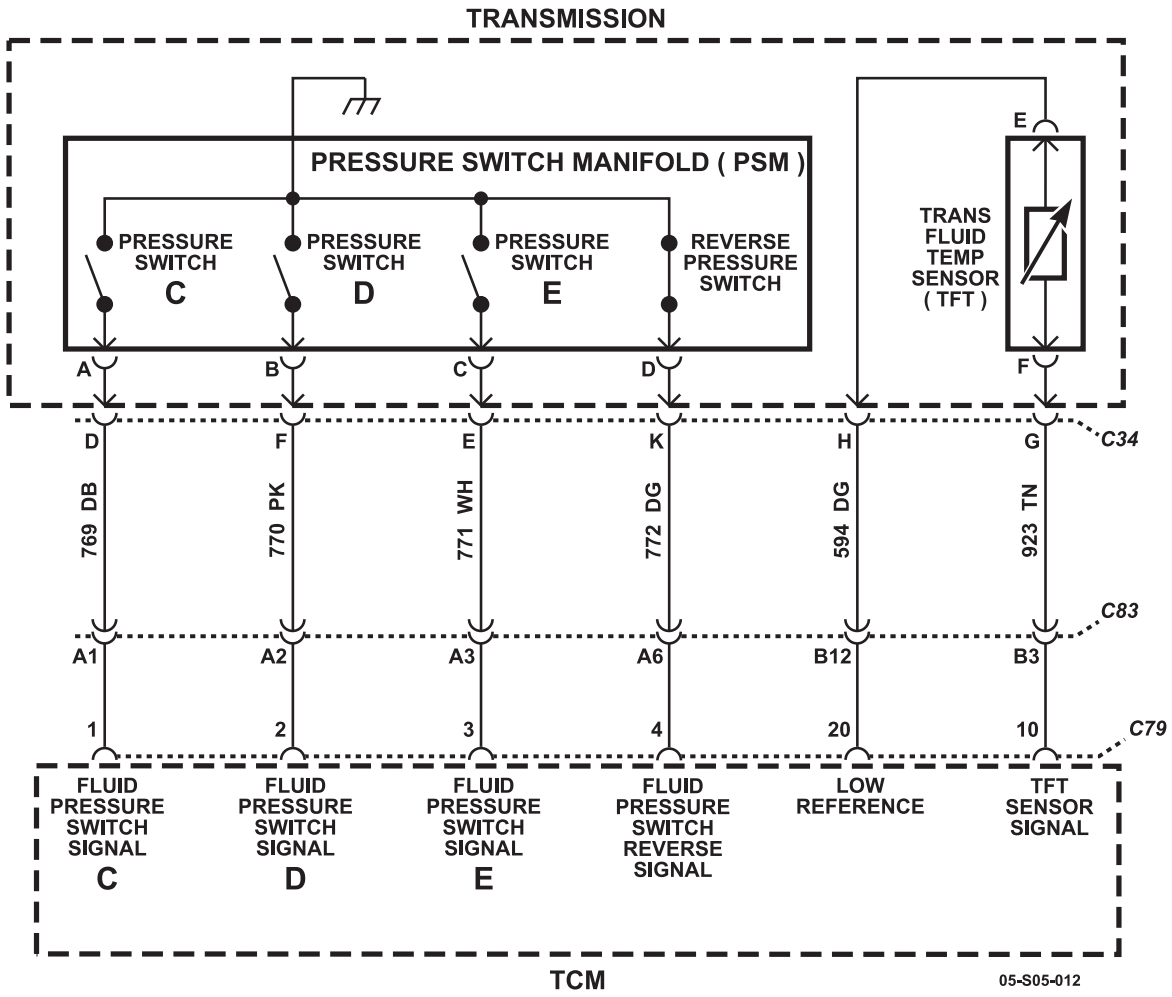


Figure OBD-94: Transmission Pressure Switch Solenoid E Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The E pressure switch monitors E shift valve positioning and relays it to the transmission control module (TCM). When E pressure switch is in the open state, E shift valve should be in the unstroked position.

DTC P0872 is a type A DTC.

Conditions for Setting the DTC

DTC P0872 sets when E solenoid is commanded OFF and pressure switch E status remains ON for 2-20 seconds, depending on fluid temperature.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- The transmission fails to hydraulic default.
- DTC P0872 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that E solenoid is mechanically defective.

When a P0872 and P0870 are set in combination, this may indicate a short to ground is present at the pressure switch circuit or the shift valve is stuck in the stroked state.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. E status. Does the scan tool indicate TFP SW. E status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 3 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal E to a known good ground. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Connect the transmission C34. 2. Remove the oil pan. Refer to Transmission Oil Pan Replacement. 3. Disconnect the AT internal wiring harness from the PSM and ground terminal C. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. Refer to Pressure Switch Manifold Replacement. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch E membrane. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking E shift valve. Was the E shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the E shift solenoid and install the control valve body. Did you complete the replacement and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Clean and/or polish the sticking valve to restore free movement, or replace the control valve body assembly. Did you restore free movement or replace the valve body?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 771 (WH) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. E status. 4. Select Specific DTC. 5. Enter DTC P0872. Has the test run and passed?		System OK	Go to Step 1

DTC P0873 Transmission Pressure Switch Solenoid E Circuit High (Figure OBD-95)

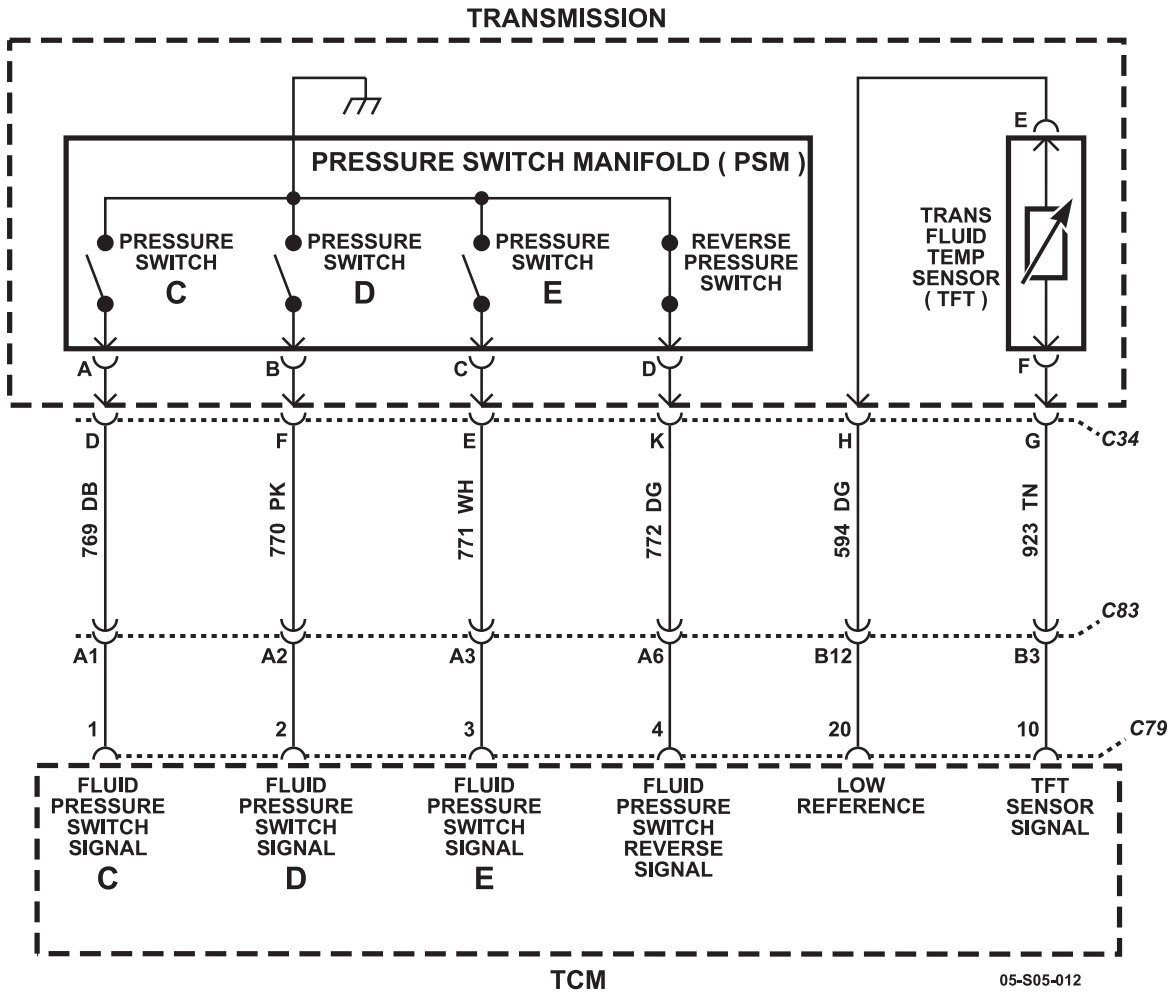


Figure OBD-95: Transmission Pressure Switch Solenoid E Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) and one normally closed (N/C) pressure switches. The E pressure switch monitors E shift valve positioning and relays it to the transmission control module (TCM). When E pressure switch is in the open state, E shift valve should be in the unstroked position.

DTC P0873 is a type A DTC.

Conditions for Setting the DTC

DTC P0873 sets during steady state operation when E solenoid is commanded ON and E pressure switch fails to switch ON after 0.1 second of E solenoid being commanded ON.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL).
- When in a forward range and shifting is completed, the transmission will fail to another forward range, unless the transmission is compromised by over speeding or direction change, then the transmission will shift to NEUTRAL.
- When in a forward range and the shift is in process, the transmission will return to a previous range, except for 1-2 shifts and 2-1 shifts which will be completed.
- When in NEUTRAL or REVERSE, the transmission will fail to NEUTRAL.
- While diagnostic response is active, the shift selector is moved from a forward range to NEUTRAL or from a forward range to REVERSE, then the transmission will shift to NEUTRAL.
- DTC P0873 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC may indicate that E solenoid is mechanically defective.
- When a P0873 and P0871 are set in combination, this may indicate an open circuit condition is present at the pressure switch.
- This DTC can be caused by a loss of prime.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. E status. Does the scan tool indicate TFP SW. E status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 3 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal E to a known good ground. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 14
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement . 2. Disconnect the AT internal wiring harness from the PSM and ground terminal C. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 13
8	1. Remove the PSM from the control valve body and leave the internal harness connected. Refer to Pressure Switch Manifold Replacement. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the pressure switch E membrane. Does the scan tool indicate TFP SW. E status is ON when grounded and OFF when open?		Go to Step 9	Go to Step 12
9	Remove the control valve body and inspect for a stuck or sticking E shift valve. Was the E shift valve stuck or sticking?		Go to Step 11	Go to Step 10
10	Replace the E shift solenoid and install the control valve body. Did you complete the replacement and install the control valve body?		Go to Step 16	

Step	Action	Value(s)	Yes	No
11	Clean and/or polish the sticking valve to restore free movement, or replace the control valve body assembly. Did you restore free movement or replace the valve body?		Go to Step 16	
12	Replace the faulty PSM. Did you complete the replacement?		Go to Step 16	
13	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 16	
14	Repair the wiring harness circuit 771 (WH) for an open or short. Did you complete the repair?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. E status. 4. Select Specific DTC. 5. Enter DTC P0873. Has the test run and passed?		System OK	Go to Step 1

DTC P0875 Transmission Pressure Switch Reverse Circuit (Figure OBD-96)

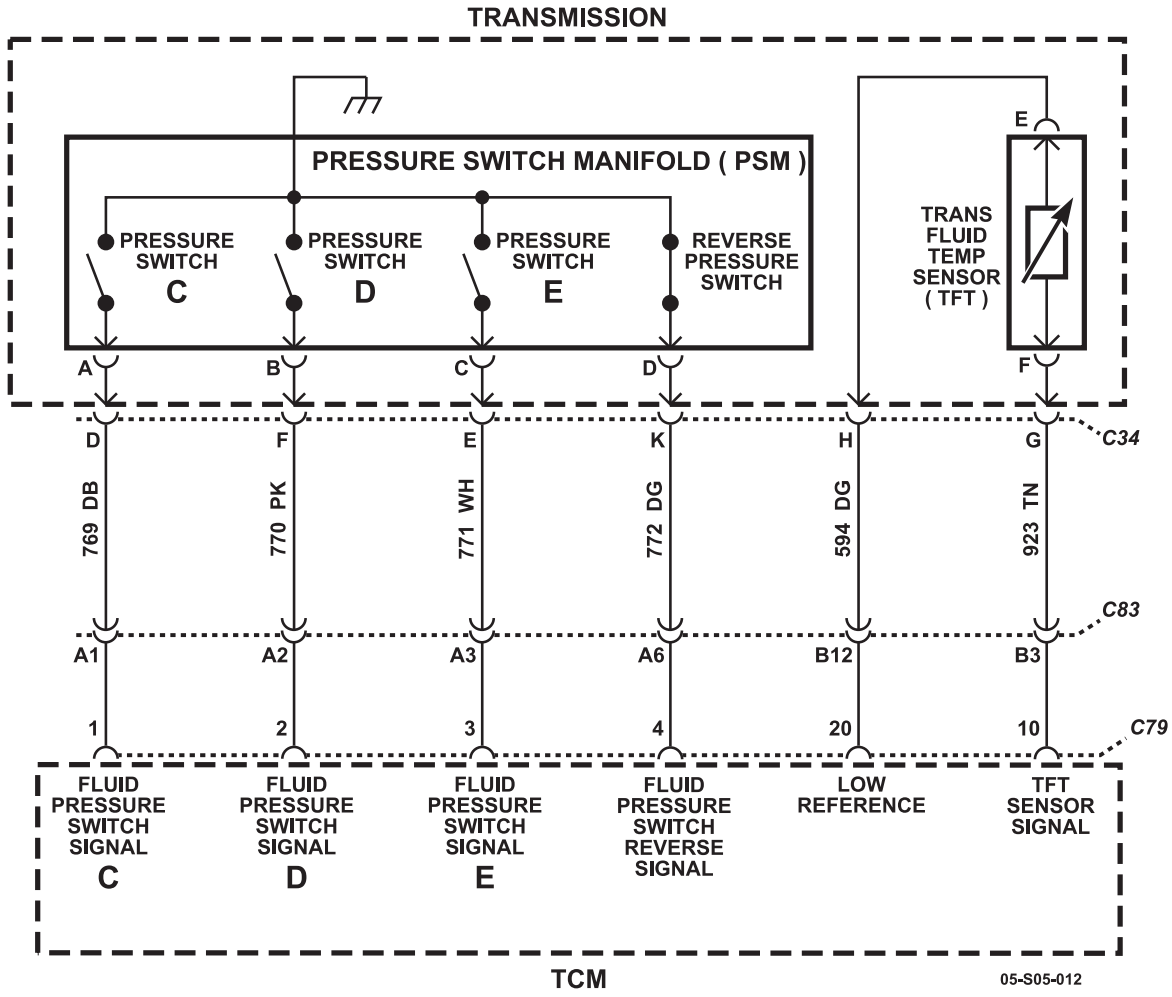


Figure OBD-96: Transmission Pressure Switch Reverse Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) pressure switches and one normally closed (N/C) pressure switch for reverse pressure. Fluid pressure is supplied to the reverse pressure switch when the manual selector valve is in any position except REVERSE. When the manual selector valve is moved to REVERSE, pressure to the reverse pressure switch is cut off causing the switch to close.

DTC P0875 is a type A DTC.

Conditions for Setting the DTC

DTC P0875 sets when PARK, NEUTRAL, or a forward range is selected and the reverse pressure switch remains in the mechanically closed/electrically on position for a period of time that is calibration dependent.

Action Taken When the DTC Sets

- The transmission control module (TCM) will illuminate the malfunction indicator lamp (MIL).
- The transmission will lock in NEUTRAL.
- DTC P0875 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC could indicate a hydraulic leak path exhausting pressure from the reverse pressure switch.
- An inactive DTC P0875 set in combination with DTC P0872 often indicates that an internal PNP switch failure occurred on a previous drive cycle. If this combination returns after clearing the DTCs, replacement of the PNP switch may be necessary.
- The intent of this code is to detect discrepancies between the range selected at the PNP and the actual position of the manual selector valve.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. R status. Does the scan tool indicate TFP SW. R status is ON?		Go to Diagnostic Aids	Go to Step 5

Step	Action	Value(s)	Yes	No
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 4 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal K to a known good ground. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 11
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement . 2. Disconnect the AT internal wiring harness from the PSM and ground terminal D. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 10
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the reverse pressure switch membrane. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Diagnostic Aids	Go to Step 9
9	Replace the faulty PSM. Did you complete the replacement?		Go to Step 13	
10	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 13	
11	Repair the wiring harness circuit 772 (DG) for an open or short. Did you complete the repair?		Go to Step 13	
12	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 13	

Step	Action	Value(s)	Yes	No
13	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. Reverse status. 4. Select Specific DTC. 5. Enter DTC P0875. Has test run and passed?		System OK	Go to Step 1

DTC P0876 Transmission Pressure Switch Reverse Circuit Stuck Open (Figure OBD-97)

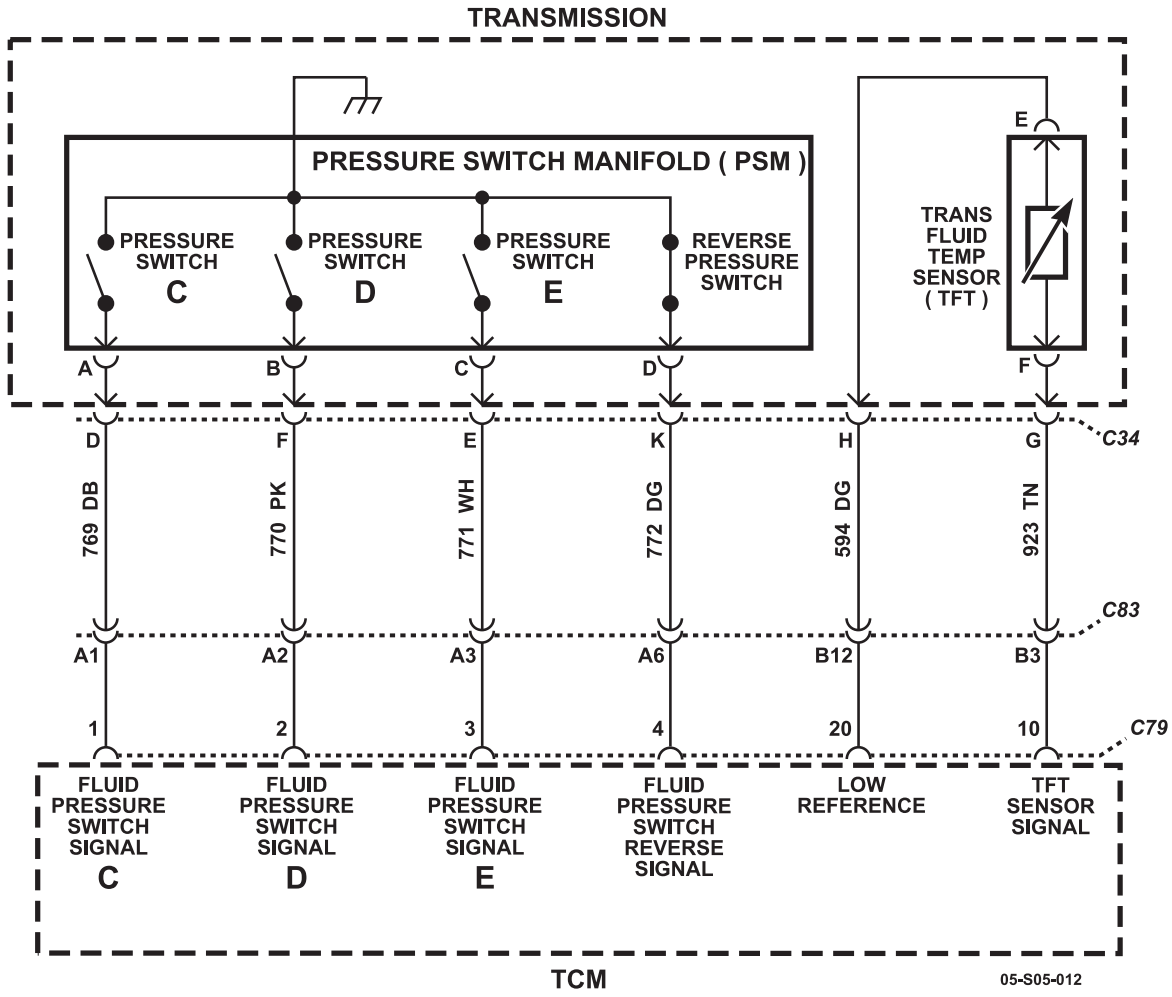


Figure OBD-97: Transmission Pressure Switch Reverse Circuit

Circuit Description

The pressure switch manifold (PSM) is a multiple-switch assembly made up of three normally open (N/O) pressure switches and one normally closed (N/C) pressure switch for reverse pressure. Fluid pressure is supplied to the reverse pressure switch when the manual selector valve is in any position, except REVERSE. When the manual selector valve is moved to REVERSE, pressure to the reverse pressure switch is cut off causing the switch to close.

DTC P0876 is a type B DTC.

Conditions for Setting the DTC

DTC P0876 sets when a forward range has been selected and the reverse pressure switch remains in the mechanically open/electrically off position for more than 1 second.

Action Taken When the DTC Sets

- The transmission control module (TCM) illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- The transmission will lock in NEUTRAL.
- DTC P0876 will be stored in TCM history.
- The TCM freezes shift adapts.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- This DTC could indicate a hydraulic leak path exhausting pressure from the reverse pressure switch.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Measure the transmission fluid level. Refer to Transmission Fluid Checking Procedure. Is the transmission fluid level correct?		Go to Step 3	Go to Transmission Fluid Checking Procedure
3	Measure the line pressure. Is the pressure within the specified value?		Go to Step 4	Go to Symptoms Automatic Transmission

Step	Action	Value(s)	Yes	No
4	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Start the engine. 6. Using the scan tool, monitor TFP SW. R status. Does the scan tool indicate TFP SW. R status is ON?		Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Disconnect C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter at C79. 4. Connect C79 terminal 4 to a known good ground. 5. Turn ON the ignition, with the engine OFF. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Step 6	Go to Step 12
6	1. Turn the ignition OFF. 2. Connect the C79 to the TCM. 3. Disconnect the transmission 20-way connector C34. 4. Turn the ignition ON. Additional DTCs might be set. 5. Connect C34 terminal K to a known good ground. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Step 7	Go to Step 11
7	1. Remove the oil pan. Refer to Transmission Oil Pan Replacement . 2. Disconnect the AT internal wiring harness from the PSM and ground terminal D. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Step 8	Go to Step 10
8	1. Remove the PSM from the control valve body and leave the internal harness connected. 2. Provide a ground connection for the PSM to either the control valve body or the transmission main case. 3. Using the eraser end of a pencil, push gently on the reverse pressure switch membrane. Does the scan tool indicate TFP SW. R status is ON when grounded and OFF when open?		Go to Diagnostic Aids	Go to Step 9
9	Replace the faulty PSM. Did you complete the replacement?		Go to Step 13	
10	Replace the AT internal wiring harness. Did you complete the replacement?		Go to Step 13	
11	Repair the wiring harness circuit 772 (DG) for an open or short. Did you complete the repair?		Go to Step 13	

Step	Action	Value(s)	Yes	No
12	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 13	
13	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Start the engine. 3. Using the scan tool, monitor TFP SW. Reverse status. 4. Select Specific DTC. 5. Enter DTC P0876. Has test run and passed?		System OK	Go to Step 1

DTC P0880 TCM Power Input Signal (Figure OBD-98)

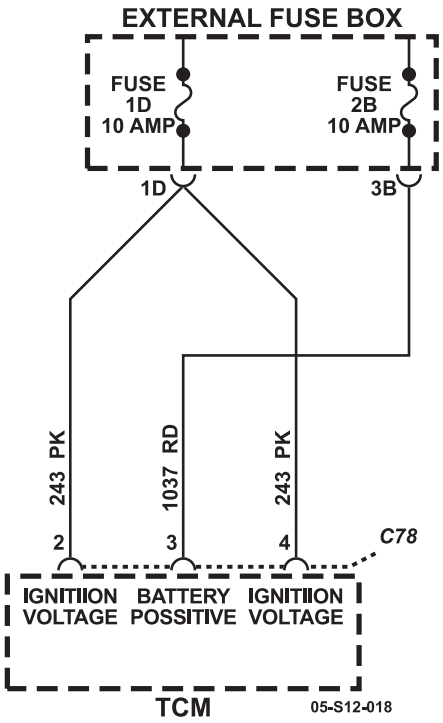


Figure OBD-98: TCM Power Input

Circuit Description

DTC P0880 will set if an abnormal power-down sequence has occurred. This condition means the transmission control module (TCM) has lost battery positive voltage circuit, supply voltage, before it has finished saving information from that drive cycle. This process is usually completed in less than 10 seconds.

DTC P0880 is a type C DTC.

Conditions for Setting the DTC

DTC P0880 sets during the next ignition cycle if the TCM loses TCM supply voltage less than 10 seconds after the ignition voltage has been turned off.

Action Taken When the DTC Sets

- The TCM does not illuminate the malfunction indicator lamp (MIL).
- DTC P0880 will be stored in TCM history.
- Loss of adaptive information for drive cycle. Revert to previous adaptive settings.
- The TCM inhibits torque converter clutch (TCC) engagement.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
  - A bent terminal
  - A backed-out terminal
  - A damaged terminal
  - Poor terminal tension
  - A chafed wire
  - A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. **NOTE:** If other DTCs are present, refer to the applicable diagnostic tables before continuing. 5. Using a DVOM, measure and record the voltage at the battery terminals. Is voltage within the specified value?	B+	Go to Step 3	Go to Battery Inspection
3	Start the engine and warm to normal operating temperature. Is the Alternator/Check Engine lamp ON?		Go to Charging System Test	Go to Step 4
4	1. Increase the engine speed to 1,000-1,500 RPM. 2. Observe the system voltage on the scan tool. Is voltage within the specified range?	13-15 Volts	Go to Step 5	Go to Charging System Test
5	1. Turn the ignition OFF. 2. Disconnect the TCM connector C78. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. Additional DTCs may set. 4. Turn the ignition ON, with the engine OFF. 5. Using a DVOM, measure the voltage between connector C78 terminal 1 and terminal 2, with the ignition ON. 6. Measure the voltage between connector C78 terminal 1 and terminal 3, with the ignition OFF. Is voltage within the specified value of B+ voltage?	0.5 Volts	Go to Step 6	Go to Step 7

Step	Action	Value(s)	Yes	No
6	1. Inspect the transmission wiring harness assembly. 2. Repair the transmission wiring harness assembly. Did you complete the repair?		Go to Step 8	
7	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 8	
8	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Using the scan tool, monitor system voltage. 3. Select Specific DTC. 4. Enter DTC P0880. Has the test run and passed?		System OK	Go to Step 1

DTC P1093 Fuel Rail Pressure Low During Power Enrichment (Figure OBD-99)

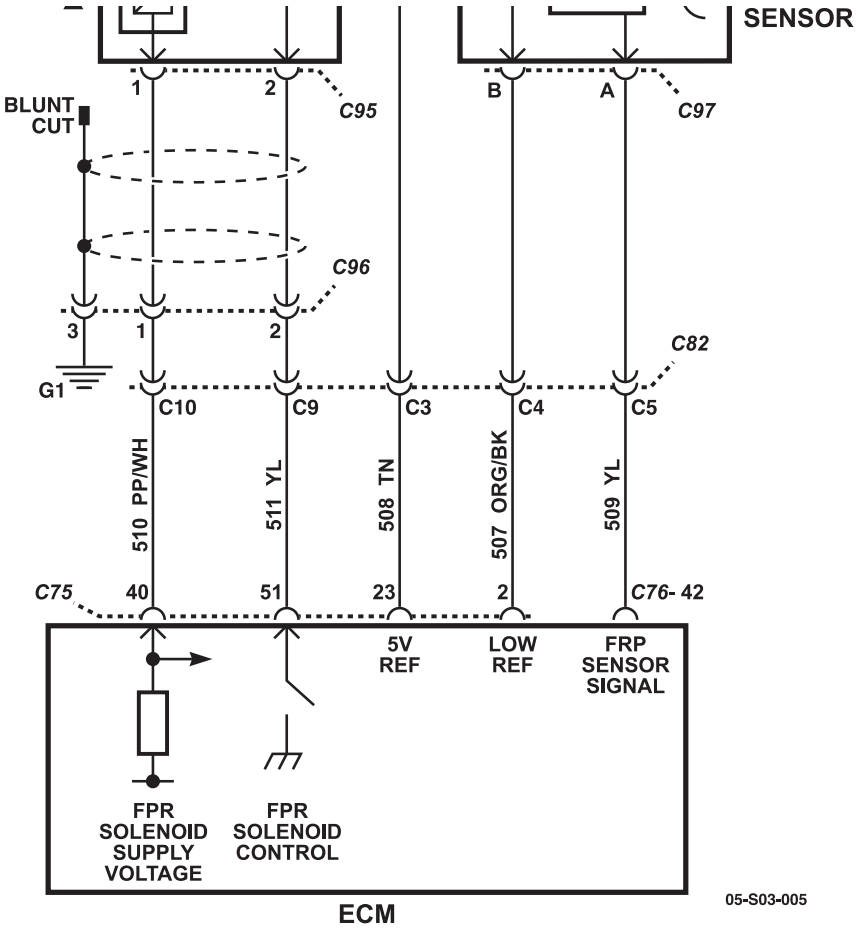


Figure OBD-99: Fuel Rail Pressure Circuit

Circuit Description

The engine control module (ECM) uses the fuel rail pressure (FRP) sensor to determine fuel pressure to the fuel injectors. This is then compared to the calculated target fuel pressure as determined by the ECM. The ECM adjusts the FRP by modulating the duty cycle of the control driver of the fuel pressure regulator. Injector pulse duration is determined by the measured rail pressure and the target injection fuel into each cylinder. If a sensor circuit malfunction is detected, or the commanded fuel injection pump flow is not within the proper range for a given engine load and speed, DTCs will be set.

Conditions for Setting the DTC

The difference between the commanded fuel pressure and the actual fuel pressure is more than 20 MPa.

OR

The FRP regulator fuel flow is more than 19 mm^3 at 800 RPM, or more than 44 mm^3 at 2,000 RPM.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

The engine will be in reduced power mode to replace using no more than 2,000 RPM.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- This DTC does not set for an idle condition.
- The following are some conditions that may cause DTC P0087 and DTC P1093 to set:
  - Excessive fuel return to the tank
  - A fuel injection pump failure
  - A fuel pressure regulator (RPCV) failure
- If you have to prime the fuel system, inspect for the following conditions:
  - A restricted fuel supply line
  - A fuel supply line air leak--Refer to Fuel System Diagnosis .
- A sticking fuel pressure regulator may set this DTC. Refer to Fuel System Diagnosis - High Pressure Side . Perform this test under the conditions for which the DTC set.
- If power enhancing devices have been attached to the fuel rail pressure sensor circuits, this DTC may set and adversely effect the fuel system components. Refer to Fuel System Diagnosis - High Pressure Side .
- If the condition is still intermittent, refer to Intermittent Conditions .

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Is DTC P0168 or P0090 also set?		Go to DTC P0168 or P0090	Go to Step 3
3	**NOTE:** Failure to wait until there is no engine control module (ECM) communications with the scan tool will result in misdiagnosis. 1. Turn OFF the ignition for 30 seconds. 2. Turn ON the ignition, with the engine OFF. 3. Observe the FRP Regulator Command parameter with a scan tool. Is the FRP Regulator Command more than the specified value?	20%	Go to Step 4	Go to Step 16
4	Attempt to start the engine. Does the engine start and idle?		Go to Step 5	Go to Engine Cranks but Does Not Run
5	1. Turn ON the ignition, with the engine OFF. 2. Observe the Actual Fuel Rail Pressure parameter with a scan tool. 3. Is the Actual Fuel Rail Pressure Parameter within the specified range?	1-1.8 MPa	Go to Step 6	Go to Step 10

Step	Action	Value(s)	Yes	No
6	Inspect for fuel contamination. Did you find and correct the condition?		Go to Step 17	Go to Step 7
7	1. Install the J 44638 Vacuum Gage on the fuel fitting located on the right side front of the engine. 2. Start and run the engine at idle. 3. Observe the vacuum gage while increasing RPM slowly to wide open throttle (WOT) in Park or Neutral. Does the vacuum measure less than the specified value through the entire RPM range?	5 inches	Go to Step 8	Go to Step 11
8	1. Start and idle the engine until the idle speed drops to 680 RPM. 2. Command the fuel pressure control to 160 MPa with a scan tool. 3. Observe the Actual Fuel Rail Pressure parameter with a scan tool. Is the Actual Fuel Rail Pressure parameter more than the specified value?	145 MPa	Go to Step 9	Go to Fuel System Diagnosis High Pressure Side
9	**NOTE:** If the fuel temperature is near 121°C (250°F) during the duplication of the complaint or in the Failure Records for this DTC, inspect for a restriction in the fuel cooler air flow or the fuel heater always ON. Refer to Fuel Heater Always On . 1. Ensure that the J 44638 is still installed on the engine. 2. Operate the vehicle within the conditions for which the customer complaint occurs. Does the vacuum measure less than the specified value through the entire operating range?	12 inches	Go to Diagnostic Aids	Go to Step 11
10	1. Disconnect the fuel rail pressure (FRP) sensor. 2. Observe the Actual Fuel Rail Pressure with a scan tool. 3. Does the Actual Fuel Rail Pressure measure more than the specified value?	175 MPa	Go to Step 15	Go to Step 14
11	Replace the fuel filter. Did you complete the replacement?		Go to Step 12	
12	1. Ensure that the J 44638 is still installed on the engine. 2. Start and run the engine under the conditions for which the high vacuum occurred in the previous test. Does the vacuum measure less than or equal to the specified value?	5 inches at idle 12 inches at high speed	Go to Step 17	Go to Step 13
13	Repair the restriction in the fuel supply lines between the fuel tank and the fuel injection pump. Did you complete the repair?		Go to Step 17	
14	Inspect the fuel rail pressure sensor signal circuit 509 (YL) for a short to ground between C76 pin 42 and pin A of the fuel rail pressure sensor. Repair as necessary. Did you find and correct the condition?		Go to Step 17	Go to Step 16

Step	Action	Value(s)	Yes	No
15	Replace the faulty fuel rail pressure sensor. Did you complete the replacement?		Go to Step 17	
16	Replace the faulty ECM. Did you complete the replacement?		Go to Step 17	
17	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 18
18	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code (DTC) List	System OK

DTC P1094 Fuel Rail Pressure Low During Idle or Decel Fuel Cut-Off (DFCO) (Figure OBD-100)

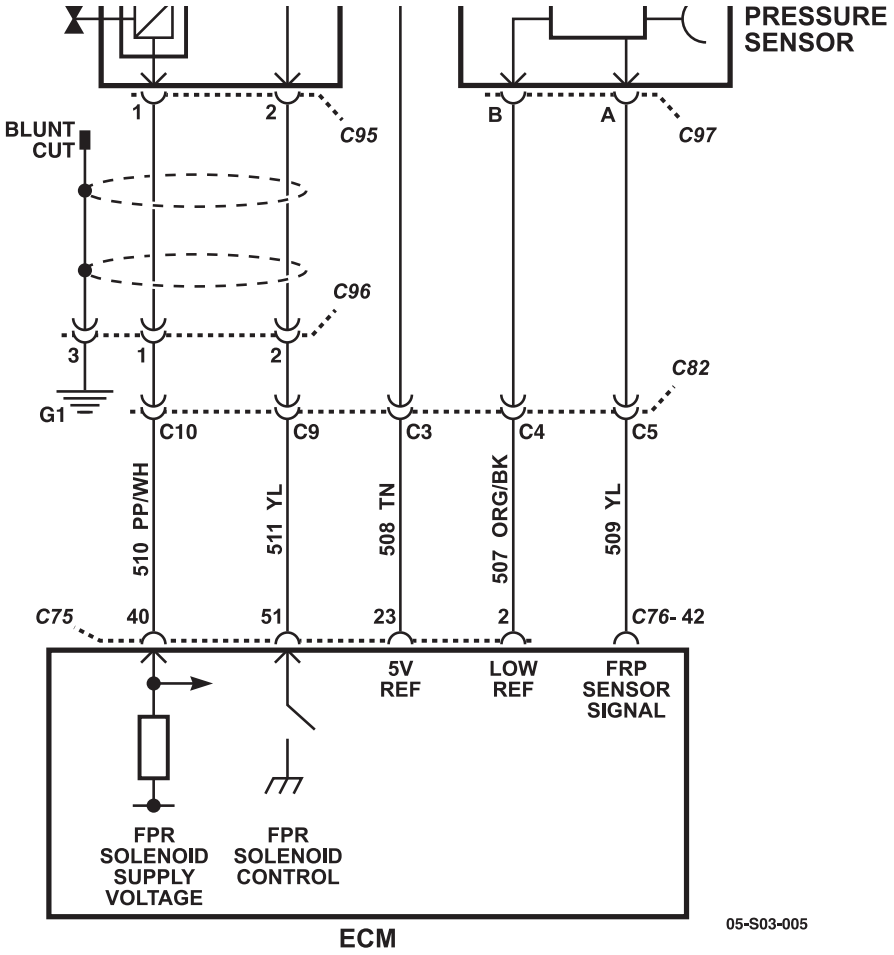


Figure OBD-100: Fuel Rail Pressure Circuit

Circuit Description

The engine control module (ECM) uses the fuel rail pressure (FRP) sensor to determine fuel pressure to the fuel injectors. This is then compared to the calculated target fuel pressure as determined by the ECM. The ECM adjusts the FRP by modulating the duty cycle of the control driver of the fuel pressure regulator. Injector pulse duration is determined by the measured rail pressure and the target injection fuel into each cylinder. If a sensor circuit malfunction is detected, or the commanded fuel injection pump flow is not within the proper range for a given engine load and speed, DTC will be set.

Conditions for Setting the DTC

The difference between the FRP sensor and the commanded fuel injection pump flow is more than 30 MPa

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Diagnostic Aids

- If you have to prime the fuel system, inspect for the following conditions:
  - A restricted fuel supply line
  - A fuel supply line air leak--Refer to Fuel System Diagnosis .
- If the condition is still intermittent, refer to Intermittent Conditions .

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Is DTC P1093 also set?		Go to DTC P1093	Go to Step 3
3	Inspect the for fuel contamination. Did you find and correct the condition?		Go to Step 10	Go to Step 4
4	Attempt to start the engine. Does the engine start and continue to run?		Go to Step 5	Go to Engine Cranks but Does Not Run
5	Is the customer concern also a surging idle?		Go to Fuel Pressure Regulator Diagnosis	Go to Step 6
6	1. Start and idle the engine. 2. Observe the fuel rail pressure (FRP) regulator fuel flow with a scan tool. Does the FRP regulator fuel flow measure more than the specified value?	12000 mm	Go to Step 7	Go to Diagnostic Aids
7	Test the fuel pressure regulator solenoid control circuit 511 (YL) between C75 pin 51 and pin 2 of the fuel pressure regulator for a short to ground. Did you find and correct the condition?		Go to Step 10	Go to Step 8
8	Test for an intermittent or poor connection at the ECM. Did you find and correct the condition?		Go to Step 10	Go to Step 9
9	Replace the faulty ECM. Did you complete the replacement?		Go to Step 10	

Step	Action	Value(s)	Yes	No
10	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 11
11	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code (DTC) List	System OK

DTC P1125 Accelerator Pedal Position (APP) System (Figure OBD-101)

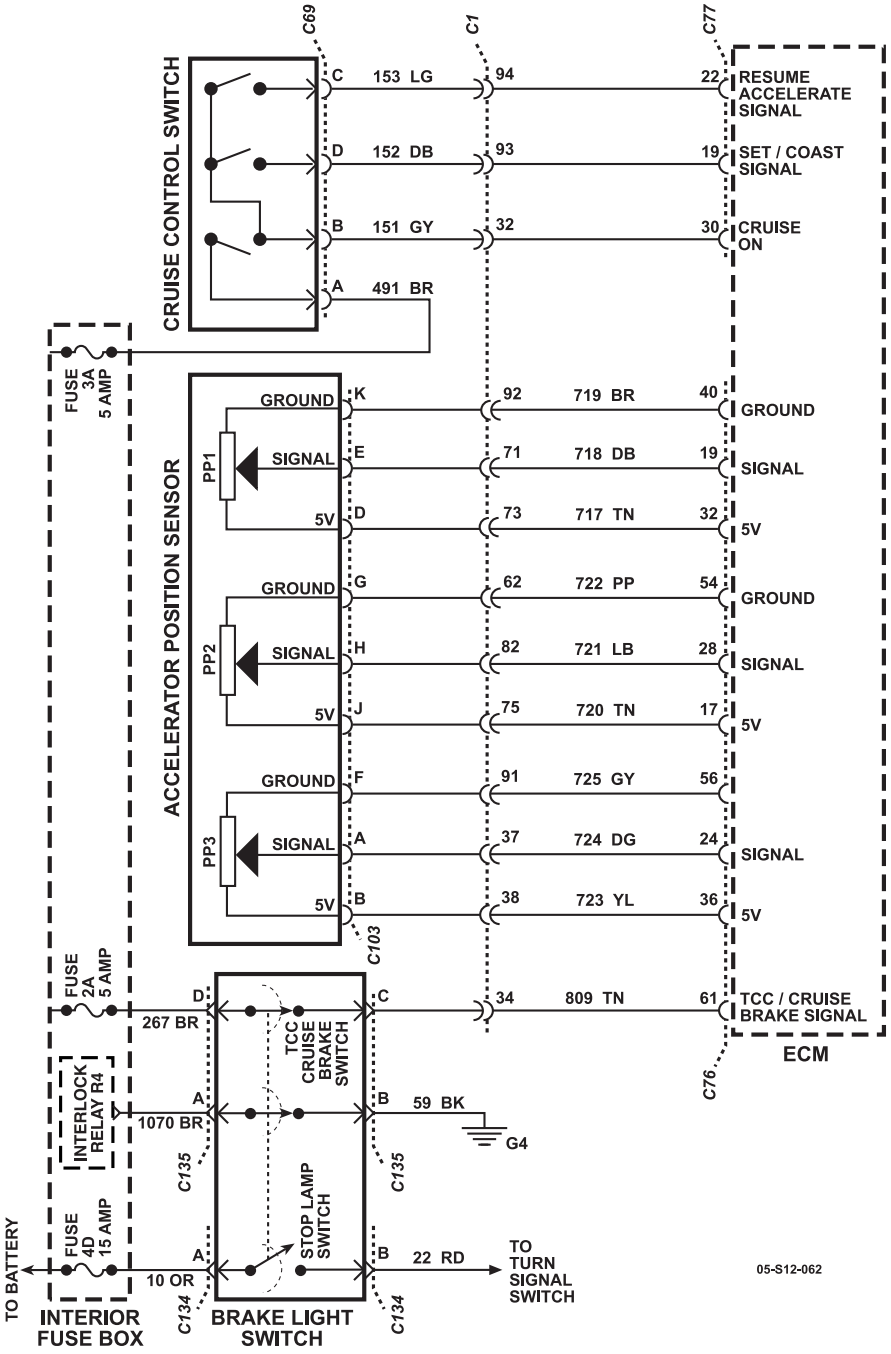


Figure OBD-101: Accelerator Pedal Position Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within one housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via fuel injector control. If the ECM detects a condition with more than one sensor within the APP sensor, DTC P1125 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The ECM detects a condition with more than one APP sensor.
- All of the above conditions present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Diagnostic Aids

- The APP sensor 2 5-volt reference circuit is shared with the barometric pressure (BARO) sensor and the turbo boost solenoid and they are internally connected within the ECM.
- For an intermittent, refer to Intermittent Conditions .

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Is DTC P0642, P0643, P0652, P0653, P0698, or P0699 also set?		Go to Diagnostic Trouble Code (DTC) List - Vehicle in Vehicle DTC Information	Go to Step 3
3	This DTC indicates that 2 or more accelerator pedal position (APP) sensor DTCs are set. Are other APP sensor DTCs set?		Go to Diagnostic Trouble Code (DTC) List - Vehicle in Vehicle DTC Information	

DTC P1123, P1226, P1229, P1232, P1235, P1238, P1241, P1244 Injector Output Circuit (Figure OBD-102)

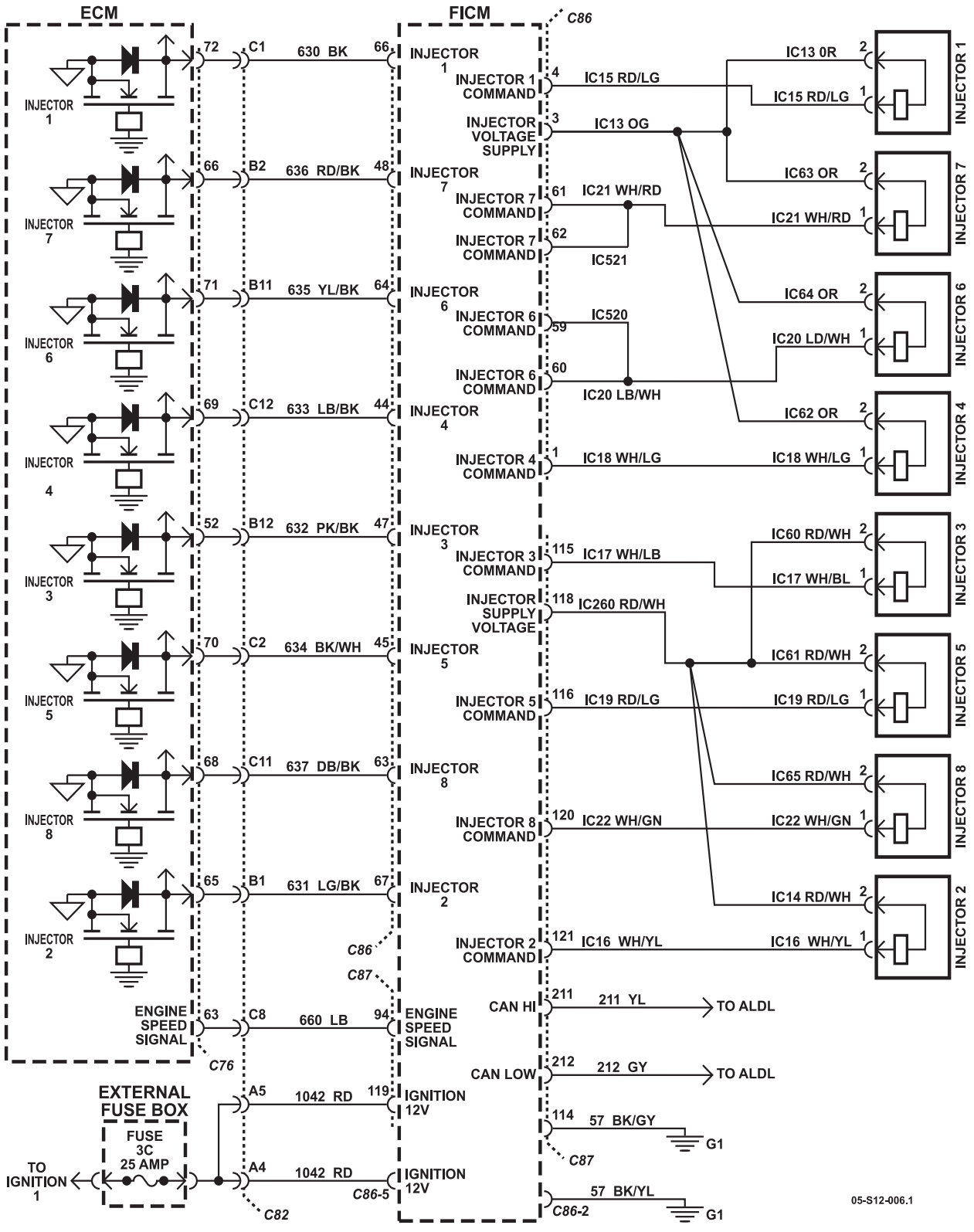


Figure OBD-102: Injector Output Circuit

Circuit Description

The engine control module (ECM) enables the appropriate fuel injector on the compression stroke for each cylinder. The ECM controls the fuel injection control module (FICM) by grounding the control circuit via a solid state device called a driver. The ECM monitors the state of the driver. If the ECM detects an incorrect voltage for the commanded state of an injector driver, DTCs P1223, P1226, P1229, P1232, P1235, P1238, P1241, or P1244 will set.

Conditions for Setting the DTC

- The ECM detects that the commanded state and the actual state of the control circuit does not match.
- The condition exists for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?			
2	1. Start and idle the engine. 2. Monitor the DTC Failed This Ignition parameter with a scan tool. Do any of the DTCs P1223-1244 fail this ignition?		Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Intermittent Conditions
4	Are DTC P1223, P1232, P1238, and P1241 all set?		Go to Step 9	Go to Step 5
5	Are DTC P1226, P1229, P1235, and P1244 all set?		Go to Step 9	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Turn OFF the ignition. 2. Disconnect the harness connector C86 of the fuel injection control module (FICM). **NOTE:** Use the J 35616-94 Connector Adapter of the J 35616 to probe the FICM connector. 3. While cranking the engine, measure the frequency of the appropriate fuel injector control circuit with a DVOM. Is the voltage frequency more than the specified value?	2.9 Hz	Go to Step 12	Go to Step 7
7	1. Turn OFF the ignition. 2. Disconnect harness connector C87 of the engine control module (ECM). 3. Test the appropriate fuel injector control circuit for an open or short to another affected fuel injector control circuit. Did you find and correct the condition?		Go to Step 16	Go to Step 8
8	1. Turn OFF the ignition. 2. Verify the harness connector C87 of the ECM is still disconnected. 3. Probe the affected fuel injector control circuits with a test lamp connected to battery voltage. Does the test lamp illuminate on any of the fuel injector control circuits?		Go to Step 10	Go to Step 15
9	1. Turn OFF the ignition. 2. Disconnect the harness connector C87 of the ECM. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from each of the fuel injector control circuits with a DVOM. Is the voltage more than the specified value on any of the fuel injector control circuits?	1 V	Go to Step 11	Go to Step 15
10	Test the appropriate fuel injector control circuit for a short to ground. Did you find and correct the condition?		Go to Step 16	Go to Step 13
11	Test the appropriate fuel injector control circuit for a short to voltage. Did you find and correct the condition?		Go to Step 16	Go to Step 14
12	Inspect for poor connections at the harness connector of the FICM. Did you find and correct the condition?		Go to Step 16	Go to Step 14
13	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 16	Go to Step 15
14	Replace the faulty FICM. Did you complete the replacement?		Go to Step 16	
15	Replace the faulty ECM. Did you complete the replacement?		Go to Step 16	

Step	Action	Value(s)	Yes	No
16	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 17
17	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code (DTC) List	System OK

DTC P1404 Exhaust Gas Recirculation (EGR) Closed Position Performance (Figure OBD-103)

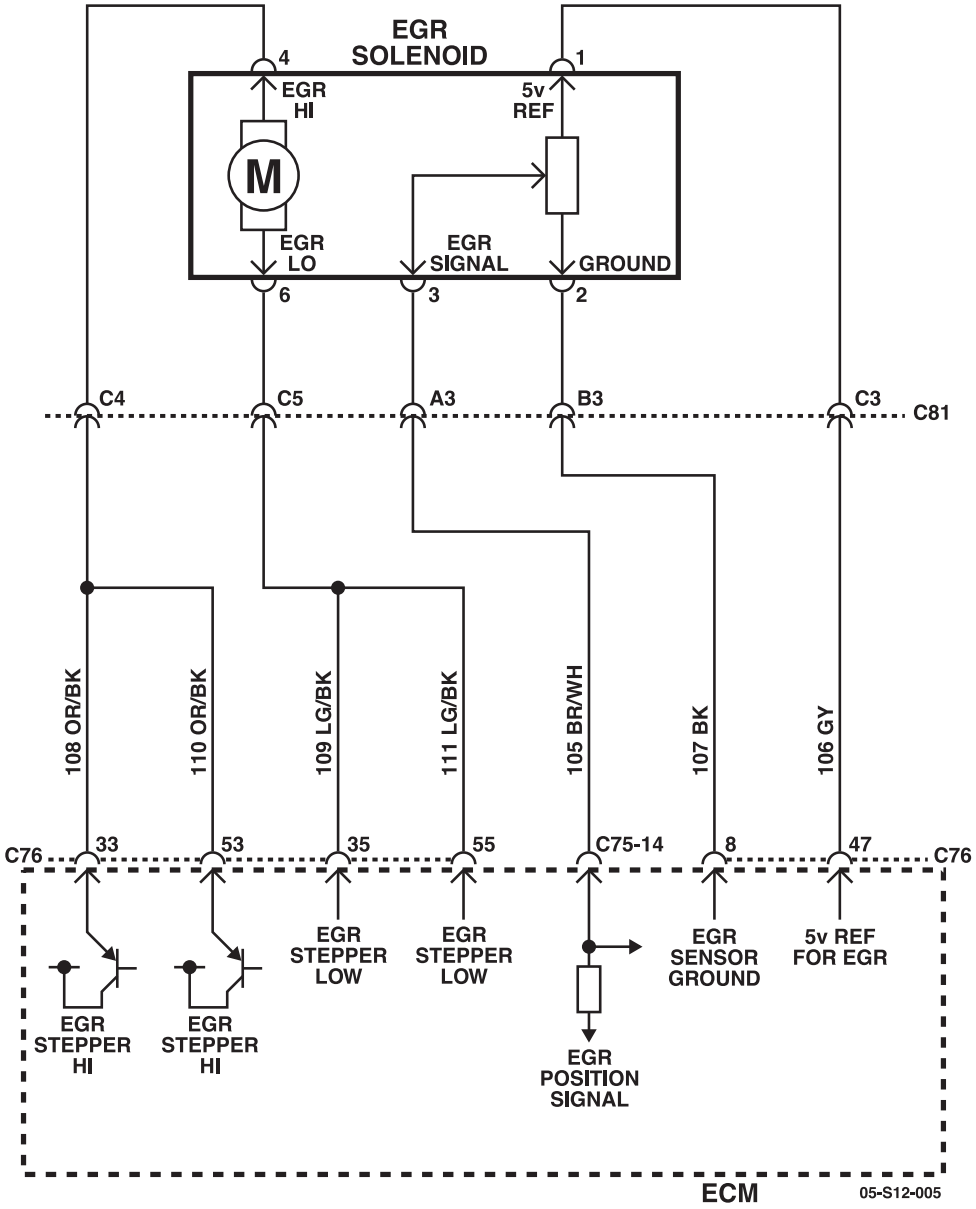


Figure OBD-103: Exhaust Gas Recircuiation (EGR) Position Sensor

Circuit Description

The engine control module (ECM) uses the exhaust gas recirculation (EGR) position sensor to determine the position of the EGR valve. The ECM sends a reference voltage through the 5-volt reference circuit to the EGR position sensor. The ECM provides a voltage return path for the sensor through the low reference circuit. A variable voltage signal, based on the EGR valve position, is sent from the sensor to the ECM through the EGR position sensor signal circuit. The ECM compares the actual EGR position with the desired EGR position when the EGR valve is commanded open or closed. If the ECM detects a difference between the learned closed position and the commanded closed position for a calibrated amount of time, DTC P1404 sets.

Conditions for Setting the DTC

- The actual EGR position is 0.8 volts, 6 percent, more than the learned closed position when the EGR valve is commanded closed, or the EGR learned minimum position is more than 1.25 volts.
- The above condition is present for more than 5 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and upda

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check - Vehicle
2	**NOTE:** Attaching the shop exhaust system to the vehicle may cause false exhaust gas recirculation (EGR) DTCs to set. 1. Turn ON the ignition. 2. Observe the EGR Position parameter with a scan tool. Does the EGR Position parameter read more than the specified value?	1.25 Volts	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition cycle?		Go to Step 4	Go to Intermittent Conditions
4	Is DTC P0403, P0405, or P0406 also set?		Go to DTC P0403 or DTC P0405 or DTC P0406	Go to Step 5
5	Test for shorted terminals and poor connections at the exhaust gas recirculation (EGR) valve. Did you find and correct the condition?		Go to Step 12	Go to Step 6

Step	Action	Value(s)	Yes	No
6	1. Disconnect the EGR valve. 2. Turn ON the ignition. 3. Set up the DVOM to measure amperage. 4. Connect a test lamp and a DVOM in series between the 5-volt reference circuit 106 (GY) of the EGR position sensor and the low reference circuit 107 (BK) of the EGR position sensor. 5. Measure the amperage and note as Current Draw. 6. Remove the DVOM and connect the test lamp between the 5-volt reference circuit 106 (GY) of the EGR position sensor and the low reference circuit 107 (BK) of the EGR position sensor. 7. Connect a DVOM in parallel between the low reference circuit 107 (BK) of the EGR position sensor and a good ground. 8. Measure the voltage and note as Low Reference Voltage Drop. 9. Divide the Low Reference Voltage Drop by the Current Draw in order to calculate the resistance in the low reference circuit. Is the calculated resistance more than the specified value?	5 ohms	Go to Step 7	Go to Step 9
7	Test for shorted terminals and poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 12	Go to Step 8
8	1. Disconnect C76 to the ECM. 2. Repair the high resistance in the low reference circuit 107 (BK). Did you find and correct the condition?		Go to Step 12	Go to Step 11
9	1. Remove the EGR valve. 2. Inspect for debris and damage that will cause the EGR valve to stick and clean, if necessary. Did you find and correct the condition?		Go to Step 12	Go to Step 10
10	Replace the faulty EGR valve. Did you complete the replacement?		Go to Step 12	
11	Replace the faulty ECM. Did you complete the replacement?		Go to Step 12	
12	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 13
13	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code (DTC) List	System OK

DTC P1550 Fuel Injector Control Module (FICM) System Voltage (Figure OBD-104)

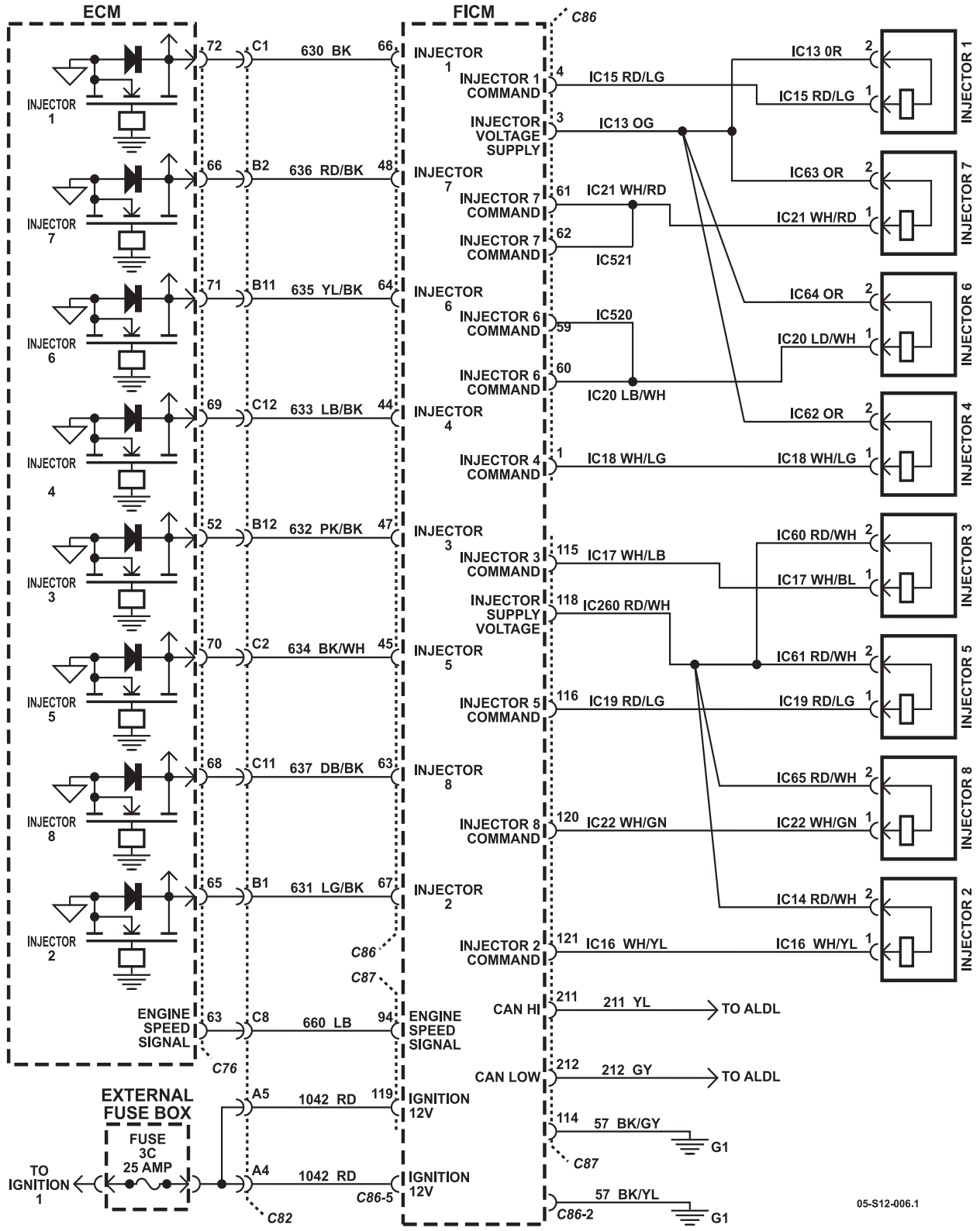


Figure OBD-104: Fuel Injector Control Module (FICM) System Circuit

Circuit Description

The fuel injector control module (FICM) activates the fuel injector. The engine control module (ECM) signals the FICM to turn ON the injectors through the fuel injector control circuits. The FICM self monitors the supply voltage whenever the ignition is ON.

Conditions for Setting the DTC

The FICM detects low supply voltage for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check - Vehicle in Vehicle DTC Information
2	Do any other DTCs set?		Go to Diagnostic Trouble Code (DTC) List	Go to Step 3
3	**NOTE:** Use connection pin adapters from J 35616-B Adapter Kit. 1. Turn OFF the ignition. 2. Disconnect the fuel injection control module (FICM) connectors. 3. Turn ON the ignition. 4. Probe the FICM power circuits with a DVOM connected to one of the FICM ground circuits. Does the voltage measure more than 10 volts?		Go to Step 5	Go to Step 4
4	Repair high resistance in the FICM power or ground circuits. Did you complete the repair?		Go to Step 6	
5	Replace the faulty FICM. Did you complete the replacement?		Go to Step 6	

Step	Action	Value(s)	Yes	No
6	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 7
7	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2122 Accelerator Pedal Position (APP) Sensor 1 Circuit Low Voltage (Figure OBD-105)

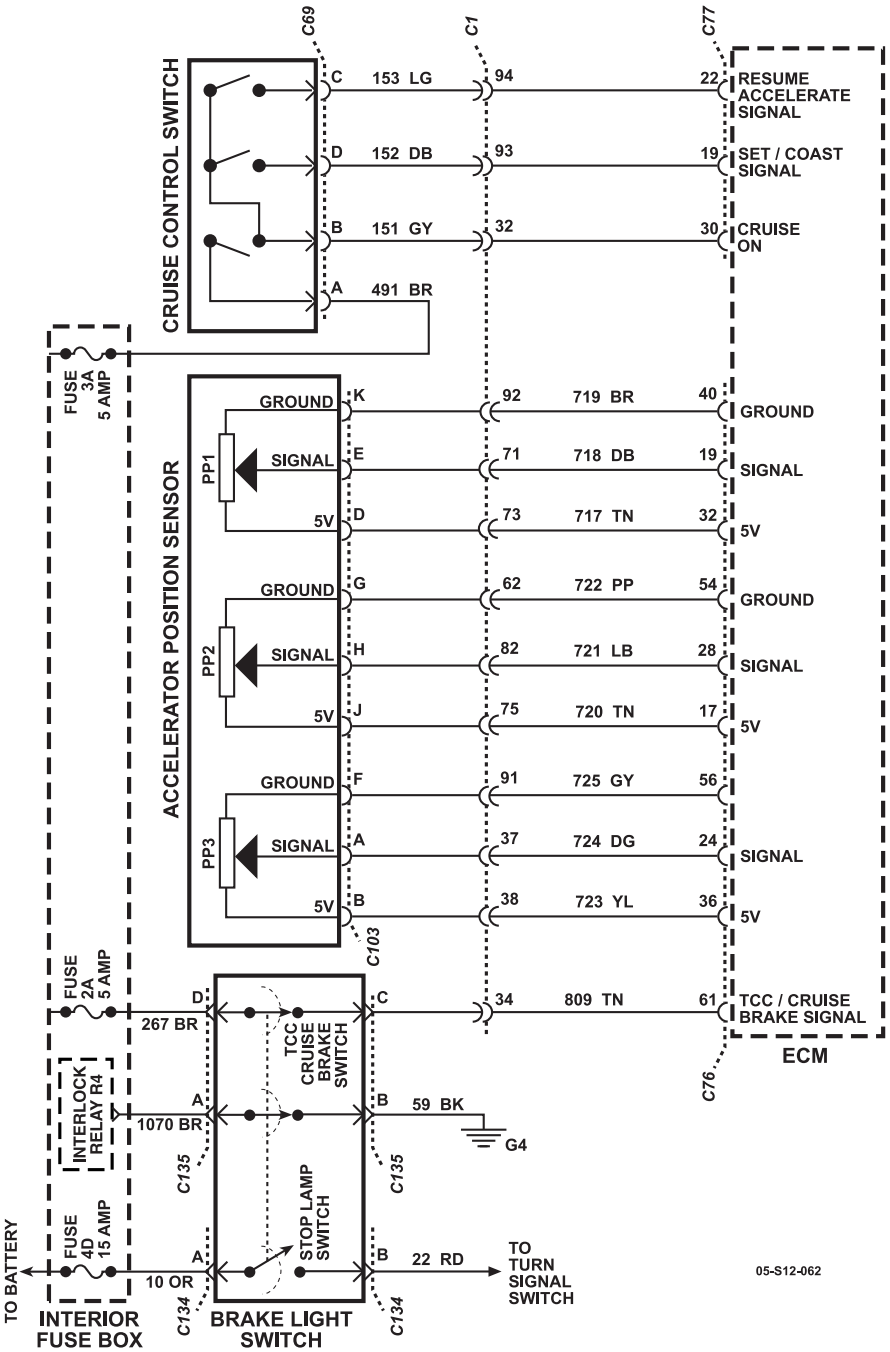


Figure OBD-105: Accelerator Pedal Position (APP) Sensor 1 Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within 1 housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines low voltage with the APP sensor 1 circuit, DTC P2122 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 1 voltage is less than 0.25 volts.
- The above condition is present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option using the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 10	Go to Intermittent Conditions
4	1. Disconnect the APP sensor harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Test for voltage at the APP sensor 1 5-volt reference circuit 717 (TN) with a DVOM. Does the DVOM indicate voltage more than the specified value?	5 Volts	Go to Step 5	Go to Step 6
5	1. Connect a fused jumper between the APP sensor 1 5-volt reference circuit 717 (TN) and the APP sensor 1 signal circuit 718 (DB). 2. Observe the APP sensor 1 voltage parameter with a scan tool. 3. Does the scan tool indicate APP sensor 1 voltage at the specified value?	5 Volts	Go to Step 11	Go to Step 8
6	1. Disconnect C75 (ECM) harness connector containing the APP sensor 1 5-volt reference circuit 717 (TN). 2. Test the APP sensor 1 5-volt reference circuit 717 (TN) for a short to ground. Did you find and correct the condition?		Go to Step 15	Go to Step 7
7	Test the APP sensor 1 5-volt reference circuit 717 (TN) for an open or high resistance. Did you find and correct the condition?		Go to Step 15	Go to Step 12
8	1. Disconnect the ECM C76 containing the APP sensor 1 signal circuit 718 (DB). 2. Test the APP sensor 1 signal circuit 718 (DB) for a short to ground. Did you find and correct the condition?		Go to Step 15	Go to Step 9
9	Test the APP sensor 1 signal circuit 718 (DB) for an open or high resistance. Did you find and correct the condition?		Go to Step 15	Go to Step 12
10	Repair the intermittent condition as necessary. Did you complete the repair?		Go to Step 15	
11	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 15	Go to Step 13

Step	Action	Value(s)	Yes	No
12	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 15	Go to Step 14
13	Replace the faulty APP sensor assembly. Did you complete the replacement?		Go to Step 15	
14	Replace the faulty ECM. Did you complete the replacement?		Go to Step 15	
15	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step16
16	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2123 Accelerator Pedal Position (APP) Sensor 1 Circuit High Voltage (Figure OBD-106)

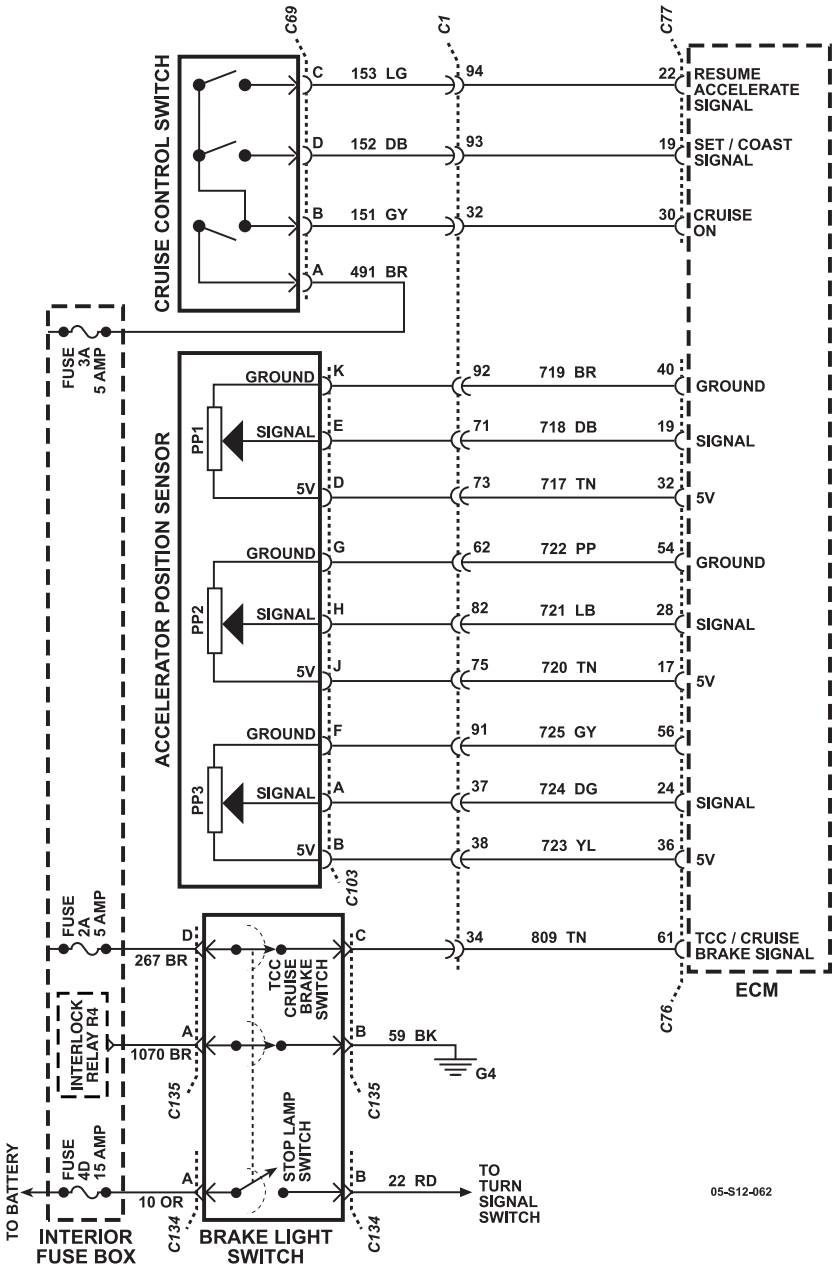


Figure OBD-106: Accelerator Pedal Position (APP) Sensor 1 Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within 1 housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines high voltage in the APP sensor 1 circuit, DTC P2123 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 1 voltage is more than 4.75 volts.
- The above condition is present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control. *The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option on the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) sensor wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 9	Go to Intermittent Conditions
4	1. Disconnect the APP sensor harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Observe the APP sensor 1 voltage parameter with a scan tool. Does the scan tool indicate the APP sensor 1 voltage at the specified value?	0 Volts	Go to Step 5	Go to Step 6
5	1. Connect a fused jumper between the APP sensor 2 signal circuit 721 (LB) and the APP sensor 1 low reference circuit 722 (PP). 2. Observe the APP sensor 2 voltage parameter with a scan tool. 3. Does the scan tool indicate APP sensor 2 voltage at the specified value?	0 Volts	Go to Step 10	Go to Step 8
6	1. Turn OFF the ignition. 2. Disconnect C76 (ECM) harness connector containing the APP sensor 1 signal circuit 718 (DB). 3. Turn ON the ignition. 4. Test the APP sensor 1 signal circuit 718 (DB) for a short to voltage. Did you find and correct the condition?		Go to Step 14	Go to Step 7
7	1. Turn OFF the ignition. 2. Disconnect the other ECM harness connector. 3. Test the APP sensor 1 signal circuit 718 (DB) for a short to all other APP circuits at the APP sensor harness connector. Did you find and correct the condition?		Go to Step 14	Go to Step 11
8	1. Disconnect C76 ECM harness connector containing the APP sensor 1 low reference circuit 719 (BR). 2. Test the APP sensor 1 low reference circuit 719 (BR) for an open or high resistance. Did you find and correct the condition?		Go to Step 14	Go to Step 11
9	Repair the intermittent condition as necessary. Did you complete the repair?		Go to Step 14	
10	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 14	Go to Step 12

Step	Action	Value(s)	Yes	No
11	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 14	Go to Step 13
12	Replace the faulty APP sensor assembly. Did you complete the replacement?		Go to Step 14	
13	Replace the faulty ECM. Did you complete the replacement?		Go to Step 14	
14	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 15
15	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2127 Accelerator Pedal Position (APP) Sensor 2 Circuit Low Voltage (Figure OBD-107)

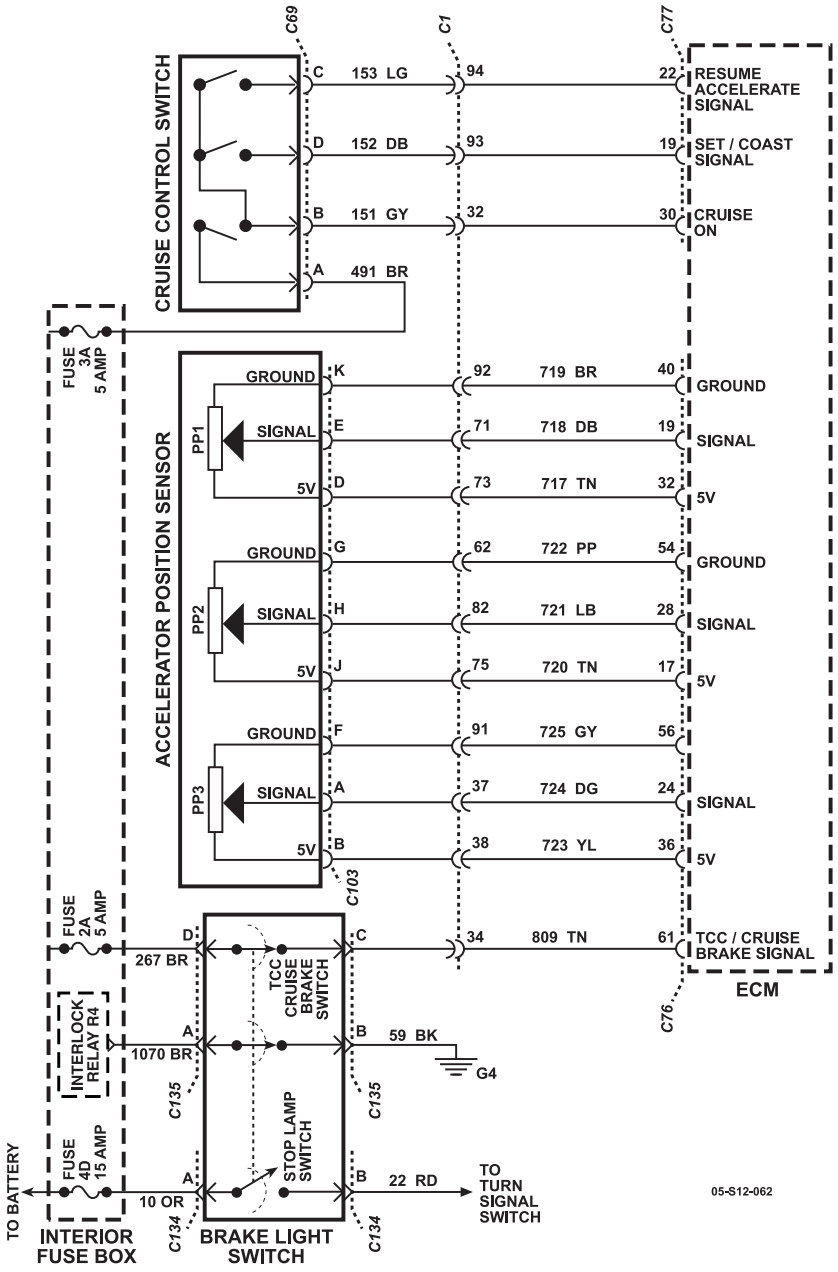


Figure OBD-107: Accelerator Pedal Position (APP) Sensor 2 Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within 1 housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines high voltage with the APP sensor 2 circuit, DTC P2127 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 2 voltage is less than 0.25 volts.
- The above condition is present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option on the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) sensor wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 8	Go to Intermittent Conditions
4	1. Disconnect the APP sensor harness connector. 2. Turn ON the ignition with the engine OFF. 3. Test for voltage at the APP sensor 2 5-volt reference circuit 720 (TN) with a DVOM. Does the DVOM indicate voltage within the specified range?	4.8-5.2 Volts	Go to Step 5	Go to Step 6
5	Test for voltage at the APP sensor 2 signal circuit 721 (LB) with a DVOM. Does the DVOM indicate voltage at the specified value?	5.05 Volts	Go to Step 9	Go to Step 7
6	1. Disconnect C75 (ECM) harness connector containing the APP sensor 2 5-volt reference circuit 720 (TN). 2. Test the APP sensor 2 5-volt reference circuit 720 (TN) for an open. Did you find and correct the condition?		Go to Step 13	Go to Step 10
7	1. Disconnect C75 (ECM) harness connector containing the APP sensor 2 signal circuit 721 (LB). 2. Test the APP sensor 2 signal circuit 721 (LB) for a short to ground. Did you find and correct the condition?		Go to Step 13	Go to Step 10
8	Repair the intermittent condition, as necessary. Did you complete the repair?		Go to Step 13	
9	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 11
10	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 12
11	Replace the faulty APP sensor assembly. Did you complete the replacement?		Go to Step 13	
12	Replace the faulty ECM. Did you complete the replacement?		Go to Step 13	

Step	Action	Value(s)	Yes	No
13	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 14
14	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to the Diagnostic Trouble Code	System OK

DTC P2128 Accelerator Pedal Position (APP) Sensor 2 Circuit High Voltage (Figure OBD-108)

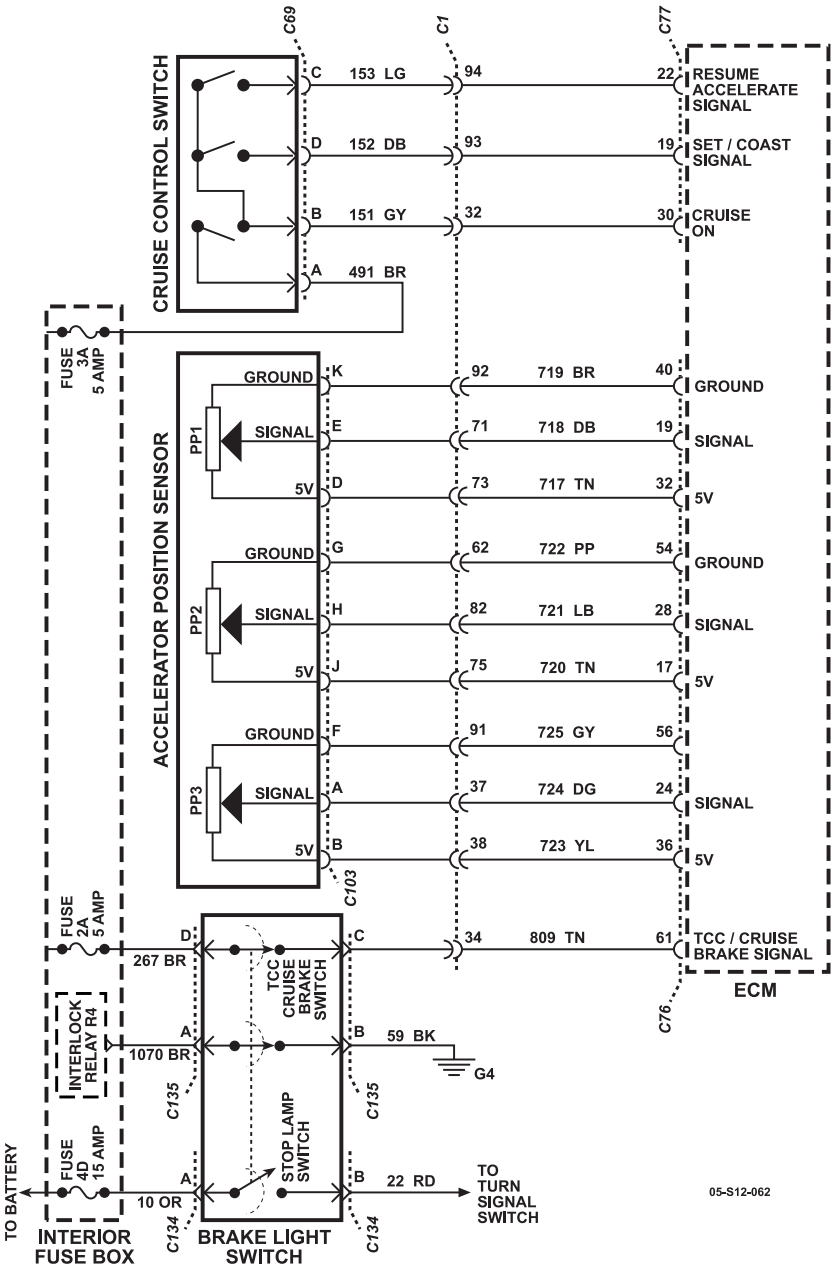


Figure OBD-108: Accelerator Pedal Position (APP) Sensor 2 Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within 1 housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines high voltage with the APP sensor 2 circuit, DTC P2128 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 2 voltage is more than 4.75 volts.
- The above condition is present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option on the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) sensor wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 8	Go to Intermittent Conditions
4	1. Disconnect the APP sensor harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Measure voltage at the APP sensor 2 signal circuit 721 (LB) with a DVOM. Does the DVOM indicate voltage within the specified range?	4.8-5.2 Volts	Go to Step 5	Go to Step 7
5	Probe the signal circuit 721 (LB) of the APP sensor 2 with a test lamp that is connected to a good ground. Does the test lamp illuminate?		Go to Step 8	Go to Step 6
6	1. Connect a fused jumper between the APP sensor 3 signal circuit 724 (DG) and the APP sensor 2 low reference circuit 722 (PP). 2. Observe the APP sensor 3 voltage parameter with a scan tool. Does the scan tool indicate APP sensor 3 voltage at the specified value?	0 Volts	Go to Step 12	Go to Step 10
7	1. Turn OFF the ignition. 2. Disconnect C75 (ECM) harness connector containing the APP sensor 2 signal circuit 721 (LB). 3. Test the APP sensor 2 signal circuit 721 (LB) for an open or for high resistance. Did you find and correct the condition?		Go to Step 16	Go to Step 8
8	1. Turn ON the ignition. 2. Test the APP sensor 2 signal circuit 721 (LB) for a short to voltage. Did you find and correct the condition?		Go to Step 16	Go to Step 9
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Test the APP sensor 2, signal circuit 721 (LB) for a short to all other APP circuits at the APP sensor harness connector. Did you find and correct the condition?		Go to Step 16	Go to Step 13

Step	Action	Value(s)	Yes	No
10	1. Disconnect C76 ECM harness connector containing the APP sensor 2 low reference circuit 722 (PP). 2. Test the APP sensor 2 low reference circuit 722 (PP) for an open or high resistance. Did you find and correct the condition?		Go to Step 16	Go to Step 13
11	Repair the intermittent condition as necessary. Did you complete the repair?		Go to Step 16	
12	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 16	Go to Step 14
13	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 16	Go to Step 15
14	Replace the faulty APP sensor assembly. Did you complete the replacement?		Go to Step 16	
15	Replace the faulty ECM. Did you complete the replacement?		Go to Step 16	
16	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 17
17	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to the Diagnostic Trouble Code	System OK

DTC P2132 Accelerator Pedal Position (APP) Sensor 3 Circuit Low Voltage (Figure OBD-109)

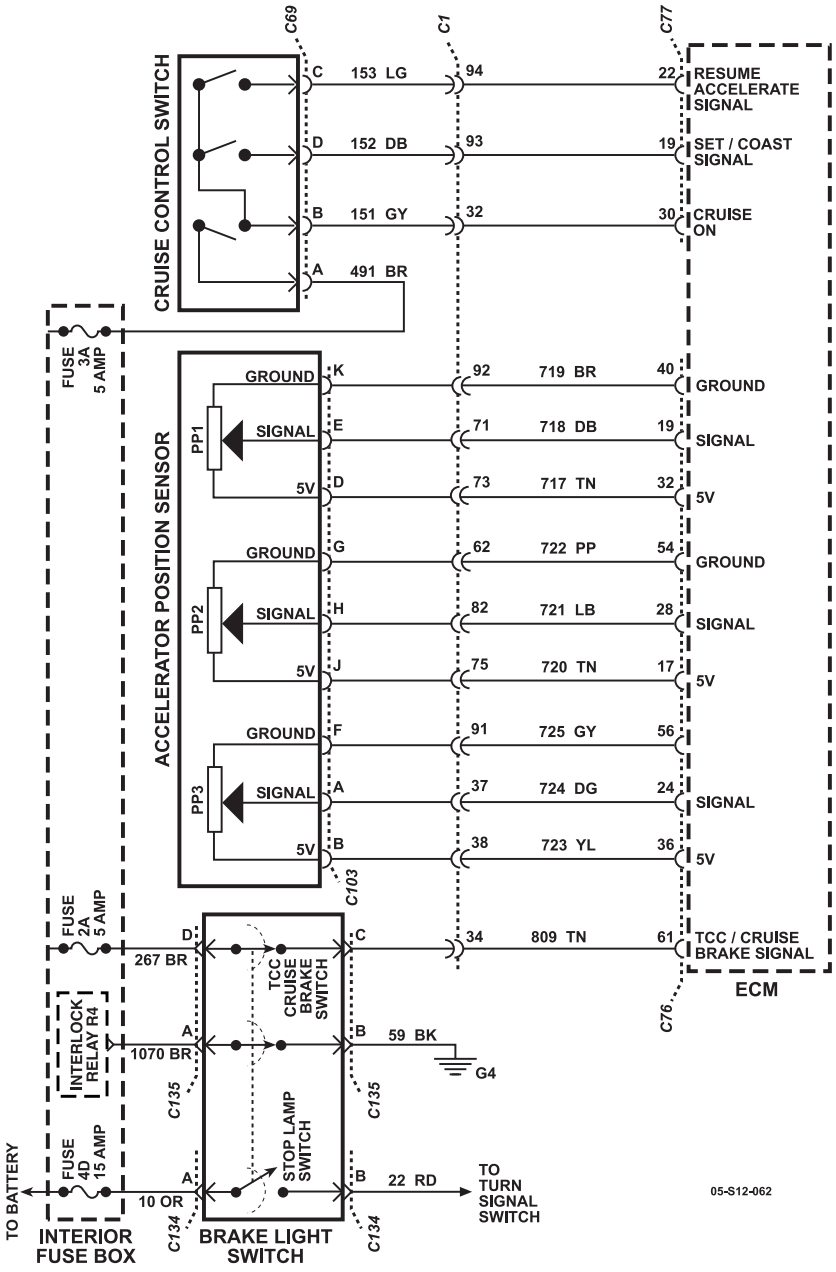


Figure OBD-109: Accelerator Pedal Position (APP) Sensor 3 Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within 1 housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines low voltage with the APP sensor 3 circuit, DTC P2132 sets.

APP Sensor	Actual Pedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 3 voltage is less than 1.49 volts.
- The above condition is present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option on the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) sensor wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 8	Go to Intermittent Conditions
4	1. Disconnect the APP sensor harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Test for voltage at the APP sensor 3 5-volt reference circuit 723 (YL) with a DVOM. Does the DVOM indicate voltage more than the specified value?	5 Volts	Go to Step 5	Go to Step 6
5	Test for voltage at the APP sensor 3 signal circuit 724 (DG) with a DVOM. Does the DVOM indicate voltage at the specified value?	5.05 Volts	Go to Step 9	Go to Step 7
6	1. Disconnect C75 (ECM) containing the APP sensor 3 5-volt reference circuit 723 (YL). 2. Test the APP sensor 3 5-volt reference circuit 723 (YL) for an open. Did you find and correct the condition?		Go to Step 13	Go to Step 10
7	1. Disconnect C76 (ECM) containing the APP sensor 3 signal circuit . 2. Test the APP sensor 3 signal circuit 724 (DG) for a short to ground. Did you find and correct the condition?		Go to Step 13	Go to Step 10
8	Repair the intermittent condition as necessary. Did you complete the repair?		Go to Step 13	
9	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 11
10	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 13	Go to Step 12
11	Replace the faulty APP sensor assembly. Did you complete the replacement?		Go to Step 13	
12	Replace the faulty ECM. Did you complete the replacement?		Go to Step 13	

Step	Action	Value(s)	Yes	No
13	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 14
14	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2133 Accelerator Pedal Position (APP) Sensor 3 Circuit High Voltage (Figure OBD-110)

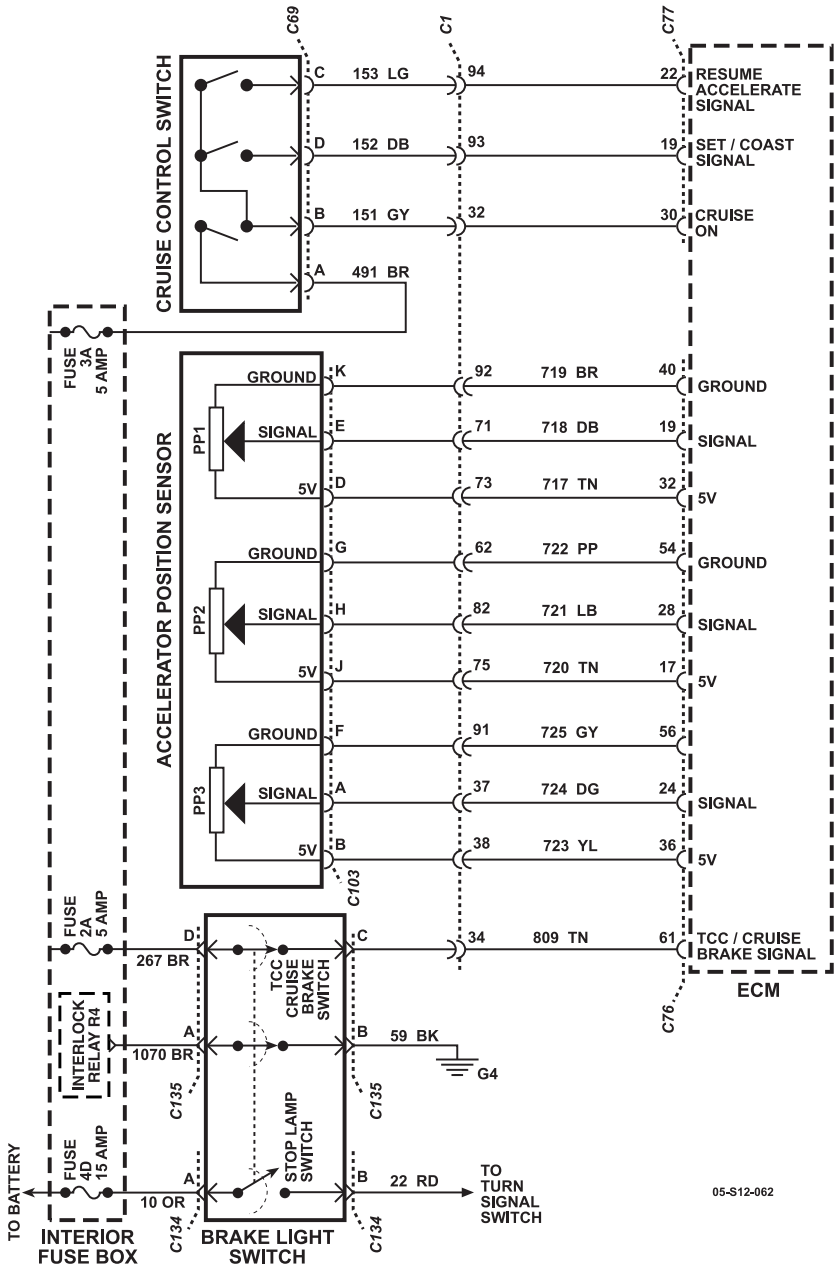


Figure OBD-110: Accelerator Pedal Position (APP) Sensor 3 Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within 1 housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines high voltage with the APP sensor 3 circuit, DTC P2138 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 3 voltage is more than 4.75 volts.
- The above condition is present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option on the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) sensor wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 8	Go to Intermittent Conditions
4	1. Disconnect the APP sensor harness connector. 2. Turn ON the ignition, with the engine OFF. 3. Measure voltage at the APP sensor 3 signal circuit 724 (DG) with a DVOM. Does the DVOM indicate voltage within the specified range?	4.8-5.2 Volts	Go to Step 5	Go to Step 7
5	Probe the signal circuit 724 (DG) of the APP sensor 3 with a test lamp that is connected to a good ground. Does the test lamp illuminate?		Go to Step 8	Go to Step 6
6	1. Connect a fused jumper between the APP sensor 2 signal circuit 721 (LB) and the APP sensor 3 low reference circuit 725 (GY). 2. Observe the APP sensor 2 voltage parameter with a scan tool. Does the scan tool indicate APP sensor 2 voltage at the specified value?	0 Volts	Go to Step 12	Go to Step 10
7	1. Turn OFF the ignition. 2. Disconnect C76 containing the APP sensor 3 signal circuit 724 (DG). 3. Test the APP sensor 3 signal circuit 724 (DG) for an open or for high resistance. Did you find and correct the condition?		Go to Step 16	Go to Step 8
8	1. Turn ON the ignition. 2. Test the APP sensor 3 signal circuit 724 (DG) for a short to voltage. Did you find and correct the condition?		Go to Step 16	Go to Step 9
9	1. Turn OFF the ignition. 2. Disconnect the ECM harness connectors. 3. Test the APP sensor 3 signal circuit 724 (DG) for a short to all other APP circuits at the APP sensor harness connector. Did you find and correct the condition?		Go to Step 16	Go to Step 13

Step	Action	Value(s)	Yes	No
10	1. Disconnect C76 containing the APP sensor 3 low reference circuit 725 (GY). 2. Test the APP sensor 3 low reference circuit 725 (GY) for an open or high resistance. Did you find and correct the condition?		Go to Step 16	Go to Step 13
11	Repair the intermittent condition as necessary. Did you complete the repair?		Go to Step 16	
12	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 16	Go to Step 14
13	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 16	Go to Step 15
14	Replace the faulty APP sensor assembly. Did you complete the replacement?		Go to Step 16	
15	Replace the faulty ECM. Did you complete the replacement?		Go to Step 16	
16	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 17
17	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2138 Accelerator Pedal Position (APP) Sensor 1-2 Correlation (Figure OBD-111)

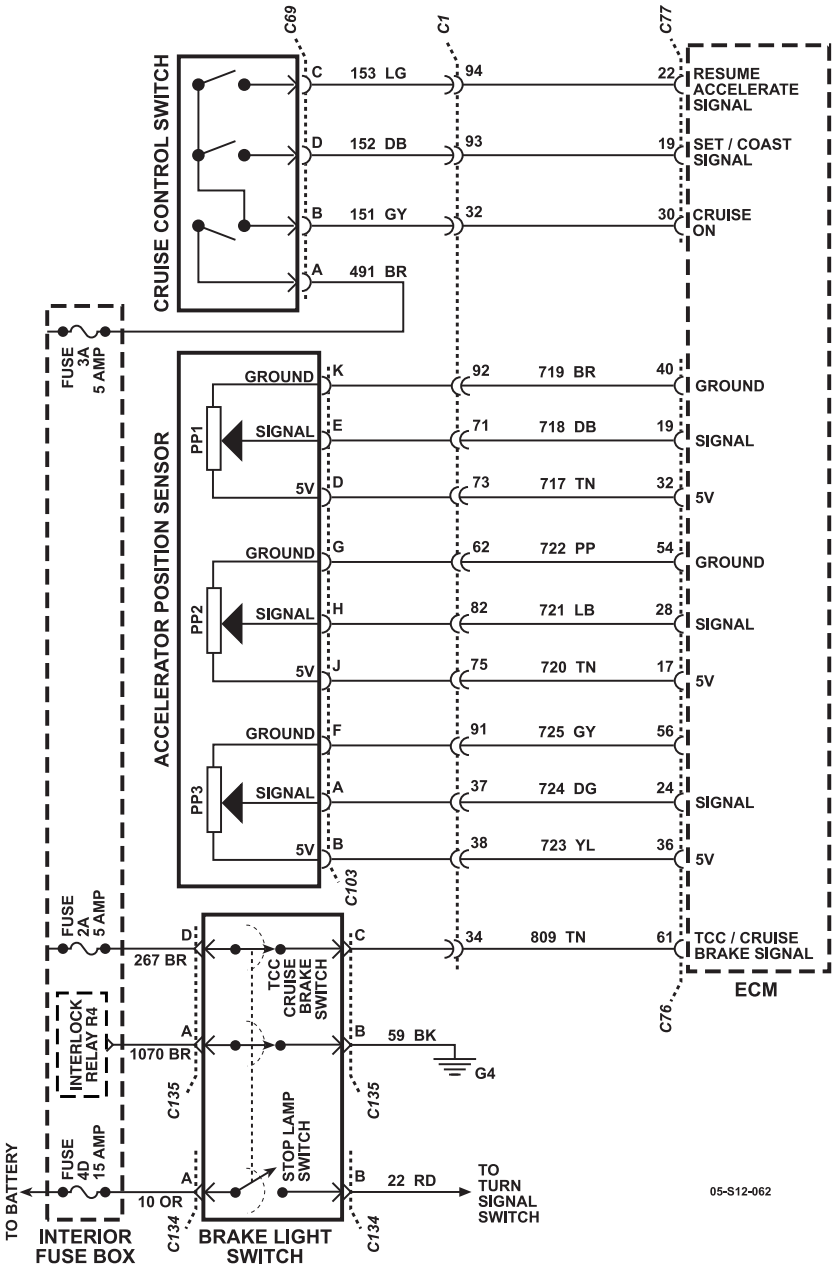


Figure OBD-111: Accelerator Pedal Position (APP) Sensor Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within 1 housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines an out of range condition between APP sensor 1 and APP sensor 2, DTC P2138 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 1 and the APP sensor 2 are more than 10 percent out of range of each other.
- The above condition is present for less than 1 second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option on the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) sensor wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 4	Go to Intermittent Conditions
4	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition. 4. Test for voltage at the APP sensor 2 5-volt reference circuit with a test lamp connected to ground. Does the test lamp illuminate?		Go to Step 5	Go to Step 14
5	Connect a test lamp between the APP sensor 2 5-volt reference circuit 720 (TN) and the APP sensor 2 low reference circuit 722 (PP). Does the test lamp illuminate?		Go to Step 6	Go to Step 15
6	1. Disconnect the test lamp. 2. With the APP sensor harness connector still disconnected, observe the APP sensor 1 voltage parameter with a scan tool. Is the APP sensor 1 voltage less than the specified value?	1 Volt	Go to Step 13	Go to Step 7
7	Is the APP sensor 2 voltage more than the specified value?	4 Volts	Go to Step 8	Go to Step 9
8	Test the APP sensor 1 signal circuit 718 (DB) for a short to the APP sensor 3 signal circuit 724 (DG) with a DVOM. Did you find and correct the condition?		Go to Step 22	Go to Step 10
9	Test the APP sensor 1 signal circuit 718 (DB) for a short to the APP sensor 2 signal circuit 721 (LB) with a DVOM. Did you find and correct the condition?		Go to Step 22	Go to Step 10
10	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition. 4. Test for voltage at the APP sensor 1 5-volt reference circuit 717 (TN) with a test lamp connected to ground. Does the test lamp illuminate?		Go to Step 11	Go to Step 16
11	Connect the test lamp between the APP sensor 1 5-volt reference circuit 717 (TN) and the APP sensor 1 low reference circuit 719 (BR). Does the test lamp illuminate?		Go to Step 12	Go to Step 17

Step	Action	Value(s)	Yes	No
12	1. Connect a fused jumper wire between the APP sensor 1 signal circuit 718 (DB) and the APP sensor 1 5-volt reference circuit 717 (TN). 2. Observe the APP sensor 1 voltage parameter with a scan tool. Does the scan tool indicate voltage at the specified value?	5 Volts	Go to Step 18	Go to Step 13
13	1. Turn OFF the ignition. 2. Disconnect C76 that contains the APP sensor 1 signal circuit 718 (DB). 3. Test the APP sensor 1 signal circuit 718 (DB) for high resistance with a DVOM. Did you find and correct the condition?		Go to Step 22	Go to Step 20
14	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector that contains the APP sensor 2 5-volt reference circuit. 3. Test the APP sensor 2 5-volt reference circuit for high resistance with a DVOM. Did you find and correct the condition?		Go to Step 22	Go to Step 20
15	1. Turn OFF the ignition. 2. Disconnect C76 that contains the APP sensor 2 low reference circuit 722 (PP). 3. Test the APP sensor 2 low reference circuit 722 (PP) for high resistance with a DVOM. Did you find and correct the condition?		Go to Step 22	Go to Step 20
16	1.Turn OFF the ignition. 4. Disconnect C75 that contains the APP sensor 1 5-volt reference circuit 717 (TN). 5. Turn ON the ignition. 6. Test the APP sensor 1 5-volt reference circuit 717 (TN) for high resistance with a DVOM. Did you find and correct the condition?		Go to Step 22	Go to Step 20
17	1. Turn OFF the ignition. 2. Disconnect C76 that contains the APP sensor 1 low reference circuit 719 (BR). 3. Test the APP sensor 1 low reference circuit 719 (BR) for resistance with a DVOM. Did you find and correct the condition?		Go to Step 22	Go to Step 20
18	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 22	Go to Step 19
19	Replace the faulty APP sensor assembly. Did you complete the replacement?		Go to Step 22	
20	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 22	Go to Step 21

Step	Action	Value(s)	Yes	No
21	Replace the faulty ECM. Did you complete the replacement?		Go to Step 22	
22	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 23
23	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2139 Accelerator Pedal Position (APP) Sensor 1-3 Correlation (Figure OBD-112)

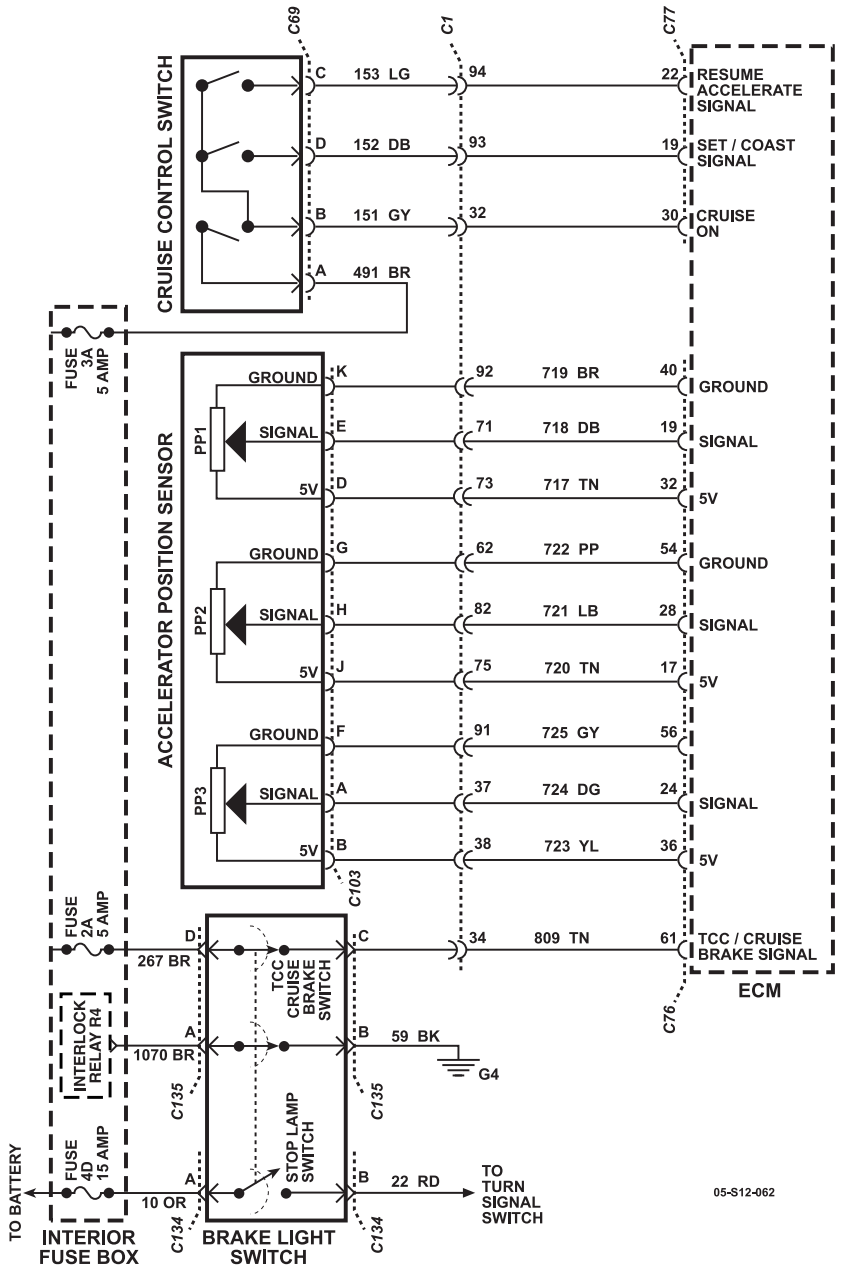


Figure OBD-112: Accelerator Pedal Position (APP) Circuit

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within one housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines an out of range condition with the APP sensor 1 and APP sensor 3, DTC P2139 sets.

APP Sensor	Actual Pedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 2 and the APP sensor 3 are more than 10 percent out of range of each other.
- The above condition is present for less than one second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 4	Go to Step 3
3	1. Select the DTC option using the scan tool. 2. Lightly touch and move the related accelerator pedal position (APP) wiring harnesses and connectors while monitoring the DTC information. Did this DTC fail this ignition during the above test?		Go to Step 4	Go to Intermittent Conditions
4	Is DTC P2138 also set?		Go to DTC P2138	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the APP sensor harness connector. 3. Turn ON the ignition. 4. Test for voltage at the APP sensor 3, 5-volt reference circuit 723 (YL) with a test lamp connected to ground. Does the test lamp illuminate?		Go to Step 6	Go to Step 10
6	Connect a test lamp between the APP sensor 3, 5-volt reference circuit 723 (YL) and the APP sensor 3 low reference circuit 725 (GY). Does the test lamp illuminate?		Go to Step 7	Go to Step 12
7	1. Disconnect the test lamp. 2. With the APP sensor harness connector still disconnected, observe the APP sensor 1 and the APP sensor 3 voltage parameters with a scan tool. Are both APP sensor 2 and 3 voltages above the specified value?	4 Volts	Go to Step 8	Go to Step 15
8	1. Probe the APP sensor 1 signal circuit 718 (DB) with a test lamp connected to ground. 2. Observe the APP sensor 1 and the APP sensor 3 voltage parameters with a scan tool. Are both APP sensor 1 and 3 voltages below the specified value?	1 Volt	Go to Step 9	Go to Step 11
9	Test the APP sensor 1 signal circuit 718 (DB) for a short to the APP sensor 3 signal circuit 724 (DG) with a DVOM. Did you find and correct the condition?		Go to Step 17	Go to Step 15
10	1. Turn OFF the ignition. 2. Disconnect C75 that contains the APP sensor 3, 5-volt reference circuit 723 (YL). 3. Test the APP sensor 3, 5-volt reference circuit 723 (YL) for high resistance with a DVOM. Did you find and correct the condition?		Go to Step 17	Go to Step 15

Step	Action	Value(s)	Yes	No
11	1. Turn OFF the ignition. 2. Disconnect C76 that contains the APP sensor 3 signal circuit 724 (DG). 3. Turn ON the ignition. 4. Test the APP sensor 3 signal circuit 724 (DG) for high resistance with a DVOM. Did you find and correct the condition?		Go to Step 17	Go to Step 13
12	1. Turn OFF the ignition. 2. Disconnect C76 that contains the APP sensor 3 low reference circuit 725 (GY). 3. Test the APP sensor 3 low reference circuit 725 (GY) for high resistance with a DVOM. 4. Did you find and correct the condition?		Go to Step 17	Go to Step 15
13	Inspect for poor connections at the harness connector of the APP sensor. Did you find and correct the condition?		Go to Step 17	Go to Step 14
14	Replace the APP sensor assembly. Did you complete the replacement?		Go to Step 17	
15	Inspect for poor connections at the harness connector of the ECM. Did you find and correct the condition?		Go to Step 17	Go to Step 16
16	Replace the faulty ECM. Did you complete the replacement?		Go to Step 17	
17	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 18
18	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2140 Accelerator Pedal Position (APP) Sensor 2-3 Correlation

Circuit Description

The accelerator pedal position (APP) sensor is mounted on the accelerator pedal control assembly. The sensor is made up of 3 individual sensors within one housing. Three separate signal, low reference, and 5-volt reference circuits are used in order to interface the APP sensor with the engine control module (ECM). Each sensor has a unique functionality to determine the pedal position as shown in the table below. The ECM uses the APP sensor to determine the amount of acceleration or deceleration desired by the person driving the vehicle via the fuel injector control. If the ECM determines an out of range condition with the APP sensor 2 and APP sensor 3, DTC P2140 sets.

APP Sensor	ActualPedal Position	% Depressed as Observed on a Scan Tool	Voltage as Observed on a Scan Tool
1	Pedal at rest	0	.52 - .80
1	Pedal at full travel	100	2.12 - 2.78
2	Pedal at rest	0	4.25 - 4.53
2	Pedal at full travel	100	2.24 - 2.93
3	Pedal at rest	0	3.95 - 4.13
3	Pedal at full travel	100	2.69 - 3.16

Conditions for Setting the DTC

- The APP sensor 1 and the APP sensor 3 are more than 10 percent out of range of each other.
- The above condition is present for less than one second.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- If one or more APP sensor DTCs are set for a single APP sensor, the following occurs:
  - The control module will not command Reduced Engine Power mode.
  - The control module will use the remaining two APP sensors to calculate throttle response.
- If certain multiple APP sensor DTCs are set for more than one APP sensor, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to a predetermined value to limit the amount of throttle control.
  - The message center displays Reduced Engine Power.
- If all three APP sensors are out of range, the following occurs:
  - The control module commands Reduced Engine Power mode.
  - The APP indicated angle is limited to 0 percent. The control module only allows the engine to idle.
  - The message center displays Reduced Engine Power.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Is DTC P2138 also set?		Go to DTC P2138	Go to Step 3
3	Is DTC P2139 also set?		Go to DTC P2139	

DTC P2146 Injector Positive Voltage Control Circuit Group1

Circuit Description

The fuel injection control module (FICM) supplies high voltage to each fuel injector on the ignition voltage circuits. The FICM energizes each fuel injector by grounding the command circuit between the FICM and the fuel injector. The FICM monitors the status of the ignition voltage circuits and the fuel injector command circuits. When a fuel injector circuit condition is detected by the FICM, all of the fuel injectors on the affected ignition voltage circuit will be disabled. If a circuit condition is detected on a fuel injector circuit for cylinders 1, 4, 6, or 7, DTCs P0201, P0204, P0206, P0207 will set, along with DTC P2146. If a circuit condition is detected on a fuel injector circuit for cylinders 2, 3, 5, or 8, DTCs P0202, P0203, P0205, P0208 will set, along with DTC P2149.

Conditions for Setting the DTC

The engine control module (ECM) detects a circuit fault related to the high voltage circuit to cylinders 1, 4, 6, and 7.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Is DTC P0201, P0204, P0206, or P0207 also set?		Go to DTC P0201-P0208	Go to Step 3
3	Replace the faulty fuel injection control module (FICM). Did you complete the replacement?		Go to Step 4	
4	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 5
5	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2149 Injector Positive Voltage Control Circuit Group 2

Circuit Description

The fuel injection control module (FICM) supplies high voltage to each fuel injector on the ignition voltage circuits. The FICM energizes each fuel injector by grounding the command circuit between the FICM and the fuel injector. The FICM monitors the status of the ignition voltage circuits and the fuel injector command circuits. When a fuel injector circuit condition is detected by the FICM, all of the fuel injectors on the affected ignition voltage circuit will be disabled. If a circuit condition is detected on a fuel injector circuit for cylinders 1, 4, 6, or 7, DTCs P0201, P0204, P0206, P0207 will set, along with DTC P2146. If a circuit condition is detected on a fuel injector circuit for cylinders 2, 3, 5, or 8, DTCs P0202, P0203, P0205, P0208 will set, along with DTC P2149.

Conditions for Setting the DTC

The engine control module (ECM) detects a circuit fault related to the high voltage circuit to cylinders 2, 3, 5, and 8.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) when the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Freeze Frame/Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	Is DTCs P0202, P0203, P0205, or P0208 also set?		Go to DTC P0201-P0208	Go to Step 3
3	Replace the faulty fuel injection control module (FICM). Did you complete the replacement?		Go to Step 4	
4	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 5
5	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2227 Barometric Pressure (BARO) Sensor Performance (Figure OBD-113)

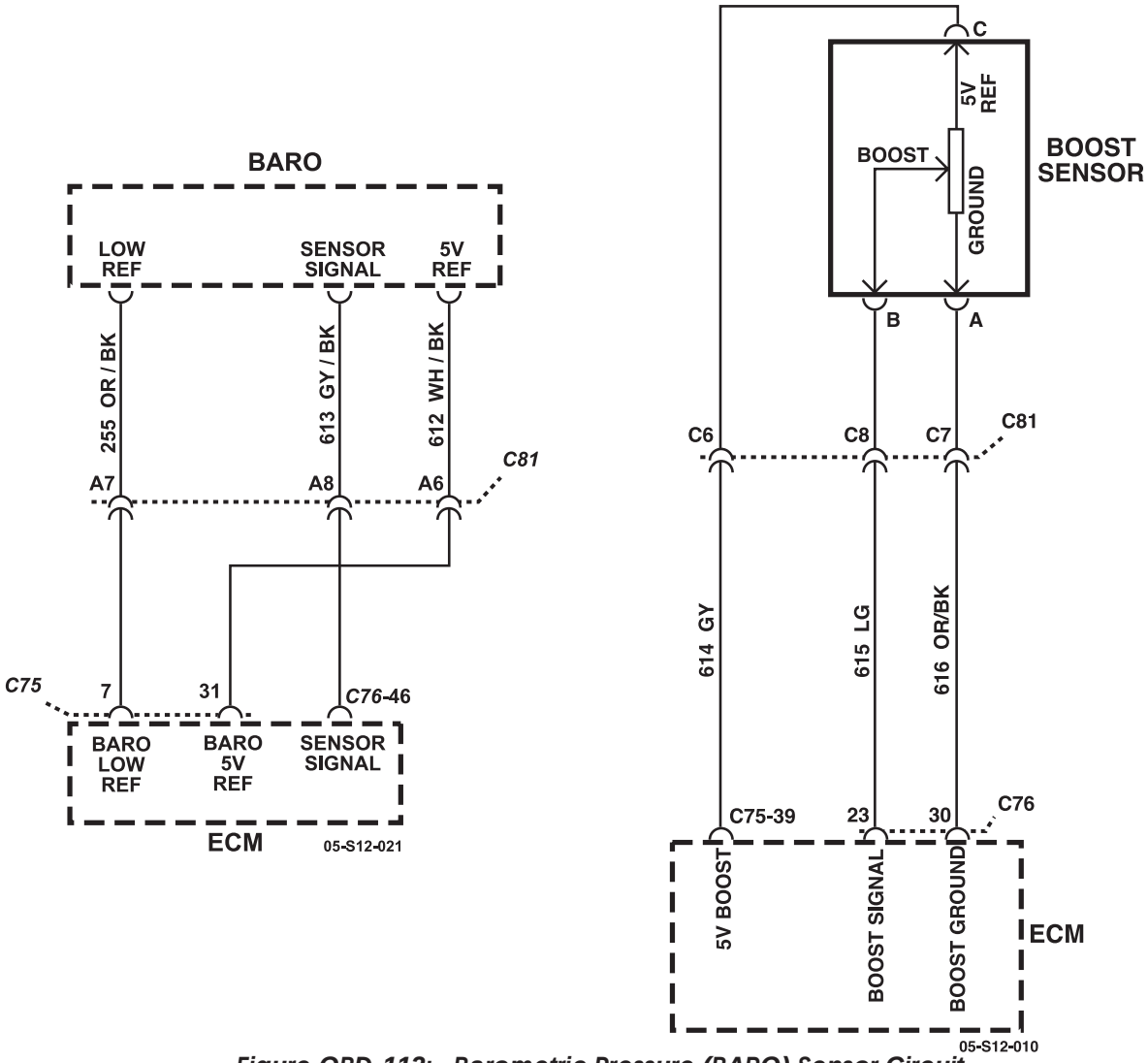


Figure OBD-113: Barometric Pressure (BARO) Sensor Circuit

Circuit Description

The barometric pressure (BARO) sensor measures the pressure of the atmosphere. This pressure is affected by altitude and weather conditions. A diaphragm within the BARO sensor is displaced by the pressure changes that occur from varying altitudes and weather conditions. The sensor translates this action into electrical resistance. The BARO sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The BARO sensor provides a signal voltage to the ECM, relative to the pressure changes on the BARO sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Changes in BARO due to weather are relatively small, while changes due to altitude are significant. Pressure can range from 56 kPa at an altitude of 4 267 meters (14,000 feet), to 105 kPa at or below sea level. The BARO sensor has a range of 8-207 kPa. The ECM uses the BARO sensor input for fuel delivery and other diagnostics.

Within the ECM, the diagnostic compares the BARO sensor input to the boost pressure sensor input. If the ECM detects that the inputs are not within a specified amount of each other, DTC P2227 sets.

Conditions for Setting the DTC

The ECM detects that the difference between the BARO pressure and the boost pressure is more than 15 kPa for 6 seconds.

Action Taken When the DTC Sets - Federal

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center (DIC), if equipped, may display a message.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

ALTITUDE MEASURED IN METERS (M)	ALTITUDE MEASURED IN FEET (FT)	BAROMETRIC PRESSURE MEASURED IN KILOPASCALS (KPA)
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check

Step	Action	Value(s)	Yes	No
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the BARO parameter with a scan tool. 3. Compare the barometric pressure (BARO) value to the range specified in the altitude vs. barometric pressure table. Is the BARO parameter within the range specified in the altitude vs. barometric pressure table?		Go to Step 3	Go to Step 7
3	1. Observe the Boost Pressure Sensor parameter with a scan tool. 2. Compare the Boost Pressure Sensor value to the range specified in the altitude vs. barometric pressure table. Is the Boost Pressure Sensor parameter within the range specified in the altitude vs. barometric pressure table?		Go to Step 4	Go to Step 13
4	1. Connect a J 23738-A Mityvac to the BARO sensor port. 2. Observe the BARO parameter with a scan tool. 3. Apply vacuum with the J 23738-A until 10 inches Hg is reached. Does the BARO parameter decrease?		Go to Step 5	Go to Step 24
5	1. Start the engine. 2. Operate the vehicle, at a consistent altitude, within the Conditions for Running the DTC. 3. Observe the BARO parameter with a scan tool. Does the BARO parameter change more than the specified value?	15 kPa	Go to Step 7	Go to Step 6
6	1. Operate the vehicle, at a consistent altitude, within the Conditions for Running the DTC. 2. Observe the Boost Pressure Sensor parameter and the BARO parameter with a scan tool. Is the difference between the Boost Pressure Sensor parameter and the BARO parameter more than the specified value?	15 kPa	Go to Step 13	Go to Intermittent Conditions
7	Test for an intermittent and for a poor connection at the BARO sensor connector. Did you find and correct the condition?		Go to Step 27	Go to Step 8
8	1. Disconnect the BARO sensor. 2. Measure the amperage between the 5-volt reference circuit 612 (WH/BK) and the low reference circuit 255 (OR/BK), at the BARO sensor connector, with a DVOM. Is the amperage more than the specified value?	170 mA	Go to Step 9	Go to Step 10
9	1. Connect a jumper wire between the 5-volt reference circuit 612 (WH/BK) and the BARO sensor signal circuit 613 (GY/BK) at the BARO sensor connector. 2. Observe the BARO parameter with a scan tool. Is the pressure more than the specified value?	205 kPa	Go to Step 24	Go to Step 19
10	Test for an intermittent and for a poor connection at the engine control module (ECM). Did you find and correct the condition?		Go to Step 27	Go to Step 11

Step	Action	Value(s)	Yes	No
11	1. Disconnect the ECM. 2. Measure the resistance of the 5-volt reference circuit 612 (WH/BK) between the BARO sensor connector and C75 pin 31 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 23	Go to Step 12
12	Measure the resistance of the low reference circuit 255 (OR/BK) between the BARO sensor connector and C75 pin 7 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 23	Go to Step 26
13	Test for an intermittent and for a poor connection at the boost pressure sensor connector. Did you find and correct the condition?		Go to Step 27	Go to Step 14
14	1. Disconnect the boost pressure sensor. 2. Measure the amperage between the 5-volt reference circuit 612 (WH/BK) and the low reference circuit 255 (OR/BK), at the boost pressure sensor connector, with a DVOM. Is the amperage more than the specified value?	170 mA	Go to Step 15	Go to Step 16
15	1. Connect a jumper wire between the 5-volt reference circuit 612 (WH/BK) and the signal circuit 613 (GY/BK) of the boost pressure sensor at the connector. 2. Observe the Boost Pressure Sensor parameter with the scan tool. Is the pressure more than the specified value?	254 kPa (36 psi)	Go to Step 25	Go to Step 20
16	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 27	Go to Step 17
17	1. Disconnect the ECM. 2. Measure the resistance of the 5-volt reference circuit 612 WH/BK) between the boost pressure sensor connector and C75 pin 31 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 23	Go to Step 18
18	Measure the resistance of the low reference circuit 255 (OR/BK) between the boost pressure sensor connector and C75 pin 7 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 23	Go to Step 26
19	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 27	Go to Step 21
20	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 27	Go to Step 22
21	1. Disconnect the ECM. 2. Measure the resistance of the BARO sensor signal circuit 613 (GY/BK) between the BARO sensor connector and C76 pin 46 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 23	Go to Step 26

Step	Action	Value(s)	Yes	No
22	1. Disconnect the ECM. 2. Measure the resistance of the boost pressure sensor signal circuit 615 (LG) between the boost pressure sensor connector pin B and C76 pin 23 of the ECM, with a DVOM. Is the resistance more than the specified value?	5 ohms	Go to Step 23	Go to Step 26
23	Repair the high resistance in the circuit. Did you complete the repair?		Go to Step 27	
24	Replace the faulty BARO sensor. Did you complete the replacement?		Go to Step 27	
25	Replace the faulty boost pressure sensor. Did you complete the replacement?		Go to Step 27	
26	Replace the faulty ECM. Did you complete the replacement?		Go to Step 27	
27	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 28
28	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2228 Barometric Pressure (BARO) Sensor Circuit Low Voltage (Figure OBD-114)

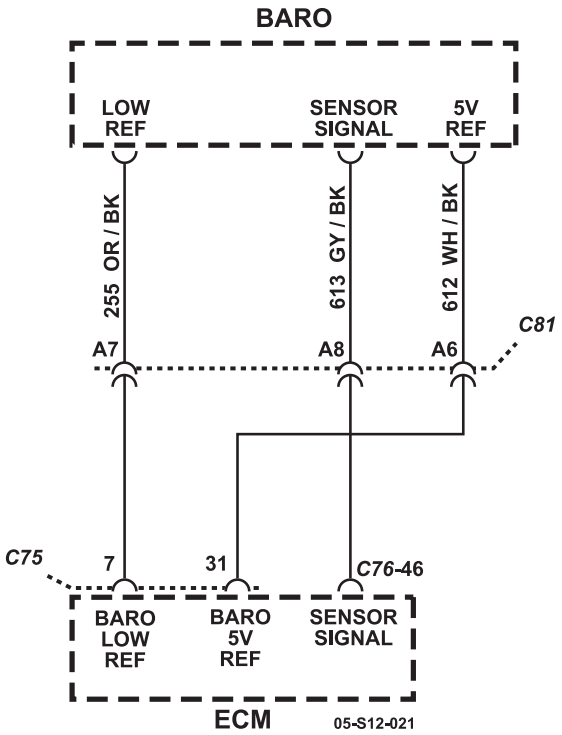


Figure OBD-114: Barometric Pressure (BARO) Sensor Circuit

Circuit Description

The barometric pressure (BARO) sensor measures the pressure of the atmosphere. This pressure is affected by altitude and weather conditions. A diaphragm within the BARO sensor is displaced by the pressure changes that occur from varying altitudes and weather conditions. The sensor translates this action into electrical resistance. The BARO sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The BARO sensor provides a signal voltage to the ECM, relative to the pressure changes on the BARO sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Changes in BARO due to weather are relatively small, while changes due to altitude are significant. Pressure can range from 56 kPa at an altitude of 4 267 meters (14,000 feet), to 105 kPa at or below sea level. The BARO sensor has a range of 8-207 kPa. The ECM uses the BARO sensor input for fuel delivery and other diagnostics.

The ECM monitors the BARO sensor signal for pressure outside of the normal range. If the ECM detects a BARO sensor pressure that is excessively low, DTC P2228 sets.

Conditions for Setting the DTC

The BARO is less than 40 kPa for 10 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

ALTITUDE MEASURED IN METERS (M)	ALTITUDE MEASURED IN FEET (FT)	BAROMETRIC PRESSURE MEASURED IN KILOPASCALS (KPA)
4 267	14,000	56-64
3 962	13,000	58-66
3 658	12,000	61-69
3 353	11,000	64-72
3 048	10,000	66-74
2 743	9,000	69-77
2 438	8,000	71-79
2 134	7,000	74-82
1 829	6,000	77-85
1 524	5,000	80-88
1 219	4,000	83-91
914	3,000	87-95
610	2,000	90-98
305	1,000	94-102
0	0 Sea Level	96-104
-305	-1,000	101-105

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Start the engine. 2. Monitor the Diagnostic Trouble Code (DTC) Information with a scan tool. Does the scan tool indicate that DTC P0652 is also set?		Go to DTC P0652	Go to Step 3
3	Observe the BARO parameter with a scan tool. Does the scan tool indicate that the pressure is less than the specified value?	40 kPa	Go to Step 5	Go to Step 4

Step	Action	Value(s)	Yes	No
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records Did the DTC fail this ignition?		Go to Step 5	Go to Intermittent Conditions
5	1. Turn OFF the ignition. 2. Disconnect the barometric pressure (BARO) sensor electrical connector. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the 5-volt reference circuit 612 (WH/BK) of the BARO sensor to a good ground, with a DVOM. Is the voltage more than the specified value?	4.8 Volts	Go to Step 6	Go to Step 7
6	Connect a 3-amp fused jumper wire between the 5-volt reference circuit 612 WH/BK) of the BARO sensor and the signal circuit 613 (GY/BK) of the BARO sensor. Does the scan tool indicate that the BARO sensor pressure is more than the specified value?	205 kPa	Go to Step 9	Go to Step 8
7	Test the 5-volt reference circuit 612 WH/BK) of the BARO sensor for an open. Did you find and correct the condition?		Go to Step 13	Go to Step 10
8	Test the signal circuit of the BARO sensor for the following: • A short to ground • A short to low reference • An open Did you find and correct the condition?		Go to Step 13	Go to Step 10
9	Inspect for poor connections at the BARO sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 11
10	Inspect for poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 13	Go to Step 12
11	Replace the faulty BARO sensor. Did you complete the replacement?		Go to Step 13	
12	Replace the faulty ECM. Did you complete the replacement?		Go to Step 13	
13	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 14

Step	Action	Value(s)	Yes	No
14	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2229 Barometric Pressure (BARO) Sensor Circuit High Voltage (Figure OBD-115)

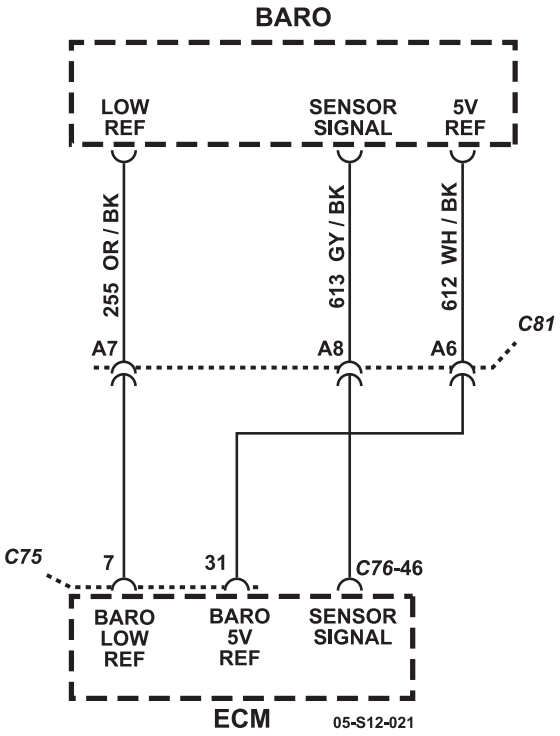


Figure OBD-115: Barometric Pressure (BARO) Sensor Circuit

Circuit Description

The barometric pressure (BARO) sensor measures the pressure of the atmosphere. This pressure is affected by altitude and weather conditions. A diaphragm within the BARO sensor is displaced by the pressure changes that occur from varying altitudes and weather conditions. The sensor translates this action into electrical resistance. The BARO sensor wiring includes 3 circuits. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit. The ECM supplies a ground on a low reference circuit. The BARO sensor provides a signal voltage to the ECM, relative to the pressure changes on the BARO sensor signal circuit. The ECM converts the signal voltage input to a pressure value.

Changes in BARO due to weather are relatively small, while changes due to altitude are significant. Pressure can range from 56 kPa at an altitude of 4 267 meters (14,000 feet), to 105 kPa at or below sea level. The BARO sensor has a range of 8-207 kPa. The ECM uses the BARO sensor input for fuel delivery and other diagnostics.

The ECM monitors the BARO sensor signal for pressure outside of the normal range. If the ECM detects a BARO sensor pressure that is excessively high, DTC P2229 sets.

Conditions for Setting the DTC

The BARO is more than 110 kPa for 10 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Turn ON the ignition, with the engine OFF. 2. Observe the BARO sensor pressure with a scan tool. Does the scan tool indicate that the pressure is more than the specified value?	110 kPa	Go to Step 4	Go to Step 3
3	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 4	Go to Intermittent Conditions
4	Monitor the Diagnostic Trouble Code (DTC) Information with a scan tool. Does the scan tool indicate that DTC P0653 is also set?		Go to Step 7	Go to Step 5
5	1. Turn OFF the ignition. 2. Disconnect the electrical connector of the barometric pressure (BARO) sensor. 3. Turn ON the ignition, with the engine OFF. Does the scan tool indicate that the BARO parameter is less than the specified value?	11 kPa	Go to Step 6	Go to Step 8
6	1. Connect a jumper wire between each of the terminals in the BARO sensor harness connector and the corresponding terminal at the BARO sensor. 2. Measure the voltage from the low reference circuit 255 (OR/BK) of the BARO sensor at the jumper wire terminal to a good ground with a DVOM. Is the voltage more than the specified value?	0.2 V	Go to Step 9	Go to Step 10
7	1. Turn OFF the ignition. 2. Disconnect the electrical connector of the BARO sensor. 3. Turn ON the ignition, with the engine OFF. Does the scan tool indicate that the BARO sensor pressure is less than the specified value?	11 kPa	Go to DTC P0653	Go to Step 8

Step	Action	Value(s)	Yes	No
8	Test the signal circuit 613 (GY/BK) of the BARO sensor for a short to voltage. Did you find and correct the condition?		Go to Step 14	Go to Step 13
9	Test the low reference circuit 255 (OR/BK) of the BARO sensor for high resistance or an open. Did you find and correct the condition?		Go to Step 14	Go to Step 11
10	Inspect for poor connections at the BARO sensor. Did you find and correct the condition?		Go to Step 14	Go to Step 12
11	Inspect for poor connections at the engine control module (ECM). Did you find and correct the condition?		Go to Step 14	Go to Step 13
12	Replace the faulty BARO sensor. Did you complete the replacement?		Go to Step 14	
13	Replace the faulty ECM. Did you complete the replacement?		Go to Step 14	
14	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 15
15	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2563 Turbocharger Boost Control Position Sensor Performance (Figure OBD-116)

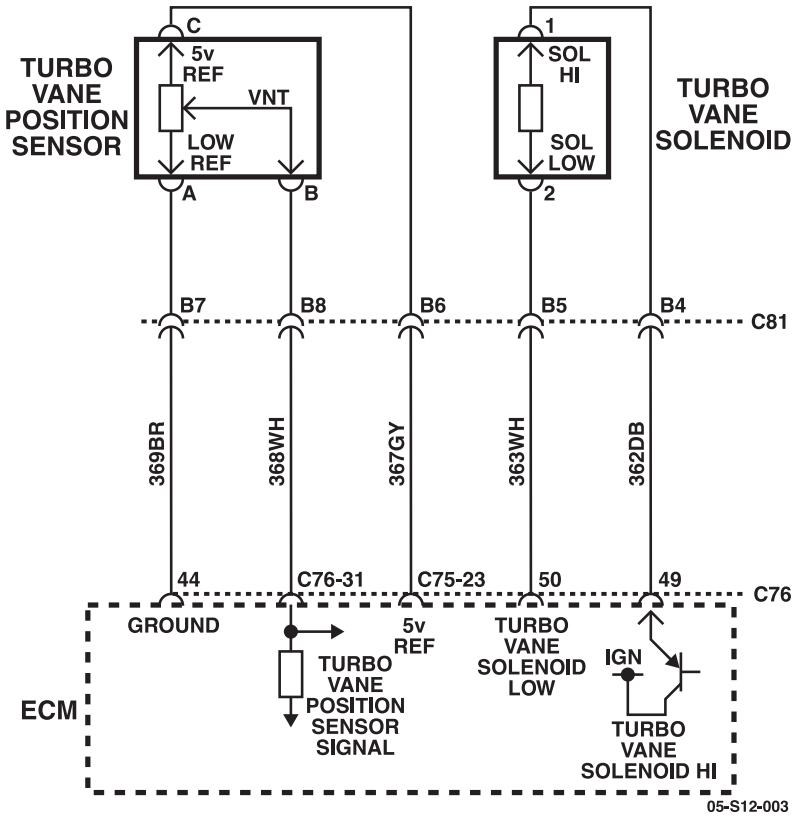


Figure OBD-116: Turbocharger Boost Control Position Sensor

Circuit Description

The position of the turbocharger vanes is controlled by the engine control module (ECM). The ECM utilizes a turbocharger vane control solenoid valve and a turbocharger vane position sensor to control the turbocharger vanes. When the engine is not under load, the turbocharger vanes are in an open position, or no boost condition. When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger vanes, thus increasing the boost. The ECM will vary the boost dependant upon the load requirements of the engine. The vane position sensor uses the following 3 circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

The ECM provides the sensor with 5 volts on the 5-volt reference circuit and a ground on the low reference circuit. Movement of the sensor from the closed position to the open position provides the ECM with a signal voltage through the position sensor signal circuit. If the ECM detects that the commanded position does not meet the actual position, DTC P2563 will set.

Conditions for Setting the DTC

- The ECM detects that the commanded vane position does not match the actual position.
- The above condition exists for more than 12 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecu-

tiveignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Diagnostic Aids

- If any service has been performed on the turbocharger or on the turbocharger components, a turbocharger relearn must be performed. Failure to perform the turbocharger learn procedure may cause this DTC to set. Refer to Turbocharger Learn Procedure .
- An intermittent condition with the turbocharger vane control solenoid valve may cause this DTC to set. For an intermittent condition, refer to Intermittent Conditions .

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Turn ON the ignition, with the engine OFF. 2. Monitor the DTC information with a scan tool. Is DTC P0652, P0653, P2564, or P2565 also set?		Go to Diagnostic Trouble Code	Go to Step 3
3	1. Perform the Turbocharger Learn Procedure. 2. Turn OFF the ignition for 30 seconds. 3. Turn ON the ignition, with the engine OFF. 4. Clear the DTCs with the scan tool. Is the procedure complete?		Go to Step 4	
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 5	Go to Diagnostic Aids
5	1. Select the TC Vane Pos. Ctrl. Solenoid test in Scan Tool Output Controls. 2. Raise the engine RPM to 1,000 and maintain. 3. Command the turbocharger vane position control solenoid valve ON with a scan tool. Does the engine speed decrease when the valve is commanded ON?		Go to Step 6	Go to Step 9

Step	Action	Value(s)	Yes	No
6	1. Select the TC Vane Position Sensor test in Scan Tool Output Controls. 2. With the engine at idle, observe the TC Vane Position Sensor and the Desired TC Vane Position while commanding the TC Vane Position Sensor to 100 percent with the scan tool. Is the TC Vane Position at or near the Desired TC Vane Position while commanding the TC Vane Position Sensor from 0 percent to 100 percent?		Go to Step 15	Go to Step 7
7	1.Turn OFF the ignition. 3. Disconnect the turbocharger vane position sensor. 4. Turn ON the ignition, with the engine OFF. 5. Measure the voltage from the 5-volt reference circuit 367 (GY) to a good ground with a DVOM. Is the voltage less than the specified value?	4.8 Volts	Go to Step 16	Go to Step 8
8	Measure the amperage between the 5-volt reference circuit 367 (GY) and a good ground at the turbocharger vane position sensor connector with a DVOM. Is the amperage less than the specified value?	170 mA	Go to Step 17	Go to Step 13
9	1. Turn OFF the ignition for 30 seconds. 2. Disconnect the turbocharger vane control solenoid valve. 3. Test for an intermittent and for a poor connection at the vane control solenoid valve. Did you find and correct the condition?		Go to Step 24	Go to Step 10
10	1. Turn OFF the ignition. 2. Disconnect the turbocharger vane position control solenoid valve. 3. Measure the resistance of the turbocharger vane position control solenoid valve high control circuit 362 (DB) between C76 pin 4 and pin 1 of the turbocharger vane position control solenoid connector with a DVOM. Is the resistance above the specified value?	5 ohms	Go to Step 18	Go to Step 11
11	1.Remove the turbocharger vane position control solenoid valve. **NOTE:** The solenoid valve may be in 3 different positions: • Open--Light is visible through the slot. • Closed--The surface of the valve in the slot is smooth. • At rest--The surface of the valve in the slot is serrated. 4. Observe both sets of slots on the side of the valve. A serrated surface, which is part of the sliding piece visible through the slots, should be fully visible in both slots. Is the serrated surface visible through the solenoid valve slots?		Go to Step 12	Go to Step 21

Step	Action	Value(s)	Yes	No
12	1. Connect the turbocharger vane position control solenoid valve connector. 2. Turn ON the ignition, with the engine OFF. 3. Depress and hold the button at the tip of the control solenoid valve. 4. Command the control solenoid valve ON with the scan tool. 5. Observe the slot closest to the button when commanding the solenoid valve to ON. Does the spool valve move and open the slot on the vane control solenoid valve?		Go to Step 15	Go to Step 21
13	1. Turn OFF the ignition for 30 seconds. 2. Remove the turbocharger vane position sensor. 3. Connect the turbocharger vane position sensor connector. 4. Turn ON the ignition, with the engine OFF. Observe the TC Vane Position with the scan tool. Is the TC vane position at the specified value?	100%	Go to Step 14	Go to Step 19
14	1. Fully depress the turbocharger vane position sensor plunger. 2. Observe the TC Vane Position with the scan tool. Is the TC vane position at the specified value?	0%	Go to Step 15	Go to Step 19
15	1. Inspect the turbocharger for debris or damage. 2. If required, replace the turbocharger. Is the procedure complete?		Go to Step 24	
16	1. Turn OFF the ignition. 2. Disconnect C75 (ECM). 3. Test the vane position sensor 5-volt reference circuit 367 (GY) for an open between C75 pin 23 and pin C of the vane position sensor connector. Did you find and correct the condition?		Go to Step 24	Go to Step 20
17	1. Turn OFF the ignition. 2. Disconnect the ECM. 3. Test the vane position sensor 5-volt reference circuit 367 (GY) for high resistance between C75 pin 23 and pin C of the vane position sensor connector. Did you find and correct the condition?		Go to Step 24	Go to Step 20
18	Repair the high resistance in the circuit. Did you complete the repair?		Go to Step 24	
19	Test for an intermittent and for a poor connection at the vane position sensor. Did you find and correct the condition?		Go to Step 24	Go to Step 22
20	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 24	Go to Step 23
21	Replace the faulty turbocharger vane control solenoid valve. Did you complete the replacement?		Go to Step 24	

Step	Action	Value(s)	Yes	No
22	Replace the turbocharger vane position sensor. Did you complete the replacement?		Go to Step 24	
23	Replace the faulty ECM. Did you complete the replacement?		Go to Step 24	
24	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Perform the turbocharger learn procedure. Refer to Turbocharger Learn Procedure . 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 25
25	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2564 Turbocharger Boost Control Position Sensor Circuit Low Voltage (Figure OBD-117)

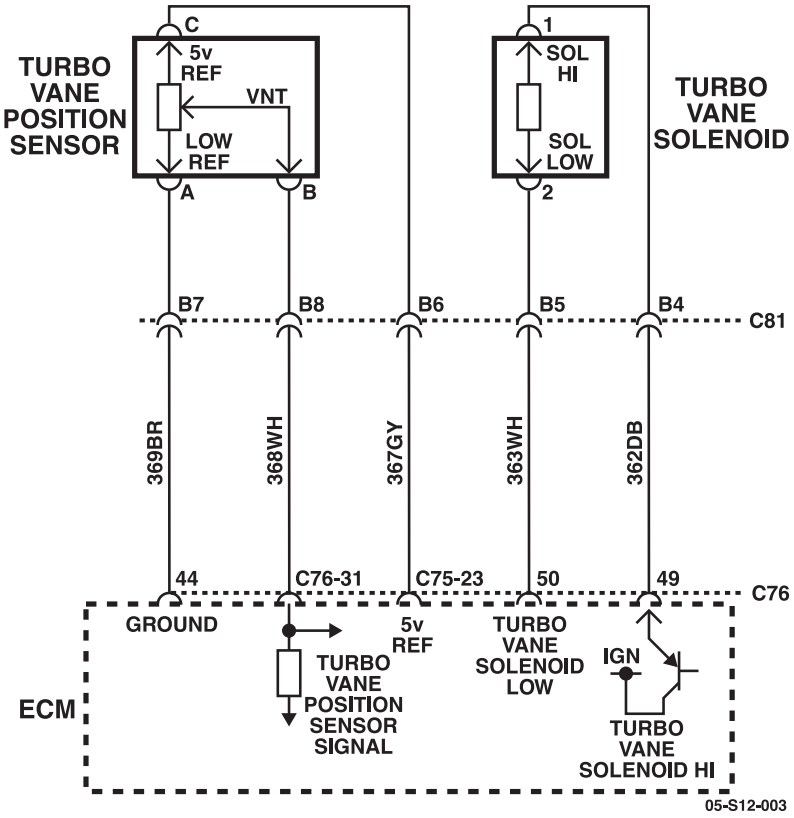


Figure OBD-117: Turbocharger Boost Control Position Sensor Circuit

Circuit Description

The position of the turbocharger vanes is controlled by the engine control module (ECM). The ECM utilizes a turbocharger vane control solenoid valve and a turbocharger vane position sensor to control the turbocharger vanes. When the engine is not under load, the turbocharger vanes are in an open position, or no boost condition. When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger vanes, thus increasing the boost. The ECM will vary the boost dependant upon the load requirements of the engine. The vane position sensor uses the following three circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

The ECM provides the sensor with 5 volts on the 5-volt reference circuit and a ground on the low reference circuit. Movement of the sensor from the closed position to the open position provides the ECM with a signal voltage through the position sensor signal circuit. If the ECM detects an excessively low position sensor signal voltage, DTC P2564 will set.

Conditions for Setting the DTC

- The turbocharger vane position sensor voltage is less than 1 volt.
- The above condition exists for more than 6 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecu-

tive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Turn ON the ignition, with the engine OFF. 2. Monitor the DTC Information with a scan tool. Is DTC P0652 also set?		Go to DTC P0652	Go to Step 3
3	1. Start the engine. 2. Select the TC Vane Position Sensor test in Scan Tool Output Controls. 3. With the engine at idle, observe the turbocharger (TC) vane position and the desired TC vane position while commanding the TC vane position sensor to 100 percent with the scan tool. Is the TC vane position at or near the desired TC vane position while commanding the TC vane position sensor from 0-100 percent?		Go to Step 4	Go to Step 5
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 5	Go to Intermittent Conditions
5	1. Turn OFF the ignition. 2. .Disconnect the turbocharger vane position sensor. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the 5-volt reference circuit 367 (GY) to a good ground with a DVOM. Is the voltage less than the specified value?	4.8 Volts	Go to Step 7	Go to Step 6
6	Measure the voltage from the signal circuit 368 (WH) to a good ground with a DVOM. Is the voltage less than the specified value?	4.8 Volts	Go to Step 8	Go to Step 9

Step	Action	Value(s)	Yes	No
7	1. Turn OFF the ignition. 2. Disconnect C75 (ECM). 3. Test the vane position sensor 5-volt reference circuit 367 (GY) for an open and for a high resistance between C75 pin 23 and pin C of the vane position sensor connector. Did you find and correct the condition?		Go to Step 13	Go to Step 10
8	1. Turn OFF the ignition. 2. Disconnect C76 (ECM). 3. Test the vane position sensor signal circuit 368 (WH) for a short to ground. Did you find and correct the condition?		Go to Step 13	Go to Step 10
9	Test for an intermittent and for a poor connection at the vane position sensor. Did you find and correct the condition?		Go to Step 13	Go to Step 11
10	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 13	Go to Step 12
11	Replace the turbocharger vane position sensor. Did you complete the replacement?		Go to Step 13	
12	Replace the faulty ECM. Did you complete the replacement?		Go to Step 13	
13	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Perform the turbocharger learn procedure. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 14
14	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2565 Turbocharger Boost Control Position Sensor Circuit High Voltage (Figure OBD-118)

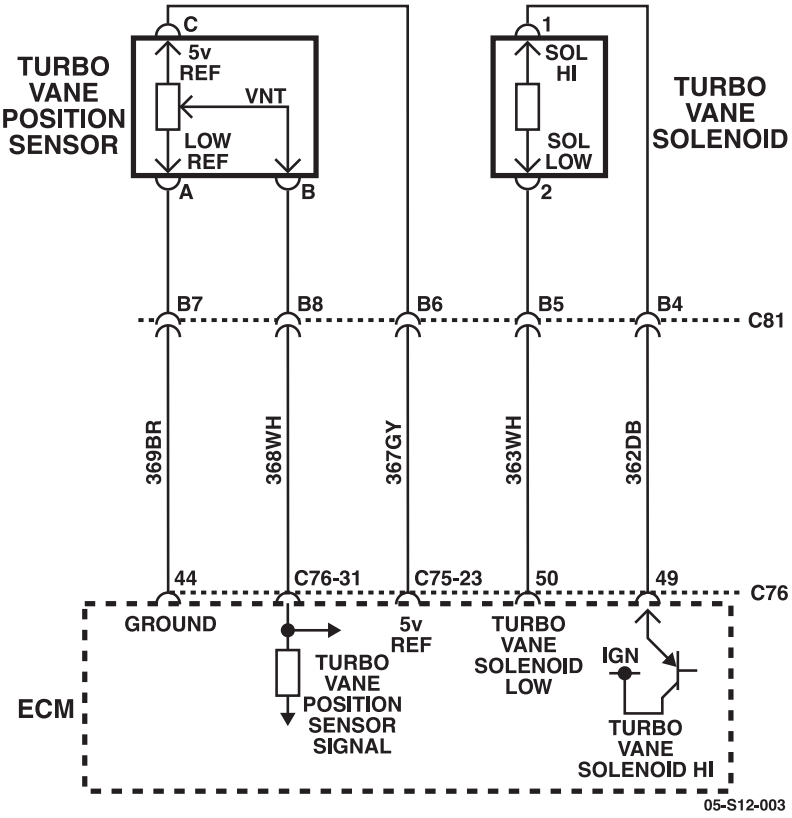


Figure OBD-118: Turbocharger Boost Control Position Sensor Circuit

Circuit Description

The position of the turbocharger vanes is controlled by the engine control module (ECM). The ECM utilizes a turbocharger vane control solenoid valve and a turbocharger vane position sensor to control the turbocharger vanes. When the engine is not under load, the turbocharger vanes are in an open position, or no boost condition. When the engine is under load, the ECM commands the control solenoid valve to close the turbocharger vanes, thus increasing the boost. The ECM will vary the boost dependant upon the load requirements of the engine. The vane position sensor uses the following 3 circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

The ECM provides the sensor with 5 volts on the 5-volt reference circuit and a ground on the low reference circuit. Movement of the sensor from the closed position to the open position provides the ECM with a signal voltage through the position sensor signal circuit. If the ECM detects an excessively high position sensor signal voltage, DTC P2565 will set.

Conditions for Setting the DTC

- The ECM detects that the turbocharger vane position sensor signal voltage is more than 3.9 volts.
- The above condition exists for more than 6 seconds.

Action Taken When the DTC Sets

- The control module illuminates the malfunction indicator lamp (MIL) on the second consecutive ignition cycle that the diagnostic runs and fails.
- The control module records the operating conditions at the time the diagnostic fails. The first time the diagnostic fails, the control module stores this information in the Failure Records. If the diagnostic reports a failure on the second consecutive ignition cycle, the control module records the operating conditions at the time of the failure. The control module writes the operating conditions to the Freeze Frame and updates the Failure Records.

Conditions for Clearing the MIL/DTC

- The control module turns OFF the malfunction indicator lamp (MIL) after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current DTC, Last Test Failed, clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other emission related diagnostic.
- Clear the MIL and the DTC with a scan tool.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Turn ON the ignition, with the engine OFF. 2. Monitor the DTC Information with the scan tool. Is DTC P0653 also set?		Go to DTC P0653	Go to Step 3
3	1. Start the engine. 2. Select the TC Vane Position Sensor test in Scan Tool Output Controls. 3. With the engine at idle, observe the TC vane position sensor and the desired TC vane position while commanding the TC vane position sensor to 100 percent with the scan tool. Is the TC vane position at or near the desired TC vane position while commanding the TC vane position sensor from 0-100 percent?		Go to Step 4	Go to Step 5
4	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 5	Go to Intermittent Conditions
5	1. Turn OFF the ignition. 2. Disconnect the turbocharger (TC) vane position sensor. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage from the signal circuit 368 (WH) pin B to the low reference circuit 369 (BR) pin A of the vane position sensor connector with a DVOM. Is the voltage less than the specified value?	4.8 Volts	Go to Step 7	Go to Step 6
6	Is the voltage more than the specified value?	5.2 Volts	Go to Step 11	Go to Step 8

Step	Action	Value(s)	Yes	No
7	Measure the voltage from the signal circuit 368 (WH) to a good ground with a DVOM. Is the voltage less than the specified value?	4.8 Volts	Go to Step 12	Go to Step 10
8	Measure the current between the 5-volt reference circuit 367 (GY) pin C and the low reference circuit 369 (BR) pin A at the TC vane position sensor connector, with a DVOM. Is the current less than the specified value?	180 mA	Go to Step 9	Go to Step 13
9	Test the vane position sensor low reference circuit 369 (BR) for high resistance between C76 pin 44 and pin A of the vane position sensor connector. Did you find and correct the condition?		Go to Step 17	Go to Step 14
10	Test the vane position sensor low reference circuit 369 (BR) for an open and for a high resistance between C76 pin 44 and pin A of the vane position sensor connector. Did you find and correct the condition?		Go to Step 17	Go to Step 14
11	**NOTE:** Disconnecting the engine control module (ECM) may eliminate the short during testing. Test the vane position sensor signal circuit 368 (WH) for a short to voltage between C76 pin 31 and pin B of the vane position sensor connector. Did you find and correct the condition?		Go to Step 17	Go to Step 14
12	Test the vane position sensor signal circuit 368 (WH) for an open and for a high resistance between C76 pin 31 and pin B of the vane position sensor connector.. Did you find and correct the condition?		Go to Step 17	Go to Step 14
13	Test for an intermittent and for a poor connection at the vane position sensor. Did you find and correct the condition?		Go to Step 17	Go to Step 15
14	Test for an intermittent and for a poor connection at the ECM. Did you find and correct the condition?		Go to Step 17	Go to Step 16
15	Replace the faulty turbocharger vane position sensor. Did you complete the replacement?		Go to Step 17	
16	Replace the faulty ECM. Did you complete the replacement?		Go to Step 17	
17	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Perform the turbocharger learn procedure. Refer to Turbocharger Learn Procedure . 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 2	Go to Step 18

Step	Action	Value(s)	Yes	No
18	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code	System OK

DTC P2636 Fuel Transfer Pump Flow Insufficient

Circuit Description

The fuel pump is located on the left frame rail between the fuel tanks. The engine control module (ECM) provides ignition positive voltage to the coil side of the fuel pump relay. The ECM energizes the fuel pump relay, which applies power to the fuel transfer pump. Fuel is transferred from the rear fuel tank to the front fuel tank in order to ensure all of the usable fuel volume is available to the engine. If the ECM commands the transfer fuel pump ON and a predetermined change in the front and rear fuel level sensors does not occur, this DTC sets.

Conditions for Setting the DTC

The ECM detects a primary fuel level increase and a secondary fuel level decrease of less than 2.6 liters (0.70 gallons) each, within 120 seconds.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The malfunction indicator lamp (MIL) will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.
- The fuel gage will be commanded to empty.

Conditions for Clearing the DTC

- A current DTC Last Test Failed clears when the diagnostic runs and passes.
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

Diagnostic Aids

- When outside temperatures are below 0°C (32°F), the fuel tank pickup screen may ice over from water in the fuel tank.
- If the engine is running while fueling the vehicle, this DTC may set.
- The fuel will default to empty when this DTC sets.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Is DTC P0461, P0462, P0463, P2067, or P2068 also set?		Go to Diagnostic Trouble Code (DTC) List	Go to Step 3

Step	Action	Value(s)	Yes	No
3	**NOTE:** The fuel level must be between 25-50 percent in order to perform this diagnostic procedure. If the fuel level is not within this range, misdiagnosis will occur. 1. Turn ON the ignition, with the engine OFF. 2. Command the fuel pump relay ON and OFF with a scan tool. Does the fuel pump relay click?		Go to Step 9	Go to Step 4145
4	1. Remove the fuel pump relay from the underhood electrical center. 2. Probe the ground circuit of the fuel pump relay with a test lamp that is connected to battery voltage. Does the test lamp illuminate?		Go to Step 5	Go to Step 25
5	1. Probe the fuel pump relay control circuit with a test lamp that is connected to a good ground. 2. Command the fuel pump relay ON and OFF with a scan tool. Does the test lamp turn ON and OFF?		Go to Step 22	Go to Step 6
6	Does the test lamp remain illuminated?		Go to Step 7	Go to Step 8
7	Test the fuel pump relay control circuit for a short to voltage. Did you find and correct the condition?		Go to Step 31	Go to Step 24
8	Test the fuel pump relay control circuit for an open or a short to ground. Did you find and correct the condition?		Go to Step 31	Go to Step 24
9	Command the fuel transfer pump ON with a scan tool. Does the fuel transfer pump operate?		Go to Step 17	Go to Step 10
10	1. Remove the fuel pump relay from the underhood electrical center. 2. Turn ON the ignition, with the engine OFF. 3. Probe the battery voltage circuit of the fuel pump relay with a test lamp that is connected to a good ground. Does the test lamp illuminate?		Go to Step 11	Go to Step 12
11	Connect a fused jumper wire between the fuel pump relay battery voltage circuit and the fuel pump supply voltage circuit. Does the fuel pump operate?		Go to Step 22	Go to Step 15
12	Is the battery positive voltage fuse open?		Go to Step 13	Go to Step 27
13	Test the battery voltage circuit of the fuel pump relay for a short to ground. Did you find and correct the condition?		Go to Step 31	Go to Step 14
14	Test the fuel pump supply voltage circuit for a short to ground. Did you find and correct the condition?		Go to Step 31	Go to Step 23
15	Test the fuel transfer pump supply voltage circuit for an open. Did you find and correct the condition?		Go to Step 31	Go to Step 16

Step	Action	Value(s)	Yes	No
16	Probe the ground circuit of the fuel transfer pump with a test lamp that is connected to battery voltage. Does the test lamp illuminate?		Go to Step 23	Go to Step 26
17	Observe the fuel level sensor rear tank voltage parameter with a scan tool. Is the voltage less than the specified value?	2.2 Volts	Go to Step 19	Go to Step 18
18	Add the specified amount of fuel to the rear fuel tank. Did you complete the action?	19 L (5 gal)	Go to Step 19	
19	1. Connect a fused jumper wire between the fuel pump relay battery voltage circuit and the fuel pump voltage supply circuit. 2. Observe the Fuel Level sensor voltage parameter with a scan tool. Does the rear fuel level sensor voltage parameter decrease as the fuel pump is operating?		Go to Step 20	Go to Step 21
20	1. Disconnect the outlet hose from the fuel transfer pump. 2. Connect a section of rubber hose with a clamp to the outlet port of the transfer pump. 3. Insert the other end of the rubber hose into a container to measure more than 4 liters (1.06 gallons). 4. Operate the transfer pump with a scan tool for a total of 120 seconds. Measure the fuel in the container. Does the fuel volume measure more than the specified value?	2.6 L (0.70 gal)	Go to Intermittent Conditions	Go to Step 21
21	Inspect for the following conditions: • A restriction in the fuel lines between the front and rear fuel tanks • The rear fuel sender for a restriction Did you find and correct the condition?		Go to Step 31	Go to Step 29
22	Inspect for poor connections at the harness connector of the fuel pump relay. Did you find and correct the condition?		Go to Step 31	Go to Step 28
23	Inspect for poor connections at the harness connector of the fuel transfer pump. Did you find and correct the condition?		Go to Step 31	Go to Step 29
24	Inspect for poor connections at the harness connector of the engine control module (ECM). Did you find and correct the condition?		Go to Step 31	Go to Step 30
25	Repair the open ground circuit of the fuel pump relay. Did you complete the repair?		Go to Step 31	
26	Repair the open ground circuit of the fuel transfer pump. Did you complete the repair?		Go to Step 31	

Step	Action	Value(s)	Yes	No
27	Repair the open battery voltage circuit of the fuel pump relay. Did you complete the repair?		Go to Step 31	
28	Replace the faulty fuel pump relay. Did you complete the replacement?		Go to Step 31	
29	Replace the faulty fuel transfer pump. Did you complete the replacement?		Go to Step 31	
30	Replace the faulty ECM. Did you complete the replacement?		Go to Step 31	
31	1. Clear the DTCs with a scan tool. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Diagnostic Aids	Go to Step 32
32	Observe the Capture Info with a scan tool. Are there any DTCs that have not been diagnosed?		Go to Diagnostic Trouble Code (DTC) List	System OK

DTC P2771 Four Wheel Drive (4WD) Low Switch Circuit

Circuit Description

The 4WD low signal circuit is used to notify the transmission control module (TCM) that the vehicle is in 4WD low range.
DTC P2771 is a type B DTC.

Conditions for Setting the DTC

DTC P2771 sets when one of the following conditions occur:

- The transfer case switch indicates high range, and the calculated range is low range for 5 seconds or greater.
- The transfer case switch indicates low range, and the calculated range is high range for 5 seconds or greater.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- DTC 2771 will be stored in TCM history.
- The TCM inhibits torque converter clutch (TCC) engagement.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- Inspect for any transmission DTCs that may have set again.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Install the scan tool. 2. Turn ON the ignition, with the engine OFF. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Records. 4. Clear the DTC. 5. Using the scan tool, monitor 4WD Low status and select 4HI followed by 4LO with the transfer case selector. Does the scan tool indicate 4WD low status as NO when 4HI is selected, and YES when 4LO is selected?		Go to Diagnostic Aids	Go to Step 3

Step	Action	Value(s)	Yes	No
3	Select 4HI followed by 4LO using the transfer case selector. Does the scan tool indicate 4WD low status as YES for both selector positions?		Go to Step 4	Go to Step 9
4	Remove the connector at the transfer case selector. Does the scan tool indicate 4WD low status as YES?		Go to Step 5	Go to Step 7
5	Inspect 4WD Low signal circuit for a short to ground. Did you find a condition?		Go to Step 6	Go to Step 15
6	Inspect and repair the short to ground in 4WD Low signal circuit. Did you complete the repair?		Go to Step 16	
7	Inspect the transfer case switch for proper operation or a short to ground. Did you find a condition?		Go to Step 8	Go to Step 15
8	Replace the faulty transfer case switch. Did you complete the replacement?		Go to Step 16	
9	Using the transfer case selector, select 4HI followed by 4LO. Does the scan tool indicate 4WD Low status as NO for both selector positions?		Go to Step 10	Go to Step 15
10	1. Remove the connector at the transfer case switch. 2. Ground 4WD Low signal circuit to a known ground. Does the scan tool indicate 4WD low status as NO?		Go to Step 11	Go to Step 13
11	Inspect the short to ground in the brake switch signal circuit. Did you find a condition?		Go to Step 12	Go to Step 15
12	Repair the open condition in the 4WD Low signal circuit. Did you complete the repair?		Go to Step 16	
13	Inspect the transfer case switch for an open condition. Did you find an open condition?		Go to Step 14	Go to Step 15
14	Replace the faulty transfer case switch. Did you complete the replacement?		Go to Step 16	
15	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 16	
16	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. Monitor the 4WD Low status with the scan tool. The 4WD Low status must indicate NO when 4WD HI is selected, and YES when 4WD LO is selected. 3. Select Specific DTC. 4. Enter DTC P2771. Has the test run and passed?		System OK	Go to Step 1

DTC P2810 Solenoid G Electrical (Figure OBD-119)

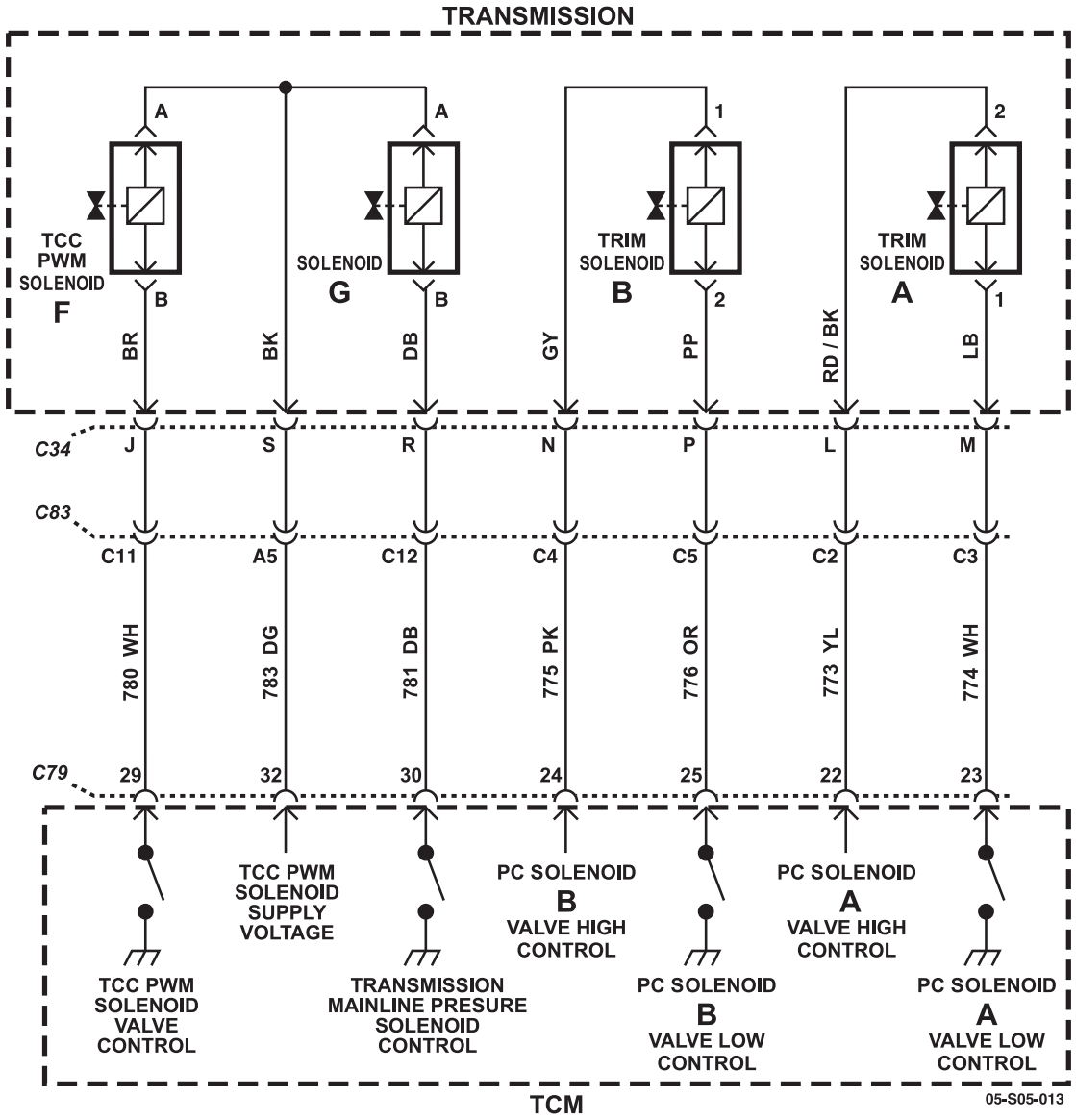


Figure OBD-119: Solenoid G Circuit

Circuit Description

G solenoid is a normally-closed (N/C) solenoid used to modulate the transmission main pressure. Under specific conditions, low throttle setting, low engine torque, low engine speed, and low transmission output speeds, the transmission control module (TCM) commands the G solenoid on.

When G solenoid is applied, fluid is routed to the main pressure regulator valve; this in turn reduces the main pressure schedule and improves the volume of oil through the overage circuit. By modulating main pressure, cooler flow at idle can be increased allowing improved cooling and reducing transmission pump noise.

Conditions for Setting the DTC

DTC P2810 is set when the TCM detects an open circuit, short to ground, or short to power at G solenoid circuit for greater than 2 seconds.

Action Taken When the DTC Sets

- The TCM illuminates the malfunction indicator lamp (MIL) during the second consecutive trip in which the Conditions for Setting the DTC are met.
- DTC P2810 will be stored in TCM history.

Conditions for Clearing the DTC

A scan tool can clear the code from TCM history. The TCM automatically clears the DTC from TCM history if the vehicle completes 40 warm-up cycles without failure.

Diagnostic Aids

- Inspect the wiring for poor electrical connections at the TCM. Inspect for the following conditions:
- A bent terminal
- A backed-out terminal
- A damaged terminal
- Poor terminal tension
- A chafed wire
- A broken wire inside the insulation
- When diagnosing for an intermittent short or open, massage the wiring harness while watching the test equipment for a change.
- You may have to drive the vehicle in order to experience a condition.
- Solenoids are sensitive to battery voltage spikes and poor ground connections.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Install the scan tool. 2. Start the engine. **NOTE:** Before clearing the DTC, use the scan tool in order to record the Freeze Frame and Failure Records for reference. The Clear Info function will erase the data. 3. Record the DTC Freeze Frame and Failure Record Records. 4. Clear the DTC. 5. Using the scan tool, observe ignition voltage. Is the voltage within the specified range?	9-18 Volts	Go to Step 3	Go to DTC P0562 for low voltage or DTC P0563 for high voltage
3	1. Turn the ignition OFF. 2. Disconnect the C79 at the TCM. 3. Install the J 39700 breakout box and the J 43799 breakout box adapter. 4. Using a DVOM, measure voltage between connector C79 terminal 30 and terminal 32. 5. Turn the ignition ON, with the engine OFF. 6. Using the scan tool, command G solenoid to ON. Is the voltage within the specified value when G solenoid is commanded ON.	B+	Go to Step 4	Go to Step 10

Step	Action	Value(s)	Yes	No
4	1. Turn the ignition OFF. 2. Using a DVOM, measure the resistance between connector C79 terminal 30 and terminal 32. Is the resistance reading within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Diagnostic Aids	Go to Step 5
5	1. Turn the ignition OFF. 2. Connect the C79 at the TCM. 3. Disconnect the wiring harness from the transmission 20-way C34. 4. Using a DVOM, measure resistance on the transmission side of the 20-way connector terminals R and S. Is the resistance within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Step 6	Go to Step 7
6	Inspect the wiring harness circuit for an open or short to ground between C34 and C79. Did you find and correct a condition?		Go to Step 11	
7	1. Connect the transmission 20-way C34. 2. Remove the oil pan. 3. Remove the AT internal wiring harness at G solenoid connector. 4. Using a DVOM, measure the resistance of G solenoid. Is the solenoid resistance within the specified value?	22.0 ohms [commat] 20°C (68°F)	Go to Step 8	Go to Step 9
8	Replace the faulty AT internal wiring harness. Did you complete the replacement?		Go to Step 11	
9	Replace the faulty G solenoid. Did you complete the replacement?		Go to Step 11	
10	**NOTE:** In most cases, the TCM is not at fault. Investigate thoroughly before replacing the TCM. Replace the faulty TCM. Did you complete the replacement?		Go to Step 11	
11	Perform the following procedure in order to verify the repair: 1. Clear the DTC. 2. Drive the vehicle under normal operating conditions. 3. Select Specific DTC. 4. Enter DTC P2810. Has the test run and passed?		System OK	Go to Step 1

DTC U0073 High Speed CAN Communication Bus (Figure OBD-120)

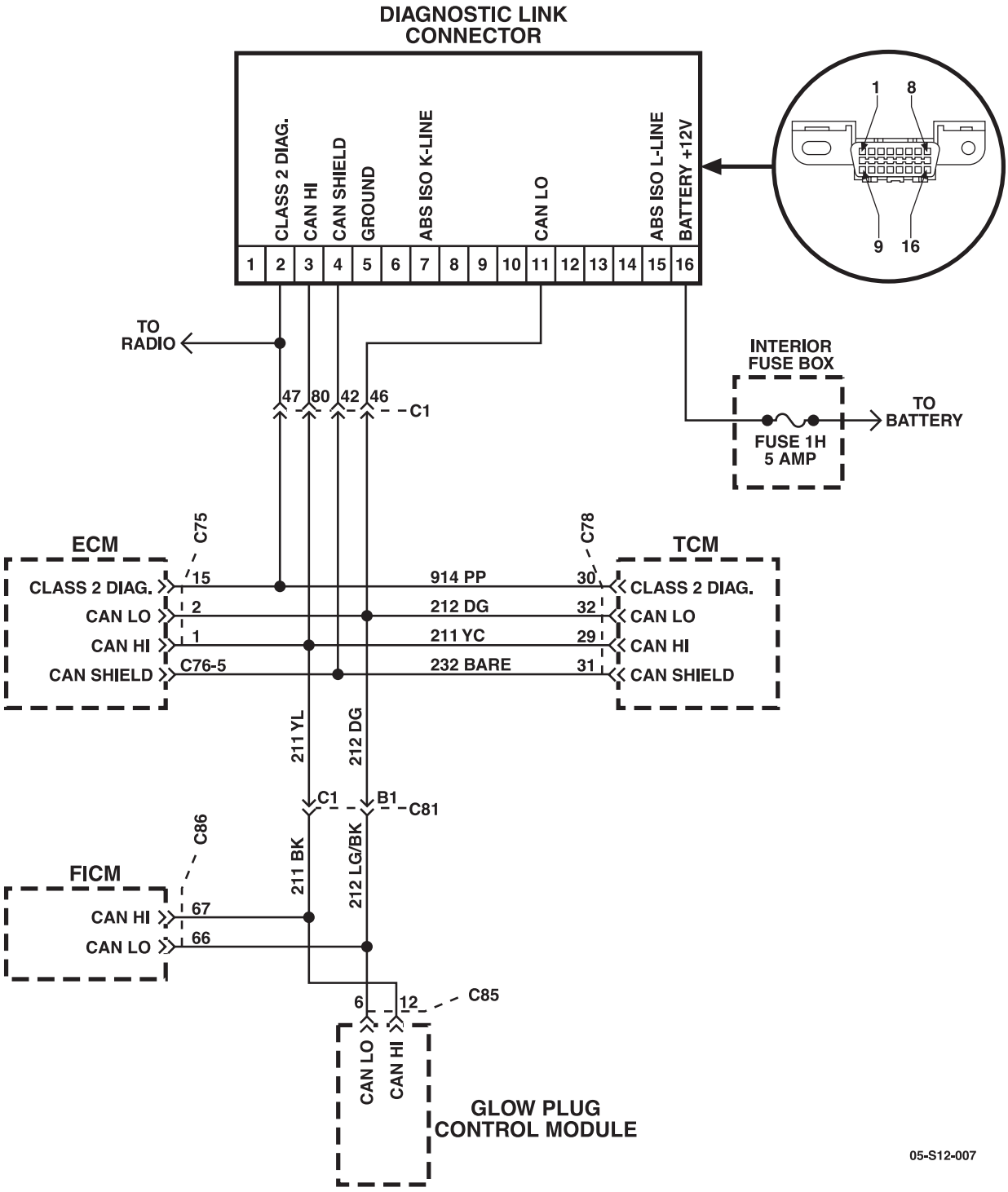


Figure OBD-120: CAN Communication Bus Circuit

Circuit Description

Modules connected to the controller area network (CAN) serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the modules. If no communication is detected on

CAN serial data circuit, the DTC is set. A total non communication condition may be caused by a short to battery or voltage on any of the CAN circuits or a short between the CAN high and low circuits.

The following modules communicate on CAN serial data (LLY engine):

- The engine control module (ECM)
- The transmission control module (TCM)
- The fuel injector control module (FICM)
- The glow plug controller module (GPCM)

Conditions for Setting the DTC

A total non communication condition is detected on CAN serial data circuit.

Action Taken When the DTC Sets

- The module uses a default value for the missing parameter.
- The malfunction indicator lamp (MIL) will illuminate on the second consecutive ignition cycle that the diagnostic runs and fails, for the type B DTCs. For a detailed description about DTC types, refer to Diagnostic Trouble Code (DTC) Type Definitions in Engine Controls - 6.6L (LLY).

Conditions for Clearing the MIL/DTC

The MIL/DTC clearing depends on DTC type. For information about DTC types, refer to Diagnostic Trouble Code (DTC) Type(s) in Engine Controls - 6.6L (LLY).

DTC Type B

- The MIL clears after 3 ignition cycles when the malfunction is no longer present.
- A current DTC clears when the malfunction is no longer present.
- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Observe the Freeze Frame/Failure Records for this DTC. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Does the DTC fail this ignition?		Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
3	1. Turn OFF the ignition. 2. Disconnect the fuel injector control module (FICM). 3. Disconnect the CAN circuits from the FICM. 4. Reconnect the FICM. 5. Operate the vehicle within the Conditions for Running the DTC. 6. Retrieve DTCs from engine control module (ECM) and transmission control module (TCM). Does the DTC reset as current in any module?		Go to Step 4	Go to Step 7

Step	Action	Value(s)	Yes	No
4	1. Turn OFF the ignition. 2. Disconnect the glow plug control module (GPCM). 3. Disconnect the CAN circuits from the GPCM. 4. Reconnect the GPCM. 5. Operate the vehicle within the Conditions for Running the DTC. 6. Retrieve DTCs from ECM and TCM. Does the DTC reset as current in any module?		Go to Step 5	Go to Step 7
5	**NOTE:** • If the vehicle is not equipped with TCM skip to the next step. • If the code set only in TCM, disconnect the ECM in this step. • If the code was set by ECM or by both modules, disconnect the TCM in this step. 1. Turn OFF the ignition. 2. Disconnect the module conform to the important statement. 3. Disconnect the CAN circuits from the module. 4. Reconnect the module. 5. Operate the vehicle within the Conditions for Running the DTC. 6. Retrieve DTCs from the module still connected. Does the DTC reset as current?		Go to Step 6	Go to Step 7
6	**NOTE:** Turn ON the ignition, with the engine OFF, when testing for a short to voltage. Use DVOM MIN/MAX function to capture intermittent conditions. 1. Turn OFF the ignition. 2. Disconnect the last module still connected to CAN bus. 3. Test the CAN serial data circuits for a short to ground, short to voltage, an open, or a short between them. • Testing for Intermittent Conditions and Poor Connections • Circuit Testing • Connector Repairs • Wiring Repairs Did you find and correct the condition?		Go to Step 9	Go to Step 7
7	Inspect for an intermittent or poor connections at the last disconnected/reconnected module. Did you find and correct the condition?		Go to Step 9	Go to Step 8
8	**NOTE:** Perform the module setup procedure if required. Replace the last disconnected/reconnected module. Did you complete the replacement?		Go to Step 9	

Step	Action	Value(s)	Yes	No
9	1. Reconnect all wires and modules. 2. Clear the DTCs with a scan tool. 3. Turn OFF the ignition for 30 seconds. 4. Start the engine. 5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records. Did the DTC fail this ignition?		Go to Step 3	System OK

DTC U0100-U299 Lost Communication With Engine Control Module (ECM) (Figure OBD-121)

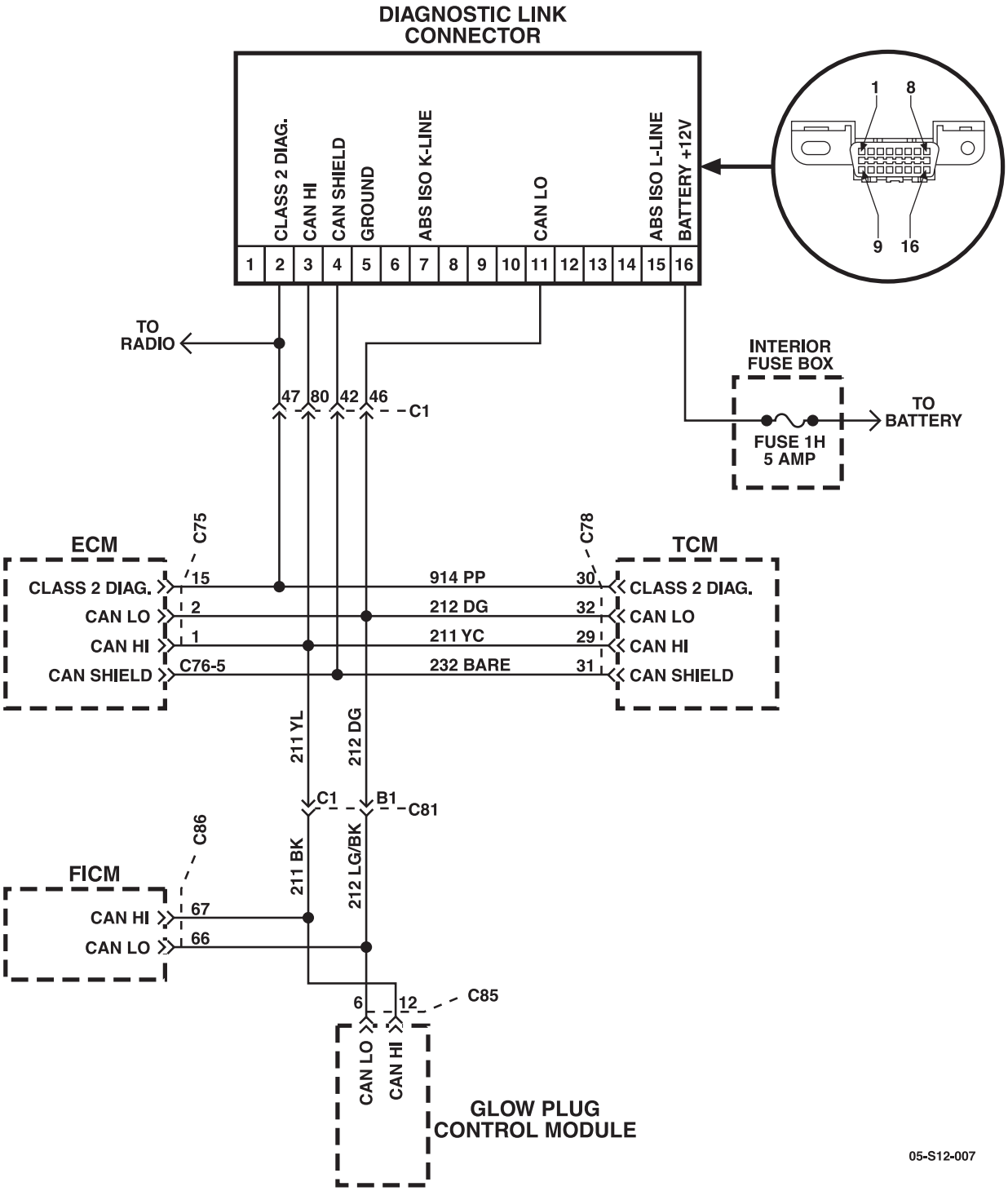


Figure OBD-121: CAN Communication Bus Circuit

Circuit Description

Modules connected to the controller area network (CAN) serial data circuits monitor for serial data communications during normal vehicle operation. Operating information and commands are exchanged among the modules. The modules have prerecorded information about what messages are needed to be exchanged on the serial data circuits. The messages are supervised and also, some

periodic messages are used by the receiver module as an availability indication of the transmitter module. Each message contains the identification number of the transmitter module. A module with a CAN serial data circuits malfunction or which loses power during the current ignition cycle will have a Loss of Communication DTC set by other modules that depend on information from that failed module. If any of the CAN circuits are shorted to battery voltage, ground or between them, no communication is possible on CAN serial data bus, and a DTC U0073 is set.

Conditions for Setting the DTC

A supervised periodic message that includes the transmitter module availability has not been received.

Action Taken When the DTC Sets

- The module uses a default value for the missing parameter.
- The malfunction indicator lamp (MIL) will illuminate on the second consecutive ignition cycle that the diagnostic runs and fails, for the type B DTCs. For a detailed description about DTC types, refer to Diagnostic Trouble Code (DTC) Type Definitions in Engine Controls - 6.6L (LLY).

Conditions for Clearing the MIL/DTC

The MIL/DTC clearing depends on DTC type. For information about DTC types, refer to Diagnostic Trouble Code (DTC) Type(s) in Engine Controls - 6.6L (LLY).

- DTC type B
  - The MIL clears after 3 ignition cycles when the malfunction is no longer present.
  - A current DTC clears when the malfunction is no longer present.
  - A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

Diagnostic Aids

- A poor connection at the inoperative module may cause this code to set.
- An improperly powered module may cause this code to set.

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check
2	1. Install a scan tool. 2. Start the engine. 3. Retrieve DTCs from engine control module (ECM). Is DTC U0073 set as current?		Go to DTC U0073	Go to Step 3

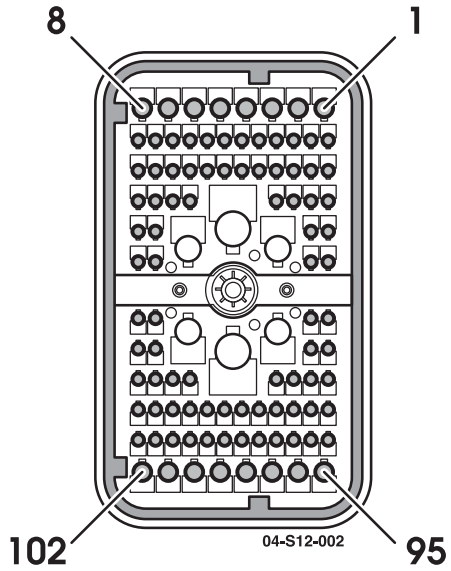
Step	Action	Value(s)	Yes	No
3	**NOTE:** Use the DTC descriptor list in order to determine which module is not communicating on controller area network (CAN) serial data bus. 1. Turn the ignition ON, with the engine OFF. 2. Test the following circuits of the module that is not communicating on CAN serial data bus for an open or a short to ground: • The battery positive voltage input circuits • The battery positive voltage output circuits • The ignition voltage input circuits • The ignition voltage output circuits • The switched battery positive voltage circuits Refer to the following: • Control Module References for the applicable schematic • Circuit Testing in Wiring Systems • Wiring Repairs in Wiring Systems Did you find and correct the condition?		Go to Step 9	Go to Step 4
4	1. Turn OFF the ignition. 2. Test the ground circuits of the module that is not communicating on CAN serial data bus for an open. Refer to the following: • Control Module References for the applicable schematic • Circuit Testing in Wiring Systems • Wiring Repairs in Wiring Systems Did you find and correct the condition?		Go to Step 9	Go to Step 5
5	Test the CAN serial data circuits of the module that is not communicating on CAN serial data bus for an open. Did you find and correct the condition?		Go to Step 9	Go to Step 6
6	Inspect the harness connectors of the module that is not communicating on CAN serial data bus for poor connections and terminal tension at the following circuits: • The battery positive voltage input circuits • The battery positive voltage output circuits • The ignition voltage input circuits • The ignition voltage output circuits • The switched battery positive voltage supply circuits • The ground circuits • The CAN serial data circuits Refer to the following: • Control Module References for the applicable schematic • Testing for Intermittent Conditions and Poor Connections in Wiring Systems • Connector Repairs in Wiring Systems		Go to Step 9	Go to Step 7

Step	Action	Value(s)	Yes	No
7	Replace the module that is not communicating on CAN serial data bus. Did you complete the replacement?		Go to Step 8	
8	1. Install a scan tool. 2. Turn ON the ignition with the engine OFF. 3. Select the Display DTCs function for the module which was not communicating. Does the scan tool display any DTCs which do not begin with a "U"?		Go to Diagnostic Trouble Code	Go to Step 9
9	Select the Display DTCs function for the modules which had the Loss of Communications DTC set. Does the scan tool display any DTCs which do not begin with a "U"?		Go to Diagnostic Trouble Code	Go to Step 10
10	1. Use the scan tool in order to clear the DTCs. 2. Continue diagnosing or clearing the DTCs until all the modules have been diagnosed and all the DTCs have been cleared. Did you complete the action?		System OK	

CONNECTOR LEGEND

102 WAY BULKHEAD LOCATION: LEFT SIDE FIREWALL

Connector C1



PIN	CKT	COLOR	CIRCUIT DESCRIPTION
1	739	PP	Left heated windshield power +
2	740	YL	Right heated windshield power +
3	16	LG	Ignition relay signal +

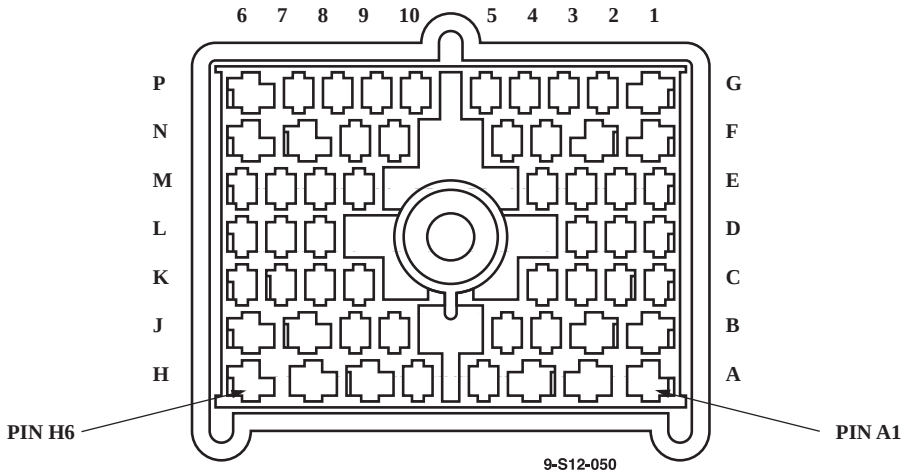
PIN	CKT	COLOR	CIRCUIT DESCRIPTION
4	20	RD	Left rear turn signal
5	12	OR	Head lamp high beam feed
6	13	TN	Head lamp low beam feed
7	33	WH	neutral safety switch feed
8	962	BR	Trailer lights
9	603	RD	ABS lamp activation
10	961	PP	TT4 lamp activation
11	606	OR	ABS diagnostic line
12	1	DB	Horn relay activation
13	42	BR	Low brake fluid lamp activation
14	640	OR	IGN+ CTIS warning circuits
15	327	YL	Water-in-fuel lamp activation
16	428	PK	CTIS buzzer activation
17	41	TN	Brake fluid level sensor feed
18	17	PP	Illumination circuit (+)
19	92	GY	CTIS rear inflate solenoid activation
20	607	TN	ABS module diagnostic line
21	47	LG	Deflate solenoid activation
22	767	BR	Compass mirror temperature signal
23	91	TN	CTIS front inflate solenoid activation
24	2	LG	Right front turn signal
25	140	OR	Reverse signal
26	3	LB	Left front turn signal
27	21	GY	Rear tail lamp feed
28	298	BR	Backup light switch feed
29	5	DG	Right rear turn signal
30	9	YL	Backup light activation
31	400	LG	Ignition +12v
32	151	GY	Cruise control ON/OFF signal
33	784	DB	T-case range switch input to the ECM (-)
34	809	TN	Brake light input for the ECM
35	242	PK	Ignition 1 Voltage
36	714	DB	Check throttle lamp activation
37	724	DG	APP sensor 3 signal
38	723	YL	APP sensor 3 (5 volt signal)
39	270	DG	Transmission temperature signal
40	520	WH	Brake lamp switch
41	644	YL	Tachometer signal
42	232	BARE	Shield
43			
44	861	BR	Rear Elocker activation signal (-)

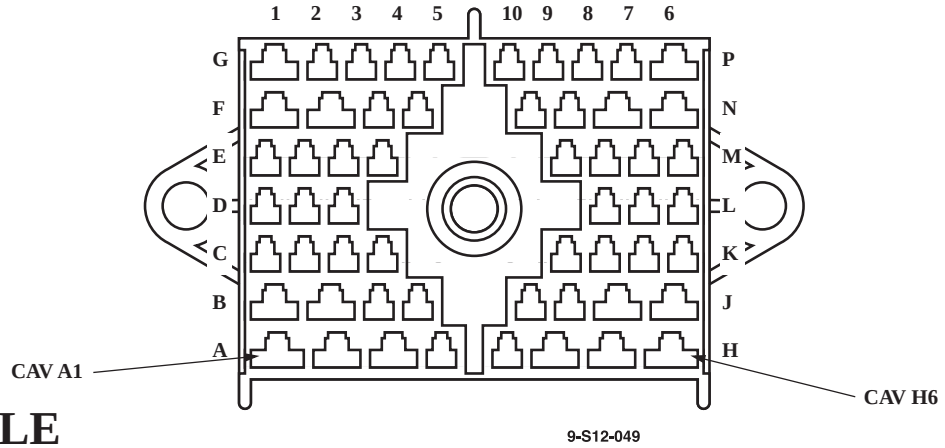
PIN	CKT	COLOR	CIRCUIT DESCRIPTION
45	862	YL	Rear Elocker activation signal (+)
46	212	DG	SAE J1939 CAN LO
47	211	YL	SAE J1939 CAN HI
48	37	YL	Batt feed to interior fuse box
49			
50	1072	BK	Shift interlock cable
51			
52	870	BR/WH	Front Elocker activation signal (-)
53	871	YL/BK	Front Elocker activation signal (+)
54	37	YL	Ignition relay feed
55	37	YL	Battery feed to interior accessories
56	667	PP	Over drive disable switch light activation (ground)
57	666	YL	Over drive disable request
58	665	DG	Tow haul switch light activation (ground)
59	664	LG	Tow Haul switch request
60			
61			
62	722	PP	Accelerator pedal position sensor 2 (+)
63	80	WH	Underhood lamp power
64	904	OR/BK	Alternator signal to instrument panel
65	941	TN	Lower windshield washer pump activation
66	580	BR	Fused battery input to the heated mirror.
67	136	BK	Vehicle speed sensor
68	353	YL	Speedometer signal (+)
69	46	WH	CTIS compressor relay activation
70			
71	718	DB	Accelerator pedal position sensor 1 signal (PWM)
72	520	WH	Brake lamp switch
73	717	TN	APP sensor 1 (5 volt signal)
74	338	DB	Wait lamp activation
75	720	TN	Accelerator pedal position sensor 1 (+)
76	198	TN	A/C request
77	663	PK	Range limited circuit
78	662	WH	High trans temp signal
79	38	RD	Head lamp switch feed
80	914	PP	Class II (J1850 data link)
81	658	BR	Check engine lamp activation
82	721	LB	Accelerator pedal position sensor 2 signal (PWM)
83	29	PK	Fuel gauge signal
84	786	RD	Fuel selector valve control
85	625	BR	Coolant temperature signal

PIN	CKT	COLOR	CIRCUIT DESCRIPTION
86	620	TN	Oil pressure reference signal
87	793	YL	Low coolant lamp activation
88	794	RD	Low air warning lamp activation
89	789	BR	Fuel selector valve control
90	210	DG	Transfer case lock lamp activation
91	725	GY	APP 3
92	719	BR	Accelerator pedal position sensor 1 (-)
93	152	DB	Cruise set/coast signal
94	153	LG	Cruise resume/accelerate signal
95	43	DB	Trailer Brake activation
96	195	YL	Headlight switch feed
97			
98	575	OR	ABS valve relay (+)
99	37	YL	start relay feed
100	37	YL	Ignition switch feed
101	688	RD	Rear window defrost feed
102	175	LB	Power window relay feed

56 WAY INSTRUMENT PANEL Location: Behind Instrument Panel C3 Male C3 Female

C3 MALE





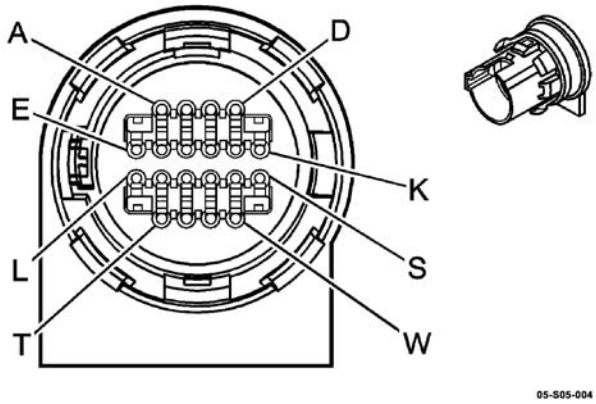
C3 FEMALE

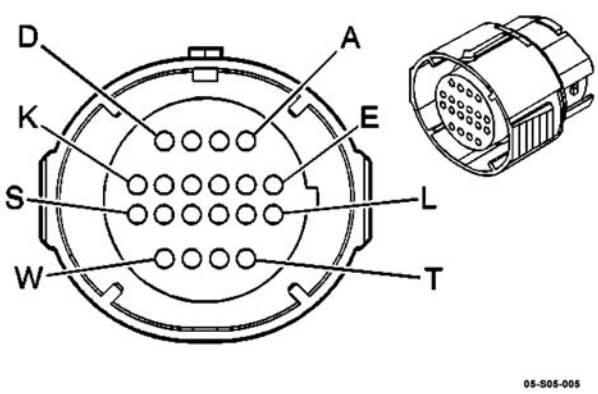
PIN	CKT	COLOR	DESCRIPTION
A1	195	YL	Headlight switch feed
A2	54	DG	Dome lamp switch feed
A3	53	DB	Dome lamps feed
A4	270	DG	Transmission temperature signal
B1	38	RD	Head lamp switch feed
B2	15	WH	Head lamp feed to dimmer module
B3	253	PP	Output +12v to switch
B4	254	WH	Low temp request to module
C1	450	PK	Seat belt lamp activation
C2	912	DB	“Bulb Check” input from the coolant/fuel module
C3	915	LB	+10 volt supply to the CTIS module
C4			
D1	338	DB	Glow plug wait lamp activation

PIN	CKT	COLOR	DESCRIPTION
D2	2	LG	Right turn indicator lamp activation
D3	961	PP	TT4 indicator lamp activation
E1	42	BR	Brake indicator lamp activation
E2	603	RD	ABS indicator lamp activation
E3	793	YL	Low washer fluid activation
E4	255	OR	High temp request to heated seat module
F1	17	PP	+ from dimmer module
F2	19	YL	Power supply to dimmer module
F3	658	BR	Check engine lamp activation
F4	327	YL	Drain Filter lamp activation
G1	517	OR	Power mirror switch battery feed
G2	210	DG	Transfer case lock lamp activation
G3	794	RD	Low coolant lamp activation
G4	879	WH/BK	Warning light activation
G5	714	DB	Check throttle lamp activation
H6	14	LB	Head lamp switch feed
H7	65	YL	Ignition feed to intermittent wiper switch
H8	61	RD	High speed windshield wiper signal
H9	12	OR	High Beam indicator lamp activation
J6	63	DG	Low speed windshield wiper signal
J7	27	OR	Intermittent wiper signal
J8	948	DG/YL	Left hand power mirror up/down signal
J9	947	DB/YL	Left hand power mirror left/right signal
K6	942	OR/BK	Left hand power mirror common +/–
K7	3	LB	Left turn indicator lamp activation
K8	944	OR	Right hand power mirror common +/–
K9	644	YL	Tachometer signal
L6	904	OR/BK	Malfunction indicator Lamp (MIL)
L7	620	TN	Oil pressure reference signal
L8	952	DB	Right hand power mirror left/right signal
M6	789	BR	Fuel selector valve control
M7	786	RD	Fuel selector valve control
M8	785	GY	Fuel selector switch feed +12v fuse 3B (Interior fuse box)
M9	953	DG	Right hand power mirror up/down signal
N6	59	BK	Ground
N7	30	GY	Ignition feed to gauges
N8	941	TN	Windshield wiper washer pump activation
N9	945	BR	Intermittent wiper relay activation
P6	55	OR	Rear cargo lamp activation
P7	29	PK	Fuel gauge signal
P8	625	BR	Coolant temperature signal

PIN	CKT	COLOR	DESCRIPTION
P9	353	YL	Speedometer signal
P10	878	LG/BK	Front ELocker time out light signal

20 WAY TRANSMISSION PASS-THROUGH location: transmission, left

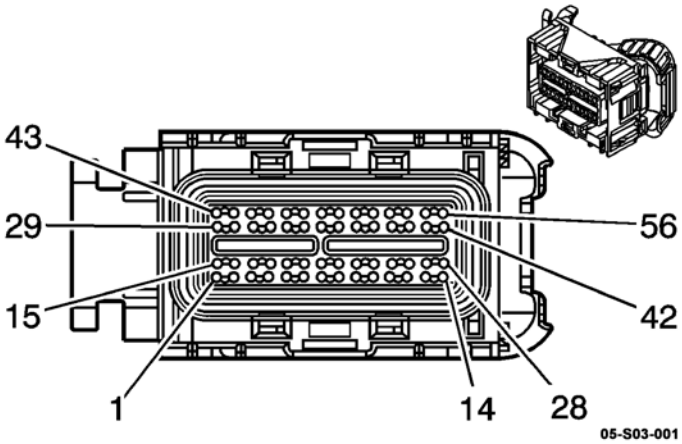




C34 MALE **C34 FEMALE**

PIN	CKT	COLOR	DESCRIPTION
A	777	DG	Shift solenoid C valve control
B	778	DB	Shift solenoid D valve control
C	782	TN	+12 volt reference
D	769	DB	Fluid pressure switch signal C
E	771	WH	Fluid pressure switch signal E
F	770	PK	Fluid pressure switch signal D
G	923	TN	TFT sensor signal
H	594	DG	Ground
J	780	WH	TCC PWM solenoid valve control
K	772	DG	Fluid pressure switch reverse signal
L	773	YL	PPC solenoid A valve high control
M	774	WH	PPC solenoid A valve low control
N	775	PK	PPC solenoid B valve high control
P	776	OR	PPC solenoid B valve low control
R	781	DB	Modulated main pressure
S	783	DG	TCC PWM solenoid supply voltage
T	272	YL	Trans ID
U			
V			
W	779	GY	Shift solenoid E valve control

56 WAY ECM J1 (BLUE) LOCATION: DRIVERSIDE UNDER ECM

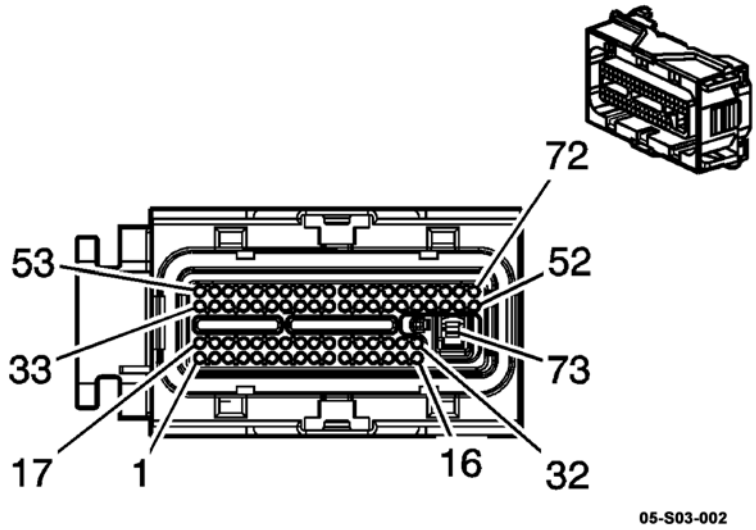


C75 Female

PIN	CKT	COLOR	DESCRIPTION
1	211	YL	SAE J1939 CAN HI
2	212	DG	SAE J1939 CAN LO
3	620	TN	Oil pressure reference signal
4	270	GN	Transmission temperature signal
5	1037	RD	+12 Battery voltage
6	625	BR	Coolant temperature signal
7	255	OR/BK	Baro sensor ground
8	156	PK/BK	Cam sensor ground
9	244	BK	Ground
10	242	PK	Ignition 1 Voltage
11			
12			
13	654	DB	MAF sensor signal
14	105	BR/WH	EGR valve position signal
15	914	PP	Class II (J1850 data link)
16			
17	720	TN	5 volt reference
18	243	PK	+12v Ignition feed ECM
19	242	PK	Ignition 1 voltage
20	1037	RD	Battery positive voltage
21			
22			
23	367	GY	5 volt reference turbo vein position sensor
24			
25			
26	338	DB	Wait to start indicator control

PIN	CKT	COLOR	DESCRIPTION
27			
28	721	LB	APP sensor 2 (5 volt signal)
29			
30			
31	612	WH/BK	Baro pressure (5 volt signal)
32	717	TN	APP sensor 1 (5 volt signal)
33	508	TN	Fuel rail pressure sensor (5 volt signal)
34	617	GY	Engine oil pressure (5 volt signal)
35			
36	723	YL	APP sensor 3 (5 volt signal)
37	513	YL	Fuel pressure regulator solenoid control
38			
39	614	GY	MAP sensor (5 volt signal)
40	510	PP/WH	Fuel pressure regulator solenoid control
41			
42	514	PK	Generator field duty cycle signal
43			
44			
45			
46	353	YL	Front differential
47	106	GY	EGR valve (5 volt signal)
48			
49			
50	254	RD	CAM sensor (5 volt signal)
51	511	YL	Fuel pressure regulator solenoid control
52	516	GY/BK	FICM relay control
53	136	BK	
54	512	PP/WH	Fuel pressure regulator solenoid supply voltage
55			
56	514	PK	Ignition voltage +12v

72 WAY ECM J2 (BLACK) LOCATION: DRIVERSIDE UNDER ECM



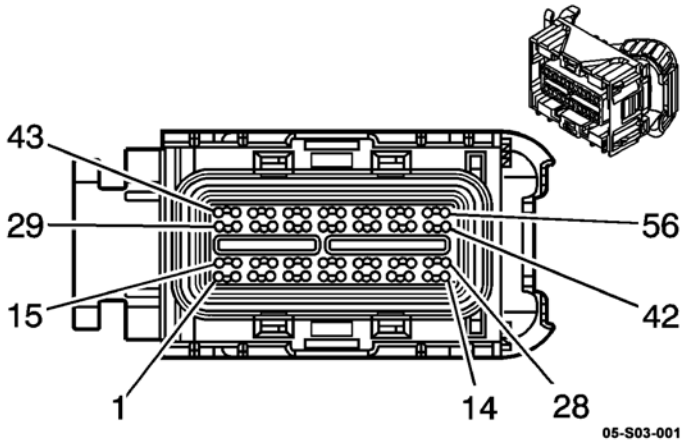
C76 Female

PIN	CKT	COLOR	DESCRIPTION
1			
2	507	OR/BK	Fuel rail pressure signal
3			
4			
5	232	BR	CAN shield
6			
7	784	DB	T-case range switch input to the ECM (-)
8	107	BK	EGR stepper motor
9			
10			
11			
12			
13			
14	624	GY	Coolant temperature sensor
15			
16			
17			
18			
19	718	DB	APP sensor 1 signal
20			
21	661	GN	Transmission control module MIL request
22			
23	615	LG	MAP sensor signal

PIN	CKT	COLOR	DESCRIPTION
24	724	DG	APP sensor 3 signal
25	619	TN/WH	Oil pressure sensor signal
26			
27	324	YL	Fuel temperature sensor signal
28	257	LG	Crank shaft sensor signal
29	251	BK	MAF sensor ground
30	616	OR/BK	MAP
31	368	WH	VNT valve position
32			
33	108	OR/BK	EGR valve high control
34	244	BK	Ground
35	109	LG/BK	EGR valve low control
36	244	BK	Ground
37			
38			
39	618	BK	Engine oil pressure
40	719	BR	APP 1
41			
42	509	YL	Fuel pressure regulator sensor signal
43			
44	369	BR	VNT position sensor
45			
46	613	GY/BK	Baro sensor signal
47			
48			
49	362	DB	Turbocharger vane position control solenoid valve high
50	363	WH	Turbocharger vane position control solenoid valve low
51			
52	632	PK/BK	Injector 3 request
53	110	OR/BK	EGR valve, high control
54	722	PP	APP 2
55	111	LG/BK	EGR valve, low control
56	725	GY	APP 3
57			
58	250	BK	Intake air temperature sensor
59			
60	520	WH	Brake lamp switch
61	809	TN	TCC brake switch/cruise control release signal
62			
63	660	LB	57x signal to the FICM
64			

PIN	CKT	COLOR	DESCRIPTION
65	631	LG/BK	Fuel injector 2 request
66	636	RD/BK	Injector 7 request
67	623	YL	Engine coolant temperature signal
68	637	DB/BK	Fuel injector 8 request
69	633	LB/BK	Injector 4 request
70	634	BK/WH	Injector 5 request
71	635	YL/BK	Fuel injector 6 request
72	630	BK	Fuel injector 1 request
73	1057	BK	Ground

56 WAY ECM (GRAY) LOCATION: DRIVERSIDE UNDER ECM

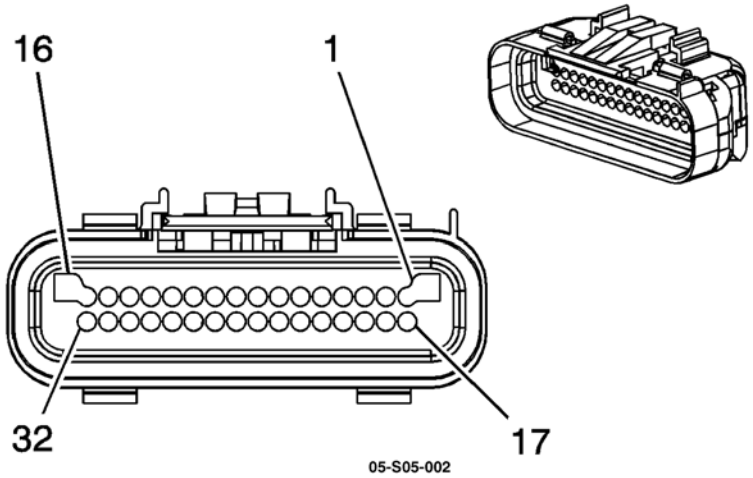


C77 Female

PIN	CKT	COLOR	DESCRIPTION
1			
2			
3			
4			
5			
6			
7			
8	243	PK	+12v Ignition input
9			
10	514	PK	Ignition 1 Voltage
11			
12	497	YL	Vehicle speed sensor high
13			
14	514	PK	Ignition 1 Voltage
15			

PIN	CKT	COLOR	DESCRIPTION
16			
17			
18	331	WH	Crank request
19	152	DB	Cruise control SET/COAST switch signal
20	439	YL	A\C request
21			
22	153	LG	Cruise RESUME\ACCELERATE
23	498	DG	Vehicle speed sensor low
24	653	YL	Intake air temperature signal
25			
26			
27			
28	714	DB	Check throttle lamp activation
29			
30	151	GY	Cruise control “ON” switch signal
31	330	PP	PRNDL switch
32			
33			
34			
35	332	BK	Starter relay
36			
37	644	YL	Tach signal
38			
39			
40	658	BR	Malfunction indicator lamp
41	410	LG	A\C clutch relay
42			
43	258	YL/BK	Crank sensor
44	244	BK	Ground
45	140	OR	Transmission reverse switch
46			
47			
48	252	BR	Fuel temperature sensor
49			
50			
51	253	BR/WH	Cam sensor signal
52	266	DB/WH	Crank sensor signal
53			
54			
55			
56			

32 WAY TCM (GRAY) LOCATION: DRIVERSIDE ON TOP OF TCM

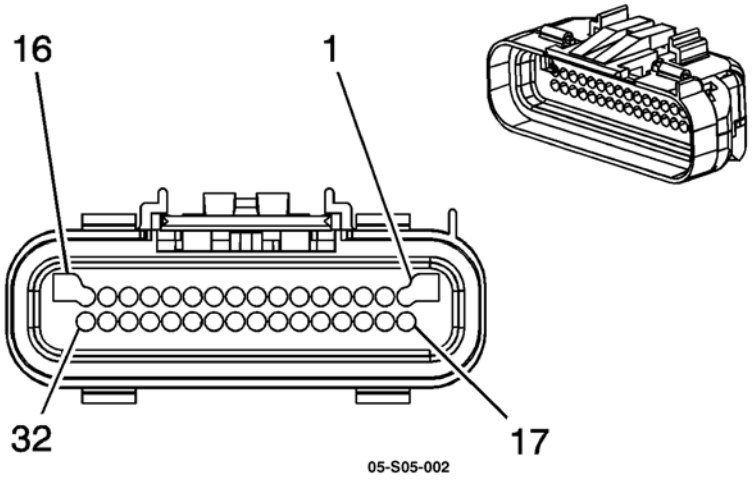


C78 Female

PIN	CKT	COLOR	DESCRIPTION
1	244	BK	Ground
2	243	PK	+12v Ignition input
3	1037	RD	+12v Battery input
4	243	PK	+12v Ignition input
5	244	BK	Ground
6			
7	520	WH	TCC brake switch/cruise control release signal
8			
9	784	DB	T-case range switch input to the ECM (-)
10	664	LG	Tow Haul switch request
11			
12	666	YL	Over drive disable request
13	1012	PK	ABS activation signal (disables TCC during ABS activation)
14			
15			
16			
17			
18			
19	665	DG	Tow haul switch light activation (ground)
20	667	PP	Over drive disable switch light activation (ground)
21			
22			
23	663	PK	Range limited circuit
24	662	WH	High trans temp signal

PIN	CKT	COLOR	DESCRIPTION
25	661	GN	Transmission control module MIL request signal
26			
27			
28	244	BK	Ground
29	211	YL	SAE J1939 CAN HI
30	914	PP	Class II (J1850 data link)
31	232	---	Shield
32	212	DG	SAE J1939 CAN LO

32 WAY TCM (RED) LOCATION: DRIVERSIDE ON TOP OF TCM

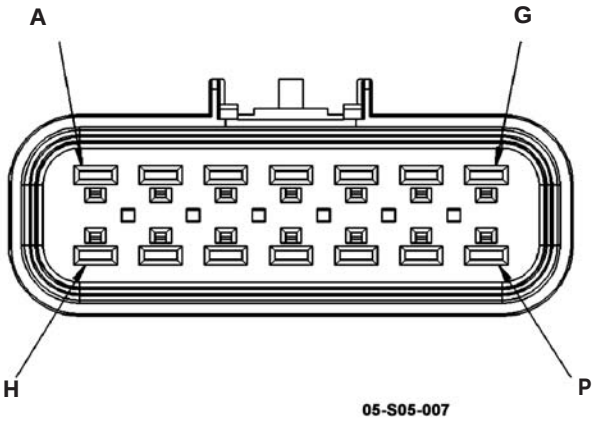


C79 Female

PIN	CKT	COLOR	DESCRIPTION
1	769	DB	Fluid pressure switch signal C
2	770	PK	Fluid pressure switch signal D
3	771	WH	Fluid pressure switch signal E
4	772	DG	Fluid pressure switch reverse signal
5	591	DB	Transmission range switch signal A
6	590	YL	Transmission range switch signal B
7	592	GY	Transmission range switch signal C
8	593	WH	Transmission range switch signal P
9			
10	923	TN	TFT sensor signal
11			
12			
13	493	OR	Transmission turine speed switch signal

PIN	CKT	COLOR	DESCRIPTION
14	494	DB	Transmission turbine speed switch low reference
15	1000	WH	Vehicle speed sensor high
16	1001	LB	Transmission OSS Low
17	495	TN	AT ISS High signal
18	496	OR	AT ISS low signal
19			
20	594	DG	Ground
21	272	YL	Trans ID
22	773	YL	PPC solenoid A valve high control
23	774	WH	PPC solenoid A valve low control
24	775	PK	PPC solenoid B valve high control
25	776	OR	PPC solenoid B valve low control
26	777	DG	Shift solenoid C valve control
27	778	DB	Shift solenoid D valve control
28	779	GY	Shift solenoid E valve control
29	780	WH	TCC PWM solenoid valve control
30	781	DB	Modulated main pressure
31	782	TN	+12 volt reference
32	783	DG	TCC PWM solenoid supply voltage

14 WAY ENGINE POWER HARNESS LOCATION: ON TOP OF ENGINE



C80 Female

PIN	CKT	COLOR	DESCRIPTION
A			
B	198	TN	A/C request
C	290	PK	Alternator field wire
D	251	BK	Ground circuit to MAF (ECM supplied)

PIN	CKT	COLOR	DESCRIPTION
E	439	YL	A\C request
F	654	DB	MAF sensor
G	904	OR/BK	Alternator signal to instrument panel
H	348	BR	AC compressor signal
J	250	BK	Intake air temperature sensor
K	653	YL	Intake air temperature signal
L	794	RD	Low coolant lamp activation
M	239	PK	Engine ignition feed
N	34	LB	Starter solenoid signal
P	34	LB	Starter solenoid signal

24 WAY ENGINE CONNECTOR HARNESS LOCATION: ON TOP OF ENGINE

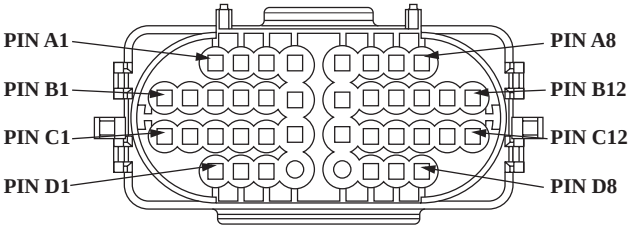
NOT ILLUSTRATED

C81 Female

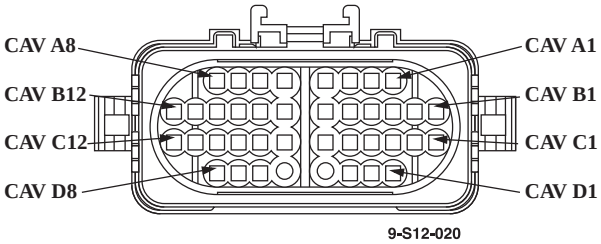
PIN	CKT	COLOR	DESCRIPTION
A1			
A2			
A3	105	BR/WH	EGR valve position signal
A4			
A5			
A6	612	WH/BK	Baro pressure (5 volt signal)
A7	255	OR/BK	Baro sensor
A8	613	GY/BK	Baro sensor signal
B1	212	DG	SAE J1939 CAN LO
B2			
B3	107	BK	EGR stepper motor
B4	362	DB	Turbocharger vane position control solenoid valve high
B5	363	WH	Turbocharger vane position control solenoid valve low
B6	367	GY	5v Ref for the turbo vein position sensor
B7	369	BR	VNT position sensor
B8	368	WH	VNT valve position

PIN	CKT	COLOR	DESCRIPTION
C1	211	YL	SAE J1939 CAN HI
C2			
C3	106	GY	EGR valve (5 volt signal)
C4	108	OR/BK	EGR valve high control
C5	109	LG/BK	EGR valve low control
C6	614	GY	MAP sensor (5 volt signal)
C7	616	OR/BK	MAP
C8	615	LG	MAP sensor signal

38 WAY ENGINE CONNECTOR HARNESS LOCATION: ON TOP OF ENGINE



C82 MALE

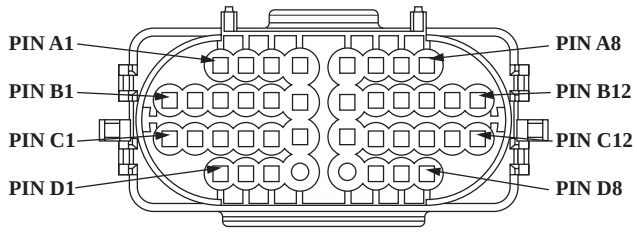


C82 FEMALE

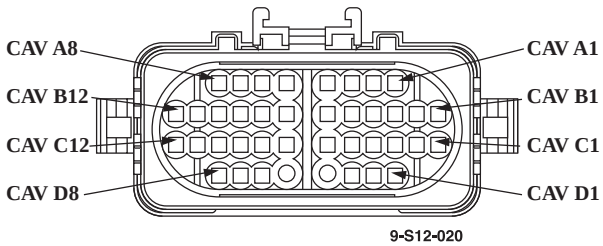
PIN	CKT	COLOR	DESCRIPTION
A1	239	PK	Engine ignition feed
A2			
A3			
A4	1042	RD	Ignition 1 voltage
A5	1042	RD	Ignition 1 voltage
A6			
A7	623	YL	Engine coolant temperature signal
A8	624	GY	Coolant temperature sensor
B1	631	LG/BK	Fuel injector 2 request
B2	636	RD/BK	Injector 7 request
B3	254	RD	CAM sensor (5 volt signal)
B4	253	BR/WH	Cam sensor signal ref 4X
B5	156	PK/BK	Cam sensor ground
B6			
B7			
B8	258	YL/BK	Crank sensor
B9	256	DB/WH	Crank sensor signal
B10	257	LG	Crank shaft sensor signal

PIN	CKT	COLOR	DESCRIPTION
B11	635	YL/BK	Fuel injector 6 request
B12	632	PK/BK	Injector 3 request
C1	630	BK	Fuel injector 1 request
C2	634	BK/WH	Injector 5 request
C3	508	TN	Fuel rail pressure sensor (5 volt signal)
C4	507	OR/BK	Fuel rail pressure signal
C5	509	YL	Fuel pressure regulator sensor signal
C6			
C7			
C8	660	LB	57x signal to the FICM
C9	511	YL	Fuel pressure regulator solenoid control
C10	510	PP/WH	Fuel pressure regulator solenoid control
C11	637	DB/BK	Fuel injector 8 request
C12	633	LB/BK	Injector 4 request
D1	324	YL	Fuel temperature sensor signal
D2	252	BR	Fuel temperature sensor
D3			
D4			
D5			
D6	619	TN/WH	Oil pressure sensor signal
D7	618	BK	Engine oil pressure
D8	617	GY	Engine oil pressure (5 volt signal)

38 WAY TRANSMISSION CONNECTOR HARNESS LOCATION: ON DRIVERS SIDE OF ENGINE



C83 MALE

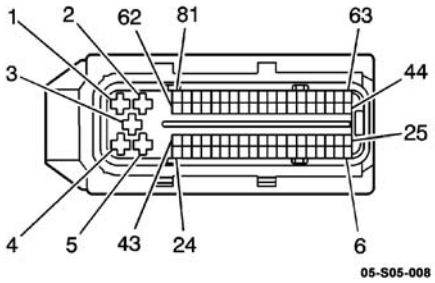


C83 FEMALE

PIN	CKT	COLOR	DESCRIPTION
A1	769	DB	Fluid pressure switch signal C
A2	770	PK	Fluid pressure switch signal D
A3	771	WH	Fluid pressure switch signal E
A4	782	TN	+12 volt reference

PIN	CKT	COLOR	DESCRIPTION
A5	783	DG	TCC PWM solenoid supply voltage
A6	772	DG	Fluid pressure switch reverse signal
A7	591	DB	Transmission range switch signal A
A8	590	YL	Transmission range switch signal B
B1	592	GY	Transmission range switch signal C
B2	593	WH	Transmission range switch signal P
B3	923	TN	TFT sensor signal
B4	493	OR	Transmission turine speed switch signal
B5	494	DB	Transmission turbine speed switch low reference
B6	331	WH	Crank request
B7	298	BR	Backup light switch feed
B8	497	YL	Vehicle speed sensor high
B9	498	DG	Vechicle speed sensor low
B10	495	TN	AT ISS High signal
B11	496	OR	AT ISS low signal
B12	594	DG	Ground
C1	272	YL	Trans ID
C2	773	YL	PPC solenoid A valve high control
C3	774	WH	PPC solenoid A valve low control
C4	775	PK	PPC solenoid B valve high control
C5	776	OR	PPC solenoid B valve low control
C6	33	WH	neutral safety switch feed
C7	140	OR	Reverse signal
C8	777	DG	Shift solenoid C valve control
C9	778	DB	Shift solenoid D valve control
C10	779	GY	Shift solenoid E valve control
C11	780	WH	TCC PWM solenoid valve control
C12	781	DB	Modulated main pressure
D1	784	DB	T-case range switch input to the ECM (-)
D2	210	DG	Transfer case lock lamp activation
D3	330	PP	PRNDL switch
D4			
D5			
D6	1000	WH	Transmission OSS High
D7	1001	LB	Transmission OSS Low
D8			

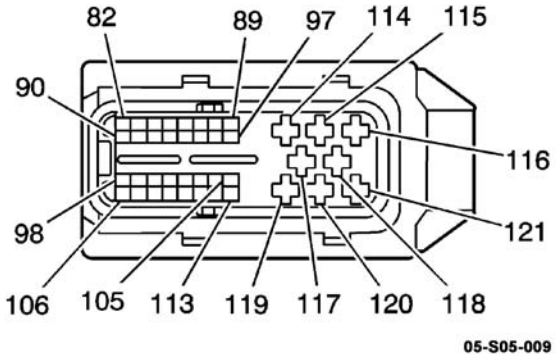
80 WAY FICM CONNECTOR LOCATION: ON THE FUEL INJECTION CONTROL MODULE



C86 Female

PIN	CKT	COLOR	DESCRIPTION
1	IC18	WH/LG	Fuel injector 4 command
2	IZ17	BK/YL	Ground G1
3	IC13	OR	Injectors 1-4-6-7 supply voltage
4	IC15	RD/LG	Fuel injector 1 command
5	1042	PK	Ignition 1 voltage
6-43			
44	633	LB/BK	Injector 4 request
45	634	BK/WH	Injector 5 request
46			
47	632	PK/BK	Injector 3 request
48	636	RD/BK	Injector 7 request
49-58			
59	IC20	DB/WH	Fuel injector 6 command
60	IC520	DB/WH	Fuel injector 6 command
61	IC21	WH/RD	Fuel injector 7 command
62	IC521	WH/RD	Fuel injector 7 command
63	637	DB/BK	Fuel injector 8 request
64	635	YL/BK	Fuel injector 6 request
65			
66	630	BK	Fuel injector 1 request
67	631	LG/BK	Fuel injector 2 request
68-81			

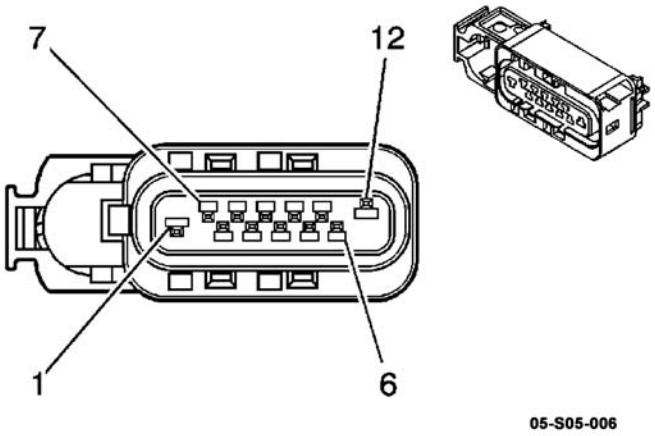
40 WAY FICM CONNECTOR LOCATION: ON THE FUEL INJECTION CONTROL MODULE



C87 Female

PIN	CKT	COLOR	DESCRIPTION
82-89			
90	212	GR	SAE J1939 CAN LO
91	211	YL	SAE J1939 CAN HI
92			
93			
94	660	LB	Engine speed signal to the FICM
95-113			
114	IZ18	BK/GR	Ground G1
115	IC17	WH/LB	Fuel injector 3 command
116	IC19	RD/LG	Fuel injector 5 command
117			
118	IC60	RD/WH	Injectors 2-3-5-8 supply voltage
119	1042	PK	Ignition 1 voltage
120	IC22	WH/GR	Fuel injector 8 command
121	IC16	WH/YL	Fuel injector 2 command

12 WAY NEUTRAL SAFETY BACKUP SWITCH CONNECTOR LOCATION: ON SIDE OF THE TRANS.



C88 Female

PIN	CKT	COLOR	DESCRIPTION
1	331	WH	Crank request
2			
3	330	PP	PRNDL switch
4	590	YL	Transmission range switch signal B
5	591	DB	Transmission range switch signal A
6	592	GY	Transmission range switch signal C
7	594	DG	Ground
8	593	WH	Transmission range switch signal P
9			
10	140	OR	Reverse signal
11	298	BR	Backup light switch feed
12	33	WH	neutral safety switch feed

Section 3 Fuel, Emissions, and Exhaust

TABLE OF CONTENTS

Air Cleaner Assembly
- Air Cleaner Filter Element Service 3-48

Air Cleaner Service 3-46
Air Horn 3-49
- Air Induction Hose Replacement 3-49

Air Intake Vent Line Replacement 3-51
Crankcase Depression Regulation Valve 3-53
Essential Tools 3-61
Exhaust System
- Catalytic Converter Replacement 3-58
- Turbo Down Pipe Replacement 3-58

Fuel Filter 3-12
Fuel Injectors 3-29
Fuel Manager (Filter-Water Separator) 3-10
Fuel Quality
- Contamination 3-7
- Diagnosis 3-3
- Fuel Oil Specific Gravity Requirements 3-8

Fuel Selector Valve 3-33
Fuel Tank
- Auxiliary 3-43
- Fuel Level Transmitter 3-41
- Fuel Tank Vent Line Service 3-36
- Lines and Valves 3-32
- Main 3-39
- Main/Auxiliary Tank Fuel Line 3-38
- Vent Filter Replacement 3-36

Injection Pump
- Fuel Injection Control Module 3-20
- Removal/Installation 3-14

Weathercap Replacement 3-49

FUEL SYSTEM GENERAL

Description

The fuel tanks store the fuel supply. A mechanical fuel injection pump, located below the engine intake, draws fuel through the fuel injector control module and the fuel filter. The fuel is used as a coolant for the fuel injector control module. The fuel pump output is controlled by the ECM, and provides fuel at the pressure needed by the fuel injectors. The fuel injectors supply fuel directly to the combustion chambers of the engine. A separate pipe returns unused fuel through a fuel cooler to the fuel tank.

Speci cations

Recommended Fuel	Diesel #2
Injection Pump Type	Bosch Common Rail
Manufacturer	Bosch
Nozzles	Bosch Pintle type
Opening Pressures	5000 - 23,000 psi

Fuel System Diagnostics

Fuel system diagnosis should begin with a preliminary inspection followed by a road test to confirm existence of a problem. Preliminary inspection consists of visual checks designed to rule out faults caused by leaks, fuel line damage, or loose electrical connections.

Diagnostic Aids

Important: Since it is difficult to diagnose intermittent conditions, it is critical that every step of the diagnostic table be performed with thoroughness. Since many failures can cause similar symptoms.

It is also important to perform visual checks for a pinched harness (at the intake manifold and turbocharger), and for proper wiring connections at the engine connectors.

An intermittent problem can be caused by the following:

- Poor connections
- Rubbed through wire insulation
- Broken wire inside the insulation

Road Test

1. Note the battery voltage. Low voltage can cause ECM power-up and initialization problems. Battery voltage should be no lower than 11.5 volts for satisfactory operation.
2. Connect the scan tool to the diagnostic link connector. Set the tool to record the fault codes, or have a helper use the tool to interrogate the system during the test.
3. Start the engine and check the idle operation. Note any faults such as rough idle, stalling or excessive smoke.
4. Apply the service brake and shift the transmission into a drive range. Note if the engine stalls, runs rough or another fault occurs.
5. Drive the vehicle on the road at the posted speed limits. Note the operation under light and heavy acceleration, and at normal cruise speeds. Note the faults such as surge, miss, vibration, noise, low power, smoke (blue, black, white).
6. Shift into neutral at cruise speed and note the engine operation. If a vibration or noise was experienced but it now stops, the problem may be with the drive belt, the engine mount, accessory, U-joint or the torque converter.
7. Return to the shop and note any fault codes recorded by the ECM. If a fuel system fault was noted during the road test, refer to the diagnosis charts, perform the fuel system tests and check the system electrical components with the scan tool.

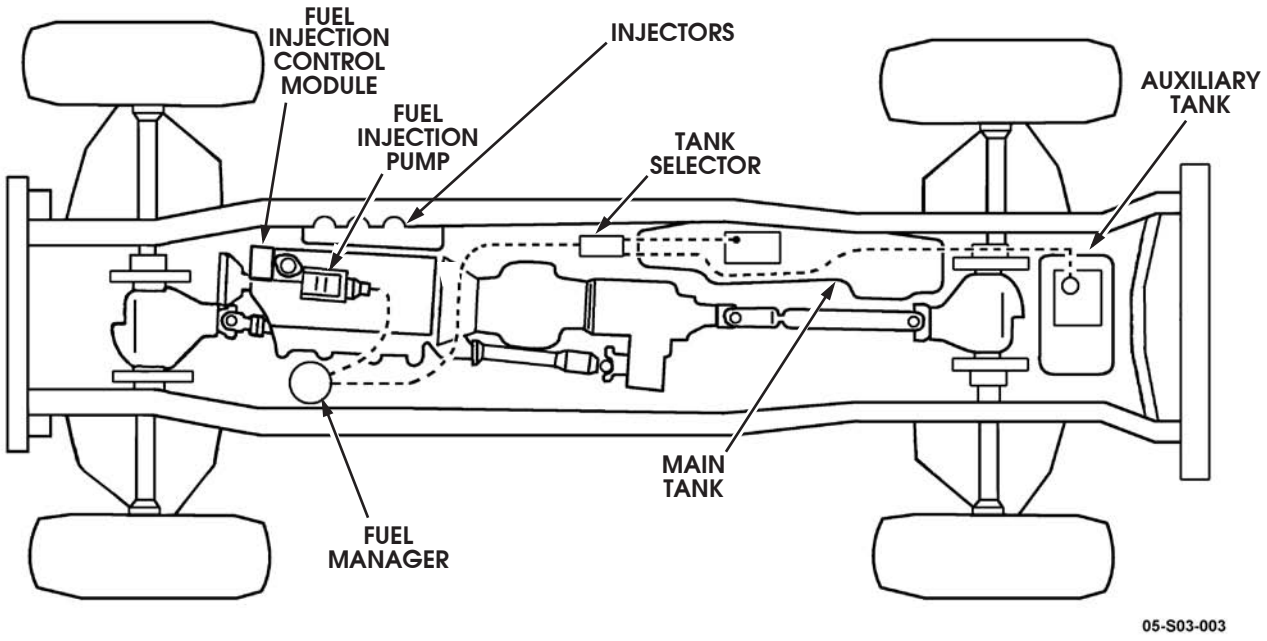


Figure 3-1: Fuel System Components

Fuel System Diagnosis

Steps	Action	Value(s)	Yes	No
1	Did you preform the Powertrain On-Board Diagnostic (OBD) System Check?	—	Go to step 2.	Go to the Diagnostic systems check.
2	Check the condition of the batteries. Is the condition of the batteries OK?	—	Go to step 3.	Go to step 9.
3	Check for adequate fuel in the fuel tank. Is the fuel at an adequate level?	—	Go to step 4.	Go to step 9.
4	Check the quality of the fuel. Refer to chapter 3 Fuel, Emissions and Exhaust. Is the fuel quality OK?	—	Go to step 5.	Go to step 9.
5	Check for the proper cranking speed. Is the engine cranking speed OK?	—	Go to step 6.	Go to step 9.
6	Check for a restriction in the fuel return system. Does the fuel return system operate properly?	—	Go to step 7.	Go to step 9.
7	Check for air in the fuel system. Is there any air in the fuel system?	—	Go to step 10.	Go to step 9.
8	Check for an improper connection or corrosion at the engine ground (G1). Was a problem found and repaired?	—	Go to step 16.	Go to step 13.
9	Make the appropriate repairs. Is the action complete?	—	Go to step 10.	—
10	Verify the condition has been repaired. Is the action complete?	—	Injection System OK.	Go to Driveability Symptoms.

Fuel System Driveability Symptoms

PROBLEM	POTENTIAL CAUSE	CORRECTION
Hard Starting	1. Driver/owner not following the recommended start procedure.	1. Remind the driver/owner of the required procedure. Demonstrate the procedure if necessary.
	2. Fuel contaminated, low quality or the wrong the fuel.	2. Drain off sample at the fuel filter drain plug. Flush the tank, lines, and the filter if the fuel is contaminated, wrong grade or type, suspect quality or shows wax buildup.
	3. The air filter is plugged.	3. Remove and clean the filter, housing, air horn and the inlet hose. Replace the filter if plugged.
	4. Excessive water in the fuel filter.	4. Drain off the water at the drain plug. Then remove, clean, and reinstall the filter.
	5. The fuel return, drain or the vent line is restricted, plugged or damaged.	5. Check the lines for damage. Verify the flow with compressed air. Repair or replace the lines as necessary.
	6. The coolant temperature sensor has a fault.	6. Inspect the engine coolant temperature (ECT) sensor. Use the scan tool to compare the ECT with the ambient air temperature on a cold engine. If the coolant temperature reading is more than 5 degrees more or less than the ambient air temperature on a cold engine, inspect for a high resistance in the coolant sensor circuit or the sensor itself.
	7. A glow plug fault.	7. Test the voltage to and from the relay/controller, and at the plugs. Repair the wiring, replace the relay/controller, or replace the glow plug(s) as needed. Refer to the test procedures in this section and in sections 2 and 12.
	8. No cranking signal to the ECM	8. Test with a scan tool. Look for a bad ground, connections, or damaged/failed crankshaft position sensor.
	9. Exhaust system is restriction.	9. Look for damaged pipes, converter, especially on the vehicles used off road.
	10. Low engine cranking speed.	10. Check state of charge of the batteries, load test and check the connections. Refer to the test procedures in Section 12. Check the engine oil viscosity to ensure it is correct for the ambient temperature. Refer to the specifications in Section 1. Check the starter draw to determine if the starter is dragging. Refer to the test procedure in Section 12.
No Start Condition (engine cranks but will not run)	1. Excessive amount of water or wax buildup in the system.	1. Draw off a sample at the drain plug. Drain and flush the system if necessary.
	2. Blown fuse.	2. Replace the fuse. Check for shorts-grounds in the affected circuit.

Fuel System Driveability Symptoms (Continued)

PROBLEM	POTENTIAL CAUSE	CORRECTION
	3. Engine fault: • broken camshaft • damaged injection pump gears • timing gear failure	3. Inspect and repair as needed.
	4. Fuel tank selector valve problem.	4. Replace the valve if it won't switch from main to auxiliary and back.
	5. No inject signal from the ECM.	5. Run the scan tool test and replace the failed sensor, harness wire or the connector.
	6. ECM ground or feed circuit fault (on ground or ignition voltage reference signal).	6. Confirm with the scan tool. Use the multi meter to locate the fault.
	7. ECM fault.	7. Confirm with the scan tool before replacement.
Engine Starts then Stalls	1. Air leak in the fuel feed line.	1. Inspect the lines and repair as needed.
	2. Glow plug fault (cold ambient temperature).	2. Test and repair the wiring, or replace the failed glow plugs or the relay/controller.
	3. Restriction in fuel tank vent or return lines.	3. Inspect and clear the restriction. Replace the cap vent or the lines as needed.
Low Power, Sluggish Acceleration	1. Contaminated or low-quality fuel.	1. Drain, flush and refill the fuel system.
	2. High fuel temperature.	2. Normal condition in high ambient.
	3. Restriction in the air intake system.	3. Remove and clean the filter, housing, weathercap, hose, air horn.
	4. Fuel tank vent or return line restriction.	4. Clear the restrictions, replace lines.
	5. Exhaust system restriction.	5. Inspect the entire system for damage and repair as needed. If the vehicle is used for off-road operation, look for kinking, bent or flattened pipes.
	6. Air leak at the injector or line.	6. Tighten loose fittings or replace the lines if necessary.
	7. Brake drag.	7. Inspect the brake components. Look for seized or binding caliper piston, master cylinder problem, or failed hydro-boost.
	8. Torque converter stator problems. Will cause high fuel consumption and require more than normal throttle opening for acceleration.	8. Perform the torque converter diagnosis procedure in SECTION 5.
	9. Engine compression low.	9. Run a compression test. Repair valves, cam, rings as needed.
	10. Turbo diesel electronic accelerator fault such as short, ground, loose connection indicate potentiometer failure.	10. Check the pedal potentiometer wires and connections. Test with a scan tool if the check throttle light is on. Repair the wiring, or replace the pedal assembly.

Fuel System Driveability Symptoms (Continued)

PROBLEM	POTENTIAL CAUSE	CORRECTION
	11. One or more injectors failing.	11. Test the injectors. Replace the faulty injectors as needed.
	12. Air leak at the intake manifold.	12. Locate with soap and water solution (or oil). Tighten the bolts, replace the gaskets, or replace the manifold if required.
	13. Turbocharger inoperative or no boost.	13. Check the boost output. Replace the turbocharger if compressor or turbine wheel vanes are broken, chipped, or if the compressor shaft is seized/ broken.
	14. Sensor failure (coolant or air temp, baro or boost sensors, etc.).	14. Locate with a scan tool. Test and replace as needed.
	15. ECM signal voltage too low.	15. Check the battery voltage and the generator output. Repair or replace the parts as needed if voltage is below 10 or above 16.
	16. Injection pump fault.	16. Replace the pump.
Knock-Ping Under Acceleration.	1. Contaminated, incorrect or low quality fuel.	1. Drain, flush and refill the fuel system.
	2. Air leak in the fuel delivery system.	2. Inspect the injector line fittings. Tighten any loose fittings. Check all the fuel supply lines for leaks.
	3. Engine overheat caused by low coolant level.	3. Repair any leaks and add coolant.
	4. Coolant and/or air temperature sensor fault.	4. Check with the scan tool and replace as needed.
	5. Worn valve seals or guides allowing oil into combustion chambers.	5. Repair the engine as required.
	6. Carbon buildup on pistons and in chambers as a result of substandard fuel, additives or oil entering the chamber past worn rings or through valve guides.	6. Use combustion chamber conditioner to break down the carbon. Engine disassembly will be necessary if the conditioner is not effective.
Black, White, or Blue Smoke at Idle and/or Under Load	1. Incorrect or substandard fuel.	1. Drain and refill the tanks with the correct fuel.
	2. Glow plug fault (white smoke at cold start-up).	2. Test and replace the failed plugs, wires, or relay/ controller.
	3. Worn piston rings, valve guides or stem seals (blue smoke) allowing oil into combustion chamber. High oil consumption may also be noted by owner.	3. Repair the guides, replace the seals or replace the rings as needed.
	4. Over rich mixture (black smoke) caused by stuck injector.	4. Test and replace any injectors that fail the fuel injector balance test with TECH 2 (Refer to section 2)

Fuel System Driveability Symptoms (Continued)

PROBLEM	POTENTIAL CAUSE	CORRECTION
Rough Idle and/ or Hesitation Under Hard Acceleration	1. Substandard fuel.	1. Drain and replace the fuel.
	2. Air leak in fuel line or injector.	2. Locate and correct the leak.
	3. Fuel filter cap or tank vent restriction.	3. Replace the cap or the vent hose as required.
	4. Injector fault.	4. Locate and replace the faulty injector.
	5. Intake manifold leak.	5. Replace the manifold or the gaskets as needed.

Fuel System Contamination

Organic Contamination

Diesel fuel systems are susceptible to fungi and other micro-organism infestation when water is present. These fungi can grow into long strings or large globules anywhere in the fuel system. Due to the amount of water, the most prevalent location for fungi is the fuel tank.

The growths appear slimy and may be black, green, or brown. They are introduced by refueling with an unfiltered or aged fuel source.

Fungi feed on the fuel and need only trace amounts of minerals and water. As they grow and multiply, they change fuel into water, sludge, acids, and products of metabolism.

The most common symptom is a loss of performance due to fuel filter clogging. Infestation can also show up as corrosion of metal parts such as injectors, fuel pumps, and steel lines.

WARNING: To avoid personal injury do not come into physical contact with biocide agents, cleaners, or additives used to remove fungi or micro-organisms.

If fungi have caused fuel system problems, sterilize the system with a diesel fuel system biocide or cleaning agent. Follow the manufacturer's instructions.

Use of biocides while operating under heavy loads such as towing a trailer is not recommended. Such use is permissible, but no additional biocide should be used when refueling during such operations.

Contamination that is severe or does not respond to biocides may require tank removal, disassembly and steam-cleaning.

Water or Wax Contamination

1. Remove the fuel cap from the filler tube.
2. Drain the contaminated fuel into an approved container.
3. Drain the fuel filter, fuel pump and the fuel lines.
4. Refill the tank with fresh fuel.
5. Start the engine and bleed the lines, filter and the injectors.

Checking Fuel Quality

The fuel quality may cause driveability problems such as hesitation, lack of power, stalling, the inability to start, etc.

For best results, use Diesel fuel No. 2 year-round (above and below freezing conditions) as the oil companies blend Diesel fuel No. 2 to address climatic differences. Diesel fuel No. 1 may be used in **very** cold temperatures when it stays below 0° F (-18° C), however, it will produce a loss in power and fuel economy.

CAUTION: *The use of Diesel fuel No. 1 in warm or hot climates may result in stalling, poor starting when the engine is hot and may damage the fuel injection system.*

A quick check on the fuel quality can be performed with tool J–38641–B.

NOTE: The fuel quality hydrometer provides a general indication of fuel quality and should not be considered to be scientifically accurate.

1. Drain the fuel filter housing as follows:
   - Stop the engine.
   - Place a container under the drain valve hose, at the left front side of vehicle behind the driver side wheel.
   - Open the drain valve.
   - You may need to pump the plunger on the top of the fuel manager repeatedly.
   - Fill a 1-liter (0.946 quart) container with a sample of the clean fuel.
   - Close the drain valve.

NOTE: Visually inspect the fuel sample for obvious contaminants such as water or sediment. Check the odor of the sample for the presence of gasoline or other foreign solvents before testing for specific gravity.

2. Fill the hydrometer tool J–38641-B with a fuel sample as follows:
   - Squeeze the hydrometer bulb
   - Immerse the hydrometer tip in the fuel sample
   - Release the bulb and allow the fuel to enter the glass tube until the indicator floats freely.
   - Gently spin the hydrometer to relieve the surface tension of the fuel sample.
3. Read the scale on the glass bulb at the point where the top of the fuel sample contacts it:
   - Reading this scale will indicate an approximate fuel oil specific gravity.
   - Refer to the tool instructions on how to determine the API specific gravity.
   - Refer to the Fuel Oil Specific Gravity Requirements table.
4. If the correct fuel is being used in the conditions listed in Fuel Quality (below) and meets the fuel oil specific gravity requirements for Diesel No. 1 or Diesel No. 2, the fuel is OK. If not, the fuel should be replaced.
5. Prime the fuel system before starting the engine.

Fuel Oil Specific Gravity Requirements:

	Diesel No. 2	Diesel No. 1	Special Tool
API Gravity	**30-39**	**39-44**	**J–38641–B**

FUEL SYSTEM COMPONENTS

Mass Air Flow/ Air Intake Temp Sensor

The mass air flow sensor is used to measure the volume of air flow to the engine. The sensor measures mass flow rate by measuring the rate of heat lost from a tiny micro machined silicon heater/thermometer held in the air stream. The greater the rate of heat loss, the greater the air flow.

The sensor outputs are used by the engine control system to provide a faster turbo “spool-up” and crisper throttle response. In addition, low-end power is stronger and the entire power band is much smoother.

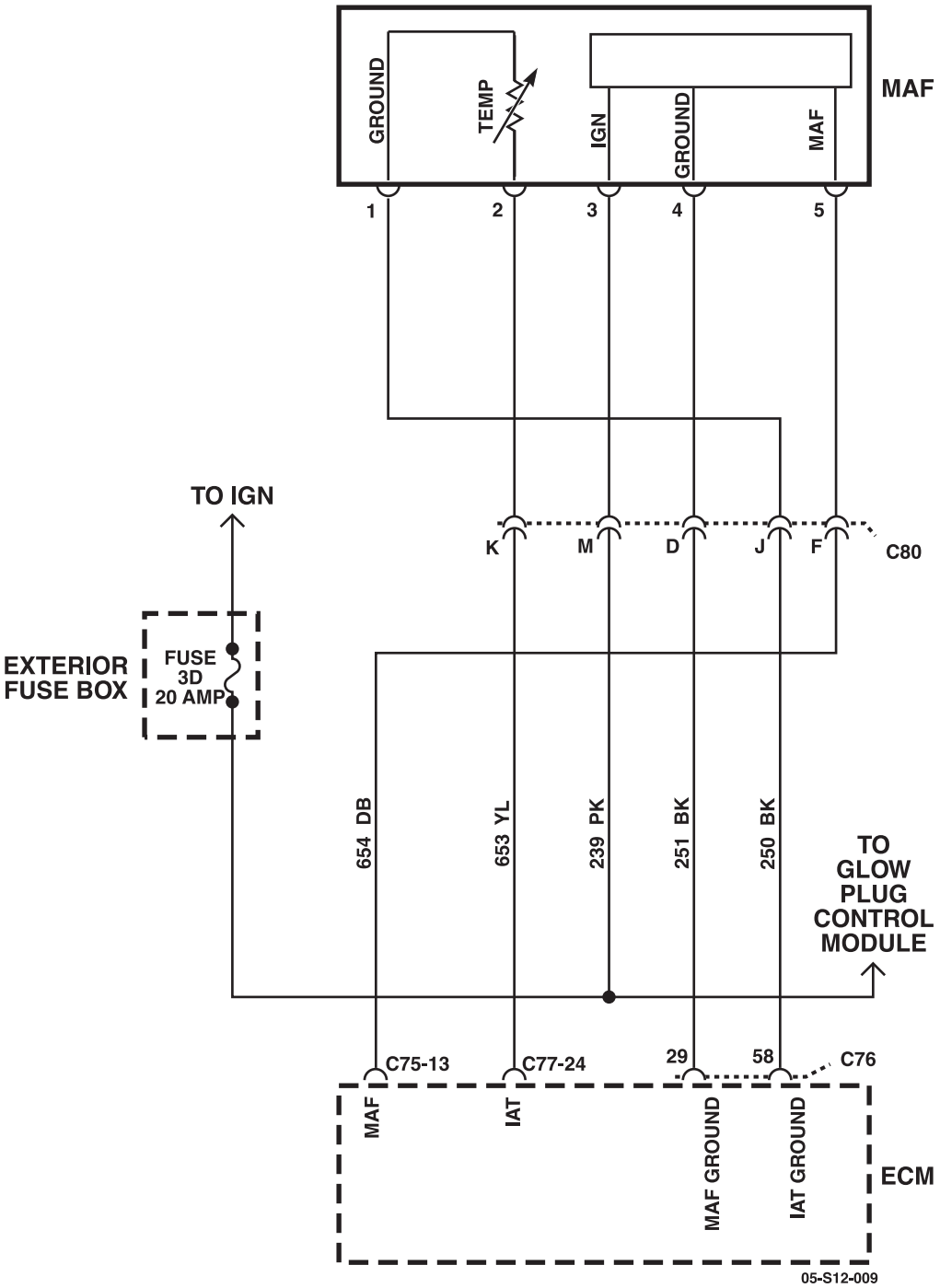


Figure 3-2: Mass Air Flow Sensor Circuit

MAF Sensor/Air Intake Temp Sensor Replacement

Removal

1. Disconnect the electrical connector from the sensor (Figure 3-3).
2. Remove the two screws securing the sensor and remove the sensor from the air intake tube.

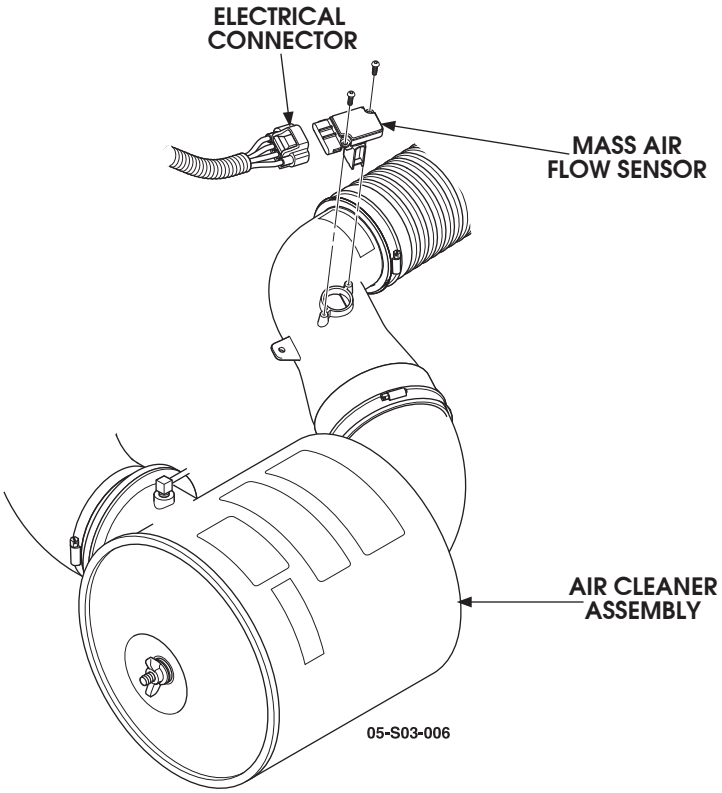


Figure 3-3: Mass Air Flow Sensor Replacement

Installation

1. Install the sensor in the air intake hose and secure with the two screws.
2. Connect the electrical connector.

Fuel Manager (Filter-Water Separator)

The fuel manager is located on the driver side of the engine compartment on the vertical portion of the cowl panel (Figure 3-4). It performs five functions which are:

- Fuel filtering (2-stage)
- Water separation
- Water detection
- Water drain
- Fuel heater

Fuel filtering and water separation is achieved through a 2-stage, replaceable, filter element. The first stage of the filter is used to remove debris from the fuel and the second stage causes water to separate from the fuel in the form of droplets. These droplets are collected in a reservoir at the bottom of the filter element housing. Water can be drained off through a drain valve and hose, located in the driver side wheel well.

Water detection and fuel heating are controlled by sensors in the filter housing. Water build-up causes the water in fuel (WIF) sensor to activate the instrument panel “drain filter” light. Fuel heating occurs during cold ambient temperatures. It is controlled by a temperature sensitive switch that is internal to the heater. When temperature falls to a point where wax build-up could occur, the switch activates the heat element within the filter housing.

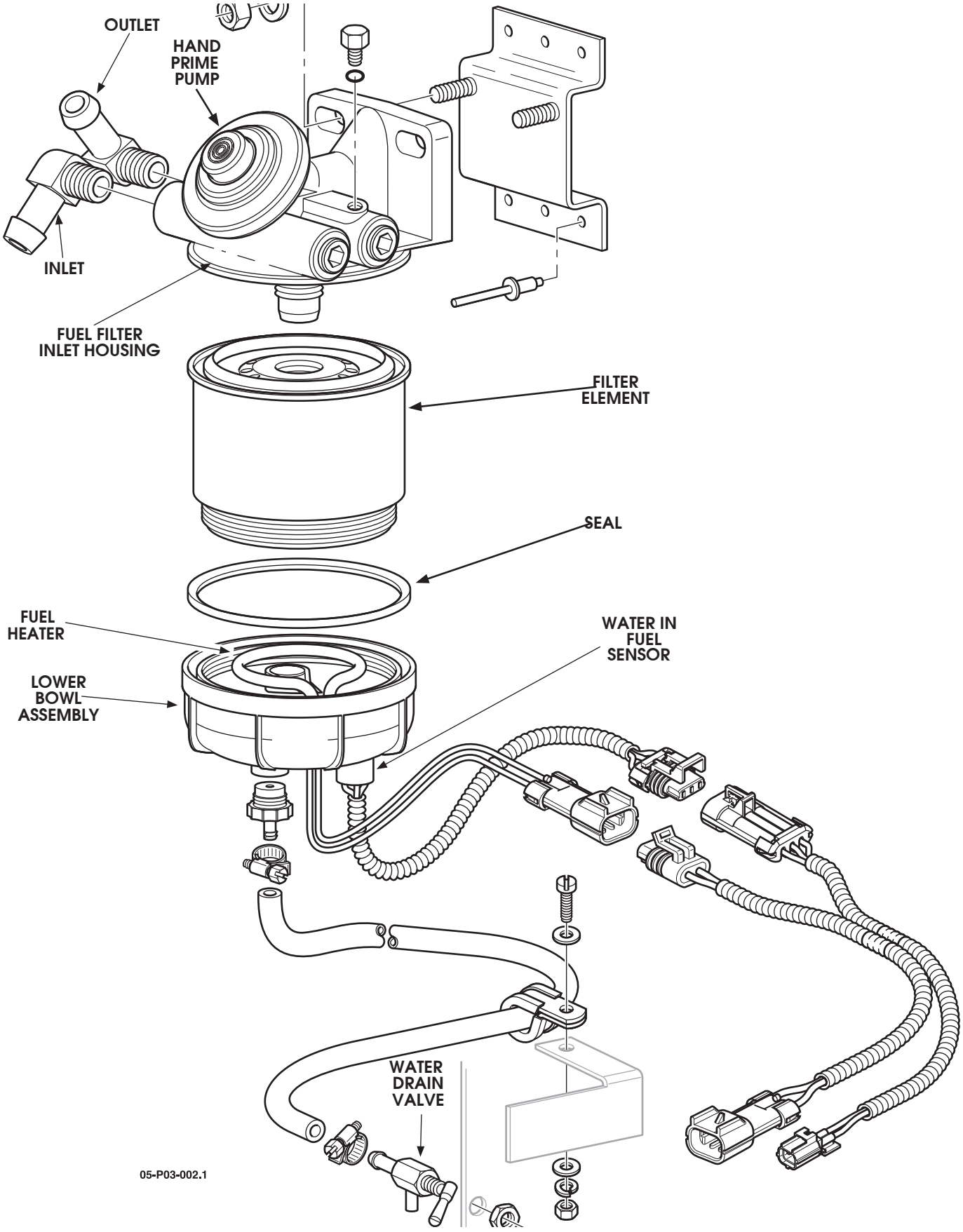


Figure 3-4: Fuel Manager Breakdown

Fuel Filter Replacement

Removal

1. Drain the fuel from the fuel manager (Figure 3-4).
2. Loosen the fuel hose clamps.
3. Disconnect the manager inlet and outlet hoses from the housing.
4. Disconnect the fuel manager electrical connectors.
5. Remove the fuel managers nuts and lock washers.
6. Remove the fuel manager assembly.
7. Remove the fuel filter from the lower bowl assembly and from the fuel filter inlet housing.

Installation

1. Install the fuel filter to the fuel filter inlet housing and install the lower bowl assembly.
2. Place the fuel manager assembly on the bracket.
3. Install the fuel manager nuts and lock washers and tighten the nuts to 15 lb-ft. (20 N·m).
4. Connect the fuel manager electrical connectors.
5. Install the fuel hoses.
6. Position the fuel hose clamps on the hoses and tighten.
7. Purge the air from the fuel manager.
8. Start the engine. If the engine stalls, repeat the above step.
9. Once the engine starts, inspect for fuel leaks.

Purging Air From Fuel Manager (Priming the Fuel System)

1. Prior to priming the engine, ensure that the following has been completed
   - There is fuel in the fuel tank.
   - The fuel filter has been installed and properly tightened.
   - The fuel lines are properly connected.
2. Press the fuel priming pump multiple times (it may take as many as forty times) (Figure 3-4). You may feel some resistance in the pump after you press it a few times.
3. Try to start the engine. If the engine does not start, begin the priming process again.
4. Start the engine and allow it to idle for a few minutes.
5. Check the filter for leaks.

Water In Fuel Sensor (WIF)

For vehicles with an illuminated drain filter light, verify that there is no water present in the fuel manager by draining a cup or two of fuel from the manager into a clear container (Figure 3-4). If water is present in the fuel, it will settle to the bottom of the container after sitting for approximately a minute.

- If water is present in the fuel, drain and clean the fuel system and replenish with fresh fuel.
- If water is not present in the fuel, change the water-in-fuel switch located in the bottom of the fuel manager
- Do not change the fuel manager for a water-in-fuel switch problem.

Fuel Heater

The fuel heater is mounted in the bottom of the fuel manager (Figures 3-4 and 3-5). The purpose of the heater is to prevent waxing of the fuel in cold temperatures. The fuel heater is internally switched on and off based on fuel temperature. When fuel temperature is less then 45˚F the heater will activate, as the fuel temperature warms to around 85˚F the heater will turn off.

The fuel heater is replaced with the lower bowl assembly.

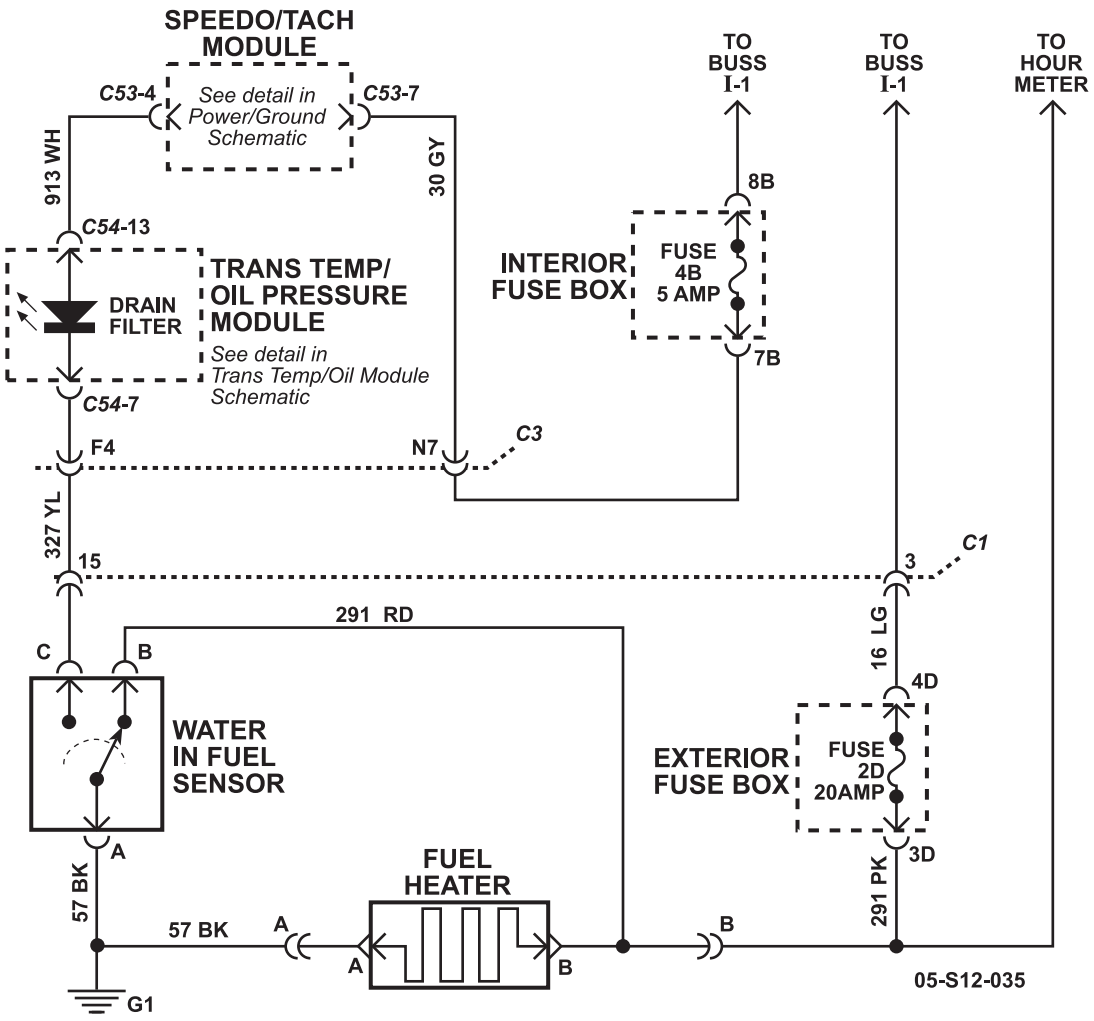


Figure 3-5: Fuel Manager Schematic

Injection Pump

The injection pump is gear driven off the cam and is located at the front of the engine valley (Figure 3-6). It has a supply pump side, a high-pressure pump side, fuel return and a pressure regulator. Timing is not required for this pump.

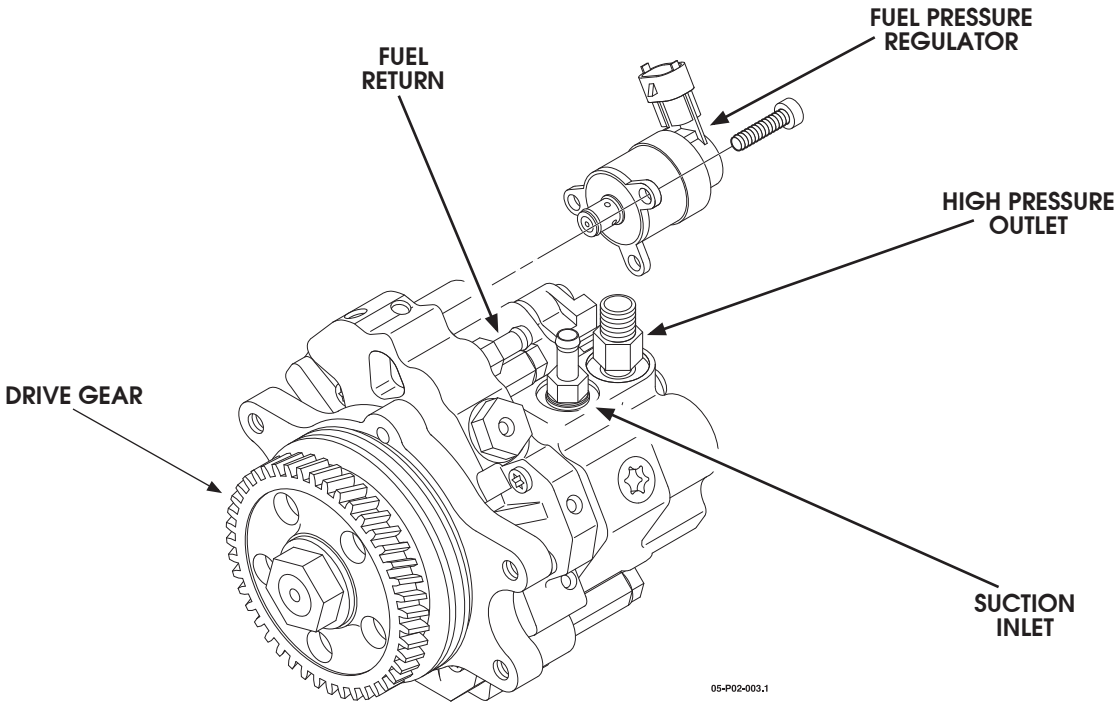


Figure 3-6: Fuel Injection Pump

Removal

1. Disconnect the negative battery cable.
2. Drain the cooling system.
3. Remove the air cleaner assembly and the air intake pipe.
4. Remove the interior engine cover (Refer to section 10).
5. Remove the drive belt.

NOTE: Do not discharge the A/C system in the next step.

6. Unbolt the A/C compressor, reposition the compressor, with the hoses attached, to the right side of the engine.
7. Remove the fuel rail inlet pipe from the injection pump and the fuel rail (Figure 3-13).
8. Remove the thermostat housing crossover (Refer to section 4).
9. Remove the center and right intake manifolds (Refer to section 2).
10. Remove the turbocharger (Refer to section 2).
11. Unplug the fuel pressure regulator wire connector.
12. Loosen the fuel supply and return line clamps and remove the hoses from the pump.
13. Remove the four pump bolts and the fuel pump from the block (Figure 3-7).

Service

The injection pump is not serviceable.The pump should be replaced as an assembly if an internal fault occurs.

Installation

1. Install the fuel pump and torque the four retaining bolts to 15 lb-ft. (20 N·m).
2. Install the fuel supply and return hoses, tighten the clamps.
3. Install the turbocharger.
4. Install the center and right intake manifolds.
5. Install the thermostat housing crossover.

6. Install the fuel rail inlet pipe and tighten to 30 lb-ft. (41 N·m).
7. Install the A/C compressor, tighten the bolts to 37 lb-ft. (50 N·m).
8. Install the drive belt.
9. Install the interior engine cover.
10. Install the air cleaner assembly and the air intake pipe.
11. Fill and bleed the cooling system (Refer to section 4)
12. Connect the negative battery cable.
13. Prime and bleed the fuel system (Refer to section 3).
14. Start the engine and inspect for fuel leaks.

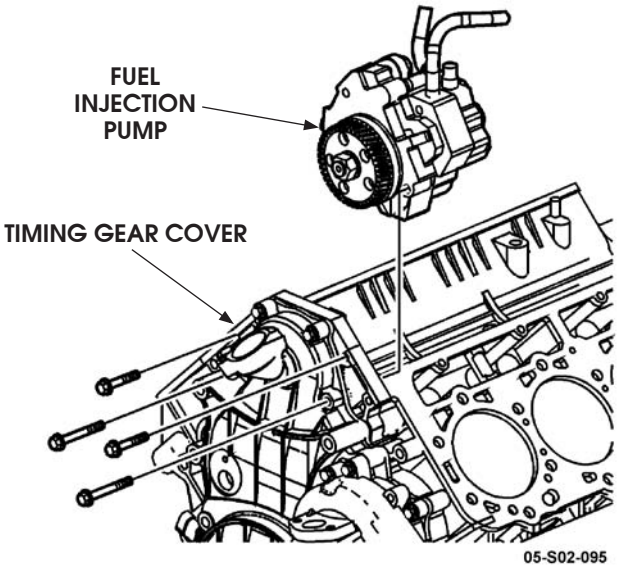


Figure 3-7: Injection Pump Removal/Installation

Fuel Pressure Regulator

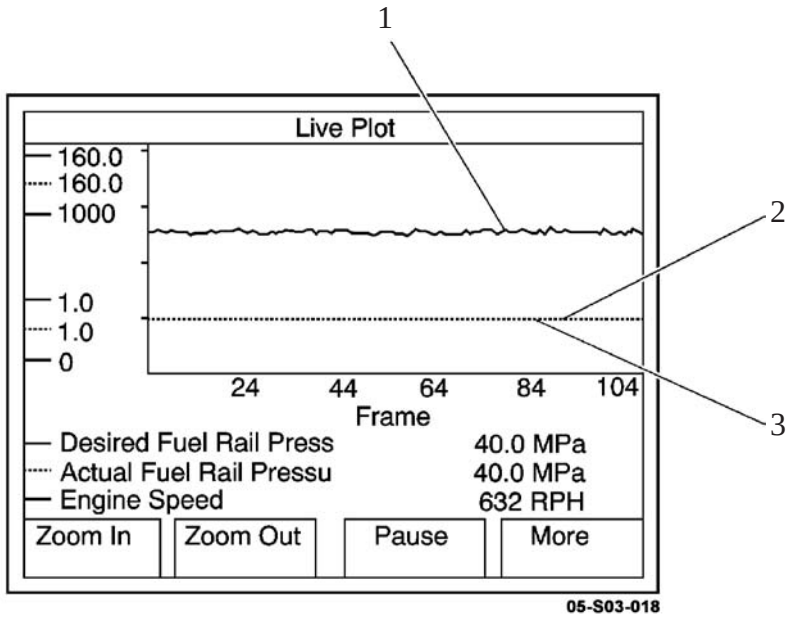
The fuel pressure regulator controls the amount of fuel available for the high-pressure pump.The normally open regulator is pulse-width modulated against spring force. It operates between 5 and 95 percent duty cycle. The higher the duty cycle the lower the output pressure. It is commanded by the ECM. When the ignition is turned off the ECM commands the pressure regulator closed for several seconds.

Diagnosis

The Fuel Pressure Regulator graphing procedure offers valuable information on regulator performance by comparing desired and actual fuel rail pressure. An almost perfect comparison between actual rail pressure and desired rail pressure is found on a fairly new, low mileage engine (Figure 3-8). A minor ripple is acceptable behavior for the fuel rail pressure regulator and is seen on high mileage engines (Figure 3-9). A "shark tooth" fluctuation in actual fuel rail pressure indicates a sticking pressure regulator (Figure 3-10).

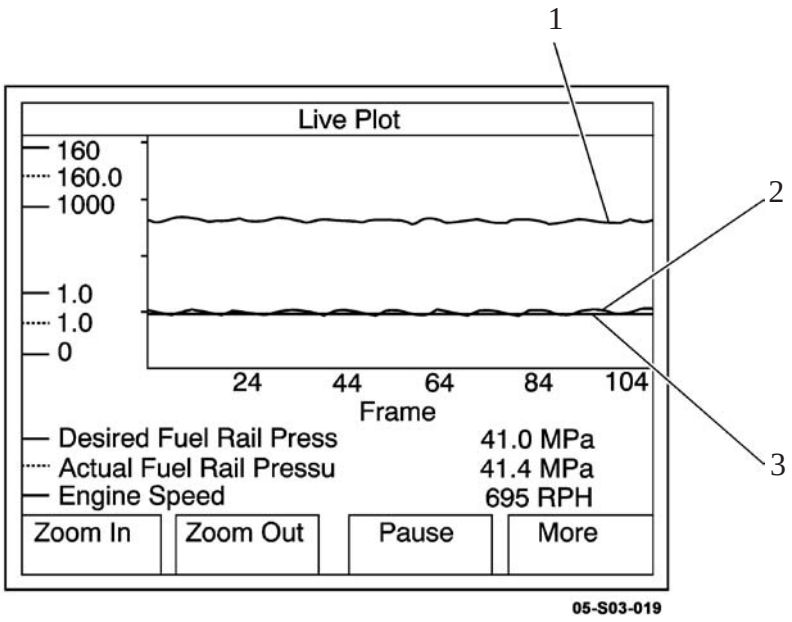
1. Set up the following Min/Max ranges for graphing the fuel rail pressure on the scan tool.
   - Engine Speed Min/Max range is 0-1,000 RPM.
   - Actual Fuel Rail Pressure Min/Max range is 1-160 MPa.
   - Desired Fuel Rail Pressure Min/Max is 1-160 MPa.
2. Start and idle the engine.

3. Observe the live plot for sharp changes or shark tooth pattern in the Actual Fuel Rail Pressure while performing the following actions:
   - Idling the engine
   - Shifting the transmission from Park to Drive and back to Park
   - Turning the steering from left stop position to right stop position
   - Turning the air conditioning ON and OFF
4. If there is a violent fluctuation in the Actual Fuel Rail Pressure, as seen in the surging graph (Figure 3-10), replace the fuel pressure regulator.



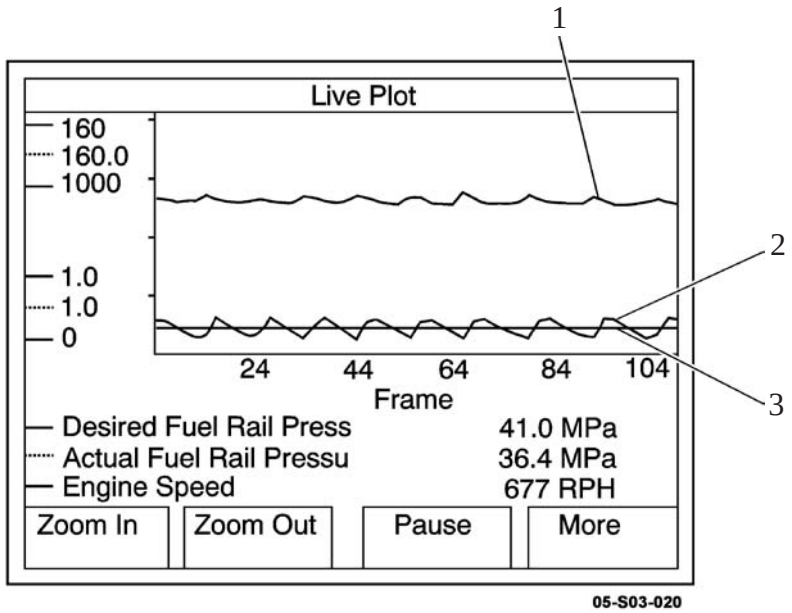
(1) Engine Speed
(2) Actual Fuel Rail Pressure
(3) Desired Fuel Rail Pressure

Figure 3-8: Good Zero Miles Fuel Pressure Regulator



(1) Engine Speed
(2) Actual Fuel Rail Pressure
(3) Desired Fuel Rail Pressure

Figure 3-9: Good 26K Miles Fuel Pressure Regulator



(1) Engine Speed
(2) Actual Fuel Rail Pressure
(3) Desired Fuel Rail Pressure

Figure 3-10: Bad Surging Fuel Pressure Regulator

Removal

1. Disconnect the negative battery cable.
2. Remove the air cleaner assembly and the air intake pipe.
3. Remove the drive belt.

NOTE: Do not discharge the A/C system in the next step.

4. Unbolt the A/C compressor, reposition the compressor, with the hoses attached, to the right side of the engine.
5. Disconnect and remove the main engine electrical harness connectors.
6. Disconnect the barometric pressure (BARO) sensor electrical connector.
7. Disconnect the engine coolant temperature (ECT) sensor electrical connector.
8. Remove the water outlet tube.
9. Disconnect the fuel temperature sensor electrical connector.
10. Disconnect the fuel pressure regulator electrical connector.
11. Clean the fuel pressure regulator and high pressure injection pump thoroughly with solvent.
12. Using compressed air, thoroughly blow dry the regulator and pump.
13. Remove the 3 fuel pressure regulator screws using a T25 TORX®.
14. Remove the fuel pressure regulator.
15. If dirt or debris is found in the bore or seating surfaces of the fuel injection pump, perform the following:
    - Place a clean rag over the bore in order to collect the excess fuel.
    - Bump the engine over in order to flush any debris out of the regulator bore.

Installation.

1. Lubricate and install NEW O-rings onto the regulator. Lubricate the O-rings with clean, NEW engine oil.
2. Install the fuel pressure regulator. Torque the three T25 TORX® screws to 35 lb-in. (4 N·m).
3. Retorque the three T25 TORX® screws to 62 lb-in. (7 N·m).
4. Connect the fuel pressure regulator electrical connector.
5. Connect the fuel temperature sensor electrical connector.
6. Install the water outlet tube.
7. Connect the ECT sensor electrical connector.
8. Connect the BARO sensor electrical connector.
9. Connect the main engine electrical harness connectors.
10. Position the A/C compressor and install the A/C compressor bolts and torque to 37 lb-ft. (50 N·m).
11. Install the drive belt.
12. Install the air cleaner assembly and the air intake pipe.
13. Connect the negative battery cable.
14. Prime the fuel system.
15. Start the engine. If the engine stalls, repeat the above step.
16. Once the engine starts, inspect for fuel leaks and verify fuel pressure regulator is functioning properly.

Fuel Rail Pressure Sensor

The fuel rail pressure sensor is mounted in the center of the right common fuel rail(Figure 3-13). Precise measurement of fuel pressure is imperative for correct system functioning. It has an operating range limit up to 29,000 psi. If it should fail the ECM sets a DTC and will use a fixed value to command the fuel rail pressure regulator.

Removal

1. Disconnect the negative battery cable.

2. Drain the cooling system (Refer to section 4)
3. Remove the air induction hose (Refer to section 3).
4. Remove the exhaust gas recirculation (EGR) cooler tube (Refer to section 3).
5. Disconnect the fuel rail pressure sensor electrical connector.
6. Prior to removal, clean the fuel pressure sensor and surrounding area thoroughly with solvent.
7. Using compressed air, thoroughly blow dry the sensor and surrounding area.
8. Remove the fuel pressure sensor.

Installation

1. Install the fuel pressure sensor and torque to 52 lb-ft. (70 N·m).
2. Connect the fuel rail pressure sensor electrical connector.
3. Install the EGR cooler tube.
4. Install the air induction hose and torque the clamps to 35 lb in (4 N·m)
5. Fill and bleed the cooling system.
6. Connect the negative battery cable.

Fuel Rail Pressure Relief Valve

The fuel rail pressure relief valve is located on the rear of the left fuel rail (Figure 3-13). The valve opens if the pressure exceeds 27,550 psi and cycles to maintain pressure. Bleed off fuel returns to the fuel return system. The fuel rail pressure relief valve should only be serviced with the left fuel rail as an assembly.

Fuel Temp Sensor

The fuel temp sensor is located in the fuel return line near the left common fuel rail (Figure 3-13). The fuel temp sensor is a thermistor, which receives a 5-volt reference signal from the ECM. The signal voltage decreases as the temperature increases. Fuel temperature affects fuel viscosity. The ECM uses this information in relating its commands to the FICM.

Removal

1. Loosen the charged air cooler inlet duct connector to turbocharger clamp.
2. Remove the charged air cooler inlet duct connector from the turbocharger.
3. Disconnect the fuel temperature sensor electrical connector.
4. Remove the fuel temperature sensor from the fuel return line.

Installation

1. Install the fuel temperature sensor and torque to 16 lb-ft. (22 N·m).
2. Connect the fuel temperature sensor electrical connector.
3. Install the charged air cooler inlet duct connector to the turbocharger and tighten the clamp to 53 lb-in. (6 N·m).
4. Prime the fuel system.
5. Start the engine and inspect for fuel leaks.

Fuel Injection Control Module

The FICM is mounted on the right front side of the engine. The FICM commands the injectors on time. It requires 93 volts of DC and up to 20 amps to open an injector. Once open, 11 to 15 amps holds it open. the ECM commands the FICM. The high voltage creates heat in the FICM and it is cooled by fuel flowing through the unit's base.

There are two injection pulses to each injection cycle:

- Pilot injection is used up to 2500 rpm. It is a small pre-combustion fuel supply which increases combustion efficiency and reduces noise.
- Normal or main injection immediately follows pilot injection.

Removal

1. Remove the air cleaner assembly and the air inlet hose.
2. Remove the fuel lines from the FICM.
3. Disconnect the two electrical connectors from the FICM (Figure 3-11).

NOTE: When performing the next step care must be taken to ensure that you do not drop and misplace lower isolators under FICM.

4. Remove the three retaining bolts and isolators, then remove the FICM.

Installation

1. Install the FICM with the three bolts and isolators, torque to 15 lb-ft. (21N•m).
2. Connect the two electrical connectors to the FICM.
3. Install the fuel lines to the FICM and tighten the bolts to 25 lb-ft. (34 N•m).
4. Install the air cleaner assembly and the air inlet hose.
5. Start the engine and check for fuel leaks.

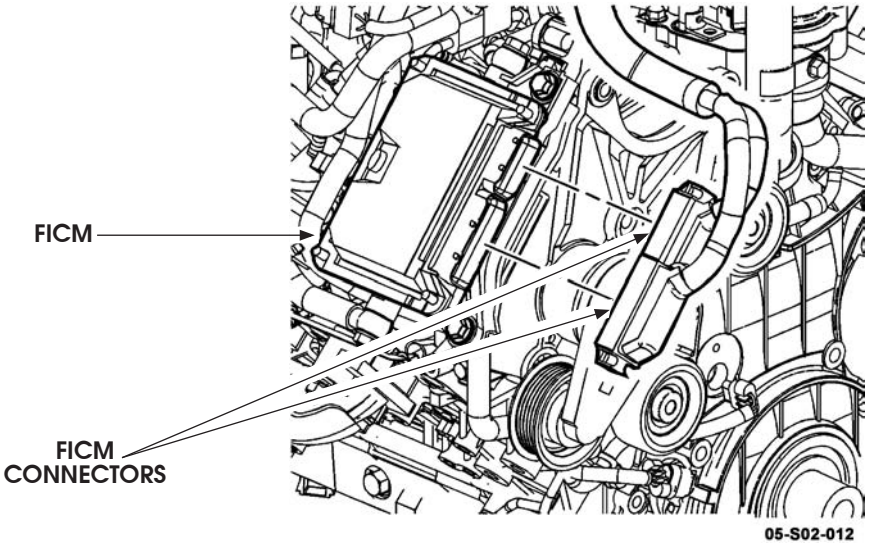


Figure 3-11: FICM Connectors

Fuel Hose or Tube

Removal

1. Release the fuel lines with the quick connect fittings (Refer to section 3), or loosen the hose clamps.
2. Remove any P clamps holding the line to the body or frame.
3. Remove the fuel line.

Installation

1. Install the fuel line in the same position as removed (Figure 3-12).
2. Install P clamps.
3. Start the engine and check for fuel leaks.

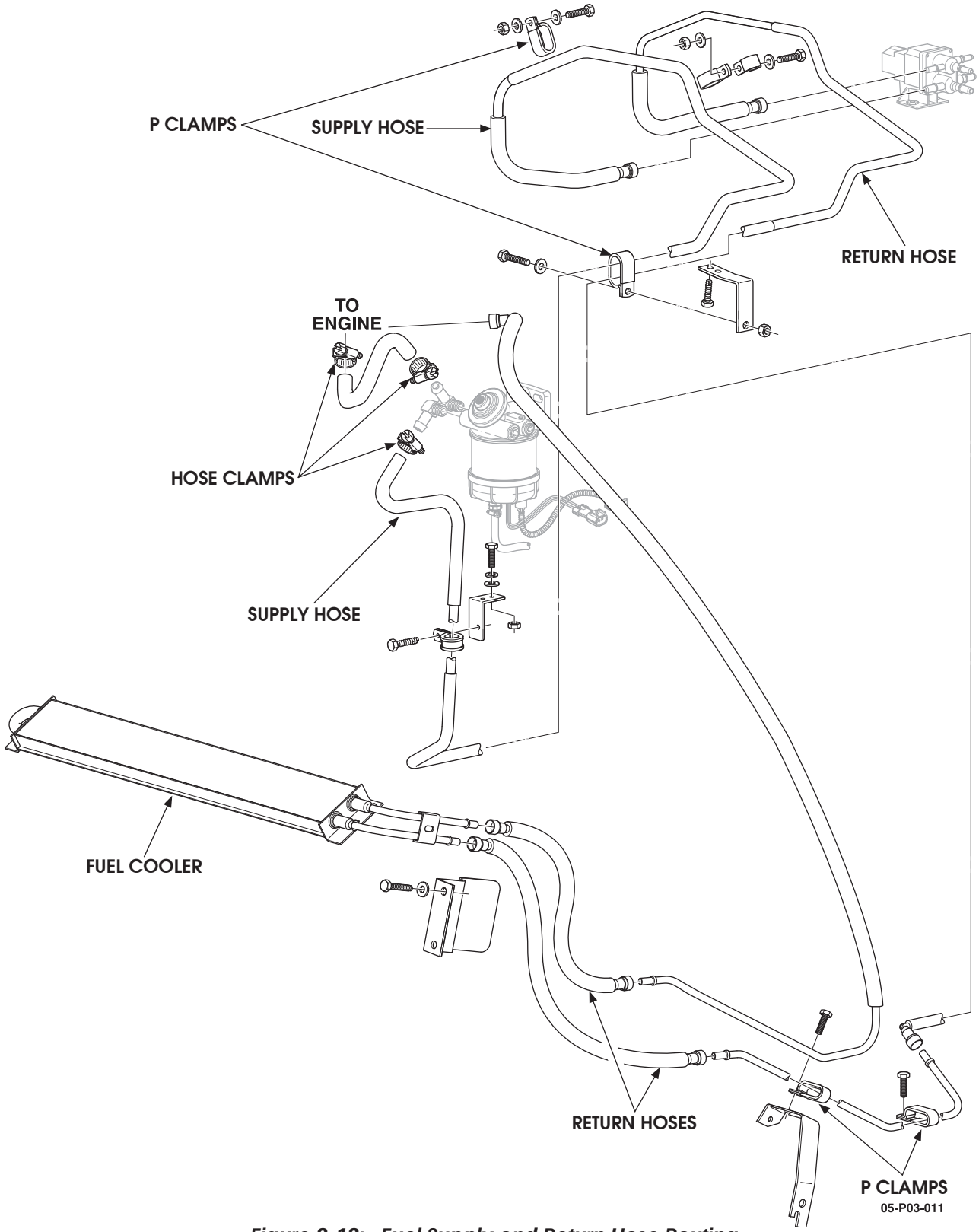


Figure 3-12: Fuel Supply and Return Hose Routing

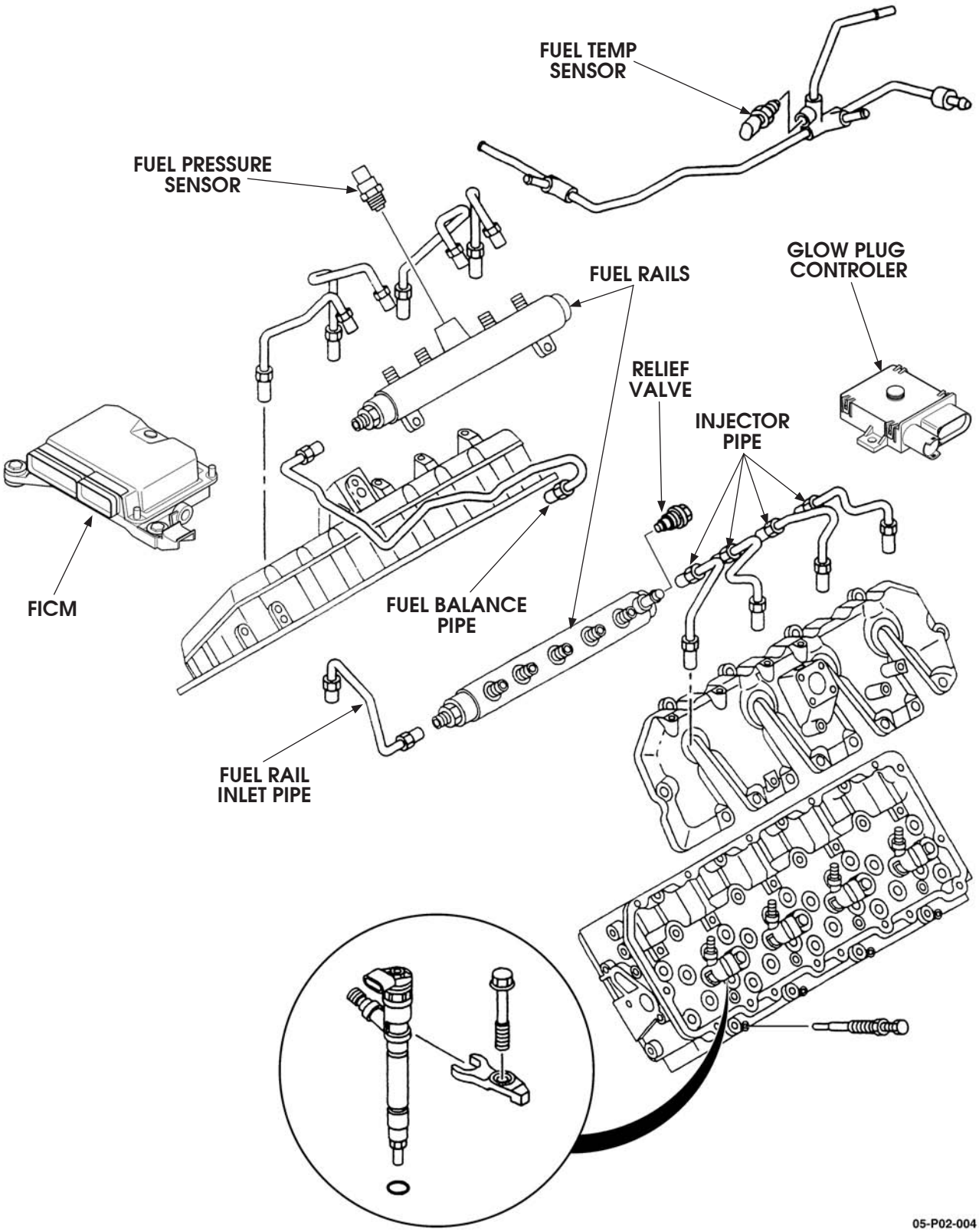


Figure 3-13: High Pressure Lines

Fuel Injector Pipe Replacement

Removal

1. Disconnect the negative battery cable.
2. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
3. Spray lithium grease, GM P/N 12346293 or equivalent, between the fuel injector line and fittings to assist in containing any debris during removal.

NOTE: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

4. Remove the fuel injector pipes (Figure 3-13).

Installation

1. Install the fuel injector pipes, hand tighten both ends of the pipe.

NOTE: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

2. Torque the injector pipes to 30 lb-ft. (41 N·m).
3. Bleed and prime the fuel system.
4. Start the engine and check for leakes.

Fuel Balance Pipe Replacement

Removal

1. Disconnect the negative battery cable.
2. Disconnect the fuel rail balance pipe from the fuel rails.
3. Remove the fuel rail balance pipe retaining bolts (Figure 3-14).
4. Remove the fuel rail balance pipe.

Installation

1. Connect the fuel rail balance pipe to the fuel rails.
2. Torque the fittings to 30 lb-ft. (41 N·m).
3. Install the fuel rail balance pipe retaining bolts and torque to 18 lb-ft. (25 N·m).
4. Bleed and prime the fuel system.
5. Start the engine and check for leaks.

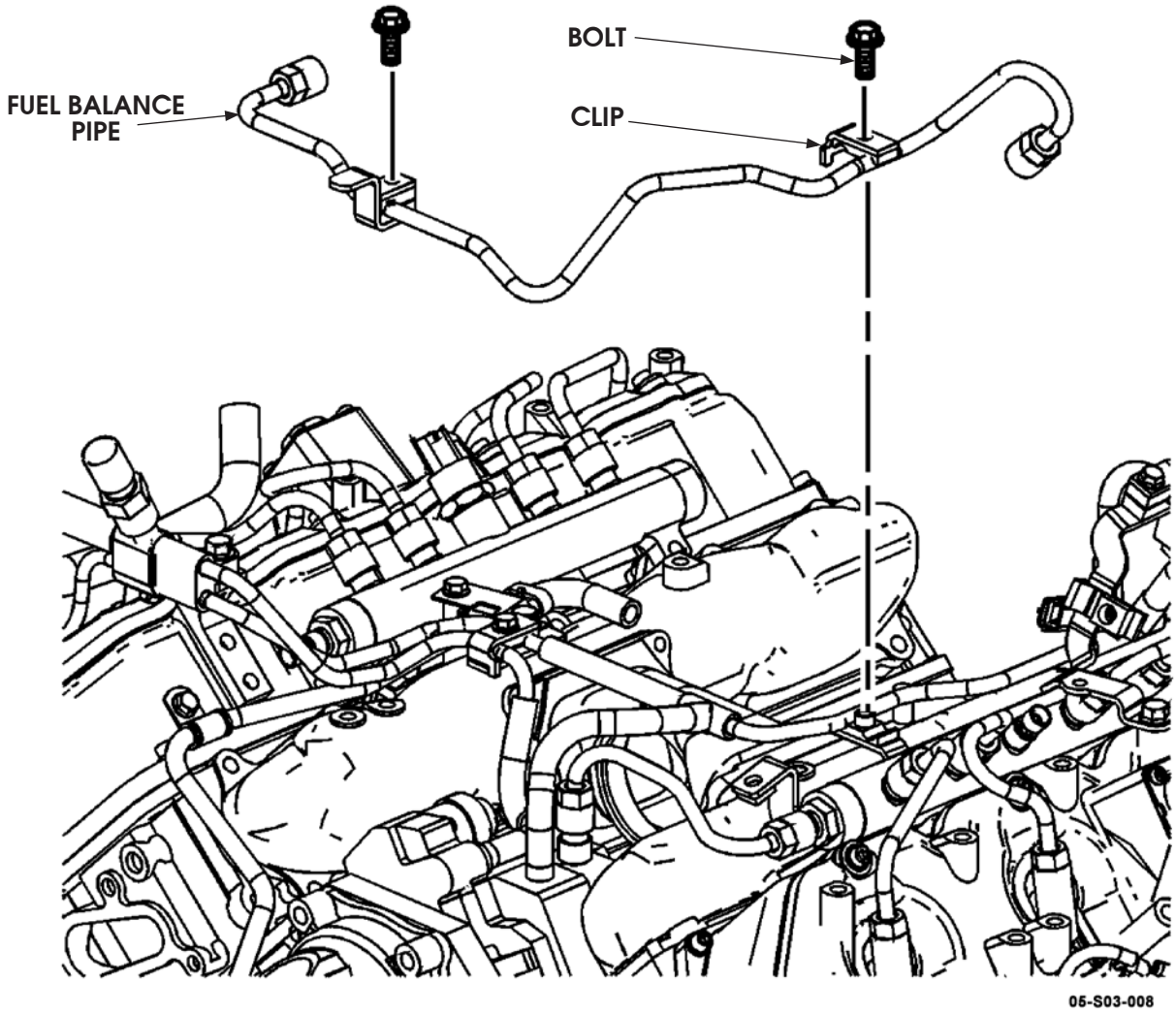


Figure 3-14: Fuel Rail Balance Pipe

Fuel Return System Diagnosis

The Fuel Return System routes fuel from the fuel injectors and the fuel injection pump. The FRP relief valve is located in the rear of the left common rail. The return fuel travels to the fuel cooler and then to the fuel tank. This fuel is used to cool and lubricate the injection pump and the injectors.

Fuel Return System Diagnosis

STEP	ACTION	YES	NO
1	**NOTE:** Do not apply more than the specified air pressure to the return line. **NOTE:** Ignition must be on for the fuel selector valve to switch. 1. Switch the fuel selector valve to the main tank. 2. Disconnect the return line at the engine. 3. Remove the fuel filler cap from the main tank filler tube. 4. Apply 1 psi air at the fuel return line that leads back to the tank. 5. Listen at the filler tube for air flowing from the tank. 6. Switch the fuel selector valve to the auxiliary tank. 7. Remove the fuel filler cap from the auxiliary tank filler tube. 8. Apply 1 psi air at the fuel return line that leads back to the tank. 9. Listen at the filler tube for air flowing from the tank. Did air flow from both of the filler tubes?	Go to step 10.	Go to step 2.
2	Did air flow from one of the filler tubes?	Go to step 5.	Go to step 3.
3	1. Disconnect the fuel return line from the engine to the fuel selector valve. 2. Apply 1 psi air at the fuel return line. Did air flow from the line?	Go to step 4.	Go to step 8.
4	1. Disconnect the fuel return line from the fuel selector valve to the main tank. 2. Remove the fuel filler cap from the main tank filler tube. 3. Apply 1 psi air at the fuel return line that leads back to the main tank. 4. Listen at the filler tube for air flowing from the tank. 5. Disconnect the fuel return line from the fuel selector valve to the auxiliary tank. 6. Remove the fuel filler cap from the auxiliary tank filler tube. 7. Apply 1 psi air at the fuel return line that leads back to the tank. 8. Listen at the filler tube for air flowing from the tank. Did air flow from both of the filler tubes?	Go to step 5.	Go to step 6.
5	1. Replace the fuel selector valve. Did you complete the replacement?	Go to step 10.	- -
6	1. Disconnect the return line at the fuel sender assembly that DID NOT have air flowing. 2. Retest using 1 psi at the fuel return line back to the tank. Did air flow from the line?	Go to step 7.	Go to step 9.
7	Replace the fuel sender assembly. Did you complete the replacement?	Go to step 10.	- -

Fuel Return System Diagnosis

STEP	ACTION	YES	NO
8	Repair or replace the fuel return line between fuel selector valve and the engine. Did you correct the condition?	Go to step 10.	- -
9	Repair or replace the fuel return line between fuel selector valve and the fuel tank. Did you correct the condition?	Go to step 10.	- -
10	1. Install and connect all components or fuel lines that were previously removed or disconnected. 2. Operate the vehicle in order to verify the repairs. Did you correct the condition?	System is ok.	- -

High Pressure Fuel System Diagnosis

STEP	ACTION	YES	NO
1	**NOTE:** If the engine fails to start perform STEP 2. 1. Remove the fuel return rubber hose from the rear of the left fuel rail and plug the hose to prevent fuel leakage. 2. Install a section of rubber fuel hose on the fuel pressure relief valve connection and place it in a clean fuel container. 3. Start and idle the engine. 4. Command the fuel rail pressure to 160 MPa with a scan tool. 5. Observe the fuel hose and container for fuel leakage. Did fuel flow into the container?	Go to step 11.	Go to step 3.
2	**NOTE:** Only perform this test when the fuel is more than 65°F (18°C). 1. Remove the air duct from the air cleaner assembly and the turbo inlet. 2. Remove the fuel return rubber hose from the rear of the left fuel rail and plug the hose to prevent fuel leakage. 3. Remove the relay that supplies ignition 1 voltage to the fuel injection control module (FICM). 4. Crank the engine for 15 seconds while observing the fuel pressure relief valve hose connection for fuel leakage. Did fuel leak from the fuel pressure relief valve at the hose connection?	Go to step 11.	Go to step 3.

High Pressure Fuel System Diagnosis

STEP	ACTION	YES	NO
3	**NOTE:** The engine cranking speed must be more than 150 RPM during the cranking portion of this test. 1. 1.Remove the relay that supplies the ignition 1 voltage to the FICM, if it was not previously removed. 2. Remove the fuel return hose from the fuel injectors of the right cylinder bank. 3. Connect the yellow hoses from J 45873 Fuel Return Volume Test Kit to the J 45873-30 Fuel Injector Test Adapters. 4. Connect the J 45873-30 with yellow hoses to each fuel injector return port of the right cylinder bank, and install the retaining clips. 5. Install the 4 yellow hoses in the J 45873 graduated cylinders in numerical order. 6. Connect the fuel return hoses to the J 45873-30 to prevent leakage. 7. Crank the engine in 15-second intervals, with 1 minute cooling time between intervals, until fuel starts to flow into all of the graduated cylinders. 8. Elevate the 4 hoses to retain the fuel in the hoses, and empty the 4 graduated cylinders into a suitable container. 9. Install the 4 yellow hoses in the J 45873 graduated cylinders in numerical order. 10. Crank the engine for 15 seconds. 11. Measure the quantity of fuel in each of the graduated cylinders. Refer to Fuel System Specifications for the desired quantities (Figure 3-15). Were any of the fuel quantities more than the specified values?	Go to step 4.	Go to step 5.
4	1. Remove the fuel feed pipes from any fuel injectors that have high return flow and install the EN 47589 Fuel Pressure Adapter Cap to the fuel rail outlets. 2. Elevate the 4 hoses to retain the fuel in the hoses, and empty the 4 graduated cylinders into a suitable container. 3. Install the 4 yellow hoses in the graduated cylinders in numerical order. 4. Crank the engine for 15 seconds. 5. Using the Retesting Fuel Injector Return Flow Values table, measure the quantity of fuel in each of the graduated cylinders. Refer to Fuel System Specifications for the desired quantities (Figure 3-16). 6. Remove the fuel feed pipes from any uncapped fuel injectors that have high return flow and install the EN 47589 to the fuel rail outlets. Did you complete the action?	Go to step 5.	- -

High Pressure Fuel System Diagnosis

STEP	ACTION	YES	NO
5	**NOTE:** The engine cranking speed must be more than 150 RPM during the cranking portion of this test 1. Remove the fuel return hoses from the fuel injectors of the left cylinder bank. 2. Connect the yellow hoses from the to the J 45873-30. 3. Connect the J 45873-30 with yellow hoses to each fuel injector return port of the left cylinder bank, and install the retaining clips. 4. Connect the fuel return hoses to the J 45873-30 to prevent leakage. 5. Crank the engine in 15-second intervals, with 1 minute cooling time between intervals, until fuel starts to flow into all of the graduated cylinders. 6. Elevate the 4 hoses to retain the fuel in the hoses, and empty the 4 graduated cylinders into a suitable container. 7. Install the 4 yellow hoses in the graduated cylinders in numerical order. 8. Crank the engine for 15 seconds. 9. Measure the quantity of fuel in each of the graduated cylinders. Refer to Fuel System Specifications for the desired quantities (Figure 3-15). Were any of the fuel quantities more than the specified values?	Go to step 7.	Go to step 6.
6	Were any fuel injector lines capped off during either cylinder bank testing?	Go to step 10.	Go to step 11.
7	1. Remove the fuel feed pipes from any fuel injectors that have high return flow and install the EN 47589 to the fuel rail outlets. 2. Elevate the 4 hoses to retain the fuel in the hoses, and empty the 4 graduated cylinders into a suitable container. 3. Install the 4 yellow hoses in the graduated cylinders in numerical order. 4. Crank the engine for 15 seconds. 5. Using the Retesting Fuel Injector Return Flow Valves table, measure the quantity of fuel in each of the graduated cylinders. Refer to Fuel System Specifications for the desired quantities (Figure 3-16). Were the fuel quantities more than the specified value at the uncapped fuel injectors?	Go to step 8.	Go to step 9.
8	Repeat the fuel injector return flow test with capping until no fuel injectors have high return fuel flow. Did you complete the action?	Go to step 9.	- -
9	1. Replace the fuel injectors that had capped off lines (Refer to section 3). 2. Install all disconnected and removed fuel system components. 3. Start and idle the engine. You may have to prime the fuel system before the engine will start. 4. Command the fuel pressure control to 160 MPa with a scan tool. Is the fuel pressure more than 145 MPa?	Go to step 12.	- -

High Pressure Fuel System Diagnosis

STEP	ACTION	YES	NO
10	Replace the fuel injection pump (Refer to section 3). Did you complete the replacement?	Go to step 12.	- -
11	Replace the fuel pressure relief valve (Refer to section 3). Did you complete the replacement?	Go to step 12.	- -
12	**NOTE:** The fuel system may have to be primed before starting the engine. 1. Install and connected all fuel system components that were previously removed or disconnected. 2. Operate the vehicle in order to verify the repairs.	System is ok.	- -

Fuel System Speci cations

The fuel return from the fuel injectors to the tank will vary based on the API value of the fuel. Measure the Fuel API with the Diesel Fuel Quality Tester. For this reason the Fuel System Diagnosis - High Pressure Side values will vary for identifying a fuel injector or fuel pump concern. Use the following tables when referred to by the diagnostic. The first table is to be used during the initial diagnosis to identify the worst fuel injectors. After the fuel injectors that fail the first part of the test are capped off, the return flow from each uncapped fuel injector must be measured again. This is because the fuel system is returning less fuel to the tank, and thus the fuel pressure is higher during the retest. Failure to use the correct table may result in the replacement of good fuel injectors.

Initial Fuel Injector Return Flow Values

API Rating	Maximum Single Fuel Injector Return Flow
30-34	3 ml
35-39	4 ml
40-44	5 ml

Figure 3-15: Initial Fuel Injector Return Flow Values

Retesting Fuel Injector Return Flow Values

API Rating	Maximum Single Fuel Injector Return Flow
30-34	4 ml
35-39	5 ml
40-44	5 ml

Figure 3-16: Retesting Fuel Injector Return Flow Values

Fuel Injectors

A fuel injector is a solenoid device, controlled by the fuel injection control module (FICM), that meters pressurized fuel to a single engine cylinder. The engine control module (ECM) energizes the low-impedance injector solenoid to open a normally closed valve. Fuel pressure is released from above the fuel injector pintle, and is returned to the fuel tank through the fuel return lines. The difference in fuel pressure above and below the pintle causes the pintle to open. Fuel from the fuel injector tip is sprayed directly into the combustion chamber on the compression stroke of the engine.

Removal

1. Disconnect the negative battery cable.
2. Remove the air cleaner assembly and the air inlet hose.
3. Remove the FICM (Refer to section 3).
4. Prior to removing the fuel injector pipes, use compressed air to blow any debris from between the injector line and fittings. Wipe the fittings clean of debris.
5. Spray lithium grease, GM P/N 12346293 or equivalent, between the fuel injector line and fittings to assist in containing any debris during removal.

NOTE: DO NOT use compressed air to clean debris from the fuel injector inlet after the fuel line is removed. Using compressed air can allow debris to enter the fuel injector inlet and damage the fuel injector.

6. Remove the fuel injector pipes (Figure 3-13).

NOTE: Label all the injector electrical connectors before the connectors are removed in order to prevent reconnecting to the wrong injector. Failure to properly connect the injectors in the correct sequence will cause severe engine damage.

7. Unplug the injector electrical connectors.
8. Remove the fuel return hose clips.
9. Remove the fuel return hose from the injectors (Figure 3-17).
10. Remove the fuel injector bracket bolts.
11. Install special tool J-46594 into the bolt hole in the fuel injector bracket.
12. Install a flare nut wrench onto J-46594 and pull back away from the fuel injector, until the injector releases from its seat.
13. Remove special tool J-46594.
14. Remove the fuel injectors and brackets.

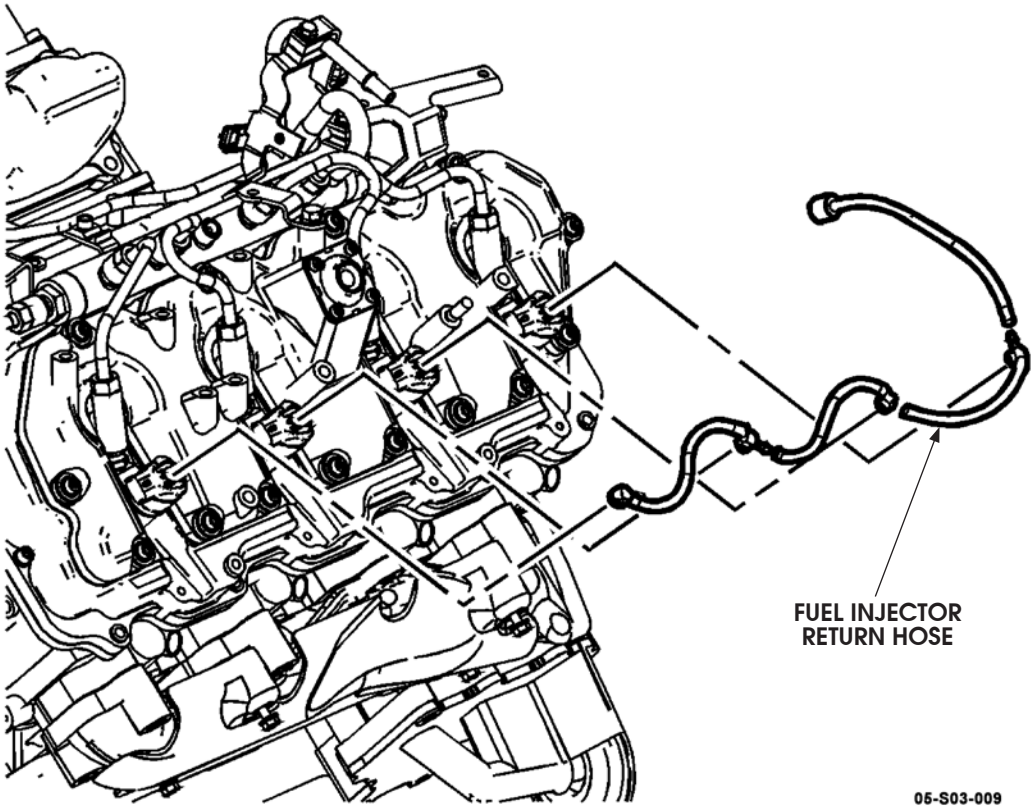


Figure 3-17: Fuel Injector Return Hose

Fuel Injector Cleaning and Inspection

NOTE: If reusing the old injectors perform the following steps.

1. Use a soft bristle non-metallic brush and top engine cleaner, GM P/N 1052626 or equivalent, to remove any deposits from the nozzle tip (1) and the copper washer sealing area (2) before re-installation (Figure 3-18).
2. Inspect the fuel injector nozzle tip (1) for any signs of discoloration (dark yellow, tan or blue) due to excessive heat.
3. Replace the injector if any damage is found.
4. Clean the fuel injector high pressure line.
5. Inspect the fuel injector line for excessive corrosion or damage to the sealing surfaces. Replace the line if any damage is found.

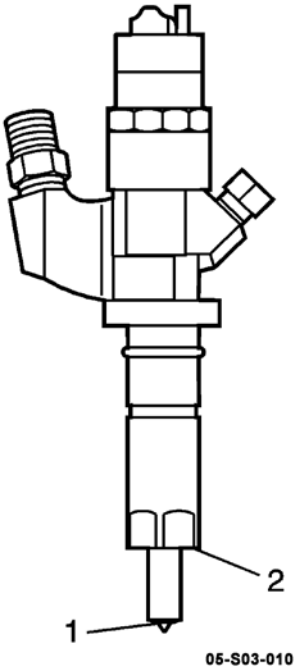


Figure 3-18: Fuel Injector Cleaning and Inspection

Installation

1. If necessary, remove the fuel injector bracket pins.
2. If necessary, remove and discard the copper washer from the fuel injector bore.
3. If necessary, remove and discard the O-ring from the fuel injector.
4. Install the fuel injectors with brackets
5. Install the fuel injector bracket bolts and torque the bolts to 22 lb-ft. (30 N·m).
6. Connect the fuel injector electrical connectors.
7. Install the fuel return hose to the injectors.
8. Install the fuel return hose clips.
9. Install the fuel injector pipes, hand tighten both ends of the pipe.

NOTE: Ensure proper torquing of the fuel injector line. An under-torqued fuel injector line will not seal properly and an over-torqued fuel injector line may damage the fuel injector fitting. An improperly sealed or damaged fuel injector line or fuel injector fitting will cause a fuel leak.

10. Torque the injector pipes to 30 lb-ft. (41 N·m).
11. Install the FICM (Refer to section 3).
12. Install the air cleaner assembly and the air inlet hose.
13. Bleed and prime the fuel system (Refer to section 3).
14. Start the engine and check for leaks.

FUEL TANKS, LINES, AND VALVES

The main and auxiliary fuel tanks are made of high density polyethylene. Auxiliary fuel tank capacity is 24.5 gallons (92.7 liters). Main tank capacity is 27 gallons (102.1 liters).

Quick connect fittings are used at most of the fuel line connection points.

Fuel level transmitters for main and auxiliary tanks are mounted within the tanks. A selector valve, mounted on the passenger side of the frame, controls tank flow and selection.

Vent lines are used at both tanks to avoid internal pressure buildup.

Fuel return lines are used to send unused fuel from the nozzles and the injection pump back to the fuel tanks.

FUEL SELECTOR VALVE

The valve's function is to switch fuel supply from the main to the auxiliary tank (and back) when needed (Figure 3-19). The valve is electrically operated by a switch in the passenger compartment. The switch is mounted on the instrument panel. Quick connect fittings are used to attach each of the six fuel lines to the valve. The valve is mounted on a bracket attached to the passenger side frame rail. Valve position is forward of the main fuel tank and B-pillar area.

Removal

1. Disconnect the fuel lines one at a time and tag them for reference (Figure 3-19).
2. Remove the bolts retaining the valve mounting bracket to the frame.
3. Disconnect the selector valve wiring connector.
4. Remove the bolts securing the selector valve to the mounting bracket and remove the valve.

Installation

1. Secure the selector valve to the mounting bracket with the bolts.
2. Connect the selector valve wiring connector.
3. Secure the mounting bracket to the frame with the bolts.
4. Connect the fuel lines.
5. Prime the fuel system.
6. Start the engine and check for proper operation and for fuel leaks.

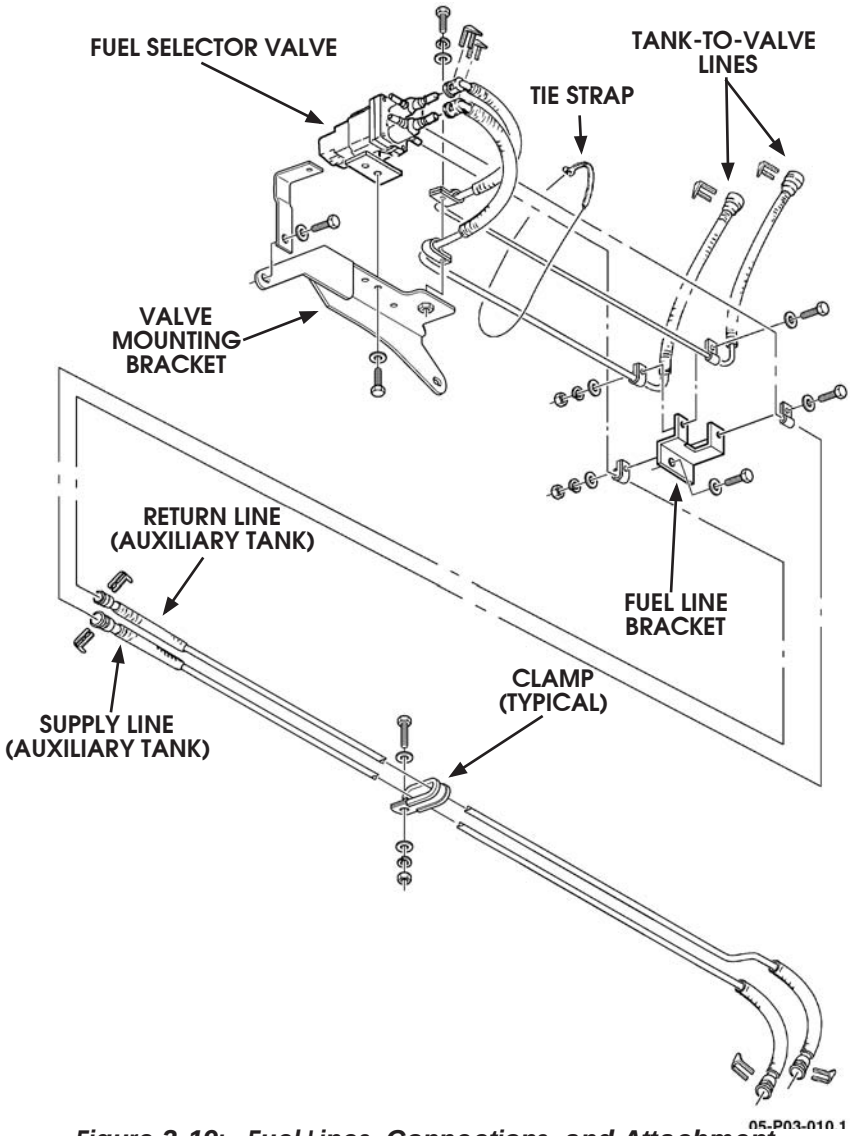


Figure 3-19: Fuel Lines, Connections, and Attachment

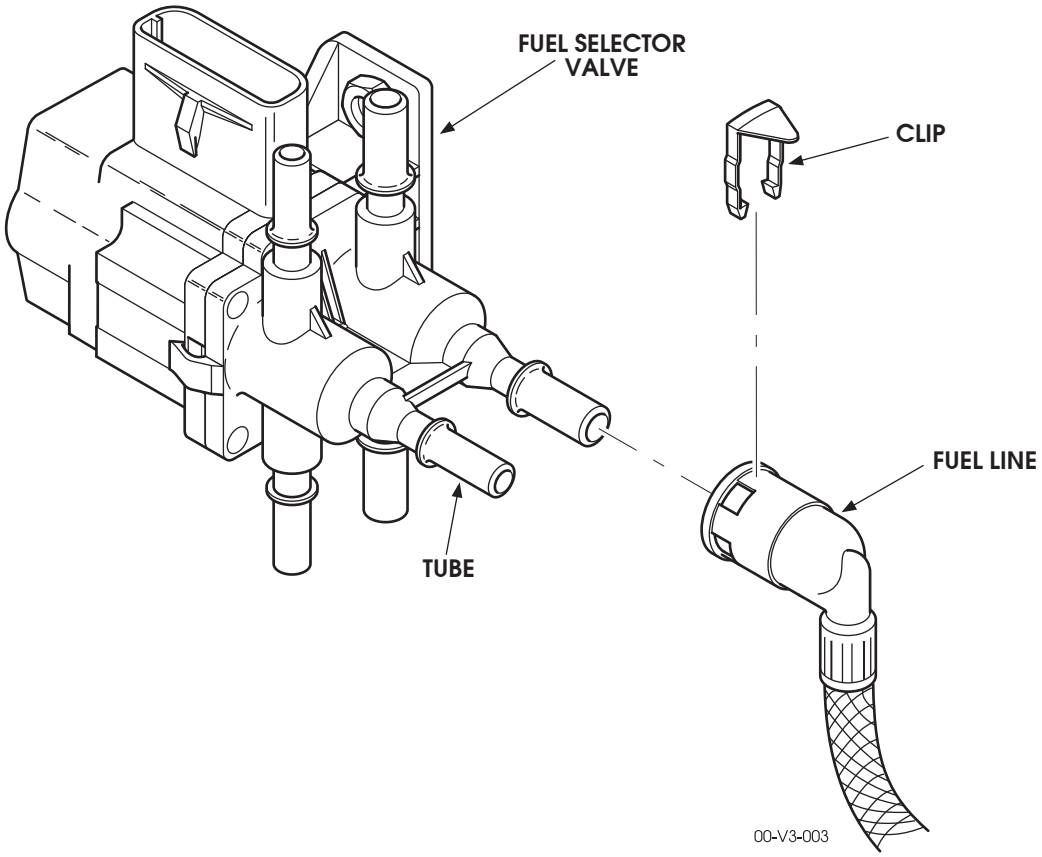


Figure 3-20: Fuel Selector Valve and Fitting

Quick Connect Fittings

Quick connect fittings are used at the main tank fuel tubes, auxiliary tank fuel tubes, and at the fuel tank selector valve (Figure 3-20).

The plastic fitting retainer only requires a screwdriver and needle nose pliers to remove.

Plastic Fittings

1. To disconnect, raise the retainer tab with a small flat blade screwdriver and remove the retainer with needle nose pliers.
2. To reconnect, push the fitting onto the tube, insert the retainer through the fitting sides, and seat it firmly.
3. Be sure the retainer seats behind the fuel tube flange.
4. Pull on the fitting afterward to verify proper seating.

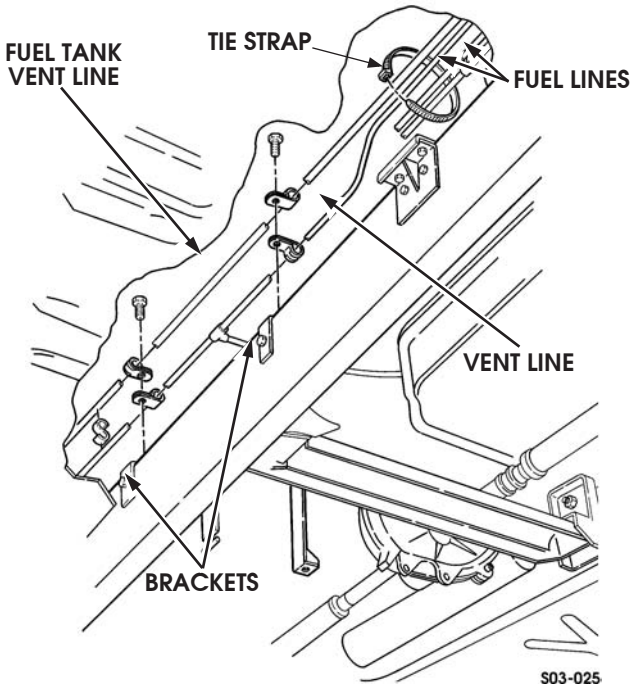


Figure 3-21: Fuel Tank Vent Line Locations

Fuel Tank Vent Line Service

Removal

1. Remove the fuel tank. (Refer to section 3)
2. Remove the clip and the fuel tank vent line hose from the vent line (Figure 3-21).
3. Remove the vent line clamps and disengage the lines.
4. Remove the tie strap securing the vent line to the fuel lines. Discard the tie strap.
5. Disconnect the fuel tank vent lines at the tank fittings and remove the lines.

Installation

1. Connect the vent lines to the tank fittings.
2. Secure the vent line to the fuel lines with a new tie strap (Figure 3-21).
3. Secure the vent lines in the brackets with clamps and bolts.
4. Install the fuel tank.

Main Fuel Tank Vent Filter

The main fuel tank vent filter is located just above the vacuum pump motor at the passenger side of the engine compartment. The filter is serviced as an assembly and should be replaced if restricted or damaged.

Removal

1. Remove the filter retaining clamp bolt and pull the filter out of the P clamp
2. Disconnect the clamp from the filter's vent line.
3. Remove the filter from the vent line

Installation

1. Connect the filter to the vent line.
2. Install the vent line clamp.
3. Install the filter in the P clamp and secure with the bolt.

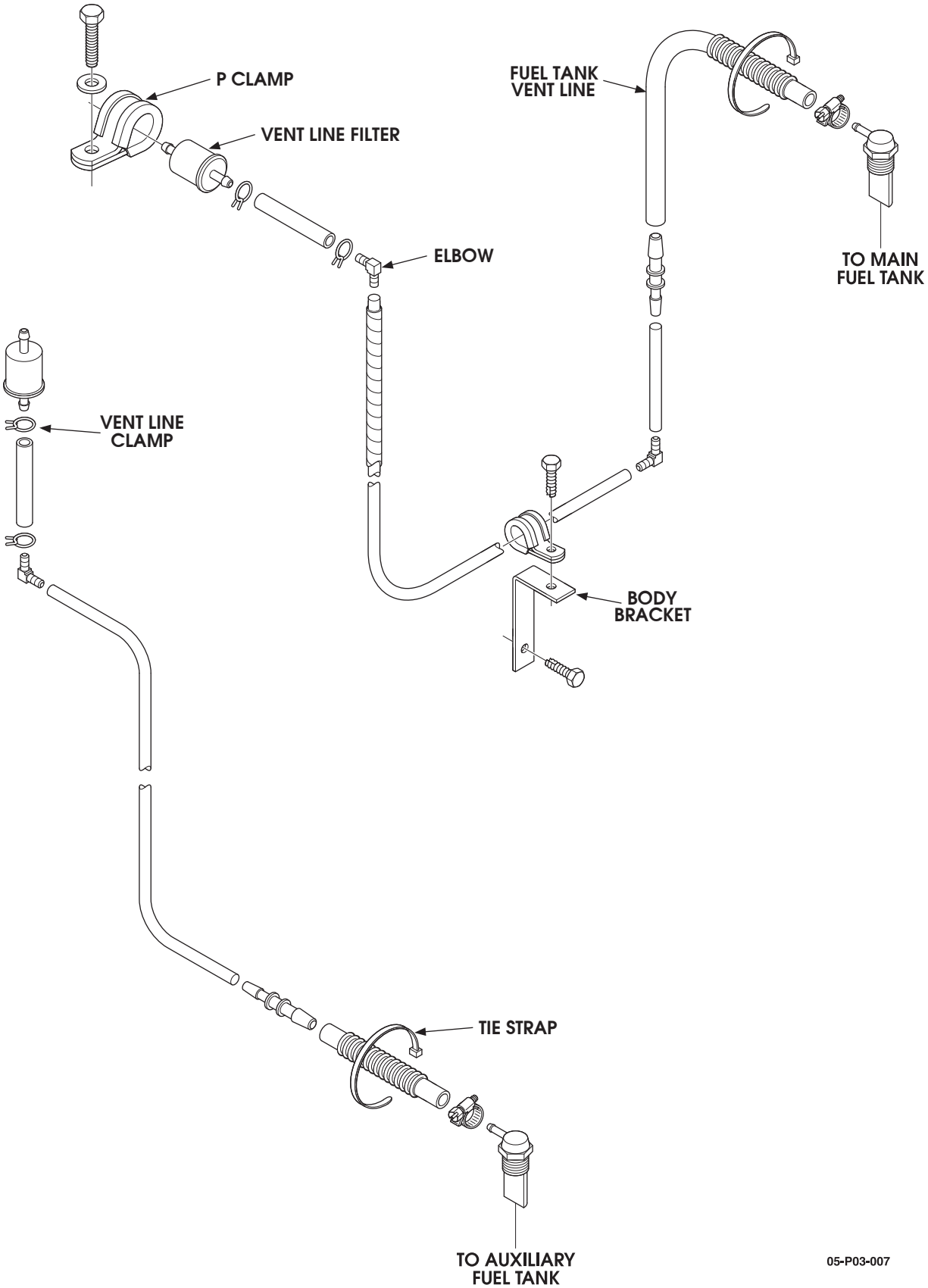


Figure 3-22: Fuel Tank Vent Filters

Auxiliary Fuel Tank Vent Filter

The auxiliary fuel tank vent filter is tie strapped to the top of the auxiliary fuel filler neck hose.
The filter is serviced as an assembly and should be replaced if restricted or damaged.

Removal

1. Remove and discard the tie straps securing the vent hose to the fuel filler neck hose.
2. Disconnect the clamp from the filter's vent line.
3. Remove the filter from the vent line

Installation

1. Install the filter on to the vent line.
2. Install the vent line clamp.
3. Secure the vent line to the fuel filler neck with new tie straps.

Main or Auxiliary Tank Fuel Line Replacement (All)

Removal

1. Drain the fuel tank.
2. Remove the main or auxiliary fuel tank as described in this section.
3. Disconnect any electrical wires, linkage parts, cables, or lines as needed if insufficient slack exists.
4. Disconnect the fuel lines at the tank tubes.
5. Remove the line clamps and the tie straps.
6. Disconnect the lines at the fuel tank selector valve and remove the lines.
7. Remove the supply and/or the return lines as needed (Figure 3-19).

Installation

1. Route the new lines as needed (Figure 3-19). Be sure the lines are not kinked, pinched, or touching hot or rotating parts.
2. Secure the lines to the frame with clamps, brackets, P-clips, and tie straps as needed.
3. Connect the rear lines to the auxiliary or main tank as required.
4. Install the main or the auxiliary fuel tank as described in this section.
5. Verify that the fuel lines are securely connected and properly routed.
6. Refill the fuel tank.
7. Check the tank operation. Verify the proper transmitter operation and selector switch function.

Fuel Tank-To-Filler Neck Hose Replacement

Removal

1. Drain the fuel tank.
2. Remove the filler tube housing bolts.
3. Disconnect the filler tube vent hose.
4. Loosen the clamps and remove the hose from the tank and filler (Figure 3-23).

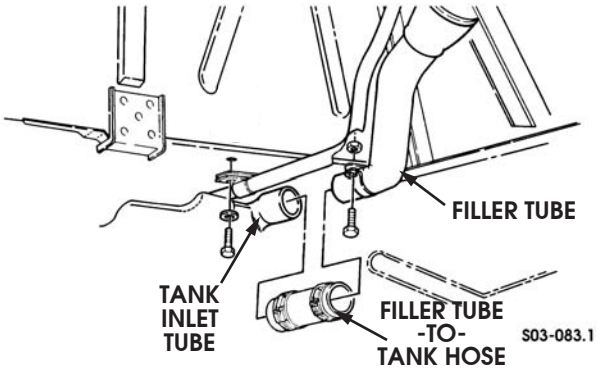


Figure 3-23: Filler Tube-To-Tank Attachment

Installation

1. Install the hose on the tank and the filler tube and tighten the hose clamps.
2. Install the filler tube and housing.
3. Fill the fuel tank and check for leaks.

Fuel Tank Draining

The fuel tank should only be drained with portable air powered drain equipment. This type of equipment is OSHA approved and will drain the tank through the filler neck.

The tank should be drained prior to removal. Follow the drain equipment manufacturer's instructions explicitly.

Main Fuel Tank

The main fuel tank is constructed of Polyethylene (Figure 3-24). It is mounted by two straps on the body, inside the right frame rail. An expandable-type drain plug is provided at the bottom of the fuel tank. The fuel tank top cover is accessible only by removal of the fuel tank from the vehicle. With the fuel tank removed, the fuel tank sending unit, fuel strainer and fuel supply tube may be serviced.

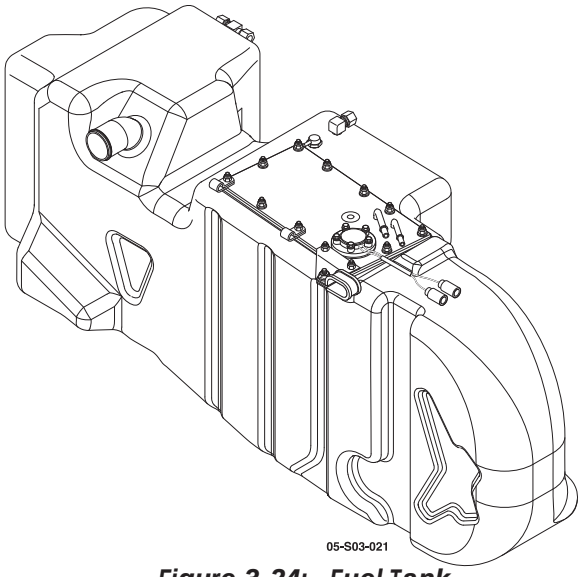


Figure 3-24: Fuel Tank

Removal

1. Drain the tank with the recommended equipment.
2. Remove the bolts attaching the fuel filler housing to the body.
3. Disconnect the tank vent lines, and hoses at the branch tee in the fuel filler housing.

4. Remove the clamps attaching the filler tube to the vent line or body.
5. Disconnect the filler housing ground strap.
6. Loosen the clamps securing the connecting hose to the filler tube and the housing (Figure 3-25).

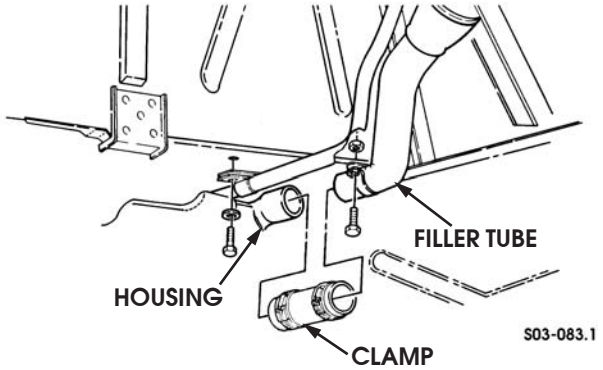


Figure 3-25: Filler Tube-to-Tank Attachment

7. Remove the fuel filler housing and the filler neck.
8. Raise the vehicle.
9. Remove the rear propeller shaft.
10. Remove the transfer case rear extension housing (Refer to section 5).
11. Rotate the rear axle yoke to a vertical position. The tank may not clear the yoke otherwise.
12. Support the tank with a transmission jack or a other suitable support device.
13. Remove the bolts and nuts attaching the front and rear upper straps to the lower straps (Figure 3-26).

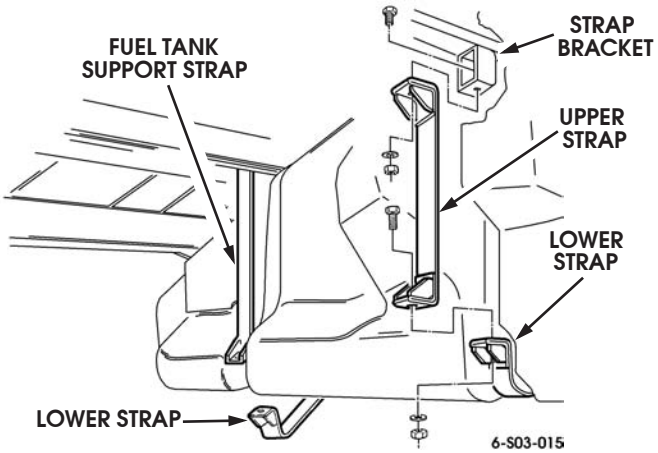


Figure 3-26: Fuel Tank Mounting Strap Attachment

14. Disconnect the vent lines at the fuel tank.
15. Lower the tank enough to gain access to transmitter wires and the fuel lines.
16. Disconnect the transmitter wires.
17. Disconnect but do not remove the rollover valve line.
18. Lower and remove the fuel tank.

Installation

1. Position the tank on a jack and raise the tank just enough to permit installation of the wires and lines.
2. Connect the fuel lines as follows:
   a. Push the lines onto the tank supply and return tubes. Note that the fuel supply tube is larger in diameter than the return tube.
   b. Push the line onto the tank tube until it snaps or clicks into place.

c. Pull on the lines to verify that there is a secure attachment.

3. Connect the wiring and vent lines. Also connect the rollover valve line.
4. Install the filler neck-to-tank hose on the fuel tank. Secure the hose with new clamp if required.
5. Position the tank and install the bolts and nuts that attach the tank upper to the lower retaining straps. Tighten the strap bolts to 23-27 lb.-in. (3 N•m) torque.

NOTE: If the upper and lower straps touch after bolt tightening, replace the straps. They are stretched and will not adequately secure the tank.

6. Install the transfer case rear extension housing.
7. Install the propeller shaft.
8. Connect the tank vent lines.
9. Lower the vehicle
10. Install the filler neck and connect the ground strap.
11. Install the filler neck housing and connect the vent line.
12. Refill the tank.
13. Start the engine and verify proper operation. Repair any leaks if necessary.

Fuel Level Transmitter/ Access Plate Replacement

The fuel level transmitter, vents, and access plate can all be serviced once the tank is out of the vehicle (Figure 3-27).

If the fuel tank requires replacement, be sure to replace all necessary gaskets, O-rings, seals, and strainer with new parts. Coat fitting threads with Loctite PST before installation.

Tank Cleaning

In cases where the tank was removed for correction of contamination, remove the transmitter and access plate for maximum access. Use a soap and water solution and low pressure steam gun. Be sure to clean out the fuel supply and return lines as well. The tank can be dried with compressed air or allowed to air dry as desired.

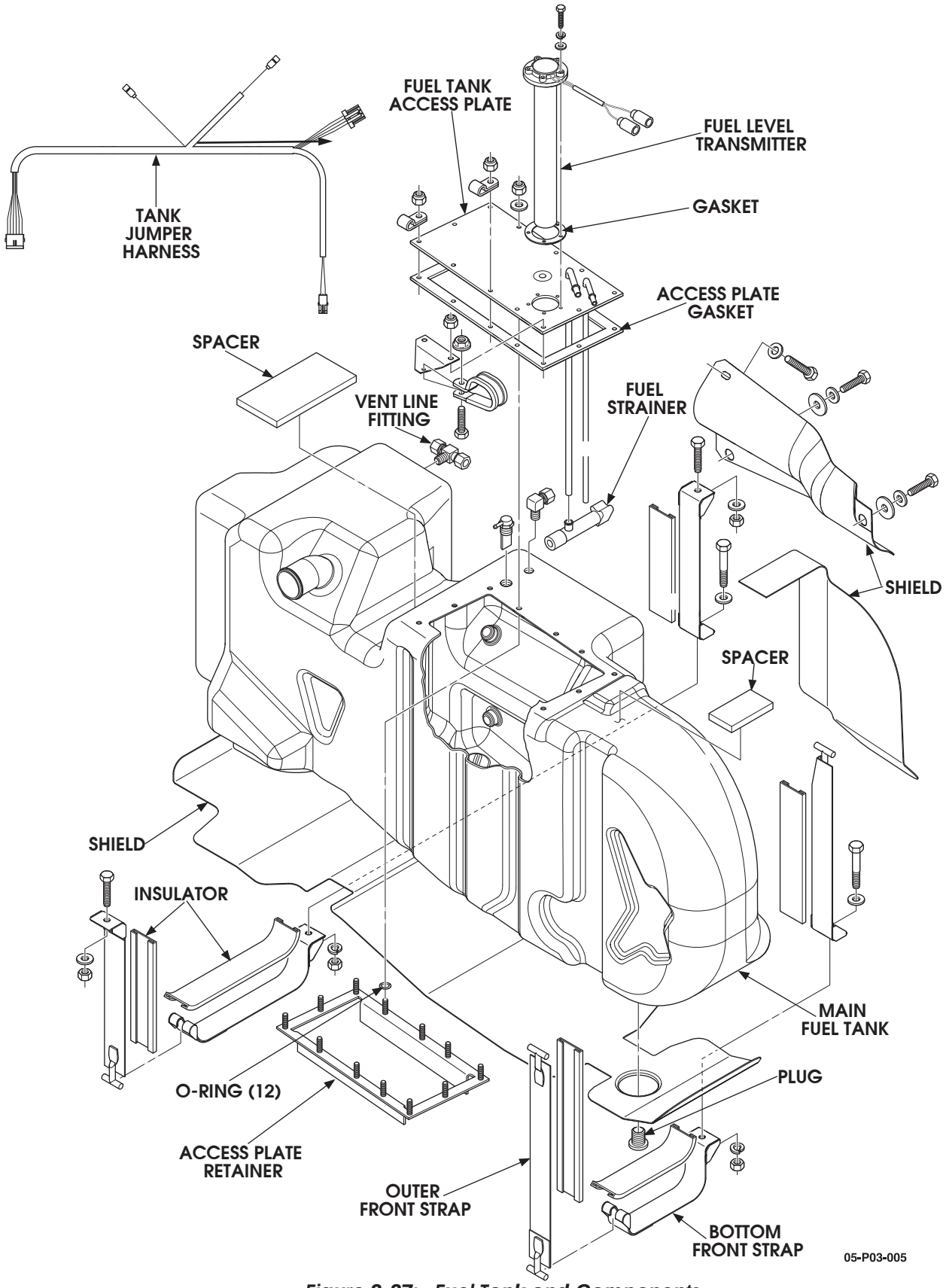


Figure 3-27: Fuel Tank and Components

Fuel Level Transmitter

Removal

1. Remove the screws, lock washers and the fuel level transmitter from the tank access plate (Figure 3-27).
2. Remove the locknuts, washers, access plate and the gasket from the tank.
3. Remove the access plate retainer and O-rings from the tank. Discard the O-rings.

Check the fuel level transmitter operation as follows:

1. Hold the transmitter in the upright or empty position.
2. Using an ohmmeter, check the resistance value at the terminals. Resistance should be 268 ± 20Ω.
3. Hold the transmitter in the inverted position simulating a full tank. Resistance should fall to 19.3 ± 8Ω.

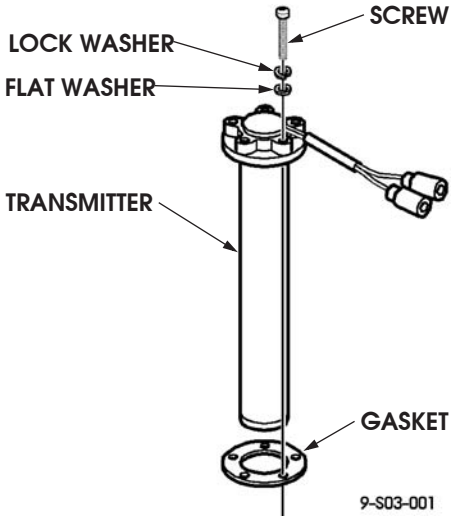


Figure 3-28: Fuel Level Transmitter

Installation

1. Thoroughly clean all the gasket surfaces.
2. Place the new O-rings on the access plate retainer studs and position the access plate retainer in the tank (Figure 3-28).
3. Set the gasket and the access plate over the studs and onto the tank.
4. Apply the liquid teflon thread sealant to the studs and loosely install the washers and the locknuts until no clearance exists between the access plate, gasket and the tank.
5. Snug the access plate locknuts in small increments and in a systematic circular pattern. Tighten the locknuts until the gasket bulges or until maximum torque of 72 lb-in. is obtained.
6. Apply the liquid teflon thread sealant to the transmitter mounting screws.
7. Secure the gasket and the transmitter to the access plate using the same method as indicated for the access plate above.
8. Cap all the tank fittings and perform a leak check. Apply leak check solution or soapy water around the access plate and the transmitter gaskets and the fasteners. Pump **3 p.s.i.** of compressed air into the tank and verify absence of leaks.

Auxiliary Fuel Tank

Removal

1. Drain the auxiliary fuel tank.
2. Remove the tank filler neck housing from the wheel house.
3. Remove the rear close out panel.
4. Remove the bolts attaching the auxiliary fuel tank filler neck and housing to the body.
5. Disconnect the fuel filler neck at the tank and vent line at the housing.
6. Support the auxiliary tank with a floor jack positioned under the fuel tank skid plate.

NOTE: Do not loosen or remove the bolts attaching the tank to the skid plate. The tank and skid plate will be removed as an assembly.

7. Remove the bolts and nuts attaching the fuel tank skid plate to the left and right frame brackets and the rear cross member.
8. Lower the tank enough to reach the fuel lines. Then disconnect the fuel lines, the fuel level transmitter wires, and the vent line. Mark the lines and the wires for assembly reference (Figure 3-29).

NOTE: The fuel supply and return lines are equipped with quick connect fittings. To disconnect, first lift and remove the fitting retainer from each fitting. Then pull the fittings free of the tank fuel tubes.

9. Lower the jack and remove the tank from under the vehicle.
10. Remove the fuel level transmitter and the access plate. (Refer to section 3).

Installation

1. If a new tank is being installed, transfer the fuel tank skid plate to the new tank.
2. Place the tank on a floor jack and position it under the vehicle.
3. Raise the tank enough to reach the feed lines.
4. Attach the vent line and the fuel level transmitter wires.
5. Connect the fuel lines. Push each line onto the fuel tank tube. Secure the lines with the retainers. Be sure the retainers are firmly seated in the line fittings.
6. Raise and align the fuel tank skid plate with the frame brackets and the rear cross member.
7. Install the fuel tank attaching bolts and nuts and tighten securely.
8. Install the fuel filler tube housing and the fuel filler cap.
9. Install the fuel filler tube shield in the wheelhouse.
10. Install the rear close out panel.
11. Refill the fuel tank.
12. Verify the tank operation and the fuel level reading.

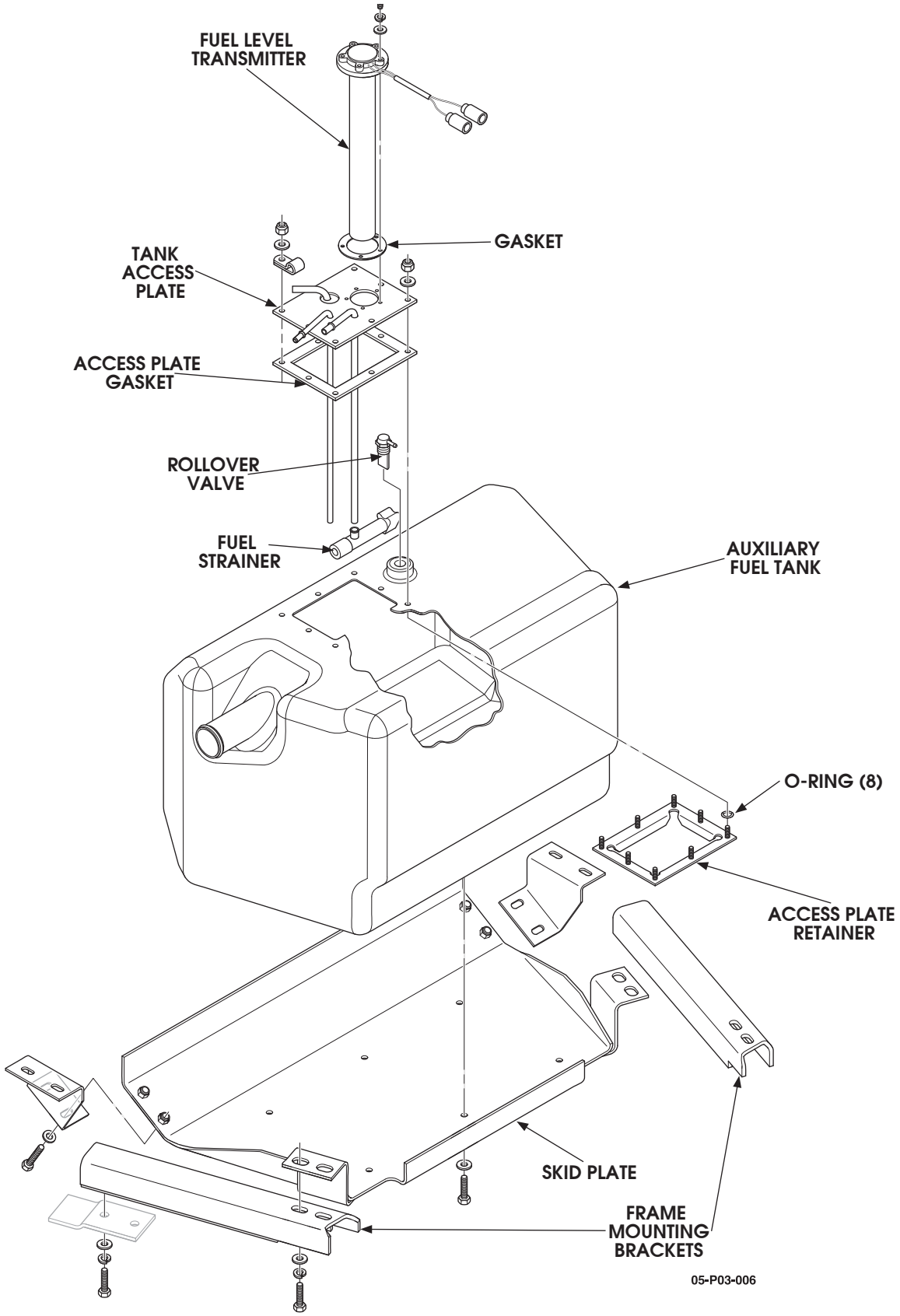


Figure 3-29: Auxiliary Fuel Tank Components

AIR CLEANER SERVICE

Removal

1. Remove the filter element (Figure 3-30).
2. Loosen the clamp and disconnect the air induction hose from the engine side of the air cleaner assembly.
3. Loosen the clamp and disconnect the CTIS inlet hose from the fitting on the air cleaner assembly.
4. Remove the central vent line from the fitting on the air cleaner assembly.
5. Remove the three screws holding the weathercap cover to the air intake duct.
6. Remove the three bolts and washers holding the air intake duct to the air intake support.
7. Remove the air intake duct and gasket.
8. Reaching through the air intake duct opening loosen the clamp holding the intake elbow to the air cleaner assembly and remove the intake elbow.
9. Loosen the two strap clamps from around the air cleaner assembly and remove them from each end.
10. Remove the air cleaner assembly.

Cleaning and Inspection

Replace the air filter if it is plugged or saturated with dirt. Clean the hose and the dust unloader with a shop towel. Clean the other components with solvent and examine for wear or damage. Replace the worn or damaged parts if necessary.

Installation

1. Install the intake elbow and the clamp on the air cleaner assembly. Do not tighten the clamp at this time.
2. Position the air cleaner assembly on the air intake support and align the elbow with the top of the support.
3. Tighten the clamp on the elbow to 45-53 lb-in. (5-6 N•m).
4. Position the air cleaner assembly and the strap clamps on the support brackets and tighten the clamps to 45-53 lb-in. (5-6 N•m).
5. Install the air intake duct and gasket to the air intake support and secure with three bolts and washers.
6. Install the weathercap and secure with three screws.
7. Connect the CTIS inlet hose to the fitting on the air cleaner and secure with the clamp.
8. Install the central vent line to the fitting on the air cleaner assembly.
9. Install the air induction hose to the engine side of the air cleaner assembly tighten clamp to 45-53 lb-in. (5-6 N•m).
10. Install the filter element.
11. If using a new canister, install new emissions labels on the canister in their original positions.

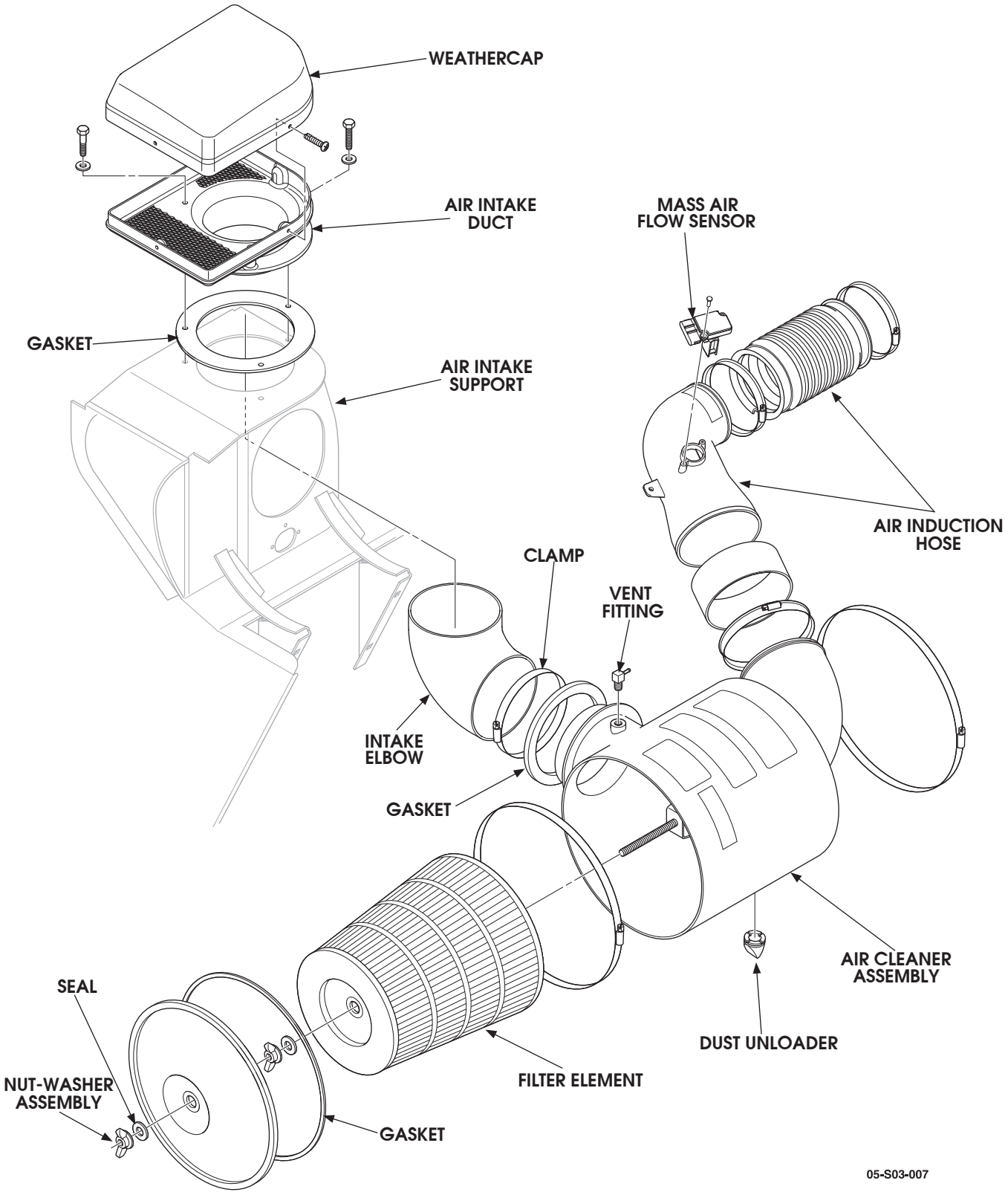


Figure 3-30: Air Cleaner Assembly and Dust Unloader

Air Cleaner Filter Element Service

Removal

1. Remove the nut-washer assembly and the seal securing the cover to the air cleaner assembly (Figure 3-31).
2. Remove the cover and gasket from the air cleaner assembly.
3. Remove the nut-washer assembly securing the filter element to the stud and pull the filter element out from the air cleaner assembly.

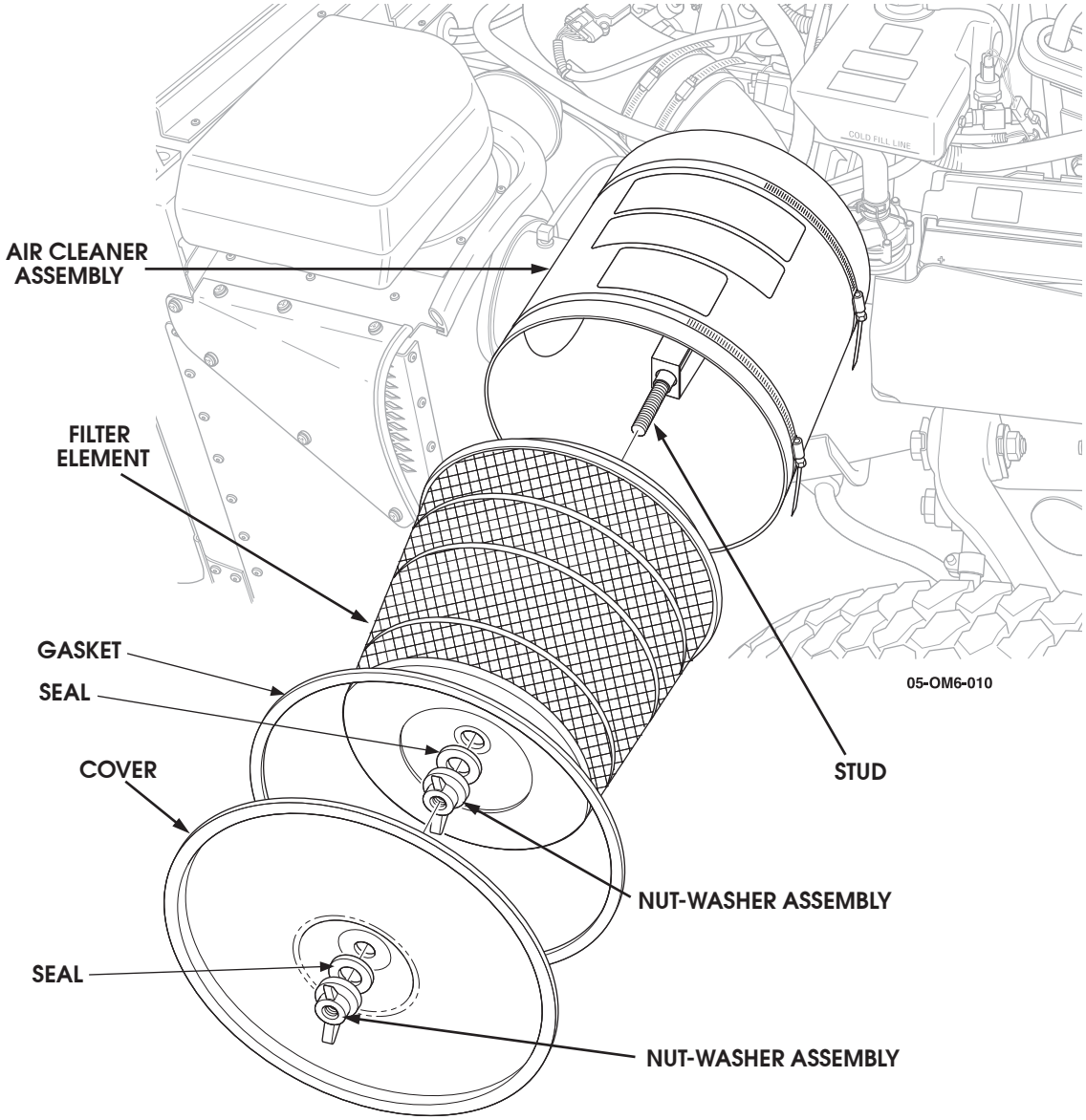


Figure 3-31: Air Cleaner Filter Element Removal/Installation

Inspection/Cleaning

1. Clean the components with compressed air, examine for wear or damage and replace if necessary.
2. Remove the dirt and dust from the air filter element by gently tapping around the air filter element and directing flow of compressed air from the inside to the outside of the filter element.

Installation

1. Slide the air filter element onto the air cleaner stud and install the seal and the nut-washer assembly and tighten to 18-35 lb-in. (2-4 N•m) (Figure 3-31).

2. Install the cover, gasket and the seal onto the air cleaner assembly and tighten the nut-washer assembly to 18-35 lb-in.

AIR HORN

Removal

1. Loosen the clamp and the remove air induction hose from the air horn.
2. Remove the PCV hose and pipe assembly from the air horn.
3. Loosen the clamp that secures the air horn to the turbo charger inlet.
4. Remove the air horn.
5. Cover the turbo charger opening to prevent any dirt entry.

Installation

1. Install the air horn on the turbo charger inlet and torque the clamp to 41 lb-in. (4.6 N·m).
2. Install the PCV hose and pipe assembly to the air horn.
3. Install the air induction hose to the air horn and torque the clamp to 35 lb in (4 N·m).

Air Induction Hose Replacement

Removal

1. Loosen the induction hose clamps.
2. Unplug the mass air flow sensor connector.
3. Remove the hose from the air horn and the air cleaner (Figure 3-30).

Installation

1. Install the induction hose on the air horn and the air cleaner.
2. Connect the mass air flow sensor connector.
3. Tighten the hose clamps to 44 lb.-in. (5 N•m).

Weathercap Replacement

Removal

1. Remove the three screws holding the weathercap cover to the air intake duct (Figure 3-32).
2. Remove the three bolts and washers holding the air intake duct to the air intake support.
3. Remove the air intake duct and gasket.

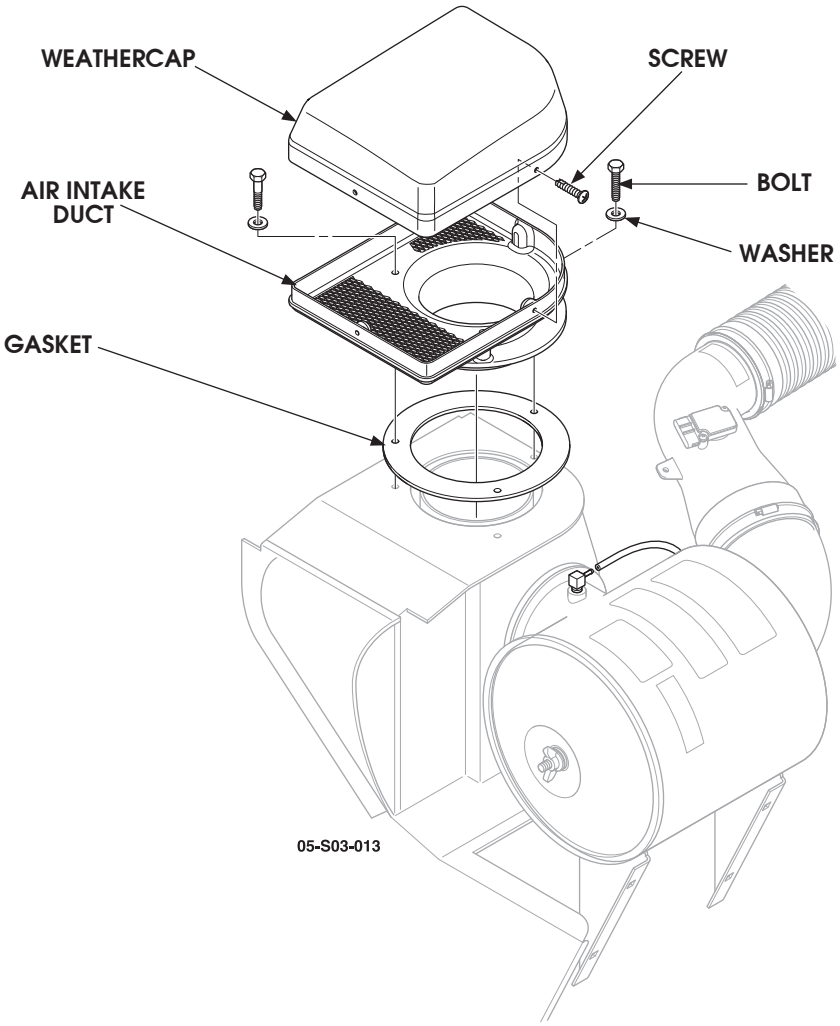


Figure 3-32: Weathercap Mounting

Installation

1. Install the gasket and air intake duct, secure with the three bolts and washers.
2. Install the weathercap and secure with three screws.

Drainage Fitting Replacement

Removal

1. Remove the air cleaner assembly.
2. Remove the three screws and the drainage fitting from the air intake support (Figure 3-33).

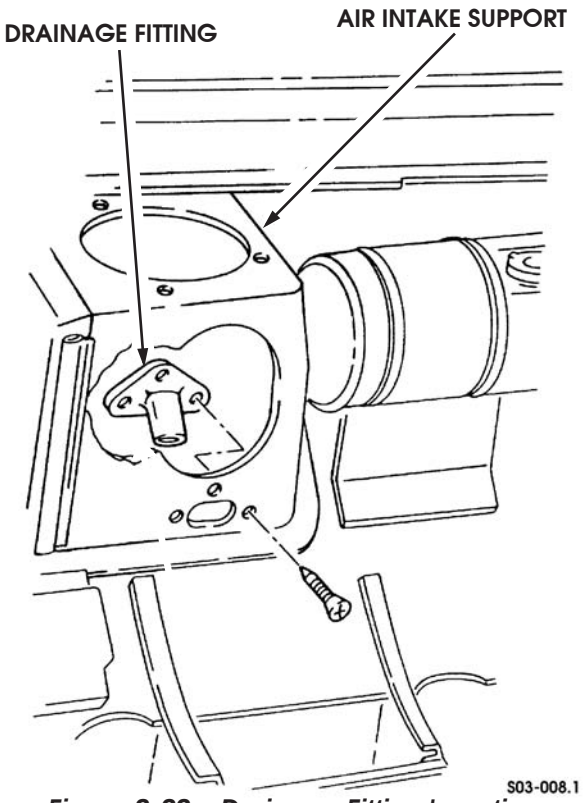


Figure 3-33: Drainage Fitting Location

Installation

1. Position the drainage fitting on the air intake support and install the fitting screws (Figure 3-33).
2. Install the air cleaner assembly.

Central Vent Line Replacement

Removal

Remove the central vent line from the tee fitting and the air cleaner fitting (Figures 3-29 and 3-30).

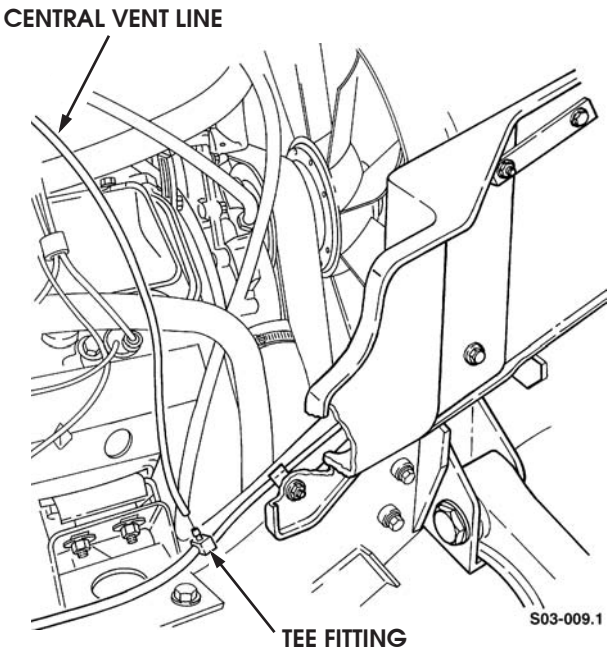


Figure 3-34: Central Vent Line Routing

Installation

Install the central vent line on the tee fitting and the air cleaner fitting (Figures 3-29 and 3-30).

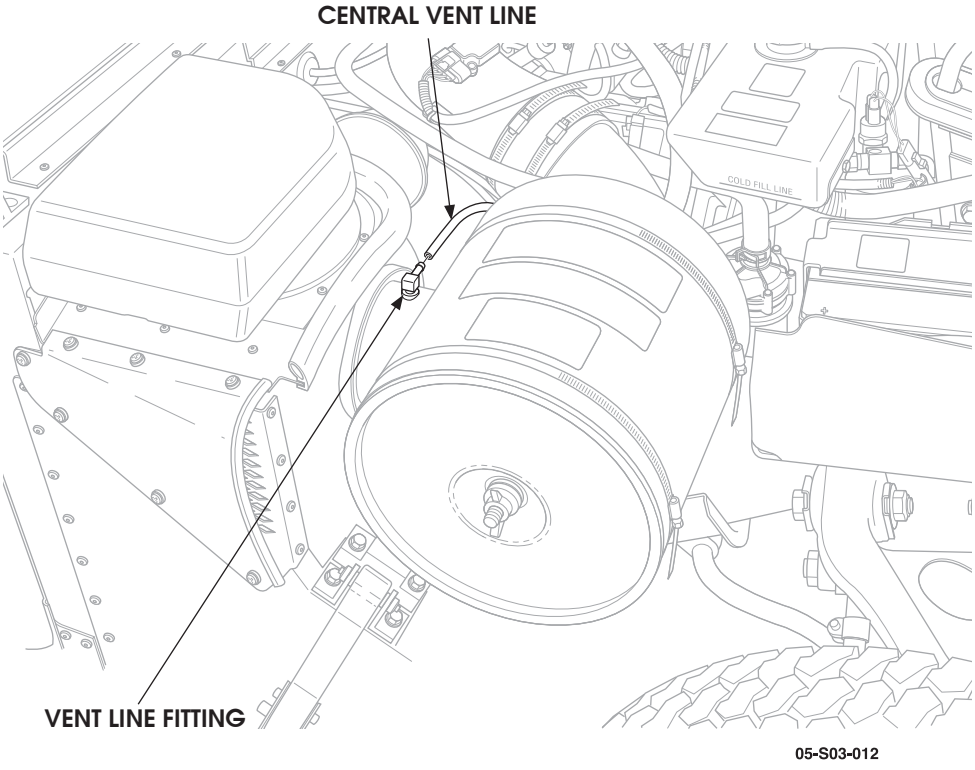


Figure 3-35: Central Vent Line Fitting Location

Positive Crankcase Ventilation (PCV) Valve

A crankcase ventilation system is used in order to provide a more complete scavenging of crankcase vapors. There are two PCV valves, one on each valve cover, that feed crankcase gases from the rocker covers into the turbocharger inlet. At higher engine speeds crankcase gases are drawn into the turbocharger inlet. At lower speeds, turbo suction is insufficient to draw in the gases.

Crankcase Ventilation System Inspection/Diagnosis

Concern	*Action*
PVC check valve stuck closed	Excessive crankcase pressure Possible oil leaks. Replace the valve.
Odors	Normal situation
Noise	Cracked hoses
Smoke	Damaged PCV diaphragm
Excessive Oil Consumption	Damaged PCV diaphragm, missing or broken spring

NOTE: Oil in the charged air cooler, hoses, turbocharger, or intake manifolds is normal with a closed crankcase ventilation system.

The maximum crankcase pressure is 4 kPa or 16 in of water at 3,100 RPM measured at the oil level indicator tube.

Exhaust Gas Recirculation (EGR) System

EGR is used as an emission control technique for reducing oxides of nitrogen (NOx) at the tailpipe. A small amount of exhaust is recirculated back into the intake manifold to dilute the incoming air charge. This has a cooling effect on combustion temperature which helps reduce the formation of NOx. The charge is further cooled by a liquid to gas cooler prior to introducing the exhaust into the intake manifold. The EGR system is monitored by the ECM with the help of a temperature sensor located in the mass air flow sensor.

EGR Valve

The EGR valve motor is a direct current (DC) stepper motor utilizing a worm gear that extends from the motor to push on the EGR valve stem (Figures 3-36 and 3-37). The worm gear is not attached to the valve stem, and can only force the valve open. A return spring is used to force the valve closed.

Removal

1. Disconnect the negative battery cable.
2. Drain the cooling system (Refer to section 4).
3. Remove the air induction hose (Refer to section 3).
4. Remove the EGR cooler tube (Refer to section 3).
5. Remove the EGR valve bolts and remove the EGR valve and discard the EGR valve gasket.

Installation

1. Install the EGR valve with a new EGR valve gasket and torque to 15 lb-ft. (20 N·m).
2. Install the EGR cooler tube.
3. Install the air induction hose and torque the clamps to 35 lb-in. (4 N·m)
4. Fill and bleed the cooling system.
5. Connect the negative battery cable.

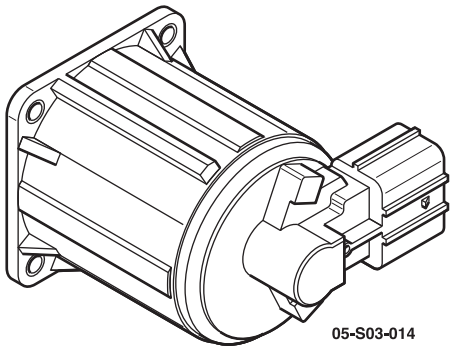


Figure 3-36: EGR Valve

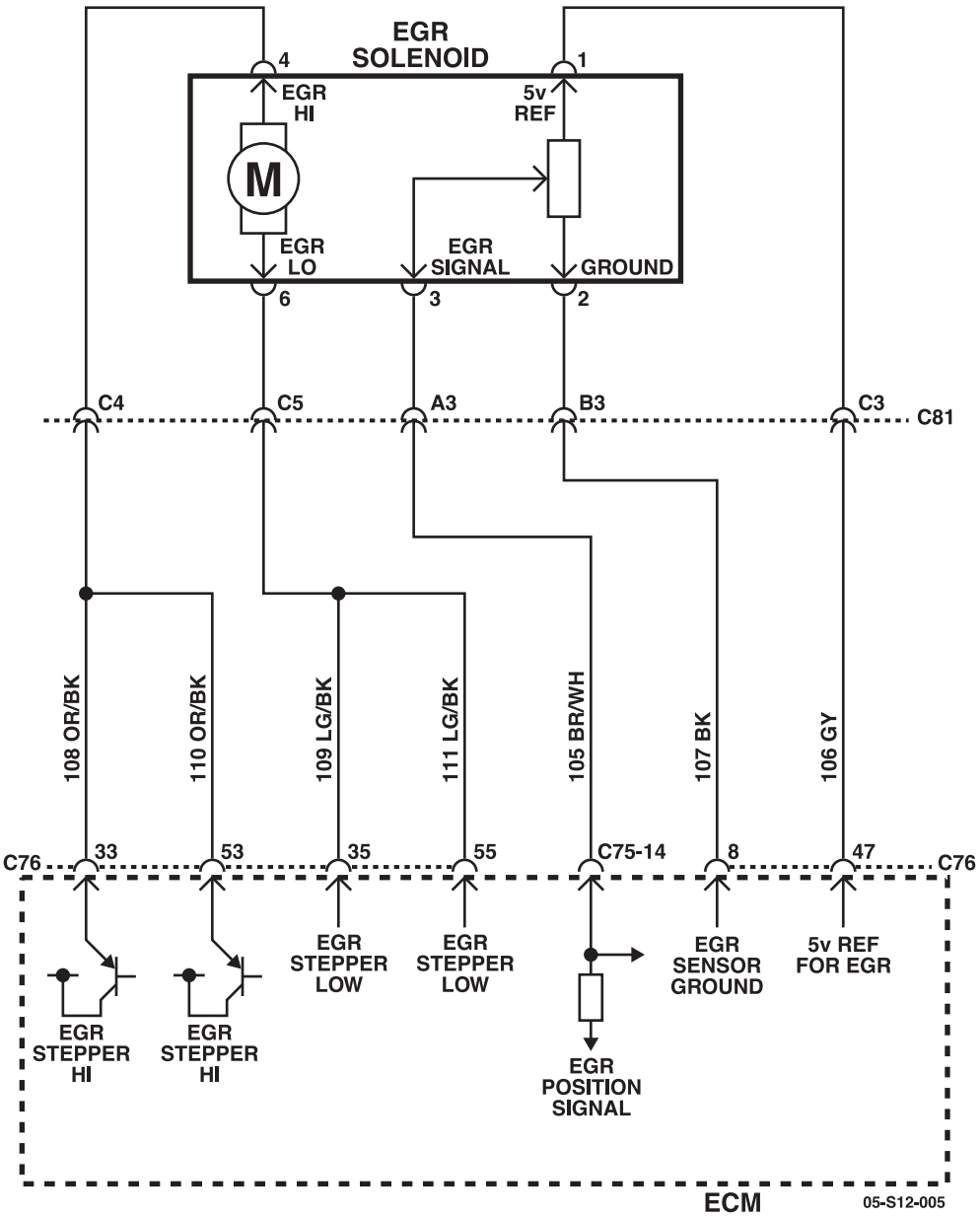


Figure 3-37: EGR Valve Electrical Circuit

EGR Cooler

The EGR cooler, located next to the right side intake manifold, has engine coolant circulating through it to cool the exhaust charge before it enters the intake manifold (Figure 3-38).

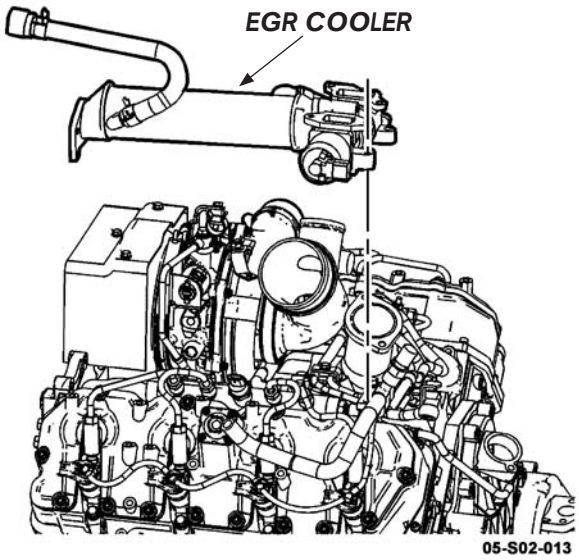


Figure 3-38: EGR Cooler

Removal

1. Disconnect negative battery cable.
2. Drain the cooling system (Refer to section 4)
3. Remove the air induction hose (Refer to section 3).
4. Loosen the charged air cooler outlet duct to intake hose clamp.
5. Remove the charged air cooler outlet duct from the intake.
6. Remove the right side positive crankcase ventilation (PCV) hose/pipe.
7. Remove the air inlet tube to intake manifold tube bolt and nut (Figure 3-39).
8. Remove the air inlet tube nuts (Figure 3-40).
9. Remove the air inlet tube.
10. Disconnect the exhaust gas recirculation (EGR) valve electrical connector.
11. Disconnect the EGR cooler heater hose.
12. Remove the EGR coolant pipe bolts.
13. Remove the EGR coolant pipe.
14. Remove the EGR cooler bolts (Figures 3-41 and 3-42).
15. Remove the EGR cooler.

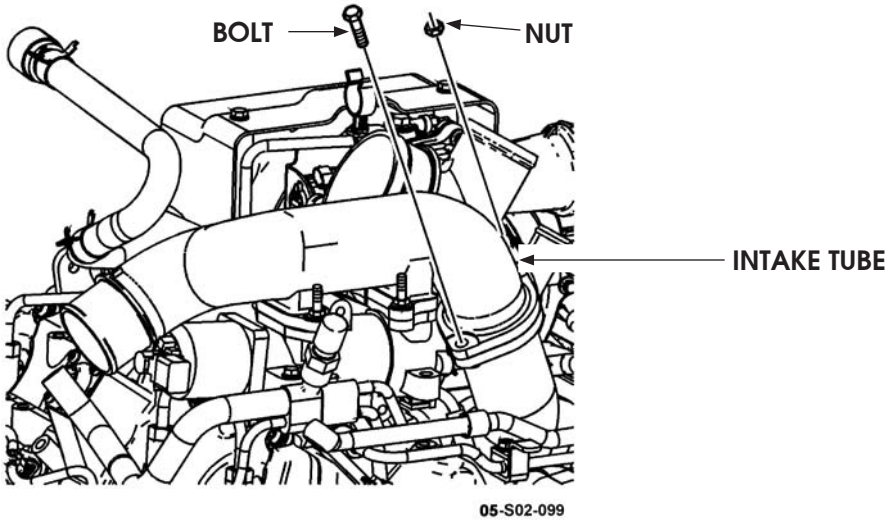


Figure 3-39: Intake Manifold Tube Bolt and Nut

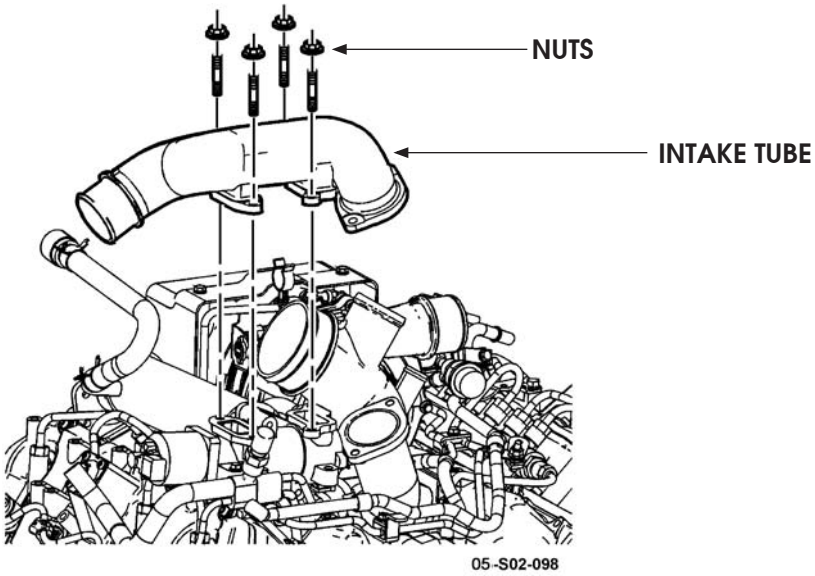


Figure 3-40: Air Inlet Tube Nuts

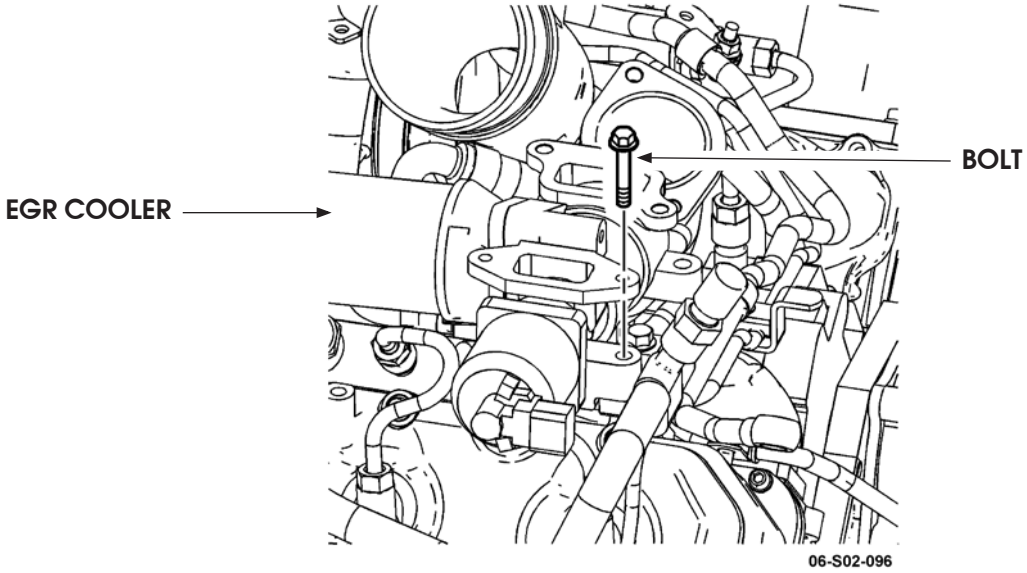


Figure 3-41: EGR Cooler Upper Bolts

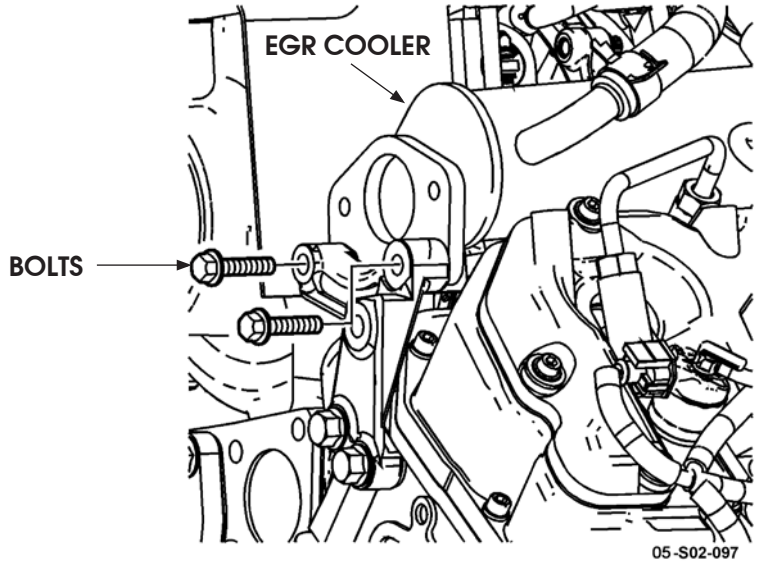


Figure 3-42: EGR Cooler Rear Bolts

Installation

1. Install the EGR cooler and torque the rear bolts to 15 lb-ft. (20 N·m) (See Figure 3-42) and the upper bolts to 37 lb-ft. (50 N·m) (See Figure 3-41).
2. Install the EGR coolant pipe and torque the bolts to 18 lb-ft. (25 N·m).
3. Connect the EGR cooler heater hose.
4. Connect the EGR valve electrical connector.
5. Install the air inlet tube.
6. Install the air inlet tube nuts and torque to 18 lb-ft. (25 N·m).
7. Install the air inlet tube to intake manifold tube bolt and nut and torque to 89 lb-in. (10 N·m).
8. Install the right side PCV hose/pipe.
9. Install the air induction hose and torque the clamps to 35 lb-in. (4 N·m)
10. Fill and bleed the cooling system.
11. Connect the negative battery cable.

EXHAUST SYSTEM

The 6.6L turbo diesel exhaust system consists of two cast iron manifolds a turbocharger, turbo down pipe, intermediate pipe, catalytic converter and tailpipe. All exhaust components are made from stainless steel and assembled using grade 8 hardware. Service to the exhaust system is replacement only (Figures 3-43 and 3-44).

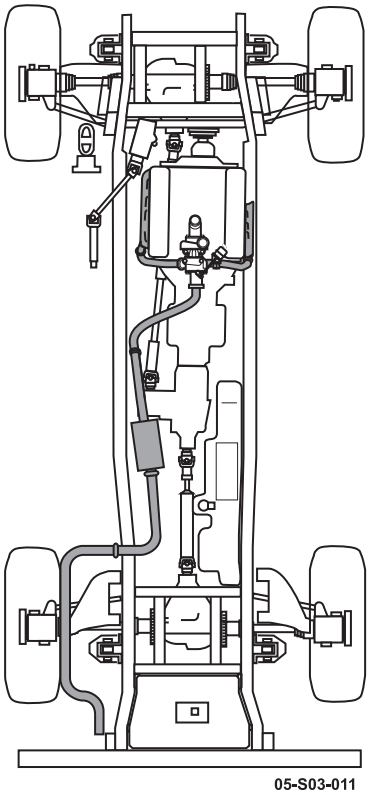


Figure 3-43: Turbo Diesel

Turbo Down Pipe Replacement

Removal

1. Remove the engine cover.
2. Remove the intermediate pipe heat shield.
3. Remove the exhaust clamps from the turbo to the down pipe, and from the down pipe to the intermediate pipe (Figure 3-44).
4. Loosen the transfer case to exhaust pipe bracket bolt.
5. Remove the down pipe and gasket.
6. Remove all of the gasket material from the intermediate pipe.

Installation

7. With new gaskets, position the new down pipe on the turbo and intermediate pipe. Tighten the clamps to 11 lb-ft. (15 N·m).
8. Tighten the exhaust bracket bolt at the transfer case to 26 lb-ft. (35 N·m).
9. Install the heat shield.
10. Install the engine cover and the console.
11. Start and run the engine. Verify that the exhaust components are clear of the body, frame and driveline components.

Catalytic Converter Replacement

Removal

1. Loosen or remove the necessary frame brackets and clamps that retain the converter and the pipe (Figure 3-44).
2. Remove the clamp attaching the converter to the intermediate pipe.
3. Remove the flange bolts attaching the converter to the tail pipe.
4. Remove the bolt at the transfer case bracket.
5. Remove the converter and gaskets.

Installation

6. With new gaskets position, the new converter assembly in the vehicle and loosely install the flange bolts and clamp.
7. Connect the necessary exhaust brackets and clamps to the frame as required.
8. Torque the exhaust flange bolts to 26 lb-ft. (35 N•m).
9. Torque the clamp to 11 lb-ft. (15 N·m).
10. Tighten the frame bracket bolts.
11. Tighten the transfer case exhaust bracket bolt to 26 lb-ft. (35 N•m).

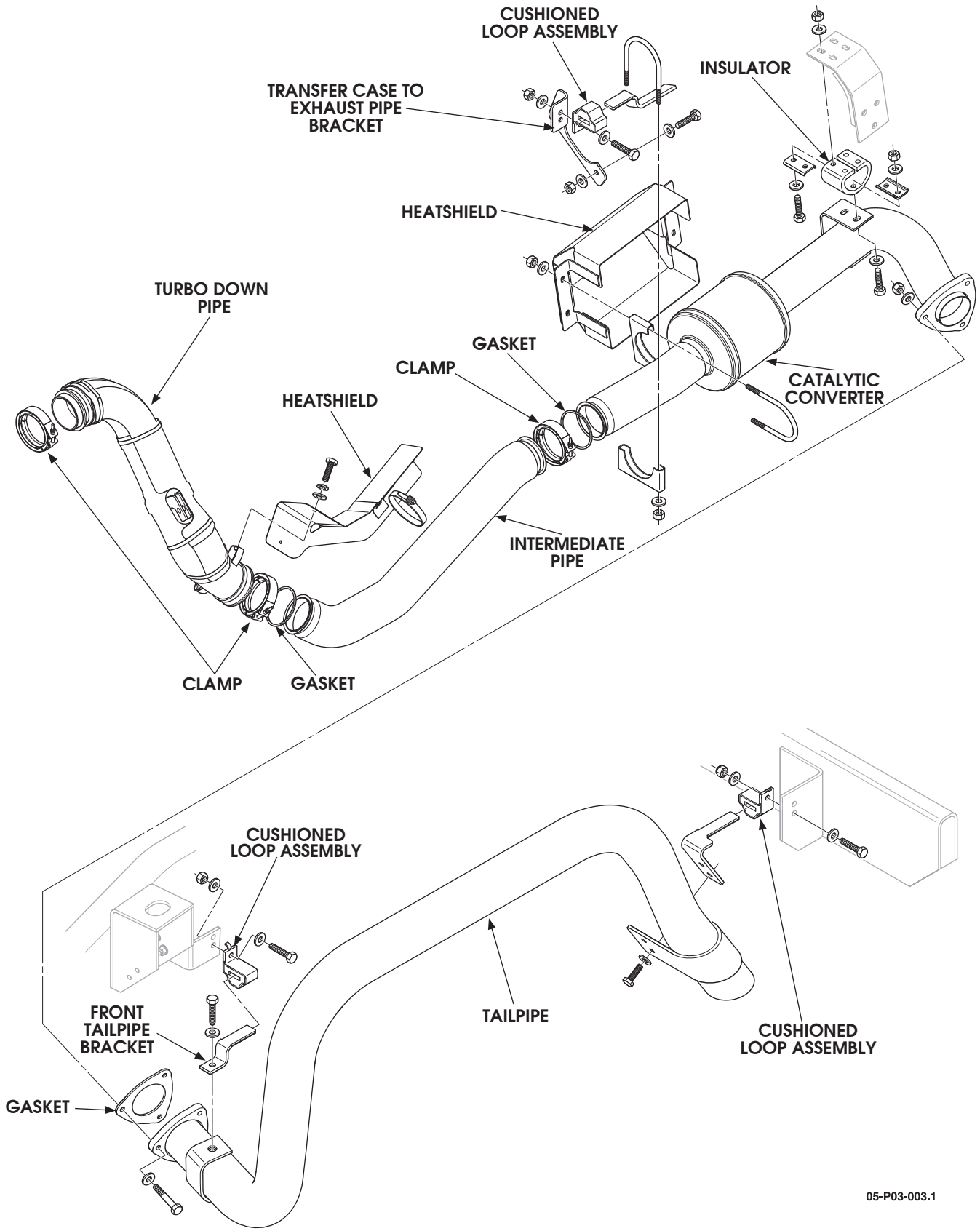


Figure 3-44: Exhaust System For VIN 6E226860 And Numerically Lower

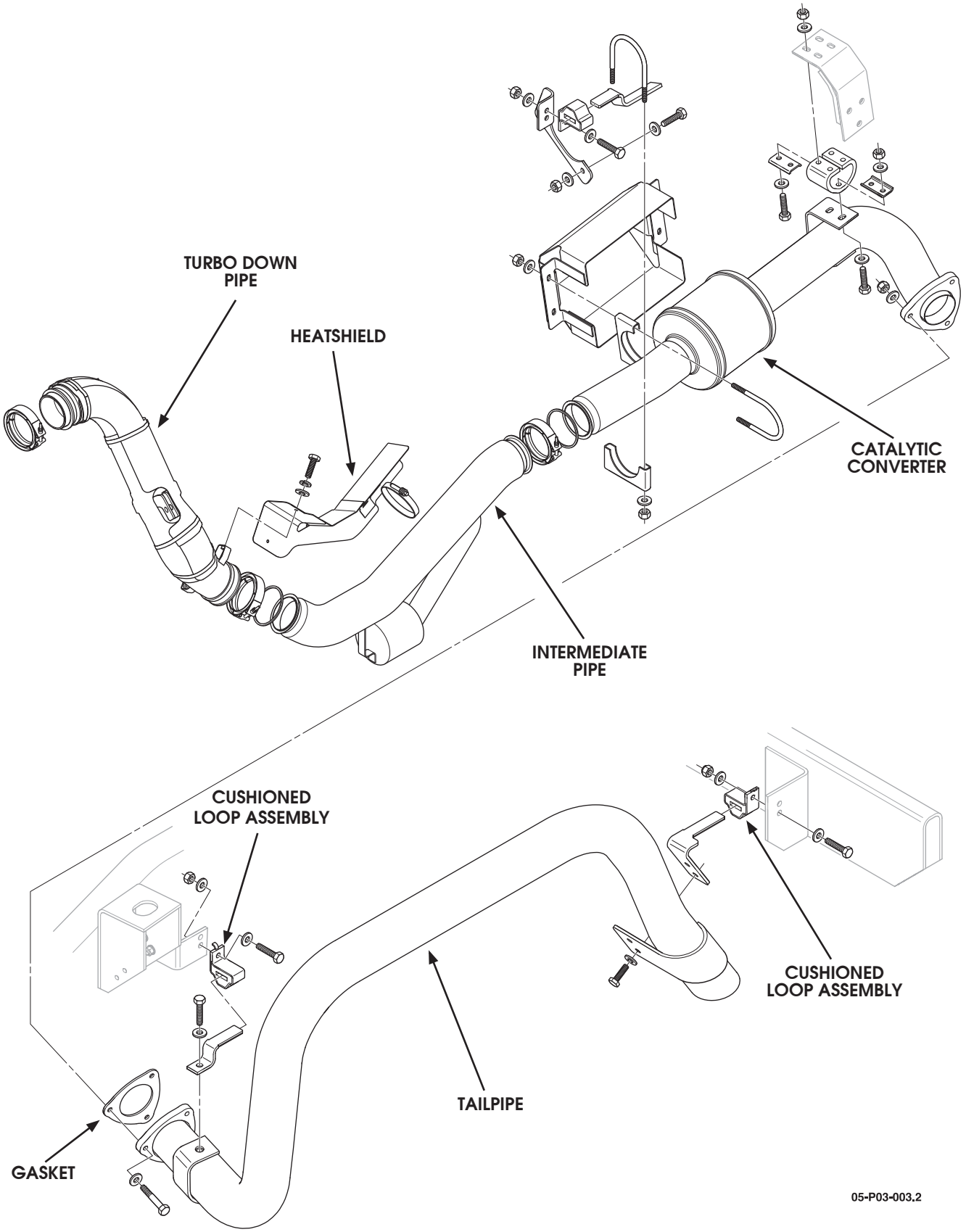
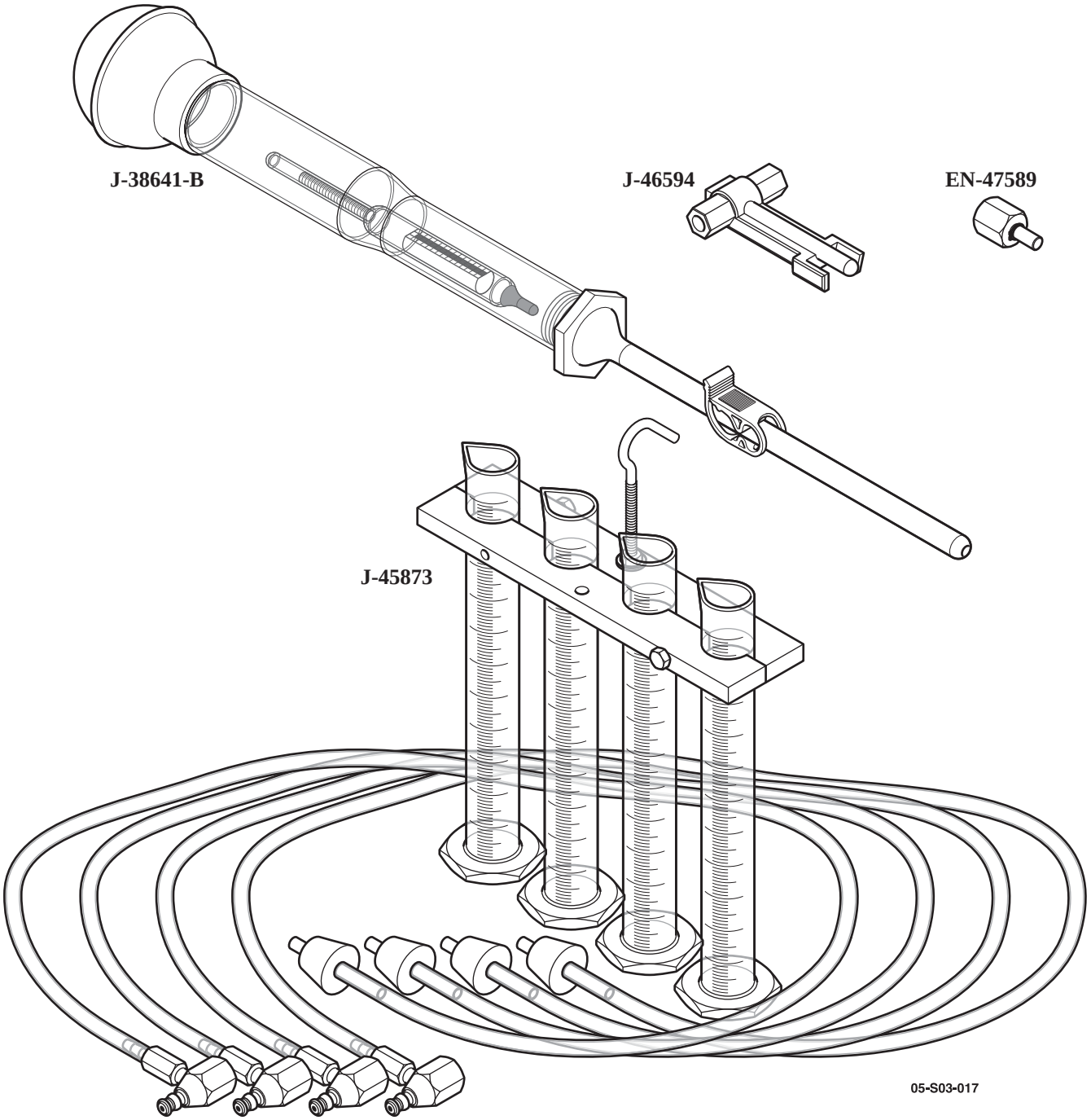


Figure 3-45: Exhaust System For VIN 6E226861 and Numerically Higher

ESSENTIAL TOOLS



Tool No.	Description
J-46594	Fuel Injector Remover
J-38641-B	Diesel Fuel Hydrometer
J-45873	Fuel Return Volume Test Kit
EN-47589	Fuel Pressure Adapter Cap

Procure from Kent-Moore.

Section 4 Cooling System

TABLE OF CONTENTS

Automatic Belt Tensioner and Belt Length Scale 4-28
Engine Cooling System
- Description 4-1
- Diagnosis and Troubleshooting 4-4
- Service 4-8

Fan and Clutch Assembly Service 4-27
Geared Fan Drive (GFD) Assembly Service 4-27
Low Coolant Sensor 4-20
Radiator
- Lower Hose Replacement 4-15
- Lower Tube Assembly Replacement 4-15
- Rear Support Bracket 4-9
- Upper Hose Replacement 4-14

Radiator and Fan Shroud Assembly 4-5
Serpentine Belt Replacement 4-26
Surge Tank
- Overflow Hose Replacement 4-17
- Replacement 4-10
- Tank-to-Lower Radiator Tube Hose 4-18
- Tank-to-Radiator Vent Hose 4-12

Thermostat Bypass Hose Replacement 4-12
Thermostat Replacement 4-21
Water Outlet Pipe Thermostat To Upper Radiator Hose Replacement 4-14
Water Pump
- Auxiliary 4-24
- Inlet Hose Replacement 4-17

Water Pump and Adapter Plate 4-22, 4-24

ENGINE COOLING SYSTEM DESCRIPTION

The cooling system removes excess heat from the engine, engine oil, power steering fluid, transfer case fluid, and transmission fluid. Some engine heat is beneficial, but excess heat can cause engine oil to break down. If lubrication is significantly reduced, engine damage may result. To keep the oil at the proper temperature, the cooling system dissipates some of the heat produced by the engine.

The water pump is gear driven by the crankshaft and does not rely on the serpentine belt for operation.

The cooling fan is also driven by the crankshaft through a geared fan drive assembly and viscous connection.

The cooling system is a closed continuous flow system with a pressure cap rated at 15 psi. The coolant travels through the engine block and circulates around the parts of the engine which generate heat: the cylinders, cylinder heads, combustion chambers, valve guides, valve seats, etc. As coolant is routed through the engine block, heat is transferred from the engine to the coolant.

The water crossover on diesel engines collects coolant from the cylinder heads, and channels it to the thermostat housing. To prevent the engine from being over-cooled, two thermostats monitor the temperature of the coolant and prevent it from being routed to the radiator until it has reached a temperature high enough to require cooling. The first thermostat begins to open at 180°F (82°C) and is fully open at 203°F (95°C), the second one opens at 185°F (85°C) and is fully open at 212°F (100°C).

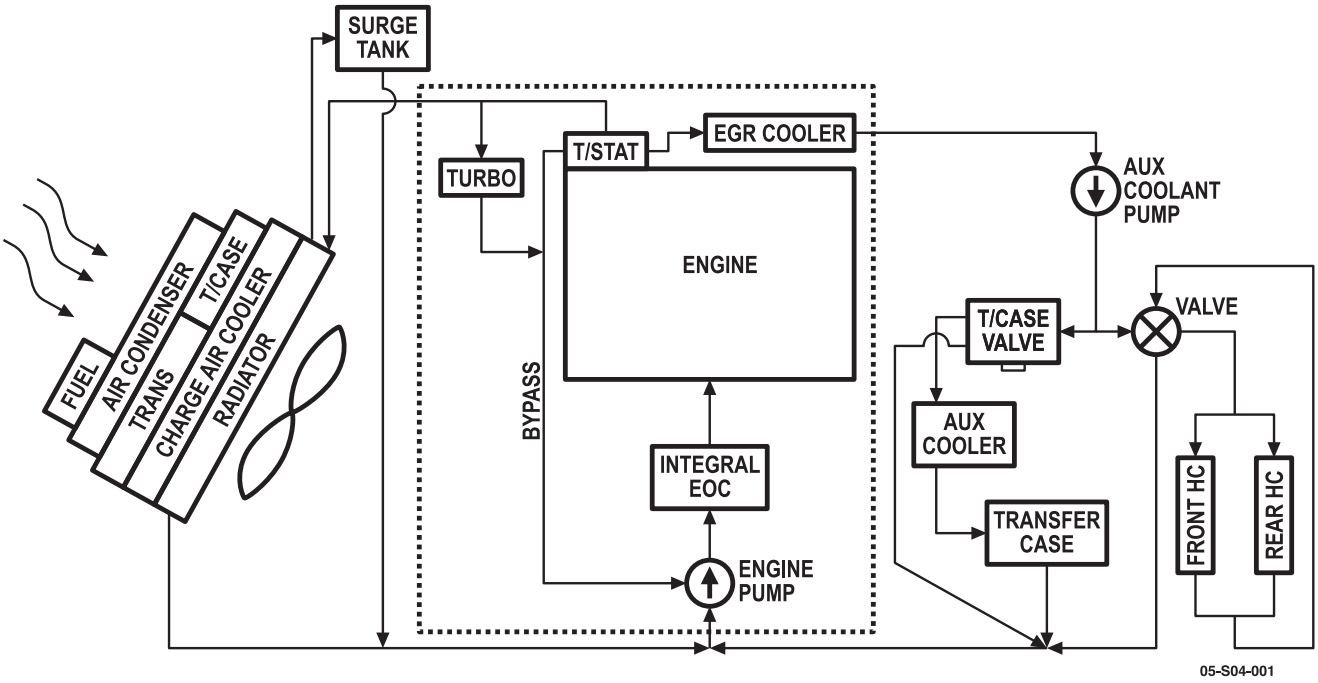


Figure 4-1: Cooling System Routing

When the thermostat detects the coolant is hot, the thermostat opens, and allows the coolant to be pumped to the radiator where it is routed through a series of fins and tubes. A fan draws in the outside air to help dissipate the heat before the coolant is recirculated back through the engine (Figure 4-1).

The fan is driven from the engine crankshaft via the geared fan drive (GFD) and a viscous drive (Figure 4-2). The GFD unit is supported by the number two cross member, connects to the harmonic balancer of the engine and places the viscous drive and fan assembly on the same plane as and close to the radiator for maximum cooling efficiency. A helical gearset is utilized within the GFD to change the drive angle from the crankshaft to the fan. 75W-90 synthetic gear lube with friction modifier lubricates the internal components of the GFD using an integral reservoir and pump. Two constant velocity joints and a torsional drive shaft connect the GFD to the engine crankshaft at the harmonic balancer.

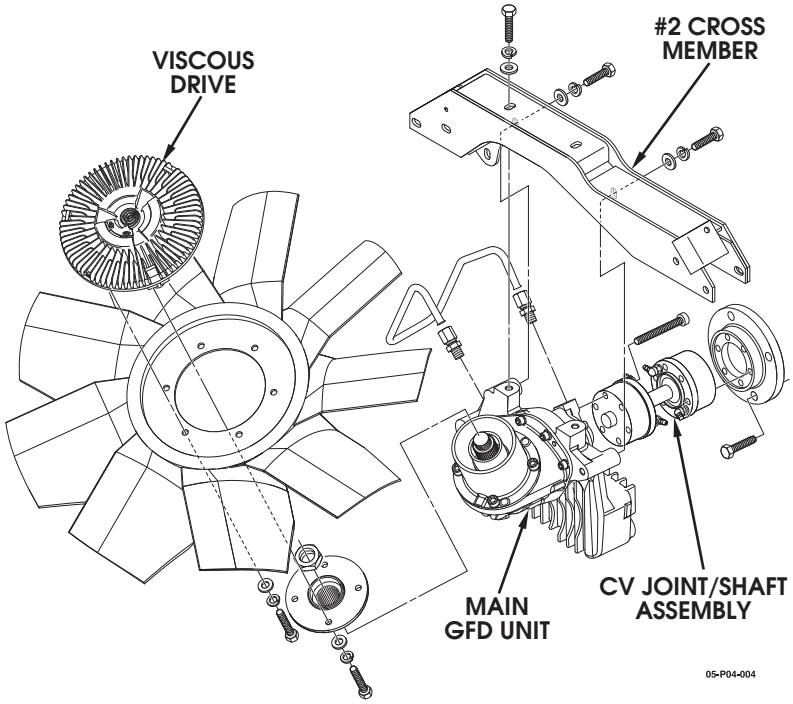


Figure 4-2: Geared Fan Drive Assembly

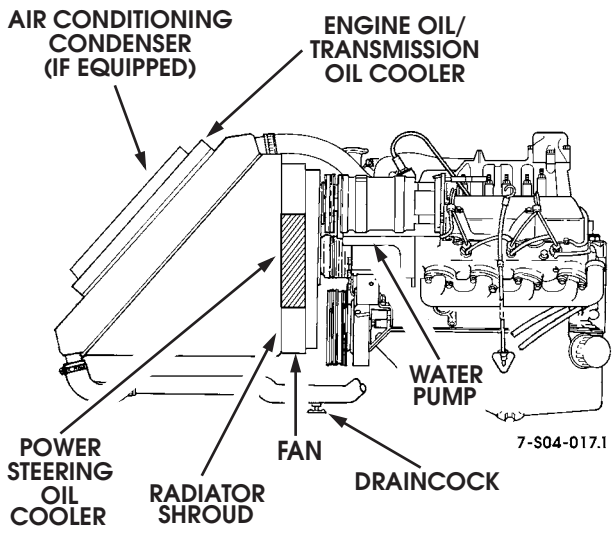


Figure 4-3: Cooling System

The heater provides heat to warm the interior of the vehicle for passenger comfort. Hot coolant leaves the engine and passes through a heater coil. A fan draws air through the heated coil which heats the air. The air is then channeled through a plenum chamber that directs the flow of the heated air into the passenger compartment.

If the engine is generating more heat than the cooling system can effectively dissipate, there may be a coolant or cooling system problem. The engine temperature sending unit transmits a signal indicating the coolant temperature to the temperature gauge on the instrument panel to let the driver know that the system should be serviced as soon as possible. Engine coolant is added to the system through the filler cap in the surge tank. After adding or refilling the cooling system, open the valve on the radiator and bleed the air from the system.

Like the radiator, the transmission oil/transfercase coolant cooler also uses a series of fins and tubes to dissipate heat from fluid. The upper half of the cooler dissipates heat from the engine coolant that is circulated through the transfercase cooler while the lower half cools transmission fluid (Figure 4-3).

The transmission fluid is cooled by the bottom half of the split cooler. Transmission fluid flows from the transmission oil outlet to the bottom half of the oil cooler where it returns to the transmission.

The bottom of the transmission torque converter housing provides for the direct mounting of a control main filter and two ports to facilitate the attachment of the oil cooler lines. The transmission cooler lines connect to a aluminum block on there way to the cooler. This block houses a pressure/thermal by-pass valve that directs the cooler circuit fluid back to the transmission until operating temperature is reached. This provides for quicker warm up of the transmission fluid.

The thermal wax element in the valve will start to move up at around 150°. By 180° the valve and seat have closed off the center port and all fluid is directed to the cooler. The owner would be alerted of an overheat condition of the transmission by the gauge and the warning light on the dash. A technician should inspect and clean this valve and block during a transmission replacement or major overhaul. Proper cooler flushing techniques with the J45096 is mandatory with encrypted code documentation on the repair order. Proper hook up location of the cooler flusher lines is the exit and entrance lines from the block to the cooler. The cooler lines from block to transmission also need to be flushed. The unit is serviced as an assembly. Check the most current service information for procedures.

The separate smaller oil cooler, mounted to the number one cross member, is used to cool the power steering fluid (Figure 4-3).

Two fluid returns are used: one from the hydro-boost and one from the power steering gear. Fluid flow through the hydro-boost is never completely restricted during braking. The hydro-boost incorporates a fluid return to release the hydraulic pressures used when applying the brakes (see Section 8 for service procedures).

ENGINE COOLING SYSTEM DIAGNOSIS AND TROUBLESHOOTING

WARNING: Do not release the surge tank cap when the engine is hot. The steam and/or the coolant may cause serious injury.

Loss of Coolant

1. Pressurize the system and check for leaks at all the cooling system hoses.
   a. Tighten the loose clamps, fasteners, and fittings.
   b. Replace the leaking hoses.
2. Pressurize the coolant system to check for leaks at the water pump or around the cylinder heads. If any leakage is present, replace the cylinder head gaskets, the cylinder heads, and the water pump.
3. Check the cylinder block for cracks, and replace it if the cylinder block is cracked.
4. Check the expansion plugs and the block heater for leaks.
5. Check the radiator and surge tank.
6. Remove the surge tank cap. With the engine running, check for excessive bubbles in the surge tank that may indicate a leaking head gaskets or a cracked cylinder head. If bubbles are present, remove the cylinder heads and check for defective head gaskets, cracked cylinder heads, or a cracked cylinder block. Replace the cylinder heads if damaged. Replace the engine if cylinder block is cracked.

Engine Coolant Temperature Gauge In The Red Zone, Engine Overheats

1. Inspect for low coolant. Verify the low coolant sensor is operating properly. (Refer to Electrical Troubleshooting, Section 12).

WARNING: Use caution when testing thermostat. Hot engine coolant will cause burns.

NOTE: Off-road driving in extremely dusty conditions may result in debris entrapment between the radiator and oil cooler. Trapped debris may increase coolant temperature.

2. Check for a clogged or blocked radiator system. Clean and flush as required. Cleaning requires the separation of the fuel cooler, AC condensor and oil cooler from the radiator and the fins of all units must be thoroughly flushed with water and compressed air.
3. Check the thermostats for proper operation. Remove the thermostats and place the thermostats in a container of water known to be 190°F (88°C). Observe the valves. If the valves do not open, replace the thermostats.
4. Check the radiator for bent fins. Straighten the fins or replace the radiator if it is damaged beyond repair.
5. Check the operation of the temperature gauge. Refer to Electrical Troubleshooting (Section 12).
6. Inspect the fan blades for damage. Replace the fan if damaged.
7. Check the fan clutch (viscous drive) operation.
   a. Check for excessive bearing play. Using fingers only, press tip of fan blade toward and away from the engine. Tip of the blade total movement should not exceed 0.20 in. (5.1 mm). If the movement is more, replace the fan drive.
   b. With the engine off and an ambient temperature of 50°F (10° C) or higher, the fan should turn evenly with noticeable drag. If the fan turns hard, very easily, or with uneven resistance, replace the fan drive.
   c. Fan noise is sometimes evident under the following normal conditions:
      - When the drive is engaged for maximum cooling.
      - During the first 15 seconds to one minute after start-up, until the drive can redistribute the silicone fluid back to its normal disengage operating condition (after overnight settling).
      - Fan noise or an excessive roar will generally occur continuously under all engine high speed conditions (2400 RPM and up) if the drive assembly is locked-up due to an internal failure. If the fan cannot be rotated by hand or there is a rough, grating feel as the fan is turned, replace the fan drive.
8. Check for a leaking or defective water pump. Replace the leaking or defective water pump.

WARNING: Do not release surge tank cap when engine is hot. Steam and/or coolant may cause serious injury.

Fan Runs Continuously (Noisy)

1. Check that all the fan bolts are present and tightened to 45 lb-ft (61 N•m).
2. Perform steps 7a and 7b above.
3. Check for fan cut off (disengagement).
4. Observe the fan drive disengagement after 1 to 1-1/2 minutes. If fan speed does not drop and coolant temperature remains below 190° F (88° C), replace the fan drive.

RADIATOR AND FAN SHROUD ASSEMBLY SERVICE

Removal

1. Remove the hood (Section 10).
2. Drain the cooling system.
3. Remove the driver side splash shield.
4. Remove the battery tray, and the left splash shield. (Sections 10 and 12).
5. Remove the fuel cooler (Section 3).
6. If equipped with air conditioning, discharge the system and remove the condenser (Section 11).
7. Remove the oil cooler (Section 1).
8. Disconnect the upper hose from the radiator (Figure 4-4).
9. Disconnect the ambient temperature switch, if equipped (Section 11).
10. Remove the surge tank.
11. Disconnect the lower radiator hose from the radiator.
12. Remove the lower mount from the radiator and the frame bracket (Figure 4-5).
13. Detach the rear support brackets from the airlift brackets (Figure 4-4).
14. Remove the radiator and the charge air cooler from the vehicle (Figure 4-5).
15. Remove the charge air cooler from the radiator.
16. Remove the fan shroud from the radiator.
17. Remove the rear support brackets and insulators from the radiator.

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage, and replace if necessary.

1. Remove any debris embedded in the radiator fins using water and compressed air (Figure 4-5).
2. Inspect the radiator for breaks, punctures, cracks, or splits.
3. Inspect the adapters and the fan shroud.

Installation

1. Secure the fan shroud to the radiator.
2. Secure the charge air cooler to the radiator.
3. Secure the rear support brackets and the insulators to the radiator with the washers and the locknuts. Tighten the locknuts to 26 lb-ft (35 N•m).
4. Align the radiator with the frame bracket, and the rear support brackets with the airlift brackets (Figures 4-5).
5. Fasten rear support brackets to air lift brackets with bolts, washers, and locknuts. Do not tighten locknuts (Figure 4-4).

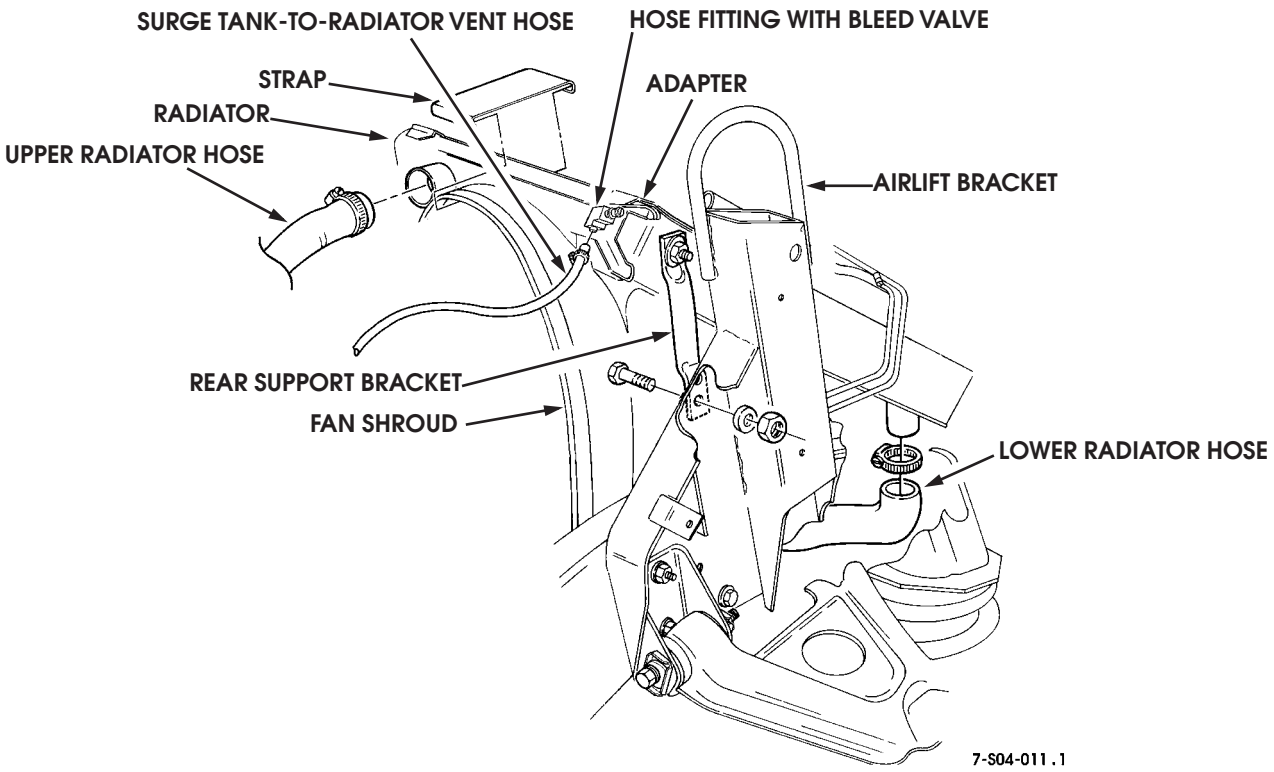


Figure 4-4: Radiator and Fan Shroud Assembly Mounting

6. Attach the lower mount and the radiator to the frame bracket with the washers, and the locknut. Do not tighten (Figure 4-5).
7. Tighten the rear support bracket locknuts to 26 lb-ft (35 N•m). Tighten the frame bracket bolt to 30 lb-ft (41 N•m) (Figures 4-4 and 4-5).
8. Install the strap on the radiator and the shroud (Figure 4-4).
9. Connect the upper and lower radiator hoses to the radiator.
10. Connect the ambient temperature switch. (Section 11).
11. Install the oil cooler (Section 1).
12. Install the fuel cooler.
13. Install the AC condenser and charge the system (Section 11).
14. Install the surge tank.
15. Connect the surge tank-to-radiator vent hose to the adapter.
16. Fill the cooling system (Section 4).
17. Check all other fluids and fill as necessary.
18. Install the splash shields and battery tray (Section 12).
19. Start the engine and check the cooling system for leaks.
20. Install the hood (Section 10).

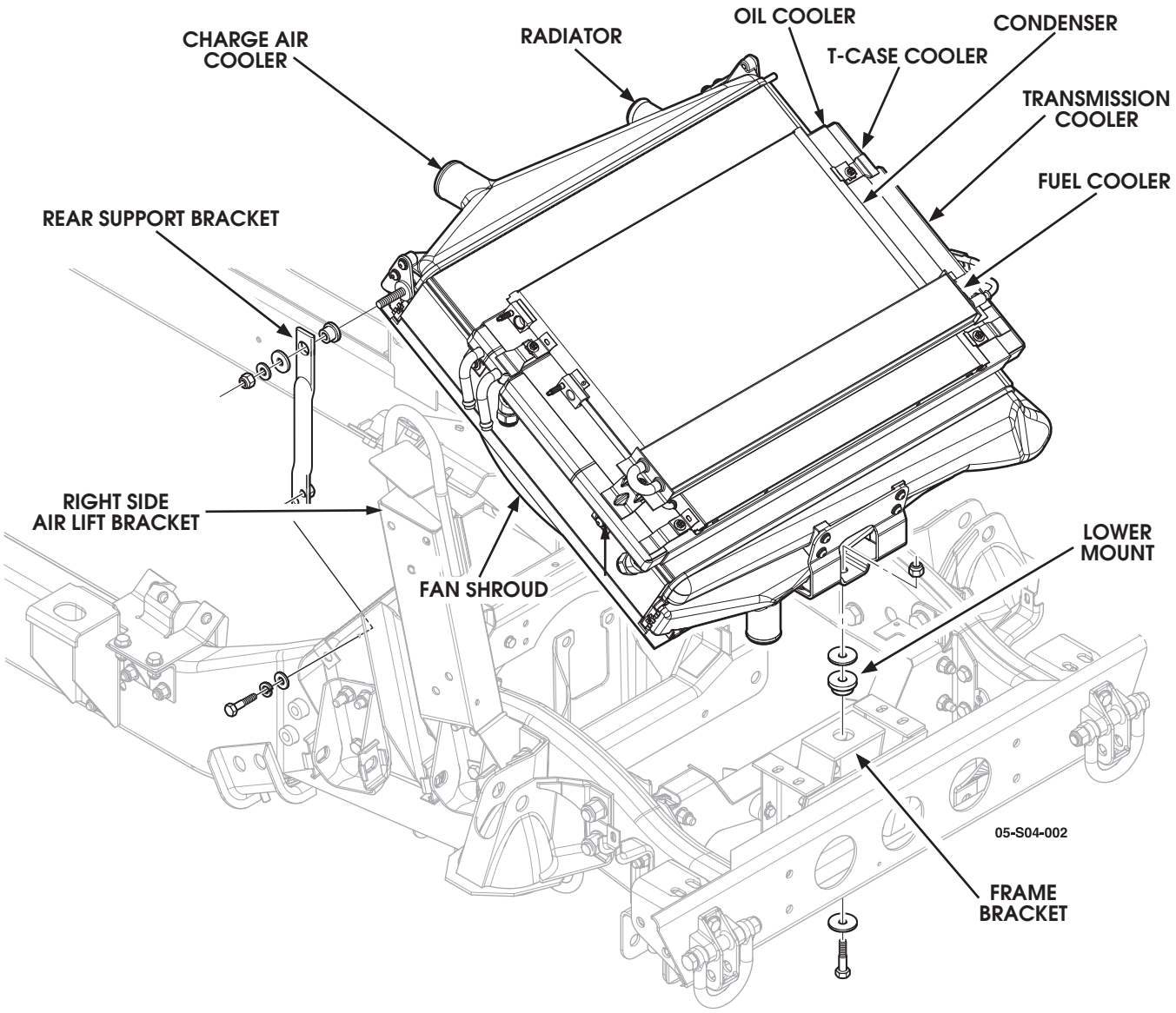


Figure 4-5: Radiator and Fan Shroud Assembly Breakdown

ENGINE COOLING SYSTEM SERVICE

Depressurizing/Draining

WARNING: To avoid injury, do not remove the surge tank filler cap before depressurizing the cooling system when the engine temperature is above 190°F (88°C).

1. If the engine is hot, place a thick cloth over the surge tank filler cap. Turn the filler cap counterclockwise to first stop to release the internal pressure (Figure 4-7).
2. After the pressure has been vented, remove the cap (Figure 4-7).
3. Open the drain valve and drain the system (Figure 4-6).
4. Close the drain valve.

Replenishing/Bleeding

1. Ensure the drain valve is closed and the heater control is set on heat (Figure 4-6).
2. Fill the system (approximately two inches above the cold fill line on the surge tank) with Dex Cool antifreeze solution.
3. Install a coolant system pressure tester and pump to approximately 10 psi.
4. Locate the bleeder on the water crossover, EGR cooler hose, and on the upper right hand corner of the radiator. Open all the bleeders and allow the coolant to flow steady before closing.
5. Depressurize the system. Remove the pressure tester, adjust the coolant level as needed and install the filler cap (Figure 4-7).
6. Start the engine and bring up to operating temperature.

WARNING: To avoid injury, do not remove the surge tank filler cap before depressurizing the cooling system when the engine temperature is above 190°F (88°C).

7. Check the coolant level, the freeze protection level and for leaks. Adjust as necessary.

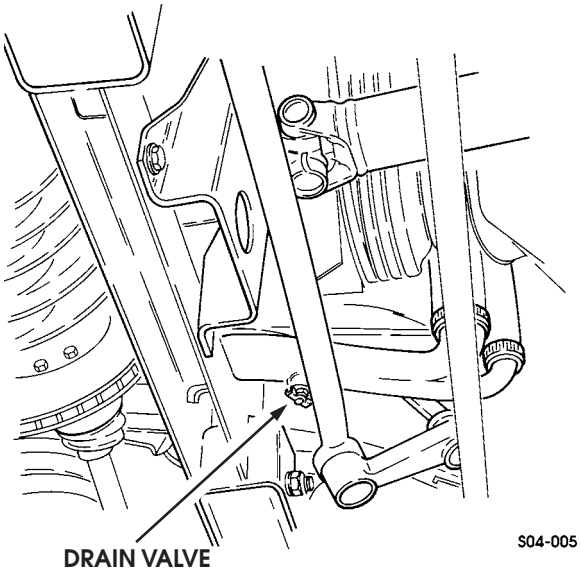


Figure 4-6: Drain Valve

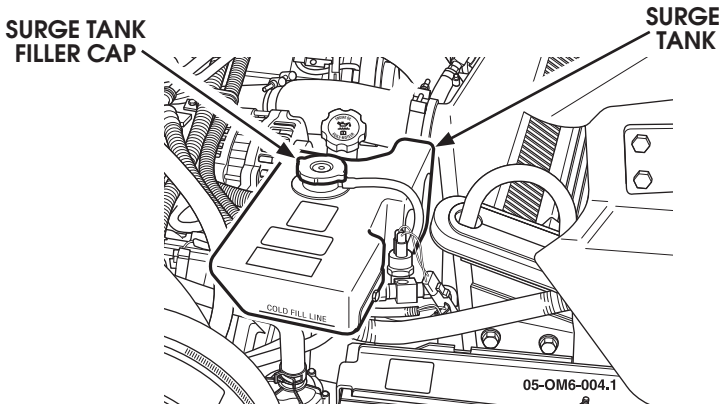


Figure 4-7: Surge Tank and Filler Cap Location

Expected Ambient Temperature	Antifreeze/ Water Mixture
120° to -32° F (49° to -36° C)	50% antifreeze/ 50% water

Table 4-1: Antifreeze Preparation Guide

RADIATOR REAR SUPPORT BRACKET REPLACEMENT

Removal

1. Remove the left splash shield (Section 10).
2. Remove the battery tray, the batteries, and the right splash shield (Section 12).
3. Remove the radiator rear support bracket and the insulator from the radiator (Figure 4-8).
4. Remove the support bracket from the airlift bracket (Figure 4-9).

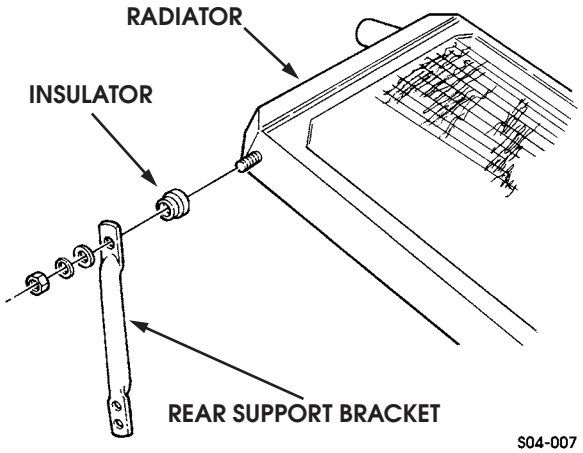


Figure 4-8: Insulator and Rear Support Bracket Location

Installation

1. Fasten the radiator rear support bracket to the airlift bracket with the bolts, washers, and locknuts. Do not tighten the locknuts (Figure 4-9).
2. Secure the insulator and the support bracket to the radiator with the washers and the locknut (Figure 4-8).
3. Tighten all the locknuts to 26 lb-ft (35 N•m).
4. Install the left splash shield (Section 10).
5. Install the battery tray, the batteries, and the right splash shield (Section 12).

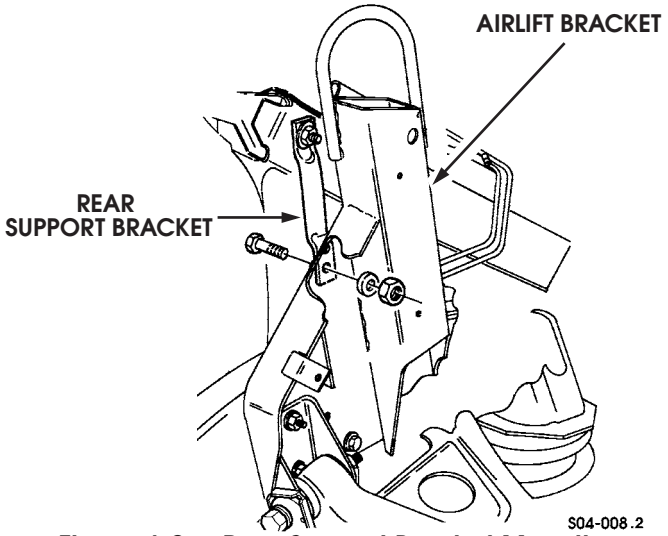


Figure 4-9: Rear Support Bracket Mounting

SURGE TANK REPLACEMENT

Removal

1. Drain the cooling system.
2. Disconnect the radiator vent hose from the surge tank (Figure 4-10).
3. Disconnect the surge tank-to-lower radiator hose from the surge tank.
4. Disconnect the overflow hose from the surge tank.
5. Disconnect the low coolant sensor wiring harness.
6. Loosen the clamps and remove the surge tank from the bracket.

Installation

1. Secure the surge tank to the bracket with clamps (Figure 4-10).
2. Connect the low coolant sensor wiring harness.
3. Connect the surge tank-to-lower radiator hose.
4. Connect the radiator vent hose to the surge tank.
5. Connect the overflow hose to the surge tank.
6. Fill and purge the cooling system.

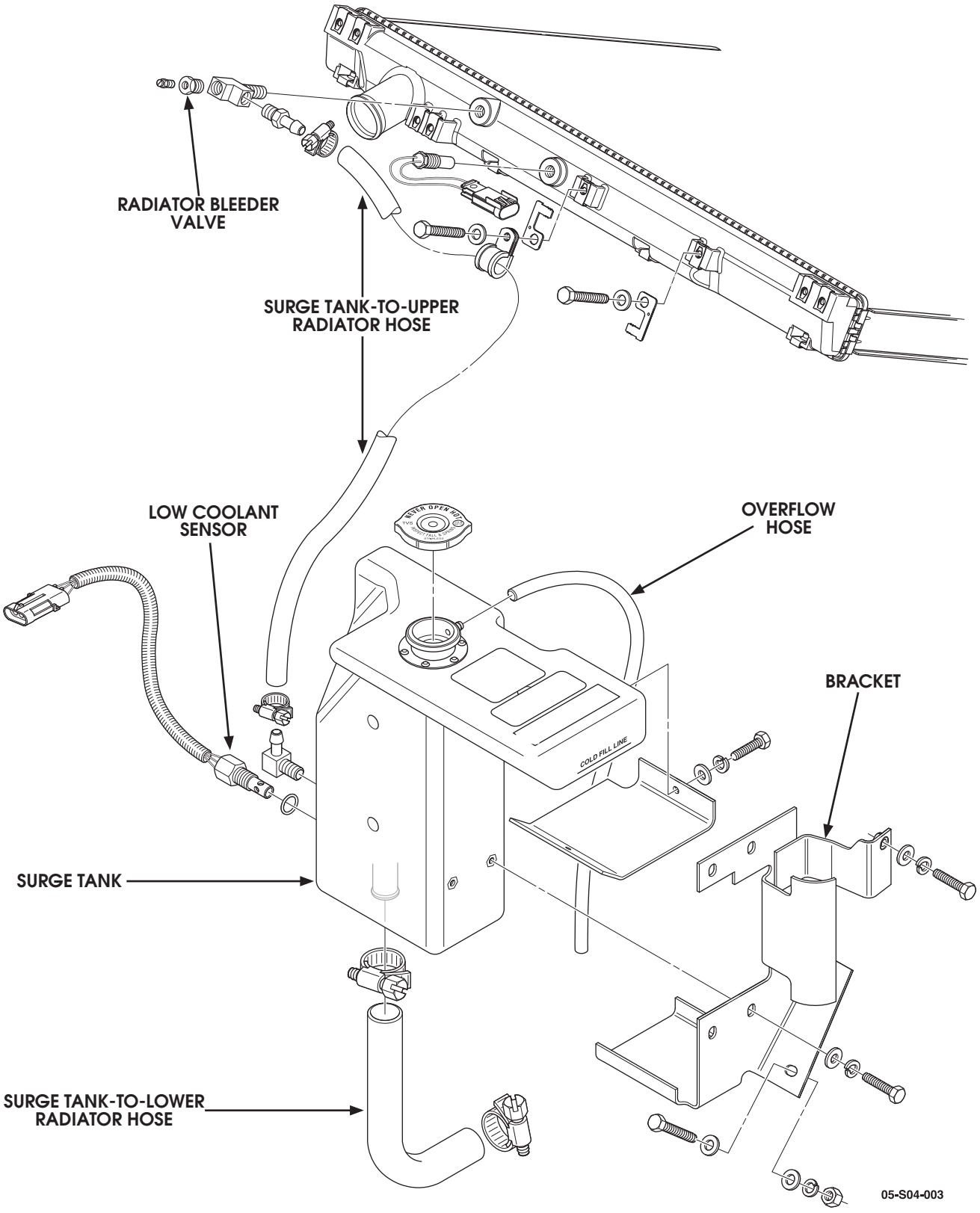


Figure 4-10: Surge Tank Replacement

SURGE TANK-TO-RADIATOR BLEEDER HOSE REPLACEMENT

Removal

1. Depressurize the cooling system.
2. Loosen the two clamps and remove the radiator vent hose from the radiator and the surge tank (Figure 4-10).
3. Reclaim the coolant.

Installation

1. Secure the radiator vent hose to the surge tank and the radiator with the two clamps (Figure 4-10).
2. Replace the coolant.
3. Tighten the coolant filler cap.

THERMOSTAT BYPASS PIPE REPLACEMENT

Removal

1. Disconnect the battery.
2. Drain the cooling system.
3. Release the serpentine belt.
4. Remove the larger center idler pulley.
5. Disconnect the rubber hose from the bypass pipe.
6. Disconnect the bypass pipe from the water cross over and the water pump.
7. Remove the water bypass pipe (Figure 4-11).

Installation

NOTE: If installing the same bypass pipe that was removed. Inspect the o rings for damage before installation.

1. Secure the bypass hose to the water pump and the water crossover (Figure 4-11).
2. Connect the rubber hose from the turbo to the bypass pipe.
3. Install the larger center idler pulley.
4. Install the serpentine belt.
5. Fill the cooling system. See cooling system service for proper filling and bleeding procedure.
6. Reconnect the battery.

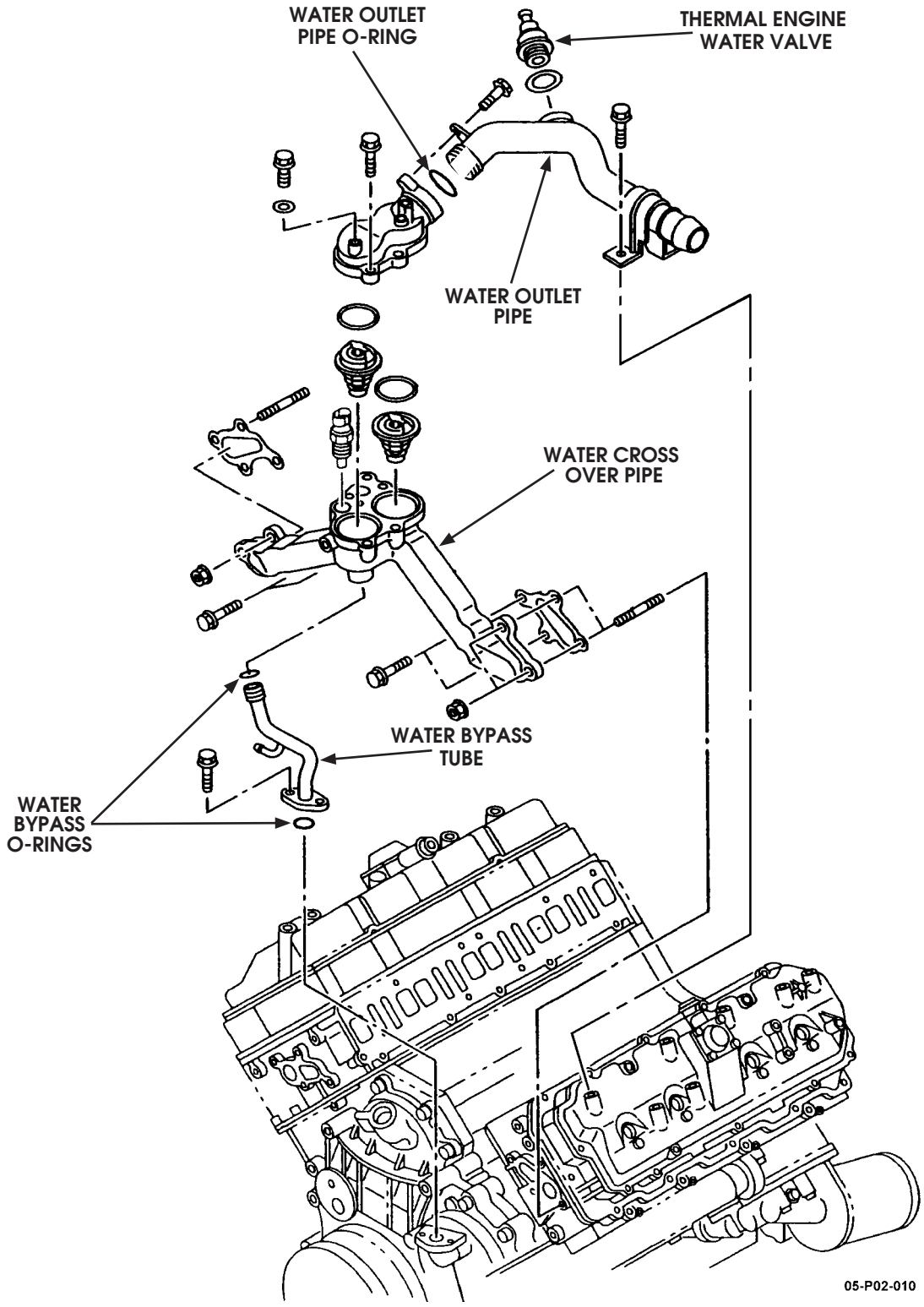


Figure 4-11: Thermostat Bypass Hose Replacement

WATER OUTLET PIPE THERMOSTAT TO UPPER RADIATOR HOSE REPLACEMENT

Removal

1. Disconnect the battery.
2. Depressurize the cooling system.
3. Drain the cooling system as necessary.
4. Disconnect the transmission control harness connector behind the AC compressor and remove the harness mount bracket.
5. Remove the charge air pipe above the engine harness connectors.
6. Disconnect the engine harness connectors and remove the harness mount bracket.
7. Remove the serpentine belt.
8. Remove the P clamp securing the AC lines and the two AC compressor connectors.

NOTE: It is not necessary to evacuate the AC system as the system can be moved out of the way.

9. Remove the AC compressor, AC lines assembly and set aside.
10. Remove the thermal engine water valve (Figure 4-11).
11. Disconnect the upper radiator hose from the water outlet pipe.
12. Remove the water outlet pipe (Figure 4-11).

Installation

NOTE: If installing the same water outlet pipe that was removed. Inspect the o ring for damage before installation.

1. Install the water outlet pipe into the water cross over pipe and secure.
2. Install the water outlet pipe into the upper radiator hose and secure.
3. Install the thermal engine water valve into the water outlet pipe.
4. Install the AC compressor and the two AC compressor connectors.
5. Secure the AC lines with the P clamp.
6. Install the serpentine belt.
7. Install the engine harness mount bracket and the engine harness connectors.
8. Install the charge air pipe.
9. Install the transmission control harness mount bracket and the transmission control harness connector.
10. Fill the cooling system. See cooling system service for proper filling and bleeding procedure.
11. Connect the battery.

UPPER RADIATOR HOSE REPLACEMENT

Removal

1. Depressurize the cooling system.
2. Drain the cooling system as necessary.
3. Loosen the clamps and remove the hose from the thermostat housing and the radiator (Figure 4-12).

Installation

1. Secure the upper radiator hose to the thermostat housing and the radiator with the clamps (Figure 4-12).
2. Fill the cooling system. See cooling system service for proper filling and bleeding procedure.

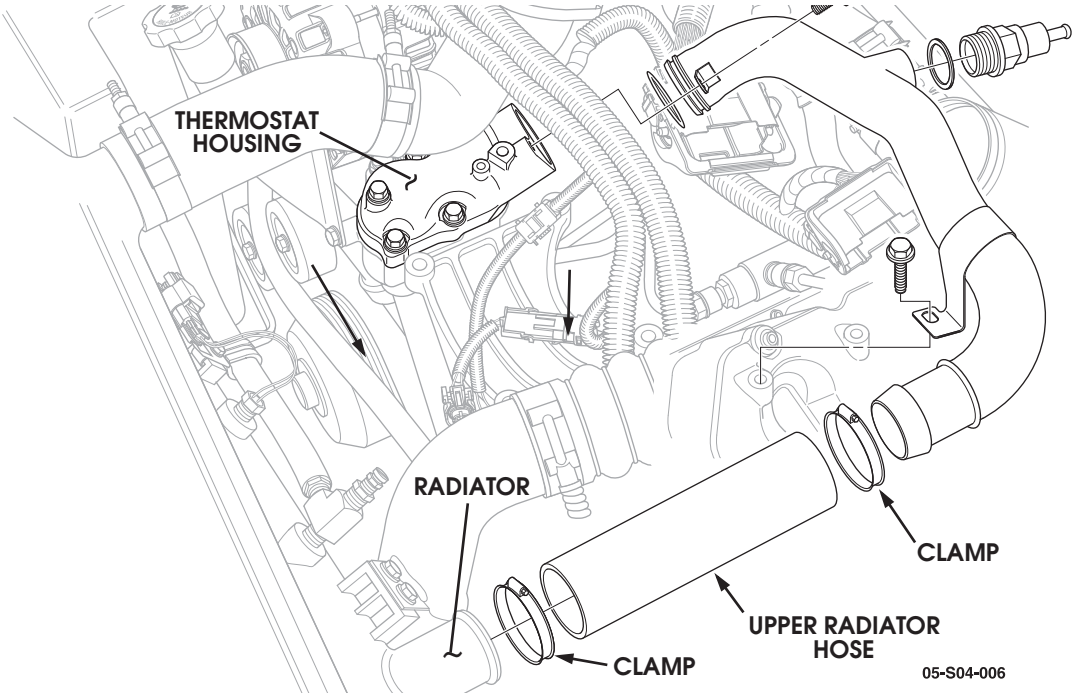


Figure 4-12: Upper Radiator Hose Location

LOWER RADIATOR HOSE REPLACEMENT

Removal

1. Drain the cooling system.
2. Loosen the clamps and remove the lower radiator hose from the radiator and the lower tube assembly (Figure 4-13).

Installation

1. Secure the lower radiator hose to the lower tube assembly and the radiator with the clamps (Figure 4-13).
2. Fill the cooling system. See cooling system service for proper filling and bleeding procedure.

RADIATOR LOWER TUBE ASSEMBLY REPLACEMENT

Removal

1. Drain the cooling system.
2. Remove the drain valve from the lower tube assembly (Figure 4-13).
3. Disconnect the radiator lower tube assembly from the frame bracket.
4. Loosen the clamp and disconnect the water pump inlet hose from the lower tube assembly.
5. Loosen the clamp and disconnect the surge tank-to-lower radiator hose from the lower tube assembly.
6. Loosen the clamp and disconnect the lower radiator hose from the lower tube assembly.
7. Remove the lower tube assembly.

Installation

1. Secure the lower tube assembly to the frame bracket with the bolts, washers, and locknuts. Tighten the locknuts to 6 lb-ft (8 N•m) (Figure 4-13).
2. Connect the lower radiator hose to the lower tube assembly and tighten the clamp.
3. Connect the surge tank-to-lower radiator hose to the lower tube assembly and tighten the clamp.
4. Connect the water pump inlet hose to the lower tube assembly and tighten the clamp.
5. Apply sealant tape to the threads of the drain valve and screw the drain valve into the lower tube assembly.
6. Fill the cooling system. See cooling system service for proper filling and bleeding procedure.

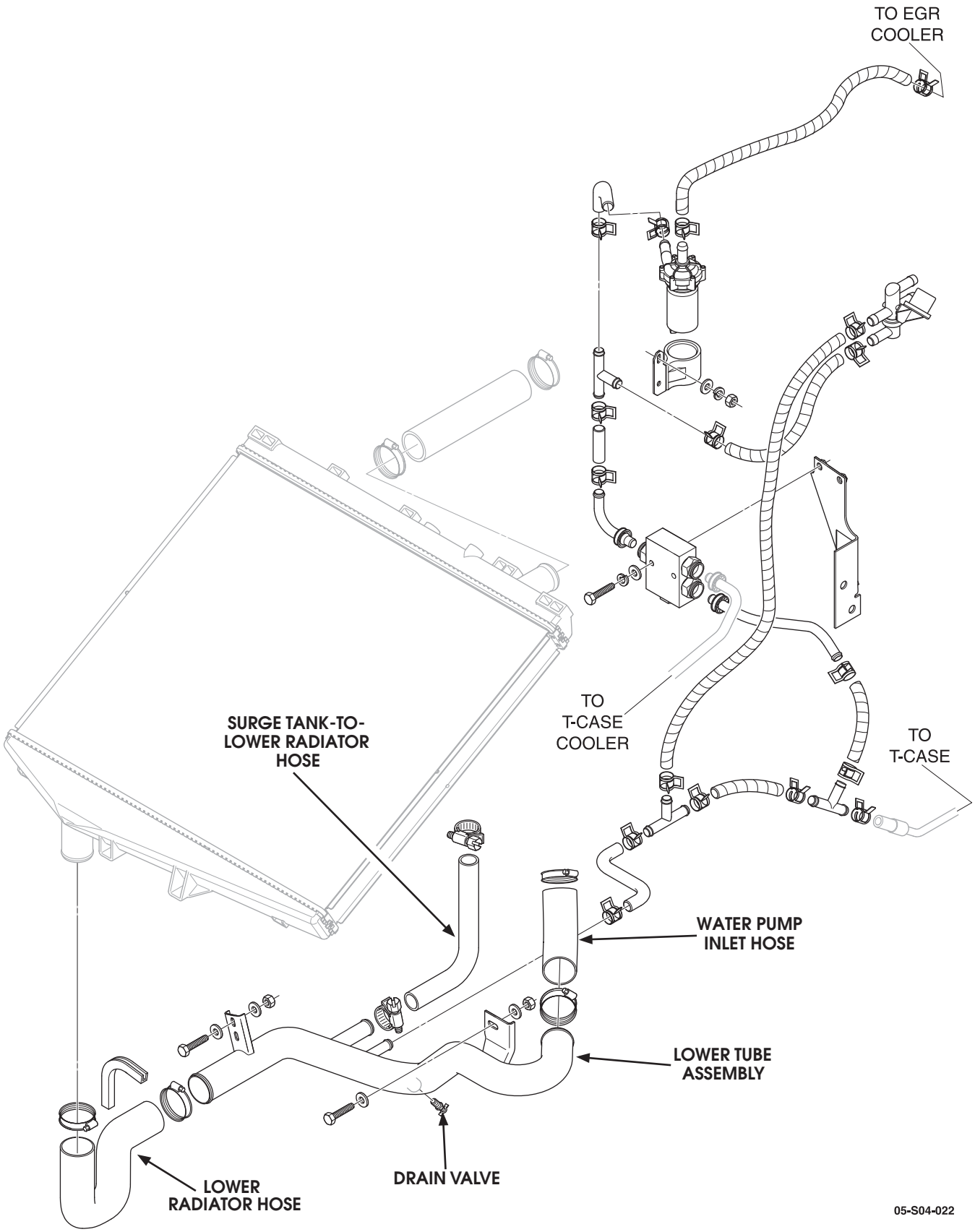


Figure 4-13: Radiator Lower Tube Assembly Location

WATER PUMP INLET HOSE REPLACEMENT

Removal

1. Drain the cooling system.
2. Loosen the clamps and remove the water pump inlet hose from the water pump and lower tube assembly (Figure 4-13).

Installation

1. Connect the water pump inlet hose to the lower tube assembly and the water pump and tighten the clamps (Figure 4-13).
2. Fill the cooling system. See cooling system service for proper filling and bleeding procedure.

SURGE TANK OVERFLOW HOSE REPLACEMENT

Removal

1. Remove the overflow hose from the surge tank filler neck (Figure 4-14).
2. Remove the screw, clamp, and the overflow hose from the body.

Installation

1. Connect the overflow hose to the surge tank filler neck (Figure 4-14).
2. Secure the overflow hose to the body with the clamp.

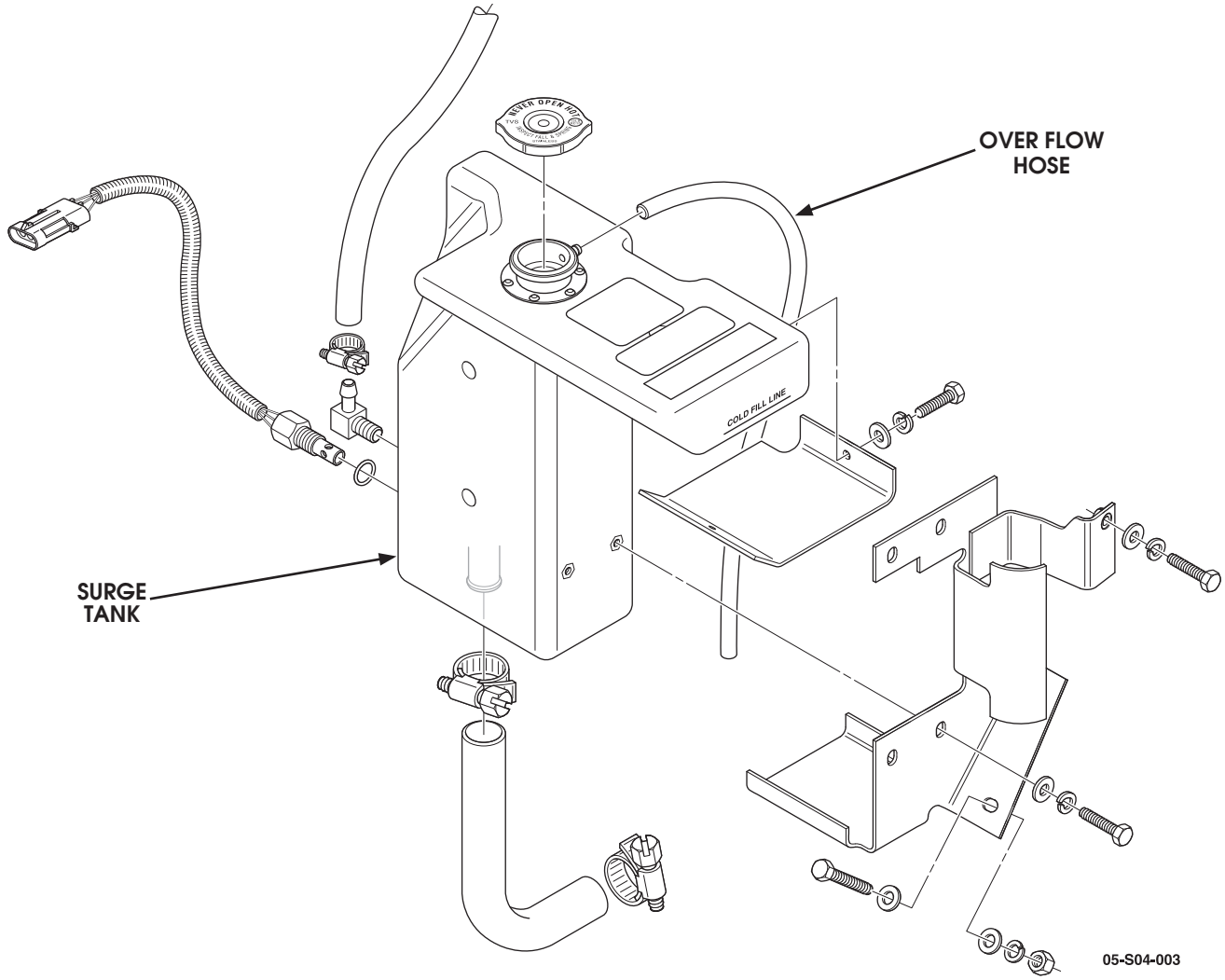


Figure 4-14: Surge Tank Overflow Hose Mounting

SURGE TANK-TO-LOWER RADIATOR TUBE HOSE REPLACEMENT

Removal

1. Drain the cooling system.
2. Loosen the clamps and remove the hose from the surge tank and lower tube assembly (Figure 4-15).

Installation

1. Install the hose on the lower tube assembly and the surge tank and tighten the clamps (Figure 4-15).
2. Fill the cooling system. See cooling system service for proper filling and bleeding procedure.

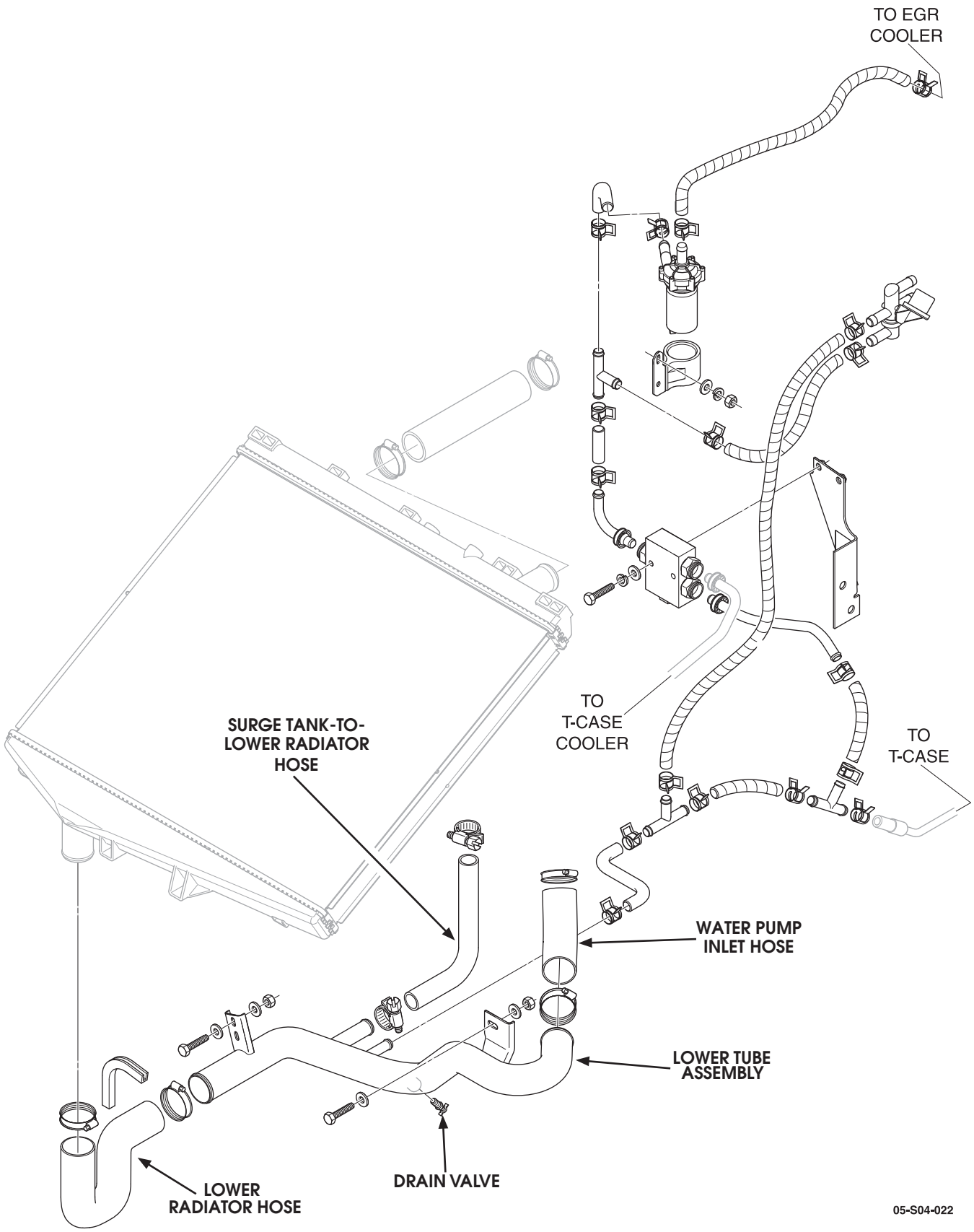


Figure 4-15: Surge Tank-to-Lower Tube Assembly Hose Location

LOW COOLANT SENSOR

The coolant level sensor is a solid-state semi-conductor device. The sensor's resistance varies as a function of its temperature. As voltage/current flows through the sensor, sensor temperature increases. In the presence of a liquid, in this case engine coolant, the temperature of the sensor is controlled by transferring heat to the coolant. Should the coolant level drop below the sensor, the heat and resistance of the sensor will rise. The "Low Coolant" warning light will then illuminate in response to the increased resistance at the sensor.

Removal

1. Drain and collect the coolant from the surge tank.
2. Disconnect the low coolant sensor electrical connector from the engine harness connector.
3. Remove the sensor and the O-ring from the surge tank (Figure 4-16).

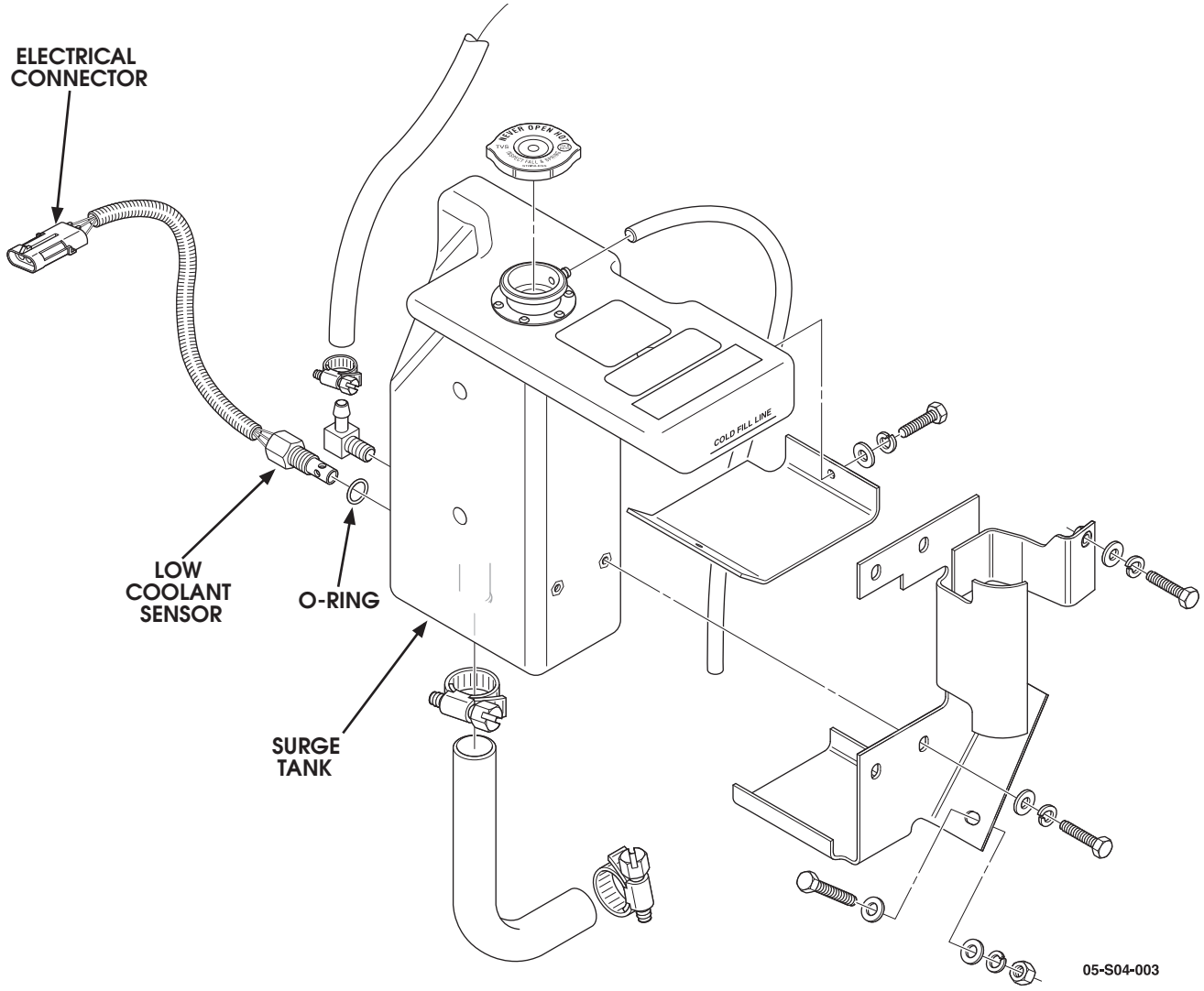


Figure 4-16: Low Coolant Sensor

Installation

1. Position the O-ring on the sensor and thread the sensor into the surge tank (Figure 4-16).
2. Plug the low coolant sensor electrical connector into the engine harness connector.
3. Fill the surge tank with coolant. See cooling system service for proper filling and bleeding procedure.

THERMOSTAT REPLACEMENT

Removal

1. Disconnect the battery.
2. Drain the engine coolant below the level of the water crossover.
3. Disconnect the transmission control harness connector behind the AC compressor and remove the harness mount bracket.
4. Remove the charge air pipe above the engine harness connector.
5. Disconnect the engine harness connector and the harness mount bracket.
6. Release the serpentine belt.
7. Remove the P clip securing the AC lines.
8. Remove the AC compressor and set aside with the AC lines still connected.
9. Remove the water outlet pipe.
10. Remove the thermostat cover (Figure 4-17).
11. Remove both of the thermostats (Figure 4-17).

Installation

1. Install the thermostats and seals into the water crossover pipe (Figure 4-17).

NOTE: The rear thermostat has 2 vent valves. Install with the vent valves towards the rear of engine (Figure 4-17).

WARNING: Damage to the thermostats and the housing can occur if the thermostats are not installed properly.

2. Install the thermostat cover and tighten the cover bolts to15 lb ft (21 N·m).
3. Fill and bleed the cooling system. See cooling system service for proper filling and bleeding procedure.
4. Install the water outlet pipe.
5. Install the AC compressor and secure the AC line with the P clip.
6. Install the serpentine belt.
7. Install the engine harness mount bracket and connect the engine harness connector.
8. Install the charge air pipe.
9. Install the transmission control harness bracket and connect the transmission control harness connector.
10. Connect the battery.

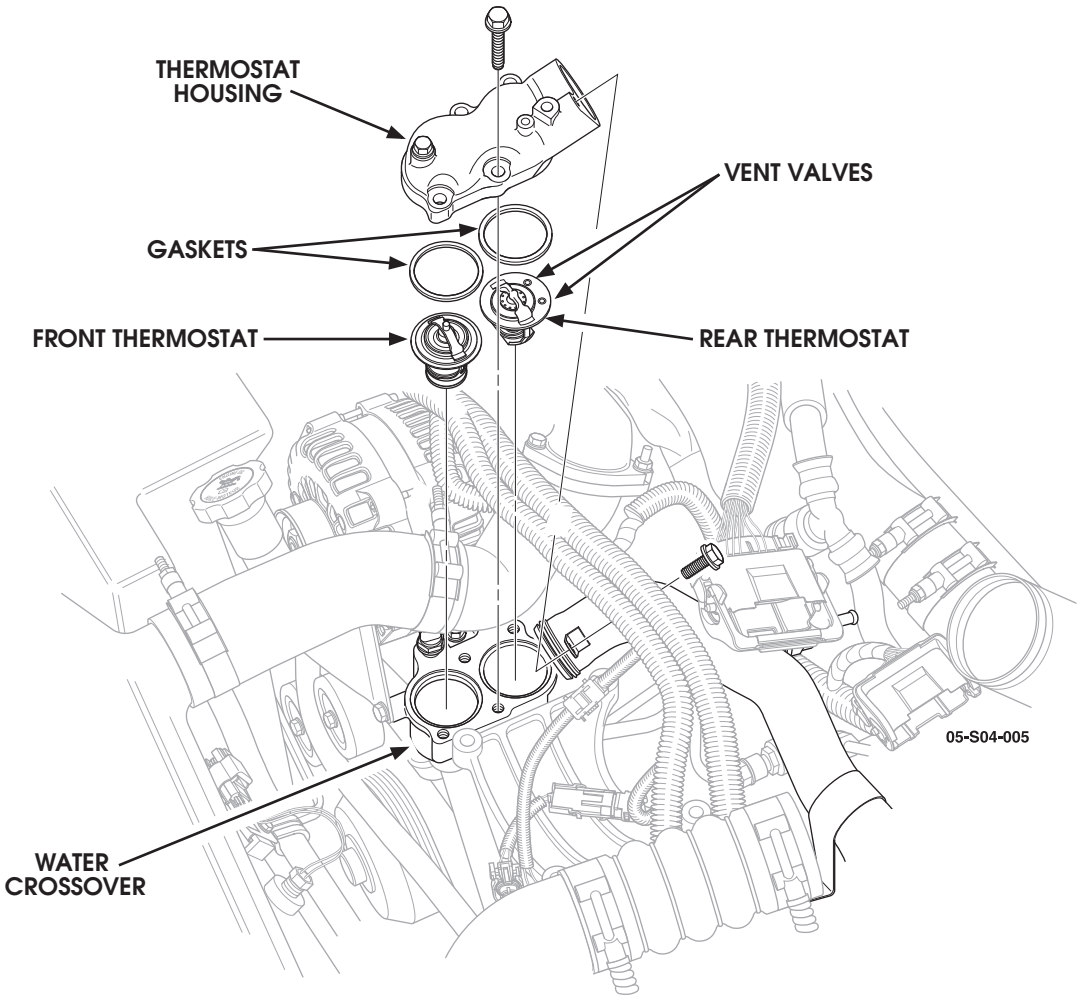


Figure 4-17: Thermostat and Cover Removal and Installation

WATER PUMP

Removal

1. Disconnect the battery.
2. Drain the engine coolant.
3. Release and remove the serpentine drive belt.
4. Remove the large center idler pulley.
5. Remove the geared fan drive shaft and coupler (Figure 4-18).
6. Remove the water bypass tube.
7. Remove the starter.
8. Remove the crank shaft damper bolt using the flywheel lock J-44643 and remove the crank shaft damper.
9. Remove the water pump inlet hose at the water pump.
10. Remove the front propshaft from the front axle.
11. Remove the water pump to engine water pipe nuts (Figure 4-19).
12. Remove the water pump assembly from the engine block (Figure 4-19).

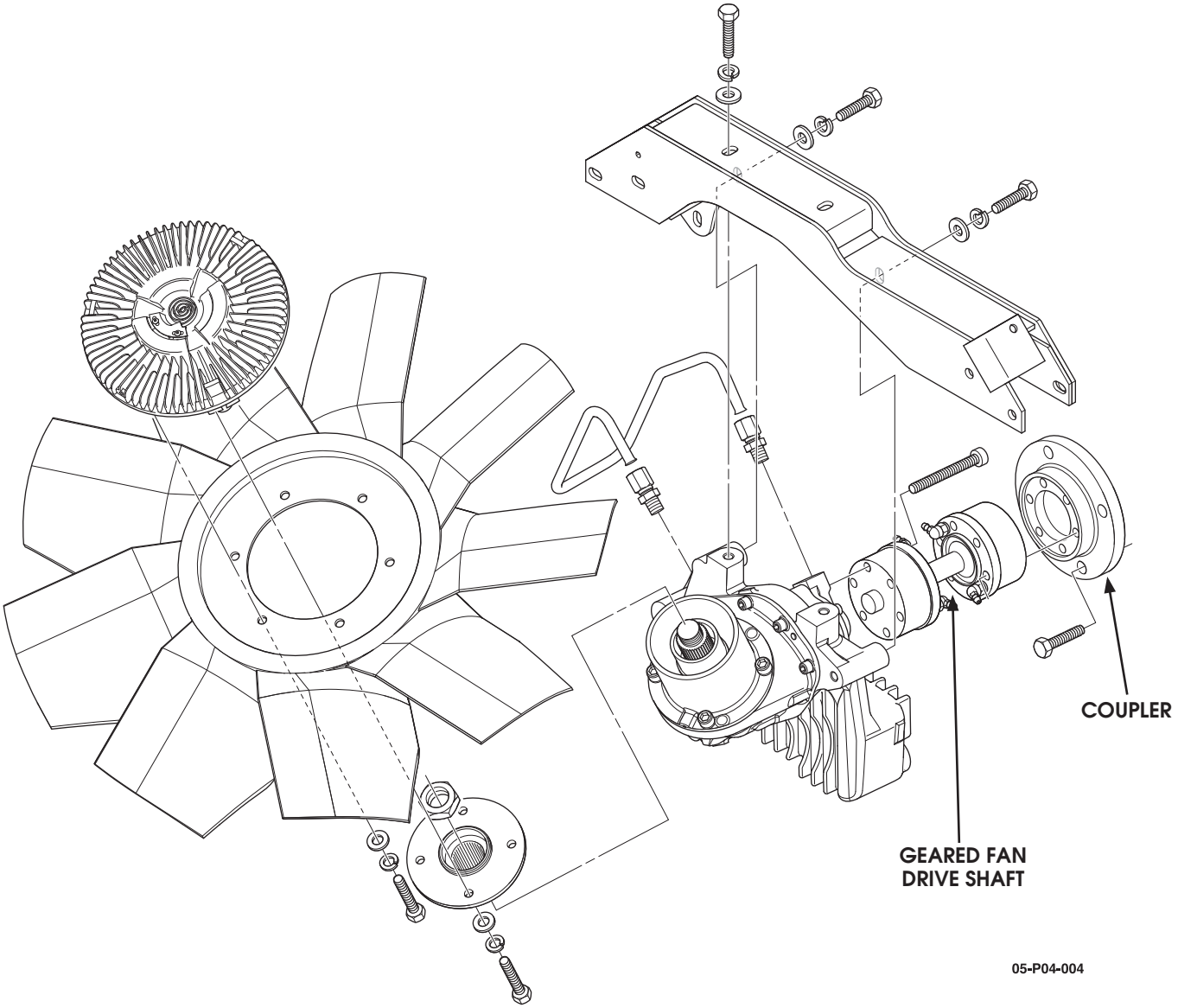


Figure 4-18: Geared fan drive shaft

Installation

1. Lubricate the water pump O-ring with engine oil.
2. Install the engine water pipe gasket and water pump O-ring on the water pump.
3. Install the water pump and the water pump bolts tighten the bolts to 15 lb ft (21 N·m) (Figure 4-19).

NOTE: Make sure the correct length bolt is used in the proper location.

4. Install the water pump to engine water pipe nuts tighten the nuts to 15 lb ft (21 N·m) (Figure 4-19).
5. Install the crank shaft damper and bolt tighten to 260 lb ft (353 N·m).
6. Install the starter tighten the bolts to 58 lb ft (78 N·m).
7. Install the water pump inlet hose at the water pump.
8. Install the front propshaft to the front axle.
9. Install the water bypass tube.
10. Install the geared fan drive shaft and the coupler (Figure 4-18).

11. Install the large center idler pulley.
12. Install the serpentine drive belt.
13. Fill and bleed the cooling system. See cooling system service for proper filling and bleeding procedure.
14. Connect the battery.

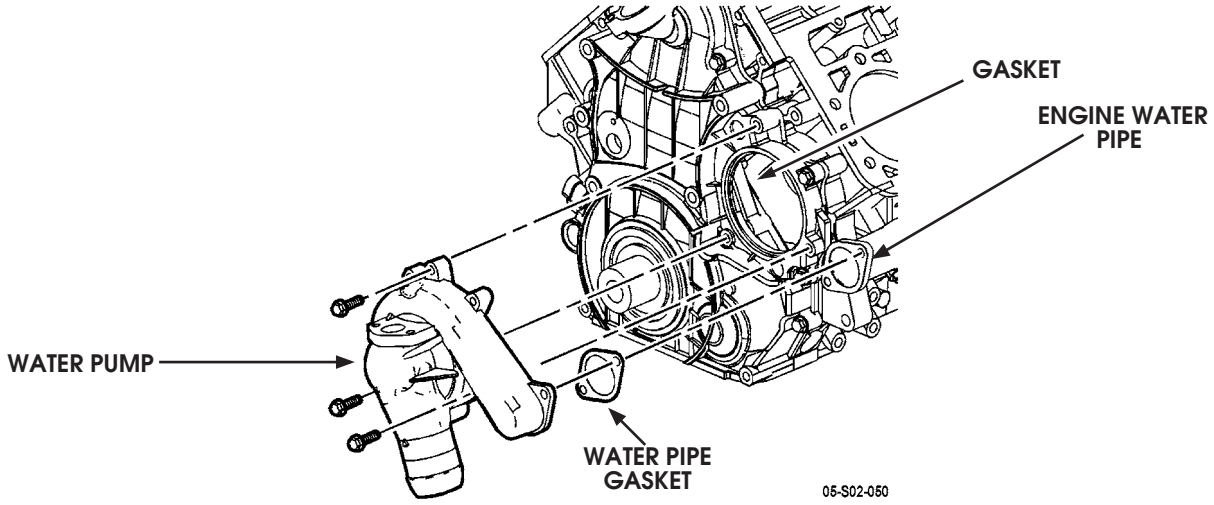


Figure 4-19: Water Pump

AUXILIARY WATER PUMP

Removal

1. Drain the cooling system.
2. Disconnect the batteries and remove the battery tray.
3. Remove the auxiliary water pump connector.
4. Remove the two hose clamps, inlet and outlet hoses from the auxiliary water pump (Figure 4-20).

Installation

1. Install the inlet, outlet hoses on the auxiliary water pump and secure with the two hose clamps (Figure 4-20).
2. Install the auxiliary water pump connector.
3. Install the battery tray and the batteries.
4. Fill and bleed the cooling system. See cooling system service for proper filling and bleeding procedure.

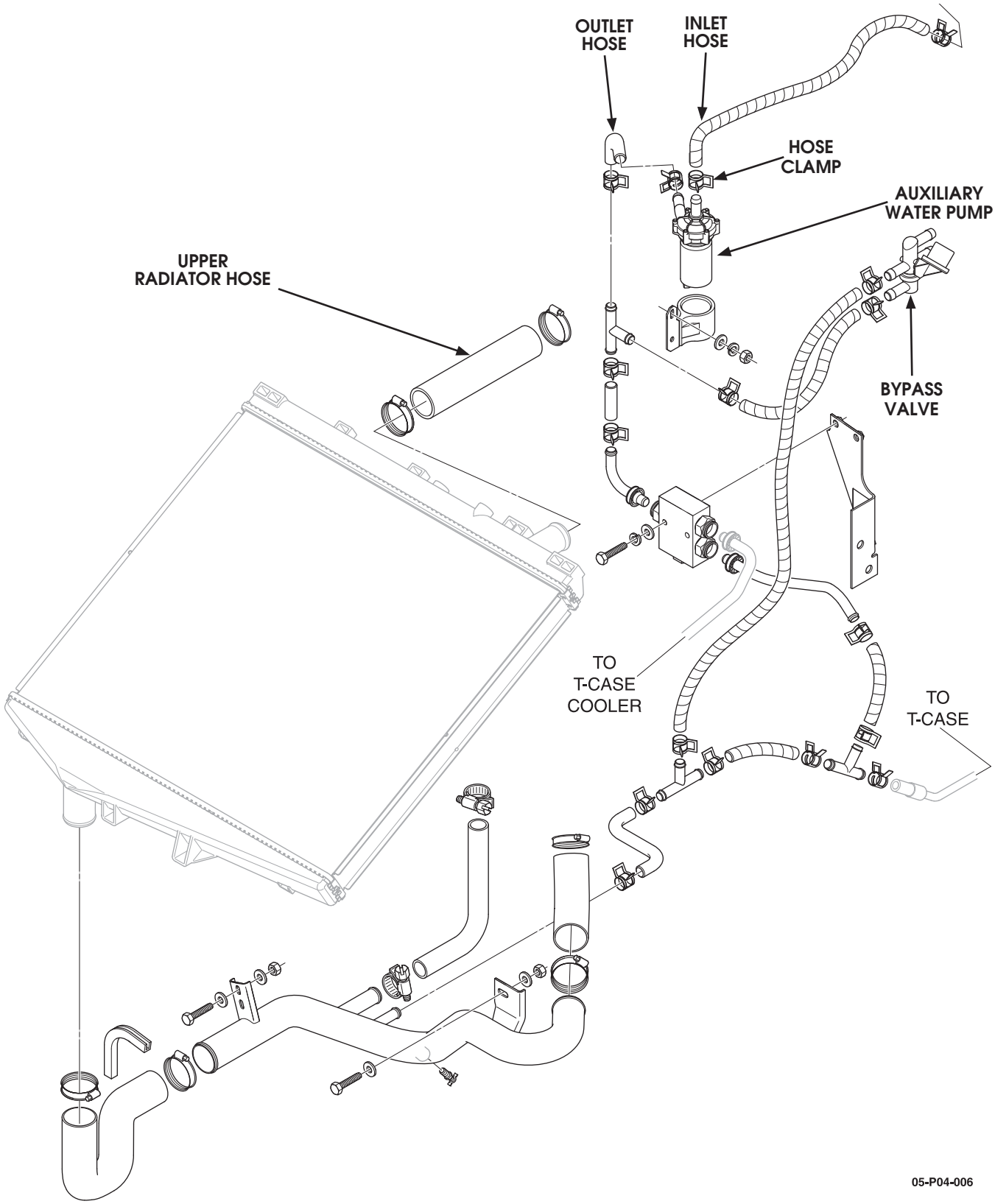


Figure 4-20: Auxiliary Water Pump

SERPENTINE BELT REPLACEMENT

Removal

1. Insert the square lug of special tool EN- 47913 in the belt tensioner. Then move the tensioner counterclockwise to loosen the belt (Figure 4-21).
2. Remove the belt from the pulleys (Figure 4-22).

Installation

1. Insert the square lug of special tool EN- 47913 in the belt tensioner and move the tensioner counterclockwise and position the serpentine belt on the pulleys as shown (Figure 4-22).
2. Release the belt tensioner. Tensioner will automatically set the belt tension when it is released.

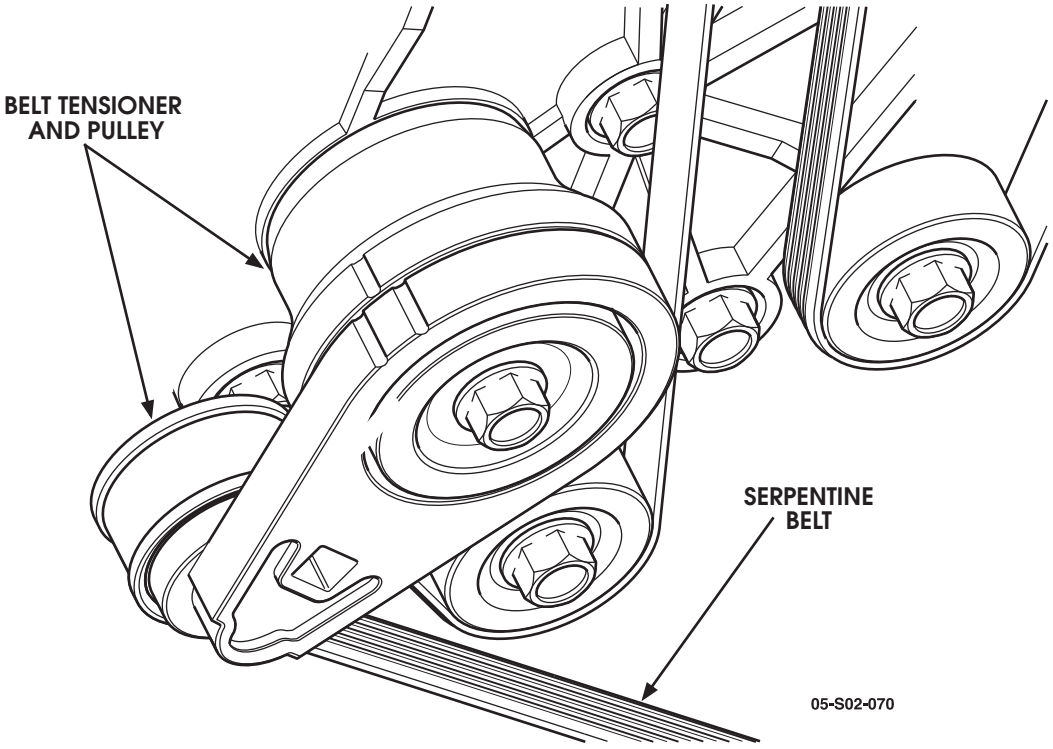


Figure 4-21: Serpentine Belt Tensioner Location

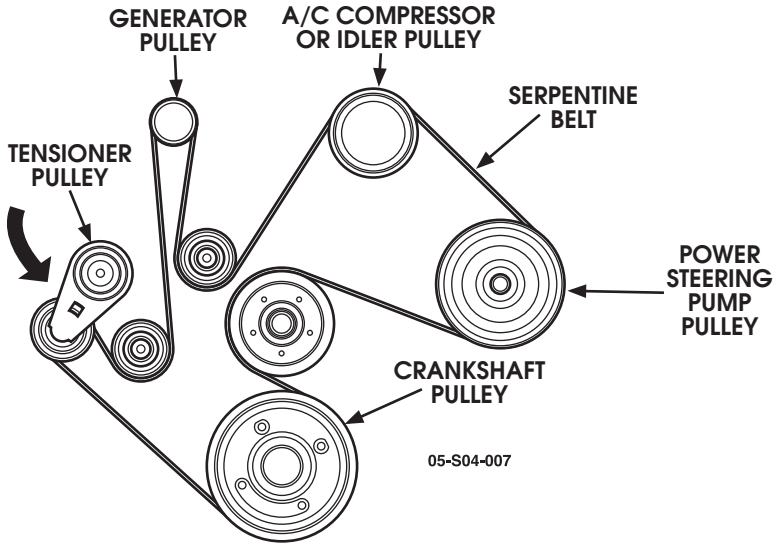


Figure 4-22: Serpentine Belt Routing

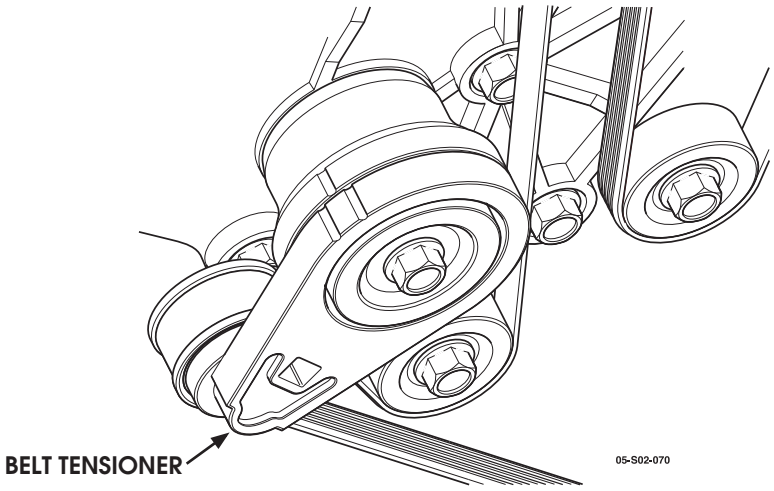


Figure 4-23: Automatic Belt Tensioner

Automatic Belt Tensioner and Belt Length Scale

A serpentine belt drives the water pump which pumps the coolant through the cooling system. Proper belt tension must be maintained at all times for the proper operation of the cooling system. This is accomplished by an automatic belt tensioner located at the front of the engine behind the coolant surge tank (Figure 4-23). The amount of belt stretch may be determined with the scale located on the arm or the belt tensioner. If the single line falls outside of the dual line parameters, replacement is required.

Inspection of a multiple ribbed serpentine belt may reveal cracks in the belt ribs. These cracks will not impair the belt performance and are not a basis for belt replacement. If excessive cracking is noted or any belt ribs are missing, the belt should be replaced.

FAN AND CLUTCH ASSEMBLY SERVICE

Removal

1. Remove the geared fan drive assembly (Figure 4-26).
2. Remove the bolts attaching the fan clutch to the GFD.
3. Remove the bolts attaching the fan to the fan clutch.

Installation

4. Slide the fan onto the clutch and tighten the bolts to 15-20 lb-ft (20-27 N•m).
5. Install the fan and clutch assembly on the GFD (Figure 4-26).
6. Install the geared fan drive assembly.

GEARED FAN DRIVE (GFD) ASSEMBLY SERVICE

Geared Fan Drive

CAUTION: If the fluid level is checked when the unit is hot, some of the expanded fluid will run out and create a low fluid condition.

The fluid level in the reservoir must be checked every 6,000 mi (9,700 km) or semiannually, whichever occurs first and topped off using HUMMER H1 Synthetic Gear Lube 75W-90 with friction modifier. Remove the fill plug when the unit is cold and ensure that the fluid is even with the bottom of the fill plug hole (Figure 4-24). The coupler shaft CV joints must be greased every 6,000 mi (9,700 km) or semiannually, whichever occurs first with a multipurpose, NLGI-LB grade chassis grease. The coupler shaft has a CV joint at the GFD end and one at the engine crankshaft end. Each CV joint contains two grease zerks, although only one zerk needs to be greased per joint. The second zerk is used to give an optional location depending on the position of the shaft when the engine stopped. This should lessen the need to bar the engine over to gain access to the zerks. Grease should be applied, using a low

pressure grease gun, to the joint slowly until old grease can be seen exiting around the sleeve on the shaft. Wipe the excess grease from the shaft when finished(Figure 4-25).

NOTE: It will be normal for some grease to exit the CV joint seals during engine operation, DO NOT replace the CV joints for this condition.

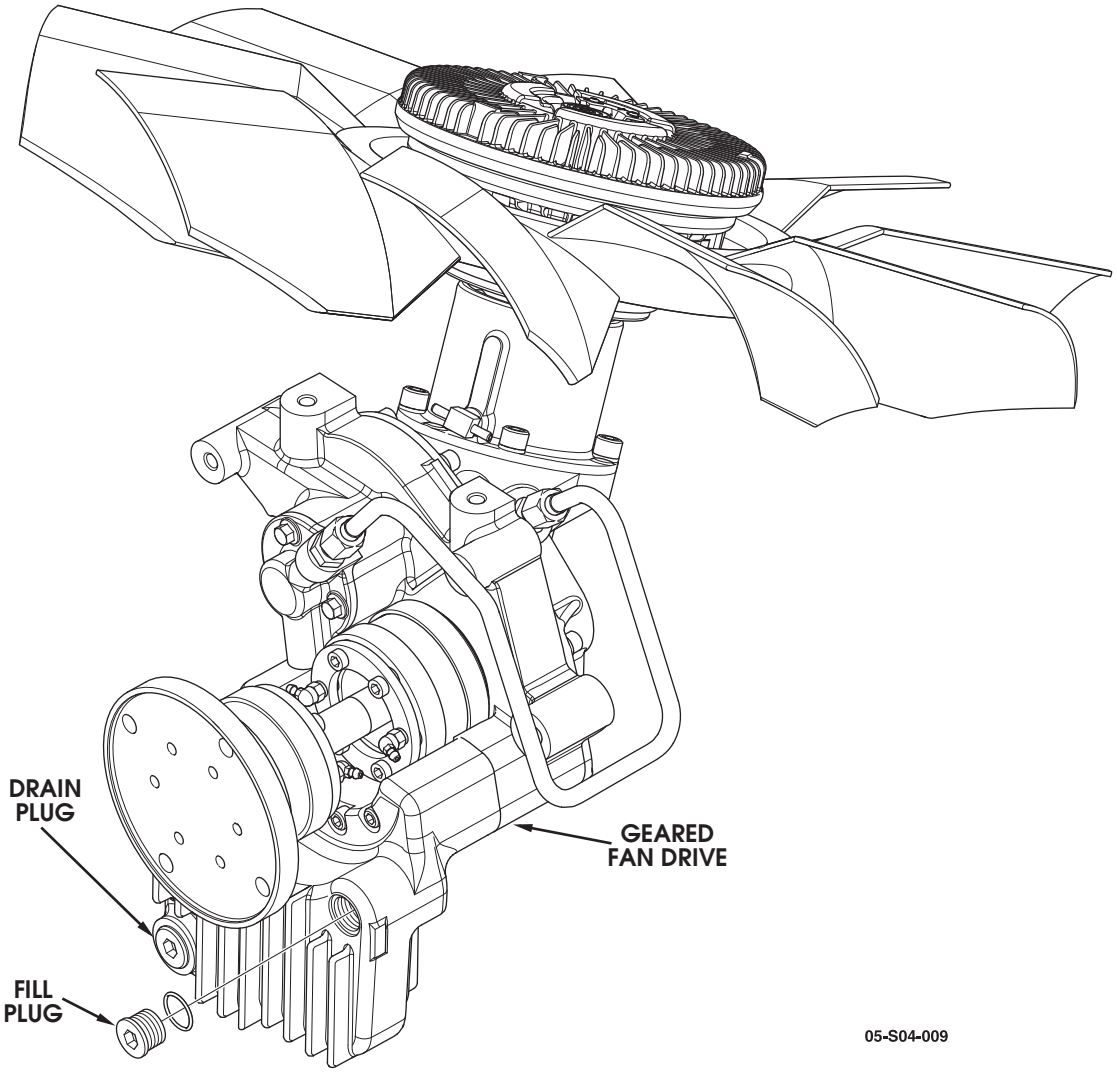


Figure 4-24: GFD Fill and Drain Plugs

Removal

1. Drain the engine coolant.
2. Remove the front driveline protection.
3. Remove the front axle assembly (See section 9).
4. Remove the lower coolant pipe.
5. Remove the four bolts securing the GFD drive flange to the harmonic balancer (Figure 4-26).
6. Remove the four bolts securing the fan and viscous drive assembly to the GFD.
7. Use “bungee cords” to support the fan assembly for GFD removal.
8. Remove the four bolts securing the GFD to the cross member and remove the GFD.

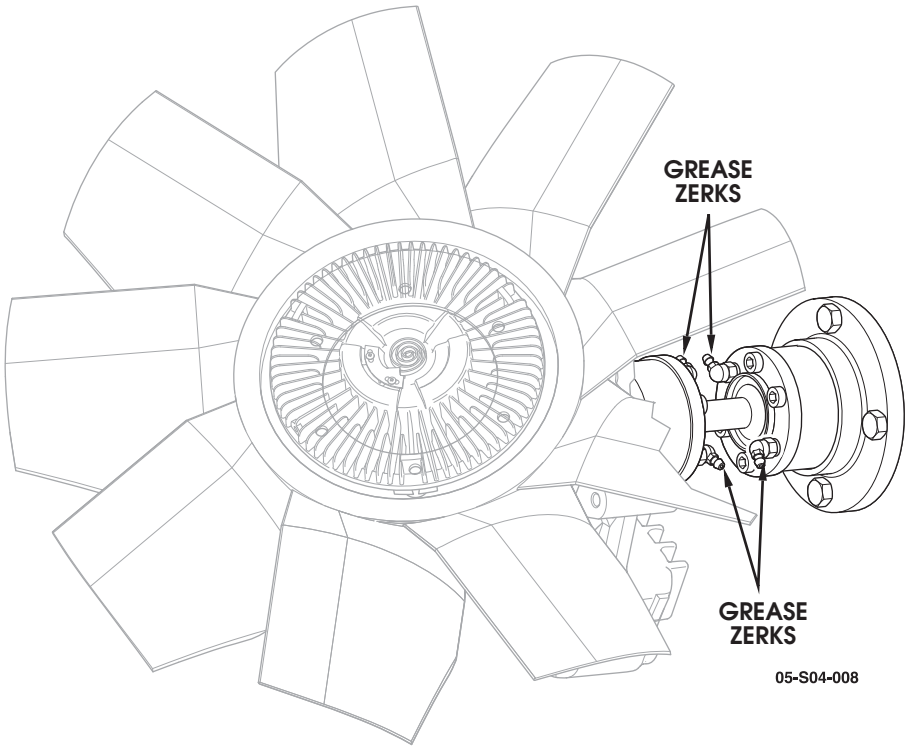


Figure 4-25: Coupler Shaft Grease Points

Installation

1. Install the GFD in the cross member and secure with four bolts and torque to 44 lb ft (60 N•m).
2. Secure the fan and viscous drive assembly to the GFD with four bolts and torque to 80-100 lb ft (108-135 N•m).
3. Secure the GFD drive flange to the harmonic balancer and torque the bolts to 44 lb ft (60 N•m).
4. Install the lower coolant pipe.
5. Install the front axle assembly.
6. Install the front driveline protection.
7. Fill the cooling system with Dex Cool coolant.

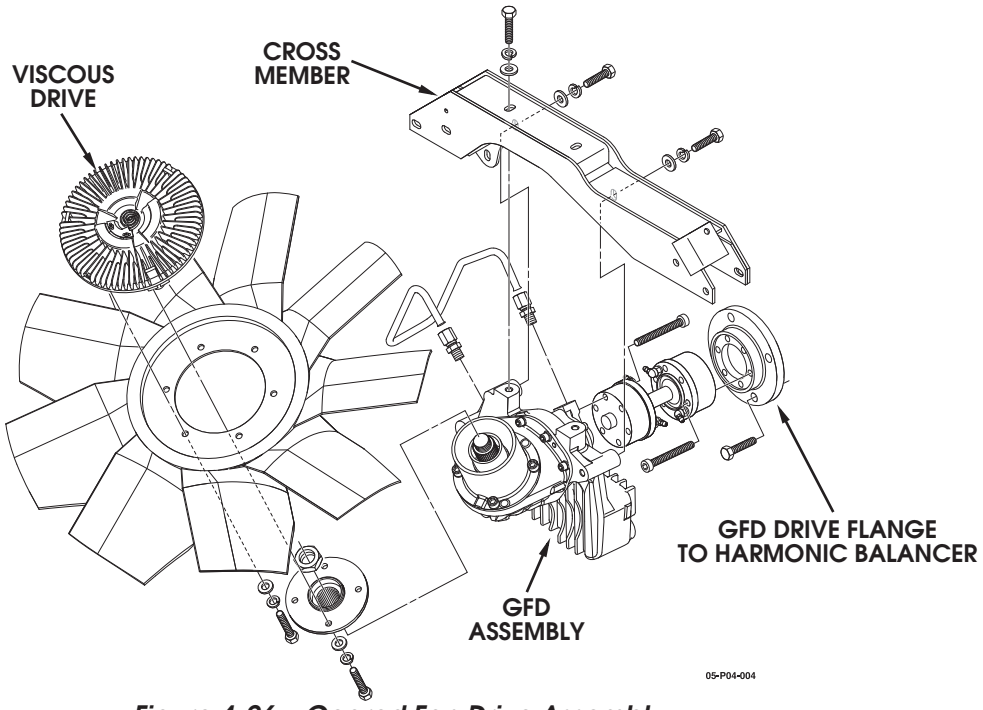


Figure 4-26: Geared Fan Drive Assembly

GEARED FAN DRIVE SEAL REPLACEMENT

CAUTION: *DO NOT lift the GFD with the oil pipe. It may induce oil leaks.*

NOTE: The disassembly and assembly process will require the use of a good quality shop press, do not attempt this procedure without the proper tools.

With the GFD removed from the vehicle and drained of fluid, place it on a clean work bench free of dirt and debris.

Disassembly

1. Remove the oil pipe (Figure 4-27).

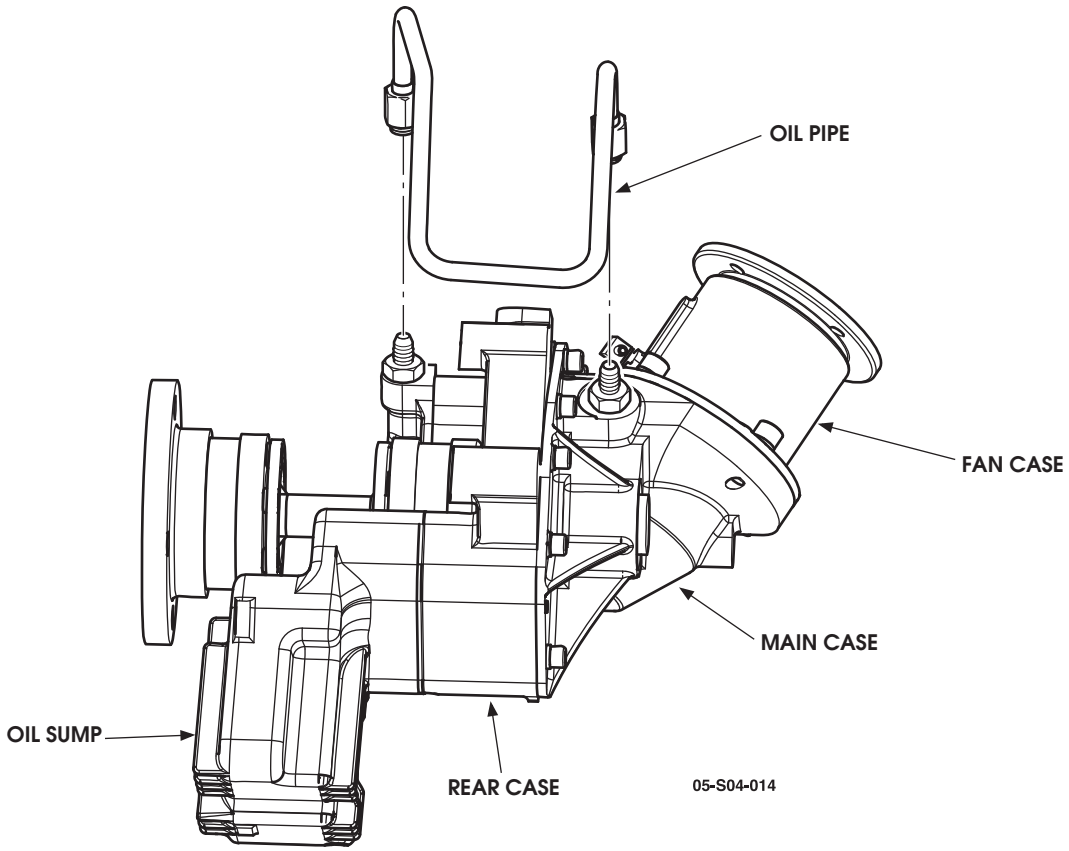


Figure 4-27: Oil Pipe

2. Remove the six bolts holding the sump assembly to the GFD and remove the sump.

3. Remove the three bolts holding the oil pump housing to the GFD and remove the housing, gerotor pump, relief spring and ball (Figure 4-28).

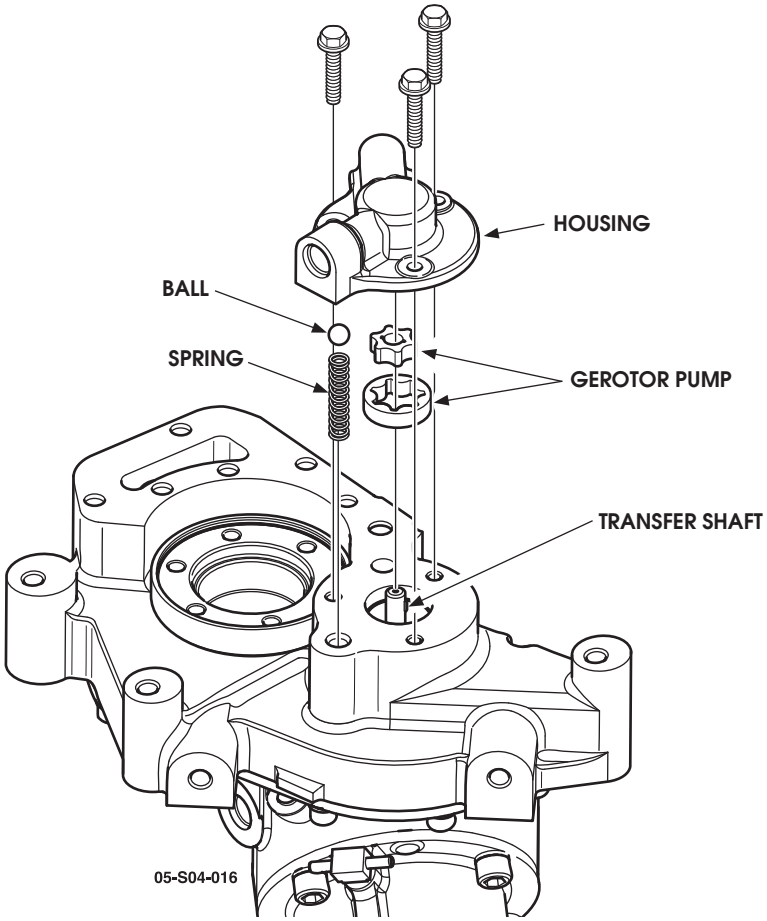


Figure 4-28: Gerotor Pump Assembly

CAUTION: *When removing the core plug care must be taken not to damage the sealing surface. It may induce oil leaks.*

4. Remove the input shaft core plug with a small screw and slide hammer close to the outside edge of the core plug (Figure 4-29).

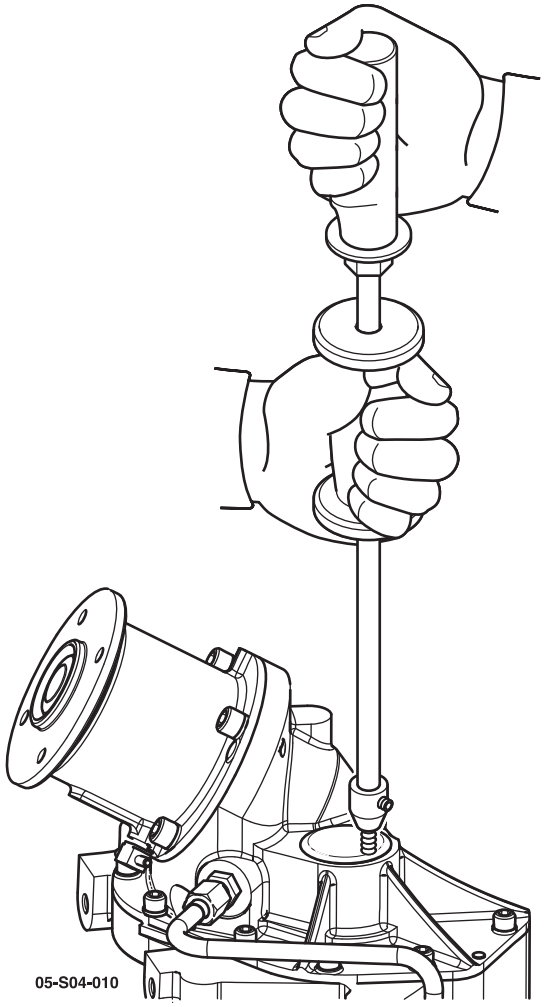


Figure 4-29: Core Plug Removal

5. Install tool J-8814-11 on the output flange (Figure 4-30).

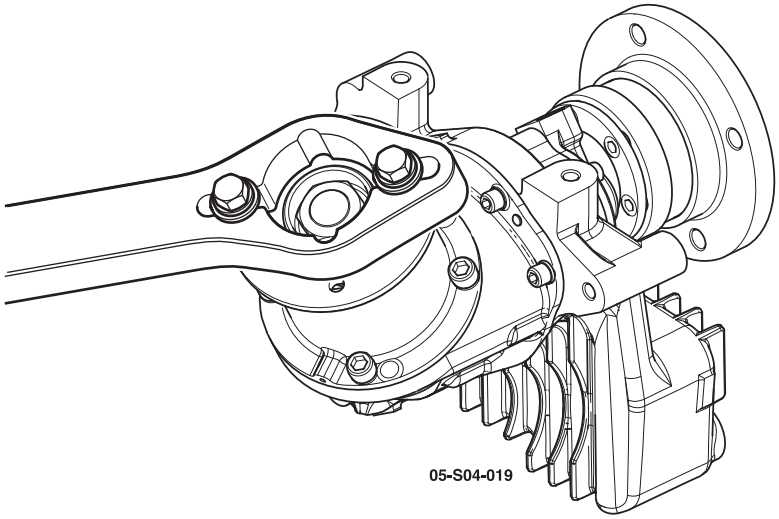


Figure 4-30: Tool J-8814-11

NOTE: The threads on the input and output shaft are left hand threads.

6. Release the locking tab on the input shaft nut and with tool EN-48032 remove the nut and locking washer (Figure 4-31).

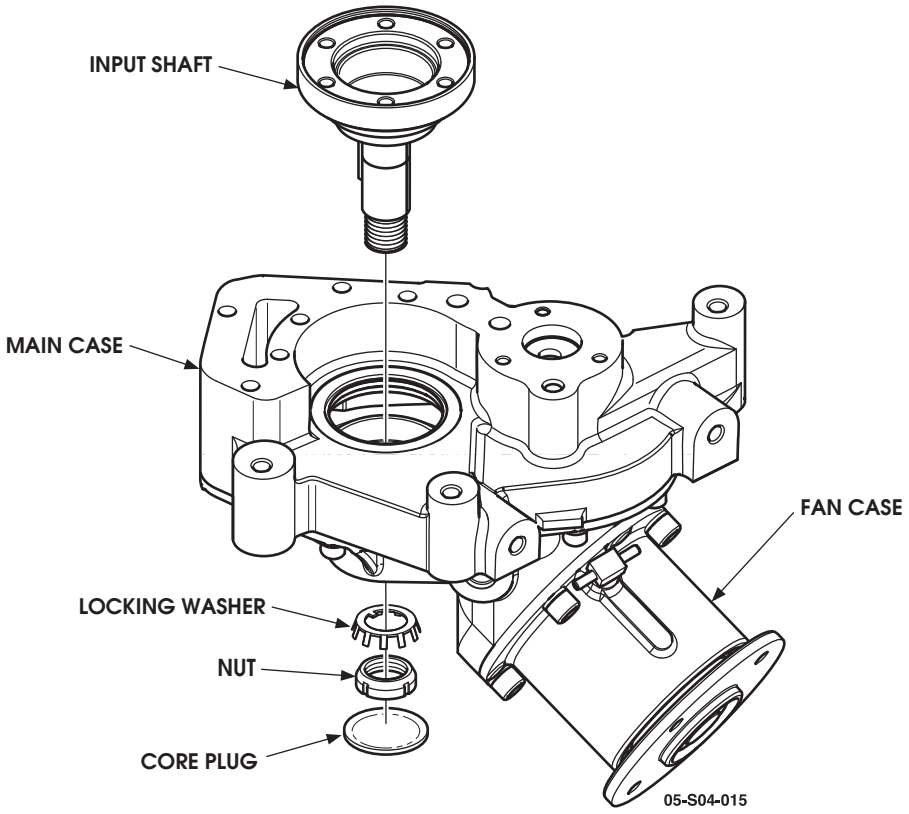


Figure 4-31: Input Shaft Removal

7. Remove the output shaft nut and remove tool J-8814-11.

CAUTION: *DO NOT impact the input shaft out of the housing, damage to the shaft, gear, bearing or the housing may result.*

CAUTION: *The transfer shaft protrudes past the main case and could be damaged if used to support the main case while pressing out the input shaft.*

8. Press the input shaft out of the GFD with a press (Figure 4-31).
9. Remove the seven bolts holding the case halves together and while holding the halves horizontal to the work bench so as to not drop the input gear or transfer shaft, separate the case halves by lifting the main case from the rear case (Figure 4-32).
10. Remove the input gear and the transfer shaft from the rear case and remove the input shaft seal.

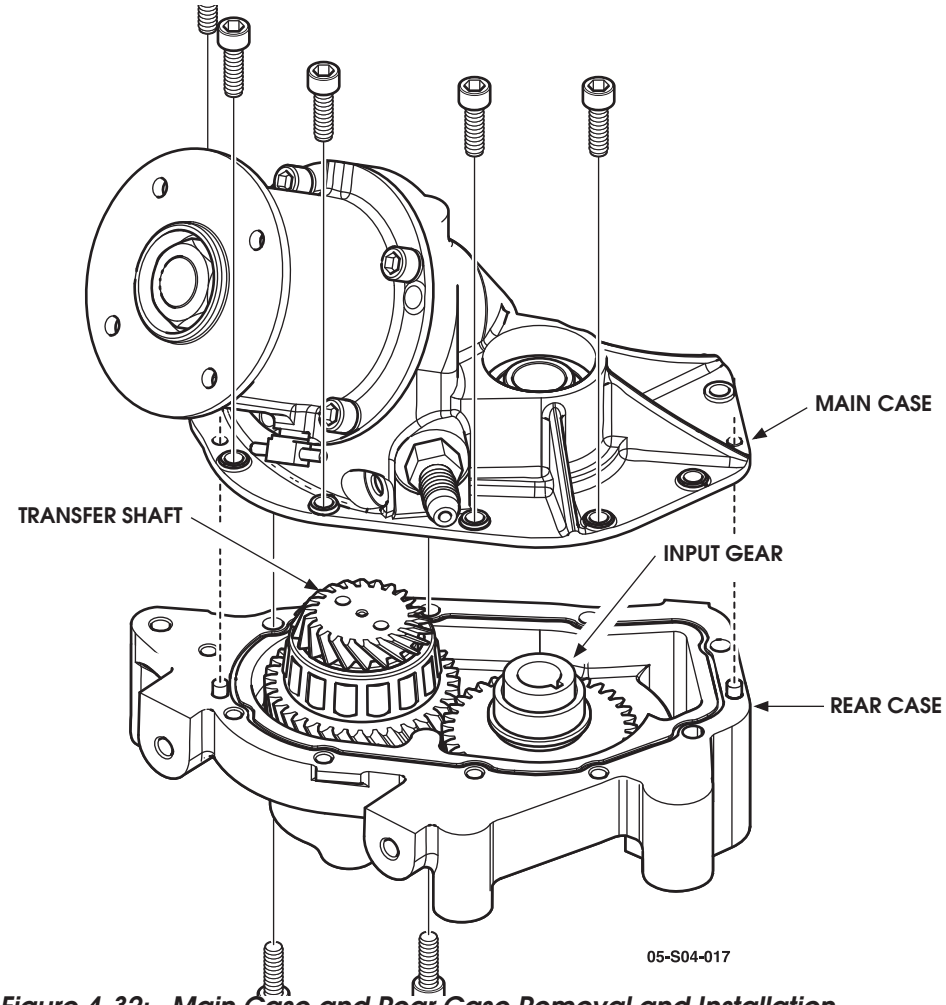


Figure 4-32: Main Case and Rear Case Removal and Installation

11. Remove the four bolts securing the fan case to the main case and remove the fan case assembly (Figure 4-33).

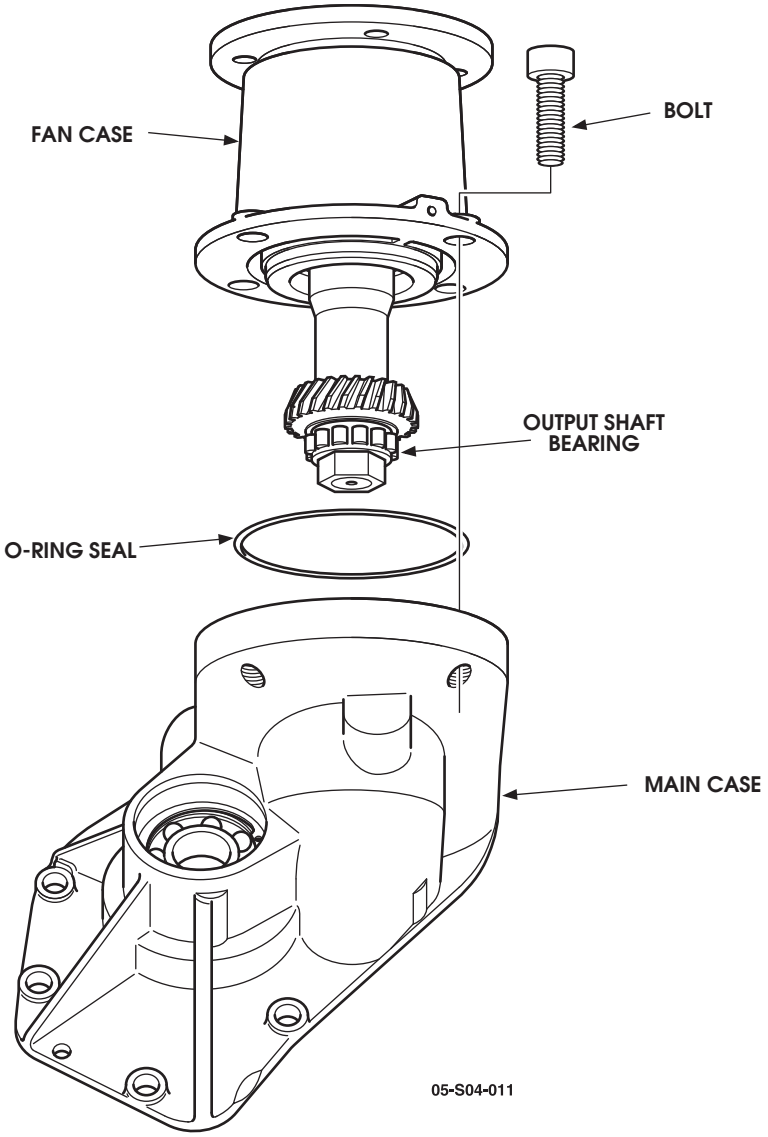


Figure 4-33: Fan Case Removal and Installation

CAUTION: *DO NOT impact the output shaft out of the housing, damage to the shaft, bearing or the housing may result.*

12. Press the output shaft out of the fan case and remove the seal (Figures 4-34 and 4-35).

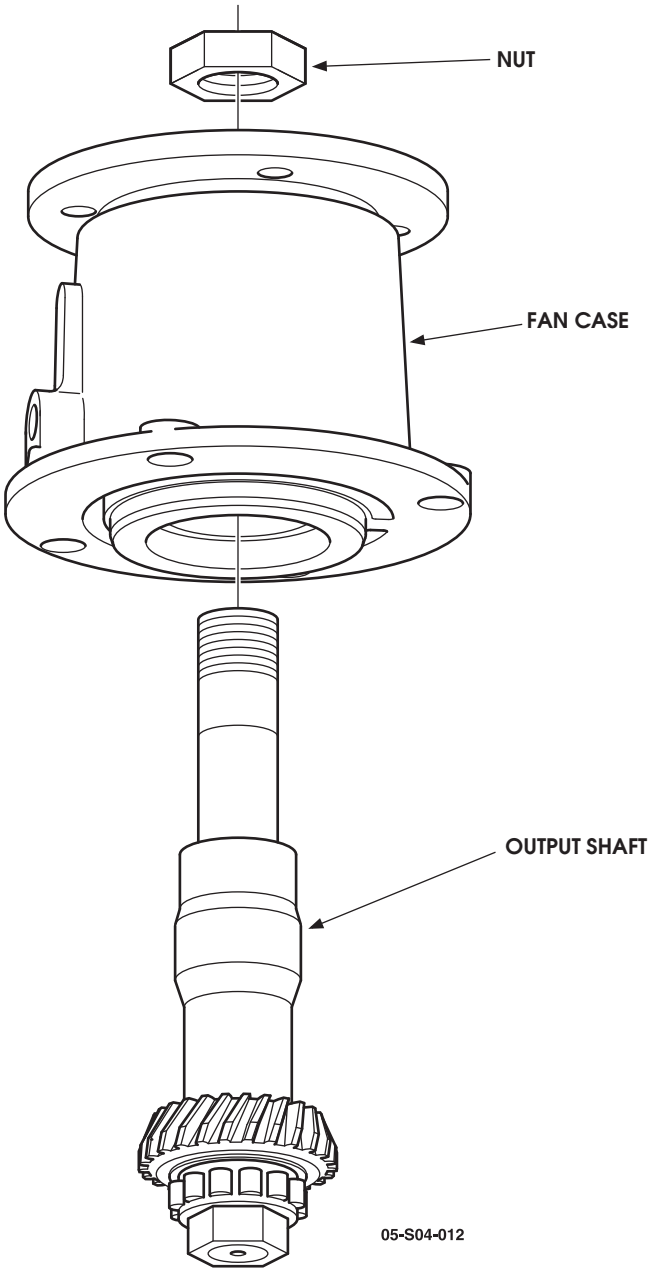


Figure 4-34: Output Shaft Removal and Installation

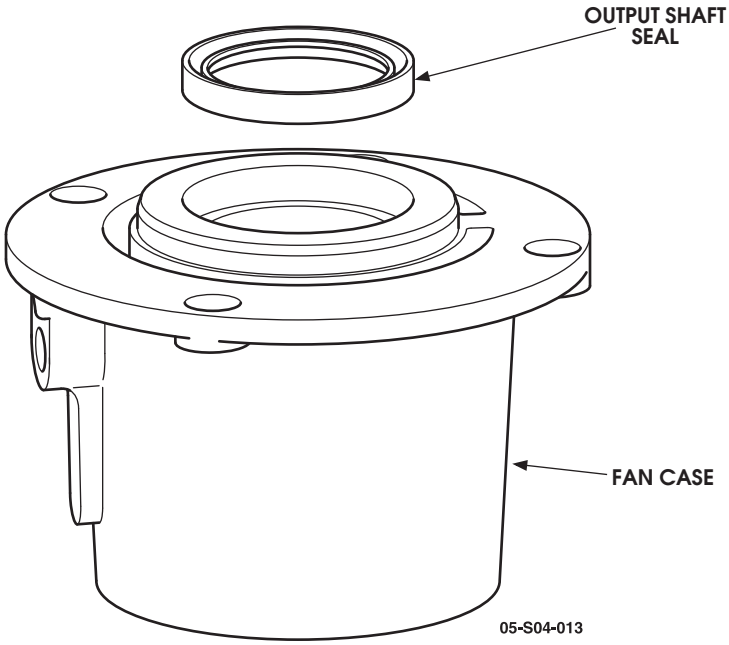


Figure 4-35: Output Shaft Seal Removal and Installation

Assembly

1. Using tool EN-48031 install the output shaft seal into the fan case and apply a light coat of gear oil on the seal lips (Figure 4-35).
2. Press the output shaft into the fan case bearing (Figure 4-34).

CAUTION: *When installing the fan case assembly into the main housing, care must be taken not to knock the rollers out of the bearing on the output shaft.*

3. Apply a light coat of gear oil on the output shaft bearing, install a new o-ring seal on the main case for the fan case and install the fan case assembly. Apply medium strength thread locker to the bolts and torque to 25 lb. ft. (34 N•m) (Figure 4-33).
4. Using tool EN-48031 install the input shaft seal in the rear case and apply a light coat of gear oil on the seal lips (Figure 4-36).

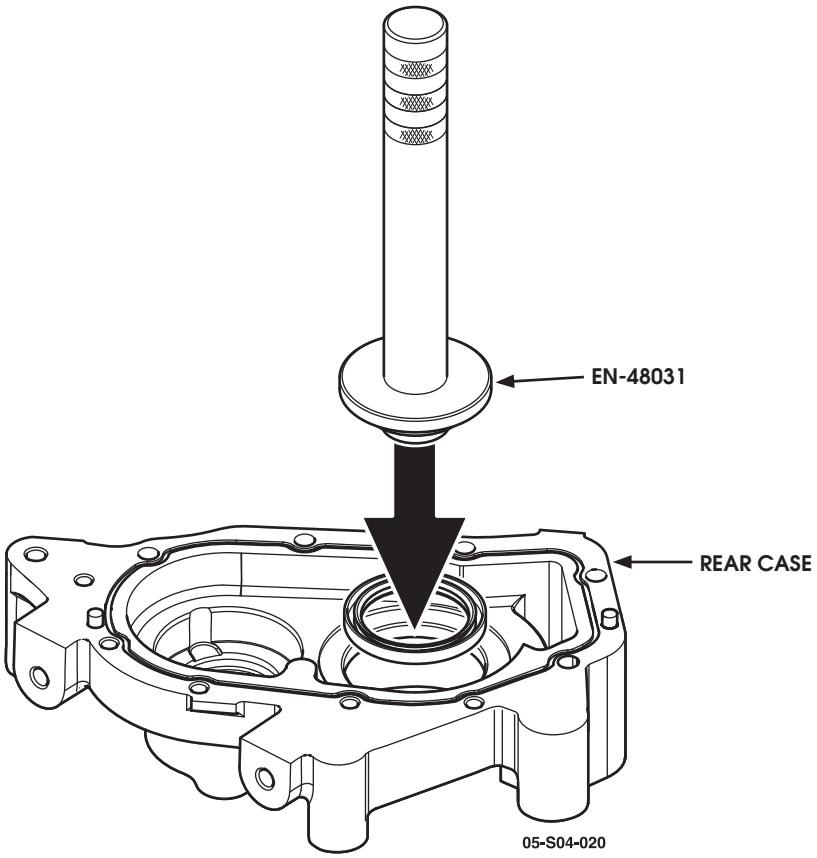


Figure 4-36: Input Shaft Seal Removal and Installation

CAUTION: *When installing the transfer shaft assembly in the rear case, the gerotor end of the shaft protrudes past the rear case and may be damaged if the rear case is not properly supported.*

5. Install the transfer shaft assembly and the input gear into the rear case and install a new o-ring seal (Figure 4-32).
6. Install the main case onto the rear case and torque the bolts to 18.5 lb. ft. (25 N•m).

CAUTION: *When pressing the input shaft in, the bearing in the main case must be supported or the case and the snap ring may be damaged.*

7. Press the input shaft into the GFD (Figure 4-37).

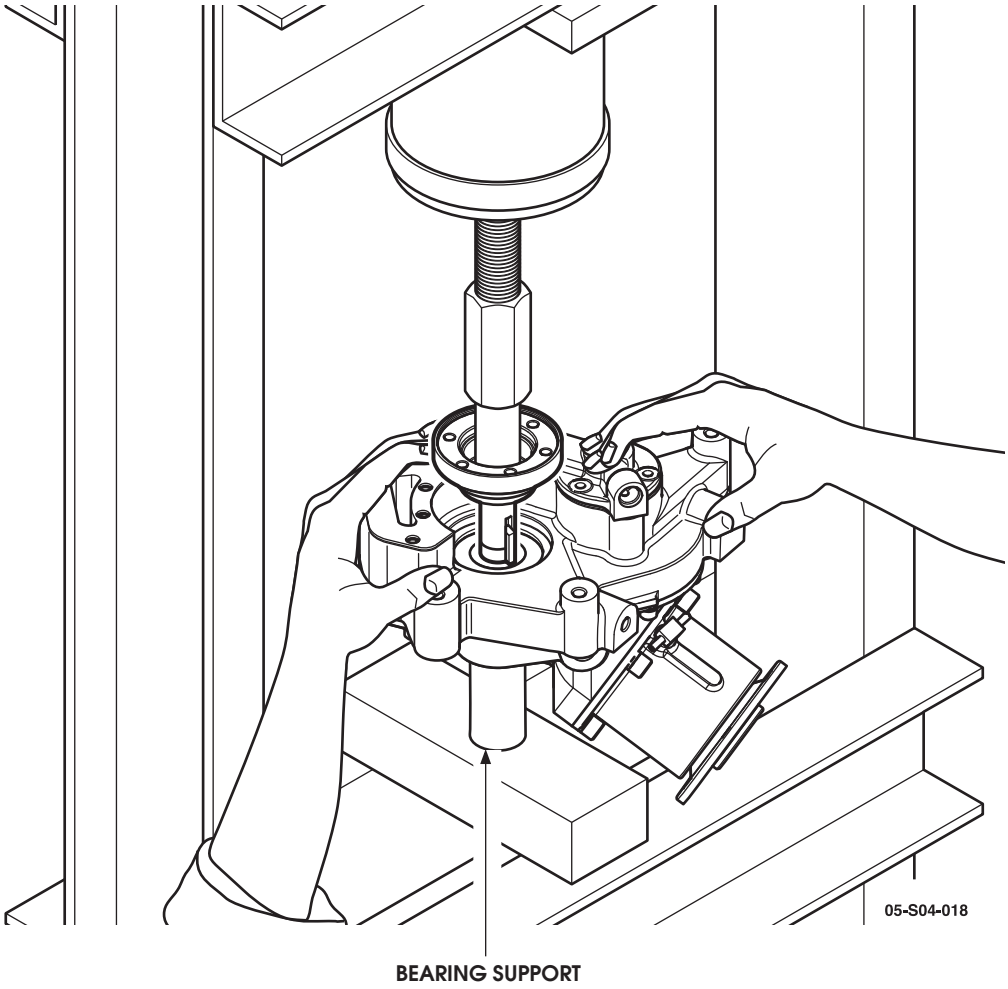


Figure 4-37: Pressing The Input Shaft

8. Install tool J-8814-11 onto the output flange, apply medium strength thread locker and torque the output shaft nut to 110 lb. ft. (150 N•m) (Figure 4-30).
9. With tool J-8814-11 still installed and using tool EN-48032, torque the input shaft nut to 70 lb. ft. (95 N•m) if the lock-washer tab does not line up, continue to tighten until tab alignment can be achieved. Once alignment is achieved, bend the lock tab in place to secure the nut.
10. Apply aviation gasket sealant to the sealing surface and install the core plug (Figure 4-31).
11. Apply a thin coat of gear lube on the gerotor pump and install it onto the transfer shaft (Figure 4-28).
12. Install new o-rings on the pump housing, install the relief spring and ball in the rear case, install the pump housing to the rear case and torque to 9 lb. ft. (12 N•m) (Figure 4-28).
13. Install the sump assembly with a new gasket and torque the bolts to 18.5 lb. ft. (25 N•m).
14. Install the oil pipe and torque the nuts to 19 lb. ft. (26 N•m) (Figure 4-27).
15. Install the GFD and fill with fluid.

Section 5 Transmission/Transfer Case

TABLE OF CONTENTS

Flywheel and Flexplate 5-33
Torque Converter/Oil Pump Seal 5-30
Transfer Case
- Assembly 5-69
- Cleaning and Inspection 5-63
- Description 5-39
- Diagnosis 5-42
- Disassembly and Overhaul 5-47
- Essential Tools 5-88
- Extension Housing Bushing and Seal 5-67
- Fluid Change 5-45
- Fluid Level 5-41
- Front Output Shaft Bearing and Seal Replacement 5-64
- Front Output Shaft Seal Replacement 5-44
- Guide Cable Replacement 5-44
- Identification 5-40
- Input Gear Bearing Replacement 5-66
- Installation 5-47
- Lever Knob 5-36
- Mainshaft Pilot Bearing Replacement 5-67
- Oil Cooler 5-40
- Operating Ranges 5-41
- Recommended Lubricant 5-41
- Removal 5-45
- Shift Control Assembly Replacement 5-34
- Shifting 5-41
- Speed Sensor and Switch Replacement 5-44
- Torque Specifications 5-87
- Vent Line Replacement 5-43

Transmission
- Abuse Protection Modes 5-9
- Control Valve Solenoid Replacement 5-27
- Cooler Flushing and flow testing Procedure 5-23
- Essential Tools 5-88
- Fast Learn Procedure 5-10
- Fill Tube Replacement 5-24
- Fluid And Filter Replacement 5-23
- Fluid Checking Procedure (COLD) 5-11
- Fluid Checking Procedure (HOT) 5-12
- Functional Test Procedure 5-17
- Gear Ratios 5-5
- Identification 5-5
- Input and Output Speed Sensors 5-6
- Input Speed Sensor Replacement 5-38
- Line Pressure Check Procedure 5-19
- Mount/Isolator 5-37
- Neutral Start Back Up (NSBU) Switch 5-7
- Neutral Start Backup Switch (NSBU) Replacement 5-36
- Oil Pan and internal oil filter Replacement 5-25

Pressure Control Solenoid 5-11
Pressure Switch Manifold Replacement (PSM) 5-29
Recommended Fluid 5-11
Removal 5-30
Road Test Procedure 5-12
Shift Solenoids 5-8
Special Tools 5-90
Speed Sensors 5-6
Torque Converter Clutch Solenoid 5-11
Torque Specifications 5-88
Transmission Control Module 5-6
Replacement 5-21
Valve Body Replacement 5-26
Vehicle Speed Sensor (VSS) 5-6
Vent Line Service 5-24
Warning Lamps 5-20

TRANSMISSION DESCRIPTION

The Allison 1000 Series transmission utilizes clutch-to-clutch shift control to achieve range changes. In every case, except shifts to or from NEUTRAL, one clutch is exhausted and another applied in order to make a range shift. The hand-off between exhausting and applying clutches is precisely controlled by the use of two pressure proportional to current PPC) solenoids. These solenoids are labeled A and B in the transmission, and are referred to as trim solenoids. For example, to make a 1-2 shift, pressure control solenoid (PC) A is used to trim pressure off the low and reverse clutch, and PC solenoid B is used to trim pressure on the 2nd clutch. The transmission control module (TCM) modulates the current to both PC solenoid A and PC solenoid B, which translates to a proportional level of pressure to the clutch. In order to make a shift, the TCM uses software and calibration settings of several program parameters in order to determine the level of current sent to the respective trim solenoids. These parameters are referred to as adaptive values. With a new transmission and TCM calibration, the adaptive values are set to a base calibration level. The transmission uses the base calibration to perform the first of each type of shift. However, once the transmission has performed a shift, the TCM evaluates the actual shift and compares it to an ideal shift in the TCM memory. Based on that comparison, the TCM changes the settings of the adaptive values to a level that it believes will result in a shift closer to the ideal shift the next time it makes that type of shift. This is referred to as adaptive shifting. When the transmission/TCM calibration is new, the TCM is in fast adaptive mode. The TCM is allowed to make large changes in the adaptive values after each shift. Once the TCM determines that a given shift is close to the ideal level, it switches to slow adaptive mode. In slow adaptive, the TCM still is evaluating shifts and changing adaptive values, but is only allowed to do so in smaller increments. When a shift switches from fast to slow adaptive mode, it is described as converged. The TCM is programmed in order to switch from fast to slow adaptive mode in as many as 15-20 shifts. It is important to understand that there are many different distinct shifts recognized by the TCM and each of these shifts has its own adaptive values. There are upshifts and downshifts to and from each range, as well as unique adaptive values for several different throttle regions for each upshift and downshift. It may take a significant amount of time before most of the shifts converge from fast to slow adaptive and thus it is not unusual to experience somewhat harsh or unpleasant shift quality until these shifts are adapted.

Torque converter clutch (TCC) engagement is accomplished by a separate pulse width modulated (PWM) solenoid, labeled F in the transmission. There are adaptive values for this as well and thus it will also require some driving for TCC engagement to converge.

If you are experiencing harsh shifts, it is important to verify whether the particular shift is converged. Use the scan tool in order to determine if the shift is converged.

- If the shift is not converged, the TCM is learning how to adapt that shift, and needs to be driven more, with the intention of performing more of the particular type of shift.
- If a particular shift is converged, but still objectionable, it is good troubleshooting practice to reset the adaptive values for that shift back to base calibration level. This will automatically reset the TCM to fast adaptive mode. The vehicle should then be driven in order to allow the TCM to relearn the shift. Many times this will correct the condition. It is possible to reset individual shifts without affecting the other shifts.

NOTE: WHEN REPLACING A FAILED TRANSMISSION WITH A REPLACEMENT UNIT, IT IS IMPORTANT TO RESET THE TCM TO BASE CALIBRATION AND FAST ADAPTIVE FOR ALL SHIFTS. This can be done in one step with the scan tool. If this is not done, the TCM adaptive values will be at the settings that it learned for the old transmission and will be in slow adaptive mode. Under these conditions, it would take an unacceptably long time for the adaptive values to converge to levels suitable for the new transmission.

TORQUE CONVERTER

The torque converter is a single-stage, polyphase, and three-element unit, consisting of a pump, stator, and turbine. At lower output speeds, the torque converter multiplies torque and provides a fluid coupling to the engine. At higher speeds, the torque converter clutch (TCC) is automatically engaged to provide direct drive from the engine to the transmission. Hydraulic fluid for converter charging pressure comes from the sump and is supplied by the input pump. The torque converter clutch is applied or released by changing direction of fluid in the torque converter. An integral converter damper minimizes the need for additional engine vibration control.

GEAR SETS

The planetary gear train includes three constant-mesh planetary gear sets containing helical gears. By the engagement of the clutches in various combinations, the planetary sets act singly or together to provide five forward ranges, neutral, and reverse.

CLUTCHES

Five clutches (two rotating and three stationary) direct the flow of torque through the transmission. All range clutches are hydraulically actuated and spring-released, with automatic wear compensation. The transmission fluid cools the clutches. The transmission control module (TCM) signals solenoid valves to apply and release clutches based on speed and power combinations and the range selected by the operator.

HYDRAULIC SYSTEM

A common hydraulic system serves the torque converter and the transmission. Transmission fluid for all hydraulic operations, lubrication, and cooling comes from the sump and is supplied by the charging pump.

TRANSMISSION FLUID FILTRATION

Fluid filtration is provided by two filter systems. A suction filter, located in the sump, provides general protection to the entire hydraulic system by filtering large particulates. A spin-on filter provides full-time protection for the control solenoids and multipass protection for the entire system. The spin-on filter is externally located on the converter housing at the lower left front of the transmission.

ELECTRO-HYDRAULIC CONTROL VALVE ASSEMBLY

The control valve assembly consists of two components. The main valve body contains the trim valves, the torque converter clutch (TCC) valve, the exhaust backfill valve, and the control main relief valve. The shift valve body contains the shift valves, the control main pressure valve, and the manual selector valve. The control valve assembly attaches to the bottom of the gearbox module and is enclosed by the oil pan.

REMOTE OIL COOLER PROVISION

The oil cooler lines are located on the right side of the converter housing near the converter housing/main housing split line. The cooler lines go out of the transmission to the transmission cooler bypass valve located on the passenger side frame rail below the engine mount bracket. From the transmission cooler bypass valve the lines go to the remote oil cooler located in the cool pack. Heat is transferred from the transmission fluid to air.

TRANSMISSION COOLER BYPASS VALVE

The transmission cooler bypass valve is located on the passenger side frame rail below the engine mount bracket. The transmission cooler bypass valve directs the cooler fluid back to the transmission until it reaches 150°F. By 180°F the valve is fully open and the fluid is directed to the oil cooler.

FILL TUBE/DIPSTICK PROVISION

All 1000 Series models have a fill tube/dipstick provision on both sides of the transmission. The fill tube and dipstick are located on the passenger side. A plug is installed in the unused location on the driver side.

PARK PAWL

All 1000 Series transmissions have a PARK pawl. The internal parking pawl is engaged by selection of the PARK position on the shift selector.

PTO PROVISION

Some 1000 Series transmissions have a provision to mount and drive a power takeoff (PTO) unit on the left and/or right side of the transmission housing. The H1 transmission does not have this feature.

TOW/HAUL MODE

Tow/Haul mode significantly changes the transmission shift pattern to reduce shift cycling and to deliver better performance, control, and cooling when towing or hauling heavy loads. For instance:

- Upshift points are raised at light to mid throttle position to use more of the available engine power for acceleration. Downshift points are raised to enhance engine braking to help slow the vehicle.
- During deceleration, the torque converter clutch (TCC) remains applied at closed throttle at lower speeds to significantly improve the effect of engine braking.
- During acceleration, the TCC is applied in 2nd range and remains applied in 3rd, 4th, and 5th. This improves the drivetrain efficiency and significantly lowers transmission sump temperature when towing heavy loads. In Normal mode, the TCC generally applies only in higher ranges and is dependent on throttle position.
- Tow/haul is designed to be most effective when the vehicle and trailer combined weight is at least 75 percent of the gross combined weight rating (GCWR) of the vehicle.
- Operation of tow/haul in a lightly loaded or non-loaded vehicle will not cause damage. However, there is no benefit to the selection of tow/haul when the vehicle is unloaded. This situation will cause a firm shift. The tow/haul switch is not a performance switch.
- Selection of tow/haul when unloaded may result in unpleasant engine and transmission driving characteristics and reduced fuel economy. Tow/haul is recommended only when pulling a heavy trailer or a large or heavy load.

Activation

- Tow/Haul is selected or de-selected via a switch on the center console. The switch will illuminate to indicate that tow/haul has been selected.
- Tow/Haul must be selected again, every time the vehicle is started, if desired.

ADAPT FUNCTION

The transmission control module (TCM) produces excellent shift quality by applying closed loop control that constantly adjusts shift characteristics for changes in operating conditions. These adjustments are based on vehicle conditions, such as grade, load, and engine power.

The learning process of comparing and adjusting shift parameters is referred to as adaptive control. The TCM constantly monitors operating conditions, such as battery voltage and transmission sump temperature, and adjusts shift parameters accordingly. After a shift is completed, the TCM compares the shift to a target shift profile in the TCM calibration and makes adjustments before the next shift of the same kind is made.

TRANSMISSION GEAR RATIOS

Transmission gear ratios are:

First gear	3.10:1
Second gear	1.81:1
Third gear	1.41:1
Fourth gear	1.00:1
Fifth gear	0.71:1
Reverse	4.49:1

TRANSMISSION IDENTIFICATION

An I.D. plate is attached to the passenger side of each Allison Transmission (Figure 5-1). The plate contains the model, date of manufacture, serial number, engineering feature configuration, transmission identification, and the engineering group (Figure 5-2).

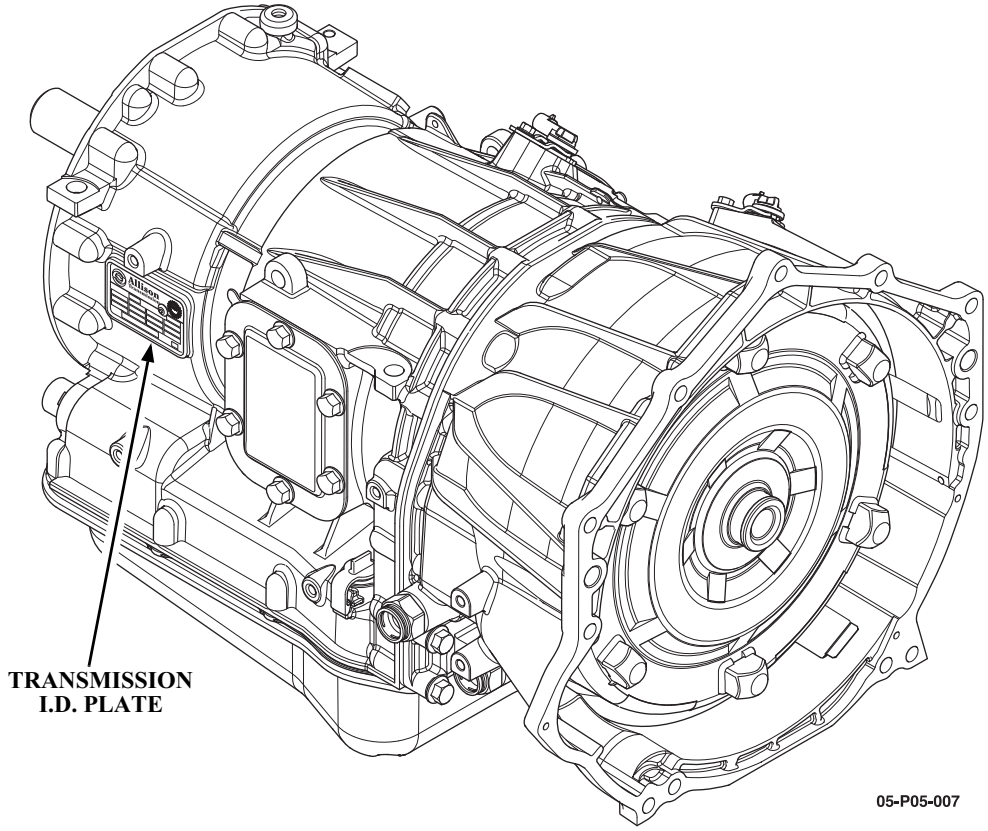


Figure 5-1: Transmission I.D. Plate location

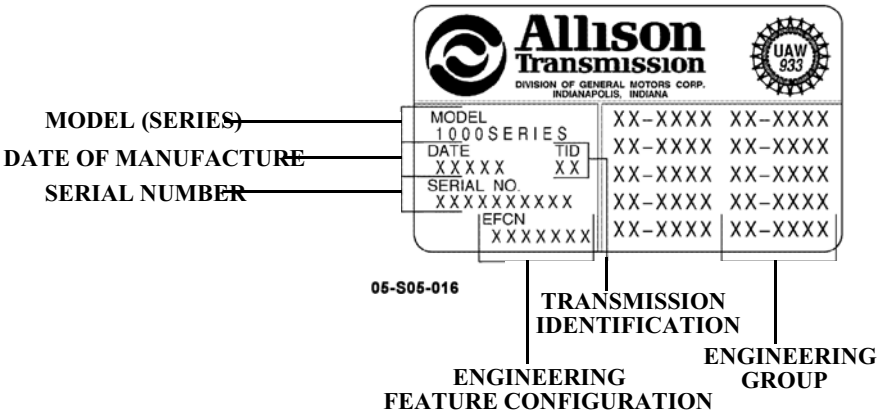


Figure 5-2: Transmission Identification (example plate)

TRANSMISSION CONTROL MODULE

A microcomputer controls the transmission by receiving and processing signals from various switches and sensors. The microcomputer determines shift sequences, shift timing, and clutch apply and release characteristics. The microcomputer is an independent controller and is referred to as a transmission control module (TCM). The TCM has a 12 volt configuration to match the configuration of the vehicle electrical system. The pressure switch manifold (PSM) and the park/neutral position (PNP) switch provide operator input to the TCM. Other data sent to the TCM include throttle position, engine, turbine, and output speeds, and sump temperature. An active special function, such as anti-lock brakes, is also an input to the TCM. The TCM processes this data to determine proper shift points, to monitor the current range, to perform ratio tests, and to compile diagnostic data. The TCM is programmed to protect the transmission and other vehicle driveline components by inhibiting actions, such as full-throttle NEUTRAL-to-range shifts and high speed direction changes. The TCM determines if a system malfunction exists and stores diagnostic codes related to the malfunction. The codes, accessed by the service technician, are used in diagnosing persistent or intermittent trouble in the system.

THROTTLE POSITION/TORQUE MANAGEMENT

The TCM receives input on throttle position/torque management, from a signal transmitted by the engine electronic controls. The engine electronic controls communicate directly to the transmission electronic controls over a serial communication interface (SCI) data link. The transmission TCM must be calibrated to receive these signals.

SPEED SENSORS

There are three speed sensors typically required for use with the 1000 Series transmissions (Figure 5-3). They include the input speed sensor (TIS), the turbine speed sensor, and the output speed sensor (TOS). The speed sensors provide RPM information to the TCM. The speed ratios between the various sensors allow the TCM to determine the transmission operating range. Speed sensor information is also used to control the timing of clutch apply pressures, resulting in the best possible shift quality. Hydraulic conditions are detected by comparing the speed sensor information, for the current range, to the range of the speed sensor information stored in TCM memory. The speed sensors are variable reluctance devices that convert mechanical motion to an AC voltage. Each sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member.

VEHICLE SPEED SENSOR (VSS)

The vehicle speed sensor is located on the transfer case (Figure 5-3). Vehicle speed sensor information is used to determine vehicle speed. The speed sensor is a variable reluctance device that converts mechanical motion to an AC voltage. The sensor consists of a wire coil wrapped around a pole piece that is adjacent to a permanent magnet. These elements are contained in a housing that is mounted adjacent to a rotating ferrous member. The signal is sent to the ECM then on to the speedo/tach module.

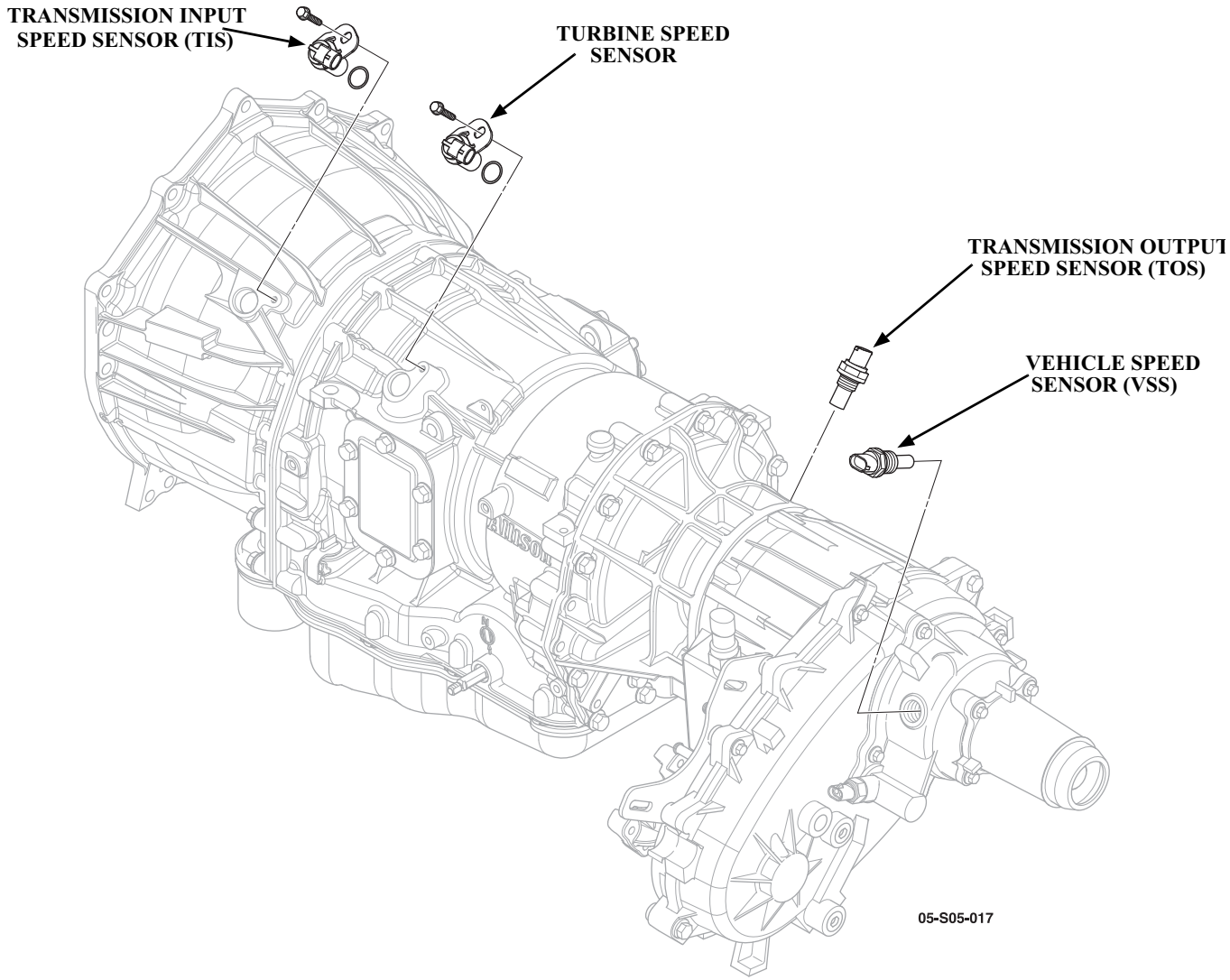


Figure 5-3: Speed Sensors

NEUTRAL START BACK UP (NSBU) SWITCH

The vehicle is equipped with a console style shift selector. In addition to the console shift selector provided for the operator, another component associated with the shift selector is the neutral start back up (NSBU) switch mounted on the selector shaft of the transmission. The NSBU switch transmits selector position information to the TCM. The NSBU switch mounts directly onto the transmission housing from the outside and detects the angular position of the shift selector shaft. this position is communicated to the TCM so that certain vehicle control functions can be coordinated with the position of the shift controls. The NSBU switch has redundant circuitry to alert the TCM in the event of a single wire or switch failure. The neutral signal output of the NSBU switch is used as confirmation that the transmission is in neutral before the engine starter is engaged. The NSBU switch is interfaced to the starter circuit. The reverse signal is used for back up lights, auto dimming mirror defeat and may be used for back up warning devices.

INTERNAL TRANSMISSION COMPONENTS

Several components of the 1000 Series electrical control system are located within the transmission, as part of the main control valve body. These components include three types of solenoids for controlling the hydraulic action of the valves, the pressure switch manifold and an internal wiring harness that links the internal components with the TCM.

SHIFT SOLENOIDS

The 1000 Series control valve body contains both normally closed (N/C) and normally open (N/O) solenoids. A N/C solenoid remains closed until a signal from the TCM energizes the solenoid. A N/O solenoid remains open until the TCM energizes the solenoid. When a solenoid valve is in the closed position, the valve blocks the flow. When a solenoid valve is in the open position, flow is permitted through the valve. The torque converter clutch pulse width modulated (TCC PWM) solenoid and the shift solenoids C, D, and E are N/C. Both solenoid types have an orifice, electrical windings, an iron core, and a steel check ball.

The solenoids used in the 1000 Series differ in their ability to control flow or fluid pressure. The solenoids may operate in the open or closed state with no modulation capability (C, D, and E solenoids), intermediate flow and resultant pressure based on duty cycle (F solenoid) or produce pressure proportional to current (A and B solenoids).

Shift solenoids C, D, and E provide the necessary logic to distribute fluid to the correct clutches. The shift solenoids provide either full control main pressure or exhaust to the head of each of the corresponding shift valves C, D, and E. Since the valve states, stroked or unstroked, are critical to providing the correct transmission range, each shift valve has a pressure switch, located in the pressure switch manifold, which provides feedback to the computer as to the position of the valve.

The modulated main pressure solenoid is a normally closed solenoid used to modulate the transmission main pressure. Under specific conditions, such as a low throttle setting, low engine torque, low engine speed, and low transmission output speeds, the transmission control module (TCM) commands the solenoid on. When the solenoid is applied, fluid is routed to the main pressure regulator valve; this in turn reduces the main pressure schedule and improves the volume of oil through the overage circuit. By modulating main pressure, the cooler flow at idle can be increased allowing improved cooling and reducing transmission pump noise.

Trim solenoids A and B are used to control on-coming, off-going and holding pressure to the five clutches. These solenoids are referred to as PPC solenoids, since the output hydraulic pressure supplied by these solenoids is proportional to the controlled current command.

Range	Pressure Switch C N/O	Pressure Switch C N/O	Pressure Switch D N/O	Pressure Switch D N/O	Pressure Switch E N/O	Pressure Switch E N/O	Pressure Switch R N/C	Pressure Switch R N/C
	Switch Status	Scan Tool Status	Switch Status	Scan Tool Status	Switch Status	Scan Tool Status	Switch Status	Scan Tool Status
R	Open	OFF*	Closed	ON	Closed	ON	Closed	ON
N	Closed	ON	Closed	ON	Closed	ON	Open	OFF
1	Open	OFF	Closed	ON	Open	OFF	Open	OFF
2	Open	OFF	Open	OFF	Open	OFF	Open	OFF
3	Closed	ON	Open	OFF	Open	OFF	Open	OFF
4	Closed	ON	Open	OFF	Closed	ON	Open	OFF
5	Open	OFF	Open	OFF	Closed	ON	Open	OFF

N/C = Normally Closed

N/O = Normally Open

* C pressure switch reverts to the Closed/ON state with throttle applied in Reverse.

The Allison 1000 series transmission consists of (5) clutches labeled C1 to C5. A combination of (2) clutches is required to be engaged to attain a torque path from the input to the output of the transmission. The following chart indicates the clutch combinations for each gear range.

Gear Range	C1	C2	C3	C4	C5	TCC
Park/Neutral	--	--	--	--	X	--
Reverse	--	--	X	--	X	--
First	X	--	--	--	X	--
Second	X	--	--	X	--	X
Third	X	--	X	--	--	X
Fourth	X	X	--	--	--	X
Fifth	--	X	X	--	--	X

This transmission utilizes clutch-to-clutch shift control to achieve ranges. In every case, except shifts to or from the neutral position, one clutch is exhausted and another is applied to make a range shift. The hand off between exhausting and applying clutches is very precisely controlled by use of two PPC (Pressure Proportional to Current) solenoids. These solenoids are “A” and “B” in the transmission and are referred to as “trim” solenoids. For example, to make a 1-2 shift, A solenoid is used to trim pressure off C5 clutch and B solenoid is used to trim pressure on C4 clutch. The transmission control module (TCM) modulates the current to both A & B solenoids, which translates to a proportional level of pressure to the clutch. In order to make a shift, the TCM uses software and calibration settings of several program parameters to determine the level of current sent to the respective trim solenoids. These parameters are referred to as “adaptive values”. With a new transmission and TCM calibration, the adaptive values are set to base calibration level. The transmission uses the calibration to perform the first of each type of shift. However, once it has performed a shift, the TCM evaluates the actual shift and compares it to an ideal shift in the TCM’s memory. Based on that comparison, the TCM changes the settings of the adaptive values to a level that it believes will result in a shift closer to the idle shift the next time it makes that type of shift. This is referred to as “adaptive shifting”. When the transmission /TCM calibration is new, the TCM is in fast adaptive mode. In other words, the TCM is allowed to make relatively large changes in the adaptive values after each shift. Once the TCM determines that a given shift is close to its ideal level, it switches to slow adaptive mode. In slow adaptive mode, the TCM is still evaluating shifts and changing adaptive values, but is only allowed to do so in small increments. When a shift switches from fast to slow adaptive mode, it is described as “converged”. The TCM is programed to try to switch from fast to slow adaptive mode in as many as 15 to 20 shifts. It is important to understand that there are many different distinct shifts recognized by the TCM, and each of these shifts has its own adaptive values. For example, there are up shifts and down shifts to and from each range, as well as unique adaptive values for several different throttle regions for each up shift and down shift. The point is, it may take a significant amount of time before most of the shifts converge from fast to slow adaptive, and it is not unusual to experience somewhat harsh or unpleasant shift quality until these shifts are adapted.

Torque converter clutch (TCC) engagement is accomplished by a separate pulse-width modulated (PWM) solenoid (F) in the transmission. There are adaptive values for this as well, and it will also require some driving for TCC engagement to converge.

TRANSMISSION ABUSE PROTECTION MODES

Transmission abuse protection modes are encountered when one of the following type of maneuvers is performed.

- Shifting from Neutral to Drive/Reverse when the engine RPM is greater than 1400 RPM.
- Shifting from Drive to Reverse when the accelerator pedal position (APP) is greater then 25%, such as rocking the vehicle when stuck and attempting to free the vehicle.
- When the transmission output speed is greater than 300 RPM while attempting a change in direction, such as Reverse to Drive, Drive to Reverse or Neutral to Reverse.

When the TCM encounters any one of the above conditions, the TCM will flash the check transmission malfunction indicator light and default to neutral. When the TCM sees that the RPM has dropped to a safe level it will then engage the selected range.

FAST LEARN PROCEDURE

In general, the fast learn procedure for the allison transmission runs a series of tests to allow the transmission control module (TCM) to “learn” individual clutch characteristics. Once the clutch data is learned, Fast Learn translates it to the adaptive data cells, which the TCM uses for clutch control during range shifts. Fast Learn is used at the assembly plant and allows the vehicle to be driven off the line in a near-fully-adapted state so as to minimize any customer shift complaints. The Scan Tool version of Fast Learn is intended to provide the same benefit following transmission repair or replacement at the dealership.

Fast Learn must be used when one of the following repairs is made to the vehicle.

- Transmission replacement or internal service/overhaul.
- Valve Body repair or replacement, including replacement of the A or B trim solenoids.
- Transmission Control Module (TCM).
- TCM software/calibration update.
- Any service in response to a shift quality complaint.

The Scan Tool is used to start Fast Learn by selecting the following functions:

- Special Functions.
- Transmission Output Controls.
- Fast Learn.

NOTE: When performing Fast Learn the following conditions must be met:

- Block the drive wheels.
- Apply the park brake.
- Apply the service brake during Drive and Reverse mode.
- 0% throttle, engine at idle RPM.
- Transmission temperature must be between 40 and 100 degrees C.
- The transfer case must be in high (H) range.

Description

Four steps are required to successfully complete the Fast Learn procedure.

1. Park Mode.
2. Drive Mode.
3. Reverse Mode.
4. C2 Learn Mode.

Park mode

While the transmission is in Park with the engine idling, Fast Learn will cycle through a series of tests where C3 and C4 clutches are repeatedly applied to learn their clutch characteristics. During the C3 and C4 clutch apply/release procedure, Fast Learn is able to characterize the A and B solenoid pressure corresponding to clutch return springs, and also is able to learn the volumes for C3 and C4 clutch packs. In addition, C5 clutch is repeatedly applied and released in Park to purge out air for later learning of its clutch volume.

Drive Mode

WARNING: While in Drive, if the Scan Tool loses communication, or becomes disconnected, the vehicle may remain in Drive and could move forward if the wheels have not been securely blocked.

Once all the Park test data has converged, the Scan Tool instructs the driver to select Drive. Once Drive is selected, the TCM engages C1 clutch to obtain Drive and learn C1 clutch volume. The TCM repeats this test until the volume learned for C1 clutch has converged.

Reverse Mode

WARNING: While in Reverse, if the Scan Tool loses communication, or becomes disconnected, the vehicle may remain in Reverse and could move backward if the wheels have not been securely blocked.

Next the Scan Tool instructs the driver to select Reverse. Once Reverse is selected, the TCM engages C5 clutch to obtain Reverse and learn C5 clutch volume. The TCM repeats this test until the volume learned for C5 clutch has converged.

After learning C1 and C5 clutch volume, Fast Learn updates the adaptive volume data for all shifts with either C1 or C5 on-coming clutch. This completes the "stationary modes" of Fast Learn.

NOTE: All shifts will be left in "fast" adaptive mode at this point.

C2 Learn Mode

Following the Reverse Mode step, the Scan Tool exits Fast Learn and the only adaptive cells that remain to be learned are the adaptive volume data for C2 clutch. The vehicle must be driven in order to make at least 3-4 upshifts on the same ignition cycle and at steady throttle position. This data is learned by the TCM intentionally overfilling C2 clutch. Once this overfill is corrected the C2 clutch volume is learned and all special Fast Learn actions are completely disabled.

NOTE: The technician should verify that the transmission shift quality is acceptable before releasing the vehicle to the customer.

RECOMMENDED FLUID

The recommended and preferred fluid for Allison transmissions is Dexron III.

In cases where Dexron III is not readily available, Dexron IIE can be used to top off the fluid level. It is not, however, recommended for use as the primary fluid for a fluid change.

Fluid Capacity

The fluid capacity of the Allison transmission used in the HUMMER H1 vehicles is:

- Transmission refill capacity (after filter change) is approximately 8.5 qt. (8.0 L).
- Dry fill capacity (after overhaul) is approximately 11.5 qts (11.0 L)
- Cooler and line capacity is approximately 1.0 qts (.94 L)

NOTE: Always fill the transmission using the dipstick level as a guide. The residual fluid left in the transmission during service could result in an overfilled condition.

Fluid Level and Condition

The transmission fluid level and the condition are important for proper operation. An incorrect fluid level can lead to shift problems, fluid breakdown, and accelerated wear.

Check the fluid level and the condition during the preliminary inspection procedure. This is important, as a low fluid level, or overfill condition can lead to slip and flare, overheating, burned fluid, slow engagement, converter shudder, and no fourth gear upshift.

An overfill condition allows the gear train to churn the fluid into foam. This action aerates the fluid causing slip, overheating, oxidation, and overflow from the vent. A low level allows the pump to take in air along with the fluid. Air in the fluid will cause the pressures to be low and develop slower than normal shifts.

TRANSMISSION FLUID CHECKING PROCEDURE (COLD)

The purpose of checking the fluid cold is to determine if the transmission has enough fluid to be operated safely until the check can be performed.

NOTE: The fluid level rises as fluid temperature increases. DO NOT fill above the "COLD" band if the transmission fluid is below normal operating temperatures.

1. Bring the vehicle to a complete stop on a level surface using the service brakes.

2. Make sure that the engine is at idle.
3. With the vehicle in the park position (P).
4. Apply the park brake and make sure it is holding properly.
5. Run the engine for at least one minute.
6. Shift to drive (D), then to neutral (N), then shift to reverse (R) to fill the hydraulic system and finally shift back to the park position (P).
7. With the vehicle in park and the engine running, remove the transmission dipstick.
8. Wipe the dipstick clean, insert the dipstick fully and remove.
9. Check the fluid reading, repeat step 8 to verify the reading.
10. Only fill to the “Cold” reading on the dipstick.
11. Perform a hot test as soon as the transmission temperature reaches 160º F-200º F (71ºC-93ºC).

TRANSMISSION FLUID CHECKING PROCEDURE (HOT)

1. Operate the transmission in drive (D) range until normal operating temperature is reached 160º F-200º F (71ºC-93ºC).
2. Bring the vehicle to a complete stop on a level surface using the service brakes.
3. Make sure that the engine is at idle.
4. With the vehicle in the park (P) position.
5. Apply the park brake and make sure it is holding properly.
6. With the vehicle in park and the engine running, remove the transmission dipstick.
7. Wipe the dipstick clean, insert the dipstick fully and remove.
8. Check the fluid reading, repeat step 7 to verify the reading.
9. If the fluid level is not within the “HOT” range, add or drain as necessary to bring the fluid to the proper level.

ROAD TEST PROCEDURE

NOTE: The Road Test Procedure should be performed only as part of the Functional Test Procedure.

The following test provides a method of evaluating the condition of the automatic transmission. The test is structured so that most driving conditions would be achieved. The test is divided into the following parts:

- Electrical Function Check
- Upshift Control and Torque Converter Clutch (TCC) Apply
- Part Throttle Detent Downshifts
- Full Throttle Detent Downshifts
- Manual Downshifts
- Coasting Downshifts
- Manual Range Selection
  - REVERSE
  - Manual FIRST
  - Manual SECOND
  - Manual THIRD

NOTE: Complete the test in the sequence given. Incomplete testing cannot guarantee an accurate evaluation.

Before the road test, ensure the following conditions are met:

- The engine is performing properly
- Transmission fluid level is correct
- Tire pressure is correct

During the road test:

- Perform the test only when traffic conditions permit
- Operate the vehicle in a controlled, safe manner
- Observe all traffic regulations
- Take along qualified help in order to View the scan tool data while conducting this test
- Observe any unusual sounds or smells
- After the road test, inspect the following conditions:
- Transmission fluid level
- Diagnostic trouble codes (DTCs) that may have set during the testing and Refer to the applicable DTC
- Scan tool data for any abnormal readings or data

Electrical Function Check

Perform this check first, in order to ensure the electronic transmission components are connected and functioning properly. If these components are not checked, a simple electrical condition could be mis-diagnosed.

1. Install the scan tool.
2. Ensure the shift selector is in PARK and set the parking brake.
3. Start the engine.
4. Verify that the following scan tool data can be obtained and is functioning properly:
   - Engine speed
   - Transmission input speed, turbine speed
   - Transmission output speed
   - Vehicle speed
   - C, D, E and REVERSE pressure switch states
   - Transmission range, engine list
   - 4WD low
   - Commanded range, current range
   - A and B solenoid reference current
   - A and B solenoid actual current
   - A and B solenoid duty cycle
   - Brake switch
   - Engine coolant temperature
   - Transmission fluid temperature
   - Throttle angle
   - Ignition voltage
   - C shift solenoid ON/OFF
   - D shift solenoid ON/OFF
   - E shift solenoid ON/OFF
   - TCC solenoid duty cycle
   - TCC slip speed
5. Monitor the brake switch signal while depressing and releasing the brake pedal. The scan tool should display the following:
   - Closed when the brake pedal is released
   - Open when the brake pedal is depressed

6. Check the garage shifts.
   - Apply the brake pedal and ensure the parking brake is set
   - Move the shift selector through the following ranges:
     - PARK to REVERSE
     - REVERSE to NEUTRAL
     - NEUTRAL to DRIVE
   - Pause 2 to 3 seconds in each selector position
   - Verify the range engagements are immediate and not harsh

NOTE: Harsh engagement may be caused by any of the following conditions:

- High idle speed Compare engine idle speed to desired idle speed
- Commanded low A or B solenoid current Compare A and B solenoid reference current to A and B solenoid actual current
- A default condition caused by certain DTCs that result in maximum full throttle shift points
- Shift is not fully adapted

NOTE: Soft or delayed engagement may be caused by any of the following conditions:

- Low idle speed Compare engine idle speed to desired idle speed
- Low fluid level
- Cold transmission fluid Inspect for low transmission fluid temperature

7. Monitor the transmission range on the scan tool engine list. Apply the brake pedal and ensure the parking brake is set while performing the following:
   - Move the shift selector through all ranges
   - Pause 2 to 3 seconds in each range
   - Return the shift selector to PARK
   - Verify that all of the selector positions match the scan tool display
8. Inspect the throttle angle input. Apply the brake pedal and ensure the parking brake is set.
   - Ensure the shift selector is in PARK.
   - Monitor the throttle angle while increasing and decreasing the engine speed with the throttle pedal. The scan tool throttle angle should increase and decrease with the engine speed.

If any of the above checks do not perform properly, record the result for reference after the completion of the Road Test Procedure.

Upshift Control and Torque Converter Clutch (TCC) Apply

The transmission control module (TCM) calculates the upshift points based on the throttle angle and the engine, turbine and output speed. When the TCM determines that conditions are met for a shift to occur, the TCM commands the shift, and controls A and B solenoid current to proper control clutch pressures during the shift.

Perform the following steps:

1. Choose a throttle position of 10 percent, 25 percent or 50 percent. All throttle angles shown should be tested to cover the normal driving range.
2. Monitor the following scan tool parameters:
   - Throttle angle
   - Vehicle speed
   - Engine speed
   - Output shaft speed
   - Commanded range
   - Slip speed
   - Solenoid states
3. Place the shift selector in drive (D).

4. Using the chosen throttle angle, accelerate the vehicle. Hold the throttle steady.
5. As the transmission upshifts, note the vehicle speed when the shift occurs for each range change. There should be a noticeable shift feel or engine speed change within 1 to 2 seconds of the commanded range change.
6. Shift speeds may vary slightly due to transmission fluid temperature or hydraulic delays in responding to the electronic controls.
   - Note any harsh, soft or delayed shifts or slipping.
   - Note any noise or vibration.
7. Repeat steps 1-6 to complete all throttle angles.

NOTE: The TCC will not engage until the engine is in closed loop operation. The vehicle must be in a near cruise condition, not accelerating or coasting, and on a level road surface.

8. Inspect for TCC apply in SECOND, THIRD, FOURTH and FIFTH range.
   - Note the TCC apply point. When the TCC applies there should be a noticeable drop in engine speed and a drop in slip speed to below 100 RPM. If the TCC apply can not be detected inspect for DTCs.
   - Lightly tap and release the brake pedal. The TCC will release on most applications.

Part Throttle Detent Downshift

1. Place the shift selector in drive (D).
2. Accelerate the vehicle to a speed just above the FOURTH to FIFTH shift point, using less than 50 percent throttle.
3. Quickly increase throttle angle to greater than 63 percent.
4. Verify the following conditions:
   - The TCC releases.
   - The transmission downshifts immediately to FOURTH range.

Manual Downshifts

Manual 5-3 Downshift

1. Place the shift selector in drive (D).
2. Accelerate the vehicle to obtain FIFTH range.
3. Release the throttle while moving the shift selector to THIRD.
4. Verify the following conditions:
   - The TCC releases.
   - The transmission downshifts immediately to FOURTH range and then to THIRD range.
   - The engine slows the vehicle.

Manual 5-2 Downshift

1. Place the shift selector in drive (D).
2. Accelerate the vehicle to obtain FIFTH range.
3. Release the throttle while moving the shift selector to SECOND.
4. Verify the following conditions:
   - The TCC releases.
   - The transmission downshifts immediately to FOURTH range, then to THIRD, then to SECOND.
   - The engine slows the vehicle.

Manual 2-1 Downshift

1. Place the shift selector in drive (D).
2. Accelerate the vehicle until the 1-2 shift occurs.
3. Go to 5 mph (8 km/h) above the 1-2 shift point.

4. Release the throttle while moving the shift selector to FIRST.
5. Verify the following conditions:
   - The TCC releases.
   - The transmission immediately downshifts to FIRST range.
   - The engine slows the vehicle.

Coasting Downshifts

1. Place the shift selector in drive (D).
2. Accelerate the vehicle to FIFTH range with the TCC applied.
3. Release the throttle and lightly apply the brakes.
4. Verify the following conditions:
   - The TCC releases.
   - Downshifts occur in normal sequence and the transmission returns to FIRST range before the vehicle comes to a stop.

Manual Range Selection

The shift solenoids control the upshifts in the manual ranges.
Perform the following tests, using 10-15 percent throttle angle.

REVERSE

1. With the vehicle stopped, move the shift selector to reverse (R).
2. Slowly accelerate the vehicle.
3. Verify that there is no noticeable slip, noise or vibration.

Manual FIRST

1. With the vehicle stopped, move the shift selector to first (1).
2. Accelerate the vehicle to maximum speed.
3. Verify the following conditions:
   - No upshifts occur.
   - The TCC does not apply.
   - There is no noticeable slip, noise, or vibration.

Manual SECOND

1. With the vehicle stopped, move the shift selector to second (2).
2. Accelerate the vehicle to maximum speed.
3. Verify the following conditions:
   - The 1-2 shift occurs.
   - The 2-3 shift does not occur.
   - There is no noticeable slip, noise, or vibration.

Manual THIRD

1. With the vehicle stopped, move the shift selector to drive (D).
2. Accelerate the vehicle to maximum speed.
3. Verify the following conditions:
   - The 1-2 shift occurs.
   - The 2-3 shift occurs.
   - There is no noticeable slip, noise, or vibration.

DIAGNOSTIC STARTING POINT - AUTOMATIC TRANSMISSION

Begin the system diagnosis with the Diagnostic System Check - Vehicle in Vehicle DTC Information. The Diagnostic System Check provides the following information:

- The identification of the control module which commands the system.
- The ability of the control module or modules to communicate through the serial data circuit.
- The identification and status of stored diagnostic trouble codes (DTCs).

The use of the Diagnostic System Check - Vehicle in Vehicle DTC Information identifies the correct procedure for diagnosing the system and where the procedure is located.

Symptoms

When it has been determined through the Diagnostic System Check - Vehicle in Vehicle DTC Information that no DTCs are present, begin symptom diagnosis by reviewing the Functional Test Procedure. This helps you determine if the condition described by the customer is normal or if a malfunction exists. If it is determined that a malfunction exists, identify the concern by referring to Symptoms - Automatic Transmission. The Symptoms - Automatic Transmission provides common diagnostic categories which relate directly to diagnostic information or procedures.

FUNCTIONAL TEST PROCEDURE

Functional Test Procedure

Step	Action	Yes	No
1	Important: Engine performance can strongly affect transmission performance. Ensure the condition is not the result of poor engine performance before continuing. Verify the customer concern. Has the customer concern been verified?	Go to Step 2.	
2	Important: Many transmissions have default actions that take place once a DTC fault is detected. These actions may appear to be transmission concerns. Perform the Diagnostic System Check - Vehicle in Vehicle DTC Information. Did you perform the Diagnostic System Check?	Go to Step 3.	Go to the Diagnostic System Check
3	Inspect for the following conditions: • Vehicle damage • Transmission oil pan damage • Transmission range selector cable damaged or out of adjustment • Inspect for loose, worn, damaged or missing: • mounts or struts. • brackets. • mounting hardware. • Transmission cooler or cooler line restrictions • Fluid leaks Did you find a condition?	Go to the appropriate repair or diagnosis section and repair as necessary	Go to Step 4.
4	Perform the Transmission Fluid Checking Procedure. Did you perform the Transmission Fluid Checking Procedure?	Go to Step 5.	Go to Transmission Fluid Checking Procedure

Functional Test Procedure

Step	Action	Yes	No
5	Perform the Road Test Procedure. Did the vehicle exhibit any objectionable performance condition?	Go to Step 6.	Go to Step 1.
6	Did the vehicle exhibit objectionable torque converter operation?	Go to Step 15.	Go to Step 7.
7	Did the vehicle produce any objectionable noise condition?	Go to Symptoms - Automatic Transmission	Go to Step 8.
8	Did the vehicle exhibit a vibration condition?	Go to Step 9.	Go to Step 10.
9	Did the vibration occur only during torque converter clutch (TCC) apply or release?	Go to Step 15.	Go to Symptoms - Automatic Transmission
10	Did the vehicle exhibit a shift speed condition, such as low or high shift speeds?	Go to Symptoms - Automatic Transmission	Go to Step 11.
11	Inspect for the following unacceptable shift qualities: • Harsh, soft, delayed or no engagement • Harsh, soft or delayed shifts • Shift shudder, flare or tie-up Did the vehicle exhibit any of these shift quality conditions?	Go to Step 12.	Go to Step 13.
12	Perform the Line Pressure Check Procedure. Is the line pressure within specification?	Go to Symptoms - Automatic Transmission	Go to Symptoms - Automatic Transmission
13	Inspect for the following unacceptable shift pattern conditions: • No upshift or downshift • Only one or two forward ranges • No first range, second range, third range, fourth range or fifth range • Slipping • Non first range start Did the vehicle exhibit any of these shift pattern conditions?	Go to Symptoms - Automatic Transmission	Go to Step 14.
14	Inspect for the following unacceptable range performance conditions: • No PARK, REVERSE or DRIVE • No engine braking • No gear selection • Incorrect gear selection Did the vehicle exhibit any of these range performance conditions?	Go to Symptoms - Automatic Transmission	System OK

Functional Test Procedure

Step	Action	Yes	No
15	Inspect for the following specific torque converter or TCC malfunctions? • Stuck ON or OFF • Early or late engagement • Incorrect apply or release • Soft or harsh apply • Clunk or shudder • No torque multiplication • Excessive slip • Poor acceleration • Engine stalls Did the vehicle exhibit any of these torque converter or TCC conditions?	Go to Torque Converter Diagnosis Procedure	System OK

LINE PRESSURE CHECK PROCEDURE

Description

Checking main line pressure helps to determine if a transmission malfunction is due to a mechanical or an electrical condition. Properly making these pressure checks requires transmission and vehicle, or test stand, preparation, recording of data, and comparing recorded data against specifications provided.

WARNING: Keep the brakes applied at all times in order to prevent unexpected vehicle motion. Personal injury may result if the vehicle moves unexpectedly.

1. Remove the oil pressure tap plug.
2. Install J 45056 pressure test adapter fitting prior to connecting the oil pressure gage (Figure 5-4).
3. All transmission fluid level and pressure checks must be made at normal operating temperatures 160-200° F (71-93° C) sump; 180-220° F (82-104° C) converter-out. Check the transmission fluid level.
4. Connect a 0-300 PSI (0-2070 kPa) oil pressure gage to the pressure test adapter fitting. Use the scan tool to check the engine RPM.
5. With the brakes applied, record the line pressure values at 600 RPM engine speed in NEUTRAL and REVERSE range. The transmission will be in converter mode, torque converter clutch not applied.
6. With the brakes applied, record the line pressure values with the engine running at 2,100 RPM in NEUTRAL. The transmission will be in converter mode, torque converter clutch not applied.
7. With the brakes applied, use the following scan tool settings to check pressures in FIRST through FIFTH gear ranges at 600 RPM. The transmission will be in converter mode, torque converter clutch not applied, at 600 RPM.
   - Select Special Functions, press ENTER.
   - Select Transmission Output Controls.
   - Select Shift transmission. This will allow the technician to shift the transmission and check line pressure in each forward gear range.
8. Compare the data recorded to the line pressure specifications in the chart below.
9. Disconnect the oil pressure gage and remove the J 45056 pressure test adapter fitting.
10. Install the oil pressure tap plug again.

LINE PRESSURE CHART

Range	Line Pressure @ 600 RPM	Line Pressure @ 2100 RPM
Forward Converter - Torque Converter Clutch Not Applied	101-200 PSI (700-1,380 kPa)	220-260 PSI (1,515-1,795 kPa)
Forward Lockup - Torque Converter Clutch Applied	N/A	145-170 PSI (1,000-1,170 kPa)
Reverse	101-200 PSI (700-1,380 kPa)	220-260 PSI (1,515-1,795 kPa)
Neutral/Park	85-105 PSI (590-720 kPa)	220-260 PSI (1,515-1,795 kPa)

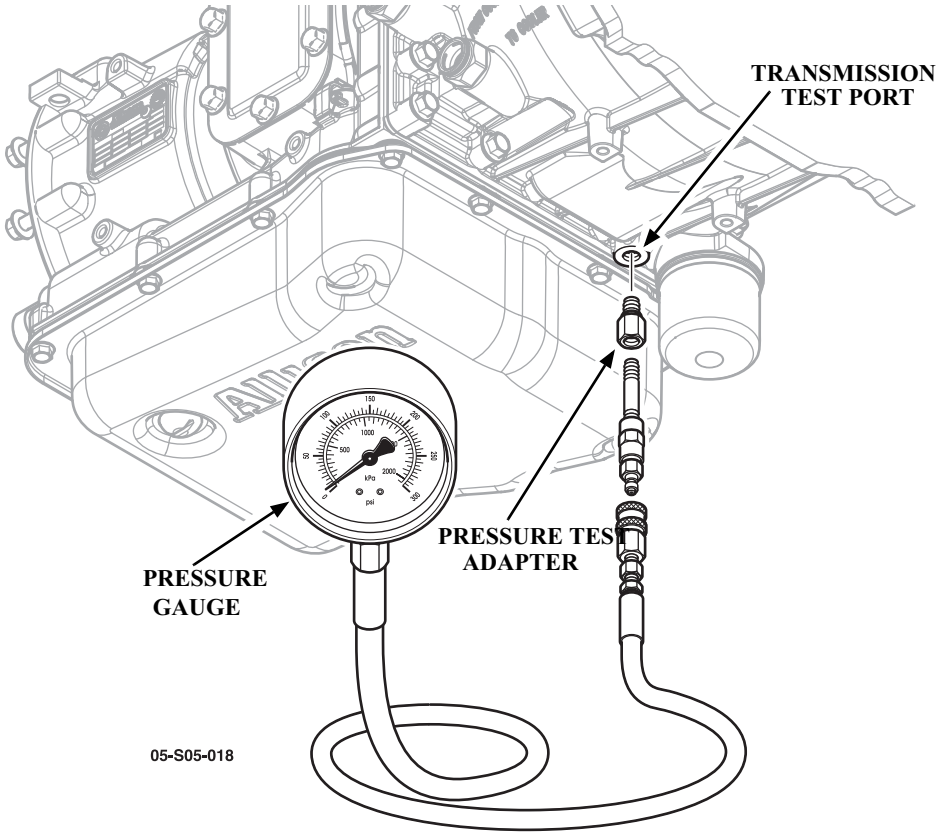


Figure 5-4: Pressure Gauge

Transmission Warning Lamps

All the HUMMER H1 vehicles are equipped with malfunction indicator lights, a check engine, a check transmission and a check throttle light. The purpose of the lights is to alert the driver when a transmission, engine, or electronic accelerator pedal circuit fault has occurred.

The warning lights are in the circuit with the TCM, which controls light operation. The lights are illuminated for a few seconds at startup as part of the bulb check and the circuit self test routine. The only other time illumination occurs, is when a system component or circuit fault occurs.

TRANSMISSION CONTROL MODULE REPLACEMENT (TCM)

Removal

1. Open the hood.
2. Disconnect the batteries.
3. Remove the electrical component cover to gain access to the ECM and the TCM (Figure 5-5).
4. Remove the ECM and mounting bracket assembly (Figure 5-5).
5. Remove the two TCM connectors.
6. Remove the four retaining nuts securing the TCM to the TCM mounting bracket.

Installation

1. Secure the TCM to the TCM mounting bracket with the four retaining nuts.
2. Plug the two connectors in to the TCM.
3. Install the ECM and mounting bracket assembly.
4. Install the electrical component cover.
5. Reconnect the batteries.
6. Close the hood.
7. Program the new TCM using the tech 2.
8. Perform the fast learn procedure.

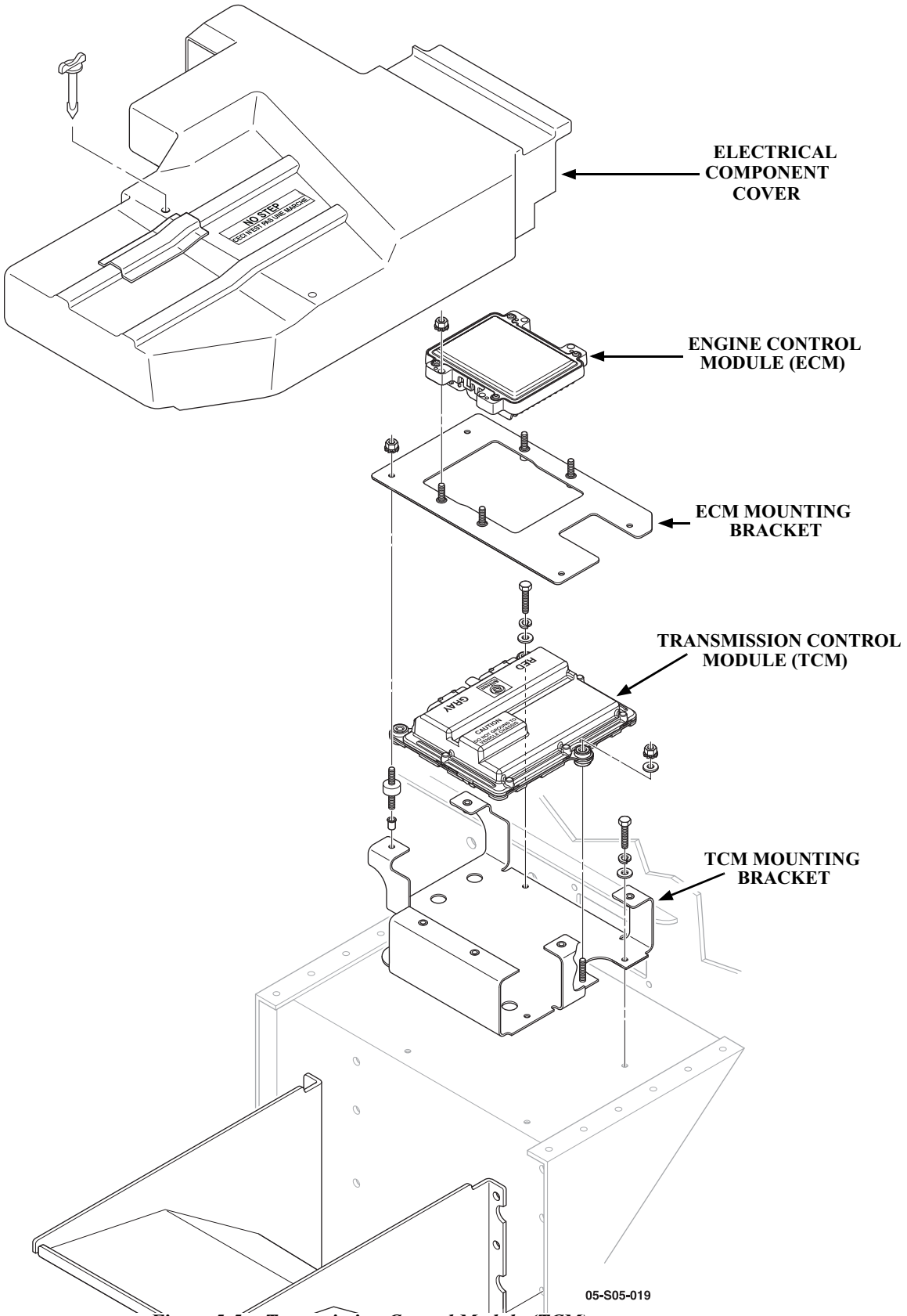


Figure 5-5: Transmission Control Module (TCM)

TRANSMISSION COOLER FLUSHING AND FLOW TESTING PROCEDURE

1. Raise the vehicle on a hoist.
2. Remove the P clamps (Figure 5-6).
3. Remove the two bolts securing the bypass valve to the frame rail (Figure 5-6).
4. Disconnect the transmission cooler lines from the transmission (Figure 5-6).
5. Disconnect the transmission cooler lines going from the bypass valve to the cooler at the bypass valve (Figure 5-6).
6. Remove the bypass valve and the cooler lines to the transmission as an assembly.
7. Remove the thermal valve by un threading it from the bypass valve.
8. Flush the bypass valve and attached lines with a parts washer.
9. Connect the flusher adapters J-44835 to the cooler lines at the adapter connections (Figure 5-6).
10. Using the trans flow transmission cooling system service tool J-45096, follow the procedure outlined on the front of the service tool for Setup, and Flow Test Flush Procedure.

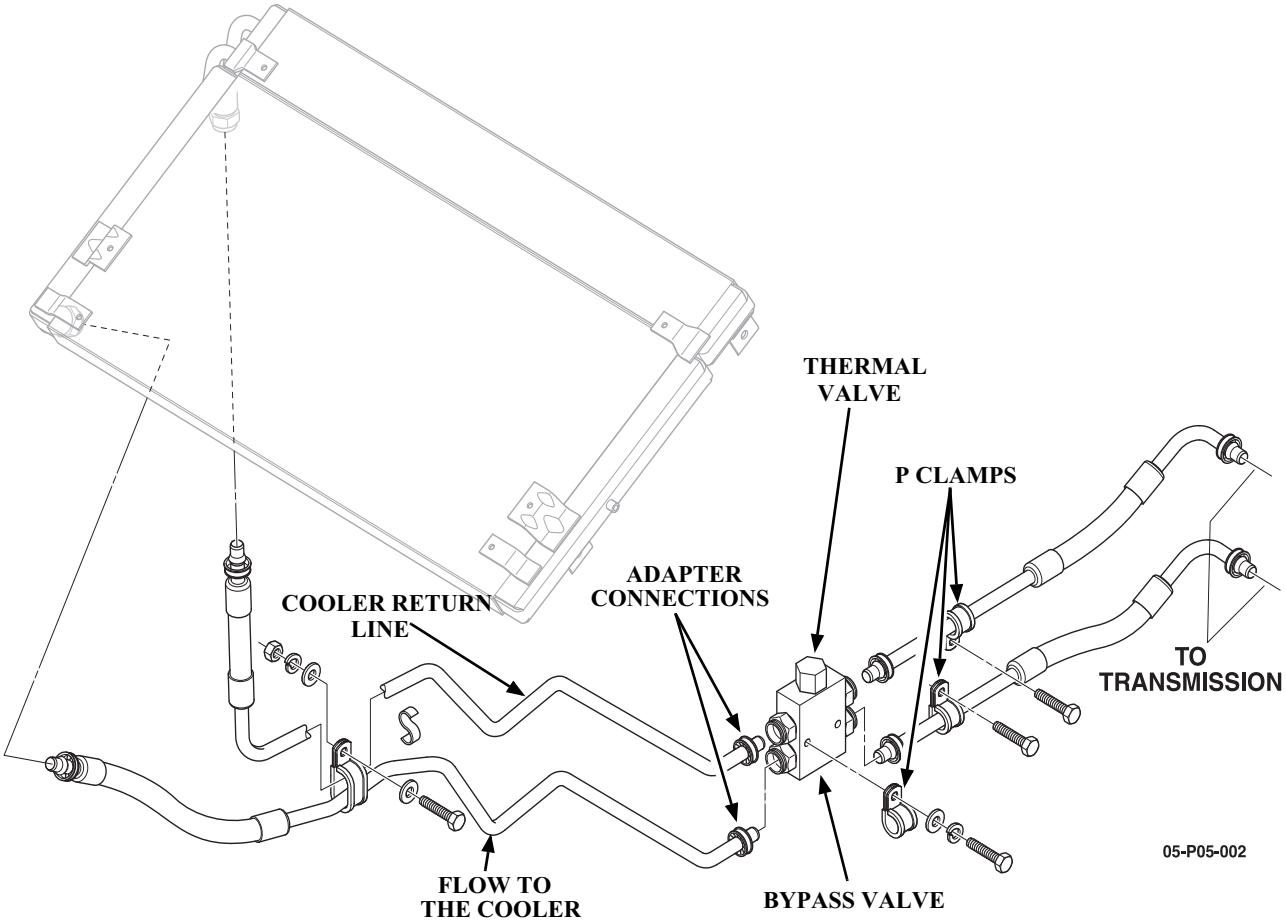


Figure 5-6: Transmission Cooler lines

Transmission Fluid and External Oil Filter Replacement

1. Position an proved waste oil container under the vehicle and remove the drain plug (Figure 5-7).
2. Loosen the spin off filter by turning it counter clockwise (Figure 5-7).
3. Remove the filter and replace it with a new filter.
4. Install and tighten the drain plug.
5. Refill the transmission with Dexron III fluid.
6. The transmission refill capacity (after filter change) is approximately 8.5 qts. (8.0 L).
7. Refer to the proper fluid checking procedure.

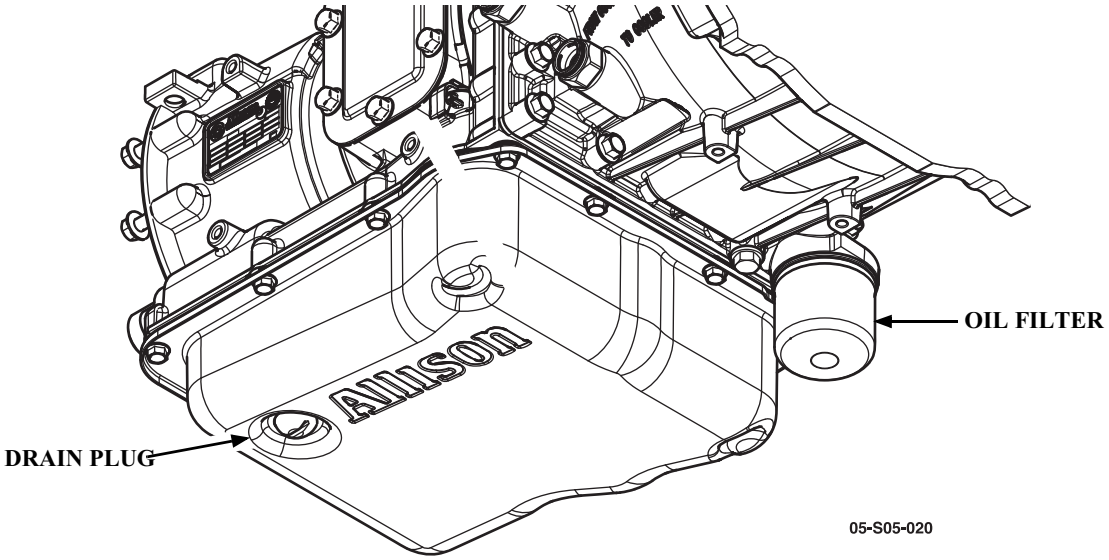


Figure 5-7: Oil Filter And Drain Plug Location

FILL TUBE REPLACEMENT

Removal

1. Remove the dipstick from the fill tube (Figure 5-8).
2. Remove the two nuts securing the fill tube to the bell housing (Figure 5-8).
3. Remove the bolt attaching the fill tube bracket to the intake manifold (Figure 5-8).
4. Work the fill tube out of the transmission.
5. Remove the fill tube seal from the transmission. Discard if damaged.

Installation

1. Install the fill tube seal in the transmission.
2. Push the fill tube into the transmission.
3. Secure the fill tube to the bell housing using the two nuts.
4. Secure the fill tube bracket to the intake manifold with the bolt.
5. Install the dipstick in the fill tube.
6. Start the engine and top off the transmission fluid level if required.

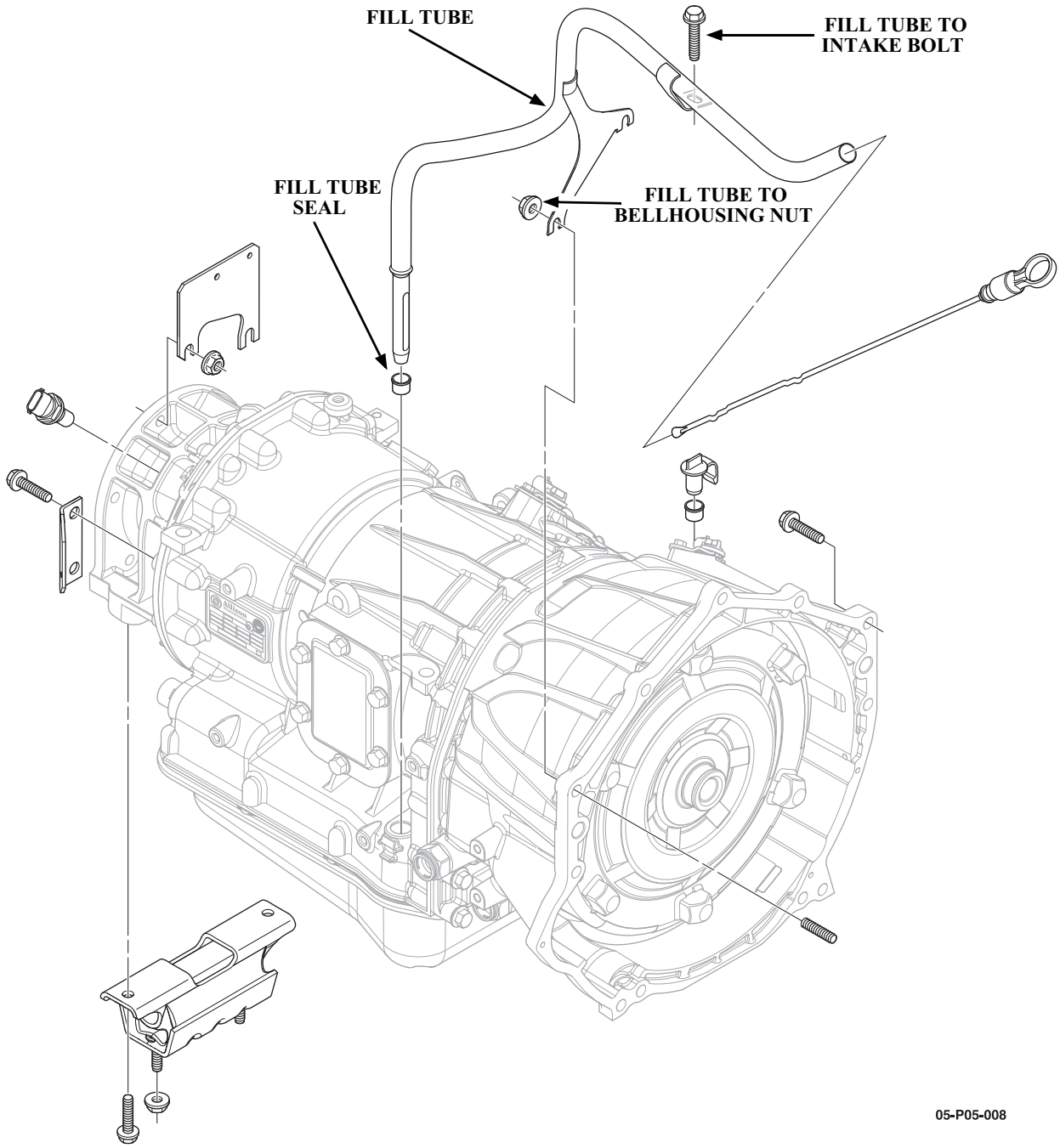


Figure 5-8: Fill Tube Replacement

OIL PAN AND INTERNAL OIL FILTER REPLACEMENT

1. Raise the vehicle on a hoist.
2. Remove the driveline protection.
3. Remove the drain plug from the oil pan and allow the fluid to drain into a suitable container.
4. Remove the12 bolts that secure the oil pan to the transmission.
5. Remove the oil pan and the gasket.
6. Inspect the magnet for excessive metallic particles or large metallic particles that may indicate the need for an overhaul or replacement of the transmission.

NOTE: DO NOT remove the transmission internal oil filter or seal if only replacing the oil pan or oil pan gasket.

7. Remove the transmission internal oil filter by pulling straight down where the suction tube is seated in the transmission case.
8. Remove the transmission internal oil filter seal from the filter or from the seal bore in the transmission case. Discard the old seal and the filter.

Installation

1. Remove all gasket material from the transmission case and the pan also remove any scratches from the transmission case that would cause a split line leak.
2. Place a new seal on the tube of the transmission internal oil filter. Be sure the seal locates against the shoulder on the internal oil filter tube.
3. Push the filter and seal into the seal bore in the transmission case and position the transmission internal oil filter properly.
4. Place a gasket on the oil pan and align the bolt holes.
5. Hold the gasket and the oil pan in place while installing two bolts to hold the parts in place.
6. Install the 10 remaining oil pan bolts and tighten the bolts to 20 lb-ft. (27 N•m).
7. Install the drain plug and tighten the drain plug to 26 lb-ft. (35 N•m).
8. Lower the vehicle.
9. Fill the transmission with DEXRON®III Automatic Transmission Fluid and follow the fluid checking procedure.

VALVE BODY REPLACEMENT

Removal

1. Disconnect the external wiring harness from the transmission main connector using J 44257 if the connector is not easily accessible.
2. Remove the oil pan and transmission internal oil filter.

NOTE: The transmission main connector is actually one end of the internal harness that protrudes through the transmission case.

3. Place a 30 mm (1 3/16 in) 12-point deep socket or box-end wrench over the connector.
4. Push inward on the socket or wrench to release the retainer feet that attach the connector to the transmission case.
5. Remove the wrench and push inward on the electrical connector to separate it from the transmission case. This allows the internal wiring harness to remain with the control valve assembly when removed.
6. Remove the two detent spring bolts and remove the detent spring assembly.

NOTE: As the control valve assembly is removed, be careful not to lose the manual selector valve pin or allow the manual selector valve to slide out of the control valve assembly.

7. Remove the fifteen bolts securing the control valve assembly.
8. Support the control valve assembly, about 10 pounds, and remove the last bolt.
9. Lower the control valve assembly to clear the locating pins in the transmission case.
10. Move the control valve assembly sideways to disengage the pin in the manual selector valve from the slot in the detent lever and remove the control valve assembly (Figure 5-9).

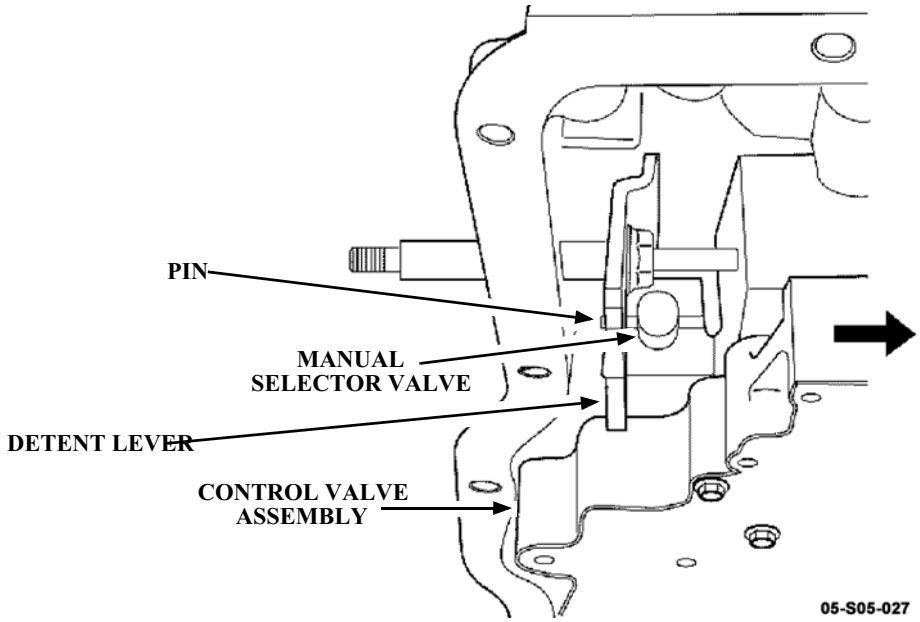


Figure 5-9: Manual Selector Valve

Installation

1. Move the control valve assembly into position under the transmission case. Engage the pin in the manual selector valve in the slot in the detent lever.
2. Align the control valve assembly with the locating pins in the transmission case. Seat the control valve assembly against the transmission case and hold in position.
3. Install one bolt to hold the control valve assembly in place.
4. Reinstall the remaining fifteen bolts that secure the control valve assembly to the transmission case and tighten the bolts to 108 in-lb (12 N·m).
5. Push the transmission main connector outward through the hole in the transmission case until the retaining feet on the connector are nearing the locked position and use J–44247 to complete the seating of the retaining feet that lock the connector into the transmission case.
6. Install the detent spring assembly onto the control valve assembly. Confirm that the roller of the detent spring assembly rests on the detent lever.
7. Install the two detent spring bolts and tighten the bolts to 108 in-lb (12 N·m).
8. Install the oil pan and transmission internal oil filter.
9. Connect the external wiring harness to the transmission main connector.
10. Fill the transmission with DEXRON®III Automatic Transmission Fluid and follow the fluid checking procedure.

CONTROL VALVE SOLENOID REPLACEMENT

Removal

1. Remove the oil pan and transmission internal oil filter.
2. Disconnect the internal wiring harness from the solenoid being changed.

NOTE: For solenoid C, it may be necessary to remove the valve body to access the retaining clip (Figure 5-10).

3. Remove the clip securing the solenoid and remove the solenoid (Figure 5-12).

NOTE: When the pressure control valve retaining bracket is removed, there are two sets of accumulators and springs which may fall from the bores. Be sure to catch the accumulators and springs so as to prevent damage to these parts (Figure 5-11).

NOTE: The pressure control valve retaining bracket must not be modified. Note that the angle between the two bracket surfaces is less than 90 degrees. Replace the bracket if the angle is 90 degrees or more (Figure 5-11).

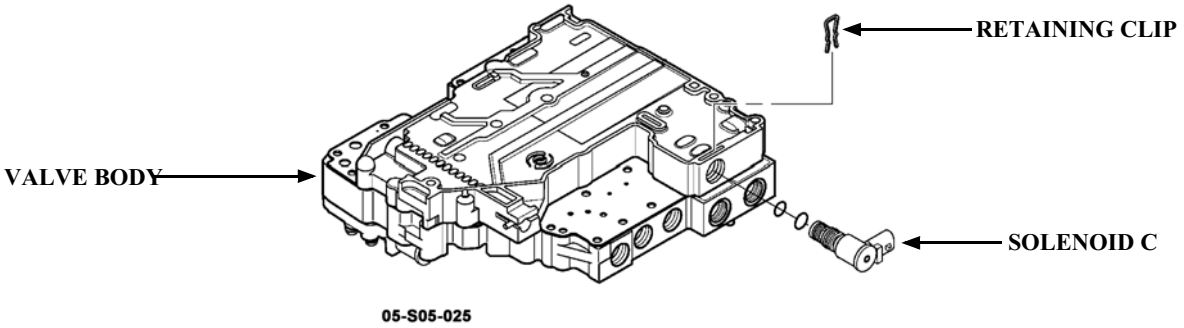


Figure 5-10: Solenoid C

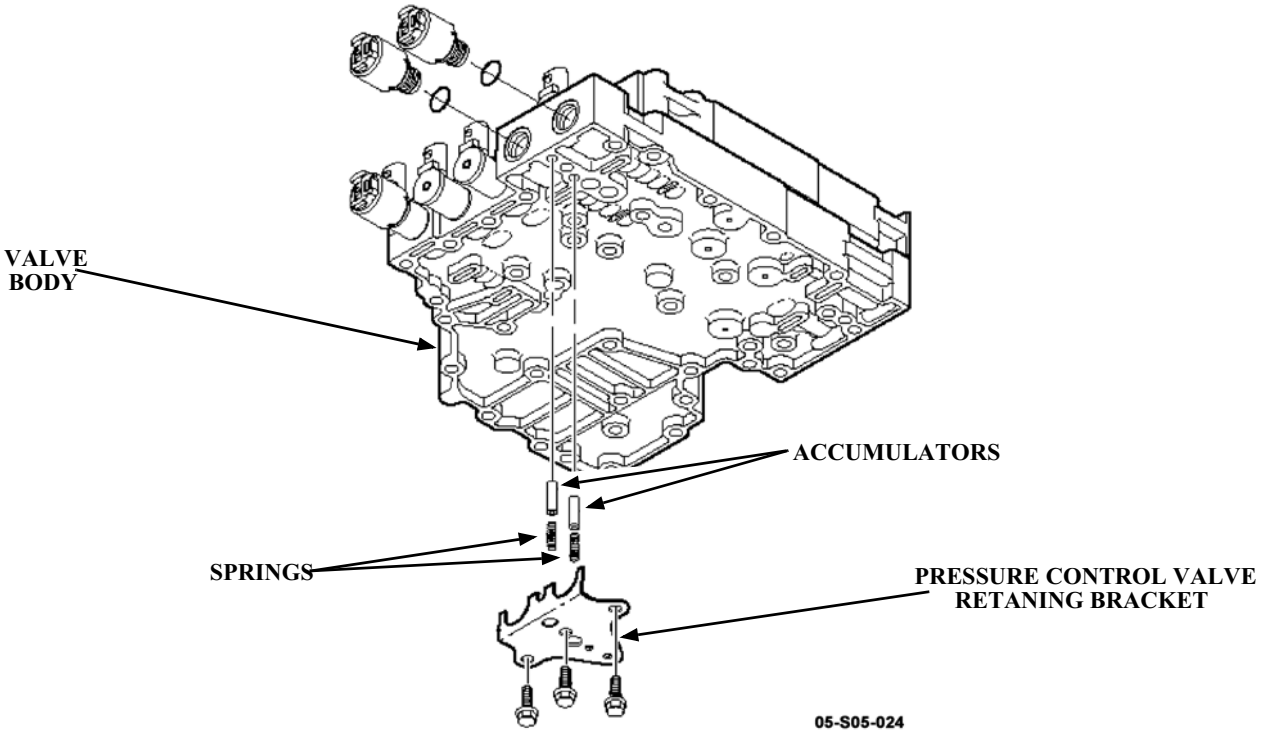


Figure 5-11: Pressure Control Valve Retaining Bracket

Installation

1. Put the new solenoid into position and secure with the clip (Figure 5-12).
2. Connect the internal wiring harness to the solenoid.
3. Install the internal filter and the transmission pan.
4. Fill the transmission with DEXRON®III Automatic Transmission Fluid and follow the fluid checking procedure.

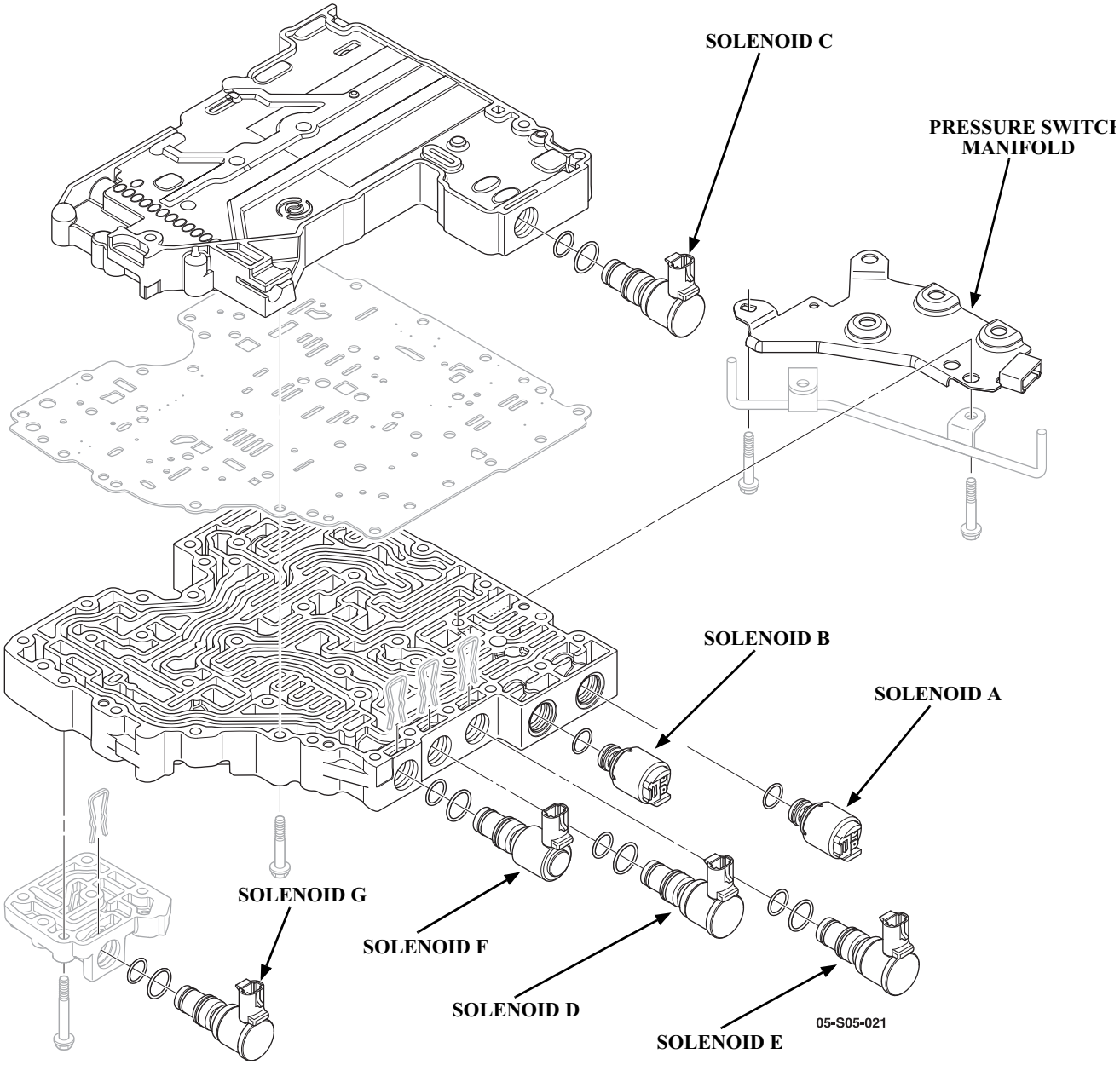


Figure 5-12: Solenoids And Pressure Switch Manifold (PSM)

PRESSURE SWITCH MANIFOLD REPLACEMENT (PSM)

NOTE: Individual pressure switches cannot be replaced. When any pressure switch needs replacing, the entire assembly must be replaced.

Removal

1. Remove the oil pan and transmission internal oil filter.
2. Disconnect the internal wiring harness connector from the PSM.
3. Remove the two bolts securing the PSM and remove the PSM (Figure 5-12).

Installation

1. Place the new PSM in position and install one bolt in a recessed location to hold the PSM in position. Start the remaining bolt in recessed locations and torque the bolts to 108 lb-in (12 N·m) (Figure 5-12).
2. Connect the internal wiring harness connector to the PSM.
3. Install the oil pan and transmission internal oil filter.
4. Refill the transmission with DEXRON III Automatic Transmission Fluid and follow the fluid checking procedure.

TRANSMISSION

Removal

1. Disconnect the batteries.
2. Remove the engine cover.
3. Remove the three bolts securing the down pipe heat shield.
4. Remove the turbo exhaust down pipe clamp at the turbo.
5. Remove the two nuts and the bolt securing the transmission dipstick tube.
6. Remove the upper transmission bell housing bolts.
7. Remove the drive line protection.
8. Drain the transmission fluid.
9. Remove the turbo exhaust down pipe to the rear exhaust camp and remove the exhaust down pipe.
10. Remove the transmission and the transfer case vent lines (Figure 5-13).
11. Remove the rear propeller shaft.
12. Remove the bolts securing the front propeller shaft to the transfer case and position the shaft out of the way.
13. Remove the Transfer case safety cable.
14. Remove the starter.
15. Remove the torque converter bolts.
16. Remove the transmission harness.
17. Remove the transmission cooler lines from the transmission.
18. Clamp the transfer case cooler lines as close to the case as possible with clamp pliers and remove the lines from the case.
19. Remove the P clamp securing the transfer case cooler lines to the adapter plate.
20. Support the transmission and remove the four bolts securing the transmission crossmember.
21. Remove the two nuts securing the crossmember to the transmission mount and remove the transmission crossmember.
22. Remove the two bolts securing the transmission mount to the transfer case adapter plate and remove the mount.
23. Remove the P clamp securing the wiring harness to the transfercase.
24. Remove the transfer case shifter cable from the transfer case shift lever (Figure 5-15).
25. Remove the six nuts securing the transfer case two the transmission and remove the transfercase.
26. Remove the transmission shifter cable from the transmission shift lever (Figure 5-15).
27. Unplug the neutral start back up (NSBU) switch.
28. Unplug the transmission harness from the transmission.
29. Remove the remaining transmission bolts and remove the transmission.
30. Before lowering the transmission install the J-21366 to hold the torque converter into place.

Installation

1. Install the J-21366 to the converter housing in order to keep the torque converter from sliding off of the turbine shaft.
2. Raise the transmission into place.
3. Remove the J-21366.

WARNING: Do not install the transmission by drawing it to the engine using the studs and bolts.

4. Align the transmission with the engine using the alignment dowels located at the rear of the engine.

NOTE: Make sure that the torque converter can be rotated before tightening the bolts and studs.

5. Install the converter housing bolts/studs and tighten the bolts/studs to 37 lb-ft (50 N•m).

NOTE: If reusing the torque converter bolts, clean the bolt threads and apply medium strength (blue) thread locker.

6. Install the torque converter bolts and tighten to 44 lb-ft (60 N•m).
7. Install the starter, secure with the two bolts and tighten to 58 lb-ft (78 N•m)
8. Install the transmission fill tube to the converter housing studs and tighten the nuts to 13 lb-ft (18 N•m).
9. Install the transfer case, secure with the six nuts and tighten to 23 lb-ft. (31 N•m).
10. Install the transmission mount, secure with the two bolts and tighten to 37 lb-ft (50 N•m).
11. Install the transmission crossmember to the transmission mount, secure with the two nuts and tighten to 30 lb-ft. (40 N•m).
12. Secure the transmission crossmember to the frame with the four nuts/bolts and tighten to 90 ft-lb (122 N•m).
13. Plug in the transmission main harness, NSBU switch and all the speed sensors.
14. Install the Transfer case safety cable.
15. Install the rear propeller shaft.
16. Install the front propeller shaft to the transfer case.
17. Install the transmission and the transfer case shift cables (Figure 5-15).
18. Install the transfer case cooler lines and remove the clamp pliers from the lines.
19. Secure the cooler lines to the adapter plate with the P clamp.
20. Install the transmission and the transfer case vent lines (Figure 5-13).
21. Install the exhaust down pipe and the heat shield.
22. Install the drive line protection.
23. Install the engine cover.
24. Connect the batteries.
25. Refill the transmission with DEXRON®III Automatic Transmission Fluid and follow the fluid checking procedure.

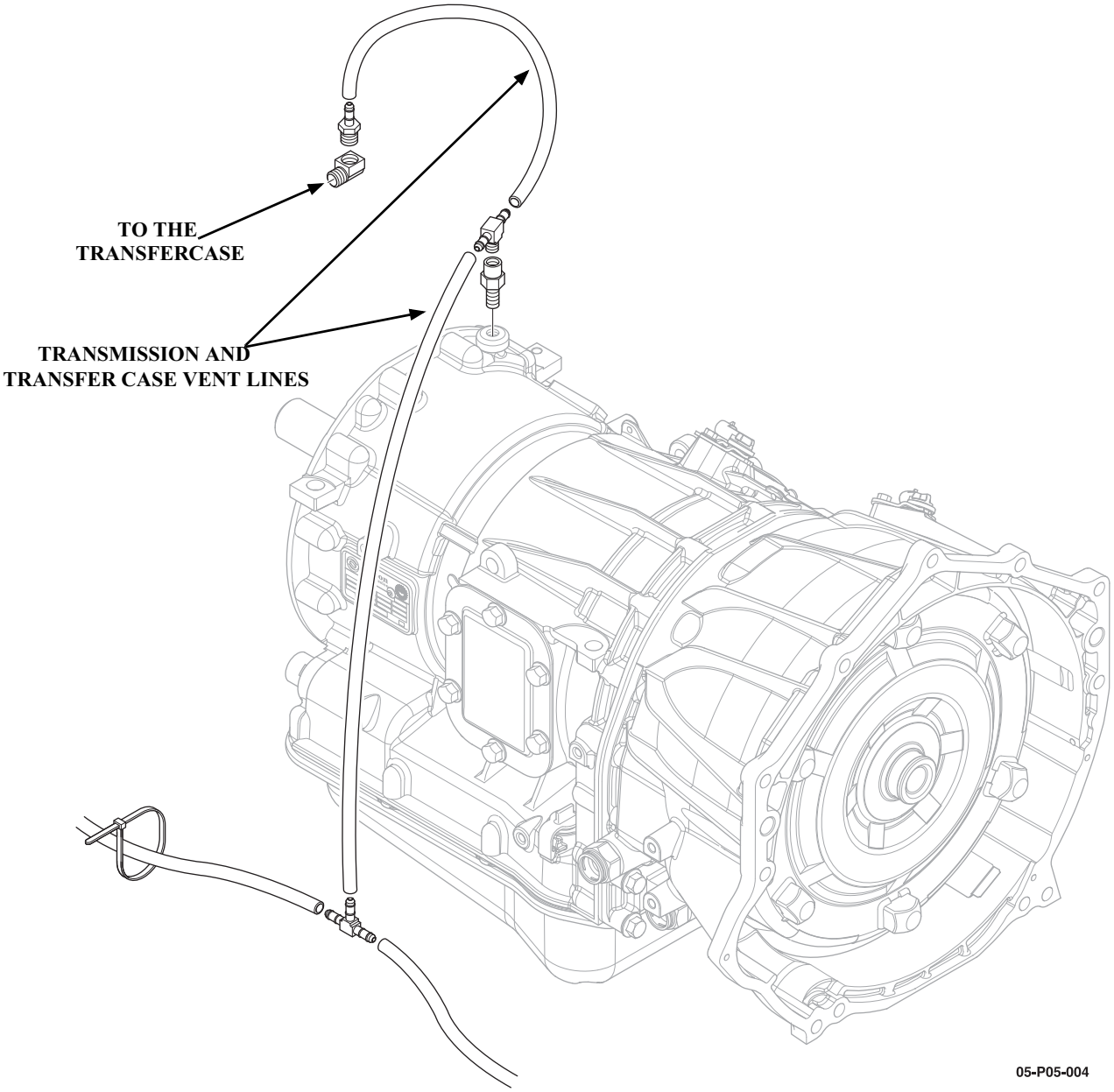


Figure 5-13: Transmission And Transfer Case Vent Lines

FLYWHEEL AND FLEXPLATE

Removal

1. Remove the transmission and drivetrain to gain access to the flywheel housing (See Section 5).
2. Install flywheel holding tool J-44643 in the starter opening and secure with two of the starter bolts removed with the starter.
3. Remove and discard the six bolts retaining the flywheel and flexplate assembly to the crankshaft and remove the flywheel washer and flywheel.

Installation

1. Install the flywheel with the beveled edge of the ring gear teeth toward the starter.
2. Install the flywheel washer with the beveled side facing the engine.
3. Secure the flywheel and washer with NEW flywheel bolts.
4. Tighten the bolts in threes steps, the first step is to 58 lb ft. (79 N•m) in the pattern shown (Figure 5-14).

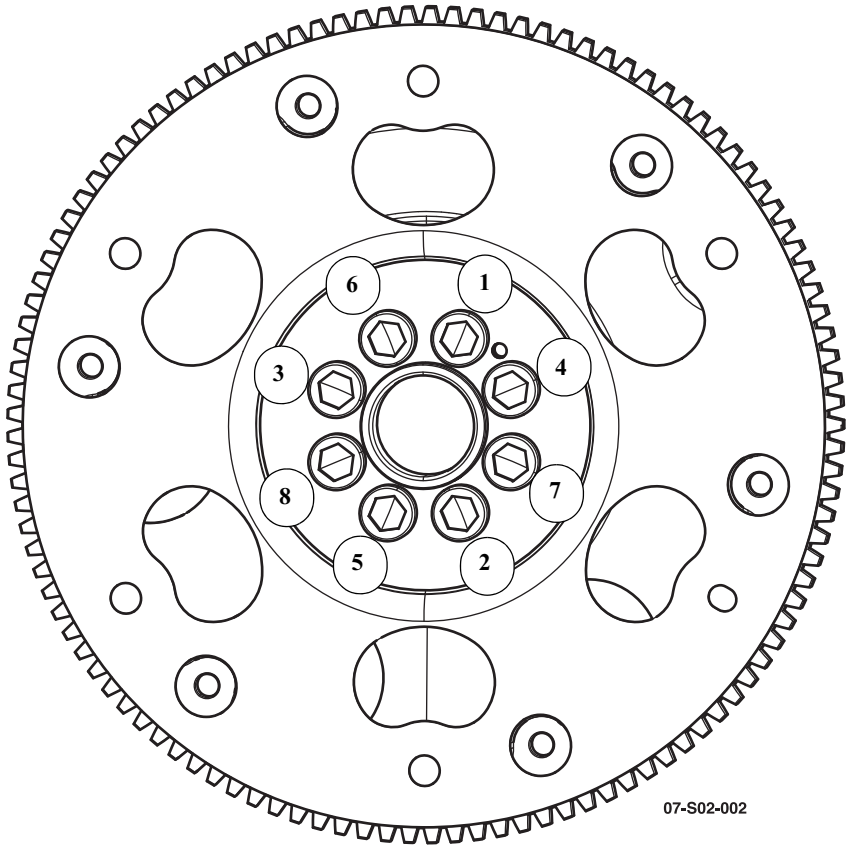


Figure 5-14: Flywheel Bolt Tightening Pattern

5. The second sequence is to tighten the bolts an additional 60 degrees using tool J-45059 in the pattern shown.
6. The third and final sequence is to tighten the bolts an additional 60 degrees using tool J-45059 in the pattern shown.
7. Remove the flywheel holding tool J-44643.
8. Install the transmission and drivetrain removed to gain access to the flywheel housing (See Section 5).

SHIFT CONTROL ASSEMBLY AND SHIFTER CABLE REPLACEMENT

Removal

1. Place the shifter in neutral (N) and disconnect the batteries.
2. Disconnect the cable clevis from the transmission lever and the transfer case lever (Figure 5-15).
3. Remove the center console and the left lower closeout panel.
4. Remove the shifter bezel and the shifter trim panel.
5. Remove the four screws securing the shifter assembly and remove the assembly.
6. Disconnect the shifter wire connector.
7. Remove the tie strap securing the boot to the cables and remove the boot.
8. Remove the cables from the shifter assembly by rotating the counter clock wise.

Installation

1. Thread the shifter cable in to the shifter assembly.
2. Install the boot and secure with a high temperature tie strap.

WARNING: A high temp tie strap must be used to secure the boot due to exhaust temperatures.

3. Reconnect the shifter wire connector.
4. Secure the shifter assembly to the body with the four screws.
5. Install the shifter bezel and the shifter trim panel.
6. Install the center console and the lower left closeout panel.
7. Install the shifter cable to the transmission lever and the transfer case lever with the clevis.
8. Reconnect the batteries.

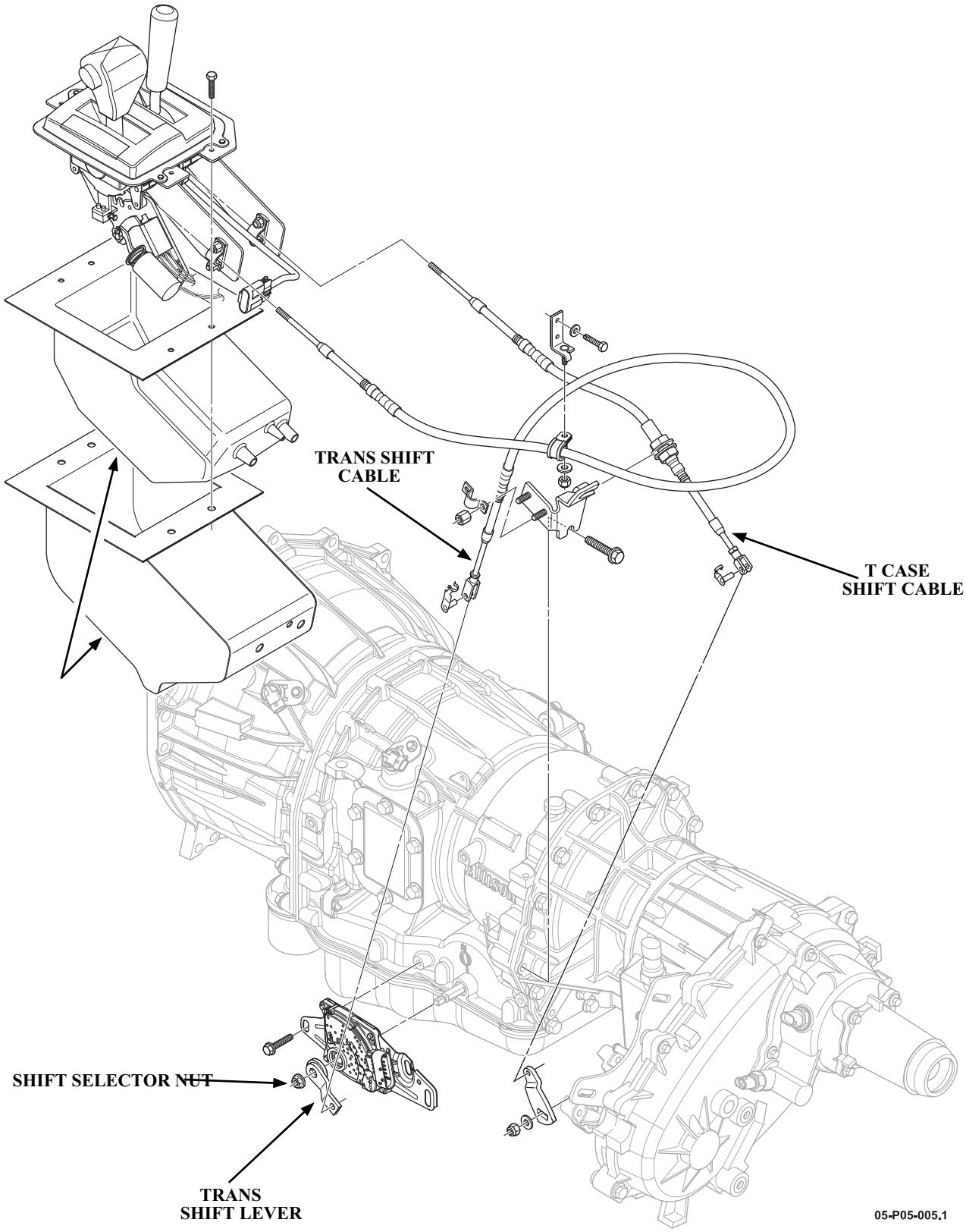


Figure 5-15: Shift Cable Attachment

TRANSFER CASE LEVER KNOB

Removal

1. Rotate the shift knob counterclockwise to unscrew the knob from the shift lever.

Installation

1. Rotate the shift knob clockwise to screw the knob on to the shift lever.

NEUTRAL START BACKUP SWITCH (NSBU) REPLACEMENT

Removal

1. Set the hand brake and Place the shifter in the neutral (N) position.

NOTE: A new NSBU switch will come in the neutral position. If reinstalling a switch that was previously removed, make sure not to change the position to ensure proper alignment.

2. Remove the front propeller shaft at the transfer case and position it out of the way.
3. Remove the NSBU switch wire connector.
4. Remove the nut securing the shift lever to the transmission (Figure 5-16).
5. Remove the two bolts securing the NSBU switch to the transmission and remove the switch (Figure 5-16).

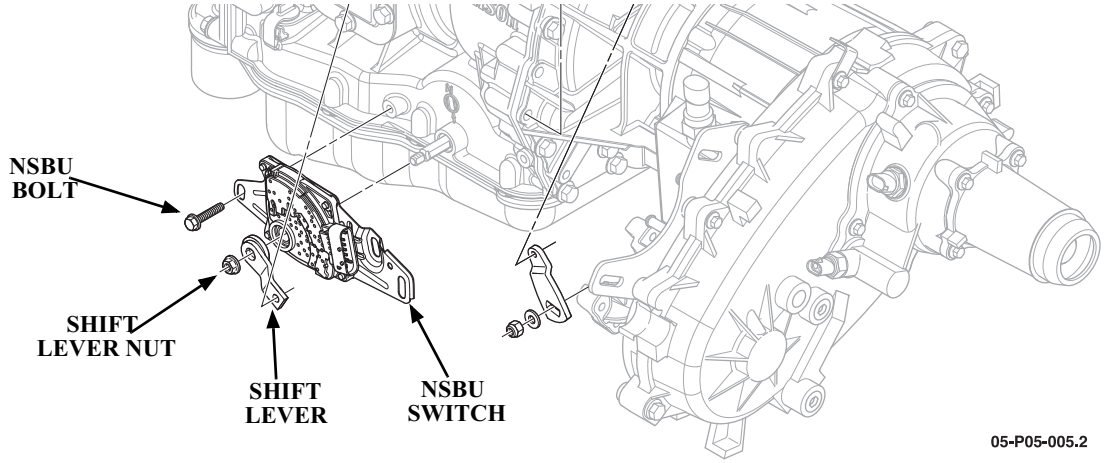


Figure 5-16: NSBU Switch

Installation

1. Make sure the shifter is in the Neutral (N) position.

NOTE: If reinstalling the switch that was removed make sure the switch position has not changed.

NOTE: If installing a new switch, the new switch comes pre positioned in neutral and is held into place with a tab that will brake away when the shifter position is changed.

2. Slide the NSBU switch over the manual shift shaft.
3. While holding the NSBU switch, install the two bolts and tighten the bolts to 20 lb-ft (27 Nm).

WARNING: While performing step 4, hold the shift lever with a wrench to keep it from moving. Damage could occur to the transmission switch if the lever is not held.

4. Install the nut securing the shift lever to the transmission and tighten to 18 lb-ft (24 N•m).
5. Install the NSBU switch wire connector.
6. Install the front propeller shaft at the transfer case.

TRANSMISSION MOUNT/ISOLATOR

Removal

1. Remove the driveline protection.
2. Support the transmission.
3. Remove the guide cable retaining nut from the transmission crossmember support bracket bolt.
4. Remove the transmission crossmember support bracket bolts, nuts and washers from the crossmember (Figure 5-17).
5. Remove the transmission crossmember support bracket bolts, locknuts and washers from the frame rail and remove the support brackets.
6. Remove the two crossmember to transmission mount/isolator locknuts and remove the crossmember.
7. Remove the two bolts holding the transmission mount/isolator to the transmission and remove the mount/isolator.

Installation

1. Position the new transmission mount/isolater into place, install and torque the bolts to 35 lb-ft. (47 N•m).
2. Install the crossmember and the two crossmember-to-transmission mount/isolater locknuts. Tighten the locknuts to 28 lb-ft. (38 N•m).
3. Install the transmission crossmember support bracket on the two bolts and the frame rail with the two washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m).
4. Install the transmission mount to crossmember bolts, locknuts and washers. Tighten the locknuts to 90 lb-ft. (122 N•m).
5. Install the guide cable and the retaining locknut to the transmission crossmember support bracket bolt. Tighten the locknut to 90 lb-ft. (122 N•m).
6. Install the driveline protection.

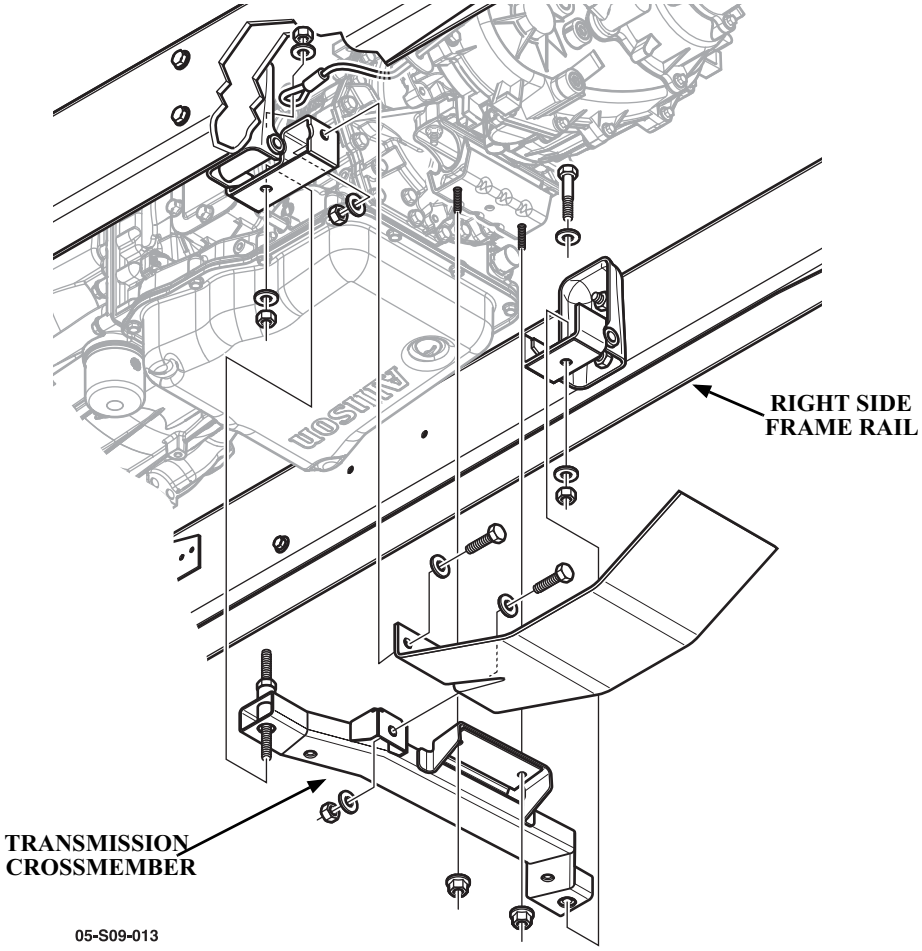


Figure 5-17: Crossmember Removal

TRANSFER CASE DESCRIPTION

Hummer H1 vehicles are equipped with the New Process Gear, model 242 transfer case. If you have questions about the transfer case that are not answered by this section, you can call the Transfer Case Hotline at 1-800-945-4327 for more information.

The 242 is a full-time, 4-wheel drive transfer case with three operating ranges plus a neutral position. The operating ranges are High (H), Low (L), and High Lock (HL). Low range (L) position provides a 2.72:1 reduction ratio for greater low speed, off-road torque capability.

The transfer case extension, bearing retainer, rear case, and front case are all aluminum castings. The front and rear output drive sprockets are interconnected by a drive chain (Figure 5-18). A differential in the transfer case, allows the front/rear output shafts to run at differing speeds. This permits full-time, 4-wheel drive operation in high range. The 242 is also equipped with an internal-mount oil cooler.

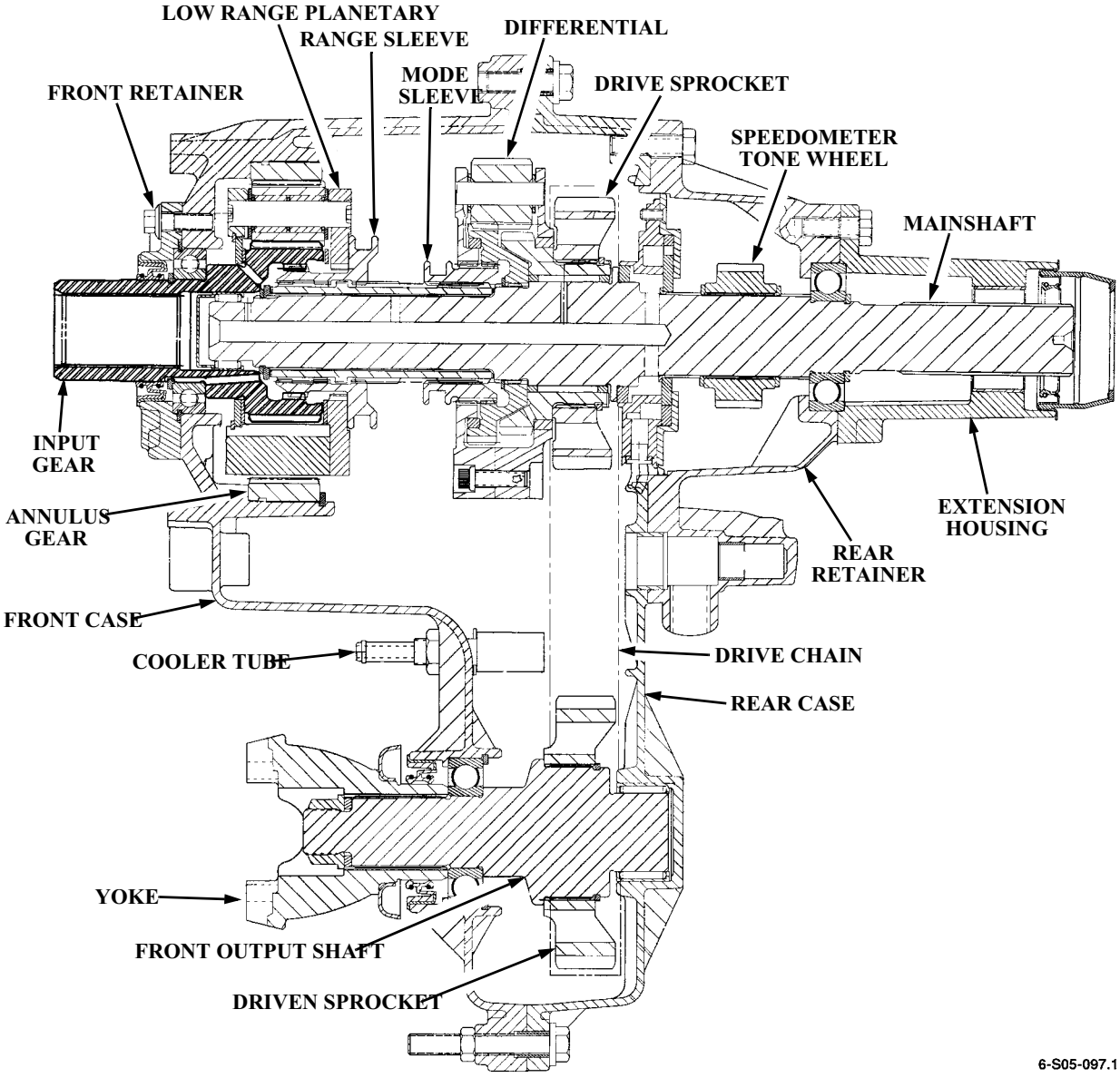


Figure 5-18: Model 242 Transfer Case

TRANSFER CASE OIL COOLER

The NP 242 used in HUMMER H1 vehicles is equipped with an internal cooler (Figure 5-19). The cooler is mounted within the front case and secured by nuts and washers. O-rings are used to seal the cooler inlet/outlet tubes. In operation, coolant from the radiator flows through the transfer case cooler. Heat from the transfer case oil is transmitted to the coolant which is then conveyed to the radiator.

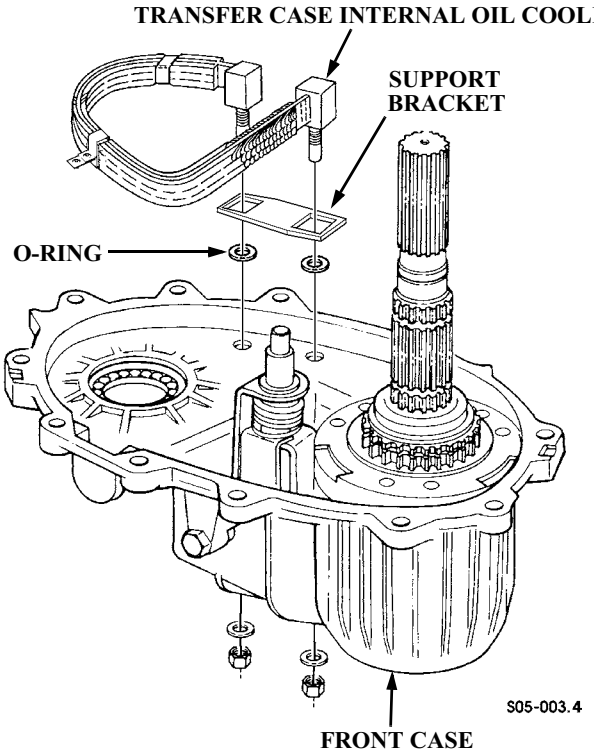


Figure 5-19: Oil Cooler Location

TRANSFER CASE IDENTIFICATION

An identification tag is attached to the rear case of each NP 242 transfer case (Figure 5-20). The tag provides the model number, assembly number, serial number, and low range ratio. The serial number also represents the date of build. For example, a serial number of 10-10-99 would represent a build date of October 10, 1999.

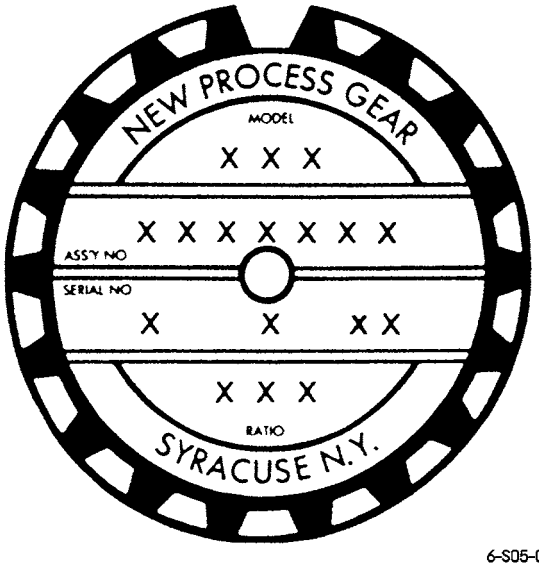


Figure 5-20: Transfer Case I.D. Tag Information

RECOMMENDED LUBRICANT

Dexron III is the recommended lubricant for the NP 242. Use it for topping off the fluid level and as replacement fluid for fluid changes, or after overhaul. Dexron IIE can also be used for topping off a low fluid level when Dexron III is not readily available.

Do not use friction modifiers or similar additives in the NP 242. Use recommended lubricants only.

Transfer Case Fluid Level

Correct transfer case fluid level is to the lower edge of the fill plug hole. Recommended fluid is Dexron III.

The vehicle must be on a level surface for an accurate fluid level check. If the vehicle is raised on a hoist to check fluid level, a drive-on style hoist is preferred. This type of hoist will keep the vehicle level.

The fill plug is just above the drain plug in the rear case. Tightening torque for the plug is 15-25 lb-ft (20-33 N•m).

OPERATING RANGES

The three operating ranges are for specific use on or off road. Usage recommendations are:

High Lock (HL)

High lock range is for use on low traction surfaces. It is an undifferentiated range and should only be employed on unpaved, or low traction surfaces; low traction defined as surfaces covered by snow, ice, sand, mud, or dirt. The differential is bypassed (locked out) in this range.

High (H)

High range is the only range recommended for use on hard, or paved road surfaces. This range can be used on, or off-road as desired.

Low (L)

Low range is for low speed, off road operation. The extra pulling power provided is useful when traversing steep grades, or driving in deep mud or sand. The low range gear provides a 2.72:1 reduction ratio when locked in the low range annulus gear.

Neutral

Neutral range is used for towing purposes.

TRANSFER CASE SHIFTING

The transfer case shift lever is adjacent to the transmission shift lever. A straight-line shift pattern is employed(Figure 5-21).

The transfer case can be shifted from High (H) to High Lock (HL) and back, at any legal speed without putting the transmission in neutral.

The vehicle must be completely stopped and the transmission shifted to neutral before a shift to low range (L). This is necessary because the low range gear must be moved into engagement with the fixed annulus. Once the low range and annulus are engaged, the transfer case is locked into a 2.72:1 reduction ratio. All output to the propeller shafts is undifferentiated and equal. Maximum recommended vehicle speed in low range is 23-31 mph (37-50 kph), with the lower speed preferred.

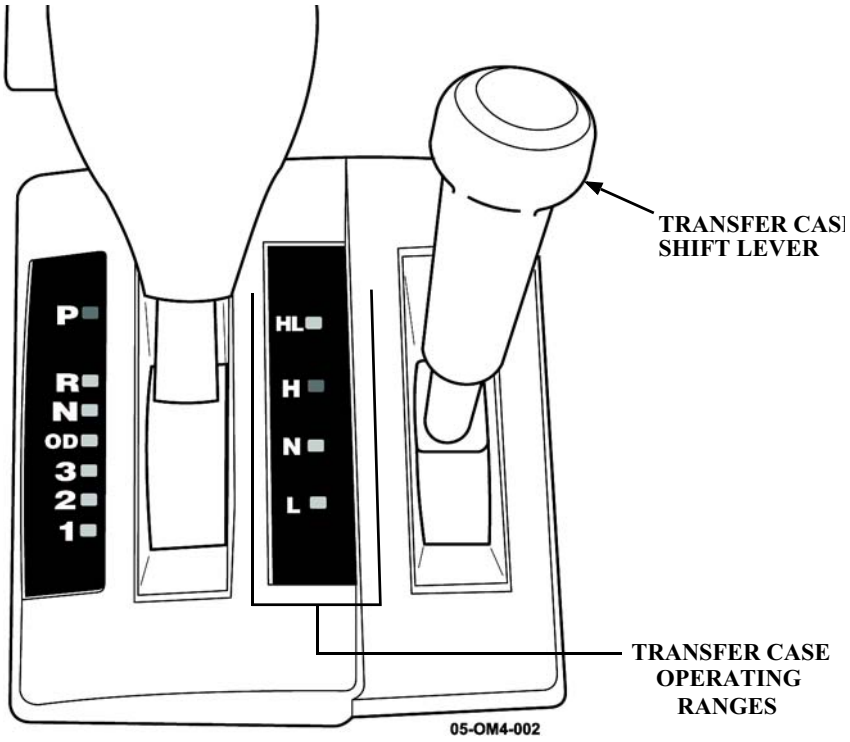


Figure 5-21: Transfer Case Shift Lever and Bezel

TRANSFER CASE DIAGNOSIS

The diagnosis guides outline probable causes of various transfer case malfunctions. The problem causes are listed in order of potential (most to least probable). The guides do not cover every possible condition or possibility. They do however, provide a means of reducing the number of components requiring further diagnosis and inspection.

TRANSFER CASE DIAGNOSIS

PROBLEM	POTENTIAL CAUSE	CORRECTION
Transfer Case Hard to Shift or Will Not Shift Into Desired Range	1. Vehicle speed too great to permit shifting.	1. Reduce speed to 15 mph if shifting from H to HL and back. Stop vehicle completely if shifting into low range.
	2. Vehicle driven for extended period on paved road surface in high lock (HL) range. Internal torque load can prevent shifting.	2. Stop vehicle completely. Shift into neutral. Then into high (H) range. Do not operate vehicle on hard road surface in high lock.
	3. Shift rod adjustment is incorrect.	3. Adjust rod. Refer to procedure in this section.
	4. Shift control housing fault.	4. Remove and inspect housing shift arms. Replace housing if shift arm is damaged or binding.
	5. Incorrect or low lubricant.	5. Add fluid, or drain and refill transfer case.
	1. Transfer case internal fault. • sector damaged or loose • range or mode fork failure • damaged gear	6. Remove and overhaul transfer case.

TRANSFER CASE DIAGNOSIS

PROBLEM	POTENTIAL CAUSE	CORRECTION
Transfer Case Noisy In All Ranges	1. Low lubricant level.	1. Add lubricant and check for leaks. Correct leaks as needed.
	2. Incorrect lubricant	2. Drain and refill transfer case.
	3. Shift rod mispositioned.	3. Adjust shift rod as described in the section.
	4. Internal component wear or damage.	4. Remove and overhaul transfer case.
	5. Extended operation on paved roads in high lock range. (Causes accelerated bearing, wear, gear wear, and chain stretch.)	5. Inform driver that only high range should be used on paved surfaces. Repair transfer case if wear or damage has occurred.
Transfer Case Jumps Out Of Gear	1. Not fully engaged in desired gear range.	1. Stop vehicle, shift into gear, and resume operation.
	2. Shift linkage bind or misadjusted.	2. Adjust shift rod. Correct bind in control housing shift arm.
	3. Range or mode fork problem: • fork cracked • inserts worn, missing • shift rail scored • shift sector or shaft worn	3. Remove, disassemble transfer case and repair as necessary.
	4. If transfer case jumps out of low range, problem is with low range gear, lockplate, or annulus.	4. Disassemble transfer case and repair as needed.
Lubricant Leaks From Vent Or Output Shaft Seals	1. Transfer case overfilled.	1. Drain to correct level. Check transfer case cooler if transfer case is overfilled and fluid appears milky for possible coolant leak.
	2. Vent or line restricted, kinked, pinched.	2. Replace vent or line as needed. Reroute line to eliminate kinks.
	3. Output seal failure (front or rear) caused by wear, incorrect installation, cut seal lip.	3. Replace seal(s). Correct cause of cut seal lip or abnormal wear of seal lip (rough surface on output shaft or yoke).
Rapid Tire Wear	1. Vehicle driven for extended periods in high lock on hard, paved road surfaces.	1. Inform driver that only high range should be used on hard, paved road surfaces.

VENT LINE REPLACEMENT

1. Loosen the clamp and remove the vent line from the fitting on the rear of transfer case.
2. Remove the bolt, clamp, and the vent line.
3. Transfer the clamp to the new vent line.
4. Connect the vent line to the tee fitting.
5. Connect the vent line to the transfer case fitting and tighten the clamp.
6. Attach the clamp and the vent line to the transmission. Tighten the clamp bolt to 16-20 lb-ft (22-27 N•m).

SPEED SENSOR AND/OR SWITCH REPLACEMENT

1. Disconnect the harness connector from the vehicle speed sensor, lock indicator switch, and/or range indicator switch.
2. Remove the switch and/or sensor from the transfer case.
3. Install the new switch and/or sensor in the transfer case.
4. Attach the harness connector to the switch or sensor.

GUIDE CABLE REPLACEMENT

1. Remove the bolts, nuts, and the washers attaching the cable bracket to the muffler bracket.
2. Remove the bolts, nuts, and washers securing the guide cable.
3. Remove the guide cable and bracket.
4. Attach the guide cable bracket to the muffler bracket.
5. Attach the guide cable bracket to the transfer case with the washers and nuts.
6. Install the guide cable and brake line support bracket. Tighten the bracket bolt to 27-33 lb-ft (37-45 N•m).

FRONT OUTPUT SHAFT SEAL REPLACEMENT

1. Mark the front propeller shaft and the transfer case yoke for alignment reference.
2. Disconnect the front propeller shaft at the yoke. Retain the U-bolts and nuts.
3. Remove the yoke nut.
4. Remove the yoke and seal washer. Use tool J–8614-01 to remove the yoke if necessary (Figure 5-22).
5. Remove the seal from the front case bore with a standard hook type seal puller.
6. Coat the outer edge of the new seal with a thin coat of RTV type sealer.
7. Lubricate the seal lip with transmission fluid and install the seal with tool J–38869.

CAUTION: *The seal can be installed incorrectly. Be sure the seal lip is toward the case interior.*

8. Smooth the seal contact surface of the yoke with 320-400 grit emery coated with transmission fluid. Then clean and install the yoke.
9. Install the yoke seal washer.
10. Install and tighten the yoke nut to 90-130 lb-ft (122-176 N•m) torque.
11. Connect the propeller shaft to the yoke. Tighten the U-bolt nuts to 13-18 lb-ft (18-24 N•m) torque.
12. Check and top off the transfer case fluid level if necessary.

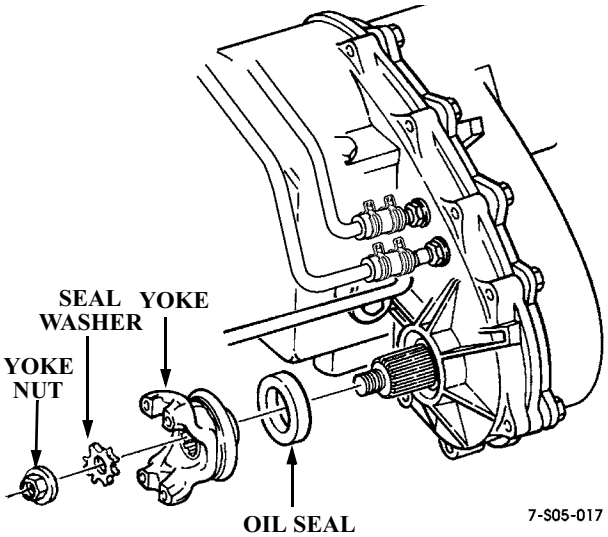


Figure 5-22: Front Output Shaft Yoke and Seal Removal/Installation

TRANSFER CASE FLUID CHANGE

The transfer case fill and drain plugs are both located in the rear of the case (Figure 5-23).

The correct fill level is to the lower edge of the fill plug hole. Recommended fluid is Dexron III.

1. Place the vehicle on a level surface. Or, if the vehicle is raised on a hoist for fluid change, a drive-on hoist is preferred. The vehicle must be level for accurate fluid level.
2. Remove the drain and fill plugs and drain the fluid into an approved container.
3. Install and tighten the drain plug to 15-25 lb-ft (20-33 N•m) torque.
4. Fill the transfer case with Dexron III. Correct level is to the lower edge of the fill plug hole.
5. Install and tighten the fill plug to 15-25 lb-ft (20-33 N•m) torque.
6. Lower the vehicle, if on a hoist.

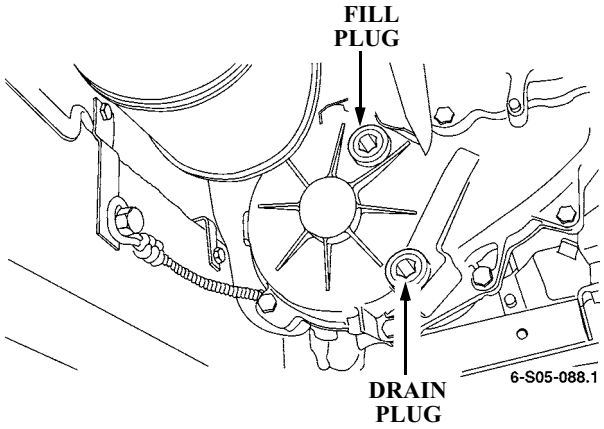


Figure 5-23: Transfer Case Drain and Fill Plug Locations

TRANSFER CASE REPLACMENT

Removal

1. Remove the drain plug and drain the oil from the transfer case. Reinstall the drain plug afterward.
2. Disconnect the propeller shafts from the transfer case.
3. Disconnect the wiring harness connectors from the vehicle speed sensors, range switch and lock switch.
4. Remove the wiring harness clamp and move the harness away from the transfer case.
5. Disconnect the vent line from the transfer case.
6. Disconnect and plug the cooler hoses at the transfer case.
7. Disconnect the shift cable at the range lever (Figure 5-24).
8. Remove the guide cable and bracket.
9. Support the transfer case with a jack. Secure the transfer case to the jack with chain.
10. Remove the nuts attaching the transfer case to the transmission adapter.
11. Slide the transfer case rearward and remove it from under the vehicle.

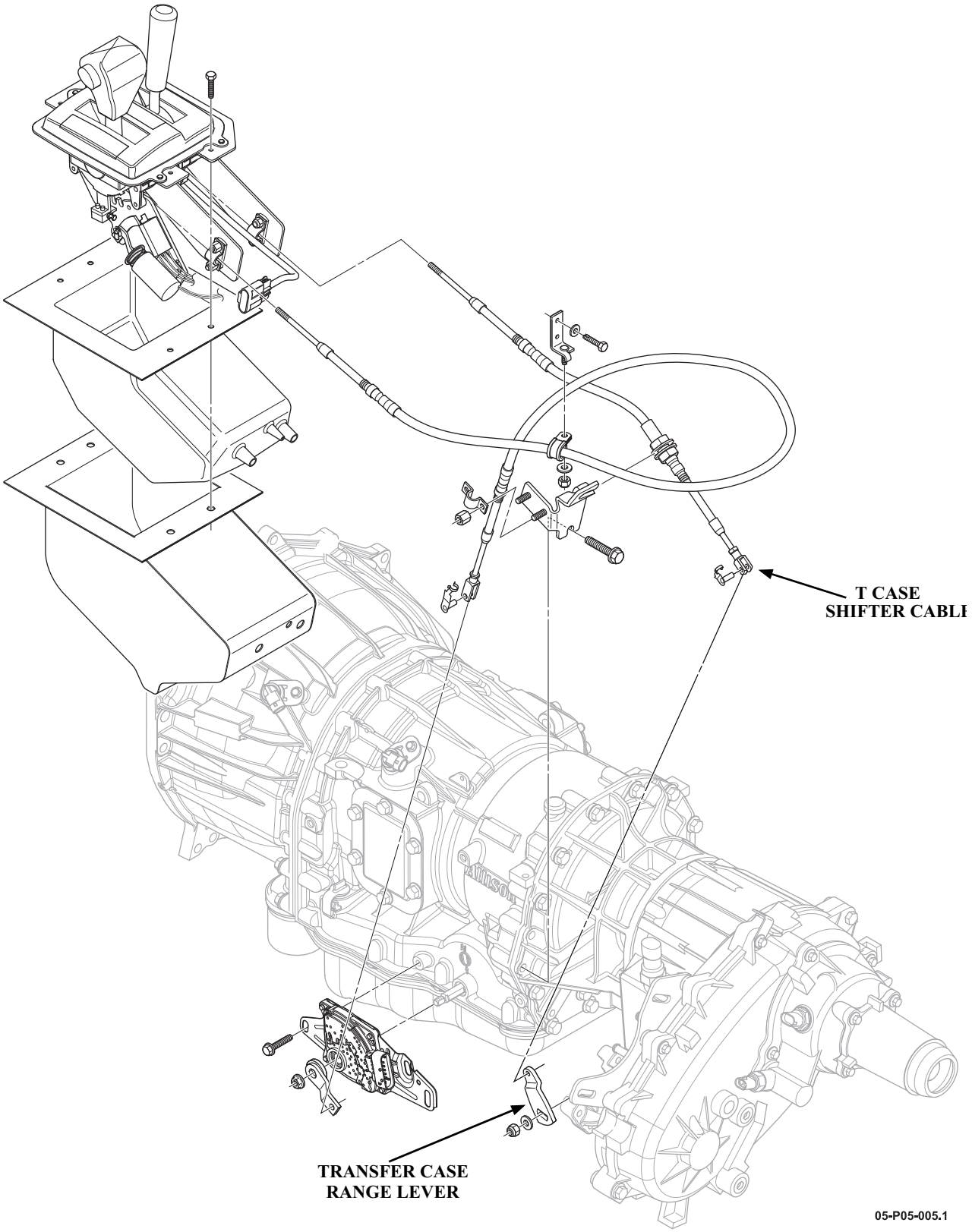


Figure 5-24: Shifter Cable Attachment

Installation

1. Mount the transfer case on a jack and secure it with a chain.
2. Apply a bead of Loctite 518 to the mounting surface of the transmission adapter.
3. Align and install the transfer case on the transmission. Tighten the transfer case attaching nuts to 37 lb-ft (50 N•m).
4. Remove the jack.
5. Connect the shift cable to the transfer case range lever (Figure 5-24).
6. Install the guide cable and bracket.
7. Connect the transfer case vent line.
8. Connect the cooler hoses to the transfer case cooler fittings.
9. Connect the front and rear propeller shafts to the transfer case. Tighten the front shaft U-bolt nuts to 13-18 lb-ft (18-24 N•m) torque.
10. Install the vehicle speed sensor wire connector.
11. Install the range indicator switch wire connector.
12. Attach the harness clamp to the transfer case.
13. Connect the wiring harness connectors to the speed sensor and switches.
14. Fill the transfer case to the bottom edge of the fill plug hole with Dexron III.
15. Check and adjust the shift cable if necessary.

TRANSFER CASE DISASSEMBLY AND OVERHAUL

1. Remove the vehicle speed sensor and both of the indicator switches.
2. Remove the front output shaft yoke (Figure 5-25). Remove the yoke nut with a suitable size socket, and impact wrench. Then remove the seal, washer, and the yoke.

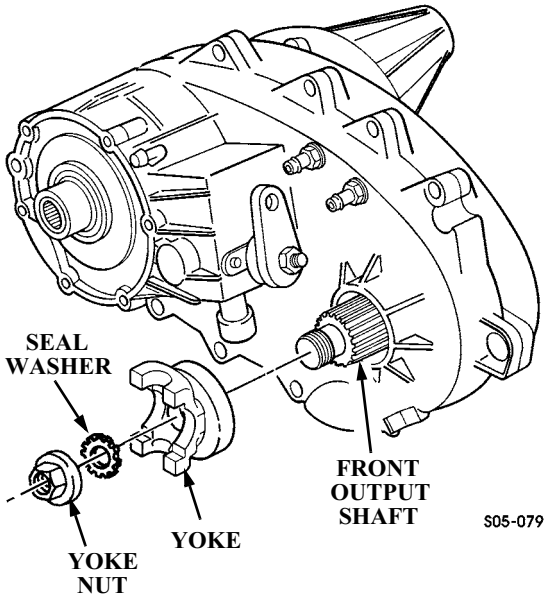


Figure 5-25: Front Yoke Removal/Installation

3. Remove the extension housing bolts. Then tap the housing counter clockwise to break the sealer bead (Figure 5-26). Use a plastic mallet to tap the housing.
4. Remove the extension housing (Figure 5-27).

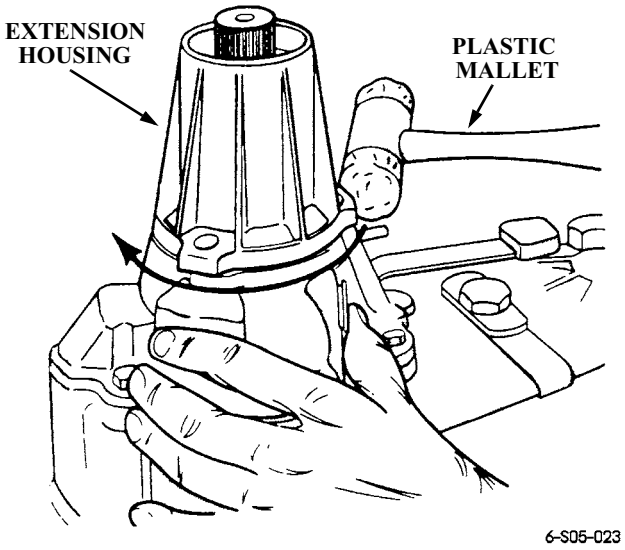


Figure 5-26: Loosening Extension Housing

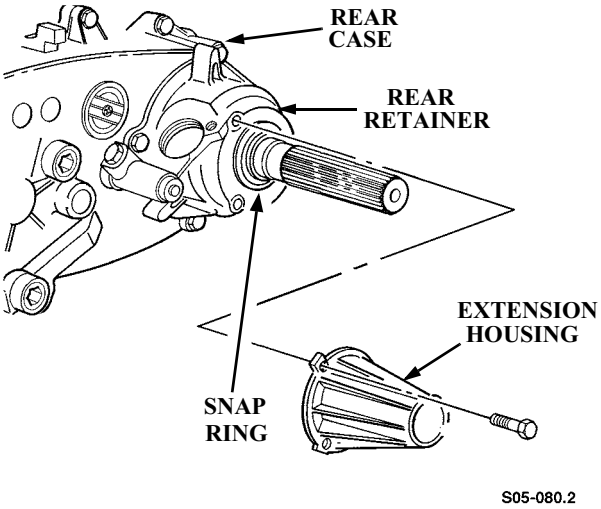


Figure 5-27: Extension Housing Removal

5. Remove the rear retainer bolts. Then remove the mainshaft bearing snap ring (Figure 5-28).
6. Pry the rear retainer upward at each lug with a screwdriver (Figure 5-29). Remove the retainer after breaking the sealer bead.

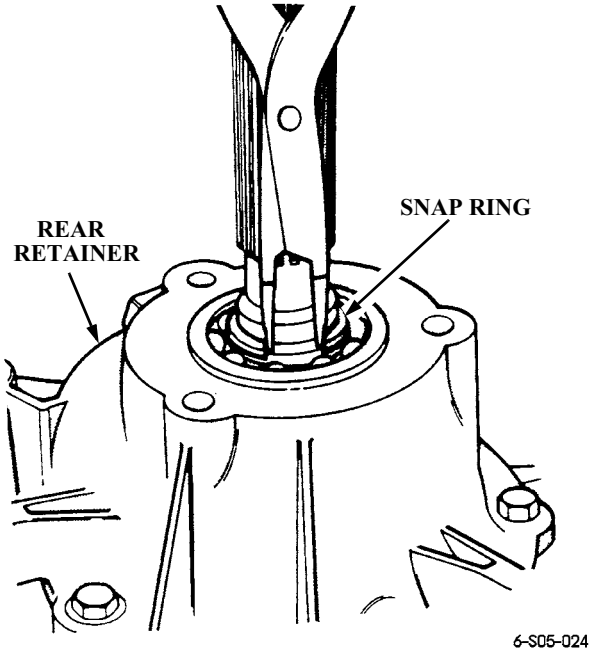


Figure 5-28: Mainshaft Bearing Snap Ring Removal

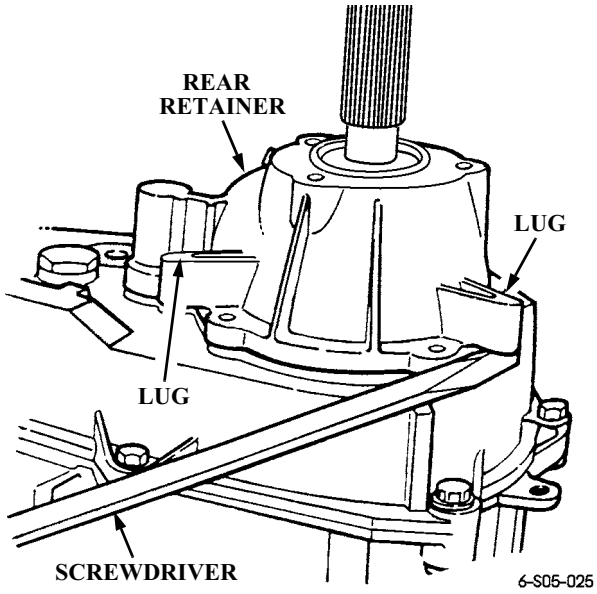


Figure 5-29: Rear Retainer Removal

7. Remove the speedometer tone wheel and the snap rings (Figure 5-30).
8. Remove the rear case attaching bolts and remove the rear case (Figure 5-31).

CAUTION: *Loosen the rear case with screwdrivers positioned in the slot at each end of the case. This will avoid damaging the case sealing surfaces.*

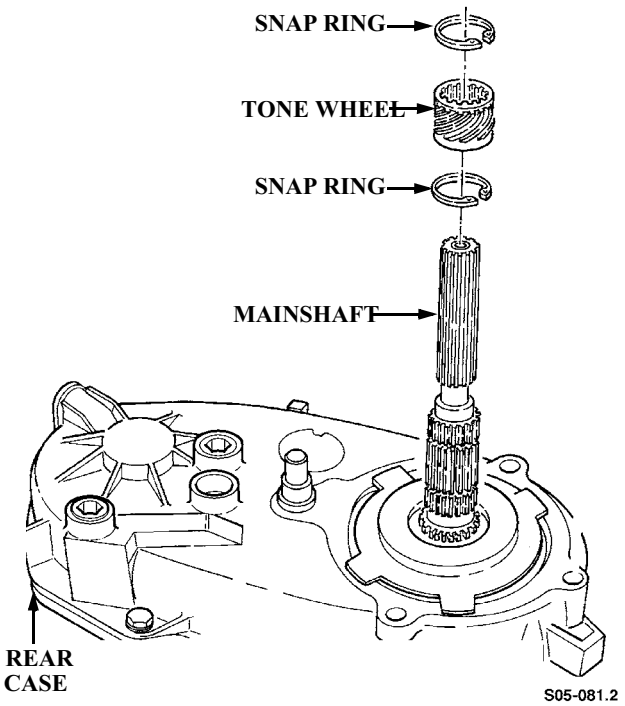


Figure 5-30: Speedometer Tone Wheel Removal/Installation

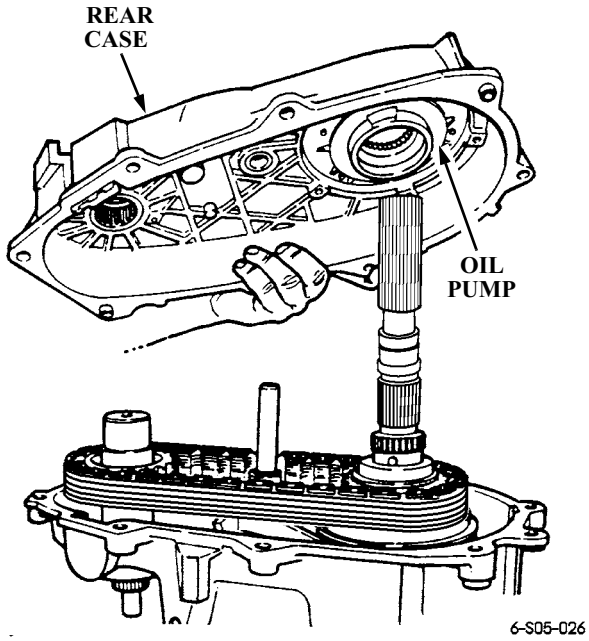


Figure 5-31: Rear Case Removal

9. Remove the oil pump, pickup tube, hose and the screen (Figure 5-32).
10. Remove the O-ring from the oil pump inlet port (Figure 5-33).

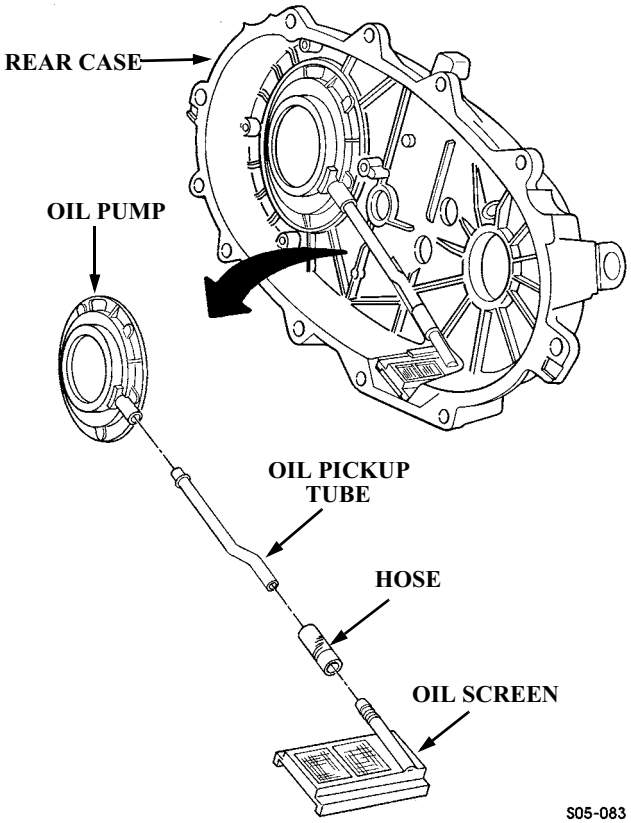


Figure 5-32: Oil Pump Assembly Removal

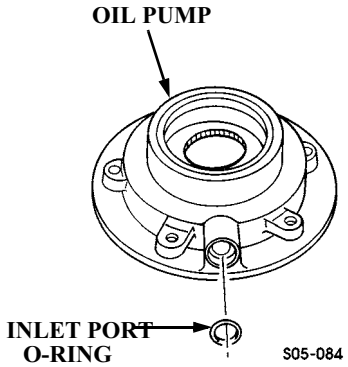


Figure 5-33: Oil Pump O-ring Location

11. Remove the drive sprocket snap ring (Figure 5-34).
12. Remove the drive sprocket (Figure 5-35).
13. Remove the drive chain.
14. Remove the front output shaft and the driven sprocket as a assembly (Figure 5-36).

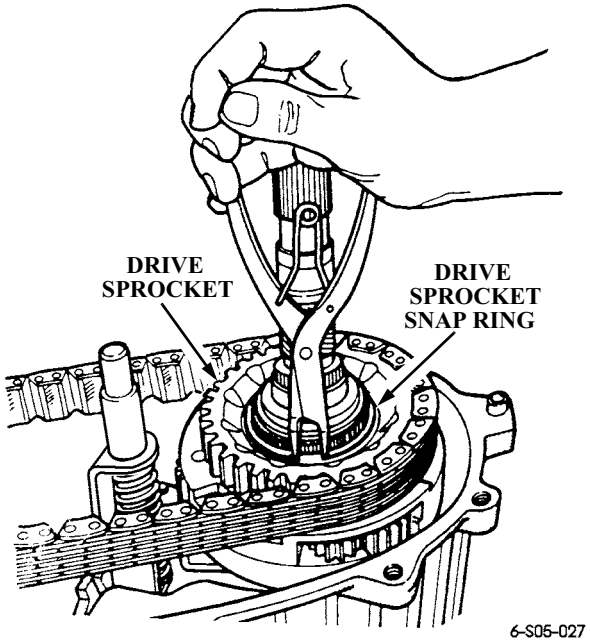


Figure 5-34: Drive Sprocket Snap Ring Removal/Installation

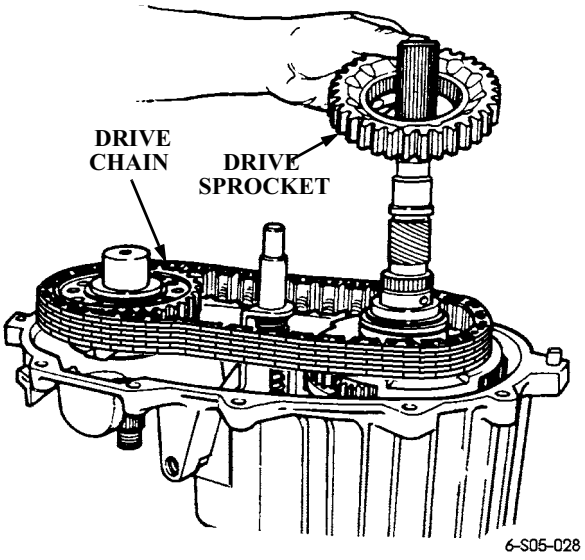


Figure 5-35: Drive Sprocket Removal

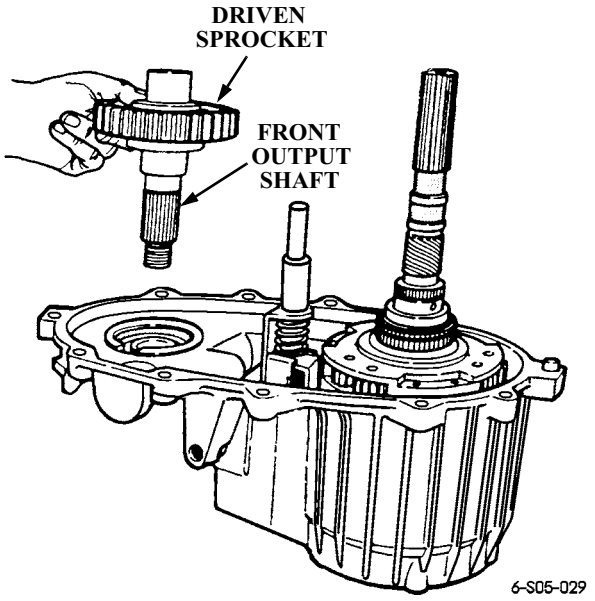


Figure 5-36: Front Shaft and Driven Sprocket Removal

15. Remove the range lever nut, washer and the lever from the sector shaft (Figure 5-37).

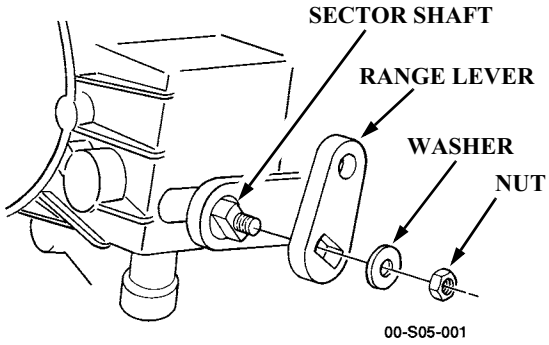


Figure 5-37: Range Lever Mounting

16. Remove the detent plug, spring and the plunger (Figure 5-38).
17. Remove the oil cooler attaching nuts and the washers. Then remove the cooler, support bracket and the O-rings (Figure 5-38).
18. Remove the shift rail (Figure 5-39).

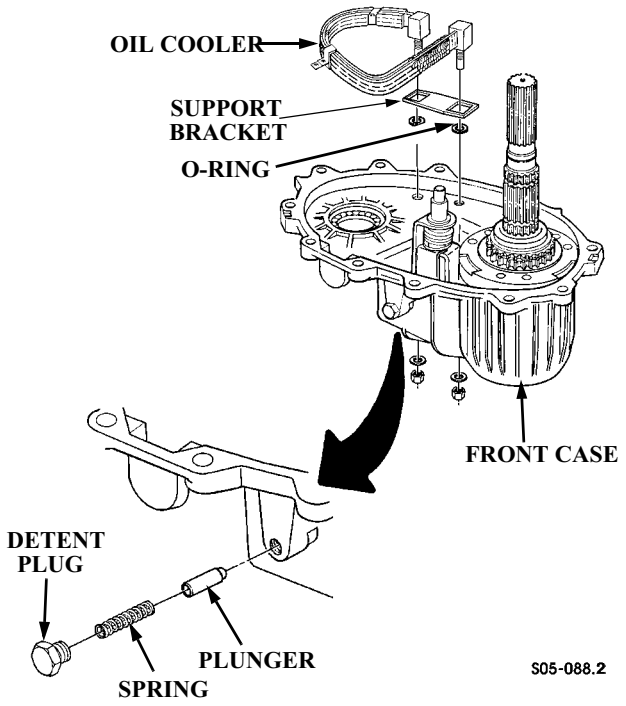


Figure 5-38: Oil Cooler and Detent Plug, Spring, Plunger Removal

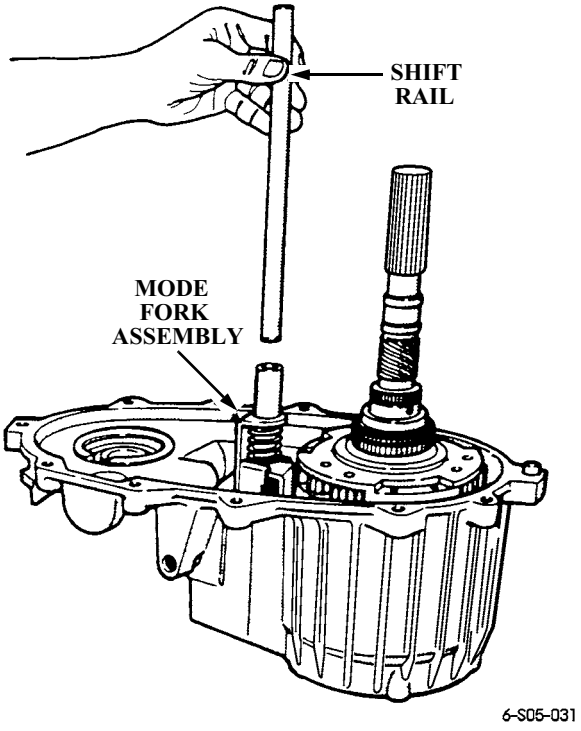


Figure 5-39: Shift Rail Removal/Installation

19. Remove the mainshaft, differential and the mode fork as an assembly (Figure 5-40).

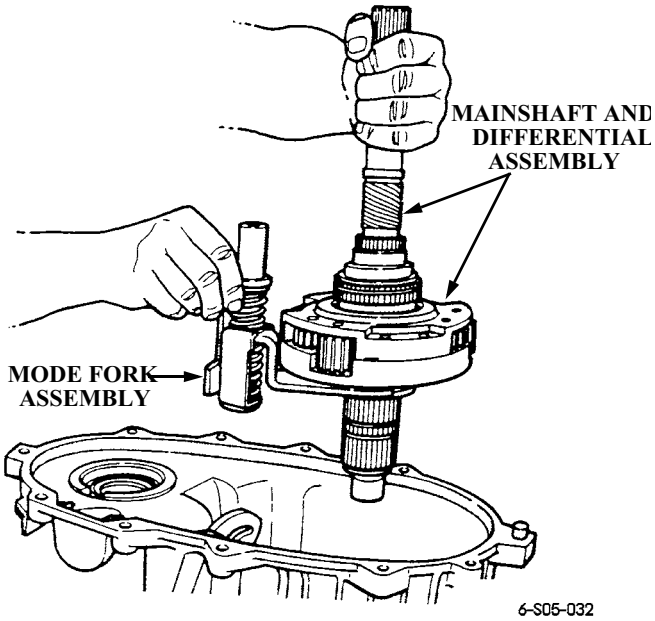


Figure 5-40: Mainshaft, Differential and Mode Fork Removal

20. Remove the mode fork and the sleeve from the mainshaft (Figure 5-41). Note the position of the sleeve for installation reference. DO NOT disassemble the fork assembly. Only the fork pads are serviceable.
21. Remove the snap ring that secures the intermediate clutch shaft on the mainshaft (Figure 5-42).

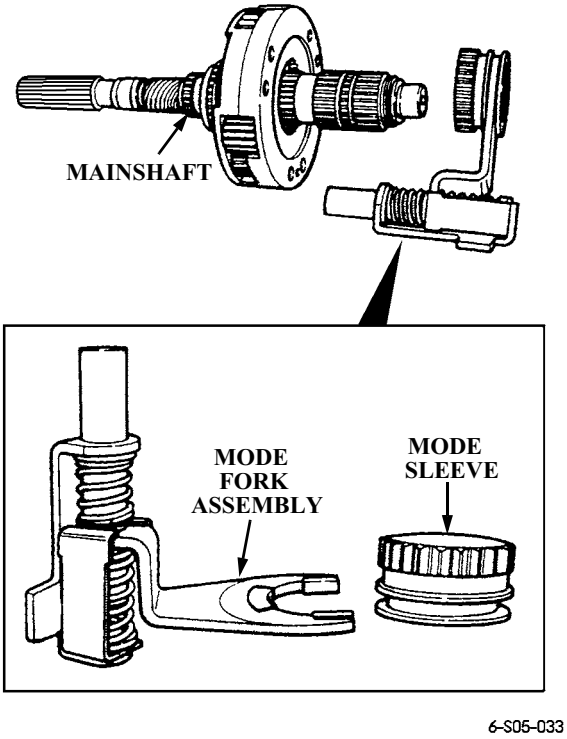


Figure 5-41: Mode Fork and Sleeve Removal

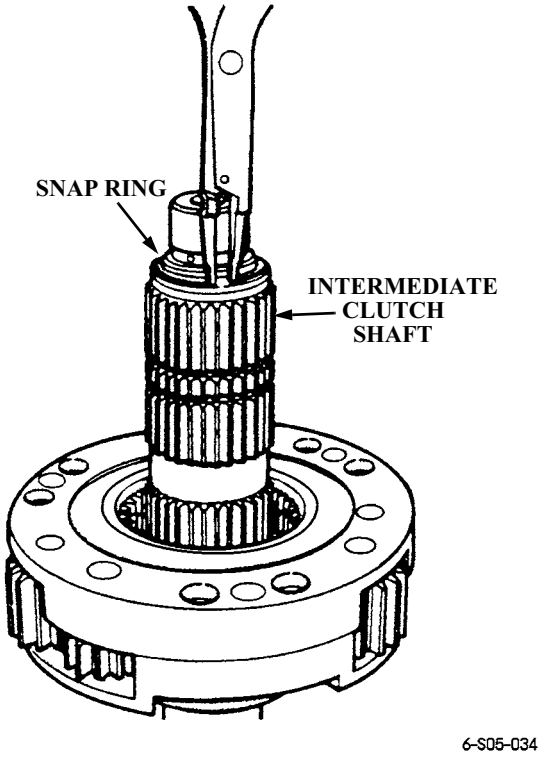


Figure 5-42: Intermediate Clutch Shaft Snap Ring Removal/Installation

22. Remove the intermediate clutch shaft, and the tabbed thrust ring from the mainshaft (Figure 5-43).

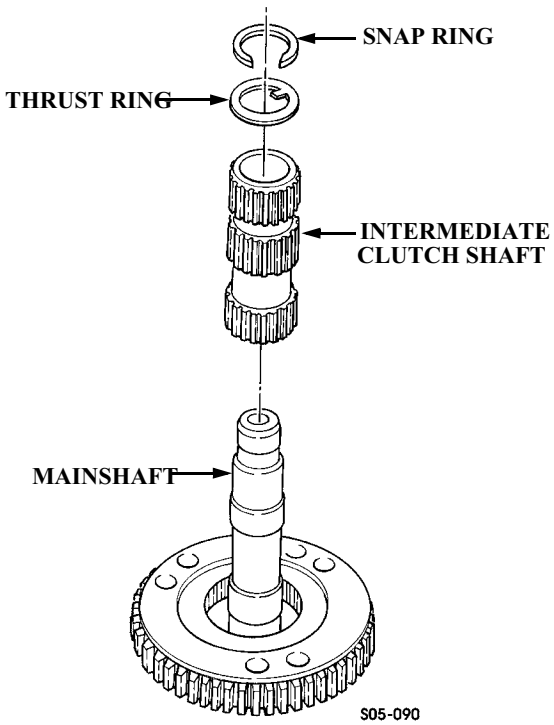


Figure 5-43: Clutch Shaft Removal

23. Remove the differential snap ring (Figure 5-44).
24. Remove the differential from the mainshaft (Figure 5-45).
25. Remove the mainshaft needle roller bearings and the spacers (Figure 5-46).

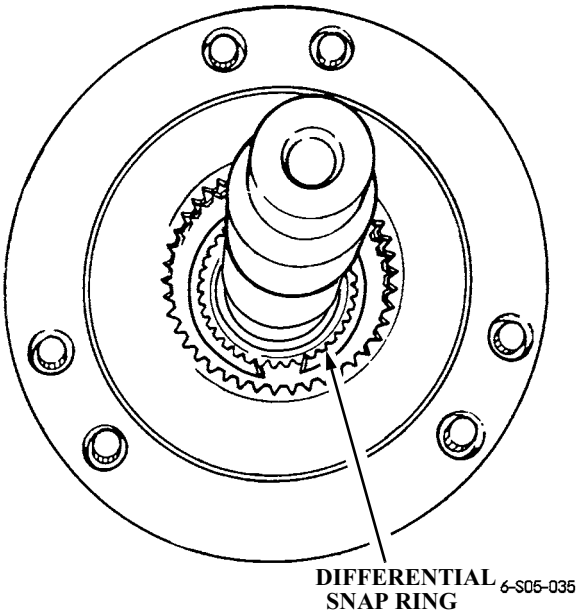


Figure 5-44: Differential Snap Ring Location

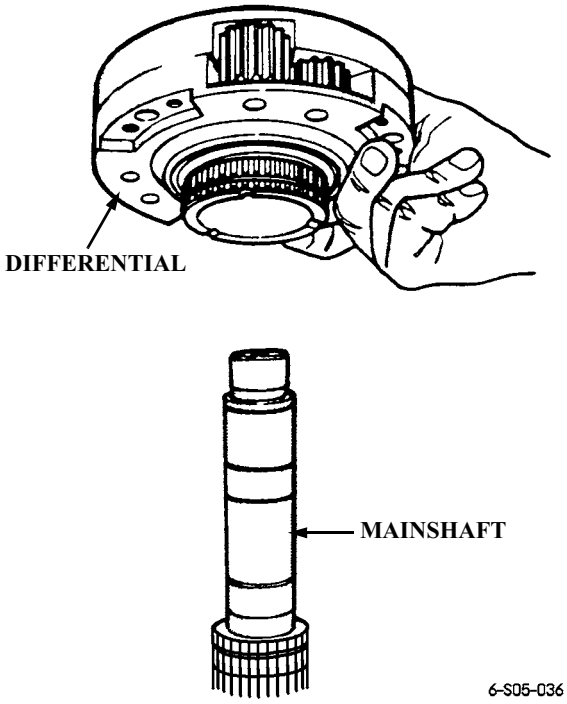


Figure 5-45: Differential Removal

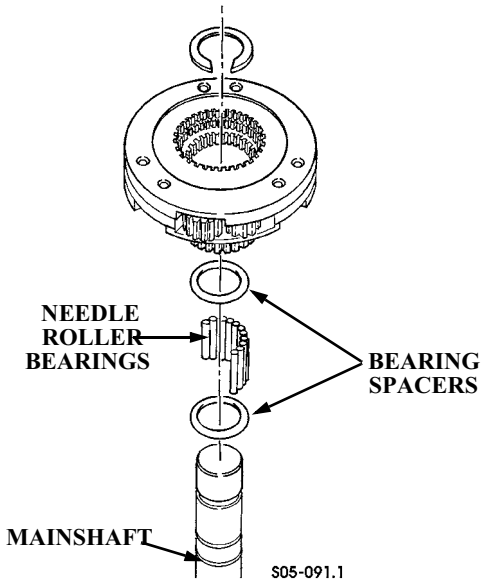


Figure 5-46: Mainshaft Bearing and Spacer Removal

26. Slide the low range fork pin out of the shift sector. Then remove the low range fork, and the sleeve as an assembly (Figure 5-47).
27. Remove the shift sector.
28. Remove the shift sector shaft bushing and the O-ring (Figure 5-48).

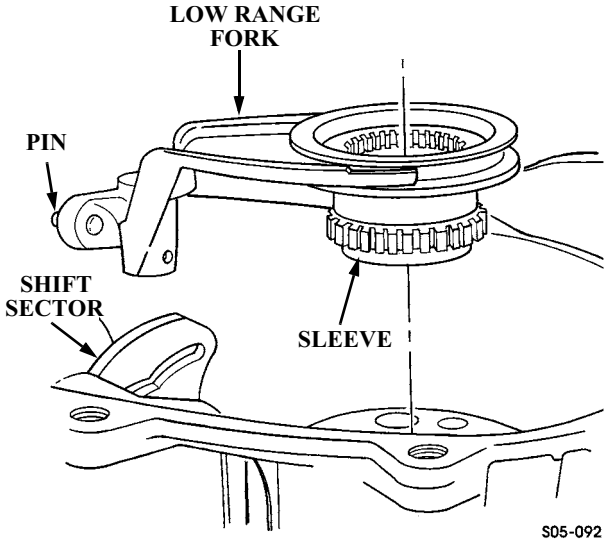


Figure 5-47: Range Fork and Sleeve Removal

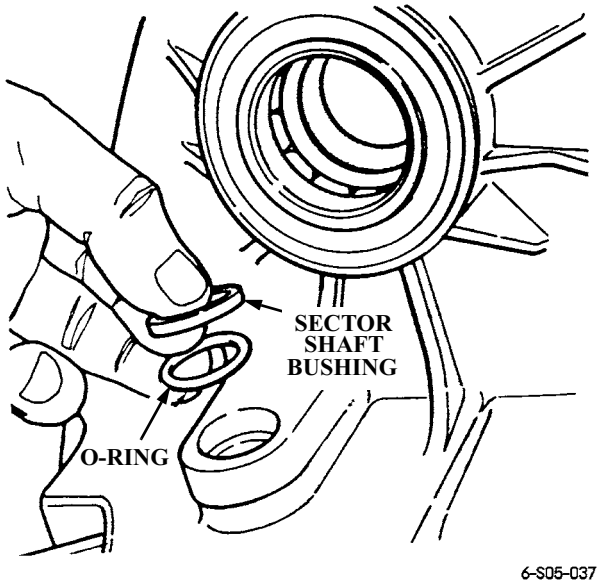


Figure 5-48: Sector Shaft Bushing and O-Ring Removal

29. Remove the bolts attaching the front retainer to the front case. Then remove the retainer by prying it loose with a screwdriver positioned in the retainer slot (Figure 5-49).

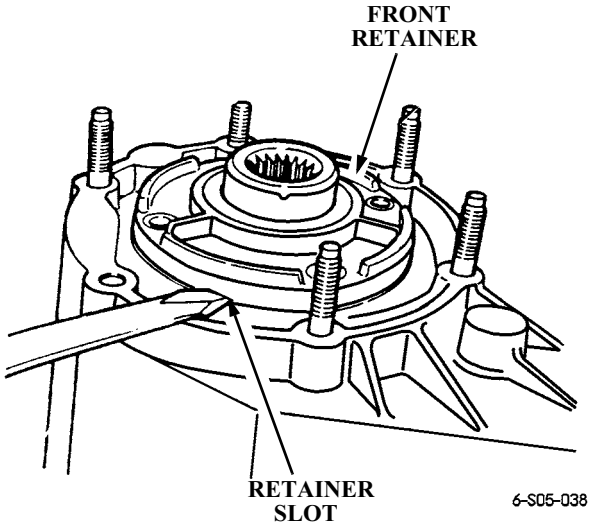


Figure 5-49: Front Retainer Removal

30. Remove the snap ring that secures the input gear in the bearing (Figure 5-50).
31. Remove the input gear, and the low range planetary as an assembly. Tap the input gear with a rawhide or a plastic mallet to free it from the bearing.
32. Disassemble the input gear and the low range planetary as follows:
    a. Remove the retaining ring that secures the input gear in the low range planetary (Figure 5-51).
    b. Remove the lock ring and the front thrust washer (Figure 5-52).
    c. Remove the input gear and the rear thrust washer from the low range planetary (Figure 5-52).

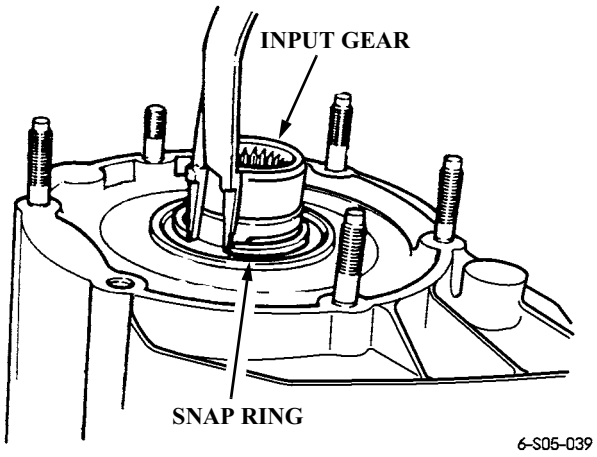


Figure 5-50: Input Gear Snap Ring Removal

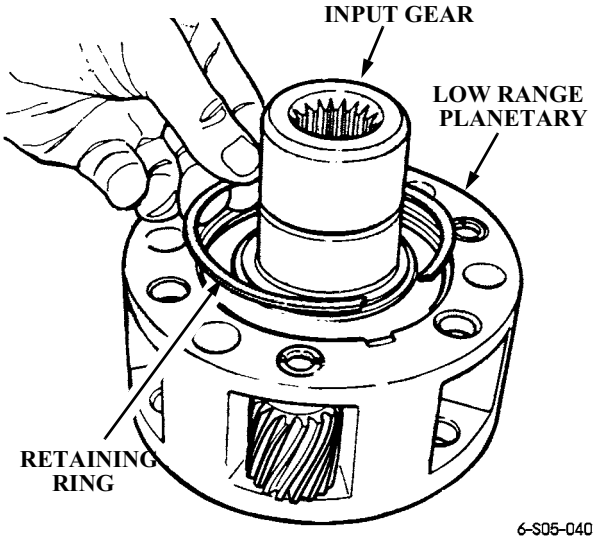


Figure 5-51: Input Gear Retaining Ring Removal

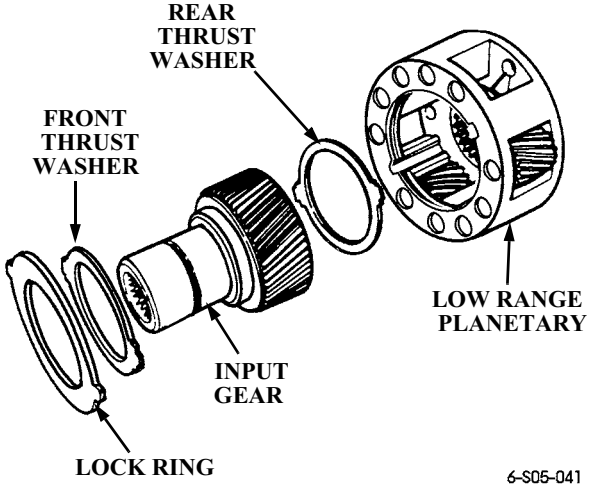


Figure 5-52: Input/Low Range Planetary Gear Disassembly Sequence

33. Remove and disassemble the differential as follows:

a. Scribe or paint a mark on the front and the rear cases for assembly reference (Figure 5-53).
b. Remove the case bolts (Figure 5-54).
c. Pry the front and the rear cases apart with two screwdrivers (Figure 5-55).
d. Remove the planet gears and the thrust washers (Figure 5-56).
e. Remove the sprocket and the mainshaft gears as an assembly (Figure 5-57).

34. Remove the output shaft front bearing seal with pry tool (Figure 5-58).

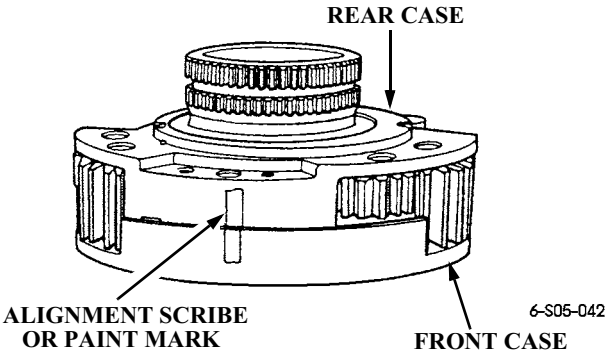


Figure 5-53: Marking Differential Cases for Assembly Reference

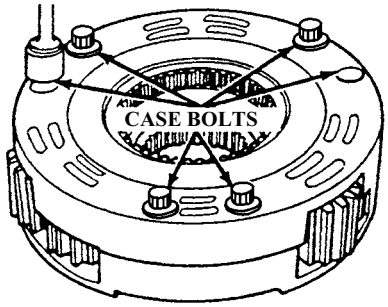


Figure 5-54: Differential Case Bolt Removal

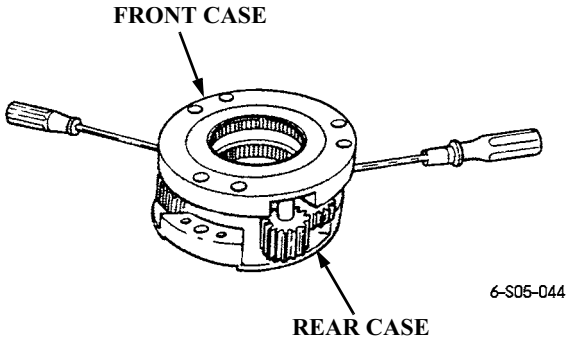


Figure 5-55: Separating Differential Cases

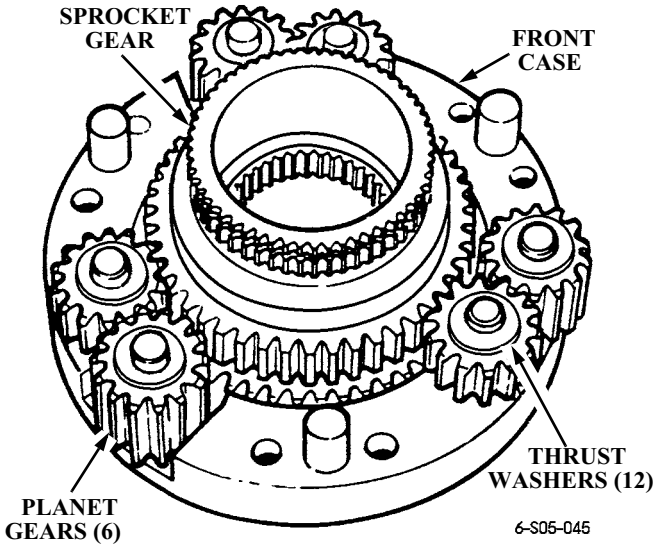


Figure 5-56: Planet Gear Locations In Bottom Case

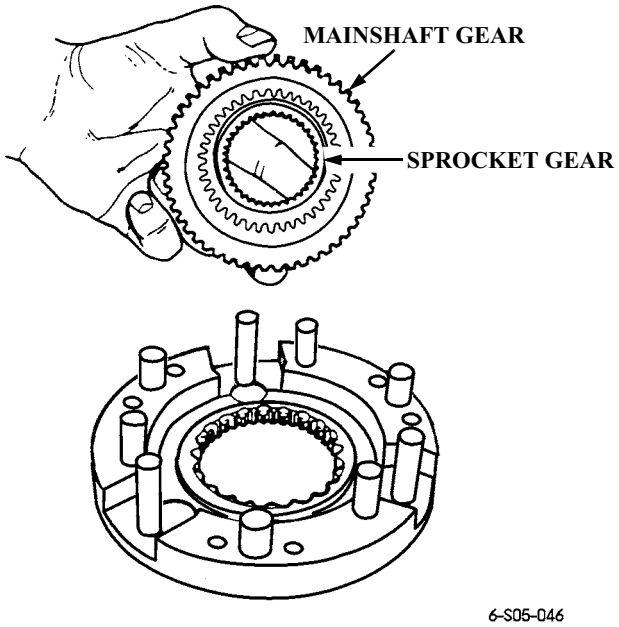


Figure 5-57: Mainshaft and Sprocket Gear Removal

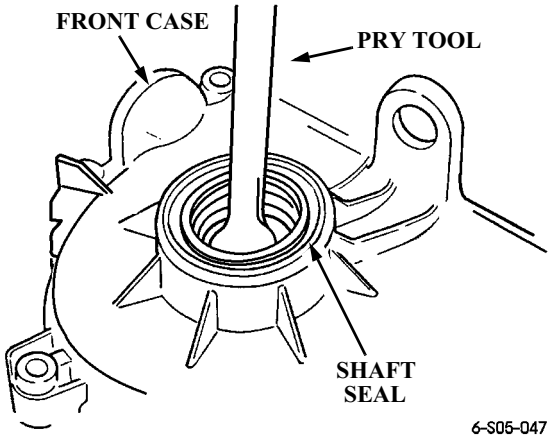


Figure 5-58: Removing Front Output Shaft Seal

TRANSFER CASE CLEANING AND INSPECTION

Clean the transfer case components thoroughly with standard parts cleaning solvent. Remove all traces of sealer from the case and retainer sealing surfaces.

Clean the oil pickup screen with solvent and dry it with compressed air. Also use compressed air to remove solvent residue from all oil feed passages and channels.

Geartrain

The differential pinion gears and thrust washers are serviceable components and can be replaced if worn or damaged. The differential cases are also serviceable but must be replaced as a set if either case is damaged.

Inspect the mainshaft splines, gear teeth and bearing surfaces carefully for evidence of wear or damage. Replace the shaft if necessary. Do not attempt to salvage it if damaged.

The range and mode forks are serviced as assemblies. Replace either part if damaged. However, the nylon pads in the forks can be replaced if worn or cracked.

Inspect the transfer case snap rings closely. Do not attempt to salvage a distorted snap ring by straightening or reshaping it. Replace any snap ring that is distorted or worn.

Inspect the low range planetary, input gear and thrust washer, retainer and snap ring. The low range planetary is serviced as an assembly only. Replace it if the case or pinions are damaged.

During inspection, also make sure the seal surface of the input gear is in good condition. Minor nicks on this surface can be reduced with crocus cloth. However, replace the gear if the seal surface is severely scored or worn.

Check condition of the low range annulus gear (Figure 5-59). Replace the front case and gear as an assembly if the gear is damaged. The annulus gear is not serviced separately.

The speedometer tone wheel should be replaced if worn, cracked or spline teeth are worn.

Inspect the differential gears, thrust washers and case halves. Replace the mainshaft gear if the gear teeth or the brass ring on the underside of the gear are damaged. Replace the differential as an assembly if the gears, case halves or the pins in the lower case half are damaged.

Inspect the case halves, extension housing, and both retainers for cracks, porosity or damaged sealing surfaces. Inspect the shafts, gears, chain and shift components for wear or damage.

Inspect all of the transfer case bearings for wear, roughness, pitting or galling. Replace worn or damaged bearings.

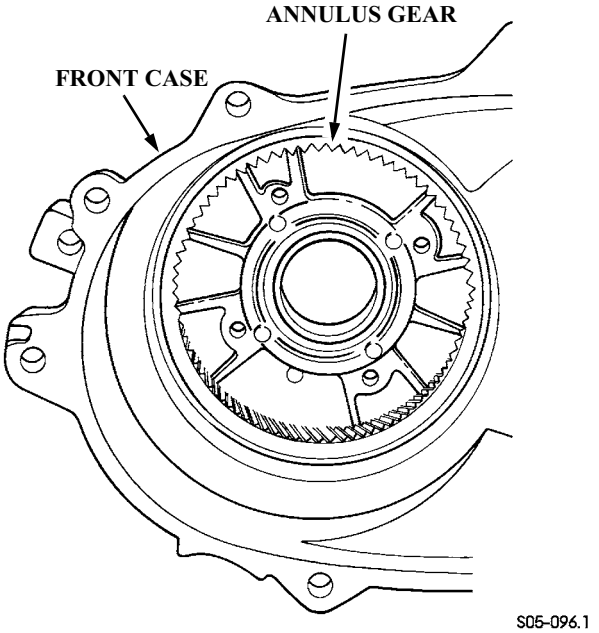


Figure 5-59: Annulus Gear Location In Front Case

Oil Pump

The oil pump is not a serviceable component. Replace the pump as an assembly if the gear teeth are worn, or if the pump has become damaged.

Bearings and Seals

The transfer case seals should be replaced during overhaul. Use new seals in the oil pump, input gear bearing retainer, front case, and extension housing. Also replace the yoke seal washer and detent plug O-ring.

FRONT OUTPUT SHAFT BEARING AND SEAL REPLACEMENT

1. Remove the snap ring securing the front bearing in the front case (Figure 5-60).
2. Tap the old bearing out rearward of the front case with plastic or raw hide mallet.
3. Install a new bearing with tool handle J–8092, and the installer tool J–33833 (Figure 5-61).
4. Lubricate the new bearing with Dexron III.
5. Install the new shaft seal with seal installer J–38869 (Figure 5-62). Then lubricate the seal lip with Dexron III.
6. Remove the front output shaft rear bearing from the rear case as follows:
   a. Clamp the rear case to a bench with wood blocks, and C-clamps.
   b. Pull the bearing using a slide hammer, adapter J–2619-01, and puller J–26369 (Figure 5-63).
   c. Install a new bearing with tool handle J–8092, and installer J–33832 (Figure 5-64). The rear bearing bore is chamfered at the top. Install the bearing so it is flush with the chamfer lower edge.

CAUTION: *Do not bottom the bearing in the bore. This will block the oil feed hole in the rear case bearing bore.*

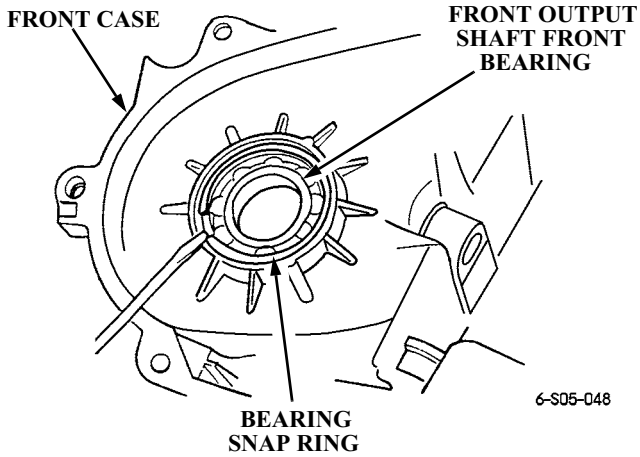


Figure 5-60: Front Output Shaft Front Bearing Snap Ring Removal/Installation

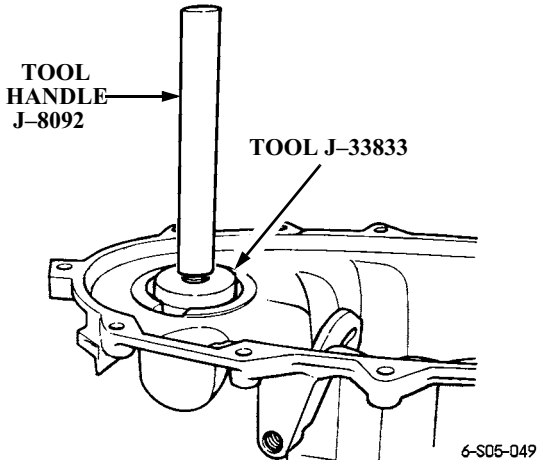


Figure 5-61: Front Output Shaft Front Bearing Installation

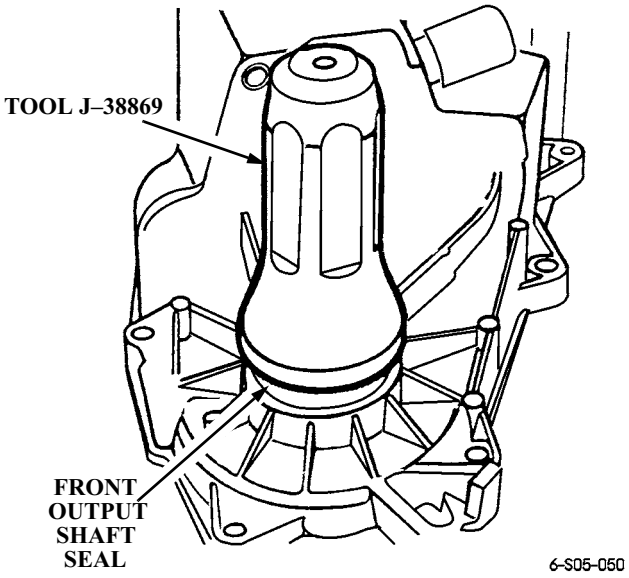


Figure 5-62: Front Output Shaft Seal Installation

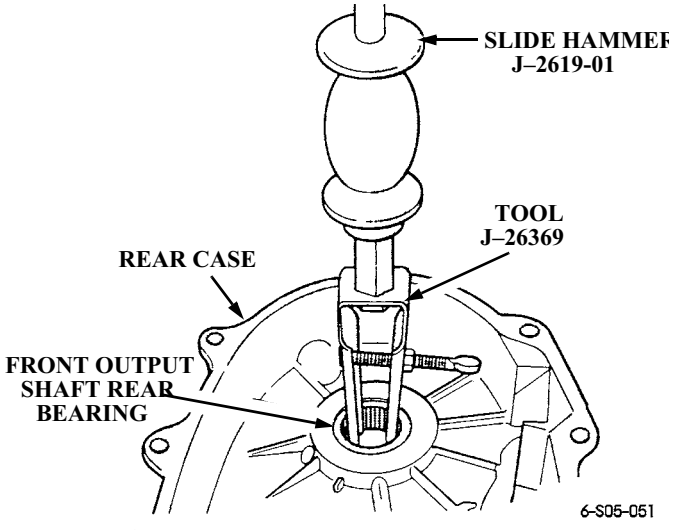


Figure 5-63: Front Output Shaft Rear Bearing Removal

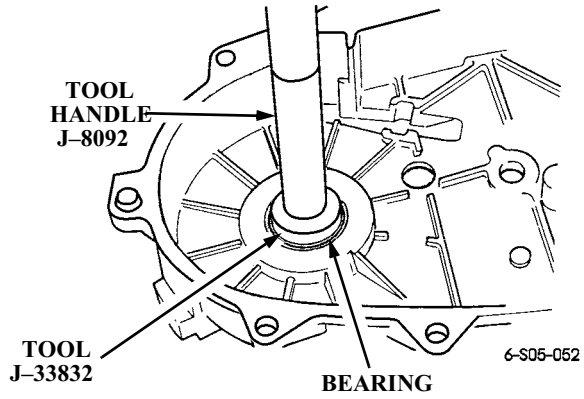


Figure 5-64: Front Output Shaft Rear Bearing Installation

INPUT GEAR BEARING REPLACEMENT

1. Remove the old bearing from the interior of the front case as shown. Use tool handle J–8092, and tool J–29170 (Figure 5-65).
2. Install the new bearing using tool handle J–8092, and tool J–29170 (Figure 5-66). Seat the bearing so the locating ring is firmly seated against the case.

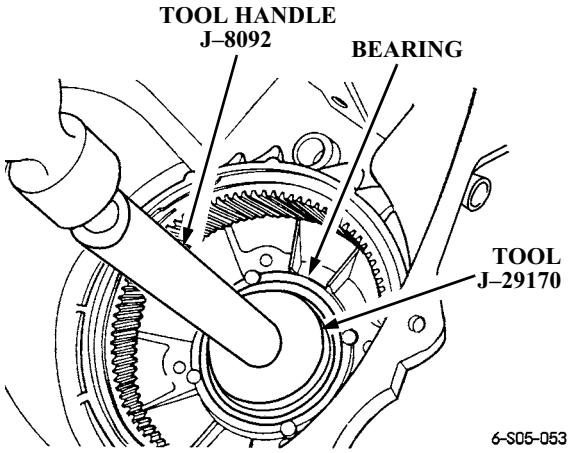


Figure 5-65: Input Gear Bearing Removal

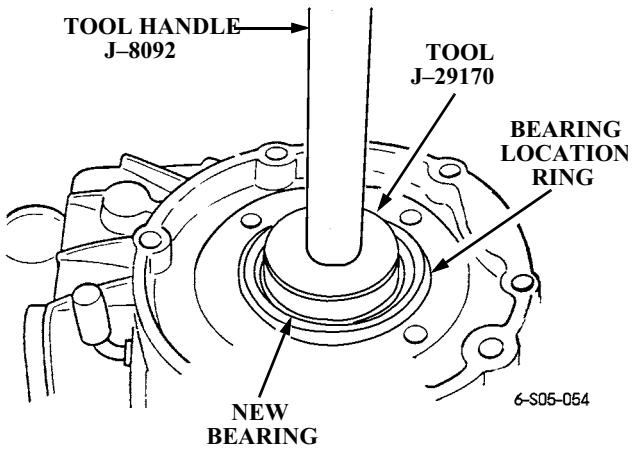


Figure 5-66: Input Gear Bearing Installation

MAINSHAFT PILOT BEARING REPLACEMENT

1. Remove the pilot bearing from the input gear with a slide hammer J–2619-01, and puller tool J–29369-1(Figure 5-67). Support the input gear on a vise, over a precut notch, or a hole in the workbench.
2. Install a new pilot bearing in the gear with tool handle J–8092, and tool J–33829 (Figure 5-68). Seat the bearing flush with the chamfer in the bearing bore.

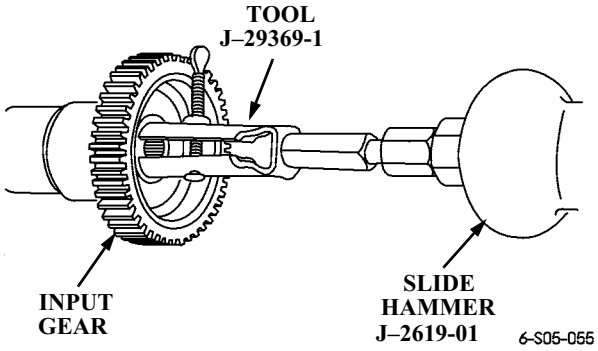


Figure 5-67: Removing Mainshaft Pilot Bearing From Input Gear

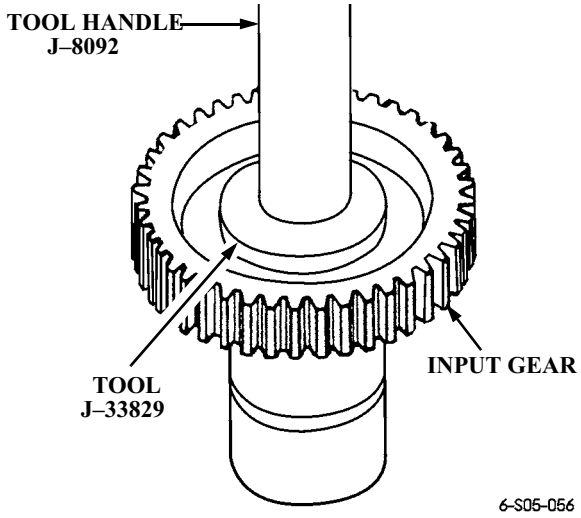


Figure 5-68: Installing Mainshaft Pilot Bearing In Input Gear

EXTENSION HOUSING BUSHING AND SEAL REPLACEMENT

1. Remove the old seal with a pry tool.
2. Drive out the old bushing with tool handle J–8092, and tool J–33839 (Figure 5-69).
3. Position the new bushing on the tool J–33839, and tap the bushing until flush with bushing bore.
4. Install the new seal in the housing with J–33843, or a suitable size installer tool (Figure 5-70).
5. Lubricate the seal lip with Dexron III or petroleum jelly.

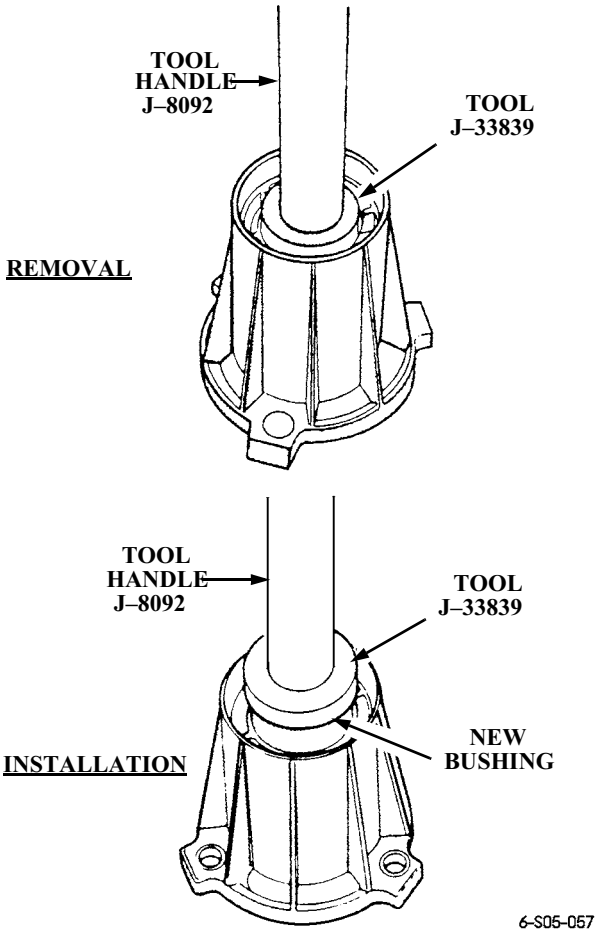


Figure 5-69: Extension Housing Bushing Replacement

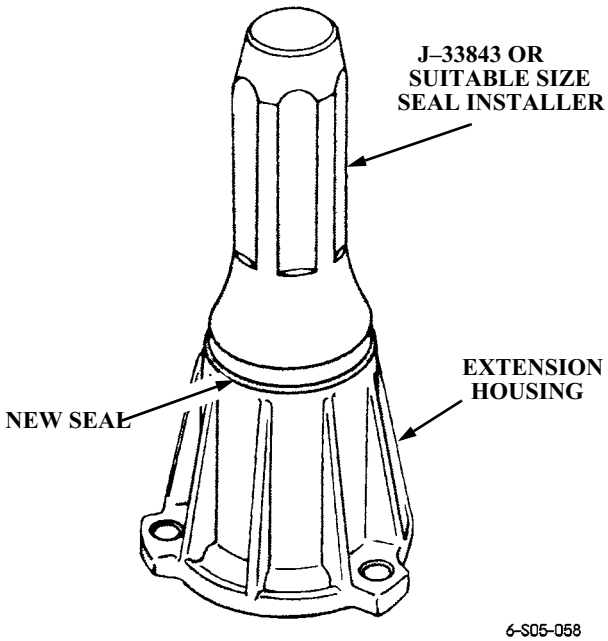


Figure 5-70: Extension Housing Seal Installation

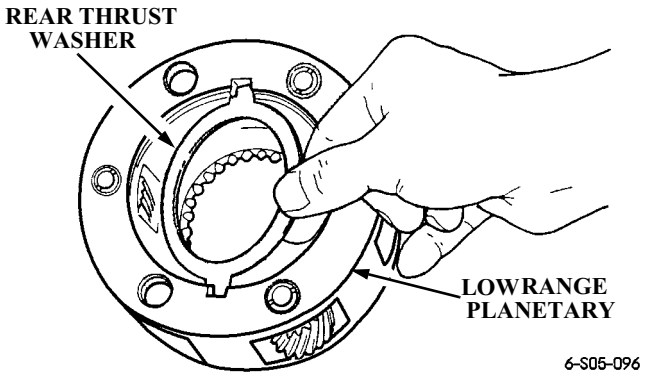


Figure 5-71: Rear Thrust Washer Installation

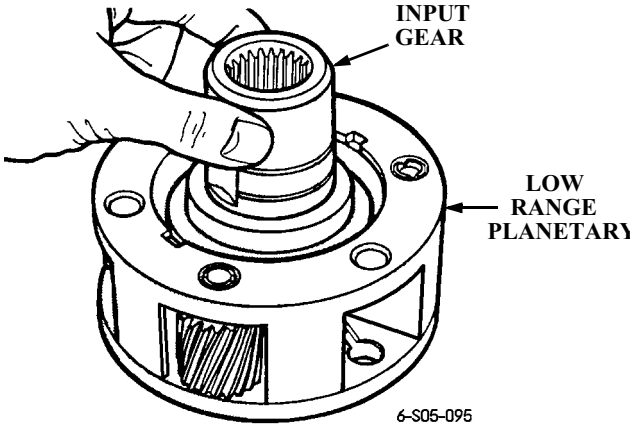


Figure 5-72: Input Gear Installation

TRANSFER CASE ASSEMBLY

1. Assemble the input gear and the low range planetary:
   a. Lubricate the gear, planetary and the thrust washers with Dexron III (Figure 5-71).
   b. Install the rear thrust washer in the planetary. Be sure the washer tabs are aligned in the planetary notches as shown (Figure 5-72)

NOTE: The thrust washers are the same size, and are interchangeable. Either washer can be used at the front or rear.

   c. Install the input gear in the planetary (Figure 5-73).
   d. Install the front thrust washer. Be sure the washer tabs are seated in planetary notches as shown (Figure 5-73).
   e. Install the lock ring (Figure 5-74) and the lock ring retainer (Figure 5-75).
2. Lubricate the shift sector shaft and install the sector in the case (Figure 5-76).
3. Install the input gear/planetary assembly in the front case (Figure 5-77). Use a wood hammer handle to tap the input gear shaft through the bearing.
4. Install the input gear snap ring (Figure 5-78).
5. Install the front retainer as follows:
   a. Install a new seal in the retainer with tool J–33831 (Figure 5-79).
   b. Apply a 3/16 in. (5 mm) bead of Loctite 518, Permatex Ultra Black, or Ultra Copper to seal the surface of the retainer.
   c. Align the oil feed slot in the retainer with the feed hole in the front case, and install the retainer (Figure 5-80).
   d. Install and tighten the retainer bolts to 12-18 lb-ft (16-24 N•m).

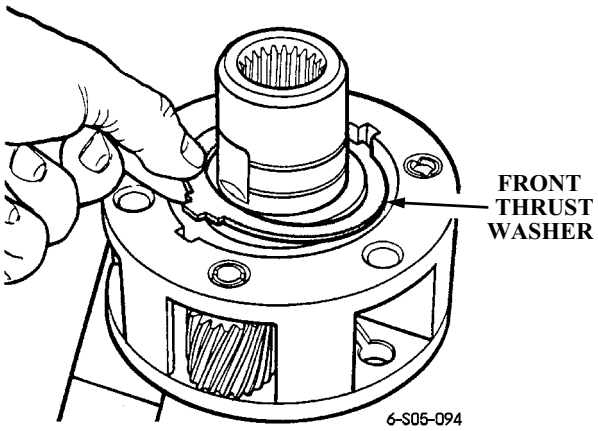


Figure 5-73: Front Thrust Washer Installation

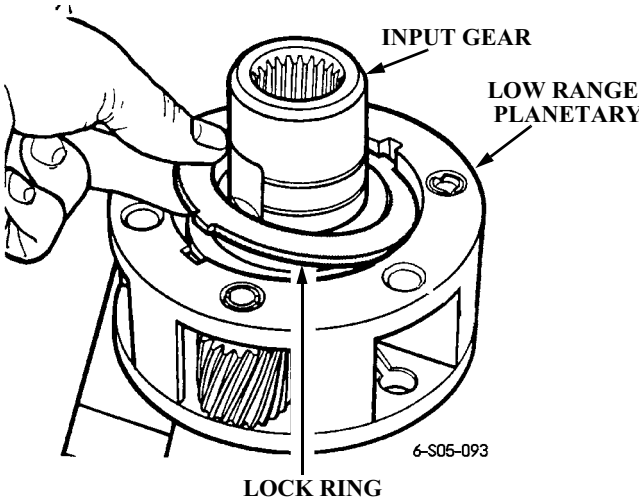


Figure 5-74: Lock Ring Installation

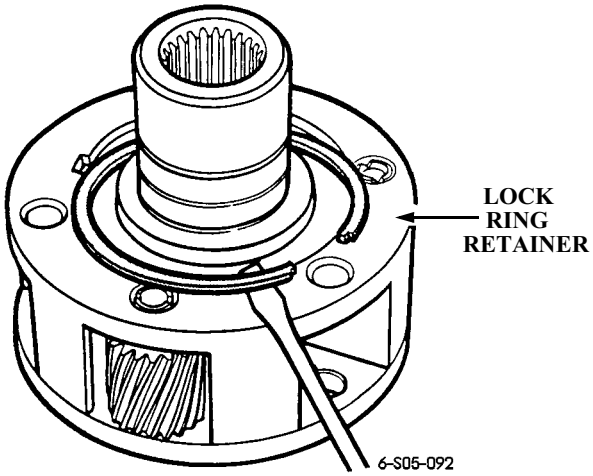


Figure 5-75: Input Gear Snap Ring Installation

6. Assemble the low range fork and hub. Replace the pads on the fork if worn or damaged (Figure 5-81).

7. Install the low range fork and hub. Be sure the hub is seated in the planetary and that the fork pin is seated in the shift sector lower slot (Figure 5-82).

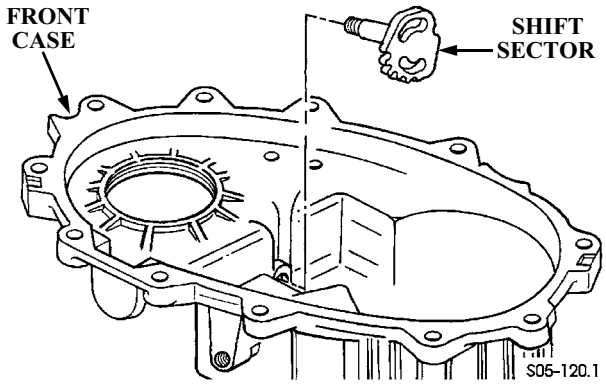


Figure 5-76: Shift Sector Installation

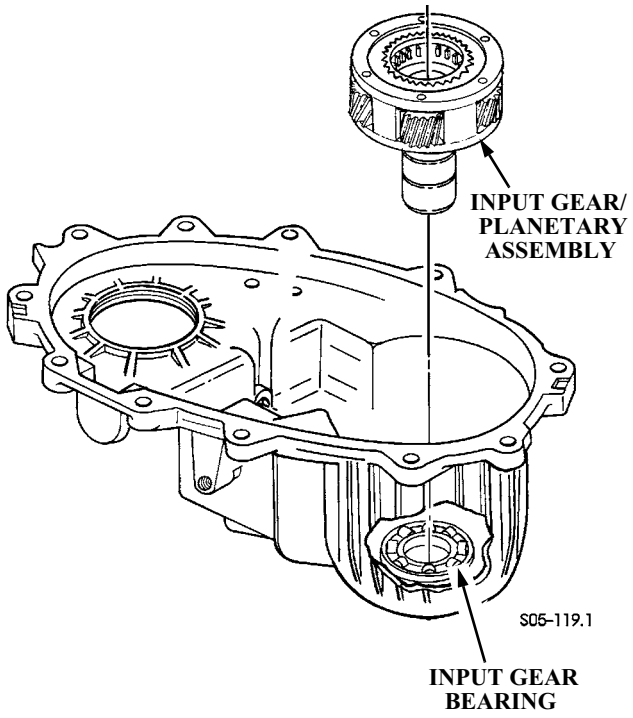


Figure 5-77: Input Gear/Low range Planetary Installation

8. Assemble the differential as follows:
   a. Lubricate the differential cases, gears and thrust washers with Dexron III.
   b. Install the mainshaft gear in the front case (Figure 5-83).
   c. Install the sprocket gear.
   d. Install a thrust washer on each of the front case pinion pins.
   e. Install the long and the short pinions in sets (Figure 5-84).
   f. Install the thrust washer at the top of each pinion.
   g. Align and install the rear case on the front case. Be sure the case alignment paint or scribe marks are matched as shown (Figure 5-85).
   h. Install and tighten the differential case bolts evenly.

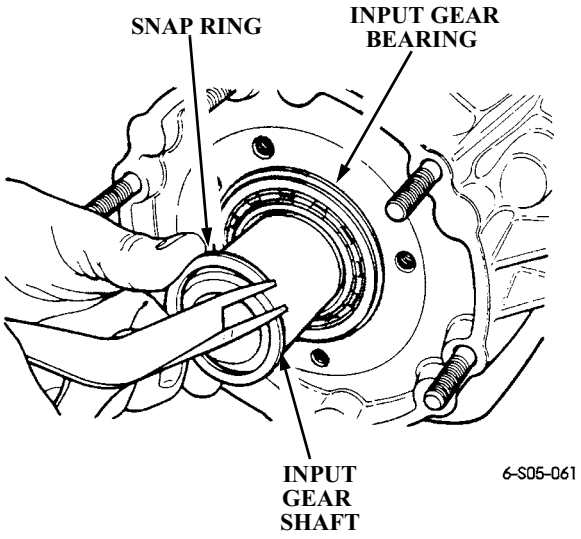


Figure 5-78: Input Gear Snap Ring Installation

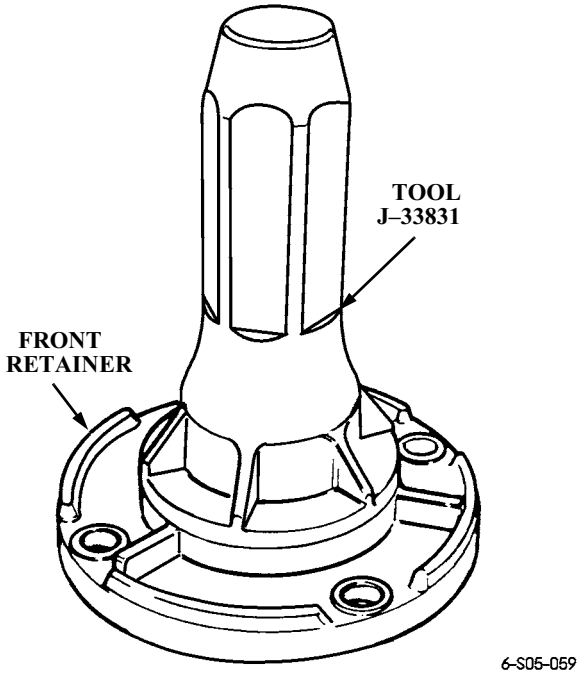


Figure 5-79: Front Retainer Seal Installation

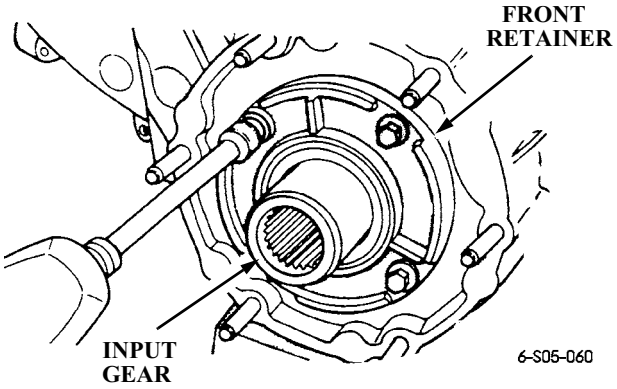


Figure 5-80: Front Retainer Installation

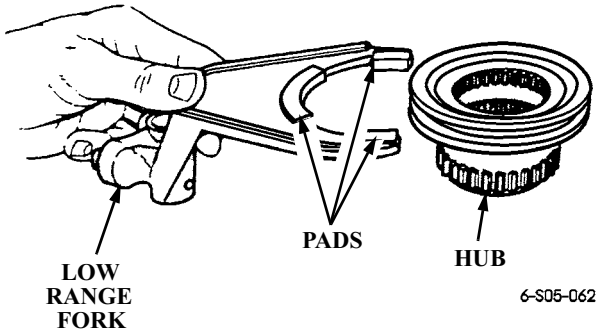


Figure 5-81: Assembling Low Range Fork and Hub

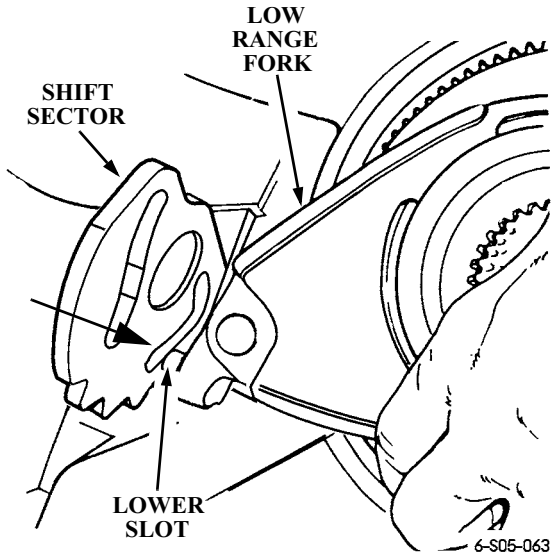


Figure 5-82: Engaging Low Range Fork Pin in Shift Sector

9. Check the condition of the tone wheel on the mainshaft. Replace the wheel if the teeth are chipped, cracked or broken.
10. Coat the needle bearing surface of the mainshaft with petroleum jelly. Then install the first spacer, 53 needle bearings and the remaining spacer. Use extra petroleum jelly to hold the needle bearings in place (Figure 5-86).
11. Install the differential on the mainshaft. Verify that the needle roller bearings were not displaced before proceeding (Figure 5-87).

12. Install the differential snap ring (Figure 5-88).
13. Install the intermediate clutch shaft. Be sure the shaft is fully seated (Figure 5-89).
14. Install the clutch shaft thrust ring and the snap ring (Figure 5-90).

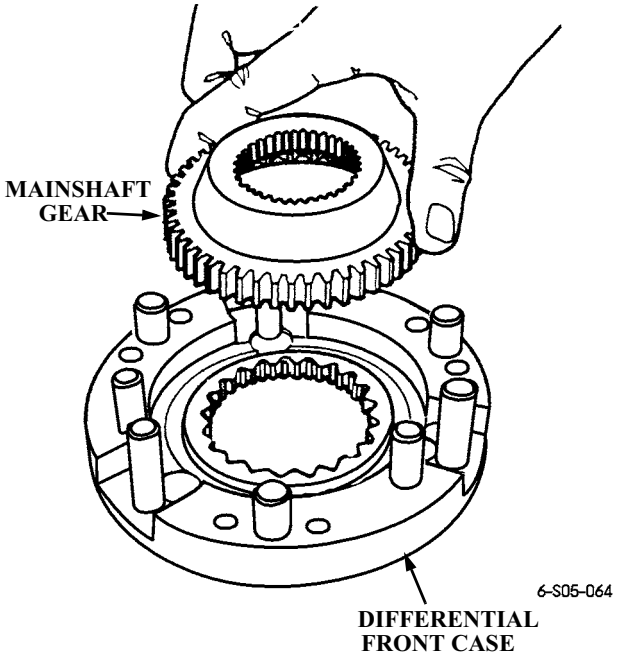


Figure 5-83: Installing Mainshaft Gear In Front Case

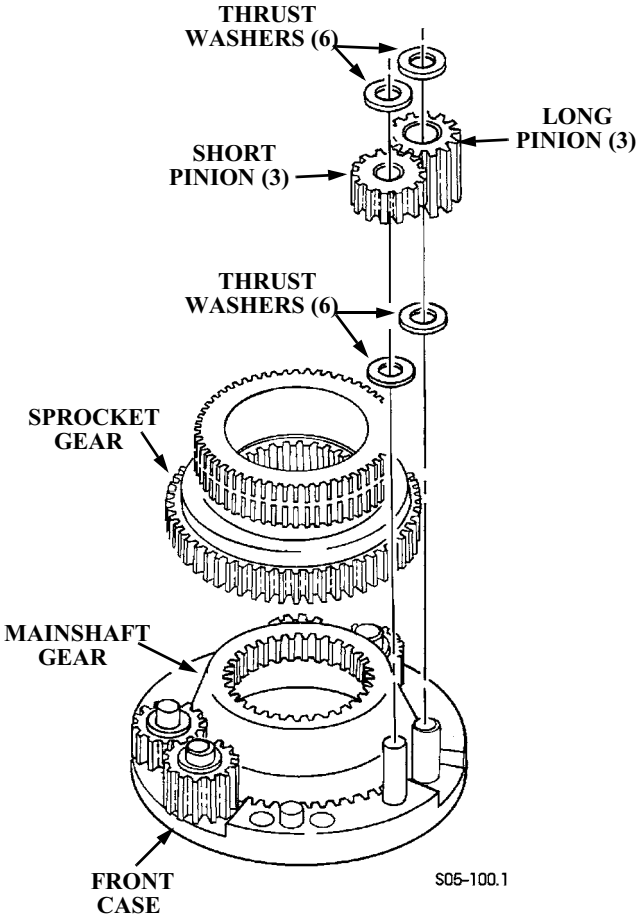


Figure 5-84: Differential Pinion and Sprocket Gear Installation

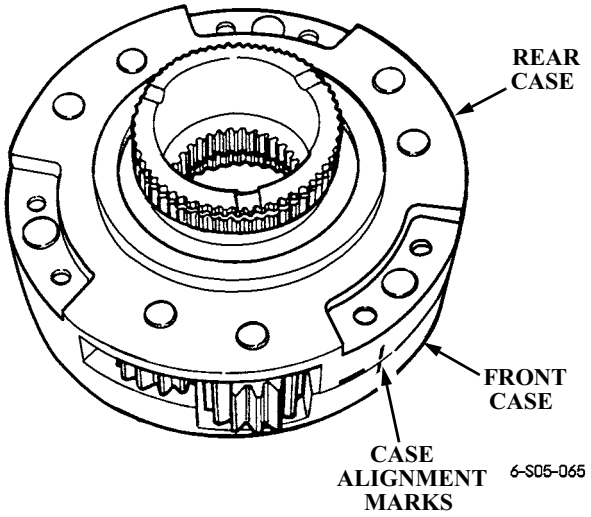


Figure 5-85: Assembling Differential Front/Rear Cases

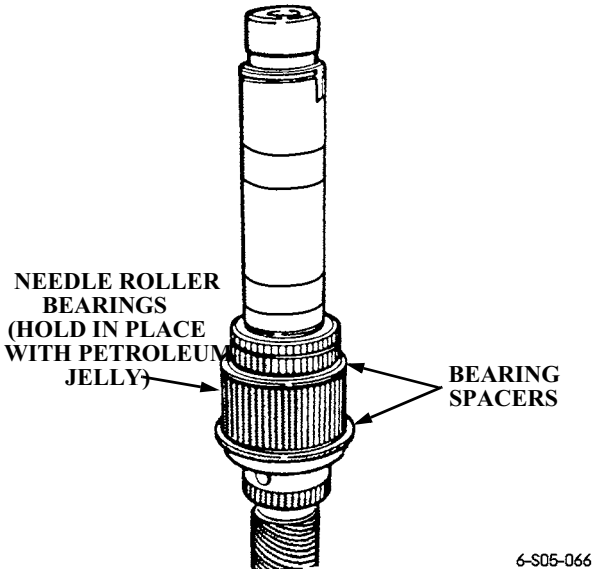


Figure 5-86: Mainshaft Bearing Roller Installation

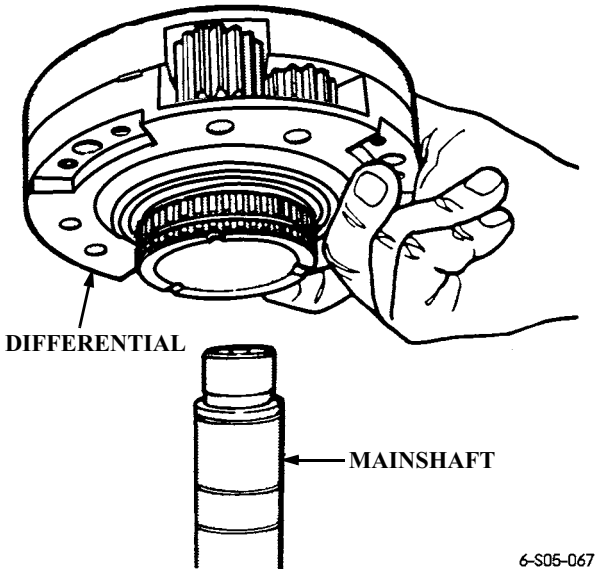


Figure 5-87: Installing Differential On Mainshaft

15. Install the mode sleeve in the mode fork. Replace the fork pads if worn or cracked. Do not reuse worn pads (Figure 5-91).
16. Install the assembled mode fork and the sleeve on the mainshaft. Then seat the sleeve in the differential (Figure 5-92).
17. Install the assembled mainshaft, differential, mode fork and sleeve. Be sure the mainshaft is seated in the input gear pilot bearing, and that the mode fork pin is seated in the upper slot of the shift sector as shown (Figure 5-95).

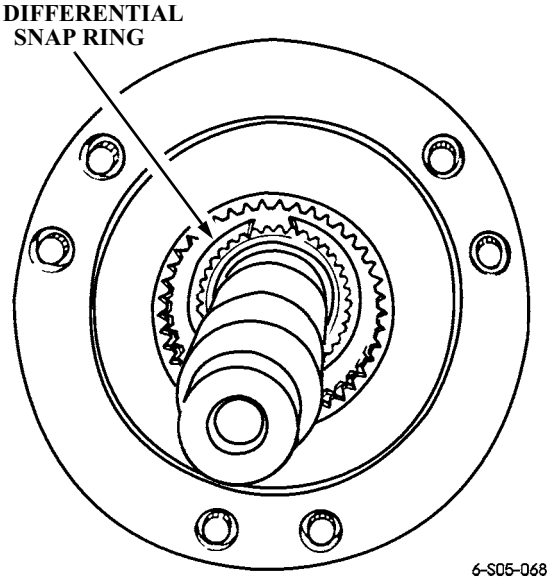


Figure 5-88: Differential Snap Ring Installation

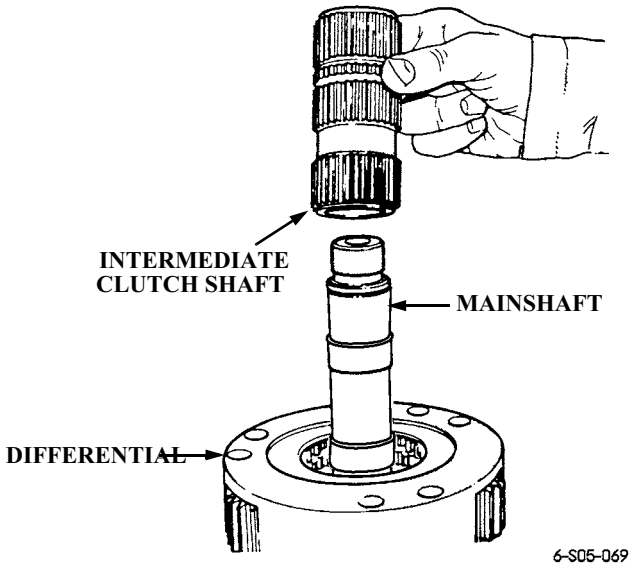


Figure 5-89: Intermediate Clutch Shaft Installation

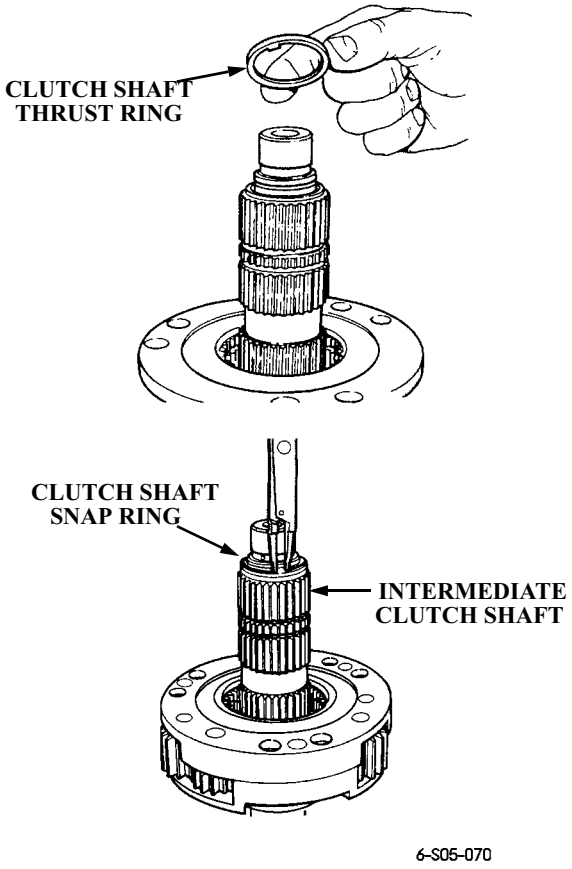


Figure 5-90: Intermediate Clutch Shaft Thrust Ring and Snap Ring Installation

18. Install the shift rail. Install the rail through the mode fork, range fork and into the case bore, and install the lock pin (Figure 5-96).

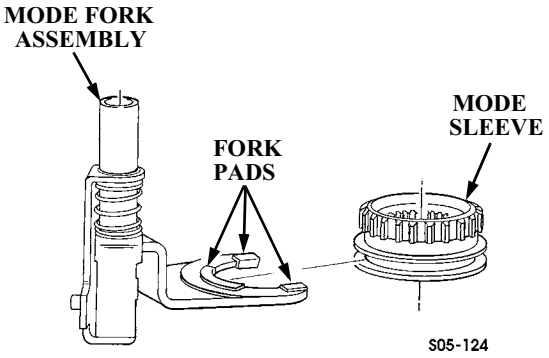


Figure 5-91: Installing Mode Sleeve in Mode Fork

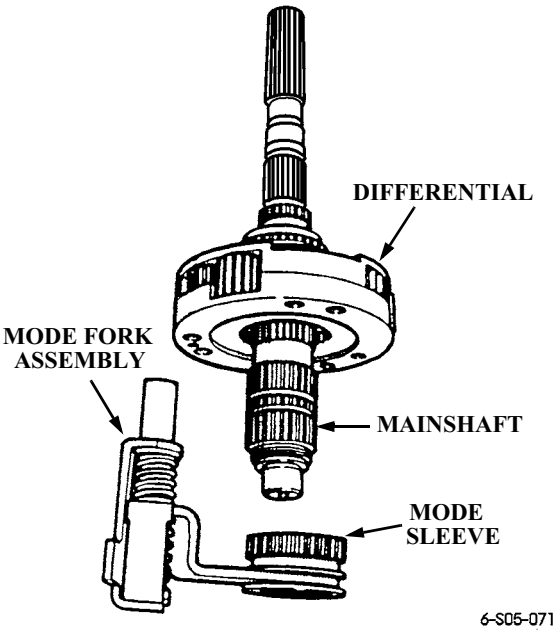


Figure 5-92: Mode Fork and Sleeve Installation

19. Install the detent plunger, spring and the plug. Replace the O-ring on the plug, and tighten the plug to 12-18 lb-ft (16-24 N•m)(Figure 5-97).
20. Install the range lever on the sector shaft, then secure the lever with the washer and the nut (Figure 5-97). Tighten the nut to 20-25 lb-ft (27-34 N•m).
21. Install the shift sector shaft O-ring, and the nylon bushing. Use a thin wall socket to seat the O-ring and the bushing.
22. Install the support bracket onto the oil cooler, then install the sealing washers. Set the oil cooler into the transfer case front half, and install the external hardware. Hand tighten only (Figure 5-93).
23. Align the upper support tab in the recess of the case, and ensure that the lower tab with the extra rivet installed rests on the recessed casting. The lower tab is designed to have the rivet compressed between the recessed casting area of the front and the rear transfer case halves when the halves are bolted together. Make sure that the tabs do not intrude into the machined mating surface area of the transfer case halves. Do not bend the cooler when moving into position, damage to the manifold area could occur from induced stress.While gently holding the cooler with a 3/4" wrench on the manifold, tighten the hardware to 15 lb-ft (Figure 5-94).

NOTE: If the cooler is tightened incorrectly, the tension placed on the cooler assembly could cause cracking, leaking and loss of transmission fluid into the transfer case assembly.

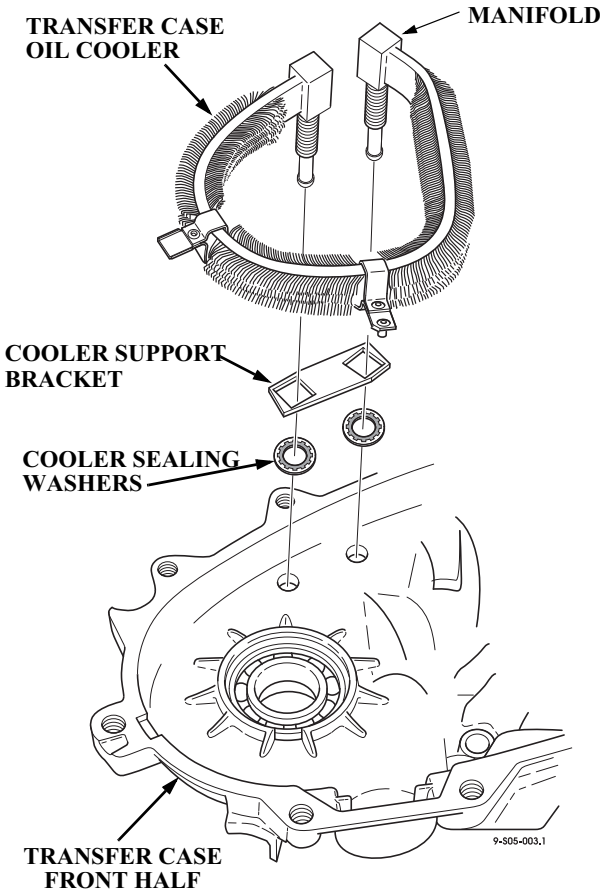


Figure 5-93: Transfer Case Cooler Support Bracket Installation

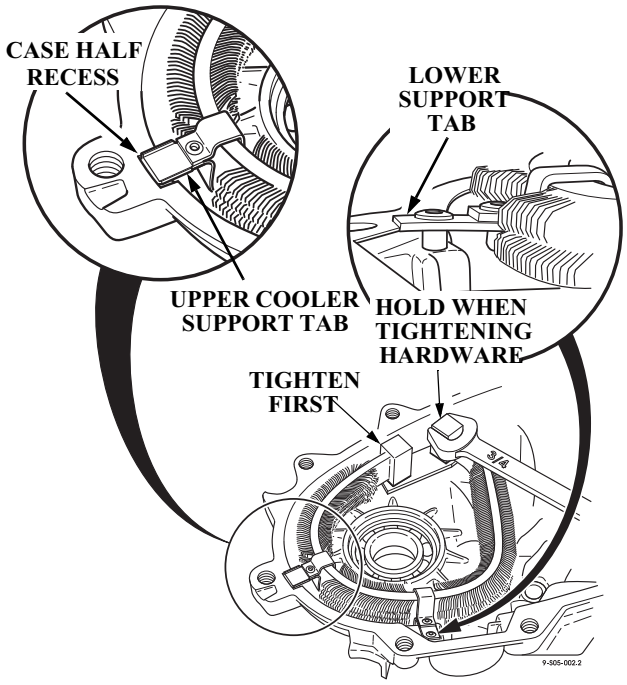


Figure 5-94: Transfer Case Cooler Support Tabs

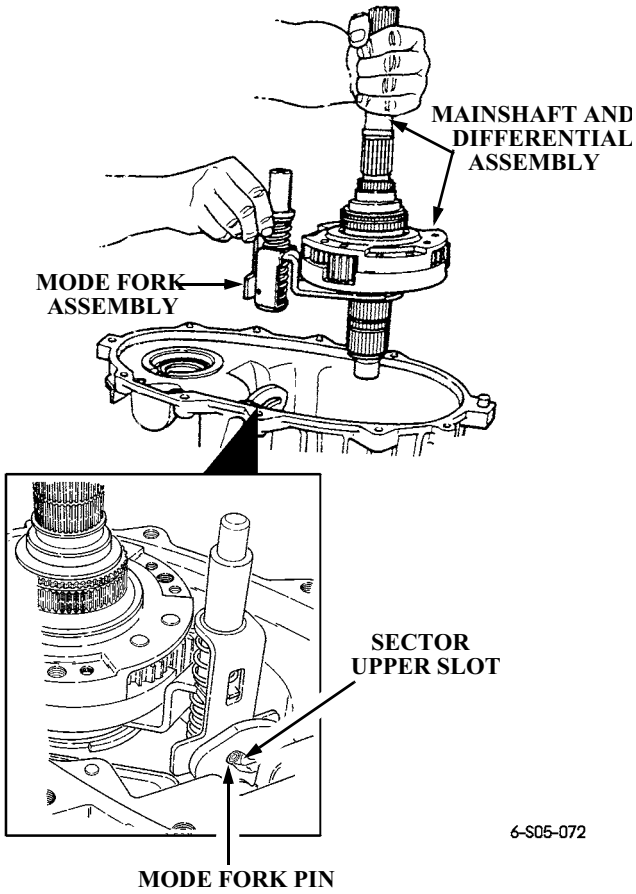


Figure 5-95: Mainshaft, Differential, and Mode Fork Installation

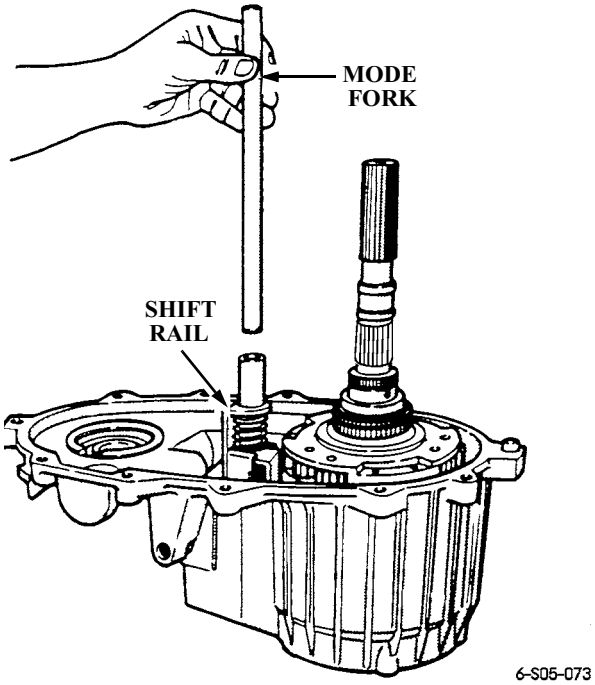


Figure 5-96: Shift Rail Installation

24. Assemble the driven sprocket and the front output shaft. Use a new snap ring if the old one is worn or distorted (Figure 5-98).

25. Install the front output shaft, and the driven sprocket. Then install the drive chain (Figure 5-99).
26. Install the drive sprocket. Slide the sprocket down onto the mainshaft. Engage the sprocket in the chain and work it onto the mainshaft splines (Figure 5-99).
27. Secure the drive sprocket to the mainshaft with a new snap ring. Be sure the snap ring is fully seated before proceeding (Figure 5-100).

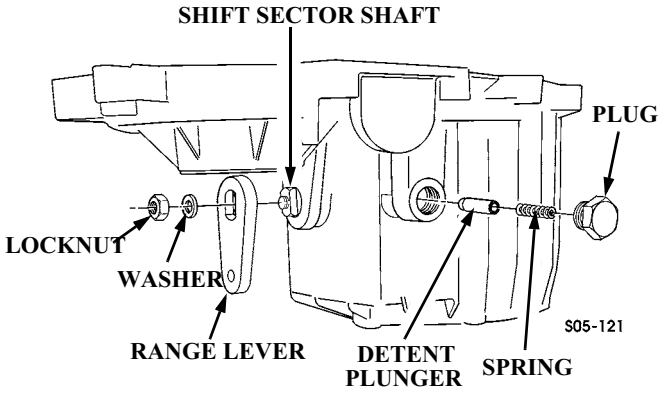


Figure 5-97: Range Cover and Shift Detent Installation

28. Install the new seal in the oil pump with tool J–33835 (Figure 5-101).
29. Install the new O-ring in the oil pump inlet port. Then assemble the pump, pickup tube, connector hose and the pickup screen (Figure 5-102).
30. Position the pump assembly in the rear case. Be sure the pickup screen is seated in the case notch as shown (Figure 5-103).

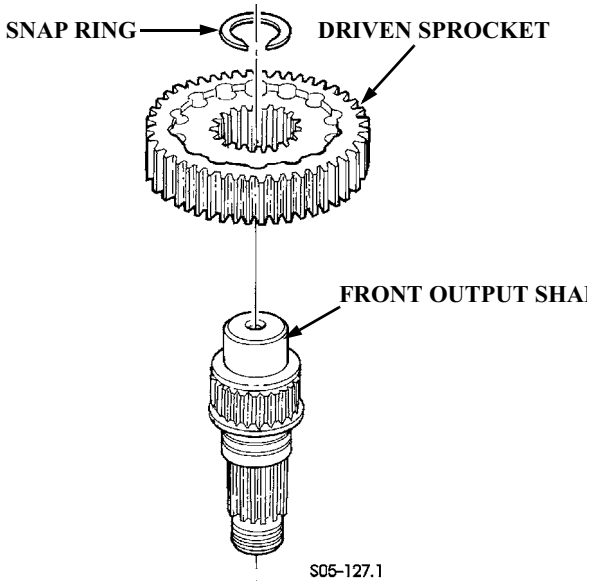


Figure 5-98: Front Output Shaft and Sprocket Assembly

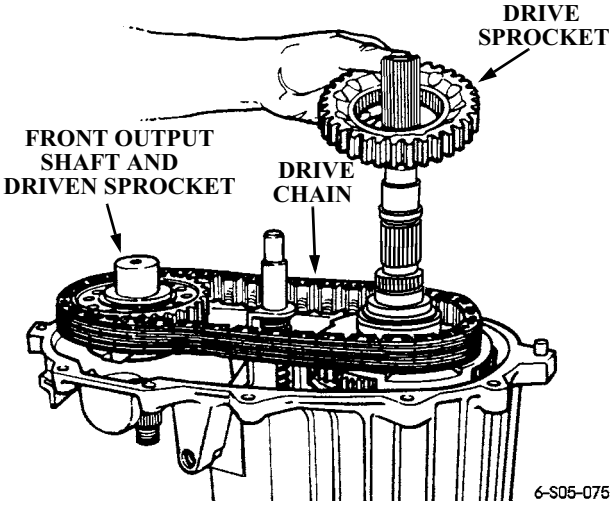


Figure 5-99: Drive Chain and Sprocket Installation

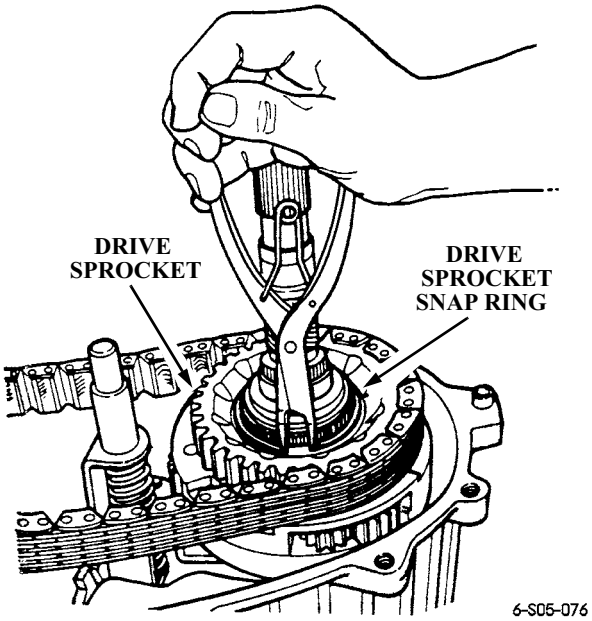


Figure 5-100: Securing Drive Sprocket to Mainshaft

31. Install the magnet in the front case pocket (Figure 5-104).
32. Apply 3/16 in. (5 mm) wide bead of Permatex Ultra Black to seal the flange of the front case. Be sure the sealer encircles each case bolt hole.
33. Align, and install the rear case on the front case (Figure 5-105). Be sure the alignment dowel is seated, and that the oil pump is properly engaged in the mainshaft splines. Also be sure the front output shaft is seated in rear bearing and the shift rail is seated in the rear case bore.
34. Install, and tighten the case bolts in diagonal pattern to 20-25 lb-ft (27-34 N•m).

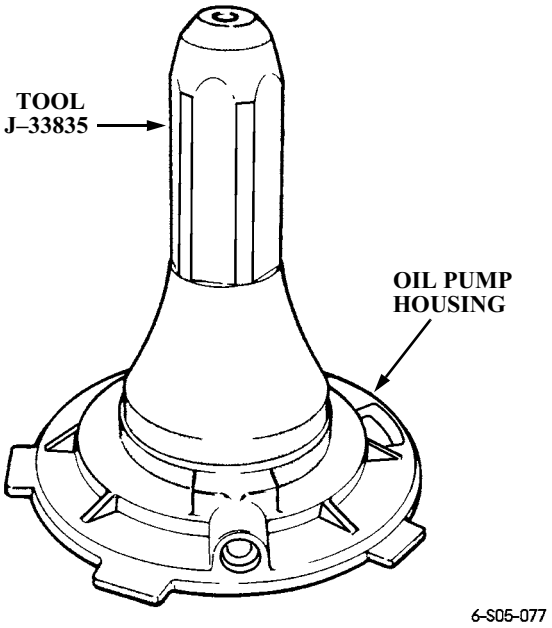


Figure 5-101: Oil Pump Seal Installation

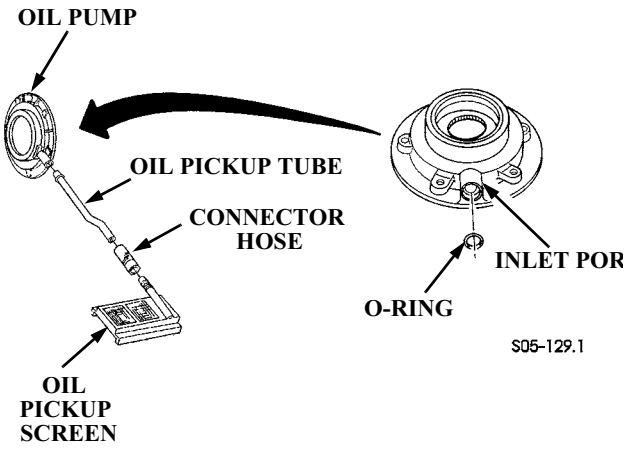


Figure 5-102: Oil Pump and Pickup Component Assembly

35. Install the speedometer tone wheel, and the snap rings (Figure 5-106).
36. Install the mainshaft bearing in the rear retainer (Figure 5-107). Use tool handle J–8092 and installer J–33832.

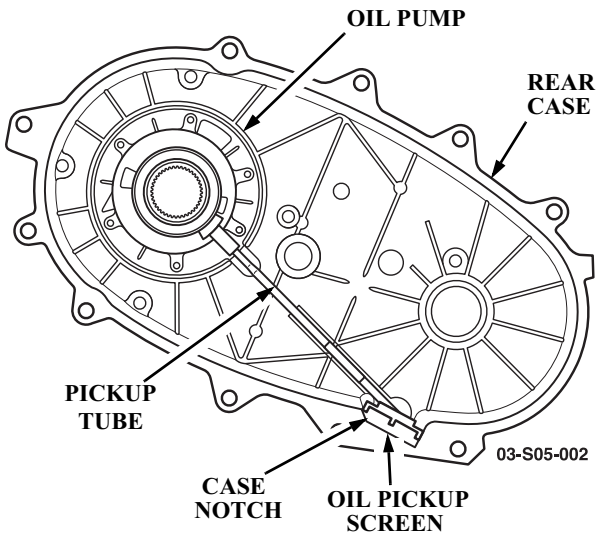


Figure 5-103: Oil Pump Assembly Installation

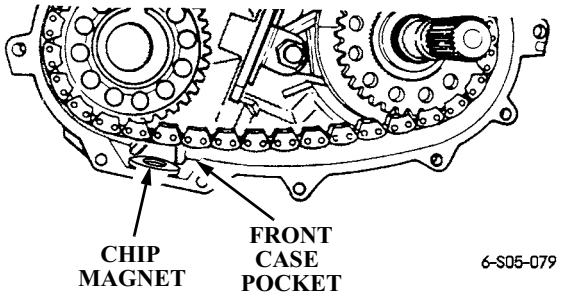


Figure 5-104: Chip Magnet Installation

37. Apply 3/16 in. (5 mm) wide bead of Loctite 518, Permatex Ultra Black or Ultra Copper to the flange surface of the rear retainer.
38. Align and install the rear retainer (Figure 5-108). Install and tighten the retainer bolts to 22-25 lb-ft (30-34 N•m).
39. Install the mainshaft bearing snap ring (Figure 5-108).
40. Apply 3/16 in. (5 mm) wide bead of Loctite 518, Permatex Ultra Black or Ultra Copper to the extension housing flange.
41. Align and install the extension housing on the rear retainer (Figure 5-109). Install and tighten the housing bolts to 20-25 lb-ft (27-34 N•m).
42. Check the seal contact surface of the front yoke. Smooth surface with 320-400 grit, use emery if necessary. Then lubricate the seal surface with Dexron III and install the yoke, new seal washer and a new yoke nut. Tighten the yoke nut to 130-200 lb-ft (176-271 N•m). Use yoke tool J–8614-01 to hold the yoke while tightening the nut (Figure 5-110).

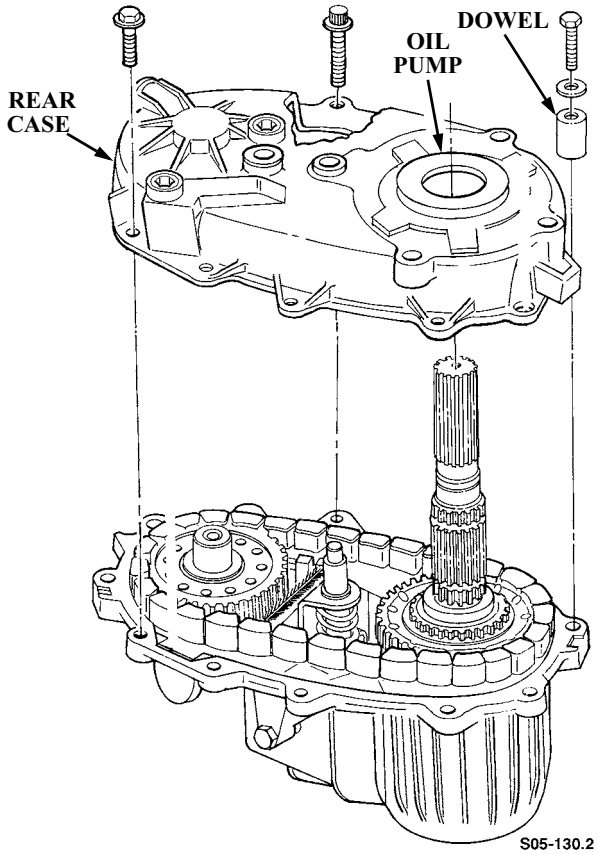


Figure 5-105: Rear Case Installation

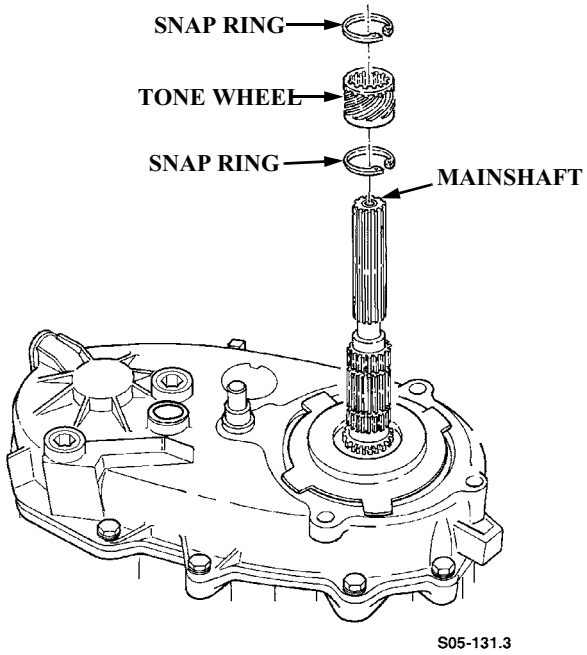


Figure 5-106: Tone Wheel Speedometer Installation

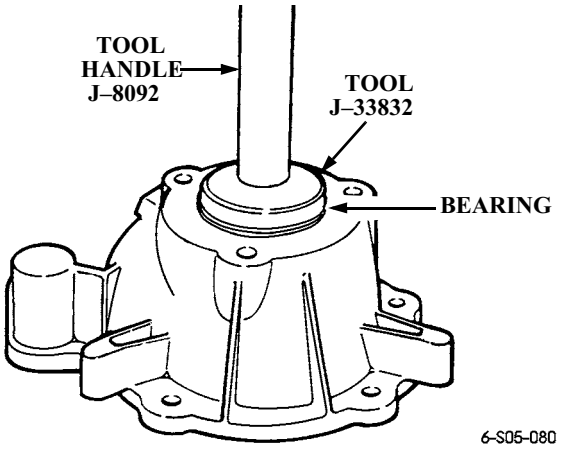


Figure 5-107: Installing Mainshaft Bearing In Rear Retainer

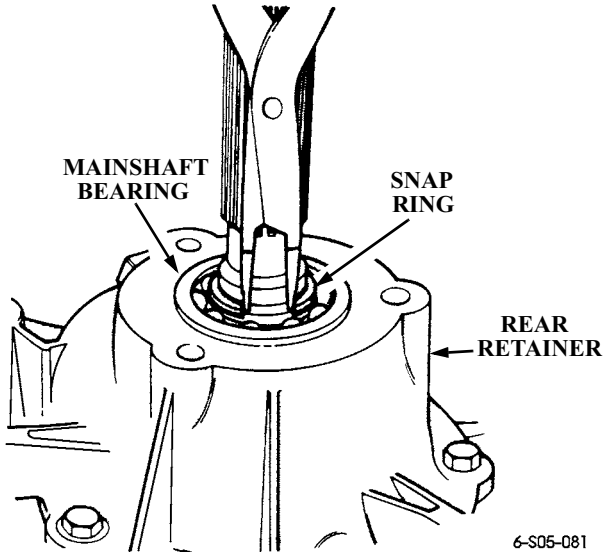


Figure 5-108: Rear Retainer and Mainshaft Bearing Snap Ring Installation

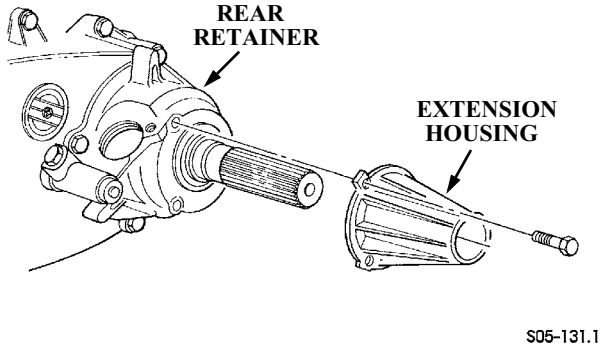


Figure 5-109: Extension Housing Installation

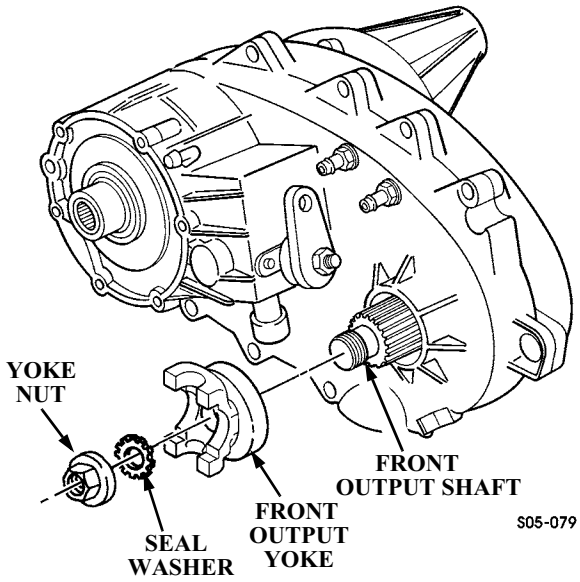


Figure 5-110: Front Yoke Installation

43. Install the drain plug in the rear case. Tighten the plug to 15-25 lb-ft (20-33 N•m).
44. Apply Loctite PST to the threads of the indicator switches and the speed sensor.
45. Install the indicator switches. Tighten the switches to 15-25 lb-ft (20-33 N•m).
46. Install the speed sensor. Tighten the sensor to 30-35 lb-ft (41-47 N•m).
47. The transfer case can be filled before or after installation in the vehicle. Tighten the fill plug to 15-25 lb-ft (20-33 N•m) after fill.

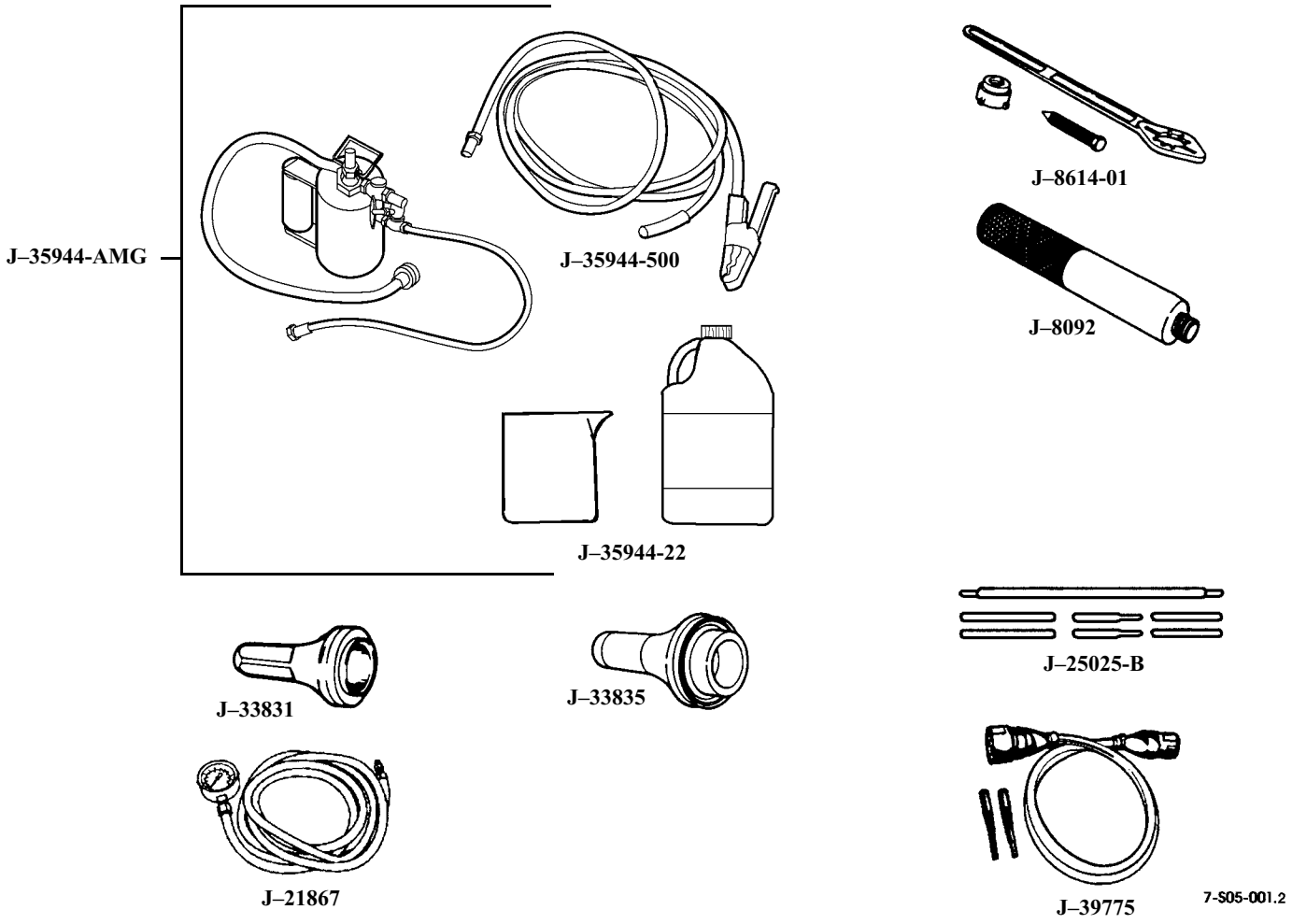
TRANSFER CASE TORQUE SPECIFICATIONS

Case bolts (all)	20-25 lb-ft (27-34 N•m)
Detent plug	12-18 lb-ft (16-24 N•m)
Drain/fill plugs	15-25 lb-ft (20-33 N•m)
Exhaust bracket nuts	18-22 lb-ft (24-30 N•m)
Extension housing bolts	20-25 lb-ft (27-34 N•m)
Front retainer bolts	12-18 lb-ft (16-24 N•m)
Front output shaft yoke nut	130-200 lb-ft (176-271 N•m)
Indicator switches (both)	15-25 lb-ft (20-34 N•m)
Oil cooler tube nuts	150-230 in.-lb (17-26 N•m)
Range lever nut	20-25 lb-ft (27-34 N•m)
Rear retainer bolts	22-25 lb-ft (30-34 N•m)
Speed sensor	30-35 lb-ft (41-47 N•m)
Transfer case mounting nuts	20-26 lb-ft (27-35 N•m)

TRANSMISSION TORQUE SPECIFICATIONS

Adapter-to-case nuts	35 lb-ft (47 N•m)
Converter bolts	44 lb-ft (60 N•m)
Converter housing cover bolts	89 lb-ft (10 N•m)
Manual shaft detent lever nut	21 lb-ft (29 N•m)
Oil pan bolts	20 lb-ft (27 N•m)
Pressure test port plug	108 lb-in (12 N•m)
Transmission-to-engine bolts/studs	37 lb-ft (50 N•M)
Valve body screws	108 lb-in (12 N•m)

ESSENTIAL TOOLS

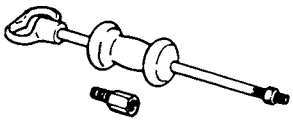


Tool No.	Description
J–35944-AMG	Transmission Oil Cooler Flush Kit
J–35944-500	Cooler Line Adapters
J–35944-22	Oil Cooler Flushing Fluid

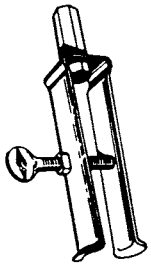
Tool No.	Description
J–8614-01	Yoke Holding Tool
J–8092	Universal Driver Handle
J–25025-B	Dial Indicator and Guide Pin Set
J–39775	Transmission Test Jumper Harness
J–21867	Pressure Gauge and Hose Assembly
J–33831	Input Seal Installer
J–33835	Pump Housing Seal Installer
J–38869	Output Shaft Seal Installer (not shown)
J–41623	Oil Cooler Release Tool (not shown)
J–42543	Selector Shaft Seal Remover/Installer (not shown)
J–42497	Extension Housing Seal Installer (not shown)
J–38694	Installer, Oil Pump to Converter Seal (not shown)
J–8614-5	Bolt Kit, Yoke Holding Tool (not shown)
J-41364-A	NSBU switch alignment tool

Procure from Kent-Moore.

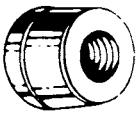
SPECIAL TOOLS



J–2619-01



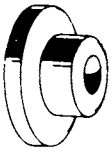
J–29369



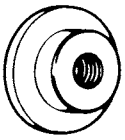
J–33839



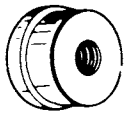
J–33829



J–33833



J–33832



J–29170

7-S01-009

Tool No.	Description
J–2619-01	Slide Hammer and Adapter
J–29369	Bushing/Bearing Remover Kit
J–33839	Rear Output Bushing Remover (use with J–8092)
J–33829	Pilot Bearing Installer (use with J–8092)
J–33833	Output Shaft Main Bearing Installer (use with J–8092)
J–33832	Front Output Shaft Rear Bearing Installer (use with J–8092)
J–29170	Input Gear Bearing Remover (use with J–8092)

Procure from Kent-Moore.

Section 6
Wheels and Tires/Central Tire Inflation System (CTIS)

TABLE OF CONTENTS

Central Tire Inflation System
- Air Intake Line and Assembly 6-62
- Air Leak Troubleshooting 6-43
- Air Pressure Gauge 6-50
- Air Pressure Gauge Lamp 6-51
- Air Pressure Indicator Lines 6-55
- Air Pressure Switch 6-54
- Compressor Fuse 6-56
- Compressor Relay 6-57
- Compressor Service 6-47
- Deflate Valve Assembly 6-57
- Description 6-40
- Dust Excluder Replacement 6-58
- Front CTI Line Replacement 6-60
- Front Supply Tube and Hose 6-59
- Instrument Cluster 6-48
- Interior Harness 6-53
- Low Pressure Alarm 6-52
- Quick-Disconnect Valve and Tube 6-63
- Rear CTI Line Replacement 6-61
- Spindle Extension and Seal 6-65
- Supply Line 6-59
- Troubleshooting 6-41
- Tube Shield Replacement 6-63

Indicator Lights
- Compressor/Low Pressure 6-50

Runflat
- Compressor Belt Replacement 6-16

Steering Stop Adjustment 6-39

Wheels and Tires
- Balancing 6-23
- Checking Wheel Alignment 6-32
- Essential Tools 6-67
- One-Piece Aluminum Wheel and Two-Piece Runflat Service 6-17
- Special Tools 6-68
- Tire, Two-Piece Aluminum Wheel, and Runflat Replacement 6-4
- Troubleshooting a Non-Balancing Wheel and Tire Assembly 6-26
- Wheel Alignment 6-29
- Wheel Alignment Correction 6-34
- Wheel and Tire Assembly Replacement 6-2
- Wheel End Vibration Correction Using Road Force Values 6-26
- Wheel Half Stud Replacement 6-14
- Wheel End Vibration Correction Using Road Force Values 6-26
- Wheel Half Stud Replacement 6-14

JACKING AND WHEEL REPLACEMENT

WARNING: Always take the wheel to an authorized service center for proper servicing. Use 17 inch diameter tires only. Mismatching tire and rim diameters is dangerous. A mismatched tire and rim assembly may explode and can result in serious injury or death.

WARNING: Put transmission into the PARK position, apply parking brake, and chock opposite wheel before removing wheel. Avoid removing any wheel when vehicle is on sloping terrain. Personal injury or damage to equipment may result. Remove only the inner group of lug nuts when removing a wheel from the vehicle. Removing the outer nuts which hold the rim together while the assembly is inflated could result in serious injury or death.

WARNING: Never mix tires of different size or tread design. Never mix bias and radial construction tires. Mixing tire types will adversely affect road handling and can lead to loss of vehicle control, and could result in serious injury or death.

NOTE: Always depress both CTIS quick-disconnect valve tabs on each axle set to prevent air loss from the other tire.

Removal

1. Remove the lug cover.
2. Remove the tube and quick-disconnect valve from spindle.
3. Loosen, but do not remove, the lug nuts (Figure 6-1).

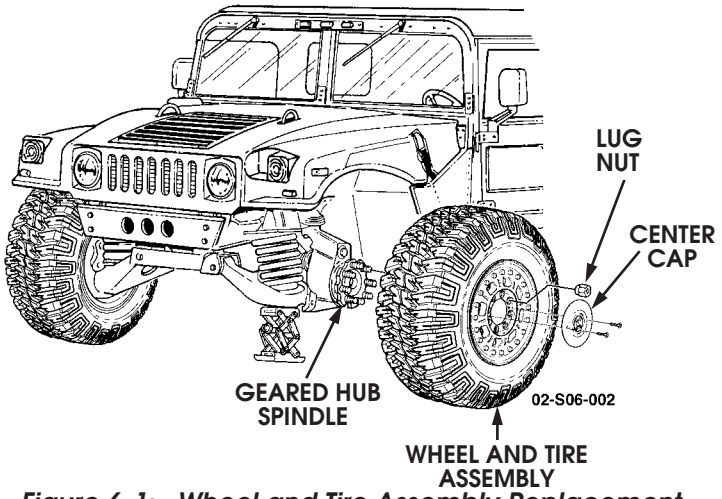


Figure 6-1: Wheel and Tire Assembly Replacement

4. Position the jack under the lower control arm at the tire and wheel assembly to be replaced. The alignment post on the top of the jack should be placed directly below the receiving hole in the lower control arm (Figure 6-2).
5. Using the ratchet, turn the jack handle clockwise to raise the vehicle. Ensure the “UP” side of the is facing you.
6. Remove the lug nuts and the wheel from the geared hub spindle.

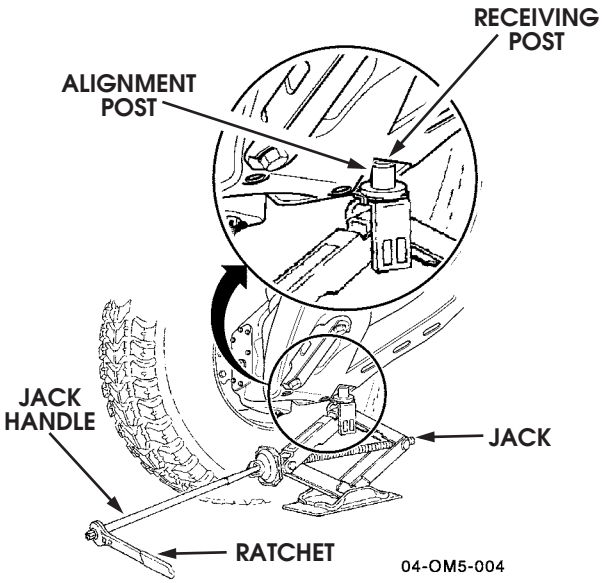


Figure 6-2: Jack Position

Installation

NOTE: The Wrangler GS-A, 37 X 12.50R17 LT touring radial tire has an asymmetrical/directional tread design. The heavier, stiffer tread goes on the outside shoulder of the tire, and must face outward when being installed. Before installing on a wheel, inspect the sidewall of the tire and ensure SIDE FACING OUTWARDS imprint is facing outward (Figure 6-3).

NOTE: Install the lug nuts with fingers to full engagement. If the nuts resist finger tightening examine the studs and the nuts for damage and replace if damaged.

1. Position the wheel on the geared hub spindle according to the marks on the mounting studs and attach with lug nuts (Figure 6-1).

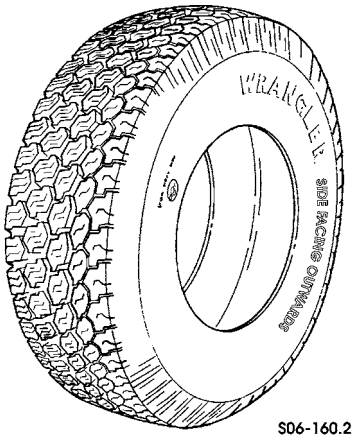


Figure 6-3: Side Facing Outwards Location

1. Remove the support and lower the corner of the vehicle.
2. One and two-piece aluminum wheel lug nut torque is 110 lb-ft (149 N•m). Use tightening sequence as shown in (Figure 6-4).

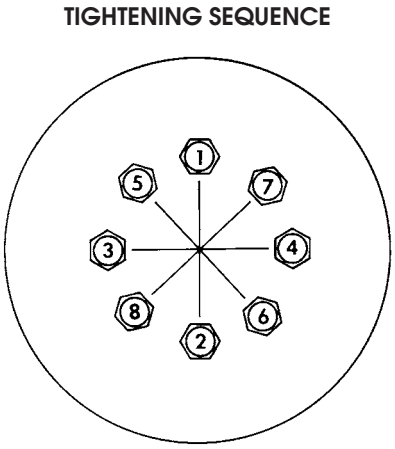


Figure 6-4: Lug Nut Tightening Sequence

CAUTION: *Do not allow pipe thread sealant into air system. Sealant will damage CTIS components and inhibit the CTIS operation.*

3. Install the CTIS quick-connect valve and tube on the spindle.
4. Install the lug cover.

TIRE, TWO-PIECE ALUMINUM WHEEL AND RUN FLAT REPLACEMENT

WARNING: Do not use tire machine. Personal injury or damage to equipment may result.

Removal and Disassembly

1. Remove the lug cover.
2. Release the quick disconnect fitting located in the center of the geared hub spindle on both wheels of the same axle.
3. Remove the brass fitting from the center of the geared hub spindle on the wheel(s) to be worked on.

WARNING: In all disassembly operations, ensure tire is totally deflated before removing wheel half locknuts. Failure to follow proper safety precautions could cause serious injury or death.

4. Remove the wheel/tire assembly from the vehicle.
5. Inspect the vehicle geared hub spindle studs for bending, looseness, or stripped threads. Replace if damaged.
6. Inspect the lug nuts for fatigue, stripped threads, or other damage. Replace if damaged.
7. Use tire chalk to mark the valve location on the sidewall of the tire.
8. Remove the valve cap and core from the air valve and deflate the tire.
9. Run a piece of wire through the air valve to ensure it is not plugged (Figure 6-5).

WARNING: Do not use unauthorized tools. Damage to equipment or serious injury may result.

10. When the tire is fully deflated, use a circular pattern and loosen the twenty wheel half locknuts securing the rim halves together. If you hear air escaping, DO NOT proceed. Wait until the sound stops and recheck the core housing for obstructions. When you are certain the tire is fully deflated, continue to remove the wheel half locknuts. Examine the locknuts for damage and replace if necessary.

WARNING: Never inflate a two-piece wheel assembly with the wheel locknuts removed in an attempt to separate inner and outer rim halves. The assembly will separate under pressure resulting in serious injury or death.

11. Install the four wheel separation bolts (J–45760) through the threaded holes in the inner wheel half (Figure 6-6). Using an air ratchet (NOT AN IMPACT WRENCH), turn each bolt in approximately a half inch at a time until the outer wheel half is released from the tire bead.

12. Remove the outer rim half and the four separation bolts.

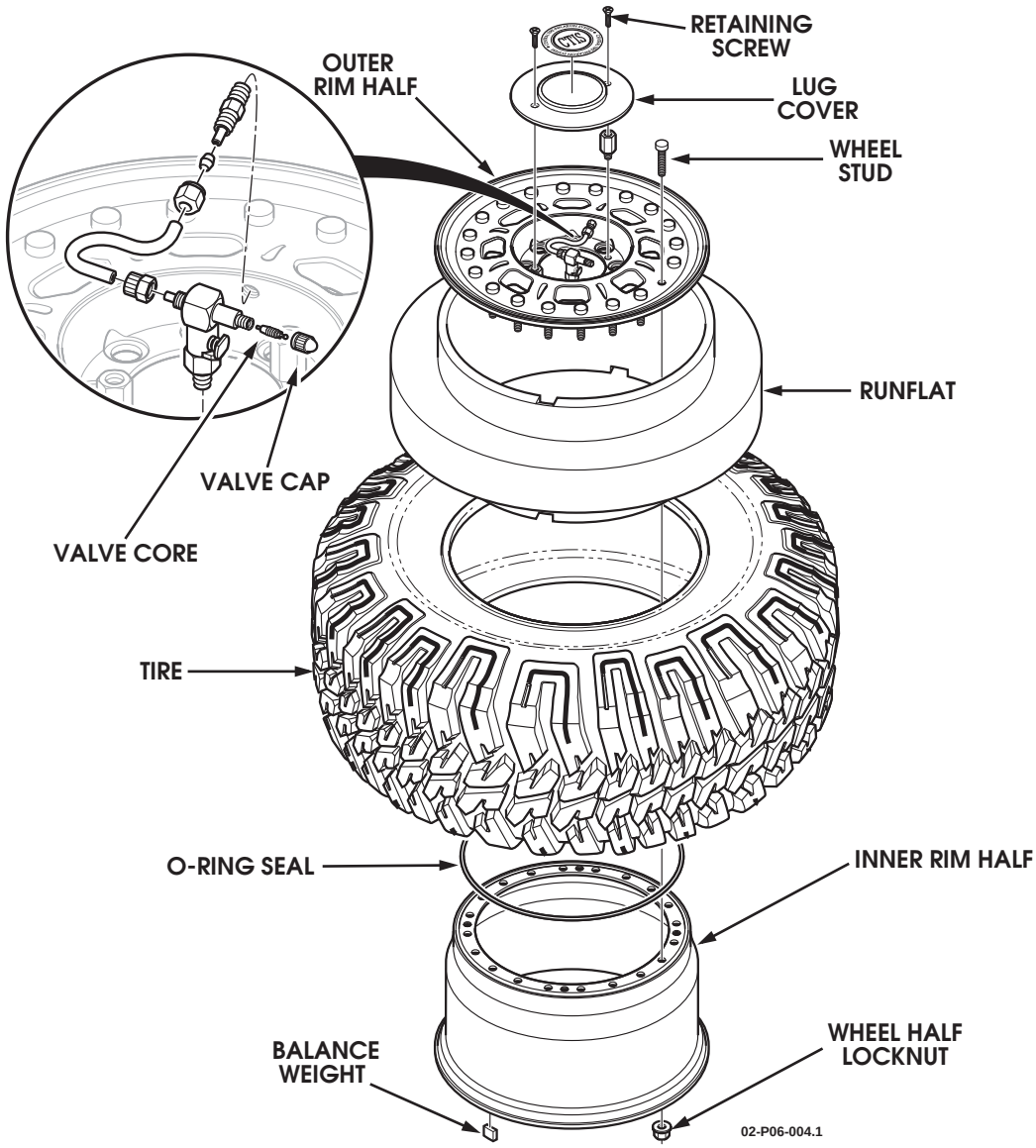


Figure 6-5: Two-Piece Aluminum Wheel Breakdown

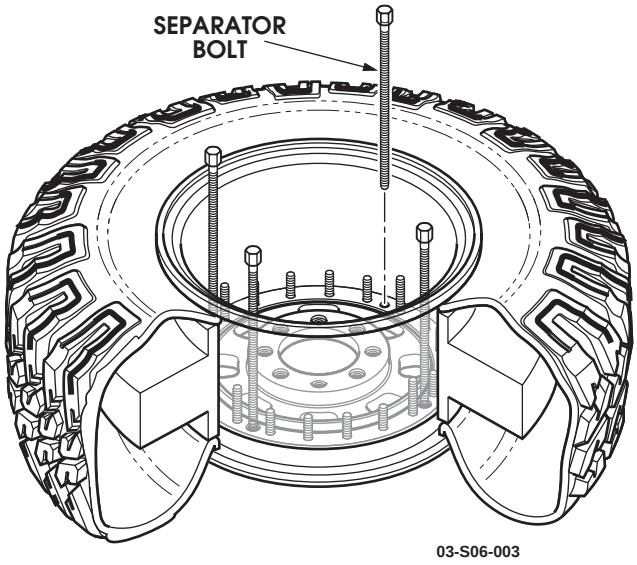


Figure 6-6: Wheel Separation Bolts

13. Remove the o-ring seal from the inner rim half. Discard the o-ring seal.
14. Assemble the inner bead separator tool (J–45770) by placing the half with the welded center shaft against the o-ring surface of the inner wheel half and secure with the two bolts and washers provided (Figure 6-7). Place the other half of the tool on the inner tire bead surface and install the large press bolt through to the threaded hole in the shaft.

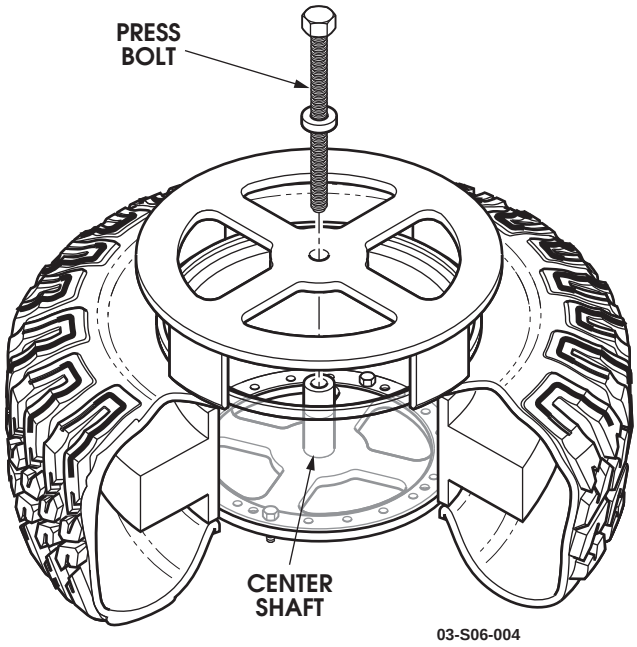


Figure 6-7: Inner Half Bead Separator

15. Rotate the press bolt until the tire bead is released from the inner wheel half. Remove the tool and the inner wheel half from the tire/runflat assembly.

WARNING: Balance weights contain lead. Wash hands after handling.

16. Remove the balance weights from the rim halves. Discard the balance weights.
17. Lay the tire flat.

WARNING: To avoid injury, ensure run flat compressor strap is centered around run flat.

18. Position the run flat compressor on an outer edge of the run flat with the handle assembly facing up and the strap centered around the run flat(Figure 6-8).

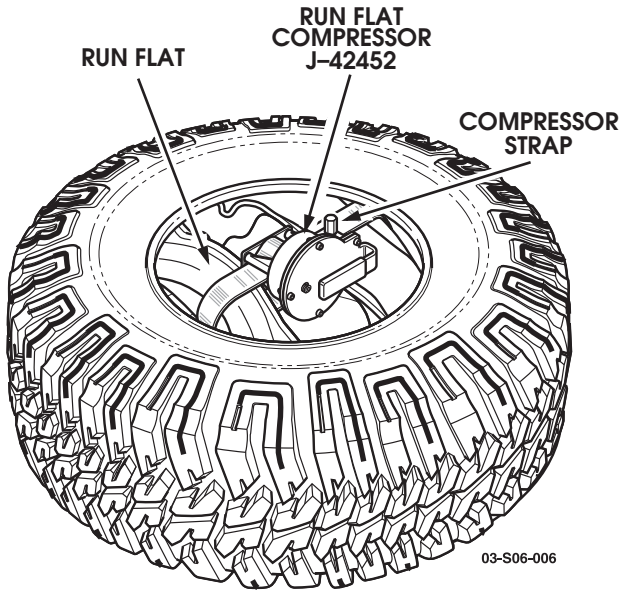


Figure 6-8: Run Flat Compressor Operation

NOTE: Compress the run flat by rotating the 3/4 nut in a clockwise direction. Rotate the 3/4 nut counterclockwise to loosen.

19. Using a run flat compressor, compress the run flat.

NOTE: It may be necessary to use a tire spoon and tire lube to remove the run flat from the tire.

20. Remove the run flat from the tire and remove the run flat compressor from the run flat(Figure 6-9).

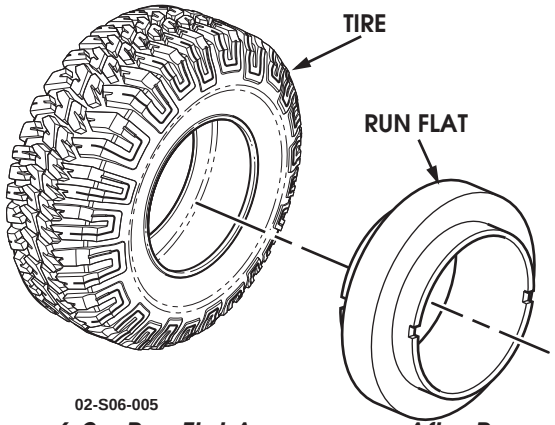


Figure 6-9: Run Flat Appearance After Removal

Inspection and Cleaning

CAUTION: *Do not reuse a tire which has been run flat without thoroughly inspecting for damage. Failure to follow these instructions may result in damage to equipment.*

1. Remove any existing lubricant that has been previously applied to the inside of the tire using a mild detergent soap and water.
2. Dry all wheel and tire parts. Ensure inside of tire is free of any run flat lubricant, dirt, debris, rust, or moisture.

WARNING: Thorough tire inspection is critical. Continued use of worn or damaged tires could result in equipment damage, serious injury or death.

3. Inspect the inside of the tire for cord or belt separation and inner liner damage. Replace the tire if damaged.
4. Inspect the tire bead for abrasions. Replace the tire if damaged.
5. Check for protruding objects inside the tire which may not be visible from outside. If the tire is punctured yet repairable, repair with internal or external tire repair kit.
6. Check tread depth on the tire. Tread should not be worn below the level of wear bars(Figure 6-10). Markings on the sides of the tires (e.g., the letters “TWI” or a triangle) show the location of the wear bars. Replace the tire if tread is worn below wear bars or 3/32 inch (2.38 mm).
7. Inspect the run flat for splitting, cracking, wear, or excessive chafing. Damaged run flat performance will be non-existent or greatly reduced. Replace the run flat if damaged (Figure 6-9).
8. Inspect the outside of the tire for sidewall damage. Replace the tire if damaged.
9. Inspect the tread for puncture damage. If damage is too extensive for patch repair, replace the tire.

WARNING: O-ring sealing surfaces must be kept clean and free from rust and dirt. Failure to do so could cause the wheel assembly to separate under pressure causing serious injury or death.

10. Using a wire brush, clean the wheel attaching studs. Clean all dirt and foreign material from the rim halves with soap and water and allow to air dry. Ensure the O-ring sealing surfaces on the rim halves are smooth and clean (Figure 6-5).
11. Inspect the rim halves for cracks, bent sealing surfaces, or oversized mounting holes. Replace the rim halves if cracked, bent, or if mounting holes are reamed.

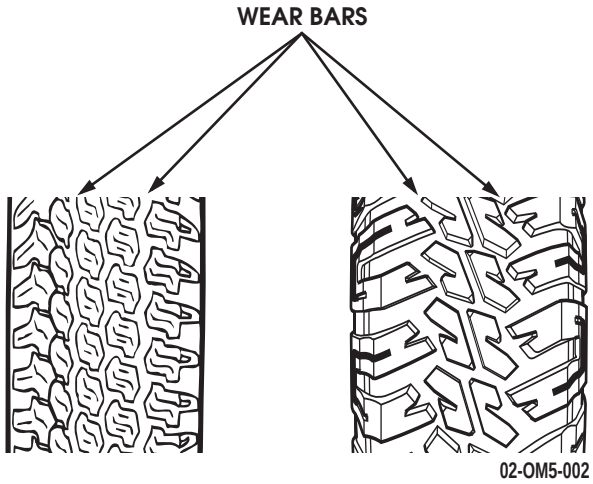


Figure 6-10: Wear Bar Identification

WARNING: Never use wheel assemblies with wheel half studs that are damaged, loose, or have stripped threads. Damaged studs can cause improper assembly which could cause individual fasteners to fail. Any of these situations could cause serious injury or death.

NOTE: When replacing a damaged wheel half stud, also replace the two adjacent studs.

12. Inspect the outer rim half for cracked, broken, corroded, pitted, bent, loose, or stripped studs. **Replace damaged studs along with the two adjacent studs**. Failure to do so may result in equipment damage, personal injury or death.
13. Inspect the valve core for cracks or deterioration. Replace the valve core if damaged (Figure 6-5).
14. Inspect the core housing for cracks or deterioration. Replace if damaged.

Repair

1. If the studs are damaged, drive the studs out of the outer rim half. Discard the studs (Figure 6-11).
2. Align the stud with the splines in the outer rim and pull the stud into the outer rim using a 1/2-20 nut, a washer and a larger nut as a spacer until the stud shoulder seats against the outer rim.

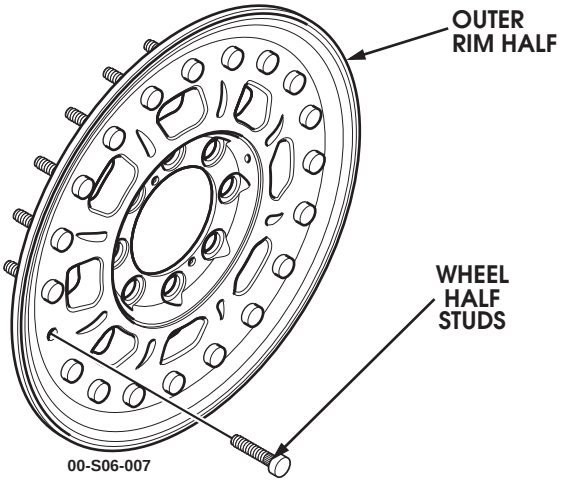


Figure 6-11: Outer Rim Half Stud Removal

Assembly

WARNING: Never use tubes in the two-piece take-apart wheel assemblies. Use of a tube defeats built-in safety features of the wheel, and could cause the wheel to come apart under pressure, resulting in serious injury or death. Use only replacement parts specified in parts manual. Wheels assembled with components which do not meet specifications could cause the assembly to separate under pressure, resulting in serious injury or death. To avoid injury ensure run flat compressor strap is centered on run flat.

1. Apply one 11-ounce tube of gel lubricant around the inside of the tire at the crown area. Using a clean brush, evenly spread the gel lubricant 4 to 5 inches wide on the tire crown area (Figure 6-12).

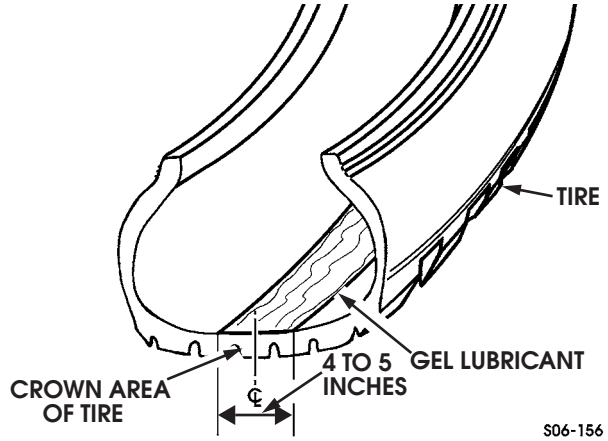


Figure 6-12: Run Flat Gel Lubricant Application

2. Position the run flat compressor on an outer edge of the run flat with the nut facing up and the strap centered around the run flat (Figure 6-13).

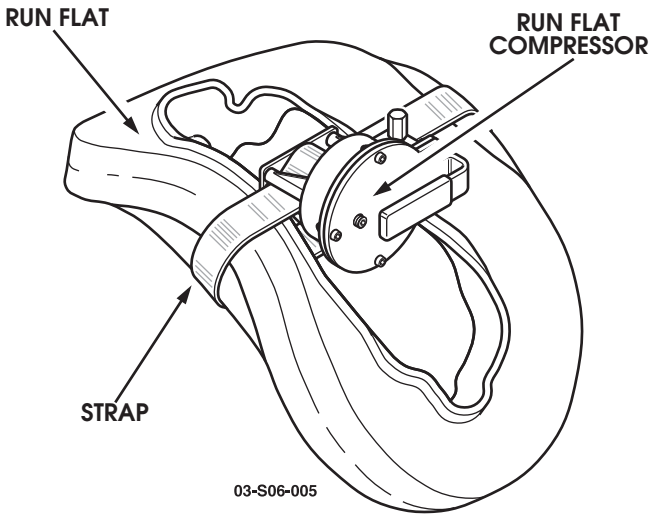


Figure 6-13: Run Flat Compressor Positioning

NOTE: Compress the run flat by rotating the 3/4 nut in a clockwise direction. Rotate the 3/4 nut counterclockwise to loosen.

3. Using a run flat compressor, compress the run flat(Figure 6-13).
4. Lubricate the bead and run flat with tire lube (Figure 6-14).

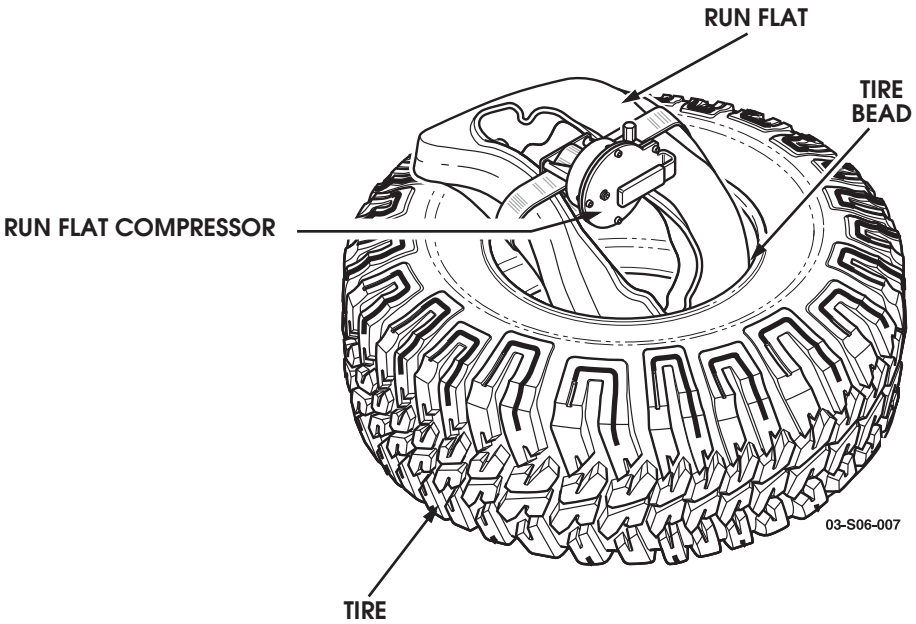


Figure 6-14: Run Flat Insertion

5. Insert the run flat, compressor side first, as far as possible into tire.
6. Lay the tire flat on it's side. Slowly loosen the compressor. The run flat should position itself inside the tire. If not, repeat steps 4 through 6 and/or use a tire spoon to assist in installation.

NOTE: If required, clean and lubricate the bearing assembly on the run flat compressor after removal.

7. Remove the run flat compressor from the tire.
8. Lubricate the O-ring seal with tire lube and install a new O-ring seal in the groove of the inner rim half. Ensure the O-ring seal is not twisted and is uniformly positioned in the groove. Do not overstretch the O-ring seal (Figure 6-17).
9. Lubricate the tire bead, rim bead seat area and the o-ring with tire lube.

NOTE: Before installing the tire on the inner rim half, inspect the tire sidewalls for a "paint dot." Paint dots are often used to indicate the tire's light spot for balancing purposes. If a paint dot is present, position the tire on the rim halves so that the paint dot is aligned with the valve insert on the outer rim half.

10. Place the outer rim half on a piece of cardboard or some other protective surface with the studs facing up.
11. Center the run flat in the tire. Carefully lower the tire over the outer rim half while lining up the notch in the runflat with the air valve notch in the wheel half.

CAUTION: *Ensure that the run flat is properly aligned with the valve stem in the wheel. Improper alignment can result in non-uniform bead pressure and improper run flat operation.*

12. Ensure the run flat is not binding on any flat portion of inner rim half. The run flat should clear the inner rim half.
13. Set the inner rim half in the tire assembly while lining up the threaded holes in the inner half with the four spreader tool receiver holes in the outer half.
14. Place the wheel half locknuts on the four long studs and alternately tighten the nuts until the remaining sixteen nuts can be started on their studs.

CAUTION: *Tighten locknuts gradually to avoid bending and/or breaking studs, or damage to wheel components.*

NOTE: If the tire bead does not seat on the rim flange after inflation, deflate the tire completely and remove from the rim. Check to ensure that a 17 inch diameter tire is being used. Also check for bent or damaged components and replace if necessary. Lubricate the tire bead and rim mating surfaces and reinstall the tire on rim.

15. Preliminarily tighten locknuts to 50 lb-ft (68 N•m) in tightening sequence shown (Figure 6-15).

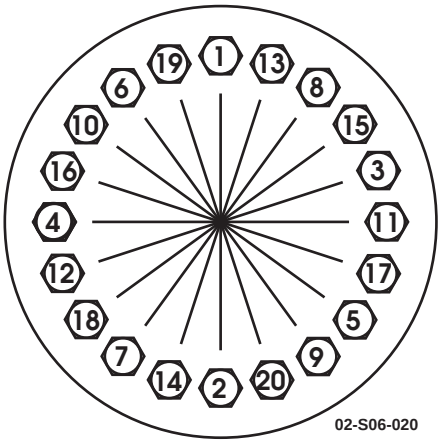


Figure 6-15: Locknut Tightening Sequence

16. Retighten locknuts to 75 lb-ft (102 N•m) in the sequence shown.
17. Turn the tire and rim assembly over so the outer rim half is exposed.
18. Check the wheel assembly for gaps at each stud(Figure 6-16). Use a 0.0015 inch (0.038 mm) thickness gauge to detect gaps. If gaps are detected, disassemble and reassemble the wheel assembly and recheck for gaps. If gaps are still detected, replace the outer rim half.



Figure 6-16: Checking Wheel Stud Gap

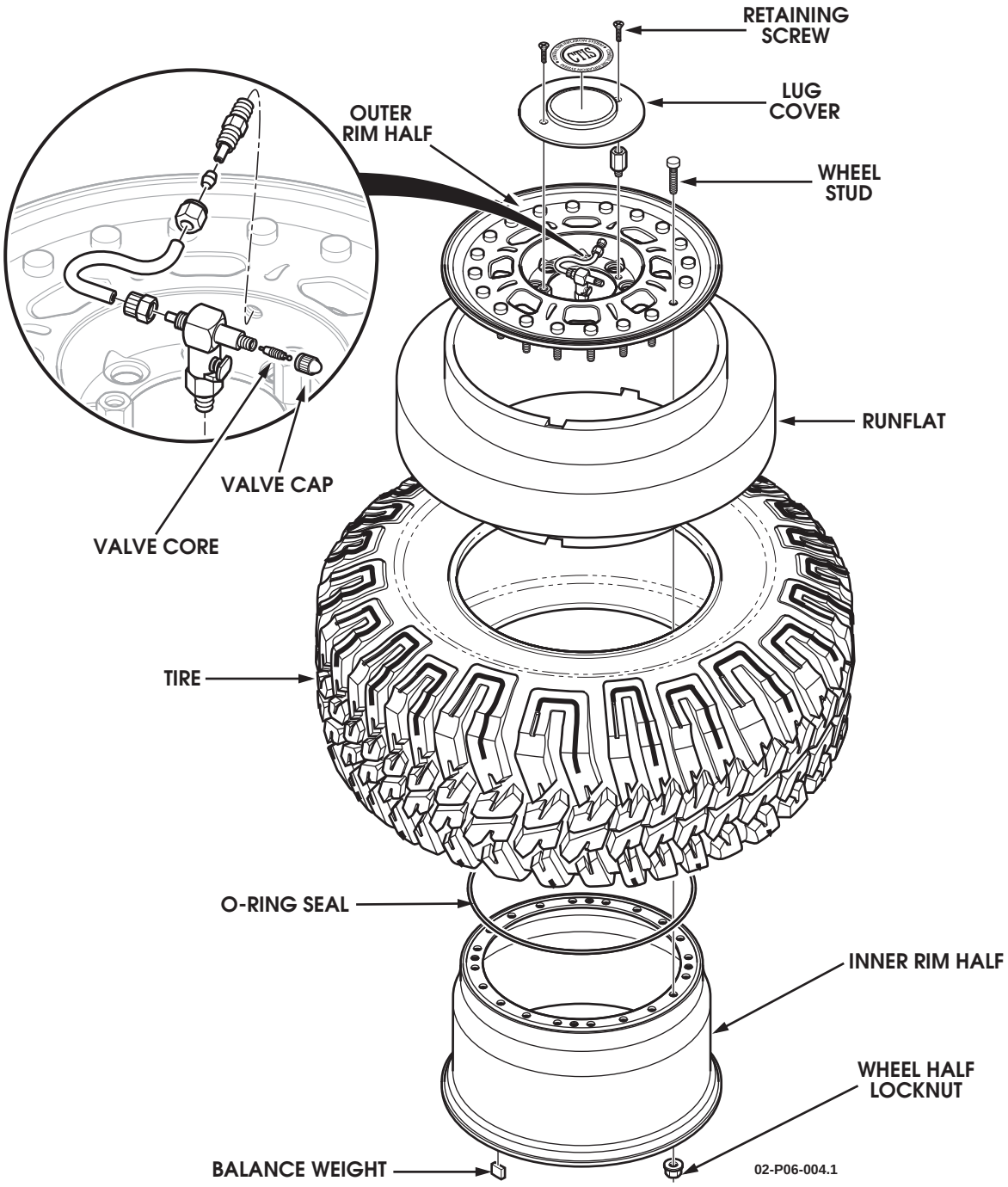


Figure 6-17: Two-Piece Wheel with One-Piece Run flat Breakdown

WARNING: Never inflate a tire without having checked wheel half locknut torques to ensure the wheel locknuts are tightened to specifications. A wheel with improperly tightened locknuts could separate under pressure, resulting in serious injury or death. Always use a tire inflation cage for inflation purposes. Stand on one side of cage during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate the tire to recommended pressure using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

NOTE: Perform the following step only if core housing was removed.

19. Apply a thread-locking compound to the core housing and thread the valve bore into the valve hole on the outer rim half. Tighten the core housing to 25-30 lb-ft (34-41 N•m).
20. Place the wheel assembly in a safety cage and inflate the tire to the recommended tire pressure.
21. Check for leaks around the rim edges, the quick disconnect valve and the CTIS hose with soapy solution(Figure 6-18).

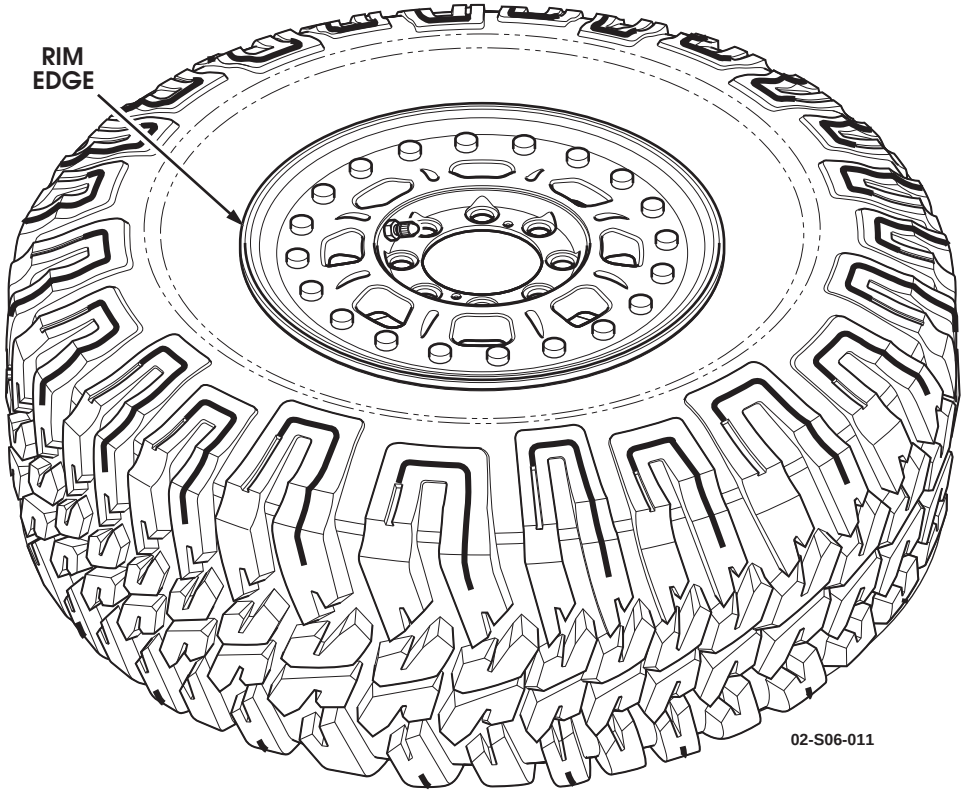


Figure 6-18: Leak Check Areas

WHEEL HALF STUD REPLACEMENT

Removal

1. Remove the wheel from the vehicle.
2. Place the wheel in a tire inflation cage.

WARNING: Ensure the tire is totally deflated before removing wheel locknuts. Failure to follow proper safety precautions may result in serious injury or death.

3. Remove the CTIS hose and quick disconnect and deflate the tire.

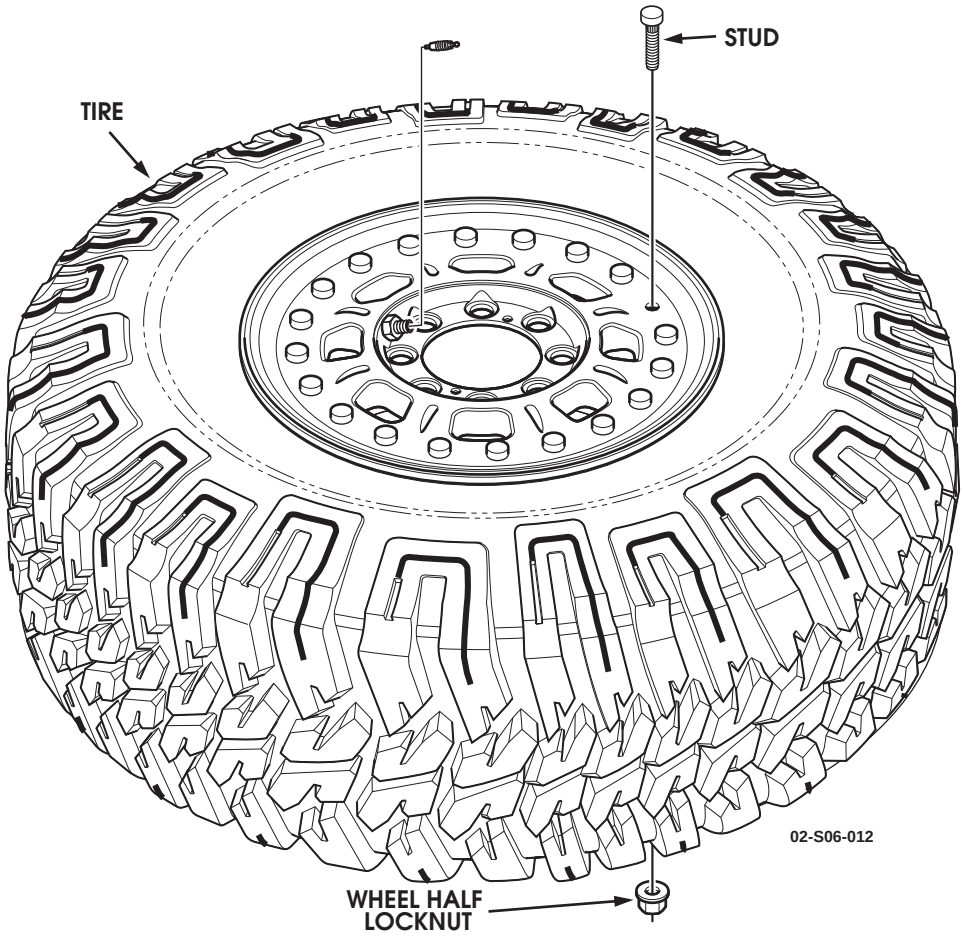


Figure 6-19: Wheel Half Stud Replacement

NOTE: When replacing broken rim stud(s), replace studs on both sides of the broken stud(s).

4. When the tire is fully deflated, loosen the wheel locknuts on each side of the broken stud(s). If you hear escaping air, do not proceed. Wait until the sound stops and recheck the valve bore. When you are certain the tire is fully deflated, proceed to remove the wheel locknut(Figure 6-19). Discard the locknut.
5. Drive the studs out of the outer rim. Discard the studs.

Cleaning and Inspection

1. Using a wire brush, clean the remaining studs. Clean all dirt and foreign material from the rim with soap and water and allow to air dry.

WARNING: Never use wheel assemblies with studs that are damaged, loose, or have damaged threads. Damaged studs can cause improper assembly, which could cause individual fasteners to fail. Any of these situations may result in serious injury or death.

2. Inspect the outer rim for cracked, broken, corroded, pitted, bent, or loose studs, and studs with damaged, mutilated, or deformed threads. Replace any defective parts(Figure 6-19).

Installation

1. Align the stud with the splines in the outer rim and pull the stud into the outer rim using a 1/2-20 nut, a washer and a larger nut as a spacer until the stud shoulder seats against the outer rim(Figure 6-19).
2. Repeat step 1 for all studs being replaced.

CAUTION: *Tighten locknuts gradually to avoid bent and broken studs, or damage to wheel components will result.*

3. Install new locknuts on all of the new studs.

NOTE: After replacing the broken stud(s), all wheel locknuts must be re-torqued.

4. Tighten all locknuts to 50 lb-ft (68 N•m) in sequence shown (Figure 6-20).
5. Tighten all locknuts to 75 lb-ft (102 N•m) in sequence shown.

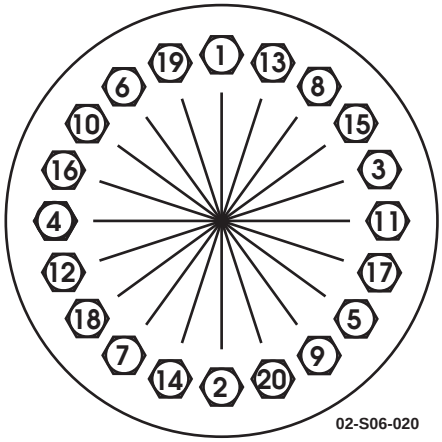


Figure 6-20: Wheel Half LockNut Tightening Sequence

6. Check the wheel assembly for gaps at each stud. Use a 0.0015 in. (0.038 mm) thickness gauge to detect gaps. If gaps are detected, disassemble and reassemble the wheel assembly and recheck for gaps. If gaps are still detected, replace the outer rim half.

WARNING: Never inflate a wheel assembly without having checked wheel locknut torques to ensure the wheel locknuts are tightened to specifications. An assembly with improperly tightened locknuts could separate under pressure, resulting in serious injury or death.

WARNING: Always use a tire inflation cage for inflation purposes. Stand on one side of the cage during inflation, never directly in front. Keep hands out of cage during inflation. Inflate assembly to recommended pressure, using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

7. Place the wheel in a safety cage and inflate the tire to the recommended tire pressure.
8. Check for leaks around the rim edges, the quick disconnect valve and the CTIS hose with soapy water.
9. Install the wheel on the vehicle.

RUN FLAT COMPRESSOR BELT REPLACEMENT

Removal

1. Remove the roll pin and the washer.
2. Remove the retaining bracket.
3. Remove the belt from the compressor.

Installation

1. Install the belt on the compressor (Figure 6-21).
2. Install the retaining bracket (Figure 6-21)
3. Install the washer and the roll pin (Figure 6-21).

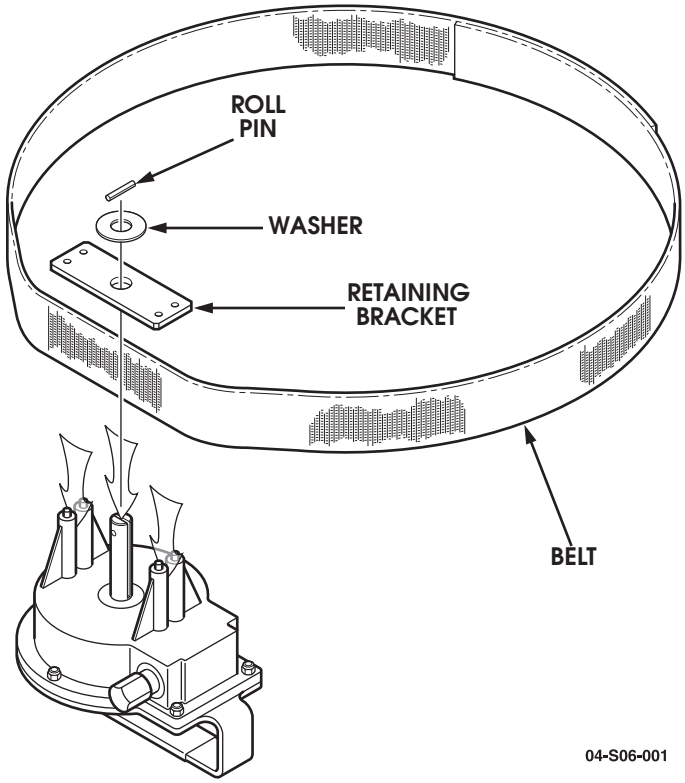


Figure 6-21: Run Flat Compressor Belt Installation

TIRE, ONE-PIECE ALUMINUM WHEEL, AND TWO-PIECE RUN FLAT SERVICE

CAUTION: *It is not recommended mixing one-piece wheel and run flat assemblies and two-piece take-apart wheel and run flat assemblies on the same vehicle. run flat profiles differ between the two types of wheel assemblies.*

Disassembly

1. Remove the lug cover.

If the vehicle is equipped with a Central Tire Inflation System (CTIS), perform steps a and b.

   a. Release the quick disconnect fitting located at the center of the geared hub spindle on all four wheels.
   b. Remove the 3/4 inch brass fitting from the center of the geared hub spindle on the wheel(s) to be worked on.

2. Remove the wheel/tire assembly from the vehicle.
3. Inspect the geared hub spindle studs for bending, looseness, or stripped threads. Replace if damaged.
4. Inspect the lug nuts for fatigue, stripped threads, or other damage. Replace if damaged.
5. Remove the valve cap and core from the air valve and deflate the tire. Run a piece of wire through the air valve to ensure it is not plugged.

WARNING: Balance weights contain lead. Wash hands after handling.

6. Remove the balance weights from the wheel if present. Discard the balance weights.
7. Install the wheel/tire assembly on the tire machine.
8. Using a tire machine, break loose both tire beads.
9. Lubricate the outside tire bead and use the tire machine to remove the bead from the wheel flange.
10. Pull the tire bead up and away from the wheel to expose the run flat assembly. This can be accomplished with a pry bars or a bead spreader devise6-22.

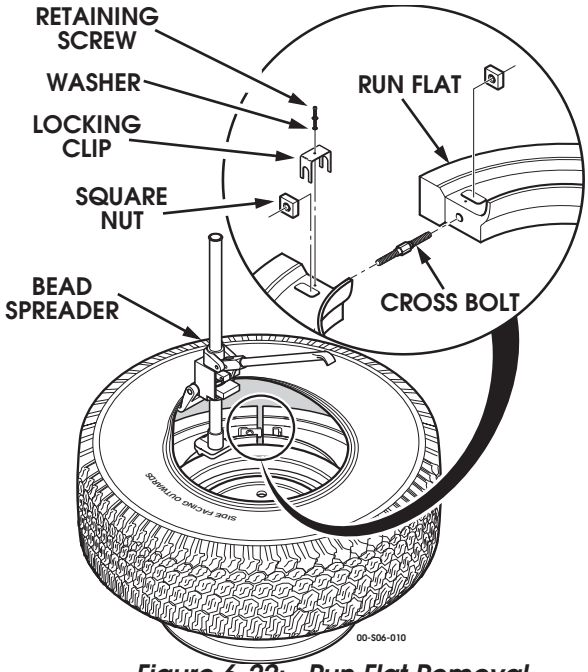


Figure 6-22: Run Flat Removal

11. Remove the retaining screw, washer and cross bolt locking clip (Figure 6-23).
12. Loosen and remove the cross bolt and square nuts securing the run flat halves together.
13. Repeat steps 11 through 13 for opposing fastener assembly.
14. Reach inside the tire and remove the run flat halves from the tire.
15. Lubricate the tire bead and remove the tire from the wheel.

Inspection and Cleaning

Cleaning

1. Remove any existing lubricant that has been applied to the inside of the tire, using a tire buffing solution.
2. Clean all of the wheel, run flat and tire parts using tire buffing solution.
3. Dry all of the wheel, run flat and tire parts. Ensure the inside of tire and all of the wheel, run flat and tire parts are free of any run flat lubricant, dirt, rust or moisture.

Tire Inspection

1. Inspect the tire for the following conditions or defects. Replace the tire if damaged.
   a. Inspect the inside of the tire for cord or belt separation and inner crown area damage.
   b. Inspect the tire bead for damage.
   c. Check for protruding objects inside the tire which may not be visible from outside. If tire is damaged, repair with external or internal tire repair kit.
   d. Check the tread depth on the tire. Tread should not be worn below level of wear bars. Markings on the side of the tires (e.g., the letters “TWI” or a triangle) show the location of wear bars. Replace the tire if the tread is worn below bars or 3/32 inch (2.38mm).

Run Flat Inspection

1. Inspect the run flat for the following conditions or defects. Replace the run flat(s) if damaged.
   a. Splitting or separation of rubber from the composite material.
   b. Wear or damage of the outside rim or centering flange.
   c. Excessive chafing or particles of the tire’s steel belt embedded into the run flat assemblies.
   d. Cross bolts for stress fatigue, cracks or thread damage.

e. Square nuts for stress fatigue, cracks or other damage.
f. Cross bolt locking clip and retaining screw for damage.

Wheel Inspection

1. Inspect the wheel for the following conditions or defects. Replace the wheel if damaged.
   a. Cracked or bent.
   b. Mounting bolt holes for stress fatigue, oversized holes, or other damage.
   c. Wheel flange for stress fatigue, deformation or other damage.
   d. Quick disconnect valve and hose for cracks or deterioration. Replace these items if damaged.

Assembly

NOTE: If tires are to be replaced allow the new tires to reach room temperature (above 60°) before mounting. This will make the tire more pliable and easier to work with.

CAUTION: *During assembly or disassembly, loose parts which are dropped inside the wheel/tire assembly must be removed. Failure to do so could result in damage to wheel/tire assembly.*

1. Apply one tube (approximately 11 ounces) of run flat gel lubricant to inside crown area of tire. Using clean brush, evenly spread gel lubricant 4 to 5 inches wide on inner crown area.

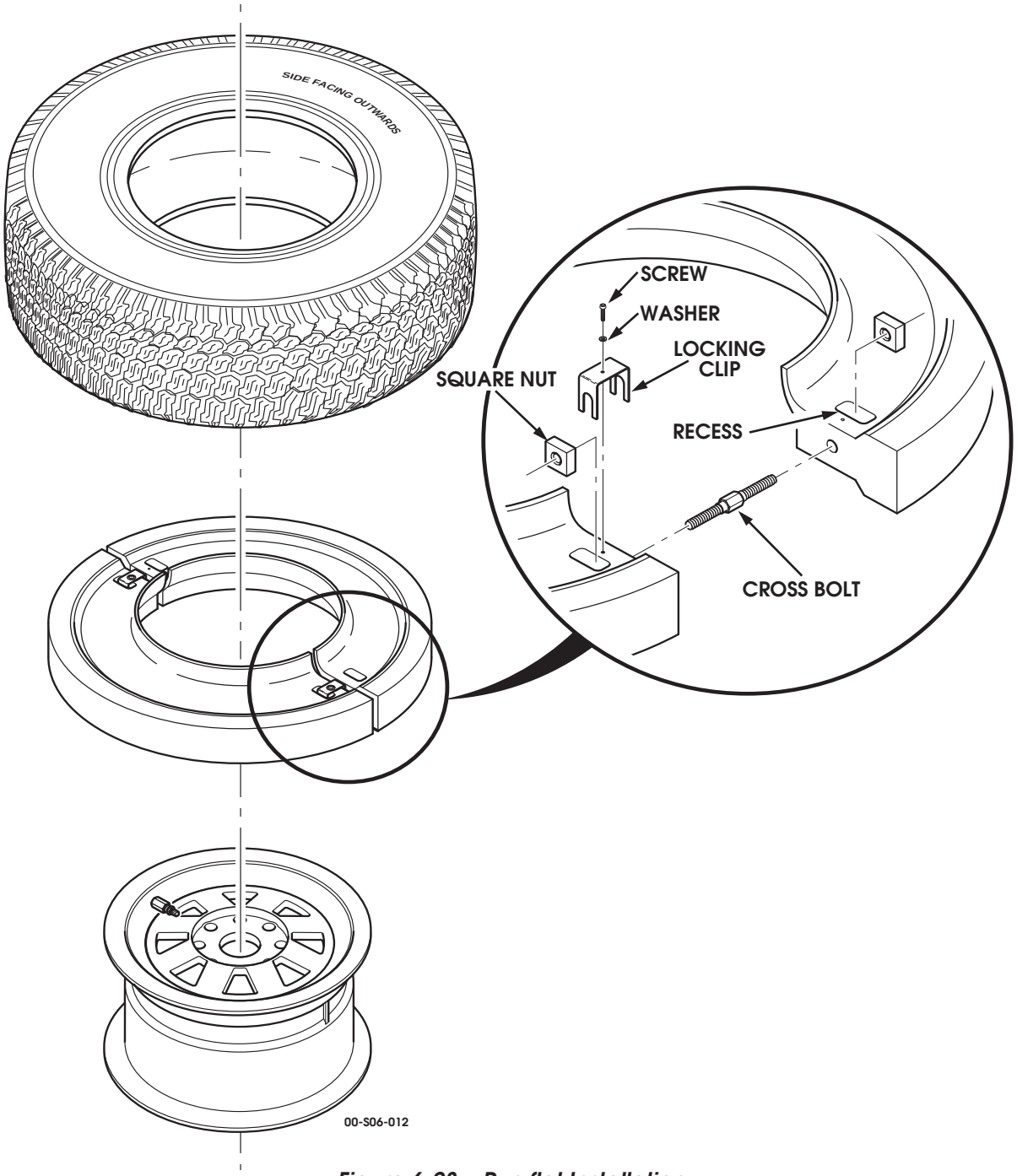


Figure 6-23: Run flat Installation

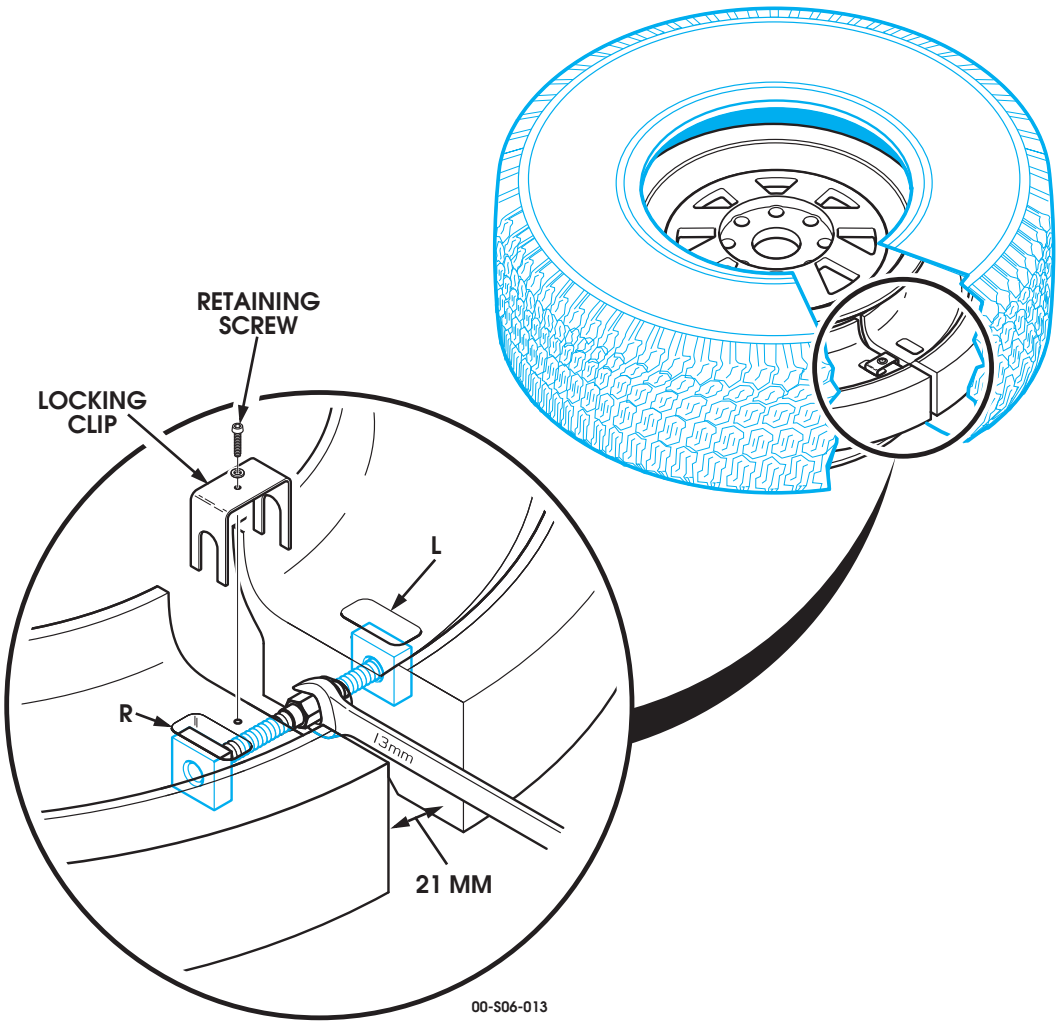


Figure 6-24: Run Flat Assembly

2. Position the wheel on the tire machine with the outside facing up. Lubricate the tire beads and mount the inside tire bead on the wheel. Ensure the “SIDE FACING OUTWARDS” lettering is faces up on GSA tires.
3. Install the right and left square nuts in the recesses of one pair of run flat ends. When looking across the run flat to the opposite side, the “R” square nut should be in the right recess and the “L” square nut in the left recess(Figure 6-24).
4. Start the cross bolt in one of the square nuts, then in the second nut and tighten until there is full engagement in both nuts. The thread engagement must be equal in both nuts.
5. Using a bead spreader, insert the run flat halves in the tire.
6. Align the gap between the second pair of run flat ends with one of the positioning fences on the wheel.
7. Assemble the second pair of run flat ends as in steps 3 and 4 and adjust the gap between the run flat ends to 53/64" (21 mm).

NOTE: The distance between the two run flat end gaps must remain equal to reduce the risk of imbalance.

8. Verify that the positioning fences are centered in the run flat end gaps and the gaps are equal.
9. Torque both cross bolts to 22 lb-ft (30 N•m) and install cross bolt locking clips, screws and washers.
10. Torque the locking clip screws to 30-35 lb-in (4-5 N•m).
11. Lubricate the tire bead and mount the tire bead on the wheel.

NOTE: Before installing a new tire inspect the tire sidewalls for a “paint dot.” Paint dots are often painted on tires to indicate the tire’s light spot for balancing purposes and may be located on either side of the tire. If paint dot is present, position tire on wheel so that paint dot is aligned with air valve on wheel. If the paint dot is not on the air valve side of tire, reference paint dot from other side of the tire for proper positioning with the air valve.

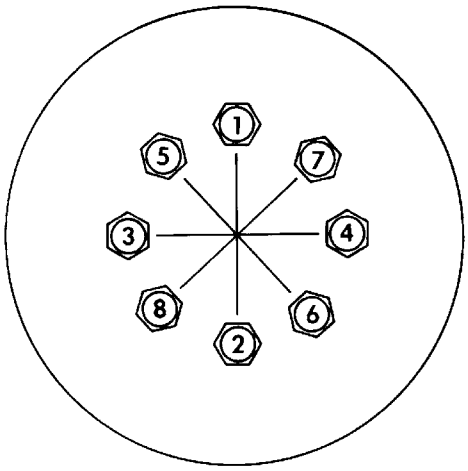
WARNING: Always use a tire inflation cage for inflation purposes. Stand one side of cage during inflation, never directly in front. Keep hands out of the cage during inflation. Inflate assembly to recommended pressure using a clip-on air chuck. Do not exceed 50 psi (345 kPa) cold inflation pressure. Failure to follow these instructions may result in serious injury or death.

12. Before installing the valve core, inflate the tire to seat the beads. Use of a tire bead seater may be required.
13. Install the valve core, inflate the tire to recommended tire pressure and install the valve cap.
14. Check for leaks around the wheel edges, the quick disconnect valve and the CTIS hose with soapy solution.
15. Balance the wheel/tire assembly with 15 oz. maximum weight. Refer to tire balance procedure in service manual if necessary.
16. Install the wheel/tire assembly on the vehicle.
    a. Roll the wheel/tire assembly to the vehicle.
    b. Place the wheel/tire assembly on the geared hub spindle studs.
    c. Start the lug nuts by hand.
    d. Snug the lug nuts.
    e. Lower the vehicle.
    f. Torque the lug nuts evenly and sequentially to 110 lb-ft (149 N•m)(Figure 6-25).

If the vehicle is equipped with CTIS perform these additional steps:

    g. Lubricate the threads on the CTIS fitting with teflon pipe sealant.
    h. Install the fitting in the geared hub spindle.
    i. Engage the quick disconnect fittings on all four wheels.

17. Install the lug cover.



S06-091

Figure 6-25: Lug Nut Tightening Sequence

Inspecting Tire Tread Wear

Tire tread wear is a good indicator of the tire balance and the suspension condition. Unbalanced tires often cause cupped or scalloped tread wear patterns (Figure 6-26). The tire wear inspection should be performed for all vibration complaints. Resolve the tire wear problems before continuing with diagnosis.

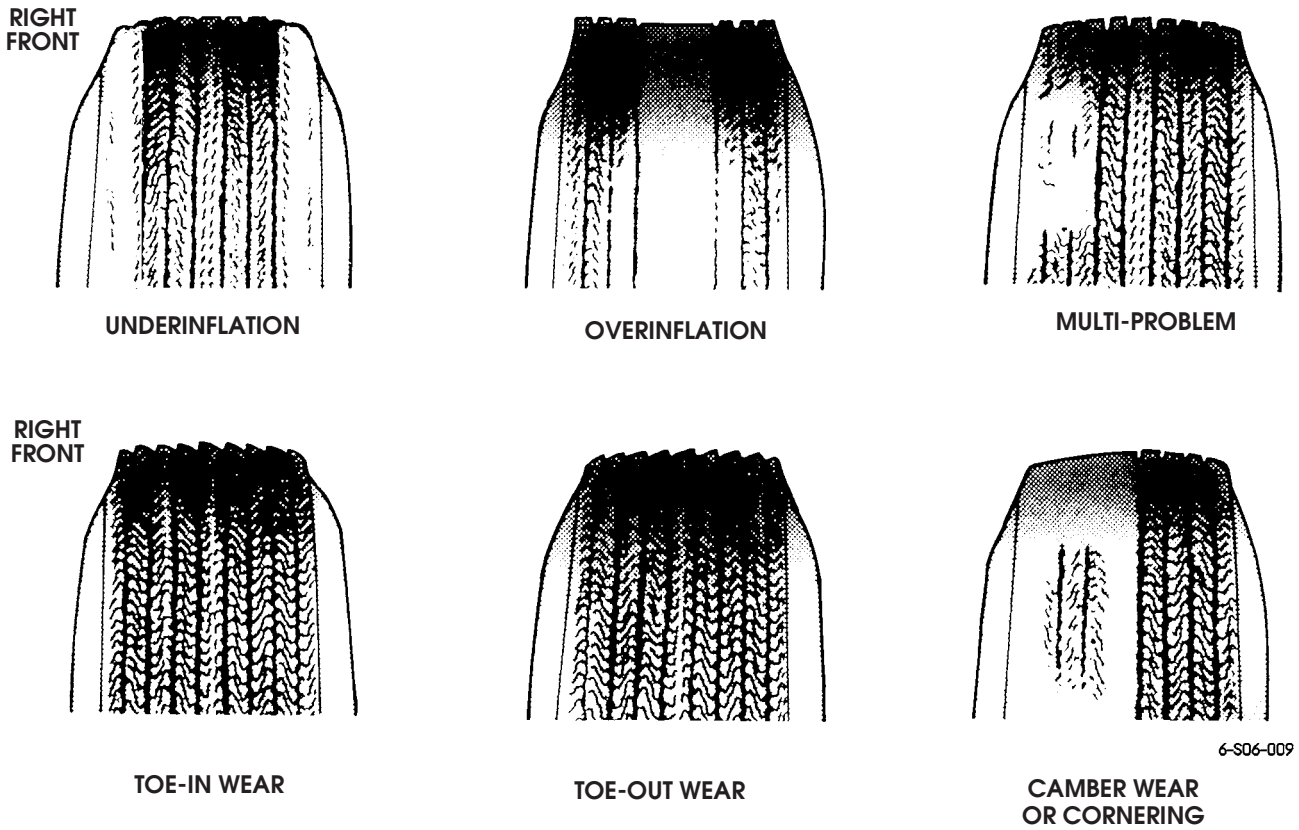


Figure 6-26: Tire Wear Patterns

WHEEL AND TIRE BALANCING

NOTE: If an excessive vibration condition exists after normal balance procedures are performed, refer to the Wheel End Vibration Correction Using Road Force Values procedure in section 6.

General

There are two types of tire and wheel balancing: static and dynamic. Static balance is the equal distribution of weight around the wheel circumference. Wheels that are statically unbalanced cause a bouncing action called vehicle shake and possible steering nibble or oscillation. This condition will eventually cause uneven tire wear (Figure 6-27).

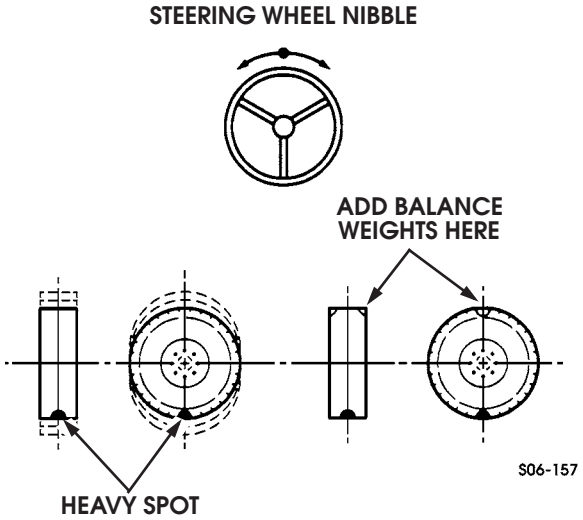


Figure 6-27: Static Imbalance Correction

Dynamic balance is the equal distribution of weight on each side of the center line, so that when the wheel spins there is no tendency for it to move from side to side. Wheels that are dynamically unbalanced may cause wheel shimmy, vehicle shake or a steering wheel vibration called nibble or oscillation (Figure 6-28).

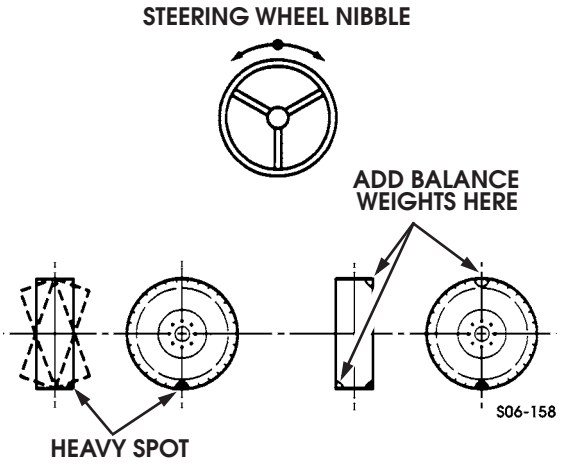


Figure 6-28: Static Imbalance Correction

NOTE: Most electronic off-vehicle balancers are more accurate than on-vehicle spin balancers. They are easy to use and give a dynamic (two-plane) balance. On-vehicle balancing is not recommended. When balancing off-vehicle, the wheel should be mounted to the balancer with a cone through the back side of the center pilot hole or by the wheel (spindle) stud holes. The spindle stud method is recommended for CTIS wheels.

Balancing

1. Remove the wheel and tire assembly from the vehicle.

WARNING: Remove all stones and foreign material from the tire tread before spin balancing. Failure to follow this warning may result in injury.

NOTE: Deposits of foreign material must be cleaned from the inside of the wheel and the tire tread to obtain a good balance. The tire should be inspected for obvious damage, then balanced according to the equipment manufacturers recommendations.

2. Mount the wheel and tire assembly, curb side out, on dynamic balancer and start the balance cycle (Figure 6-29).

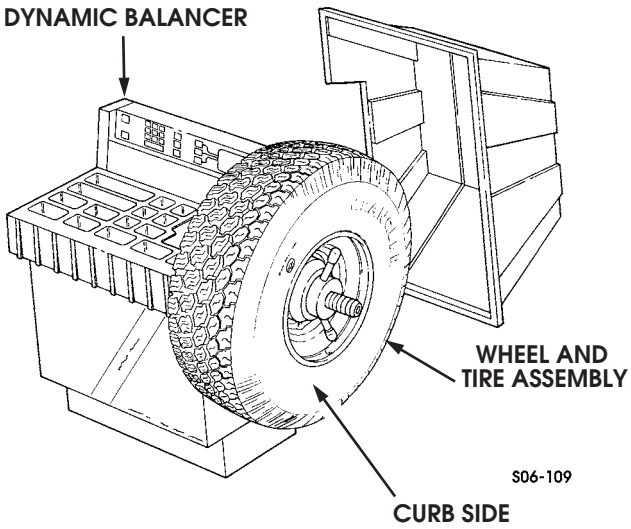


Figure 6-29: Dynamic Balancer Mounting

3. Locate and mark the wheel and tire assembly light spot on the tire (Figure 6-30).
4. Record the weight and the position readings.

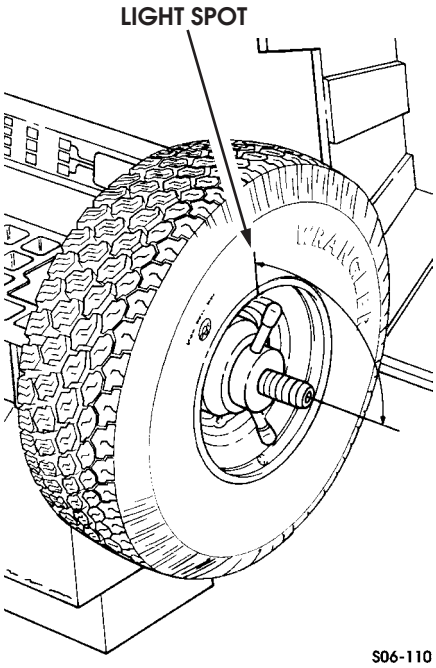


Figure 6-30: Marking Wheel and Tire Assembly Light Spot

NOTE: If more than 15 oz. of weight is required to balance the tire, wheel and run flat (if installed) assembly, rotate tire 180° on wheel. All aluminum wheel and tire assemblies require the use of tape-on weights only. Do not use wheel balancing liquids to balance the wheel and tire assembly. Balancing liquids may be incompatible with and cause damage to wheel, tire, run flat, and CTIS components.

NOTE: There is very little clearance between the geared hubs and the inside diameter of the wheels. When installing tape-on balance weights on the inside diameter of the wheel, position the weights to afford adequate clearance to the geared hubs.

5. Attach the balance weights to the inner and/or outer edges of the wheel (indicated by dynamic balancer), ensuring the weight is centered on the light spot, or weights are placed evenly to the sides of light the spot if more than one weight is used. (Figure 6-31).
6. Start the balance cycle and repeat steps 3 through 5 until the tire is properly balanced.
7. Remove the wheel and tire assembly from the dynamic balancer and install on the vehicle.

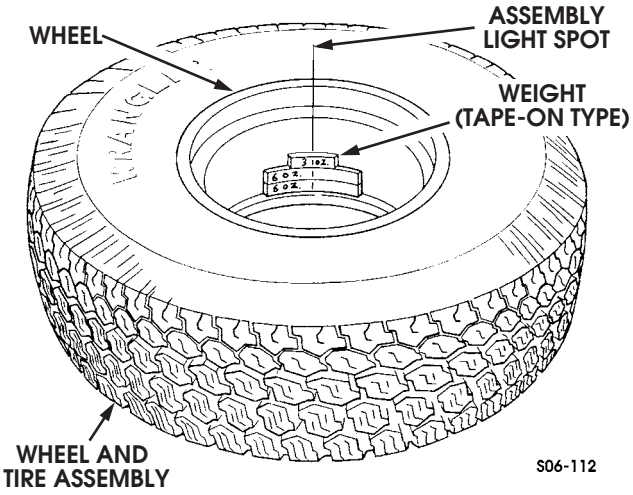


Figure 6-31: Balance Weight Placement

TROUBLESHOOTING A NON-BALANCING WHEEL AND TIRE ASSEMBLY

NOTE: If a wheel and tire assembly cannot be balanced, or balance cannot be maintained, any of the following conditions may be causing the problem:

- The run flat is moving on the wheel/rim.
- Excessive radial or lateral run out condition of the wheel.
- Improper seating of the tire bead on the wheel flange.

NOTE: Perform the following if the run flat is moving on the wheel. If an excessive run out condition is suspected, proceed to Wheel End Vibration Correction Using Road Force Values.

Suspected Run Flat Movement Procedure

1. Disassemble the wheel and remove the run flat from the tire.
2. Clean the inside of the tire, wheel and the O-ring seal with soap and water. Allow the cleaned parts to dry prior to assembly.
3. Apply run flat gel lubricant at the crown area on the inside tire area.
4. Install the run flat into the tire and assemble the wheel.
5. Balance the wheel and tire assembly.

WHEEL END VIBRATION CORRECTION USING ROAD FORCE VALUES

Initial Checks

NOTE: Before performing any vibration analysis or balance operations, drive the vehicle to warm the tires.

1. Verify the customer complaint at the affected speed, with tire pressures set to 26 psi. front and 28 psi. rear. Many tire vibrations will not be evident until the vehicle is driven long enough for the tires to reach operating temperature (10 minutes at highway speed).
2. After the complaint is verified, check all wheel end parts that could contribute to a vibration, i.e.: loose lug nuts, spindle bearings, tie rod ends, idler arm, pitman arm, steering gear and idler arm mount bolts. Perform a visual inspection of the wheels and tires for physical damage.

PROCEDURE

NOTE: Before proceeding with the following procedures, authorization from the AM General Warranty Department must be obtained.

Assembly Road Force Check Procedure

NOTE: The following tire and wheel checks must be performed on a Hunter GSP 9700 Road Force ™ measurement balance machine. If the machine is not available at your location, visit the Hunter website (www.gsp9700.com/pub/search/findgsp9700.cfm) to find a machine at a nearby location.

NOTE: Before mounting the wheel/tire assemblies on the balance machine, drive the vehicle to warm the tires and raise the tires off the ground to eliminate flat spotting.

NOTE: Use the following Hunter GSP 9700 wheel mount equipment:

- 3 inch diameter by 5/8 inch thick plastic spacer
- centering cone number 173 (purple color code) large diameter side towards the wheel
- flange plate with four rounded end pins
- wing nut with pressure ring

NOTE: If the high tire runout and the low wheel runout points are between 90 and 180 degrees apart, the tire can be rotated on the wheel to obtain more favorable road force values.

1. Set all tire pressures to **28 psi.** and perform the road force variation and balance procedures. Mark the high runout spot of the tire and the low runout spot of the wheel as indicated. If the **assembly** TIR (total indicated reading) road force exceeds 55 lb., or the **assembly** R1H (radial first harmonic) road force exceeds 35 lb., at **28 psi.**, rotate or replace the tire. Replacement tires must be obtained from the AM General Service Parts Logistics Operation.
2. Repeat the tire/wheel check procedure for the remaining assemblies.

Geared Hub Spindle Check Procedure

Measure the spindle stud radial runout and the spindle face lateral runout with dial indicator J–8001 and roller adapter J–23672.

NOTE: Mount the dial indicator base to the geared hub housing to get reliable readings.

1. Position the dial indicator to measure the wheel mount stud radial runout at 1/2 inch out from the face of the spindle (Figures 6-32 and 6-33). The indicator shaft must be positioned inline with an imaginary line starting at one stud, running across the face of the spindle through the opposing stud and the indicator.
2. Rotate the spindle slowly **(by hand)** past each stud and record the difference between the lowest reading stud and the highest reading stud. The maximum allowable difference is 0.020 inch. If the reading is within the specification, mark the stud with the lowest reading and move on to the next step. If the reading is larger than the specification, replace the geared hub spindle.

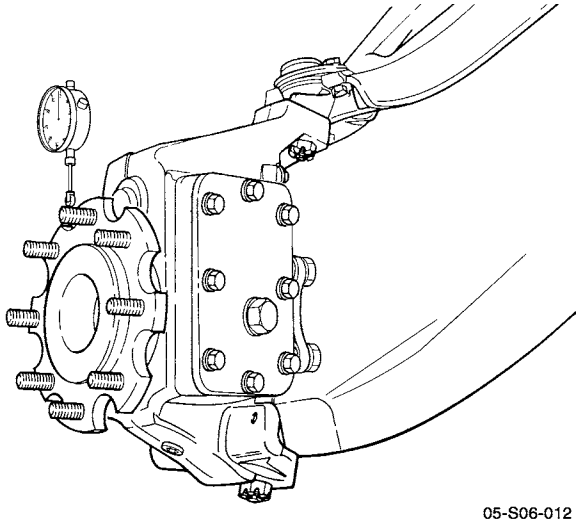


Figure 6-32: Wheel Mount Stud Radial Runout

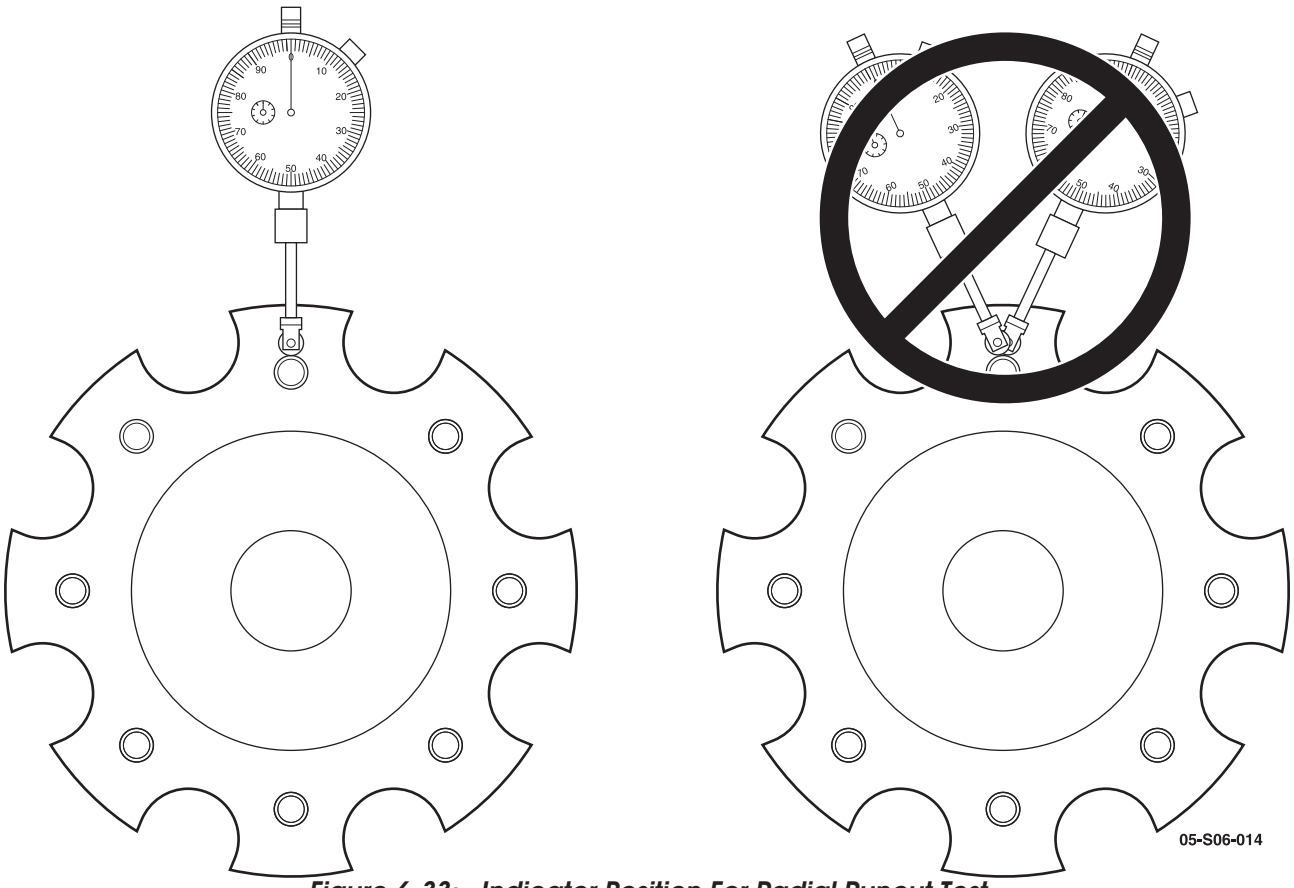


Figure 6-33: Indicator Position For Radial Runout Test

NOTE: Ensure that the spindle machined face is clean and free of rust, paint, etc. before attempting to perform the spindle lateral runout test.

3. Position the dial indicator to measure the geared hub spindle lateral runout (See Figures 6-34 & 6-35). The indicator wheel should be positioned outboard of the stud circle perpendicular to the face of the spindle. The indicator wheel will have to be lifted off the face when rotating the spindle cutout areas past the indicator. The best indicator mount position is on the geared hub housing with a magnetic base.

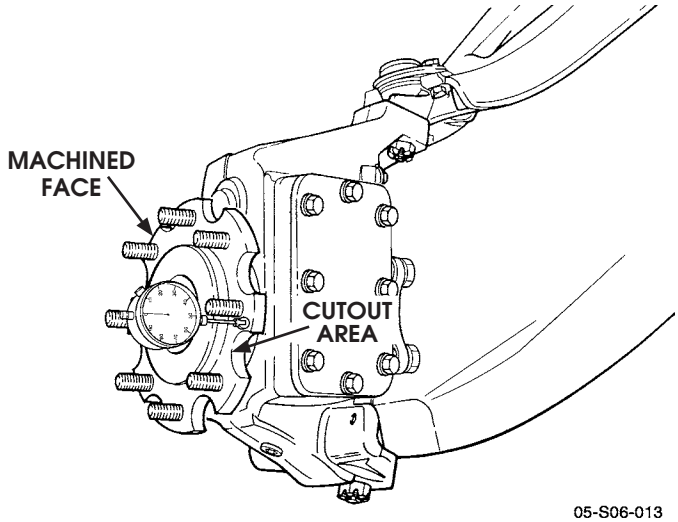


Figure 6-34: Geared Hub Spindle Lateral Runout Test

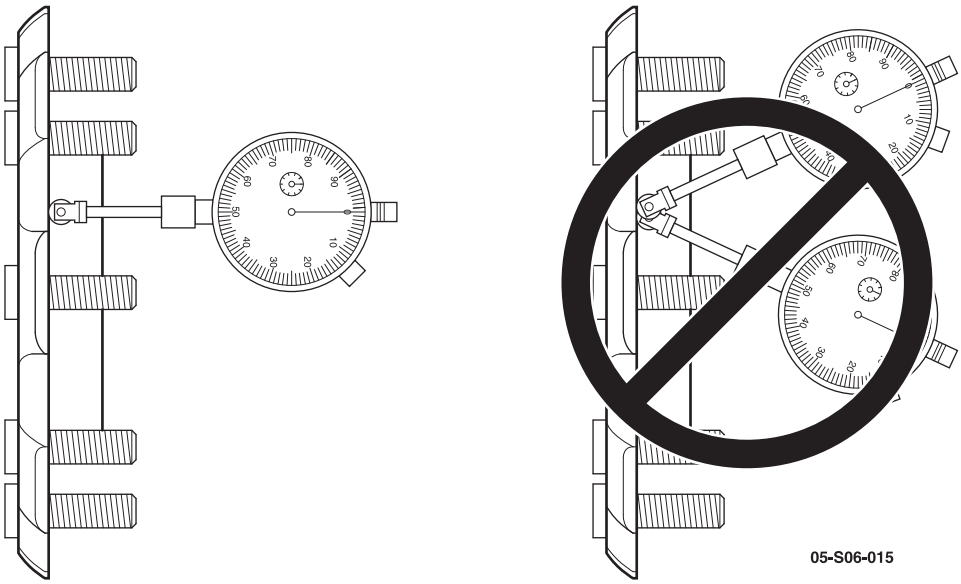


Figure 6-35: Indicator Position For Lateral Runout Test

4. Rotate the spindle slowly **(by hand)** and record the difference between the lowest and the highest reading on the indicator. The maximum difference should be 0.005 inch. If the reading is within the specification, move on to the next step. If the reading is larger than the specification, replace the geared hub spindle.
5. Repeat the spindle checks for the remaining spindles and install the tire/wheel assemblies.
6. Duplicate the complaint drive conditions and verify the repair.

WHEEL ALIGNMENT

Check the alignment on a alignment rack with the front tires in the straight-ahead position and inflated to the manufacturer's recommended pressure.

Preliminary Inspection

1. Check the tire condition, tread wear (Figure 6-26), run-out, and inflation.
2. Raise and support the vehicle so the wheels are free to rotate. Then secure the steering wheel in the straight-ahead position.
3. Check the tie rods and the upper control arms for distortion, play, or looseness (Figure 6-36). Replace any worn, or damaged parts before proceeding.

NOTE: If the vehicle was previously lifted off the ground for other service, center the steering wheel, roll the vehicle forward and back to settle the suspension and relieve the tension on the ball joints before beginning checking procedure.

4. Check the upper ball joints: With the vehicle on the ground (being careful not to damage the boot), place the tip of a pry bar between the steering knuckle and the ball joint boot (Figure 6-37). With the shank of the pry bar contacting the upper control arm as shown, pry upward and note the movement of the ball joint against a ruler. Be careful to measure only the ball joint movement and not the flex of the control arm resulting from prying against it. Any upper ball joint with more than 1/16" (1.6 mm) movement should be replaced.
5. Check the geared hubs for spindle end play or side-to-side movement by grasping the edge of the tire and attempting to move the tire up and down.

NOTE: If any spindle movement is apparent, adjust the spindle bearings.

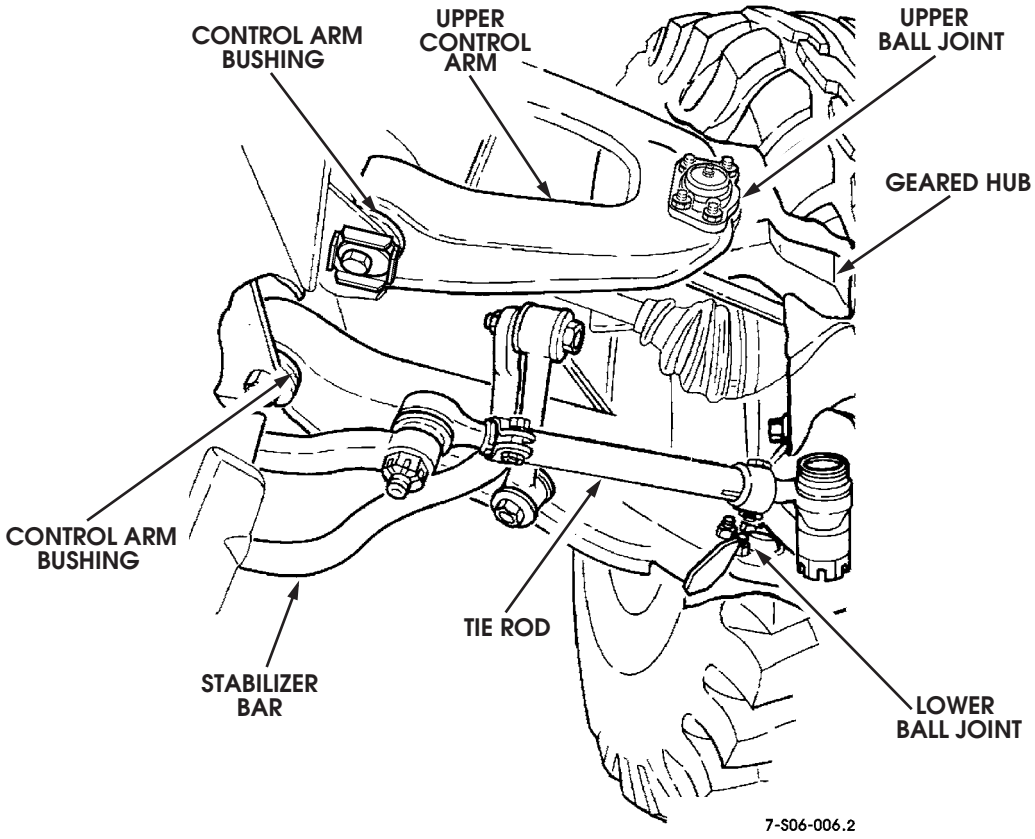


Figure 6-36: Suspension Inspection Components

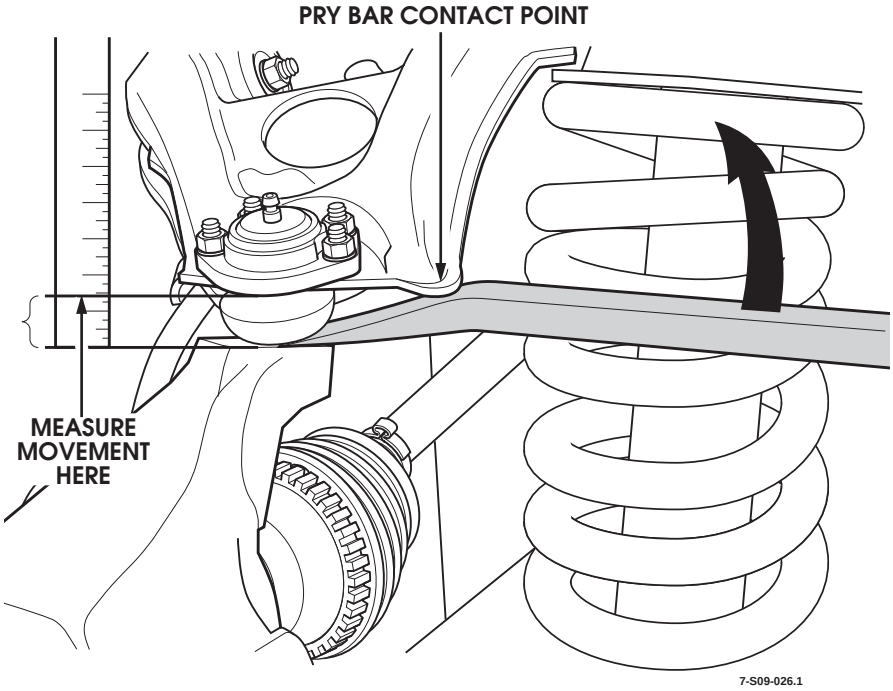


Figure 6-37: Upper Ball Joint Wear Check

6. Inspect the control arm bushings for wear or damage. Replace the bushings if necessary.
7. Check the lower ball joints: Support the lower control arm with a jack or stand to unload the lower ball joint. Place the pry bar between the lower arm at the ball joint and geared hub and measure the vertical play obtained by moving the pry bar down (Figure 6-38). Maximum play should not exceed 1/8" (3.5 mm). Replace the ball joint if end play exceeds the limit.
8. Check the steering center link, idler arm and tie rod ends for wear or damage (Figure 6-39). Replace the parts as needed before proceeding.
9. Check the idler and the steering arms by pulling the center link vertically up and down with a 50 lb. spring scale. Maximum allowable movement is 1/4 inch (7 mm), 1/8 inch (3.5 mm) up or down, when pulled within 2 inch (51 mm) of ball stud.
10. Lower the vehicle.
11. Check the tie rod end wear by trying to move the tie rod vertically and horizontally. Replace the tie rod end(s) if any movement is apparent.
12. Inspect the center link for distortion. The center link deformation will cause excessive front wheel toe. If the center link deformation is suspected, remove the suspect center link from the vehicle and place it on a level surface or next to a new center link. Carefully compare the two parts, checking for distortion and tapered hole wear. Replace the suspect center link if tapered holes are worn or if the center link is distorted.
13. Check the center link and stabilizer bar for cracks or distortion. Replace if necessary.
14. Inspect the stabilizer bar bushings for excessive wear and/or distortion. Replace if necessary.
15. Check the steering gear for looseness-to-frame, proper operation, and excessive leakage. Repair if necessary.

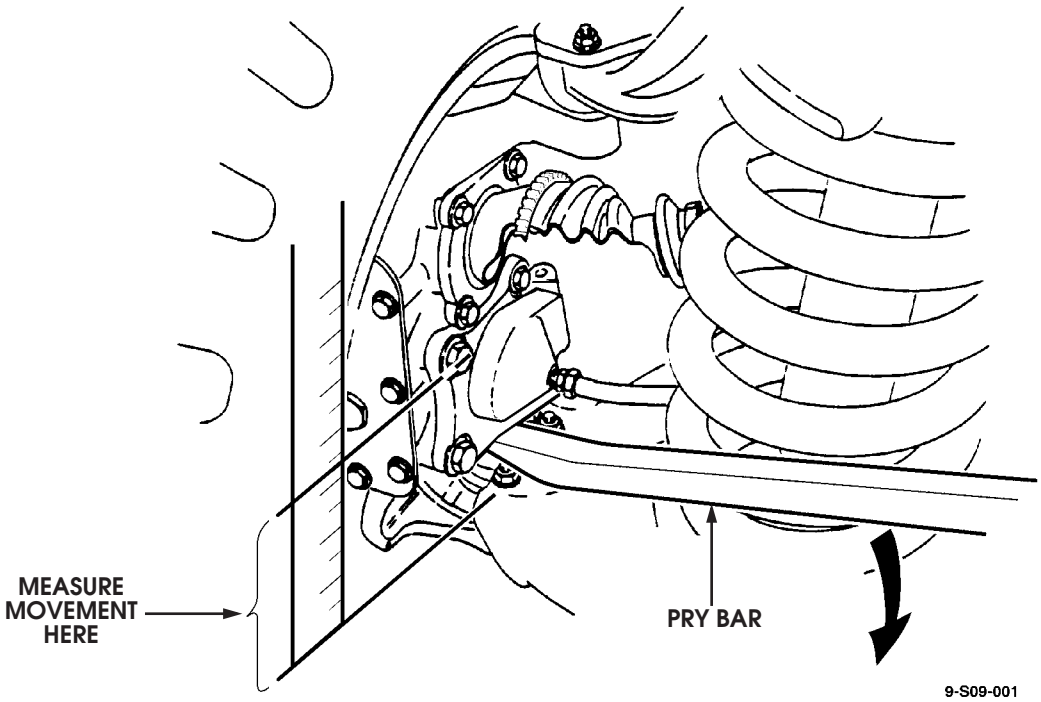


Figure 6-38: Lower Ball Joint Wear Check

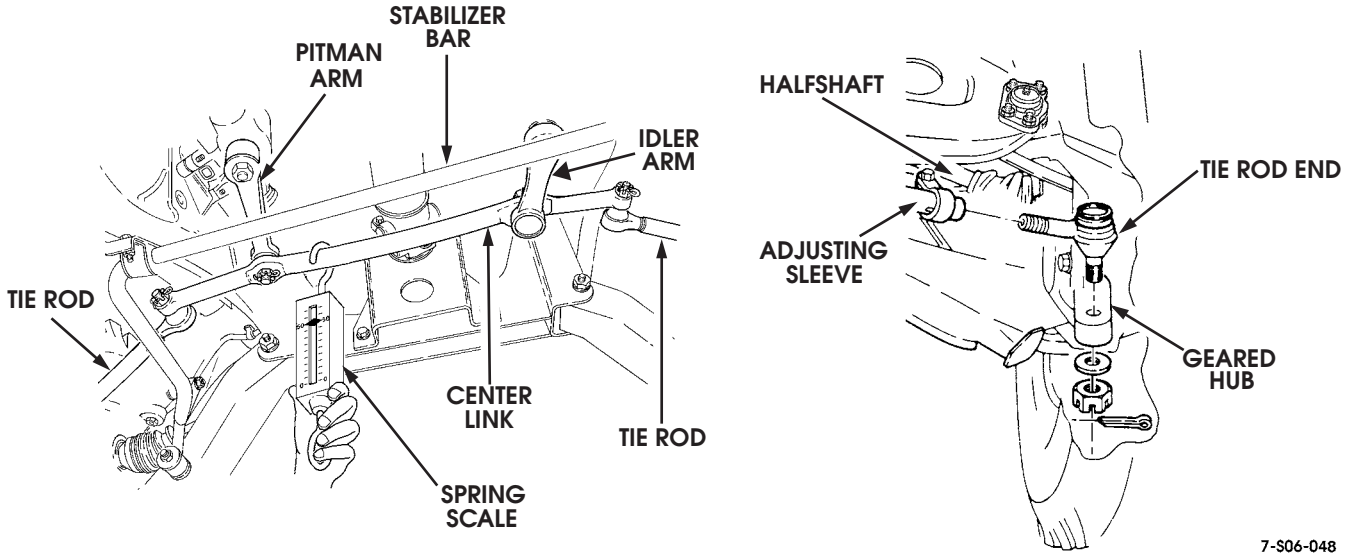


Figure 6-39: Suspension Component Identification

CHECKING WHEEL ALIGNMENT

1. Move the vehicle onto the alignment rack and position the front tires on the alignment rack turntables.
2. Place the front wheels in the straight ahead position on the turntables.
3. Install the alignment measuring equipment on the vehicle wheels. Follow the manufacturers instructions to avoid incorrect measurements.
4. Measure and record the caster, camber, toe-in, and the toe-out. Refer to the alignment specifications (Figure 6-40).
5. If the alignment angles are within specified limits, move the vehicle from the rack. However, if the angles are incorrect, leave the vehicle on the alignment rack and proceed to the Wheel Alignment Correction.

SERVICE WHEEL ALIGNMENT							
SUSPENSION POSITION	TIRE PRESSURE (PSI)	SERVICE CHECKING			SERVICE SETTING		
		CASTER (DEGREES)	CAMBER (DEGREES)	TOE-TOTAL (DEGREES)	CASTER (DEGREES)	CAMBER (DEGREES)	TOE-TOTAL (DEGREES)
FRONT	26	+1.5 to +4.0 (B)	-0.2 to +1.75 (B)	0 to +0.25 (C)	+2.5 to +3.5 (A)	+0 to +0.50 (A)	0 to +0.19 (C&E)
REAR	28	na	-0.2 to +1.75 (B)	-0.25 to 0 (D)	na	+.25 to +0.75 (A)	-0.19 to 0 (D&E)

To measure in inches, 0.1 degree = 1/16", 0.19 degrees = 1/8", 0.25 degrees = 5/32

(A) Left and right side to be equal within 0.5 degrees.

(B) Left and right side to be equal within 1.0 degrees.

(C) Toe-in (Positive sense) left and right sides to be set separately and evenly per wheel. Steering wheel must be held in a center position within + or - 5 degrees

(D) Toe-out (negative sense) left and right side to be set separately and evenly per wheel

(E) Left and right side toe settings to be equal within 0.10 degree

NOTE: Alignment settings should be checked and adjusted on a rack that allows all four wheels/tires to support vehicle weight.

Set wheel alignment while the vehicle is in its normally loaded condition.

Vehicles which are consistently operated with heavy on-board loads should have alignment adjusted with the vehicle under heavy on-board load.

Ride height should be checked and corrected if necessary and the hood should be closed while taking measurements (See “Suspension Height Measurement” Section 9).

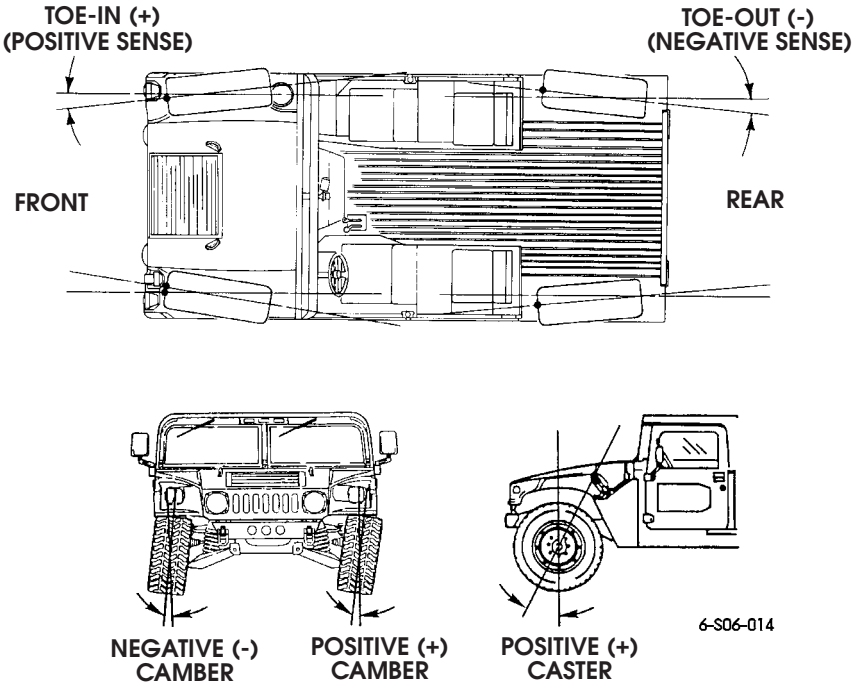


Figure 6-40: Wheel Alignment Information

WHEEL ALIGNMENT CORRECTION

Alignment adjustments should be performed one at a time and in sequence to avoid errors. Recommended adjustment sequence is:

a. caster
b. camber
c. front toe setting
d. rear toe setting
e. steering stops

Leave the vehicle on the alignment rack for each of the adjustment procedures. This way, the angle correction can be monitored continuously during the actual adjustment.

Caster Adjustment

Caster adjustment applies to the front wheels only. It is controlled by turning the pivot bolts and the eccentric washers on the upper control arm brackets (Figure 6-41). A positive caster angle is required on all HUMMER H1 vehicles.

Preferred caster angle is +2.5 to +3.5 degrees. Maximum allowable side-to-side variation is 0.5 degree.

1. Support the vehicle weight with the tires on the turntables.
2. Loosen the upper control arm pivot bolt locknuts by holding the bolt head and turning the locknut to allow movement of the bolts (Figure 6-41).
3. Pry the upper control arm brackets open to allow freedom of movement of the control arm bushings. The edges of the control arm bushings are serrated and will be difficult to move if the brackets are not pried open.
4. Adjust caster angle by turning the eccentrics on the upper control arm brackets in opposite directions (Figure 6-41).
   - Preferred caster is +2.5 to +3.5 degrees and left-right variation must not exceed 0.5 degree.
   - Turning the front eccentric outward and the rear eccentric inward increases positive caster while turning the front eccentric inward and the rear outward decreases it.
   - Shims are available in 0.060 inch and 0.120 inch (1.5 and 3.0 mm) thicknesses for use behind the control arm mount brackets if the proper angles cannot be achieved with the use of the eccentrics alone. This would be an unusual situation and the vehicle should be inspected thoroughly for bent or worn parts before installing shims.

NOTE: Refer to cam alignment nut torque adapter for proper use of tool J-45764-2.

5. Tighten the control arm pivot bolt nuts to 260 lb-ft. (359 N•m) using torque adapter J-45764-2.
6. Verify the correct caster angle at both front wheels. Be sure side-to-side caster variation does not exceed 0.5 degree.
7. Leave the vehicle on the rack for camber and toe adjustments.

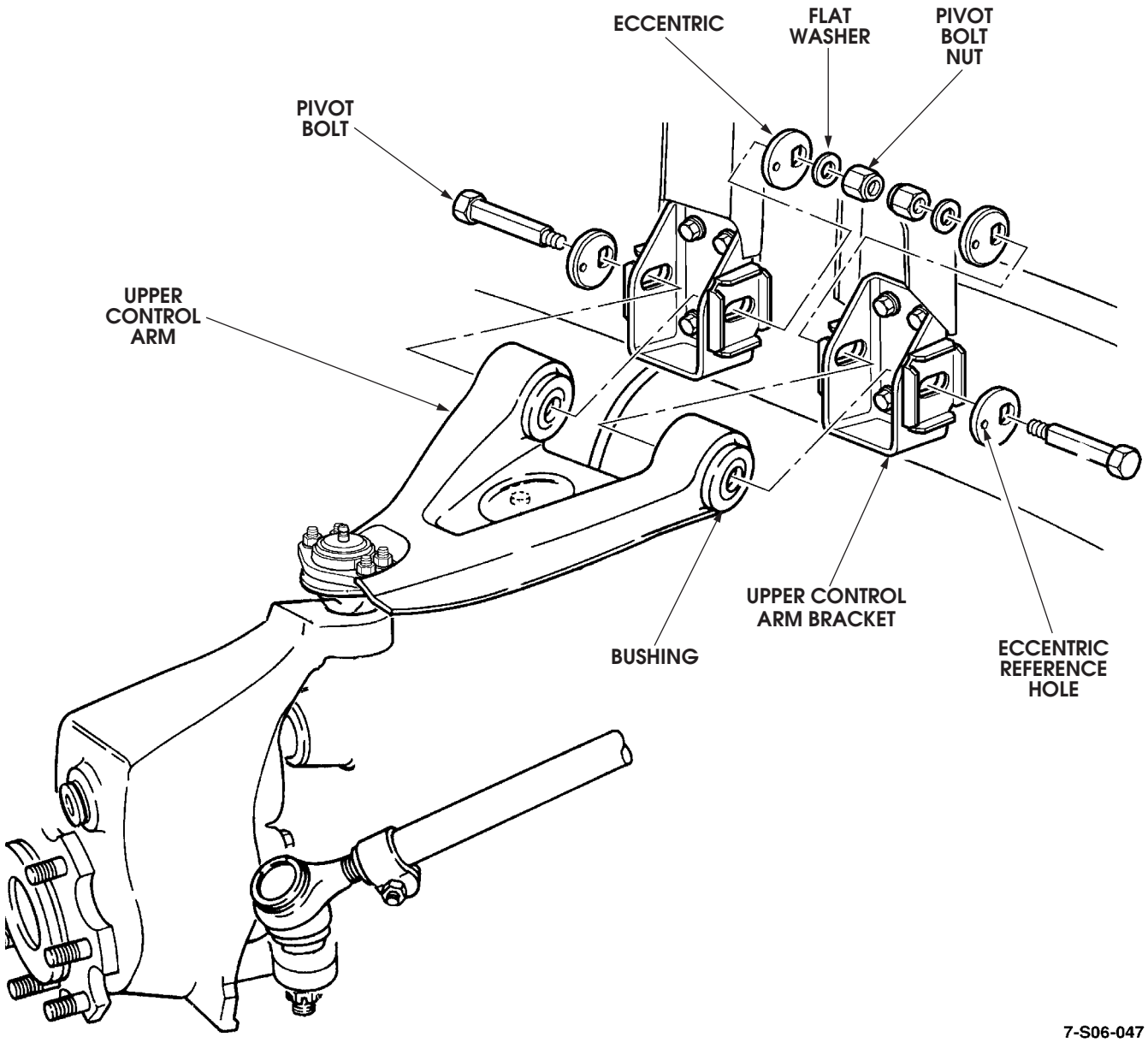


Figure 6-41: Caster/Camber Adjustment

Camber Adjustment (Front Wheels)

Camber adjustment for the front wheels is controlled by turning the pivot bolts and eccentric washers on the upper control arm brackets (Figure 6-41).

Preferred camber for all HUMMER H1 vehicles is zero to +0.5 degree. Maximum allowable side-to-side variation is 0.5 degree.

1. Support the vehicle weight with the tires on the turntables and leave the hood closed.
2. Loosen the upper control arm pivot bolt nuts by holding the bolt head and turning the nut to allow movement of the bolts (Figure 6-41).
3. Pry the upper control arm brackets open to allow freedom of movement of the control arm bushings. The edges of the control arm bushings are serrated and will be difficult to move if the brackets are not pried open.
4. Adjust the camber angle by rotating the front eccentric of the upper control arm bracket (Figure 6-41).
   - Rotating the front eccentrics inward decreases camber (negative direction) while rotating the front eccentrics outward increases the camber (positive direction).
   - Rotating the rear eccentrics of each upper control arm inward or outward in conjunction with the front eccentrics will help maintain the previously set caster angle.

NOTE: Refer to cam alignment nut torque adapter for proper use of tool J-45764-2.

5. Tighten the control arm pivot bolts to 260 lb-ft (359 N•m) using torque adapter J-45764-2.
6. Verify the correct camber angle at both front wheels. Be sure side-to-side variation does not exceed 0.5 degree.
7. Leave the vehicle on the rack for toe settings and the steering stop adjustment.

CAM ALIGNMENT NUT TORQUE ADAPTER

1. Determine the effective length of the torque wrench (A) by measuring the distance from the center of the square drive to the center of the area covered by the operator's hand (Figure 6-42).
2. The length of the torque adapter (B) (J–45764-2) is 4 inches.
3. When used in the straight or180 degree position, the following formula must be used:

$$\frac{\text{Specified Torque x Wrench Length (A)}}{\text{Wrench Length (A)} + \text{Adapter Length (B)}}$$

Example: 260 (Specified Torque) x 18.5 (Wrench Length) ÷ by 18.5 (Wrench Length) + 4 (Adapter Length) = 213.7 lb-ft.

4. When the adapter is used at 90 degrees to the torque wrench the specified torque will be the same as the wrench setting.
5. Using the adapter at any other angle to the torque wrench requires the above formula with the adjusted or effective length of the adapter (B), which will be a value between 0 and 4 inches.

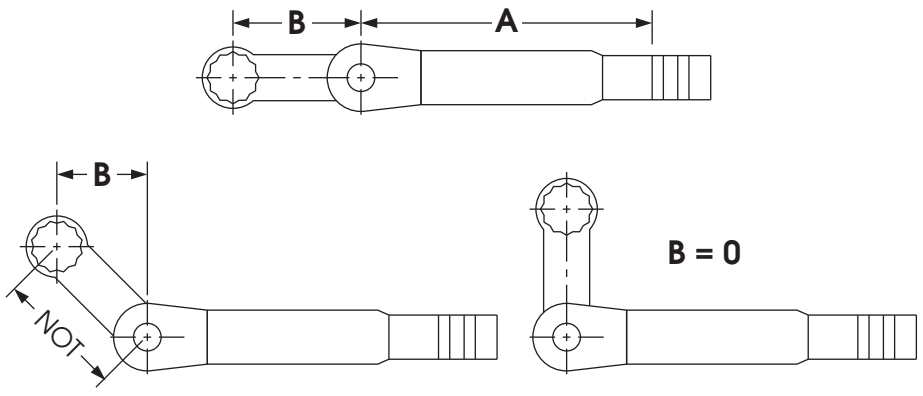


Figure 6-42: Cam Alignment Nut Torque Adapter

Camber Adjustment (Rear Wheels)

Camber adjustment for the rear wheels is controlled by shims installed between each upper control arm bracket and the airlift bracket.

Preferred camber for all HUMMER H1 vehicles is +0.25 to +0.75 degrees at the rear. Maximum allowable side-to-side variation is 0.5 degree.

1. Support lower control arms and geared hubs with jack built into alignment rack. Or, use floor jack and jack stands if rack is not equipped with built-in-jack.
2. Remove front and/or rear wheels as needed.
3. Remove upper control arm pivot bolts. Retain bolts and washers but discard nuts if they are lock-type.
4. Loosen bolts that attach upper control arm brackets to airlift bracket and frame. Do not remove the bolts; just loosen them.
5. Adjust camber angle by changing shim between each control arm bracket and airlift bracket (Figure 6-64).
   - Use the same thickness shims between each control arm bracket and the airlift bracket.
   - A thicker shim increases positive camber by 0.6º. A thinner shim increases positive camber by 0.3º. Shims are available in 0.060 inch and 0.120 inch (1.5 and 3.0 mm) thicknesses for adjustment purposes.
6. Add or remove shims as needed. Then tighten the control arm and airlift bracket attaching bolts to 90 ft-lb (122 N•m) torque.

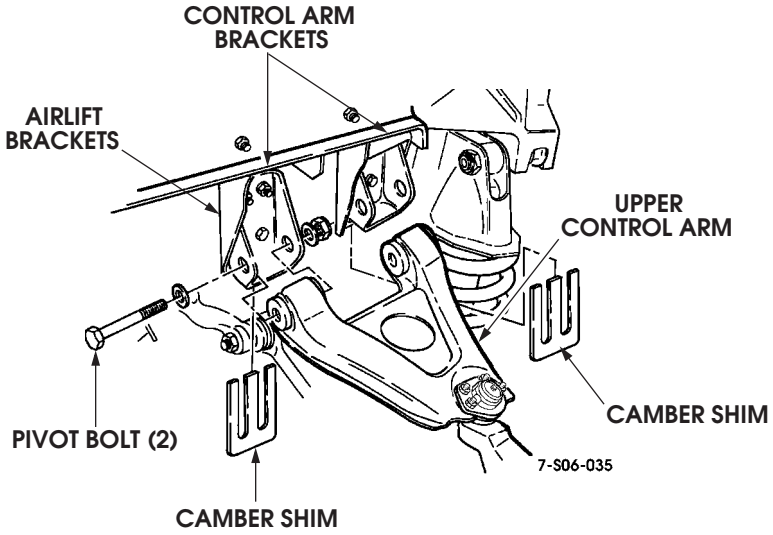


Figure 6-43: Camber Shim Location (Left Rear Shown)

7. Install but do not fully tighten the upper control arm pivot bolts.
8. Install the rear wheels as needed.
9. Remove supports and position wheels on turntables.
10. Tighten control arm pivot bolts to 260 ft-lb (352 N•m) torque.
11. Verify correct camber angle at both rear wheels. Be sure side-to-side variation does not exceed 0.5 degree.
12. Leave vehicle on rack for toe settings and steering stop adjustment.

Front Wheel Toe Adjustment

1. Position both front wheels on the alignment rack turntables. Set the front wheels in the straight-ahead position and center the steering gear.
2. Loosen the adjusting sleeve clamps on both tie rods (Figure 6-44).
3. Turn the sleeves until the toe measurement is within specifications.
4. Tighten the adjusting sleeve clamp nuts and verify the correct toe adjustment.

CAUTION: *Be sure that the bolt and nut on the adjusting sleeve clamp nut nearest to the geared hub is facing the halfshaft. The bolt and nut on the adjusting sleeve clamp nearest to the frame must be facing away (180 degrees) from the stabilizer bar. After adjustment, the lengths of both tie rod end assemblies should be the same, plus or minus 1/16 inch (1.6 mm).*

CAUTION: *The sleeve clamps must be positioned between 3/16” and 5/16” from the end of the sleeve and the bolt and nut torqued to 30 lb-ft (41 N•m) (Figure 6-46).*

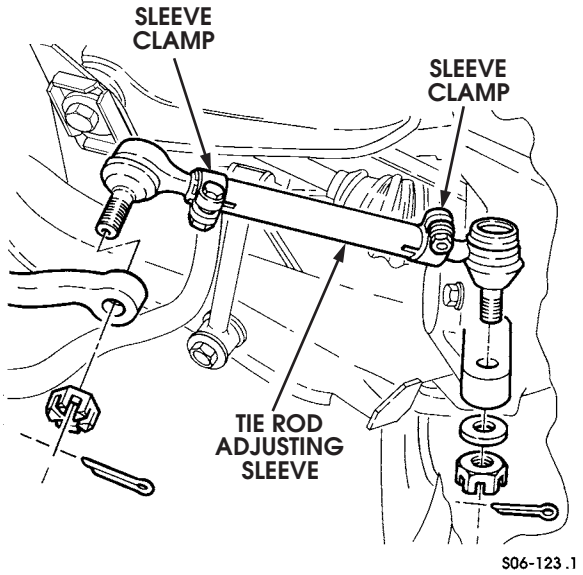


Figure 6-44: Front Wheel Toe Adjustment Points

5. Verify that the steering wheel is centered. Move the steering wheel to the straight-ahead position if necessary.

Rear Wheel Toe Adjustment

1. Position both rear wheels on the alignment rack turntables.
2. Loosen the clamps on both radius rods(Figure 6-45).
3. Turn the adjusting sleeves until the toe measurement is within specifications.
4. Tighten the clamp nuts and verify the toe adjustment.

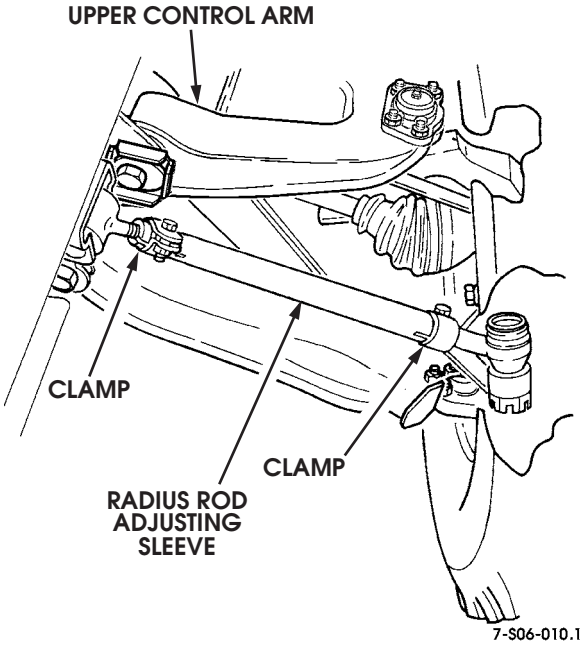


Figure 6-45: Rear Wheel Toe Adjustment Points

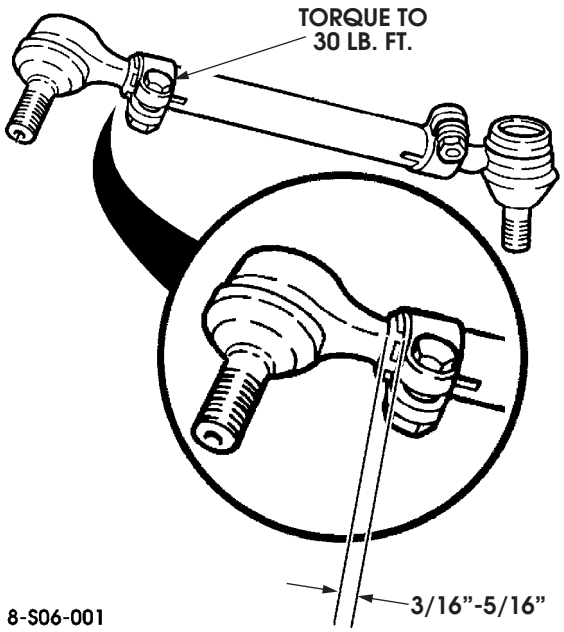


Figure 6-46: Sleeve Clamp Position

STEERING STOP ADJUSTMENT

NOTE: Alignment equipment currently used in the automotive field should be used for steering stop adjustment procedure. This procedure should be followed if alignment equipment is not available.

Removal

1. Loosen the jam nut and remove the bolt and the jam nut from the geared hub (Figure 6-47).
2. Remove the jam nut from the bolt.

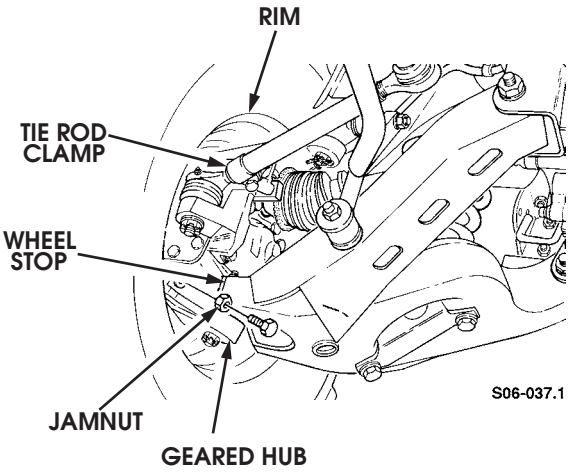


Figure 6-47: Steering Stop Adjustment

Installation

1. Apply thread-locking compound to the bolt (Figure 6-48).
2. Thread the jam nut on the bolt.
3. Secure the bolt and jam nut to the geared hub. Tighten the bolt finger tight.

Adjustment

NOTE: Prior to adjustment, ensure the length of each tie rod is the same. If the tie rod lengths are not the same ± 1/8 in. (3 mm), check the toe-in alignment setting.

1. Draw a reference chalk line 30 feet long. Mark this line A (Figure 6-48).
2. Position the vehicle so that center of left rear and left front tires are positioned directly on the reference line A.
3. Using a protractor, draw a reference line at 34 degrees from line A. Mark this line B.
4. Again, using a protractor, draw a reference line at 36 degrees from line A. Mark this line C.

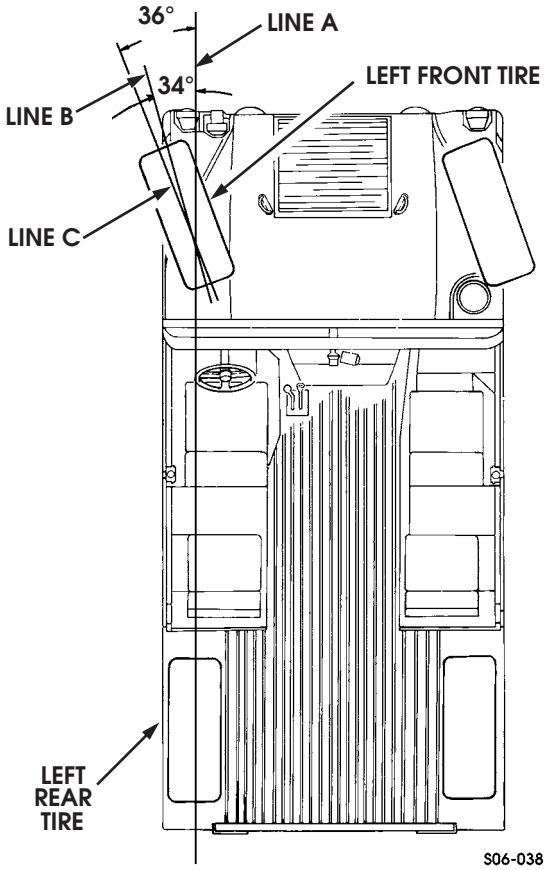


Figure 6-48: Checking Alignment

5. Roll the vehicle forward until the center of the left front tire is over the intersection of lines A, B, and C.
6. Turn the steering wheel full left.
7. If the center line of the front and rear of the left front tire is over the area between lines B and C, no adjustment is necessary.
8. If the center line of the front and rear of the left front tire is not over the area between lines B and C, loosen the jam nut and turn the bolt all the way in.
9. Turn the steering wheel until the center line of the front and rear of the left front tire is over the area between lines B and C.
10. Unscrew the bolt until the head makes contact with the wheel stop on the lower control arm (Figure 6-47).
11. Secure the bolt with the jam nut.
12. Check for clearance between the tie rod clamp and the rim.
13. Repeat the adjustment procedure for the opposite side.

CENTRAL TIRE INFLATION SYSTEM

The optional Central Tire Inflation System (CTIS) is unique to the HUMMER H1. The CTIS allows the driver to increase or decrease tire pressure based on terrain and climate conditions. The system can also be used to direct air to a tire that has a leak.

The CTIS controls are located on the instrument panel. An inflate/deflate switch determines if air is added to the tires or released from the tires. When the tires are being inflated, an indicator light on the instrument panel illuminates. If the pressure in any of the tires drops to 8 psi (55 kPa) or below, the low pressure indicator light will illuminate and an alarm will sound. If the tire pressure

ever exceeds 55 psi (379 kPa), a relief valve automatically relieves any excess pressure. The tire selector valve position determines whether the pressure in the front, rear or all four tires will be adjusted. The air pressure gauge indicates the current pressure in the tires. Refer to the short, white needle for front tire pressure and the longer, orange needle for the pressure in the rear tires. Temperature rise and fall affects air pressure in a tire. As the vehicle is operated it is typical for the air pressure to rise 3-5 psi (21-34 kPa). As the wheels and tires cool down, the air pressure will drop. This is normal and such a drop in tire pressure does not indicate any leaks in the system.

The CTIS consists of an electric air compressor that pumps air through a series of valves, tubes, and hoses to the front and/or rear tires. Compressed air travels through the manifold where three electric valves connected in parallel direct the compressed air to the front, rear or both tires. When deflation is selected, air is routed from the tires through the three electric valves and is exhausted through the deflate valves (Figure 6-49).

Each wheel assembly has a manual quick-disconnect valve which can be used to prevent air flow to and from the tire, such as during long-term storage or while changing a tire. If the vehicle will remain dormant for two weeks or more, it is a good practice to disconnect the system at the wheels. These quick-disconnect valves are also used to restrict air flow to the operational tires when the driver wants to direct air flow to a damaged tire. For example, if a tire has a small puncture and has a leak, the quick-disconnect valves on the operational tires can be disconnected, enabling compressed air to be directed exclusively to the leaking tire. This may maintain enough tire pressure in the leaking tire to allow the driver to get the vehicle to an appropriate location for safe tire repair or replacement (Figure 6-50).

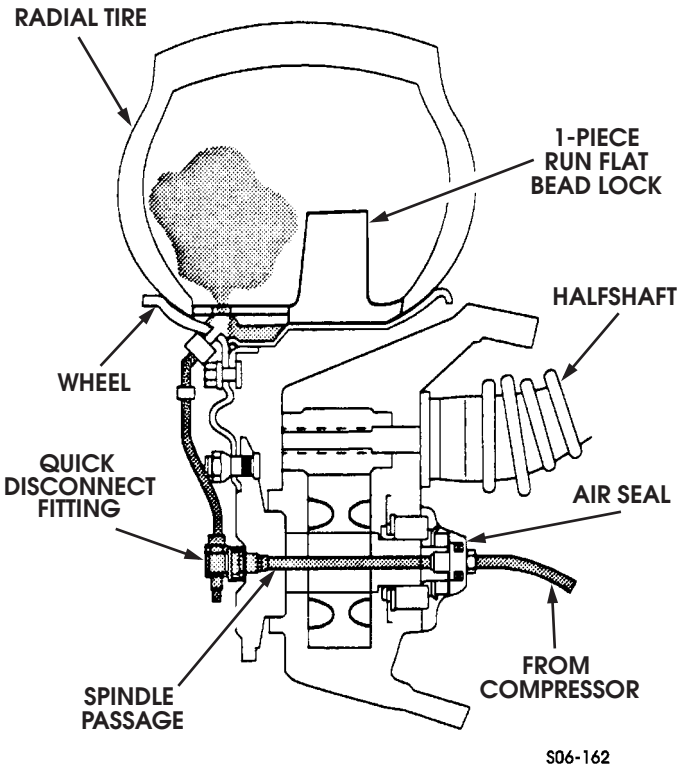


Figure 6-49: Central Tire Inflation System (CTIS)

To disconnect the CTIS from the wheel assemblies, first turn inflate/deflate switch to the OFF position. Release the four quick-disconnect valve assemblies from all four spindles by depressing the quick-disconnect valve tabs attached to the valve spindle nuts(Figure 6-50). When the tabs are depressed, the valve assemblies will spring away from the spindles about 1/2 inch (12.7 mm). To reconnect the quick-disconnect valve assemblies, push the valve assemblies toward the spindles until they click into place.

CTIS TROUBLESHOOTING

The following pages contain troubleshooting information for locating and correcting mechanical, pneumatic, and electrical problems that may develop with the CTIS.

Electrical Troubleshooting

Symptoms are listed for system malfunctions, and procedures and corrections are diagramed to assist service technicians.

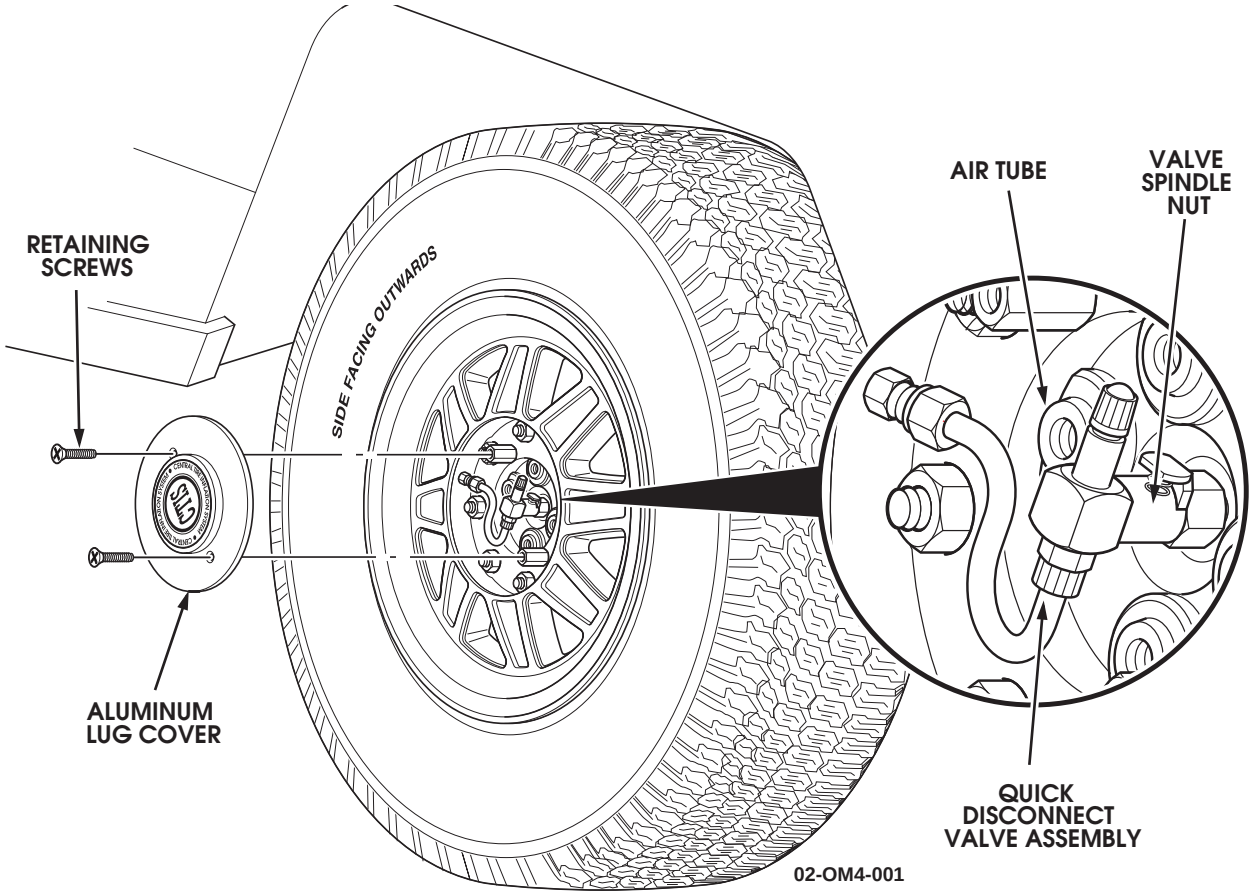


Figure 6-50: Quick-Disconnect Tab

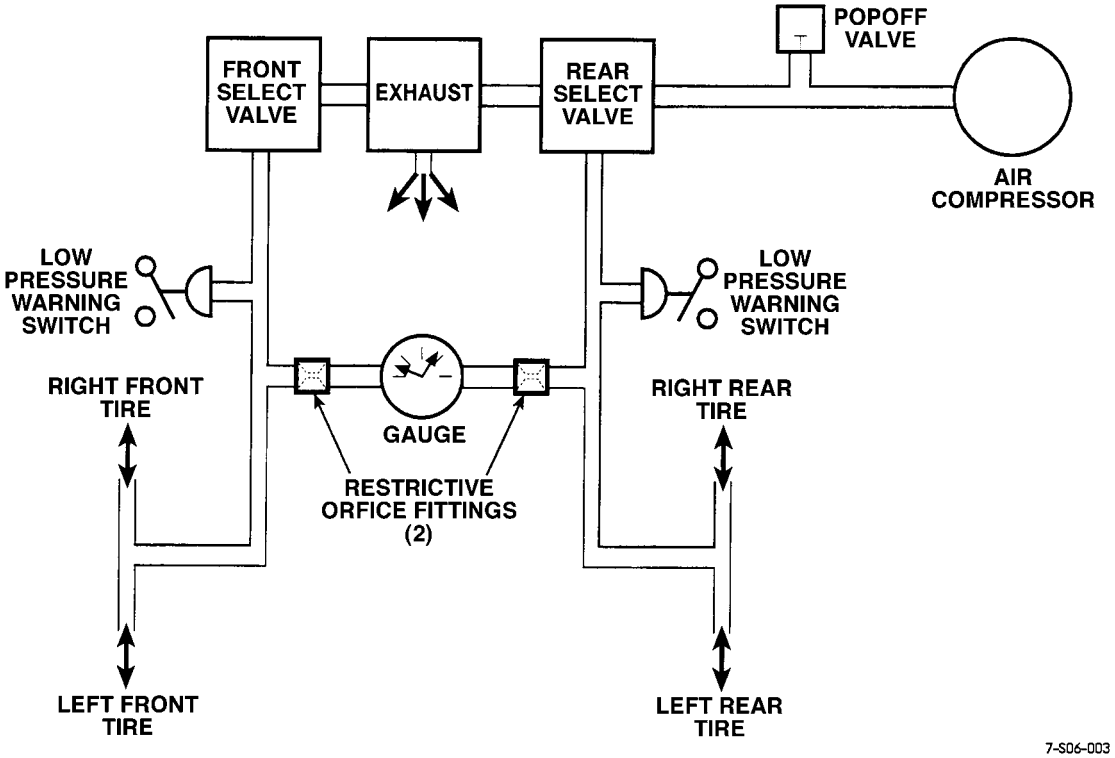


Figure 6-51: Pneumatic Diagram for Central Tire Inflation System

CTIS AIR LEAK TROUBLESHOOTING

This section contains troubleshooting information for locating and correcting air leaks within the Central Tire Inflation System.

WARNING: The CTIS air system components are subject to high pressure. Always relieve the air pressure before loosening or removing any of the air system component(s) by disconnecting the quick-disconnect valve assemblies at each wheel end. Failure to follow this warning may result in serious personal injury.

CTIS Troubleshooting Checklist

1. Fill all the tires to at least 40 psi (270 kPa) using the on-board compressor or a shop air source.
2. Note the needle positions on the air gauge. If the needles are not even, line them up by inflating the lower pressure tires. Then return the inflate/deflate switch to OFF.

NOTE: The tires are isolated from the rest of the system so that the areas between the compressor selector valve and geared hubs and selector valve can be isolated and checked.

3. Isolate each tire and wheel assembly by disconnecting each quick-disconnect valve.
4. After the tires have been isolated, measure and record each tire's air pressure.
5. After a minimum of 10 minutes, check to see if the air gauge needles have moved.

NOTE: Leaks can be detected by using soapy water, but commercially available leak detection liquids such as "Gaz-Tec" work best. Most leaks can be corrected by tightening the fittings. Replace the fittings or air lines only when necessary.

6. Determine if the front, rear, or both air systems have leaked. If a leak is detected, concentrate on that area and follow the appropriate troubleshooting chart.
   - Geared Hubs, Seals, and Fittings - Chart 1
   - Deflate Valve Area - Chart 2
   - Under the Vehicle Air Leak - Chart 3
7. After checking and repairing the leak points, place the selector switch in the BOTH position.
8. Note the gauge needle positions. Reposition or re-inflate to align the needles.
9. Wait at least two minutes and check to see if the needles have moved. If movement is detected, concentrate on detecting the leak point. Follow Refer to Troubleshooting Chart 4 – Air Compressor Leak Test in this Section..

NOTE: If the tires were hot, air loss may be a result of the tires cooling down. If this is the case, all tires should lose about the same amount of air.

10. Check the air pressure in each tire and compare it to the information taken earlier. Note any air pressure loss and concentrate on that tire position. Refer to Troubleshooting Chart 5– Tire and Quick-Disconnect Valve in this Section..

If no air loss is detected, there may be a small leak which will require an overnight evaluation.

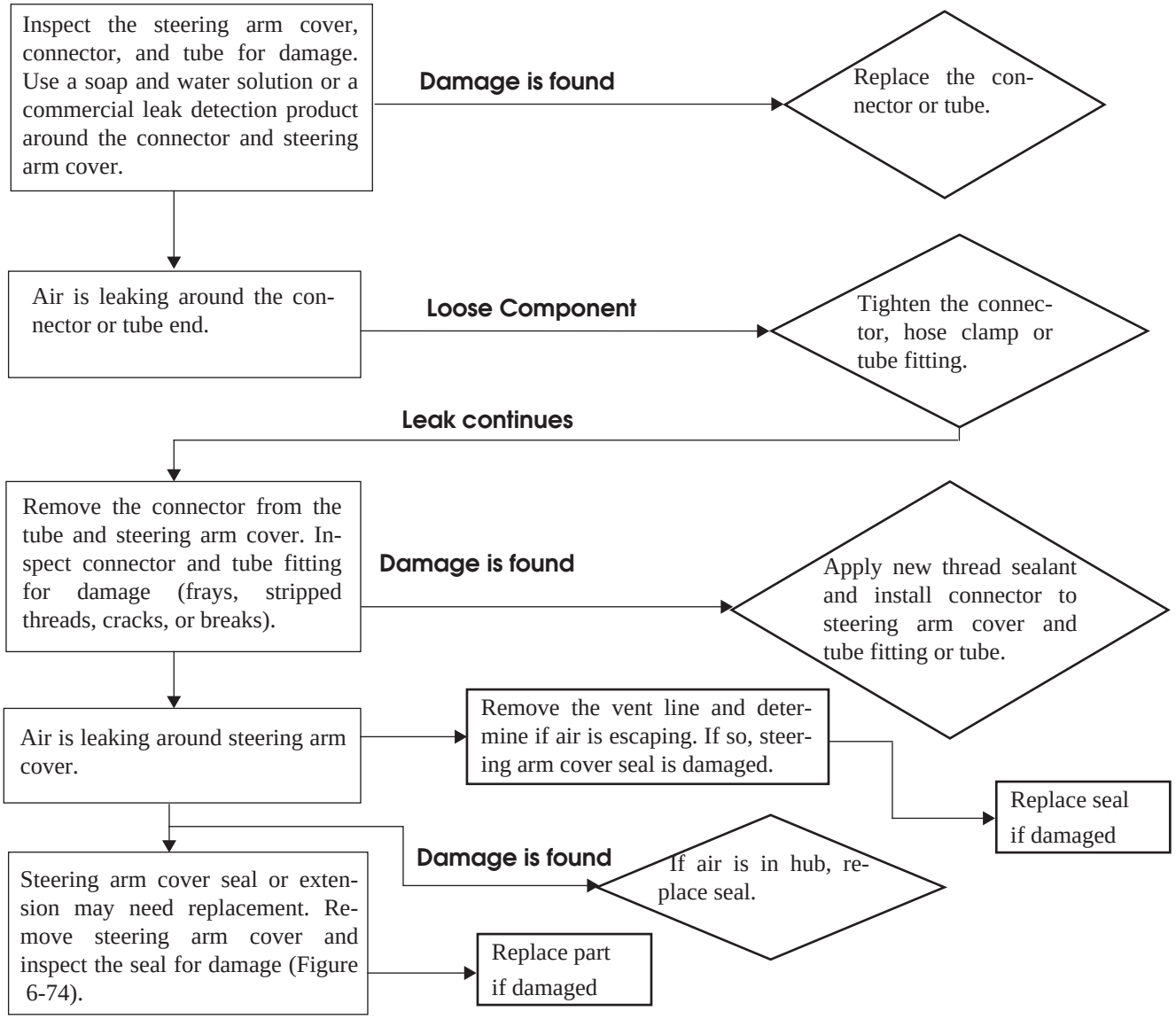
NOTE: Always complete the entire troubleshooting procedure to ensure that all potential leak points have been corrected.

Verification

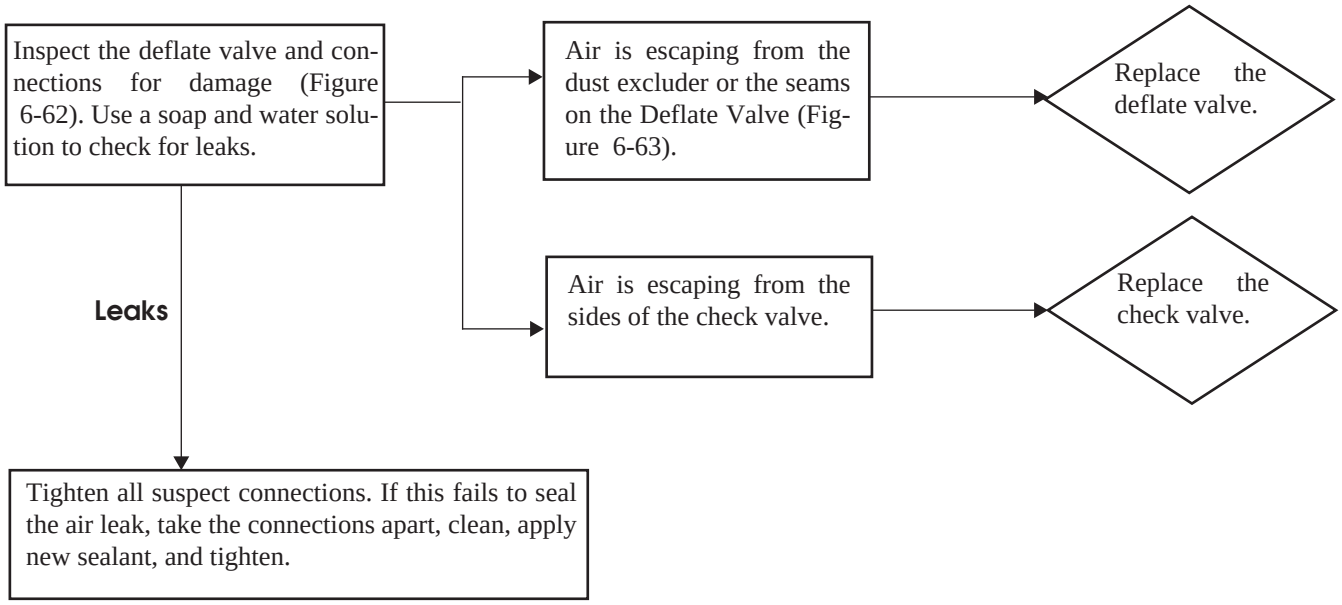
After completing the troubleshooting procedure, verify the system by repeating the CTIS Troubleshooting checklist steps.

WARNING: The CTIS air system components are subject to high pressure. Always relieve the air pressure before loosening or removing air system component(s) by disconnecting quick-disconnect valve assemblies at each wheel end. Failure to follow this procedure may result in serious personal injury.

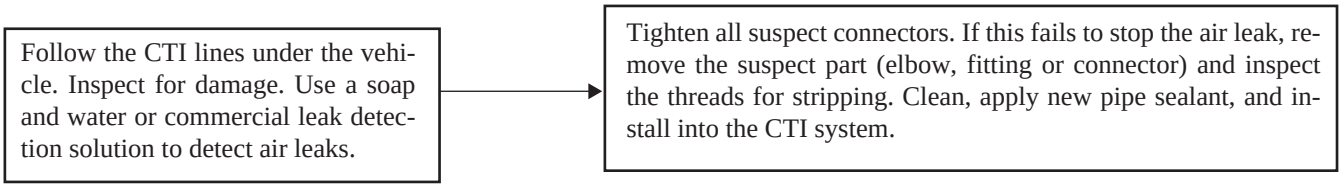
Troubleshooting Chart 1 – Geared Hubs, Seals and Fittings



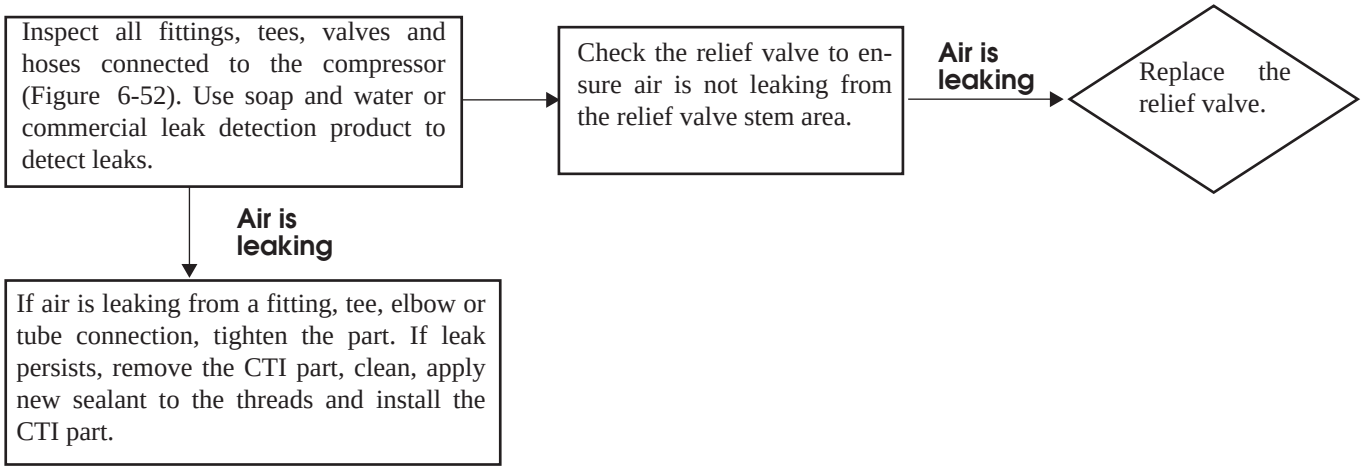
Troubleshooting Chart 2 – Deflate Valve Area



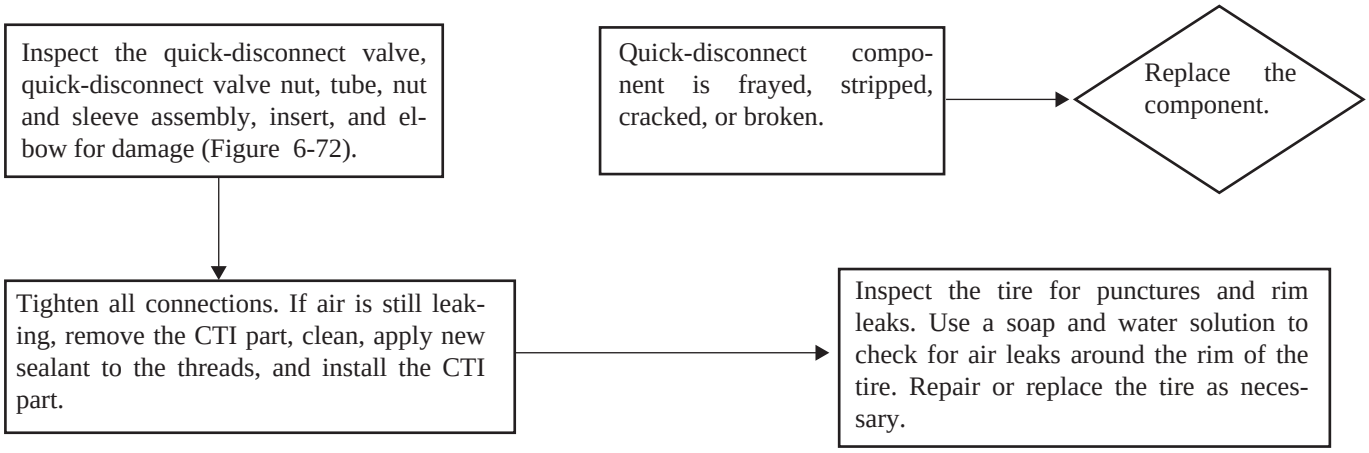
Troubleshooting Chart 3 – Under The Vehicle Air Leak



Troubleshooting Chart 4 – Air Compressor Leak Test



Troubleshooting Chart 5– Tire and Quick-Disconnect Valve



CTIS Leak Detection Test

1. Start the engine and inflate the front and rear tires to 40 psi (276 kPa).
2. Turn the tire selector switch to OFF.
3. Turn the engine OFF.
4. Remove the air vent line located at the air intake horn and listen for air escaping through the vent line.
5. Remove the transmission dipstick from the dipstick tube and listen for air or transmission fluid escaping through the dipstick tube.
6. If air or fluid is detected in steps 4 or 5, inspect the steering arm cover seals using the CTIS leak isolation test.

CTIS Leak Isolation Test

1. Start the engine and inflate the front and rear tires to 40 psi (276 kPa).
2. Turn the tire selector switch to OFF.
3. Turn the engine OFF.
4. Close (release) all four wheel quick-disconnect valves.
5. Remove the vent line from one geared hub.
6. Open (engage) the quick-disconnect valve at this wheel to allow air pressure from the tire to enter bored passage inside the geared hub.
7. Listen for escaping air around the steering arm seal through the geared hub vent opening.
8. If air is escaping through the vent line fitting, replace the steering arm seal (Section 8).
9. Inspect the other three geared hubs using steps 5, 6, 7, and 8 above.
10. Replace the defective seals as required, then retest system.

CTIS Leak Down Testing

NOTE: Suspected air loss in the CTIS after the vehicle has been parked for several days may be attributed to one of the following: improperly seated O-rings, loose air line connection(s), quick-disconnect valve(s) not connected, tire leak(s), faulty valve(s), or a faulty steering arm cover seal. Suspected air leak(s) may be detected using a soap/water solution or equivalent. O-rings that appear to be cut, distorted, or suspected of leaking should be replaced. When traversing off road in extremely muddy terrain, the dust excluder should be inspected for trapped mud.

1. Verify the quick-disconnect valves are connected to the wheels.
2. Apply the parking brake. Start the engine and allow to idle.
3. Place the tire selector switch to BOTH position and inflate/deflate switch to the INFLATE position.
4. Observe the air pressure gauges until the air pressure reaches 40 psi (276 kPa).
5. Place the inflate/deflate switch to the OFF position, and stop the engine.

6. Record the tire pressure on the instrument panel gauges and the right-rear tire pressure. Compare the recorded pressures to the readings taken 30 minutes later, If more than one (1) pound has leaked, check the system as described above to detect where the leak is located.

COMPRESSOR SERVICE

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure the hood.
2. Disconnect the power and the ground leads from the compressor(Figure 6-52).
3. Loosen the clamp securing the air intake hose to the fitting and disconnect the hose from the fitting.
4. Disconnect the compressor-to-air manifold hose from the street tee at the compressor.
5. Loosen the two clamps securing the compressor to the bracket and remove the compressor.
6. Remove the street tee from the compressor.

Cleaning and Inspection

Clean and inspect the compressor, leads, fittings, and the mounting hardware. Check for cracks, frayed wire, stripped threads, and improper operation. Replace the defective parts.

Installation

CAUTION: *Do not allow sealant into the air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to all the threads before installation.

1. Install the compressor on the bracket, and secure with two clamps.
2. Connect the compressor-to-air manifold hose to the street tee.
3. Connect the air intake hose to the fitting, and secure with the hose clamp.
4. Connect the power and the ground leads to the compressor.
5. Check the compressor for correct operation.
6. Check for any leaks.
7. Lower and secure the hood.

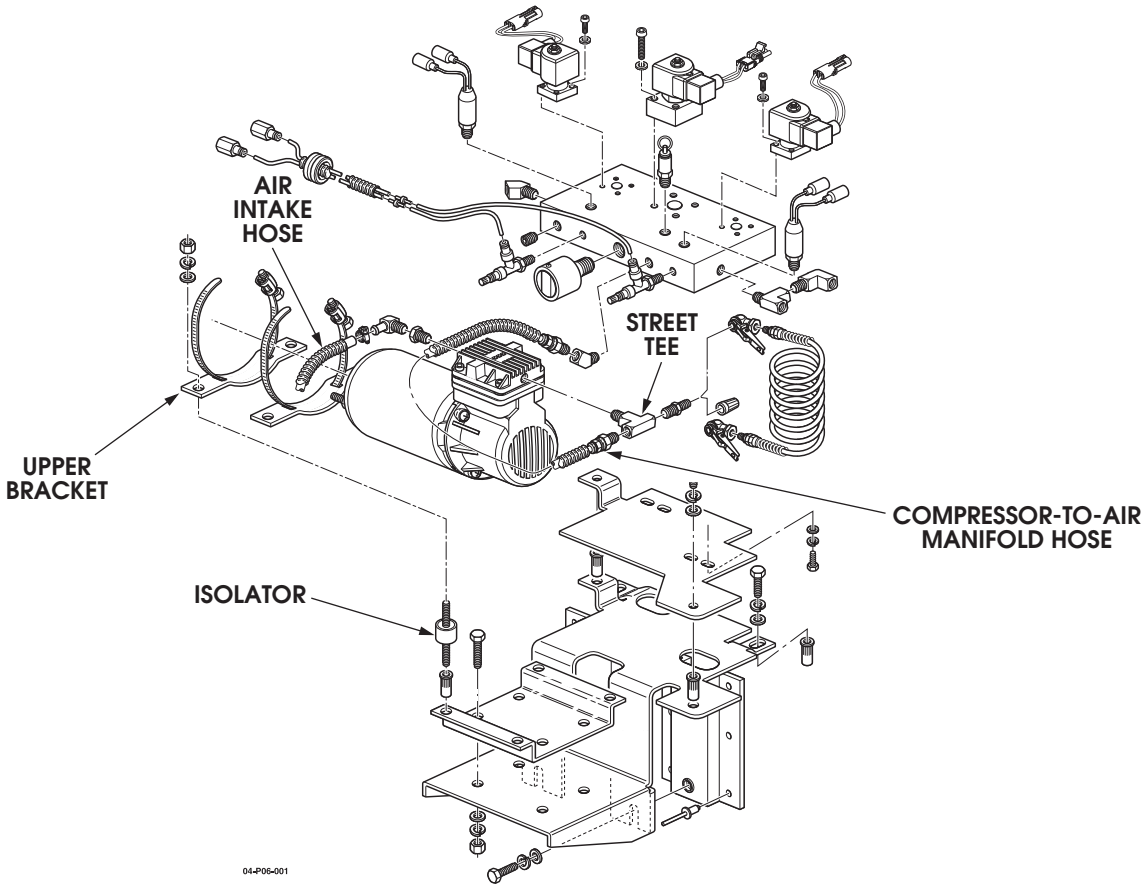


Figure 6-52: CTIS Compressor

CTIS INSTRUMENT CLUSTER

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: Prior to removal, tag all the harness connectors and air lines for installation.

Removal

1. Remove the four screws securing the CTIS module to the instrument panel and gain access to the back of the CTIS module.
2. Disconnect the air lines, the illumination bulb and socket from the back of the air pressure gauge.
3. Disconnect the harnesses from the back of the inflate/deflate switch and the selector switch.
4. Disconnect the harness from the CTIS indicator module circuit board.

Module Disassembly

1. To remove the inflate/deflate switch from the module apply pressure to the back side of the switch and push the switch through the plastic bezel. The selector switch can be removed the same way.
2. Removal of the air pressure gauge is achieved by removing the two retaining nuts.
3. Remove the retainer bracket and slide the gauge out the front of the module bezel.

Module Assembly

1. Install air pressure gauge in the module bezel and position the retainer bracket over the threaded air inlets.
2. Install the retainer nuts over the air inlets and tighten.

3. Install the switches by sliding them, harness side first, through the input holes on the CTIS module bezel. A small “pop” should be heard as the switch seats in the bezel.

Installation

1. Connect the air pressure lines, illumination bulb and socket, in the original positions, to the back of the air pressure gauge.
2. Install the harness for the inflate/deflate switch and the selector switch.
3. Install the harness for the CTIS indicator module circuit board.

NOTE: Be careful not to over tighten the retaining screws.

4. Position the CTIS module on the instrument panel and secure with the four retaining screws.

INFLATE/DEFLATE AND TIRE SELECTOR SWITCHES

Removal

1. Remove the CTIS instrument cluster panel.
2. Disconnect the harness connectors from inflate/deflate switch and tire selector switch (Figure 6-53).
3. Remove the inflate/deflate and tire selector switches from the CTIS instrument cluster and housing.

Cleaning and Inspection

Clean and inspect the inflate/deflate and the tire selector switches for damage. Replace the defective parts.

Installation

1. Install the inflate/deflate and the tire selector switches in the housing on the CTIS instrument cluster(Figure 6-53).
2. Connect the connector to switches.
3. Install the CTIS instrument cluster panel.
4. Start the engine and ensure the switches operate properly.

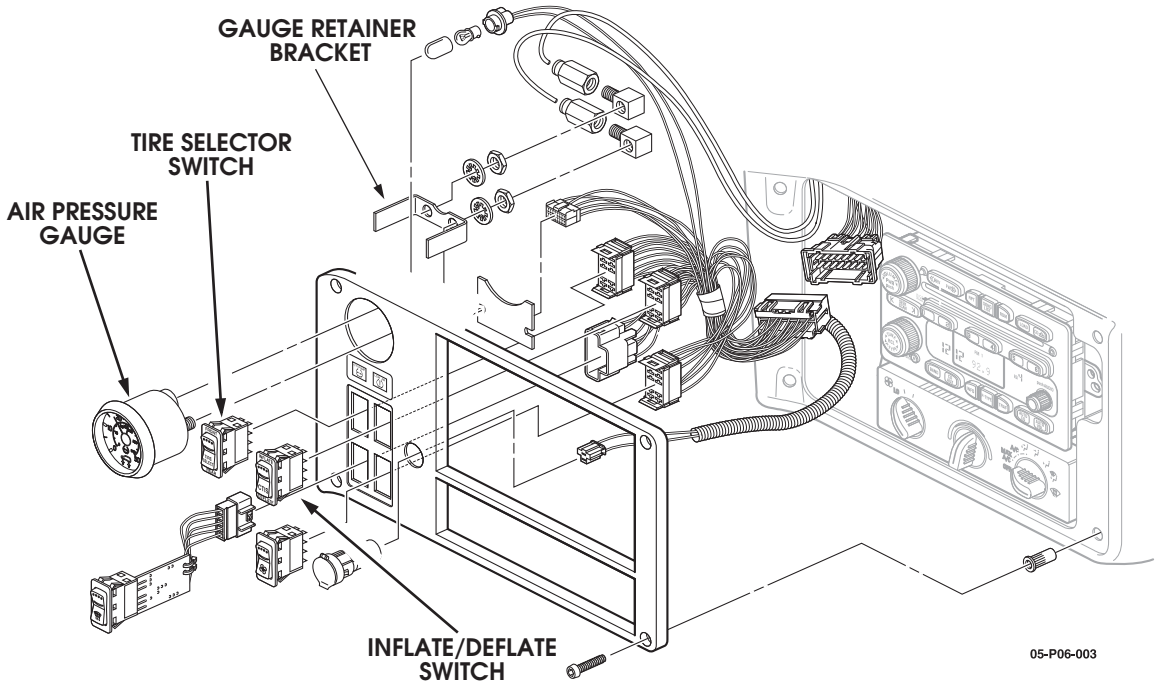


Figure 6-53: CTIS Module Exploded View

AIR PRESSURE GAUGE

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Remove the CTIS module from the instrument panel.
2. Remove the lamp from the air pressure gauge (Figure 6-54).
3. Disconnect the two air pressure indicator lines from the air pressure gauge.
4. Remove the two nuts, lock washers, bracket and air pressure gauge from the CTIS module (Figure 6-54). Discard lock washers.

Cleaning and Inspection

Clean and inspect the air pressure gauge and lamp. Check for cracks and stripped threads. Replace the defective parts.

CAUTION: *Do not allow sealant into the air system. Sealant will damage CTIS components.*

NOTE: Apply sealant to the threads prior to installation.

Installation

1. Install the air pressure gauge and bracket on the CTIS module with two nuts and lock washers. Tighten the nuts to 8 lb-in. (0.9 N•m)(Figure 6-54).
2. Connect the air pressure indicator lines in the original position.
3. Install the lamp in air pressure gauge.
4. Install the CTIS module in the instrument panel.
5. Start the engine and ensure the air pressure gauge operates properly.

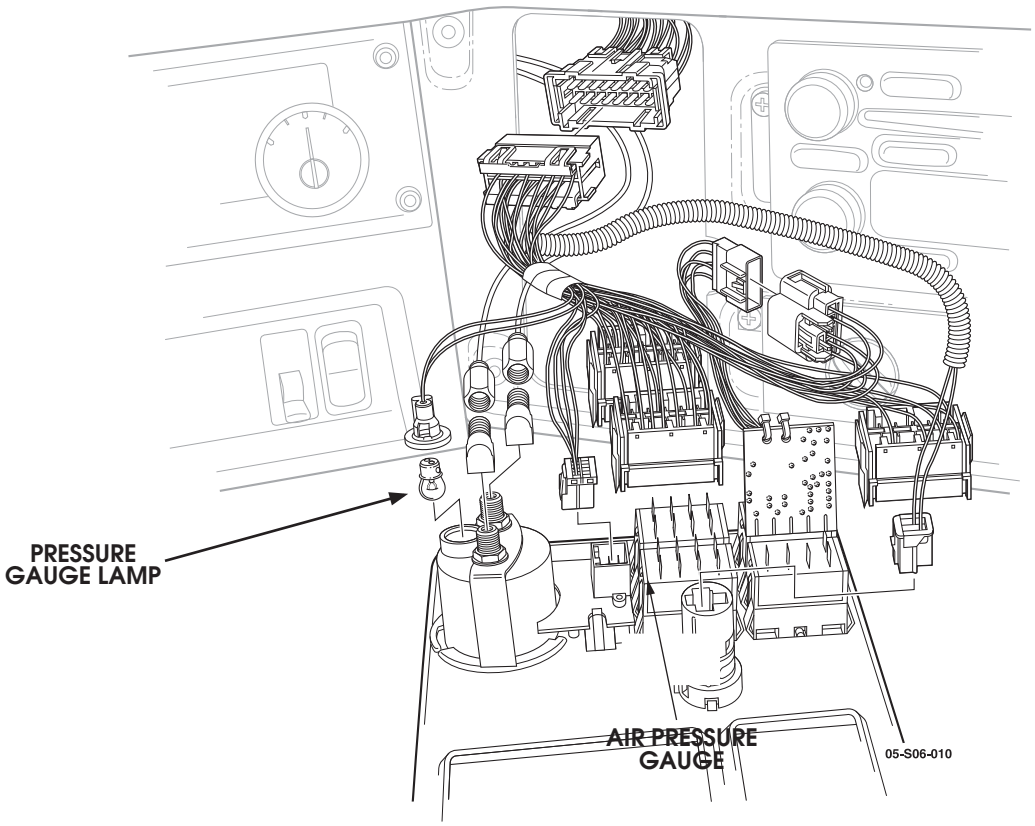


Figure 6-54: Air Pressure Gauge Replacement

AIR PRESSURE GAUGE BULB REPLACEMENT

Air Pressure Gauge Back Lighting

The air pressure gauge back lighting is the only lighting component that is serviceable on the CTIS control unit. To service the bulb in the air pressure gauge, pull the harness and bulb socket out of the back of the air pressure gauge. With the harness and bulb socket removed from the air pressure gauge, twist the bulb a quarter of a turn from the harness receiver and remove the bulb.

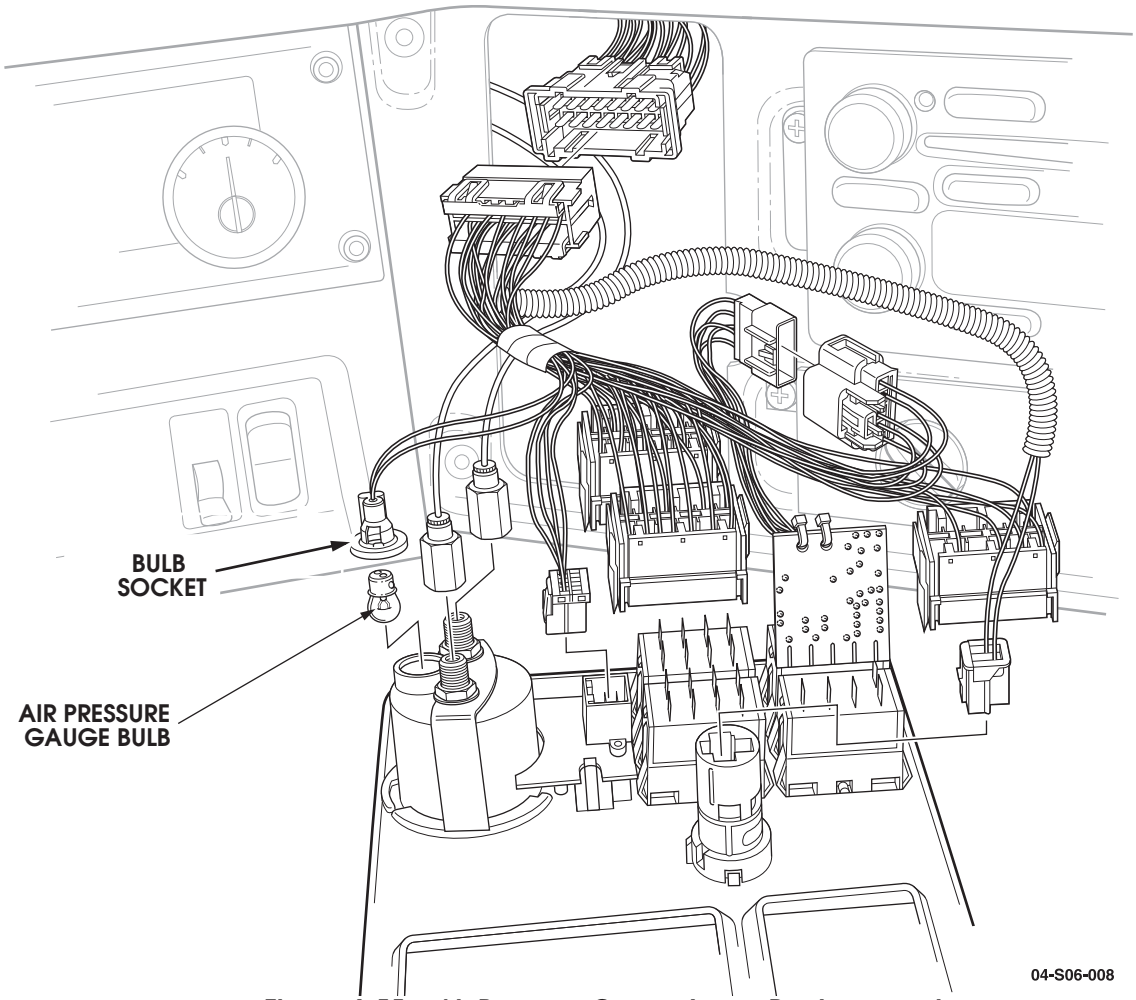


Figure 6-55: Air Pressure Gauge Lamp Replacement

CTIS LOW PRESSURE ALARM REPLACEMENT

Removal

1. Remove the interior fuse box access panel in the left close out panel under the instrument panel.
2. Remove the low pressure alarm from the face of the interior fuse box(Figure 6-56).

Installation

1. Install the low pressure alarm on the interior fuse box.
2. Install the fuse box access panel in the left closeout panel.

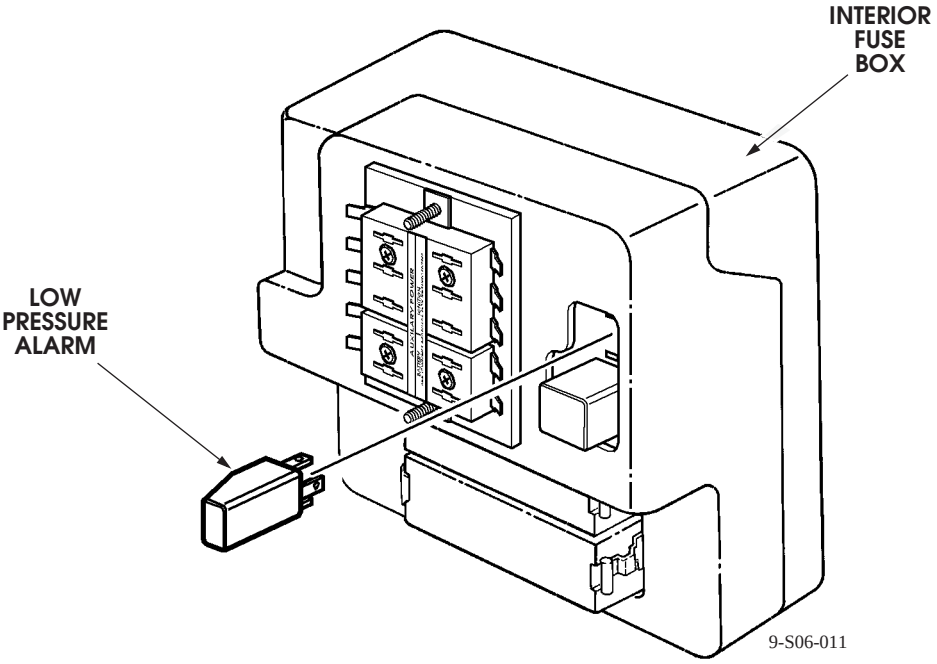


Figure 6-56: Low Pressure Alarm Location

CTIS INTERIOR HARNESS

NOTE: Prior to removal, tag all the leads for installation.

Removal

1. Remove the CTIS module from the instrument panel and gain access to the back.
2. Disconnect the harness connector from the inflate/deflate and tire selector switches (Figure 6-57).
3. Remove the lamp from the air pressure gauge.
4. Disconnect the harness connector from the I/P harness connector and remove the CTIS interior harness.

Cleaning and Inspection

Clean and inspect the CTIS harness and connectors. Check for defects such as frayed wires and cracks. Repair or replace the defective parts.

Installation

1. Connect the CTIS harness connector to the I/P harness connector (Figure 6-57).
2. Install the lamp in the air pressure gauge.
3. Connect the CTIS harness to the inflate/deflate and tire selector switches.
4. Install the CTIS module in the instrument panel.

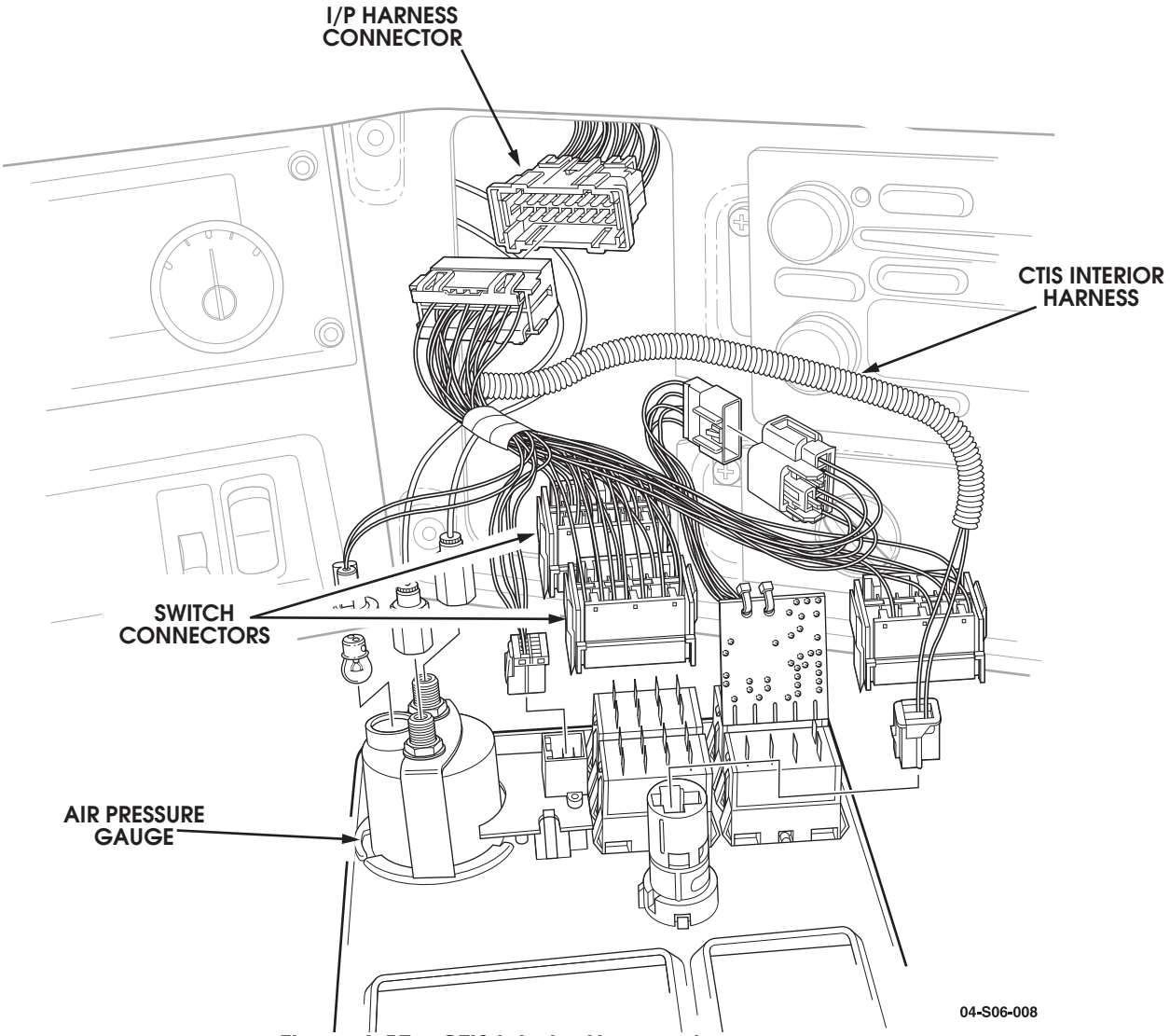


Figure 6-57: CTIS Interior Harness Appearance

AIR PRESSURE SWITCH REPLACEMENT

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: The front and rear air pressure switches are replaced similarly.

Removal

1. Disconnect the harness leads from the air pressure switch.
2. Remove the air pressure switch from the manifold.

CAUTION: *Do not allow sealant into the air system. Sealant will damage the CTIS components.*

Installation

1. Apply sealant to the threads and screw the air pressure switch into the manifold.
2. Connect the harness leads to the air pressure switch.

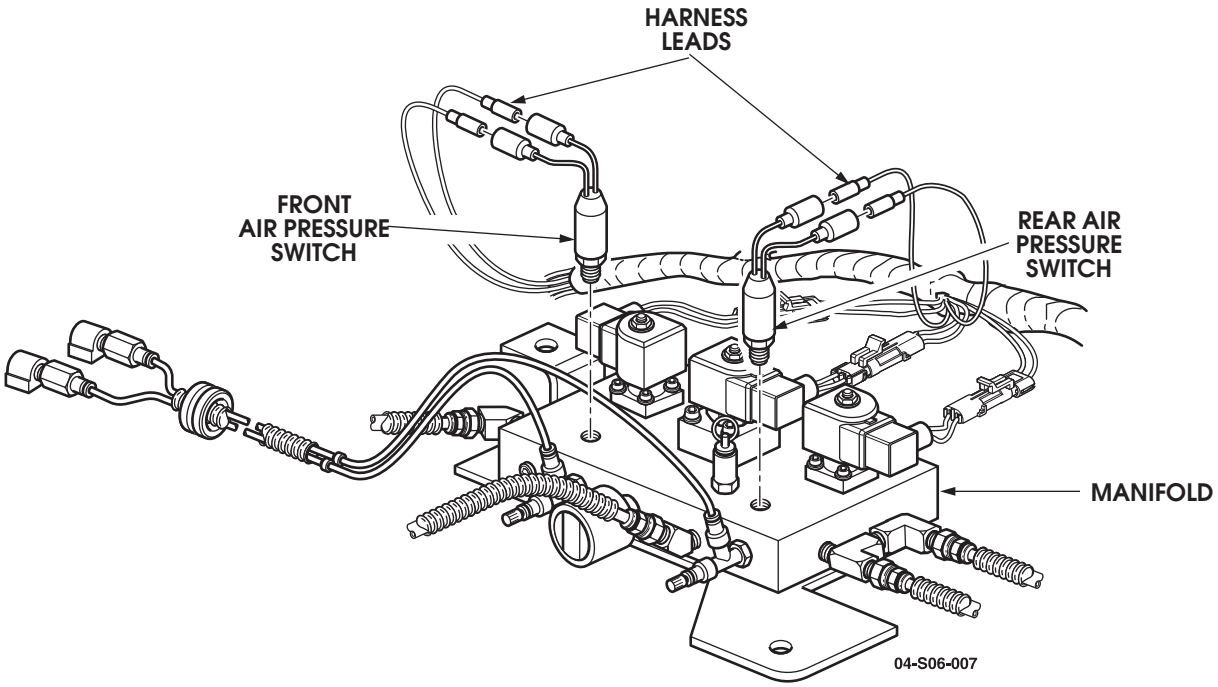


Figure 6-58: Air Pressure Switch Locations

AIR PRESSURE INDICATOR LINES REPLACEMENT

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

NOTE: Replacement procedures for the front and rear air pressure indicator lines are basically the same.

1. Remove the CTIS module from the instrument panel.

NOTE: Mark the position of the air indicator lines before removing.

2. Disconnect the air pressure indicator lines from the air pressure gauge (Figure 6-59).

CAUTION: *Do not allow sealant into the air system. Sealant will damage the CTIS components.*

NOTE: Apply sealant to the threads prior to installation.

Installation

1. Connect the air pressure indicator lines to the air pressure gauge in the position they were in prior to removal (Figure 6-59).
2. Install the CTIS module to the instrument panel.

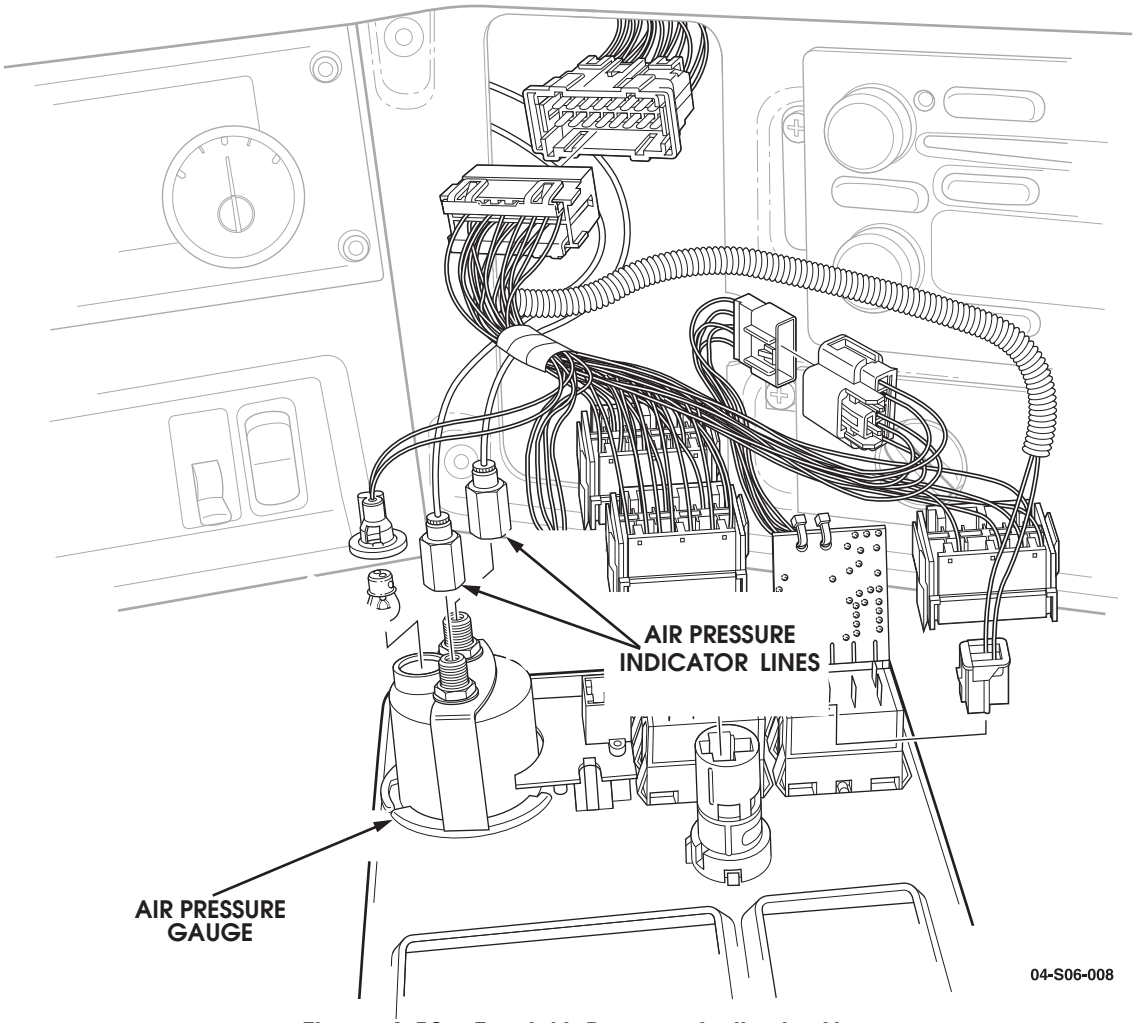


Figure 6-59: Front Air Pressure Indicator Line

CTIS COMPRESSOR FUSE REPLACEMENT

Removal

1. Raise and secure the hood.
2. Remove the left side cowl cover and the fuse box cover.
3. Remove the fuse from the box (Figure 6-60).

Installation

1. Install the fuse in the fuse box (Figure 6-60).
2. Install the plastic cover on the fuse box and install the left cowl cover.
3. Lower and secure the hood.

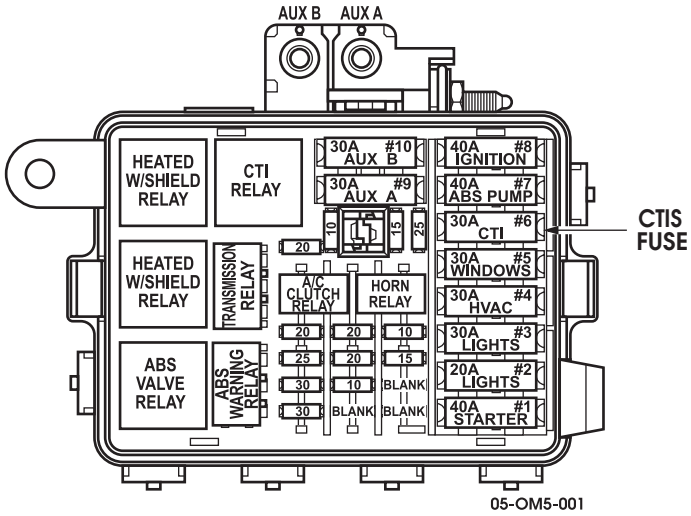


Figure 6-60: CTIS Compressor Fuse Location

CTIS COMPRESSOR RELAY REPLACEMENT

Removal

1. Raise and secure the hood.
2. Remove left cowl cover and fuse box cover.
3. Remove relay from fuse box (Figure 6-61).

Installation

1. Install relay in fuse box (Figure 6-61).
2. Install fuse box cover and left cowl cover.
3. Lower and secure hood.

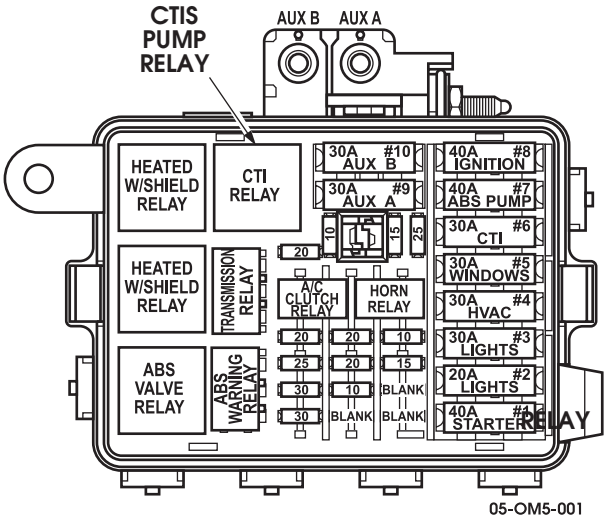


Figure 6-61: CTIS Compressor Relay Mounting

DEFLATE VALVE ASSEMBLY REPLACEMENT

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure the hood.
2. Disconnect the deflate valve electrical connector (Figure 6-62).
3. Remove the screws and the deflate valve from the manifold.

Cleaning and Inspection

Clean and inspect the deflate valve and bracket. Check for cracks and stripped threads. Replace if defective.

Installation

CAUTION: *Do not allow sealant into the air system. Sealant will damage the CTIS components.*

NOTE: Apply sealant to the threads prior to installation.

1. Secure the deflate valve to the manifold with the screws (Figure 6-62).
2. Connect the deflate valve electrical connector.
3. Lower and secure the hood.

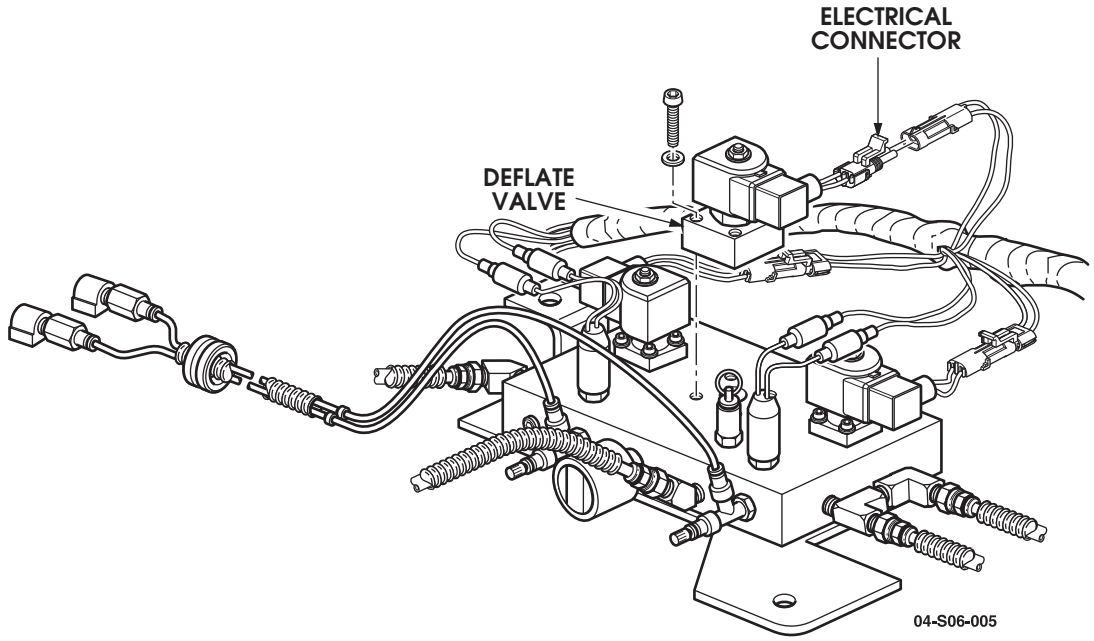


Figure 6-62: Deflate Valve Assembly Mounting

DUST EXCLUDER REPLACEMENT

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

Removal

1. Raise and secure the hood.
2. Remove dust excluder from the manifold (Figure 6-63).

Cleaning and Inspection

Clean and inspect the dust excluder. Check for cracks and stripped threads. Replace if defective.

Installation

CAUTION: *Do not allow sealant into the air system. Sealant will damage the CTIS components.*

NOTE: Apply sealant to the threads prior to installation.

1. Install the dust excluder on the manifold (Figure 6-63).
2. Lower and secure the hood.

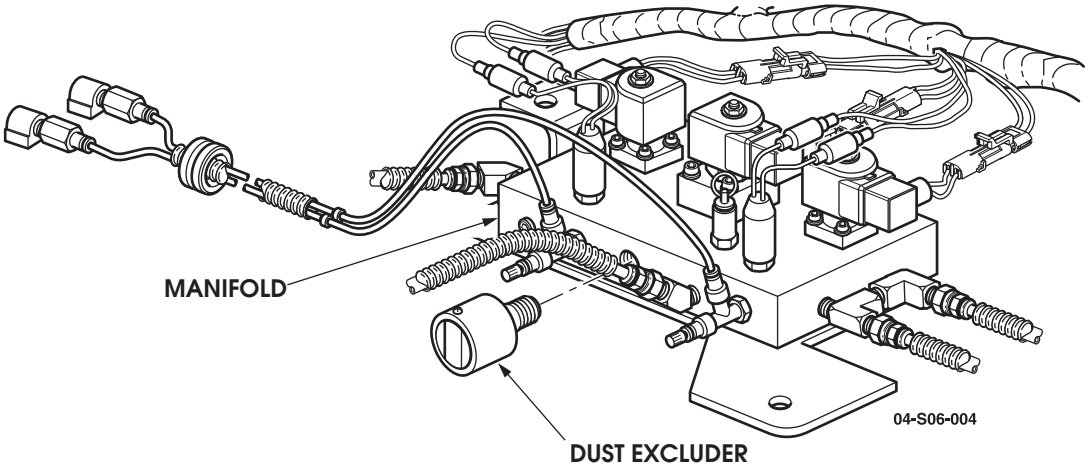


Figure 6-63: Dust Excluder Location

FRONT SUPPLY TUBE AND HOSE REPLACEMENT

WARNING: The CTIS components are subject to moderately high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

The HUMMER H1 CTIS uses rubber hoses, nylon tubing, and reinforced (braided) lines. Damaged portions of any air line type should be removed, discarded, and replaced with a new section. Leaks in air lines usually develop where there is constant rubbing or friction against another component, existing air lines, fasteners, frame rail, or air line clamp. Such leaks are usually small and difficult to detect unless adequate air pressure of approximately 20-30 psi (138-207 kPa) is in the line. If a leak is suspected, apply soap suds to the affected area for easier detection and replace damaged section.

CTIS SUPPLY LINE REPLACEMENT

1. Disconnect the supply line at the pump/valve assembly (Figure 6-64).
2. Disconnect the supply hose at the T-fitting secured to the front frame cross member (Figure 6-65).
3. Remove the tie straps securing the hose.
4. Work the line out from under the vehicle rather than through the engine compartment.
5. Tape ends of the new hose to prevent dirt entry.
6. Work the line up to the pump/valve assembly from underneath the vehicle.
7. Remove the tape from the hose ends and connect the hose to the T-fitting and the pump/valve assembly.
8. Secure the new hose with tie straps.
9. Make sure the line is clear of suspension and the engine components.

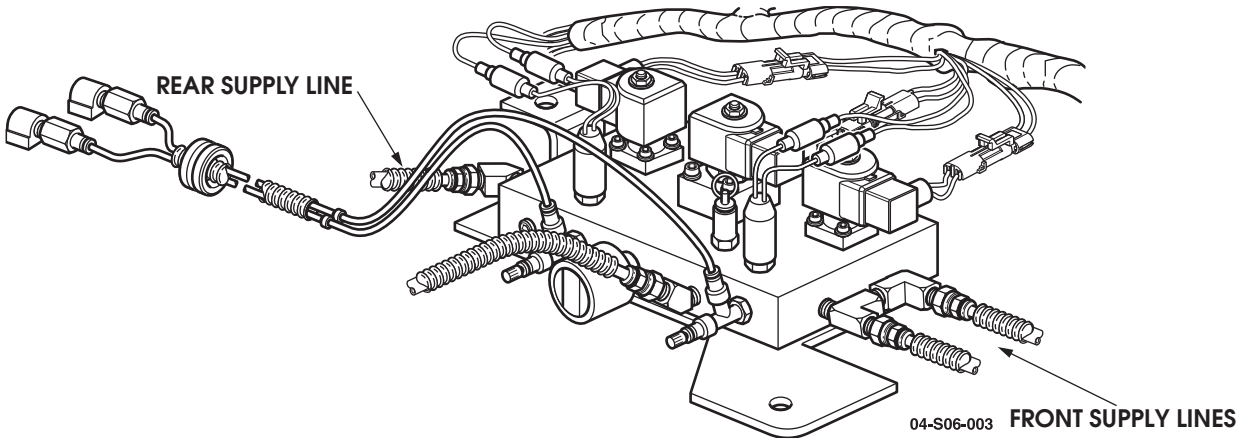


Figure 6-64: Front and Rear Supply Line Connections

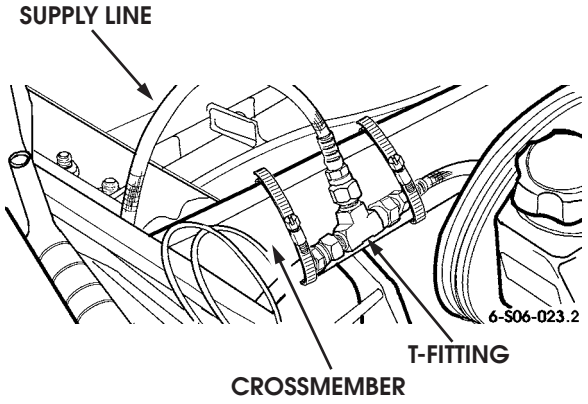


Figure 6-65: Supply Hose Connection

FRONT CTIS LINE REPLACEMENT

1. Disconnect the line at the front hub (Figure 6-66).
2. Loosen the clamp on the bracket attached to the lower control arm, then move the air line out of the bracket (Figure 6-67).
3. Disconnect the front air line at the T-fitting secured to the front cross member.
4. Cut the tie straps and remove the front air line.
5. Tape the ends of the new line to prevent dirt entry. Then route the line to the front wheel and the T-fittings.
6. Secure the hose to the fittings and in the clamp on the lower control arm bracket.
7. Install the tie straps as needed.

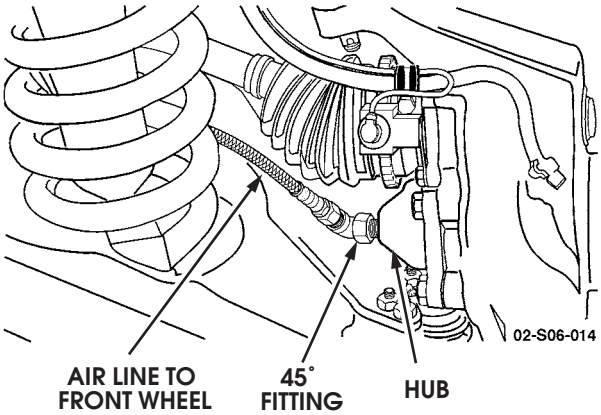


Figure 6-66: 45˚ Angle Line Connection to Hub

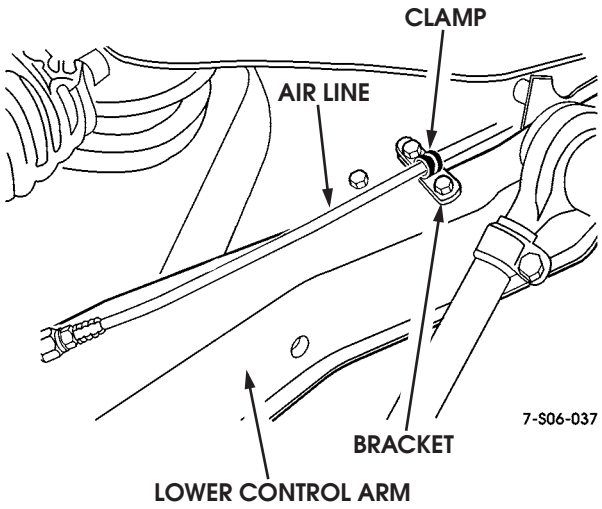


Figure 6-67: Line Bracket and Clamp Location

REAR CTIS LINE REPLACEMENT

1. Disconnect the line at the rear wheel and at the T-fitting (Figure 6-68).
2. Remove the line from the clamp on the lower control arm and from the rear hub.
3. If working on the right rear line, remove the clamp over the cross member to remove the line (Figure 6-69).
4. Tape the ends of the new line to prevent dirt entry.
5. Connect the line to the T-fitting and the rear hub.
6. Secure the line in the control arm clamp.
7. If working on the right rear line, secure the line to the cross member the with clamp (Figure 6-69).

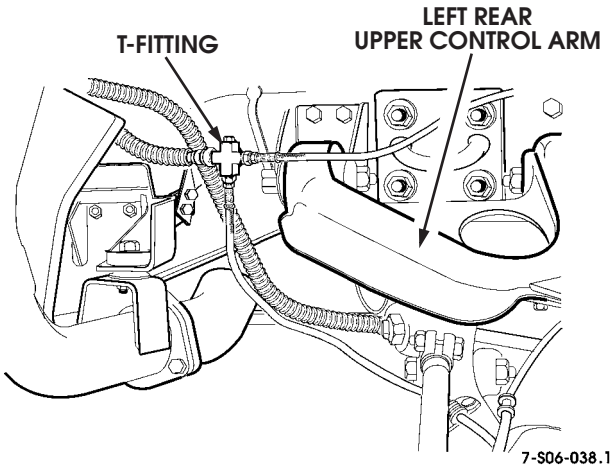


Figure 6-68: T-Fitting Location

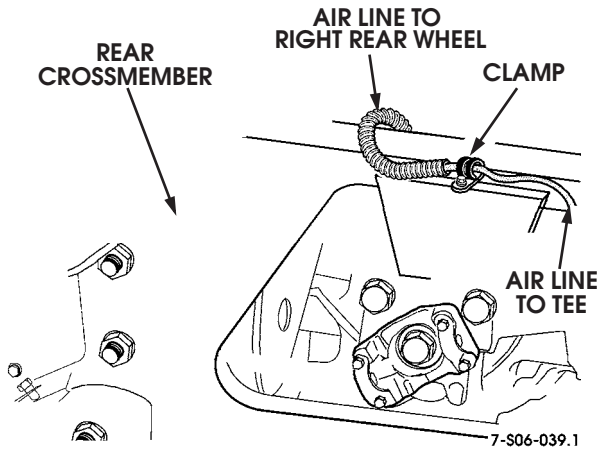


Figure 6-69: Right Rear Line Routing Over Rear Crossmember

AIR INTAKE LINE REPLACEMENT

Removal

1. Raise and secure the hood.
2. Loosen the hose clamp and disconnect the air intake hose from the connector (Figure 6-70).

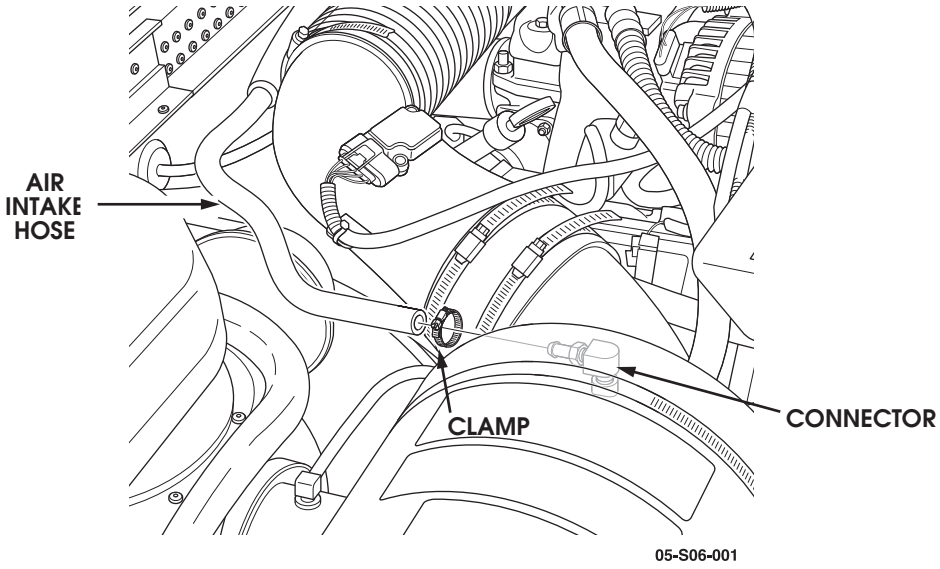


Figure 6-70: Air Intake Hose

3. Loosen the clamp and disconnect the air cleaner elbow from the air horn.
4. Remove the nut, washer, coupling, connector, and seal from the air horn.
5. Loosen the hose clamp securing the air intake hose to the compressor fitting (Figure 6-71).
6. Remove the air intake hose.

Cleaning and Inspection

Clean and inspect the air intake hose, elbow, coupling assembly and seal. Check for leaks, cracks, and stripped threads.

CAUTION: *Do not allow sealant into the air system. Sealant will damage the CTIS components.*

Installation

1. Connect the air intake hose to the compressor fitting and secure with the hose clamp (Figure 6-71).
2. Install the seal, coupling, washer, nut, and connector to the air horn(Figure 6-70).

3. Connect the air cleaner elbow to the air horn and secure with the clamp.
4. Connect the air intake hose to the air horn connector and secure with the hose clamp.
5. Lower and secure the hood.

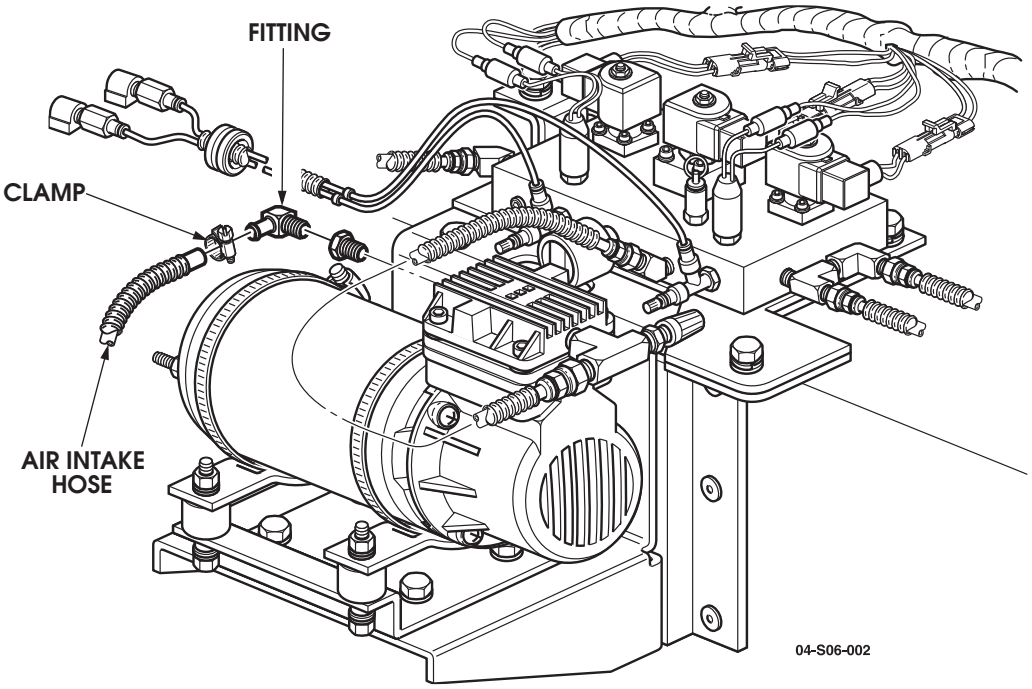


Figure 6-71: Air Intake Hose to Fitting

QUICK-DISCONNECT VALVE AND TUBE REPLACEMENT

WARNING: The CTIS components are subject to high air pressure. Always relieve the air pressure before loosening or removing air system components by disconnecting quick-disconnect valve assemblies. Failure to follow this warning may result in serious injury.

NOTE: The replacement of all four quick-disconnect valves and tube assemblies is identical.

Removal

1. Raise and support the vehicle.
2. Isolate the quick-disconnect valve of the wheel being serviced and the match on the other side of the vehicle (Figure 6-74).
3. Disconnect the compression nut and separate the tube from the quick-disconnect valve.

CAUTION: *Do not force apart the quick-disconnect valve. The quick-disconnect valve is a one-piece component. Damage to the quick-disconnect valve will result if forced apart.*

4. Remove the quick-disconnect valve from the spindle.
5. Disconnect the compression nut from the threaded connector, then remove the nut and sleeve assembly.
6. Remove the threaded connector.

Cleaning and Inspection

Clean and inspect the tube and the quick-disconnect valve. Check for leaks, stripped threads, and cracks. Replace the defective parts.

Installation

CAUTION: *Do not allow sealant into the air system. Sealant will damage the CTIS components.*

NOTE: Apply sealant to the threads prior to installation.

1. Install the quick-disconnect valve into the spindle (Figure 6-74).
2. Install the threaded connector.
3. Install the compression nut on the tube and connect the tube to the quick-disconnect valve.
4. Install the compression nut on tube and connect the tube to the threaded connector.
5. Reactivate the quick-disconnect fittings on both wheels.
6. Adjust the air pressure in the tires as needed.
7. Lower the vehicle.

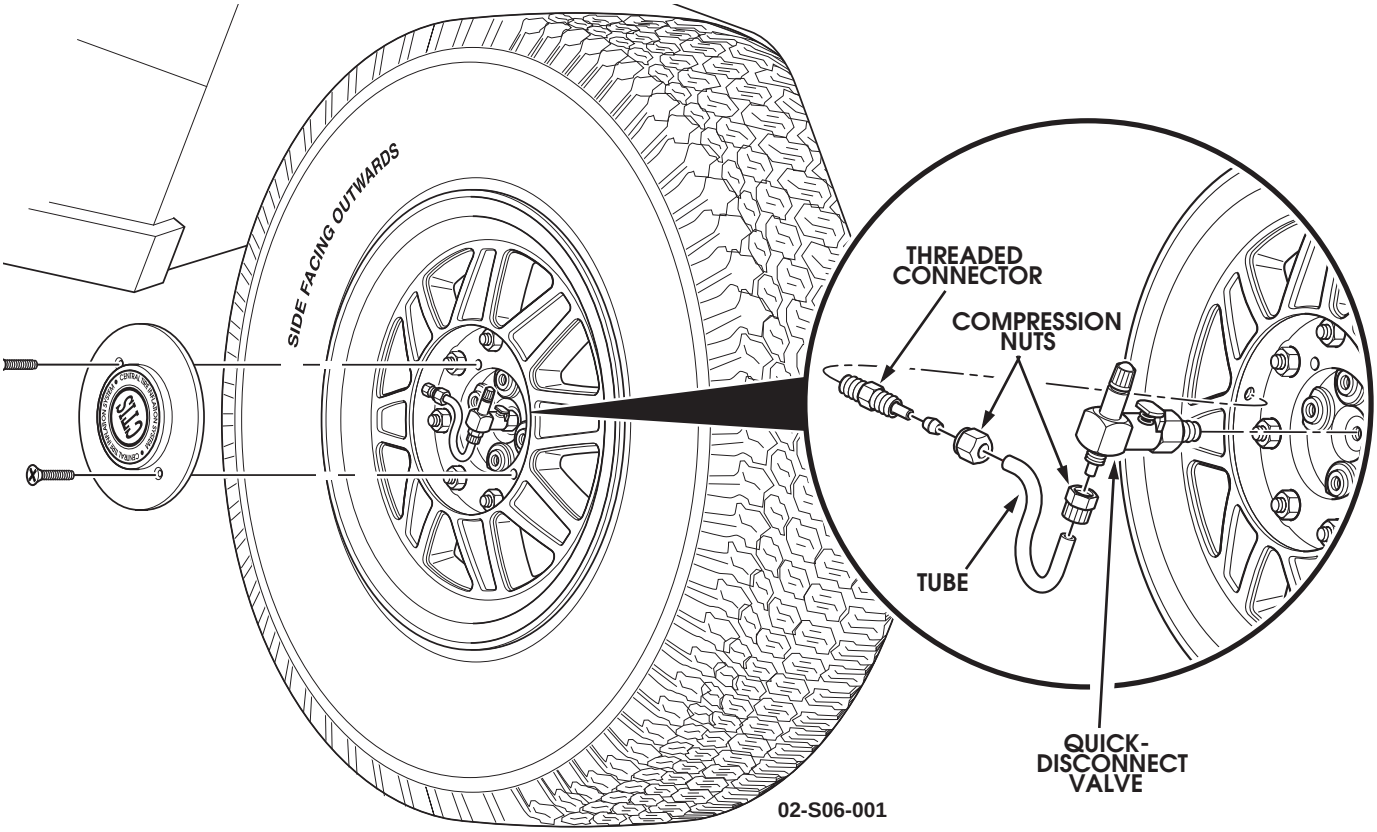


Figure 6-72: Quick-Disconnect Valve and Tube Replacement

TUBE CONNECTION SHIELD REPLACEMENT

NOTE: This procedure applies to all of the tube connection shields.

Removal

Remove the two bolts, washers, shield and two washers from the steering arm cover (Figure 6-73).

Cleaning and Inspection

Clean and inspect the shield and mounting hardware. Check for cracks and stripped threads. Replace the defective parts.

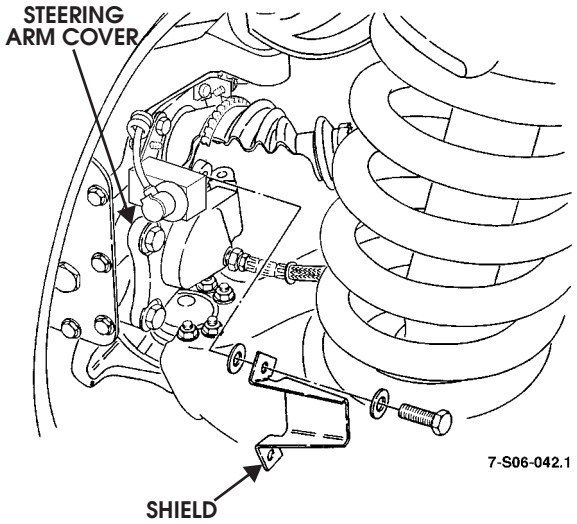


Figure 6-73: Rear Tube Connection Shield

Installation

Install the shield on the steering arm cover with two washers, bolts and two washers. Tighten the bolts to 75 lb-ft (102 N•m) (Figure 6-73).

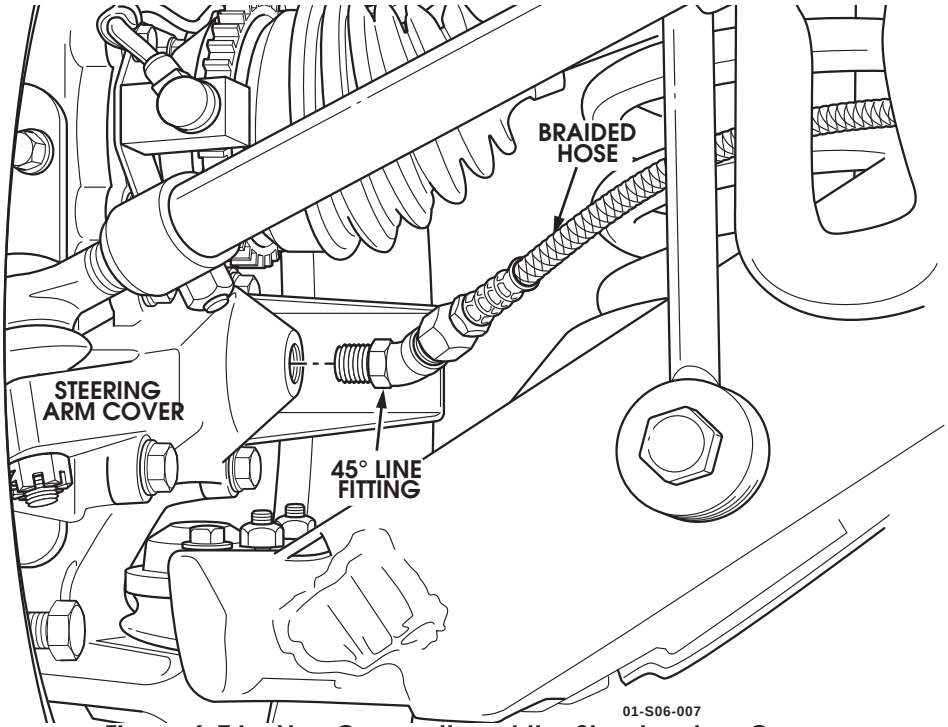


Figure 6-74: Line Connection at the Steering Arm Cover

SPINDLE EXTENSION AND SEAL REPLACEMENT

Removal

1. Remove the braided CTIS hose from the 45° line fitting and remove the line fitting from the steering arm cover (Figure 6-74).
2. Remove the tie rod end from the steering arm cover (Refer to section 9).
3. Remove the tube connection shield (Refer to section 6).
4. Remove the remaining two bolts, washers and the steering arm cover from the geared hub (Figure 6-75).
5. Remove the retaining ring and seal from the steering arm cover.

6. Remove the spindle extension from the spindle.

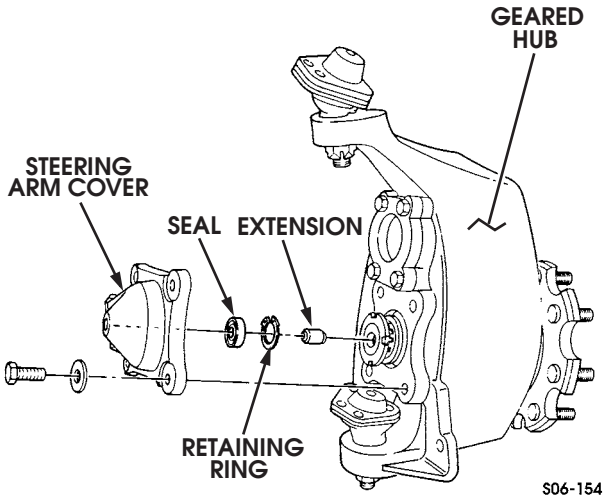


Figure 6-75: Spindle Extension and Seal

Cleaning and Inspection

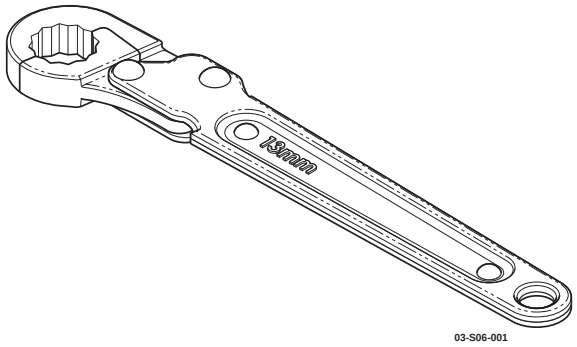
Clean and inspect the spindle extension and seal. Check for leaks and cracks. Replace the defective parts.

Installation

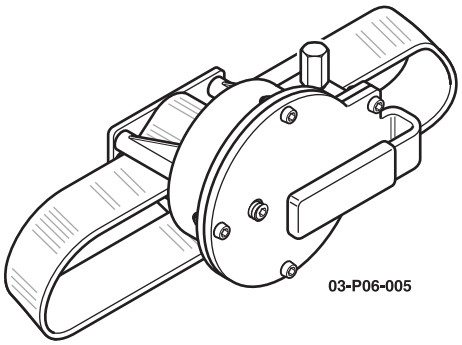
CAUTION: *Do not allow sealant or adhesive into the air system. Sealant will damage the CTIS components.*

1. Apply sealant to the seal and install the seal in the steering arm cover (Figure 6-75).
2. Secure the seal to the steering arm cover with the retaining ring.
3. Apply a small amount of adhesive to the end of the spindle extension and install into the spindle.
4. Install the steering arm cover on the geared hub with the four washers, bolts tube connection shield and the two washers. Tighten the bolts to 75 lb-ft (102 N•m).
5. Install the tie rod end to the steering arm cover (Refer to section 9).
6. Apply sealant to the threads on both ends of the 45° line fitting and install the fitting into the steering arm cover.
7. Connect and tighten the braided CTIS hose to the 45° line fitting.

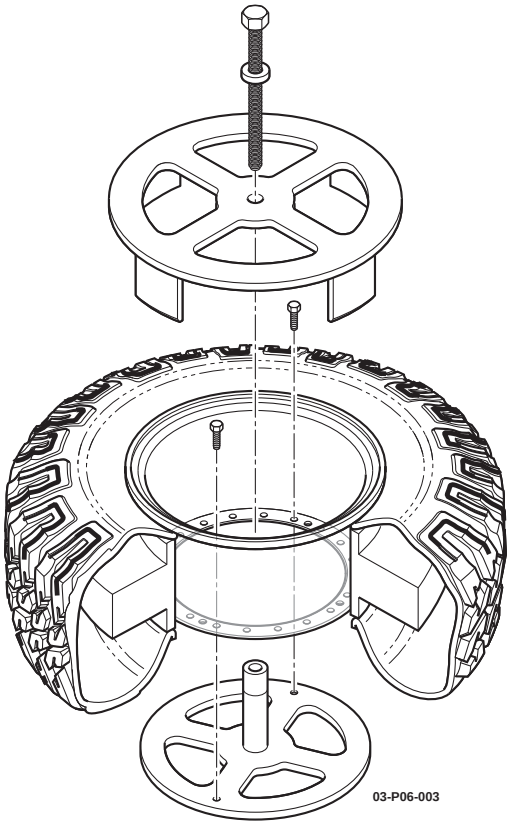
ESSENTIAL TOOLS



J–45769

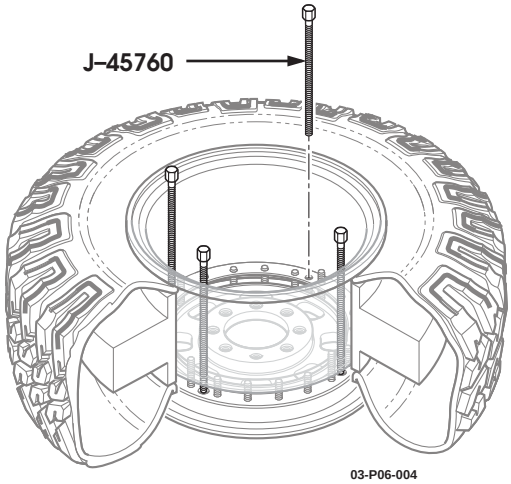


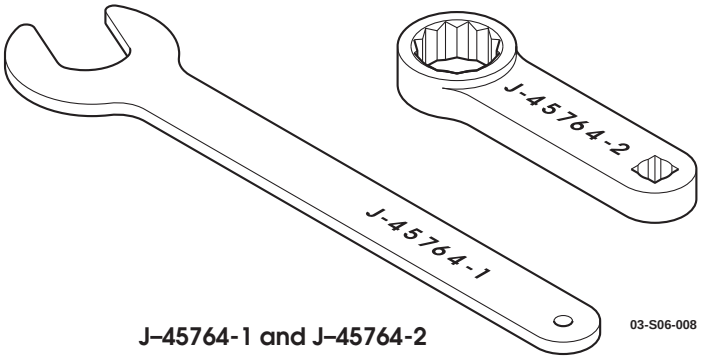
J–42452



J–45770

J–45760

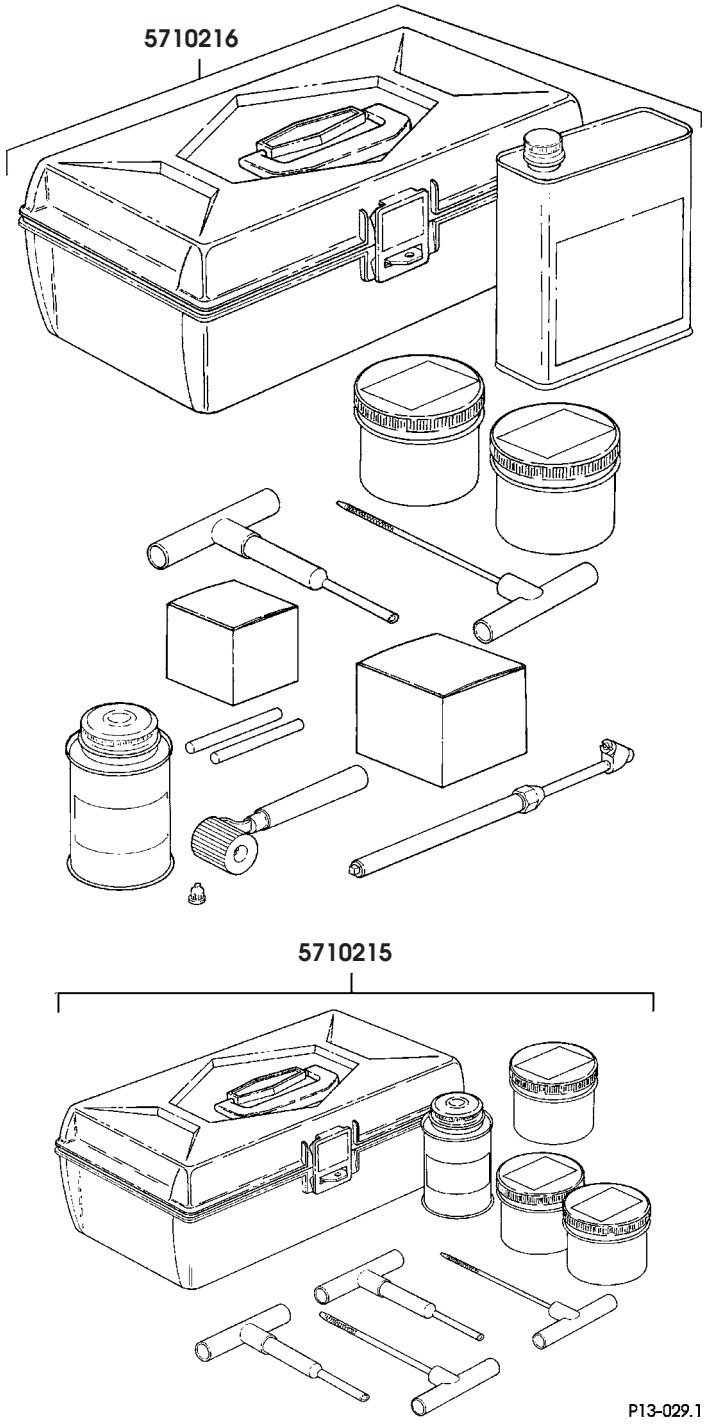




J–45764-1 and J–45764-2

Tool No.	Description
J–45769	13mm Runflat Wrench
J–42452	Pneumatic Runflat Compressor
J–45764-1	Alignment Cam Bolt Wrench
J–45764-2	Torque Adaptor
J–45770	Two-Piece Aluminum Wheel Separator
J–45760	Jack Bolts

SPECIAL TOOLS



Tool No.	Description
5710216	Internal tubeless tire repair kit
5710215	External tubeless tire repair kit

Section 7 Brake System

TABLE OF CONTENTS

Anti-lock Brake System (ABS) and Automatic Traction Control, TorqTrac 4™ (TT4™) 7-45
- ABS ECU Replacement 7-64
- ABS Modulator Replacement 7-59
  - Installation 7-62
  - Removal 7-59
- ABS/TT4 Diagnostics 7-46
  - Fault Diagnostic Procedure 7-46
- Fuse and Relay Replacement 7-64
- System Description 7-45
- System Operation 7-45

Brake Master Cylinder
- Bench Bleeding 7-15
- Bleeding 7-15
- Replacement 7-14

Brake System
- Bleeding Instructions 7-10
- Brake Line Replacement 7-17
- Brake Rotor 7-40
  - Refinishing 7-42
- Burnishing Linings and Rotors 7-13
- Caliper Overhaul, Rear 7-36
- Description 7-2
- Diagnosis 7-2
- Disc Brake Caliper Repair, Front 7-34
- Front Service Brake Caliper 7-13
- Hydro-Boost System
  - Accumulator Leakdown Test 7-10
  - Booster Functional Test 7-10
  - Noise Diagnosis 7-9
- Hydro-Boost System Diagnosis 7-9
- Left Parking Brake Cable Replacement 7-29
- Pad Replacement, Service Brake 7-12
- Parking Brake
  - Lever Adjustment 7-43
  - Lever Replacement 7-33
  - Switch Replacement 7-44
- Parking Brake Cable Replacement, L 7-29
- Parking Brake Cable Replacement, R 7-28
- Pedal Replacement, Service Brake 7-20
- Proportioning Valve Replacement 7-21
- Rear Dual Service/Parking Brake
  - Adjustment 7-31
  - Caliper Replacement 7-25
  - Pad Replacement 7-22
  - Rod Replacement 7-31
- Rotor Replacement, Service Brake 7-21
- Troubleshooting 7-5

Hydro-Boost
- Bleeding the Hydro-boost System 7-17

Hydro-Boost Replacement 7-16
Speed Sensor Replacement 7-62
Installation 7-63
Removal 7-62
Tone Wheel Replacement 7-64

POWER BRAKE SYSTEM DESCRIPTION

The hydraulic power disc brake system is a four-wheel, inboard-mounted design. The dual reservoir master cylinder stores brake fluid and converts mechanical brake pedal force to hydraulic pressure. The proportioning valve provides balanced front-to-rear braking and activates the brake warning lamp in case of a brake hydraulic system malfunction. The dual reservoir master cylinder provides fluid for separate front and rear brake systems (Figure 7-1). The hydro-boost provides power brake assist and is operated by fluid pressure from the power steering pump. The hydro-boost is equipped with an accumulator. The accumulator stores nitrogen gas under pressure in the event that both the normal assist and accumulator assist are not available. The power steering pump provides hydraulic oil pressure to operate the brake system's hydro-boost feature. If the power steering pump fails to supply hydraulic pressure to the hydro-boost, the pressure stored in the accumulator will provide enough hydraulic pressure for approximately four power-assisted stops. Applying the parking brake prevents the rear brake rotors from rotating and can also be used to help stop the vehicle in low speed emergency situations.

The disc brakes are mounted on the output flanges of the front and rear axle assemblies.

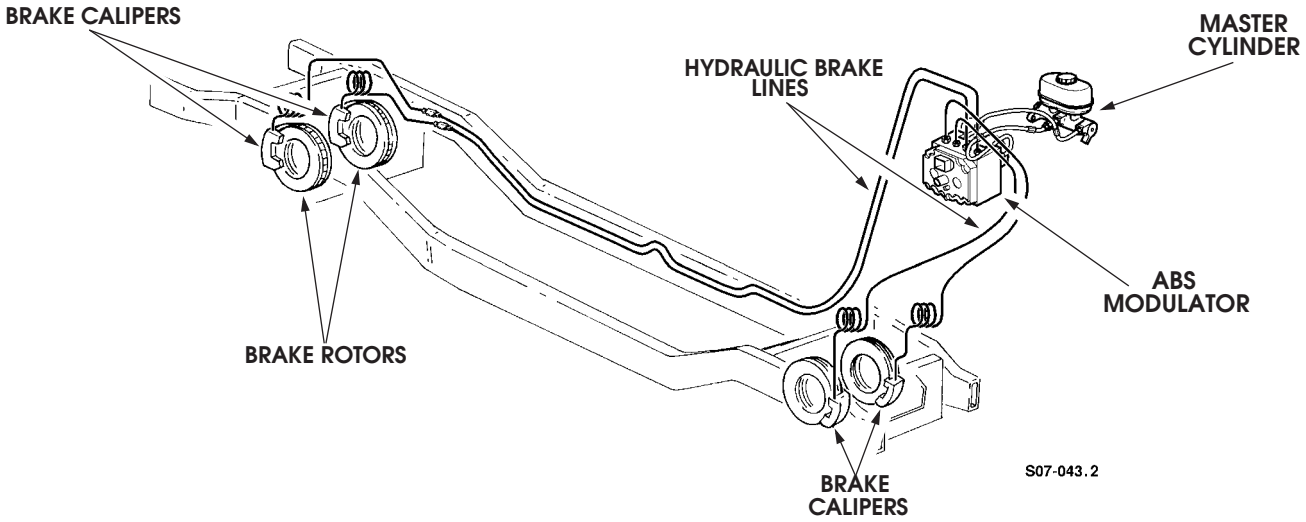


Figure 7-1: Brake System

BRAKE SYSTEM DIAGNOSIS

Road Testing

1. If the red warning light is illuminated, note the pedal action and brake response.
2. Check the brake pedal response with the transmission in Neutral and the engine running. The pedal should remain firm under steady foot pressure. If the pedal falls away, problem is either in the hydro-boost, master cylinder, or brakeline.
3. During a road test, make normal and firm brake stops in 25-40 mph range. Note if a faulty brake operation such as pull, grab, drag, noise, fade, pedal pulsation, etc. (noise and pedal pulsation during an ABS event is normal).
4. Inspect the suspect brake components and refer to problem diagnosis information for causes of various brake conditions.

Component Inspection

Fluid leak points and dragging brake units can usually be located without removing any components. The area around a leak point will be wet with fluid. The components at a dragging brake unit will be quite warm or hot to the touch.

During component inspection, pay particular attention to heavily rusted/corroded brake components (e.g. rotors, caliper pistons, lines, etc.).

Heavy accumulations of rust may be an indicator of rust and corrosion damage to a brake component. It is wise to remove surface rust in order to accurately determine the depth of rust penetration and damage. Light surface rust is fairly normal and not a major concern (as long as it is removed). However, heavy rust buildup, especially on high mileage vehicles, may actually cover structural damage to such important components as brakelines and rotors.

Diagnosing Service Brake Problems

Brake Warning Light Operation

The red brake warning light will illuminate when the parking brakes are applied, and when there is a low fluid level in the brake fluid reservoir. If the light comes on, first verify that the parking brakes are fully released. Then check the pedal action and fluid level. If a problem is confirmed, inspect the wheel brake hydraulic system.

Pedal Falls Away

A brake pedal that falls away under steady foot pressure is generally the result of a system leak. The leak point could be at a brakeline, fitting, hose, or caliper. Internal leakage in the master cylinder caused by worn or damaged piston cups, may also be the problem cause.

If leakage is severe, fluid will be evident at or around the leaking component. However internal leakage in the master cylinder will not be physically evident. Refer to the cylinder test procedure in this section.

Low Pedal

If a low pedal is experienced and the warning light is **not** on, worn lining and worn rotors are the most likely cause.

If the red warning light is on, low fluid in the master cylinder is the most likely cause. A leak at a caliper, brakeline, or brake hose will cause the fluid level in the master cylinder reservoir to become low, triggering the low fluid switch and the red brake warning light.

Spongy Pedal

A spongy pedal is most often caused by air in the system. However, substandard brake lines and hoses will also cause a condition similar to a spongy pedal. The proper course of action is to bleed the system, or replace suspect quality brake lines and hoses.

Hard Pedal or High Pedal Effort

A hard pedal or high pedal effort may be due to lining that is water soaked, contaminated, glazed, or badly worn.

Brake Drag

Brake drag occurs when the lining is in constant contact with the rotor. Drag can occur at one wheel, all wheels, fronts only, or rears only. It is a product of incomplete brakeshoe release. Drag can be minor or severe enough to overheat the linings, and rotors.

Brake drag also has a direct effect on fuel economy. If undetected, minor brake drag can be misdiagnosed as an engine or transmission/torque converter problem.

Minor drag will usually cause slight surface glazing of the lining. It can also generate hard spots in rotors from the overheat-cool down process. In most cases, the rotors, wheels and tires are quite warm to the touch after the vehicle is stopped.

Severe drag can char the brake lining all the way through. It can also distort and score rotors to the point of needing replacement. The wheels, tires and brake components will be extremely hot. In severe cases, the lining may generate smoke as it chars from overheating.

Some common causes of brake drag are:

- seized or sticking caliper piston
- caliper binding on bushings or pin slides
- incorrect length caliper mounting bolts (too long)
- loose caliper mounting bracket
- misassembled components
- misadjusted brakelight switch
- binding brake pedal
- master cylinder/hydroboost internal fault
- improperly adjusted parking brake

If brake drag occurs at all wheels, the problem may be related to a blocked master cylinder compensator port or a faulty hydro-boost.

An improperly mounted or adjusted brakelight switch can prevent full brake pedal return. The result will be the same as if the cylinder compensator ports are blocked. In this case, the brakes would be partially applied all the time causing drag.

Brake Fade

Brake fade is a product of overheating caused by brake drag. However, brake overheating and subsequent fade can also be caused by riding the brake pedal, making repeating high deceleration stops in a short time span, or constant braking on steep roads. Refer to the Brake Drag information in this section for causes.

Pedal Pulsation

Pedal pulsation whenever the ABS is not active, is caused by components that are loose, or beyond tolerance limits.

Disc brake rotors with excessive lateral runout or thickness variation are the primary causes of pulsation. Other causes are loose calipers, and worn, damaged tires.

Brake Pull

A front pull condition could be the result of contaminated lining in one caliper, seized caliper piston, binding caliper, loose caliper, loose or corroded slide pins, improper brakeshoes, or a damaged rotor.

A worn, damaged wheel bearing or suspension component are further causes of pull. A damaged front tire (bruised, ply separation) can also cause pull.

Check the tires to be sure that they are inflated to the appropriate tire pressure. It could be another cause of your vehicle “pulling” to one side.

A common and frequently misdiagnosed pull condition is where direction of pull changes after a few stops. The cause is a combination of brake drag followed by fade at the dragging brake unit.

As the dragging brake overheats, efficiency is so reduced that fade occurs. If the opposite brake unit is still functioning normally, its braking effect is magnified. This causes pull to switch direction in favor of the brake unit that is functioning normally.

When diagnosing a change in pull condition, remember that pull will return to the original direction if the dragging brake unit is allowed to cool down (and is not seriously damaged).

Rear Brake Grab

Rear grab (or pull) is usually caused by contaminated lining, bent or binding pads or improperly assembled components. This is particularly true when only one rear wheel is involved. However, when both rear wheels are affected, the master cylinder, or an improperly adjusted parking brake could be at fault.

Brakes Do Not Hold After Driving Through Deep Water Puddles

This condition is generally caused by water soaked lining. If the lining is only wet, it can be dried by driving with the brakes lightly applied for a mile or two. However, if the lining is both wet and dirty, disassembly and cleaning will be necessary.

Brake Fluid Contamination

There are two basic causes of brake fluid contamination. The first involves allowing dirt, debris, water, or other liquid materials to enter the cylinder reservoirs when the cover is off. The second involves topping off, or filling the cylinder reservoirs with a non-recommended fluid.

Brake fluid contaminated with only dirt or debris usually retains a normal appearance. Generally, the foreign material will remain suspended in the fluid and be visible. The fluid and foreign material can be removed from the reservoir with a suction gun but only if the brakes have not been applied. If the brakes are applied after contamination, system flushing will be required. The master cylinder will also have to be flushed or replaced if the contaminants cannot be removed. Foreign material lodged in the reservoir compensator/return ports can cause brake drag by restricting fluid return after brake application.

Brake fluid contaminated by a non-recommended fluid, generally appears highly discolored, milky, oily looking, or foamy. In some cases, it may even appear as if the fluid contains sludge. **However, be advised that brake fluid will darken over time and occasionally be cloudy in appearance. These are normal conditions and should not be mistaken for contamination.**

If some type of oil has been added to the system, the fluid will separate into distinct layers. To verify this, drain off a sample with a clean suction gun. Then pour the sample into a glass container and observe fluid action. If the fluid separates into distinct layers, it is definitely contaminated.

The only real correction for contamination by non-recommended fluid is to flush the entire hydraulic system and replace all the seals.

Brake Noise

Squeak/Squeal

The factory installed brakelining in HUMMER H1 vehicles is made from asbestos free materials. These materials have different operating characteristics than previous lining materials. Under certain conditions, asbestos free lining may generate some squeak, groan or chirp noise. This noise is considered normal and does not indicate a problem. The only time inspection is necessary, is when noise becomes constant or when grinding, scraping noises occur.

Constant brake squeak or squeal may be due to linings that are wet or contaminated with brake fluid, grease, or oil. Glazed linings and rotors with hard spots can also contribute to squeak. Dirt and foreign material embedded in the brake lining can also cause squeak/squeal.

Loud brake squeak, squeal, scraping, or grinding sounds are a sign of severely worn brake lining. If the lining has worn completely through in spots, metal-to-metal contact occurs. If the condition is allowed to continue, rotors can become so scored that replacement is necessary.

Thump/Clunk

Thumping or clunk noises during braking are frequently **not** caused by brake components. In many cases, such noises are caused by loose or damaged steering, suspension, drive line, or engine components. However, calipers that bind on the slide surfaces can generate a thump or clunk noise. Loose adapter bolts or halfshaft-to-rotor bolts will cause noise.

Chatter/Shudder

Brake chatter is usually caused by loose or worn components, or glazed/burnt lining. Rotors with hard spots can also contribute to chatter. Additional causes of chatter are out-of-tolerance rotors, brake lining not securely attached to the shoes, loose wheel bearings and contaminated brake lining.

Brake Lining Contamination

Brake lining contamination is a product of leaking calipers, driving through deep water puddles, or lining that has become covered with grease or oil due to leaking axle seals.

Wheel and Tire Problems

Some conditions attributed to brake components may actually be caused by a wheel or tire problem.

A damaged wheel can cause shudder, vibration and pull. A worn or damaged tire can also cause pull.

Severely worn tires with little or no tread left can produce a grab-like condition as the tire loses and recovers traction.

Flat-spotted tires can cause vibration and wheel tramp and generate shudder during brake operation.

A tire with internal damage such as a severe bruise or ply separation can cause pull and vibration.

Diagnosing Parking Brake Problems

Parking Brake Problem Causes

In most cases, the actual cause of an improperly functioning parking brake (too loose/too tight/won't hold), can be traced to a rear brake component.

The leading cause of improper parking brake operation, is excessive clearance between the brake pads and the rotor surface. Excessive clearance is a result of lining and/or rotor wear or inoperative adjuster components.

Inspect and adjust parking brake lever or linkage as necessary.

BRAKE SYSTEM TROUBLESHOOTING

Parking Brake Does Not Hold Vehicle

1. Check the parking brake adjustment and ensure the linkage and cables operate freely. Adjust the parking brake lever and/or cables or replace the damaged and worn parts.

2. Inspect the rear brake caliper brake pads for serviceability. The minimum brake lining thickness is 1/8 in. (3.2 mm). Replace all the rear brake pads if any of the pads does not meet the thickness specifications.
3. Check the calipers for binding or dragging. Check for binding caliper guide pins.

Low or Spongy Brake Pedal on First Application or Pedal Goes to Floor

CAUTION: *The HUMMER H1 is equipped with DOT 3 brake fluid.* ***Do not mix with other brake fluids****. Failure to use the proper brake fluid will damage the brake system.*

WARNING: Always wear eye protection when bleeding brakes. Failure to do this may cause personal injury if brake fluid comes in contact with eyes.

1. Remove the master cylinder cover and visually check the reservoirs for low fluid level or contamination.
   a. If the fluid is contaminated, flush the system with clean brake fluid.
   b. If the fluid is low, check for worn brake pads, observe for leakage, broken, cracked or kinked lines, worn master cylinder, etc. Replace any worn parts. Add DOT 3 as needed.
2. Check the hydro-boost. Depress the brake pedal several times, with the engine off, to exhaust the accumulator pressure. Depress the brake pedal and start the engine.
   a. The brake pedal should fall, then push back against the operator's foot.
   b. Perform a pressure test (Section 8).
   c. Replace the hydro-boost if is not operating properly.
3. Bleed the master cylinder then bleed the brakes.

Decreased Brake Pedal Travel or Slow Return

1. Check for worn brake pedal return spring. Replace the spring if worn.
2. Check the brake pedal bushings for signs of wear or binding. Replace the pedal bushings if worn and lubricate as needed.
3. Check for kinked or damaged brake lines which may restrict the brake fluid. Replace any damaged lines.
4. Check the hydro-boost. Depress the brake pedal several times, with the engine off, to exhaust the accumulator pressure. Depress the brake pedal and start the engine.
   a. The brake pedal should fall, then push back against the operator's foot.
   b. Perform a pressure test (Section 8).
   c. Replace the hydro-boost if is not operating properly.
5. Check the brake calipers for binding as a result of corrosion or dirt. Check the brake rotors for free movement. If the rotors do not move freely, remove the calipers and clean the caliper guide pins.
6. Check the parking brake cable for proper operation and adjustment. Repair as required.

Excessive Pedal Pressure Required to Stop Vehicle

1. Remove the master cylinder cover and visually check the reservoir for low fluid level or contamination.
   a. If the fluid is contaminated, flush the system with clean brake fluid.
   b. If the fluid is low, check for worn brake pads, observe for leakage, broken, cracked or kinked lines, worn master cylinder, etc. Replace any worn parts.
2. Check the fluid in the power steering pump reservoir. Fill the fluid to the proper level (Section 1).
3. Check the serpentine belt tension. Replace the belt (Section 8) if necessary.
4. Check the brake pads for proper installation, contamination, or distortion. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace the brake pads as axle sets (front or rear) if any pad does not meet specifications

NOTE: To preserve even braking, both calipers must be in equal condition.

5. Check the brake calipers for binding as a result of corrosion or dirt. Check the brake rotors for free movement. If the rotors do not move freely, remove the calipers and clean the caliper guide pins.

6. Check for frozen piston in the brake caliper. If the inner pad is not worn to the limit, but the piston cannot be retracted, rebuild or replace both calipers.
7. Check for pinched or kinked supply and return lines to the hydro-boost. Reposition or replace any damaged lines.
8. Check for damaged brake lines. Replace any damaged brake lines found.
9. Check for malfunctioning hydro-boost. Depress the brake pedal several times, with the engine off, to exhaust the accumulator pressure. Depress the brake pedal and start the engine.
   a. The brake pedal should fall, then push back against the operator's foot.
   b. Perform a pressure test (Section 8).
   c. Replace the hydro-boost if it is not operating properly.
10. Check the power steering system. Refer to step 6 in the Diagnostic portion of *Hard Steering* in Section 8.

Noisy Brakes

1. Check the brake pads for proper installation, contamination, or distortion. Check brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace the brake pads as sets (front or rear) if any of the pads does not meet specifications. Make sure pads are flat and smooth.
2. Check the rotors for glazing or scoring. Turn the rotor if glazed or scored. Do not exceed the minimum thickness shown on the inside of the rotor hat section. It is not recommended that the rotors be turned when spotted or heat checked.
3. Check the halfshaft mounting.
   a. Apply a thread-locking compound to the halfshaft and rotor-to-output flange capscrews, or use bolts with pre-applied compound, and torque to 57 lb-ft (77 N•m).
   b. Apply a thread-locking compound to the halfshaft retaining capscrew (in geared hub) and torque to 40 lb-ft (54 N•m). Tighten any loose fasteners.

Brake Chatter

On some new vehicles, roughness or a chatter sound from the brakes may be noticed during low speed brake application. The noise is a result of the lining edges of an unburnished brake pad rubbing against the rotor. Burnishing is a part of the vehicle break-in process which fully seats and conditions new brake pads. Although annoying, the brake noise is not detrimental to vehicle safety or performance, and will eventually be eliminated through normal brake use.

If chatter or roughness persists on a new vehicle, then chamfering of the brake pad lining edges can be performed. Chamfering of the brake pad is done by slightly grinding or filing the edge of the pad lining on a grinding wheel.

To complete the chamfering procedure:

1. Remove the eight service brake pads from the vehicle. Mark each pad for vehicle and caliper location.
2. Chamfer (grind or file) the brake pad lining edges. Ensure both brake pad lining edges are chamfered on each of the eight brake pads (Figure 7-2). Make sure pads are flat and even.
3. Install the eight service brake pads at the original vehicle and caliper location.
4. Operate the vehicle and check the brakes for proper operation.

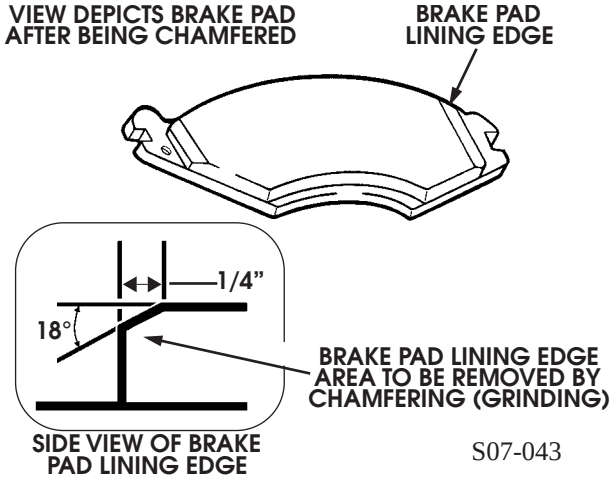


Figure 7-2: Chamfering Brake Pad

Booster or Pedal Pulsation

1. Check the hydro-boost. Depress the brake pedal several times, with the engine off, to exhaust accumulator pressure. Depress the brake pedal and start the engine.
   a. Brake pedal should fall, then push back against the operator's foot.
   b. Perform a pressure test (Section 8).
   c. Replace the hydro-boost if it is not operating properly.
2. Check thr halfshaft and rotor mounting for missing or loose capscrews. Replace the inclined-cam washers, apply a thread locking compound and torque capscrews to 57 lb-ft (77 N•m).
3. Check the brake rotor lateral run-out. Refinish any rotor not meeting the specifications. Refer to *Checking Lateral Runout* in this section for more information.

Erratic Braking Action

1. Check for the correct tire pressure.
2. Check the brake pads for excessive wear. Minimum brake lining thickness is 1/8 in. (3.2 mm). Replace the brake pads as sets (front or rear) if any pad does not meet the specifications.
3. Check the brake calipers for binding as a result of corrosion or dirt. Check for seized or binding brake caliper pistons. Repair any binding or seized caliper pistons. Check the brake rotors for free movement. If the rotors do not move freely, remove the calipers and clean caliper guide pins (Figure 7-3).

NOTE: Calipers pins must be replaced in pairs. Caliper pins and bushing should be lubricated with an approved brake component lubricant.

4. Check for leaking caliper piston seals. Replace or rebuild any calipers with leaking seals.
5. Check the rotor for glazing or scoring. Turn the rotor if glazed or scored. Do not exceed the minimum thickness shown on the inside of the rotor hat section. It is not recommended that the rotors be turned when spotted or heat checked.
6. Check for damaged brake lines. Replace any damaged brake lines.
7. Check the ABS operation. Check the ABS warning lamp. Perform a 20 mph hard deceleration on a slippery surface (sand, gravel, snow, etc). If one or more of the wheels lock repair the ABS. Refer to ABS diagnostics in this secion.
8. Check the toe adjustment. Adjust the toe, if necessary. Refer to Section 5.

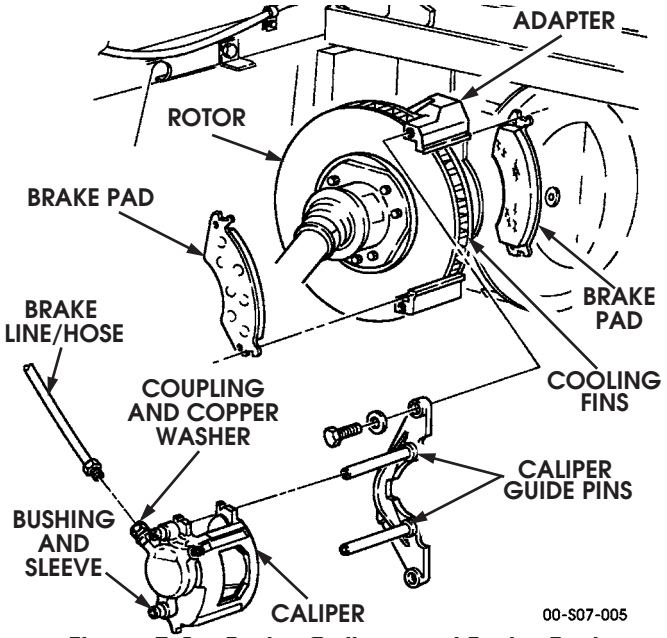


Figure 7-3: Brake Caliper and Brake Pads

HYDRO-BOOST SYSTEM DIAGNOSIS

Table 1:

PROBLEM	POSSIBLE CAUSE	CORRECTION
Slow Brake Pedal Return or Brakes Apply When Turning Steering Wheel	1. Damaged/broken return spring. 2. Excessive seal friction in booster. 3. Faulty spool action. 4. Restriction in return line from booster to pump reservoir. 5. Damaged input rod end.	1. Replace spring. 2. Replace the hydro-boost. 3. Flush the steering system while pumping the brake pedal. 4. Replace the line. 5. Replace the hydro-booster.
Grabs Suddenly or Booster Chatters - Pedal Vibrates	1. Faulty spool action caused by contamination. 2. Power steering pump belt slips. 3. Low fluid level in power steering pump.	1. Flush steering system while pumping brake pedal. 2. Replace tensioner and/or belt. 3. Fill reservoir and check for external leaks.
Accumulator Leak-Down Reserve System Does Not Hold Charge	1. Contamination in steering hydro-boost system. 2. Internal leakage in accumulator system	1. Flush steering system while pumping brake pedal. 2. Replace hydro-boost.
Excessive Brake Pedal Efforts	1. Loose, glazed, or broken pump belt. 2. No fluid in pump reservoir. 3. Leaks in system hoses. 4. Leaks at tube fittings and connections. 5. Leakage at pneumatic accumulator seal. 6. Leakage at piston seal. 7. Leakage at input seal. 8. Leakage at cover-to-housing seal. 9. Leakage at spool plug seal. 10. Leakage at ball plug	1. Replace tensioner and/or replace belt. 2. Fill reservoir and check for external leaks. 3. Replace faulty parts. 4. Tighten fittings or replace tube seats or O-rings. 5. Replace O-ring. 6. Overhaul with new seal kit. 7. Overhaul with new seal kit. 8. Overhaul with new seal kit. 9. Overhaul with spool plug seal kit. 10. Replace hydro-boost.
NOTE: The power steering fluid and brake fluid cannot be mixed. If the brake seals contact steering fluid or the steering seals contact brake fluid, seal damage will result.		

Noise Diagnosis

The following noises are associated with the hydro-boost and may or may not be cause for concern. Some noises are normal and for the most part temporary in nature. Other noises may be a sign of excessive wear or the presence of air in either the booster or the steering system.

1. A moan or low frequency hum usually accompanied by a vibration in the pedal or steering column may be observed during parking maneuvers or other low-speed maneuvers. This may be caused by a low fluid level in the power steering pump or by air in the fluid. Holding the pump at relief pressure (steering wheel held all the way in one direction) for more than five seconds will cause air to enter the system. Check the fluid level and fill if needed. The system must then sit for one hour to remove the air.
2. A high-speed fluid noise may be heard when the brake pedal is fully depressed. This condition is normal.
3. Whenever the accumulator pressure is used, a slight hiss may be noticed. It is the sound of the hydraulic fluid escaping through the accumulator valve, and is completely normal.
4. After the accumulator has been emptied and the engine is started again, another hissing sound may be heard during the first brake application or the first steering maneuver. This is caused by the fluid rushing through the accumulator charging orifice. It is normal and will only be heard once after the accumulator is emptied. If this sound continues however, even though no apparent accumulator pressure assist was made, it could be an indication that the accumulator is not holding pressure and should be checked using the procedure *Accumulator Leakdown Test* in this section.

Booster Functional Test

With the engine off, apply the brake pedal several times until the accumulator is completely depleted. Depress the brake pedal using 40 lb-ft (54 N•m) of force and start the engine. The pedal will fall and then push back against your foot.

Accumulator Leakdown Test

1. Start the engine and charge the accumulator by applying the brake pedal or by turning the steering wheel from stop to stop. Turn off the engine and let the vehicle sit for one hour. After one hour there should be at least two power-assisted applications with the engine off.
2. If the reserve system will not retain a charge for one hour, but functions normally immediately following charging, the accumulator valves are at fault. Replace the hydro-booster.
3. If the accumulator can be heard charging and discharging but does not hold a charge, replace the hydro-booster.
4. Deplete the accumulator by pressing the brake pedal several times. If the accumulator can has lost its charge, it is possible to rotate or wobble the accumulator can with respect to the housing. Replace the hydro-booster.

Handling - The booster should not be carried by the accumulator nor should the booster ever be dropped on the accumulator. The snap ring which holds the accumulator into the housing should be checked for proper positioning before the booster is used. The accumulator contains high pressure gas and with any high pressure gas a certain degree of danger is present if mishandled.

Disposal - The accumulator should not be exposed to excessive heat, fire or incineration. Before discarding accumulator following replacement, drill a 1/16 inch diameter hole in the end of accumulator can to relieve the pressure. BE SAFE! Protect your eyes. Wear approved safety glasses.

SERVICE BRAKE SYSTEM BLEEDING

NOTE: If only the front or rear half of the system has been serviced, it is usually necessary to bleed only that half of the system. However, if a firm brake pedal cannot be obtained after bleeding, it will be necessary to bleed the entire system. The brake hydraulic system can be bled manually or by using a pressure tank and adapters. Each method is outlined in the following procedures.

WARNING: Disconnect the batteries before bleeding the brake system. If the ABS modulator receives power during the bleed procedure, air may become trapped in areas in the modulator that cannot be bled by conventional techniques. The modulator would need to be replaced to obtain a firm brake pedal.

WARNING: If the reservoir has run very low or dry, bleed the master cylinder before bleeding the remainder of the brake system to keep from introducing additional air into the system.

WARNING: Always wear eye protection when bleeding brakes. Failure to do this may cause injury if brake fluid comes in contact with eyes.

Pressure Bleeding

CAUTION: *When using a pressure bleeding tank J–29532, follow the manufacturer's instructions for its use. Use only DOT 3 brake fluids when bleeding. Do not exceed the recommended working pressure when pressurizing the tank. A tank pressure of 15-20 psi (103-138 kPa) is sufficient to bleed the brake hydraulic system. Release all air pressure from the tank after using it.*

NOTE: This procedure covers bleeding at one wheel. Repeat bleeding task for remaining wheels.

1. Disconnect the batteries.
2. Remove the cap from the master cylinder. Fill the master cylinder if necessary.
3. Install the pressure tank bleeder adapter to the master cylinder (Figure 7-4).
4. Connect the line from the pressure tank to the adapter.

NOTE: Bleed the calipers in the following order: right rear, left rear, right front, left front.

5. Remove the protective cap from the bleeder screw on the caliper assembly (Figure 7-5).
6. Connect the short piece of hose to the bleeder screw, and place the other end of the hose in a container 3/4 full of brake fluid.

7. Open the valve on the line from the pressure tank to the master cylinder allowing the pressurized brake fluid to enter the system
   (Figure 7-4).
8. Open the bleeder screw 3/4 turn and observe the brake fluid in the container. Close the bleeder screw when the brake fluid flows free of air bubbles (Figure 7-5).
9. Disconnect the hose from the bleeder screw and install the protective cap on the bleeder screw.
10. Close the valve on the line from the pressure tank to the master cylinder (Figure 7-4).
11. Disconnect the line from the adapter.
12. Remove the adapter from the master cylinder and fill the master cylinder if necessary.
13. Install the master cylinder cap.
14. Connect the batteries.

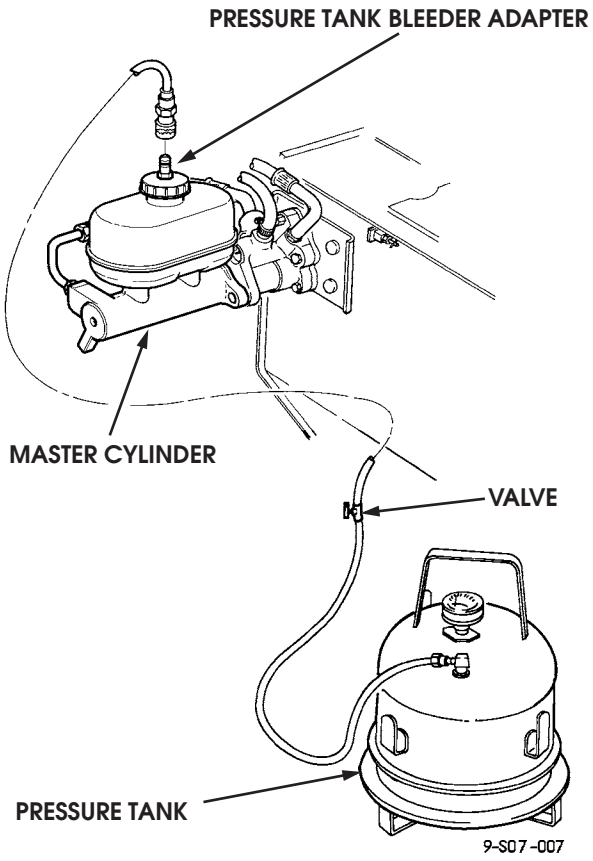


Figure 7-4: Pressure Bleeding Brake System

Manual Bleeding

NOTE: This procedure covers bleeding at one wheel. Repeat the bleeding task for remaining wheels. Assistance is required to depress the brake pedal when manually bleeding brakes while the tech opens and closes bleeder screw.

NOTE: Bleed the calipers in the following order: right rear, left rear, right front, left front.

1. Disconnect the batteries.
2. Remove the protective cap from the bleeder screw on the caliper assembly (Figure 7-5).
3. Connect the short piece of hose to the bleeder screw, and place the other end of the hose in a container 3/4 full of brake fluid.

CAUTION: *Check the master cylinder fluid level frequently during the bleeding operation and refill the reservoirs as necessary. Do not allow the master cylinder to run out of fluid at any time, or additional air will be drawn into the system.*

4. Have an assistant depress the brake pedal. Open the bleeder screw 3/4 turn.

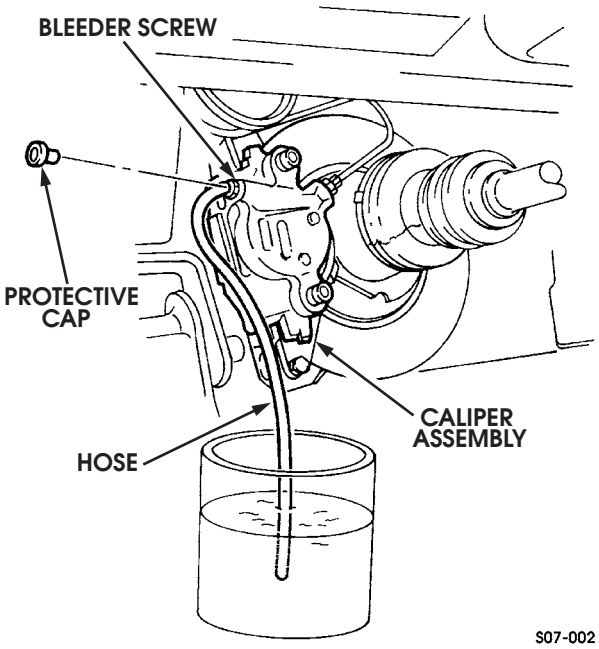


Figure 7-5: Manually Bleeding Brake System

5. When the pedal reaches the floor, tighten the bleeder screw and have your assistant slowly release the brake pedal.
6. Repeat steps 3 and 4 until the fluid flows clear and free of air bubbles.
7. Disconnect the hose from the bleeder screw and install the protective cap on the bleeder screw.
8. Connect the batteries.
9. Operate the vehicle and check the brakes for proper operation.

SERVICE BRAKE PAD REPLACEMENT

NOTE: The following procedure applies to the front brake system only.

Removal

1. Using a crowfoot, remove the two capscrews and washers securing the yoke and the caliper to the adapter.

NOTE: Note the positioning of the brake pad surfaces for installation.

2. Remove the yoke, caliper, and two brake pads.

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage, and replace if necessary.

1. Inspect the dust boot for tears or deterioration (Figure 7-6).
2. Inspect the rotor for heat cracks, spotting, discoloration, pitting, or scoring. Resurface the rotors if discolored, pitted, or scored. It is not recommended that the rotors be turned when spotted or heat cracks.
3. Inspect the brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace the brake pads. The brake pads should be replaced as an axle set (front or rear).

Installation

1. Check the brake pad backing plate notches for burrs or excess coating and ensure that the pad will fit the adapter slide with enough clearance to afford stick-free movement.
2. Lubricate the caliper guide pins, sleeves and adapter slides with Permatex® Ultra Disc Brake Caliper Lube prior to installation.

WARNING: Ensure the brake pads are installed with linings facing rotor. Failure to do this will cause poor performance, damage to equipment, and may result in injury.

3. Position the brake pads on the adapter.

NOTE: When installing the yoke and the caliper, use a suitable tool to compress the piston.

4. Apply a non-hardening thread-locking compound to the tapped holes of the adapter. Using the crowsfoot, secure the yoke and caliper to the adapter with the two washers and capscrews. Tighten the capscrews to 30-40 lb-ft (41-54 N•m).

LINING AND ROTOR BURNISHING

After you replace the brake pads and/or refinish the rotors, it is recommended that the new braking surface be broken in, or "burnished." To do this, make 20 stops, one every one to two miles at 30 mph, using medium pedal effort. The amount of time it takes to stop should be approximately five seconds. During this procedure, use care to avoid overheating the brakes.

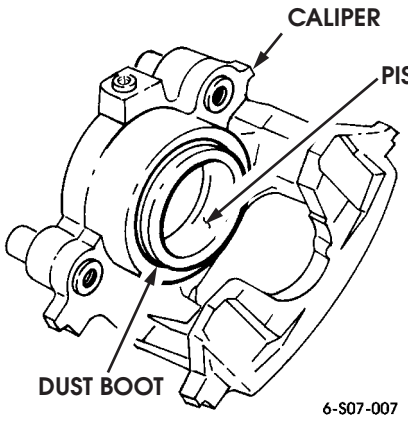


Figure 7-6: Caliper Assembly

FRONT SERVICE BRAKE CALIPER REPLACEMENT

NOTE: The following procedure applies to the front brake system only. If removing the left front caliper, the halfshaft must be removed.

Removal

1. Disconnect the brake line from the coupling (Figure 7-7).
2. Using a crowfoot, remove the two capscrews and washers securing the yoke and the caliper to the adapter.

NOTE: Note the positioning of the brake pad surfaces for installation.

3. Remove the yoke, caliper, and the two brake pads from the adapter.
4. Slide the yoke and caliper guide pins out from the caliper. Remove the coupling and washer from the caliper.

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage, and replace if necessary.

1. Clean the mating surfaces of the caliper and adapter (Figure 7-7).
2. Inspect the caliper and caliper piston for pitting, or damage (Figure 7-6).
3. Inspect the caliper guide pins and sleeves for wear.
4. Inspect the dust boot and bushings for tears or deterioration.
5. Inspect the yoke and caliper guide pins for corrosion. Perform step 6 if corroded. If not, perform step 8 (Figure 7-7).
6. Remove the caliper guide pins from the yoke. Discard the caliper guide pins.
7. Inspect the rotor for heat checks, discoloration, pitting, or scoring. Check the rotor thickness variation.

NOTE: Replace the brake pads in sets only. Replace the brake pads if the brake lining thickness is less than 1/8 in. (3.2 mm) and operation in wet and muddy conditions is expected.

8. Inspect the brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if brake lining thickness is less than 1/8 in. (3.2 mm), replace both of the pads and the pads from the opposite caliper.

Installation

1. Install a washer and coupling to the caliper (Figure 7-6).

WARNING: Ensure the brake pads are installed with the linings facing the rotor. Failure to do this will cause poor performance and damage to the equipment and may result in injury.

2. Position the brake pads on the adapter (Figure 7-7).

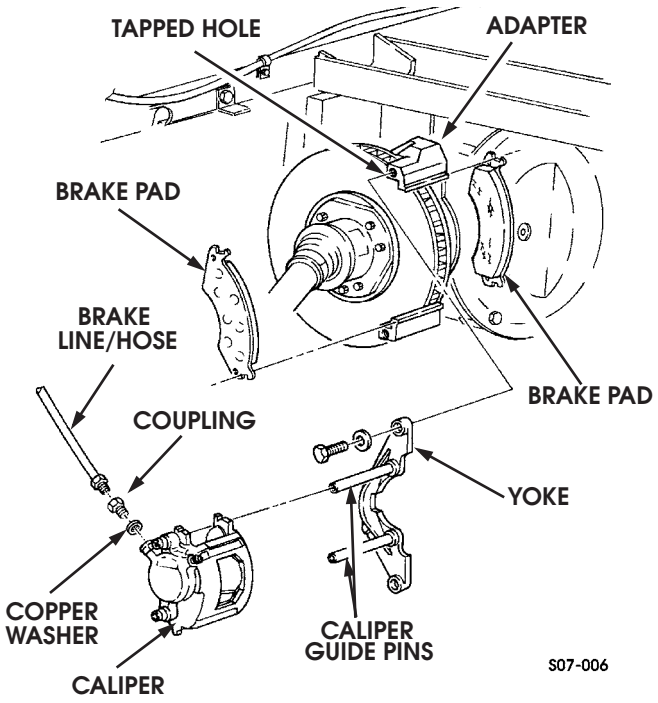


Figure 7-7: Service Brake Components

3. Inspect the caliper guide pins and replace if worn, pitted or corroded.
4. Apply a medium strength thread-locking compound to the threads of caliper the guide pins and install the pins into the yoke (if removed during cleaning and inspection). Tighten the caliper guide pins to 30 lb-ft (41 N•m).
5. Lubricate the caliper guide pins, sleeves and adapter slides with Permatex® Ultra Disc Brake Caliper Lube prior to installation.
6. Position the caliper onto the yoke.

NOTE: When installing the calipers, use a suitable tool to bottom out the piston in the caliper if needed.

7. Apply medium strength thread-locking compound to the tapped holes of the adapter. Using a crowfoot, secure the yoke and caliper to the adapter with two washers and capscrews. Tighten the two capscrews to 40 lb-ft (54 N•m).
8. Connect the brake line to the coupling and bleed the brake system.

MASTER CYLINDER REPLACEMENT

Removal

CAUTION: *Cover or plug all open connections immediately after disconnecting to prevent contamination*

NOTE: Have a drainage container ready to catch the brake fluid.

1. Disconnect the front and rear brake lines from the master cylinder (Figure 7-8).

CAUTION: *Do not apply excessive pressure or force on the master cylinder.*

2. Remove the two locknuts and master cylinder from the hydro-boost. Discard the locknuts (Figure 7-8).

Installation

1. Bench-bleed the master cylinder.

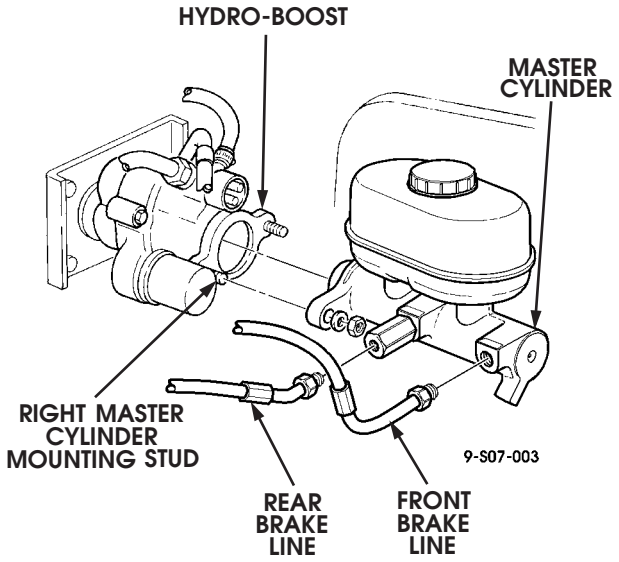


Figure 7-8: Master Cylinder

2. Install the master cylinder to the hydro-boost with two locknuts. Tighten the locknuts to 22 lb-ft (30 N•m) (Figure 7-8).
3. Install the front and rear brake lines to the master cylinder. Position the front and rear brake lines with a minimum of 1/2" clearance to the hydro-boost accumulator and the right rear modulator output line. Clearance between the front and rear lines is also 1/2" minimum.

MASTER CYLINDER BLEEDING

NOTE: The master cylinder must be filled and kept at least half full during the bleeding operation (Figure 7-9).

1. Depress the brake pedal slowly and hold. Loosen the front brake line to purge air from the front section of the reservoir.
2. Tighten the front brake line and release the brake pedal.
3. Repeat steps 1 and 2 until the front reservoir is purged of air.
4. Repeat steps 1 through 3 for the rear reservoir with the rear brake line.
5. Bleed the brake system.

MASTER CYLINDER BENCH BLEEDING

NOTE: The master cylinder must be filled and kept at least half full during the bleeding operation. Perform this procedure prior to installing the master cylinder on the vehicle.

1. Secure the master cylinder flange in a vise.
2. Remove the cover and fill the reservoir with DOT 3 brake fluid.
3. Screw the threaded end of the bleeder hose into the brake line port on the master cylinder and insert the opposite end into the reservoir. Repeat this step for the other bleeder hose (Figure 7-9).
4. Slowly push the piston into the master cylinder. Do not release the piston. Air will be forced into the hoses. Repeat as needed until no bubbles are noted from the lines. The lines must stay in the fluid until installed.
5. Refill the reservoir with DOT 3 brake fluid and repeat step 4 until no air bubbles remain in the brake fluid.

6. Remove the bleeder hoses from the brake line ports on the master cylinder.
7. Install the cap on the master cylinder and remove from the vise.
8. Install the master cylinder.
9. Bleed the brake system.

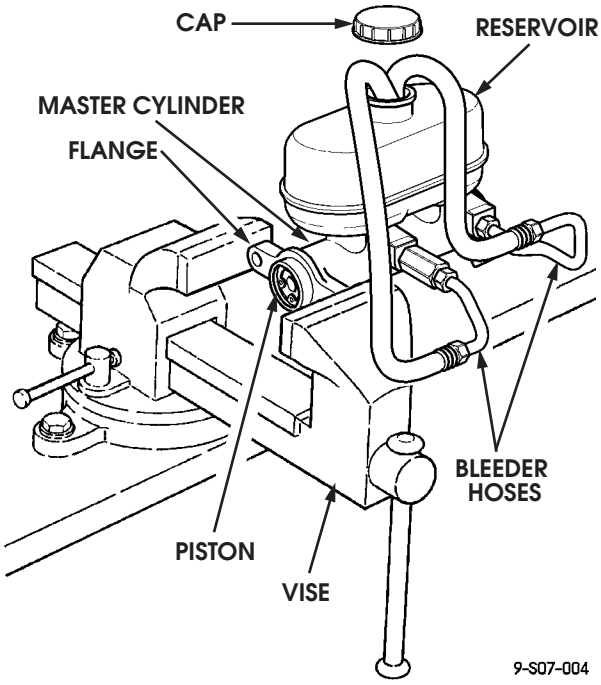


Figure 7-9: Bench Bleeding Master Cylinder

HYDRO-BOOST REPLACEMENT

Removal

1. Remove the two nuts securing the splash shield mount bracket to the hydro-boost/master cylinder assembly.
2. Remove the nut securing the mount bracket to the splash shield and remove the mount bracket.
3. Remove the two nuts securing the master cylinder to the hydro-boost and pull the master cylinder out and to one side.
4. Disconnect the two high pressure lines and one return line from the hydro-boost (Figure 7-10).
5. Remove the cotter pin, washer, and pushrod from the brake pedal bellcrank. Remove the spring washer from the brake pedal bellcrank and discard the cotter pin and spring washer.
6. Remove the four nuts, lockwashers, washers, gasket, and the hydro-boost from the cowl. Discard the lockwashers.

Installation

1. Install the gasket and the hydro-boost on the cowl with four washers, lockwashers, and nuts. Do not tighten the nuts. (Figure 7-10).
2. Install the spring washer on the brake pedal bellcrank. Connect the hydro-boost pushrod to the brake pedal bellcrank. Install the washer and cotter pin.
3. Tighten the nuts to 21 lb-ft (28 N•m).
4. Connect the two high pressure lines and one return line to the hydro-boost.
5. Install the master cylinder and the splash shield mount bracket.
6. Bleed the hydro-boost system.

BLEEDING THE HYDRO-BOOST SYSTEM

Whenever the booster is removed and installed, the steering system should be bled.

1. Fill the power steering pump reservoir to the proper level and let the fluid remain undisturbed for at least two minutes.
2. Start the engine and run momentarily. Add fluid if necessary.
3. Repeat steps 1 and 2 until the fluid level remains constant after running the engine.
4. Turn off the engine.
5. Raise the front of the vehicle so the wheels are off the ground. Support the vehicle with suitable safety stands.
6. Turn the wheels from stop to stop. Add fluid if necessary.
7. Lower the vehicle from the safety stands.
8. Start the engine and depress the brake pedal several times while rotating the steering wheel from stop to stop.
9. Turn the engine off and pump the brake pedal 4 to 5 times.

CAUTION: *The HUMMER H1 is equipped with DOT 3 brake fluid.* ***Do not mix with other brake fluids.*** *Failure to use the proper brake fluid will damage the brake system.*

10. Check the brake fluid level. Add fluid if necessary.
11. If the fluid is extremely foamy, allow the vehicle to stand a few minutes with the engine on. Then repeat steps 7, 8, and 9.
12. Check for the presence of air in the oil. Air in the oil will give the fluid a milky appearance. Air in the system will also cause the fluid level in the pump to rise when the engine is turned off.

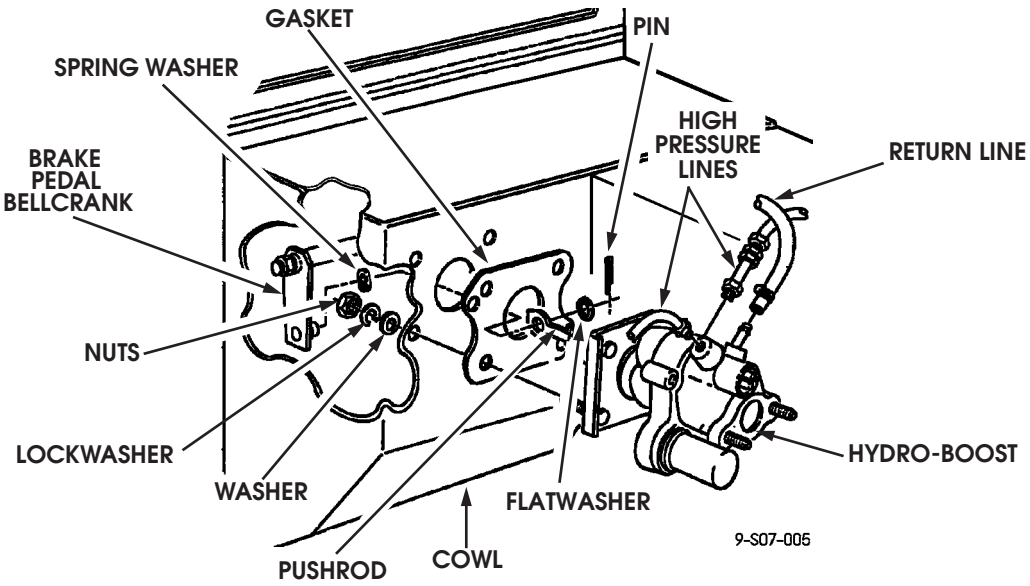


Figure 7-10: Hydro-boost Replacement Procedure

BRAKE LINE REPLACEMENT

Metal brake lines should be inspected for leaks or deterioration every time the vehicle is being serviced.

WARNING: The batteries must be disconnected when the brake hydraulic system is being serviced and bled. If the ABS motor pump runs when air is in the hydraulic system, air can get trapped behind the valves in the modulator causing a spongy brake pedal.

NOTE: After servicing the brake system, bleed the brakes and refill as necessary.

Front Brake Line Replacement

NOTE: The procedure is the same for the right and left front brake lines.

1. Disconnect the brake line from the caliper.

2. Disconnect the brake line from the the ABS modulator assembly.
3. Remove the capscrew and clamp securing the brake line to the crossmember, and remove the brake line (Figure 7-11).
4. Reverse the removal procedure for installation and bleed the brake hydraulic system.

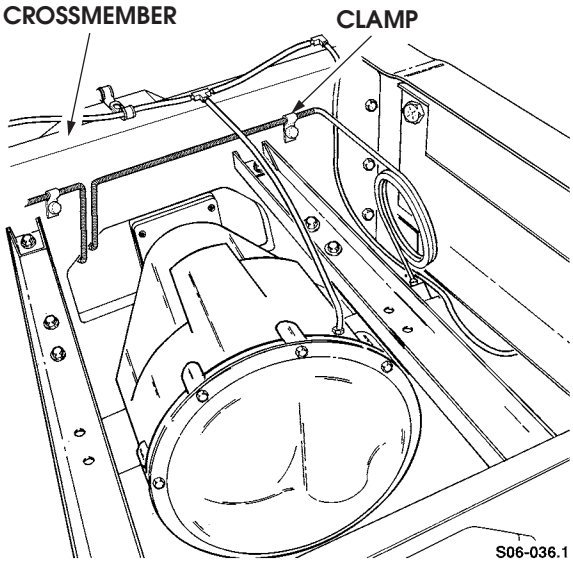


Figure 7-11: Front Brake Line Replacement

Intermediate Brake Line Replacement

NOTE: The procedure is the same for the right and left intermediate brake lines.

1. Disconnect the intermediate brake line from the ABS modulator assembly.
2. Disconnect the intermediate brake line from the rear brake line at the union located forward of the forward-rear crossmember.
3. Remove the capscrews and clamps securing the intermediate brake line to the frame rail and remove the brake line from the vehicle.
4. Reverse the removal procedure for installation and bleed the brake hydraulic system.

Rear Brake Line Replacement

Removal

1. Disconnect the rear brake line from the caliper.
2. Disconnect rear brake line from the intermediate brake line at the union located forward of the forward-rear crossmember (Figure 7-12).

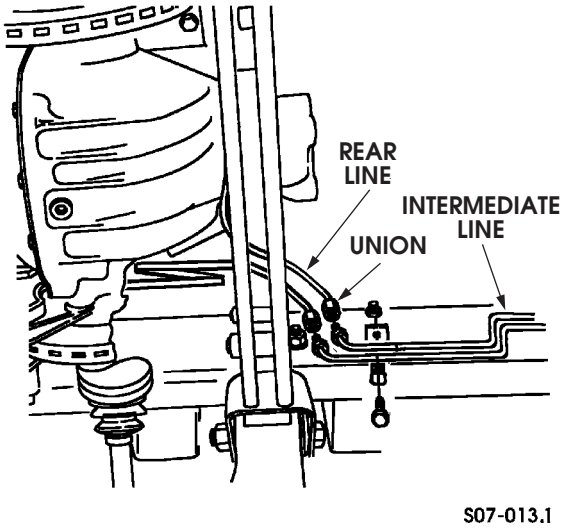


Figure 7-12: Rear Brake Line Replacement

3. Remove the capscrew and clamp securing the rear brake line to the forward-rear crossmember and remove the brake line from the vehicle.
4. Reverse the removal procedure for installation and bleed the brake hydraulic system.

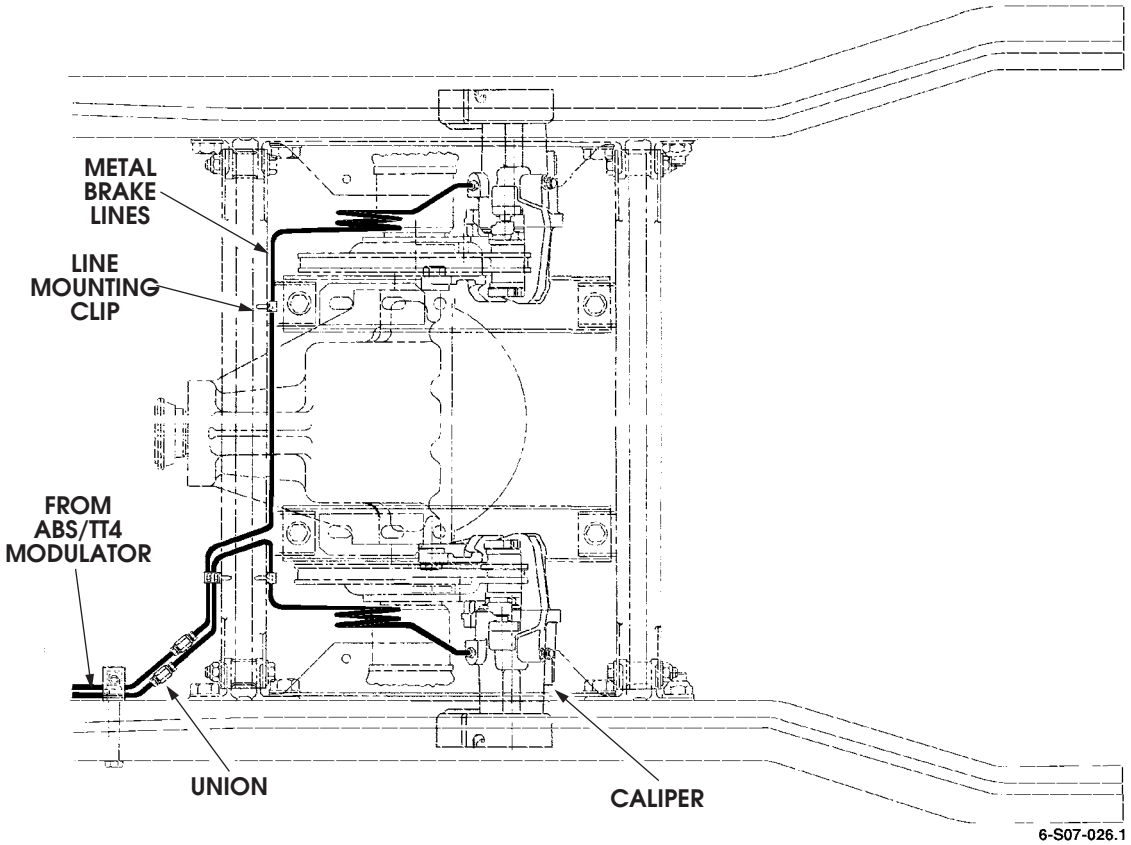


Figure 7-13: Rear Brake Component Location

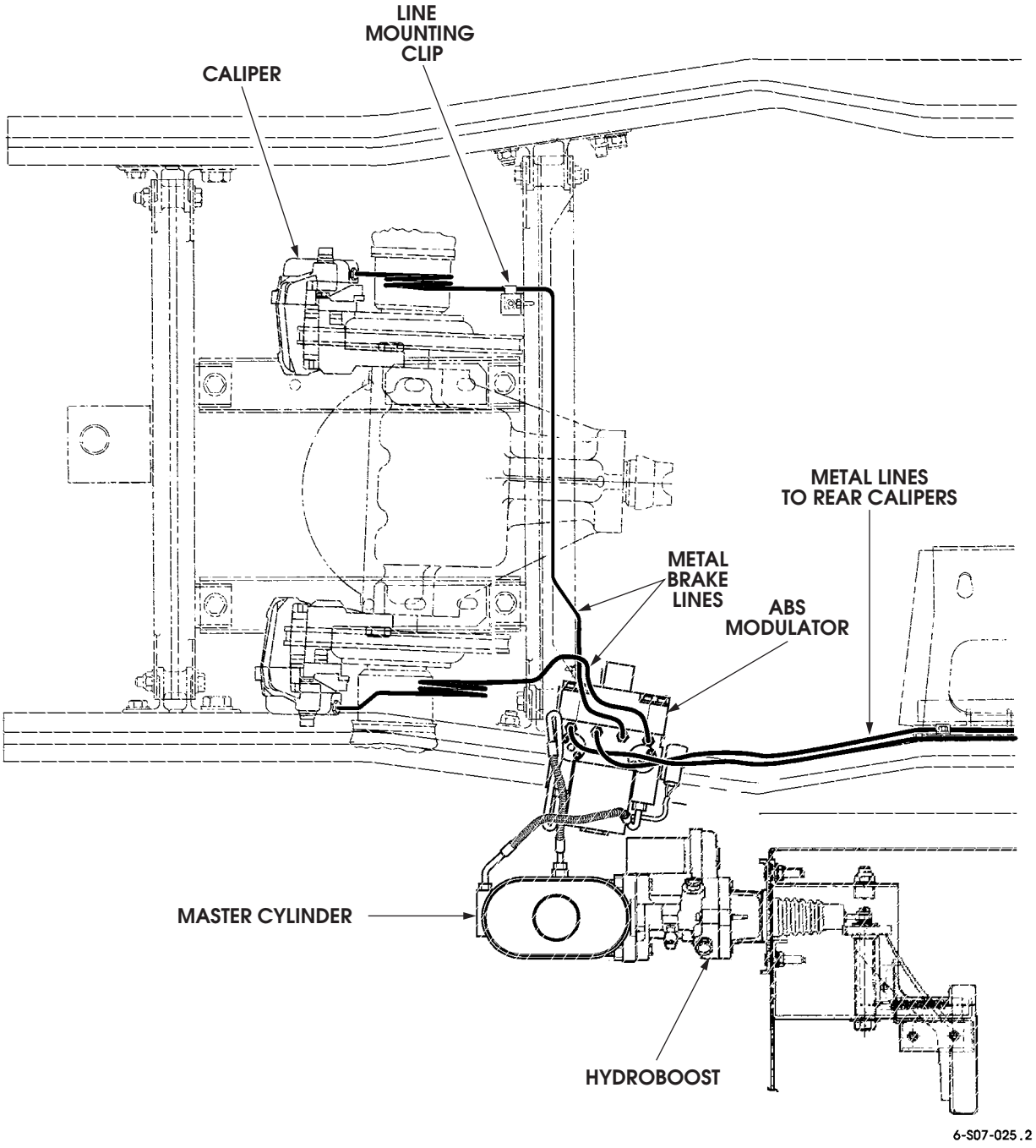


Figure 7-14: Front Brake Component Location

SERVICE BRAKE PEDAL REPLACEMENT

Removal

1. Disconnect the stoplight switch (Figure 7-15).
2. Remove the pushnut and disconnect the stoplight switch rod (if so equipped) from the brake pedal assembly. Discard the pushnut. (Figure 7-15).
3. Disconnect the return spring from the brake pedal assembly.
4. Remove the cotter pin and washer securing the hydro-boost pushrod to the brake pedal bellcrank, and disconnect the hydro-boost pushrod from the brake pedal bellcrank. Remove the spring washer. Discard the cotter pin and spring washer.
5. Remove the nut, two washers, pivot pin, and brake pedal assembly from the bracket.

6. Remove the two bushings from the brake pedal assembly. Discard the two bushings.

Installation

1. Apply silicone grease to the inside of the two bushings. Install the two bushings in the brake pedal assembly.
2. Install the brake pedal assembly on the bracket with the pivot pin, two washers, and the nut. Using the adapter and a crowfoot, tighten the nut to 60 lb-ft (81 N•m).
3. Install the spring washer on the brake pedal bellcrank. Connect the hydro-boost pushrod to the brake pedal bellcrank with the washer and new cotter pin.
4. Connect the return spring to the brake pedal assembly.
5. Use the pushnut to install the stoplight switch rod (if so equipped) to the brake pedal assembly.
6. Connect the stoplight switch.
7. Operate the vehicle and check the brakes for proper operation.
8. Check the brake lights for proper operation.

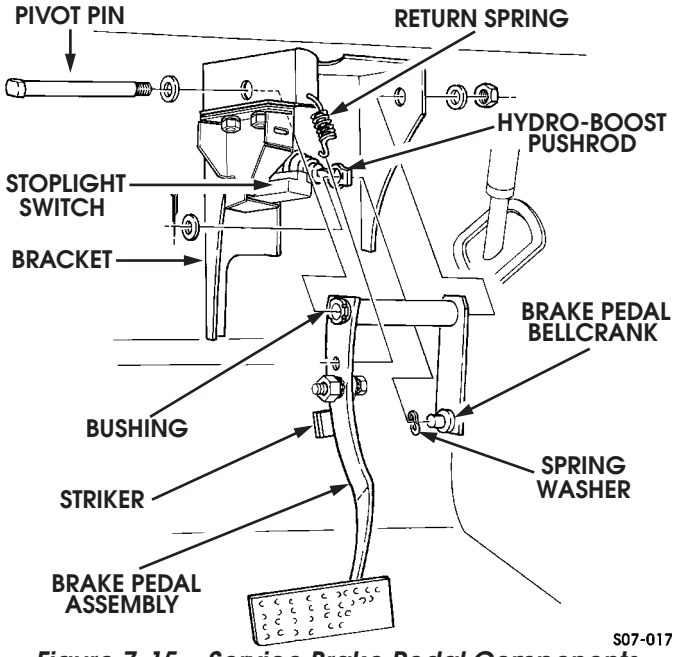


Figure 7-15: Service Brake Pedal Components

SERVICE BRAKE ROTOR REPLACEMENT

Removal

1. Remove the service brake caliper.
2. Remove the six capscrews, lockwashers, halfshaft, and rotor from the output flange. Discard the ockwashers (Figure 7-17).

Installation

1. Apply high strength thread-locking compound to the threads of the capscrews if the original capscrews are used.
2. Install the rotor on the output flange.
3. Secure the halfshaft and rotor to the output flange with twelve inclined cam lockwashers and 6 capscrews with preapplied threadlocker. Tighten the capscrews to 57 lb-ft (77 N•m).
4. Install the service brake caliper.

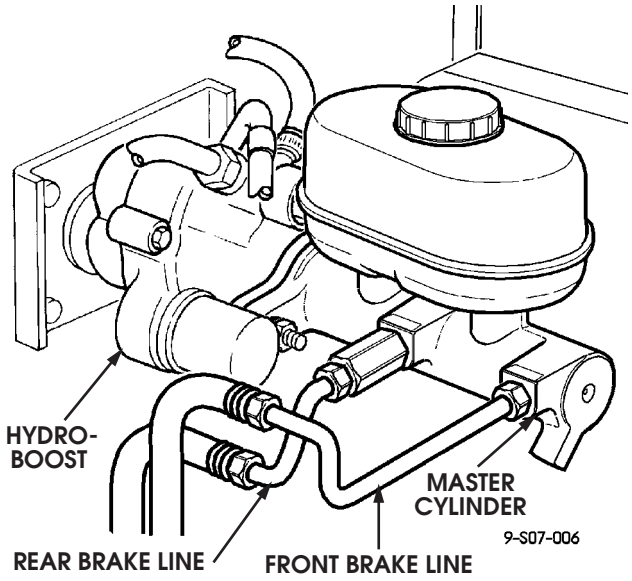


Figure 7-16: Hydro-Boost And Master Cylinder Mounting

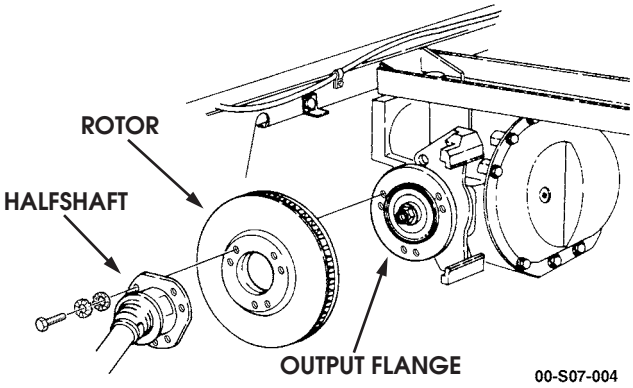


Figure 7-17: Service Brake Rotor

REAR DUAL SERVICE/PARKING BRAKE PAD REPLACEMENT

Removal

1. Put the transmission in PARK, chock the wheels, and release the parking brake.
2. Remove the cotter pin, washer, and clevis pin securing the parking brake cable to the lever. Discard the cotter pin (Figure 7-18).
3. Remove the clip securing the parking brake cable to the caliper cable bracket and disconnect the cable from the caliper cable bracket. Discard the clip.

CAUTION: *The caliper must be supported during the removal to prevent damage to the brake line.*

4. Remove the two capscrews and washers securing the yoke and caliper to the adapter, and pull the yoke and caliper away from the rotor (Figure 7-19).

NOTE: Note the positioning of the brake pad surfaces for installation.

5. Remove the two brake pads from the adapter and rotor.

Cleaning and Inspection

NOTE: Clean all components, examine for wear or damage, and replace if necessary.

1. Clean the mating surfaces of the caliper, adapter, guide pins and sleeves.

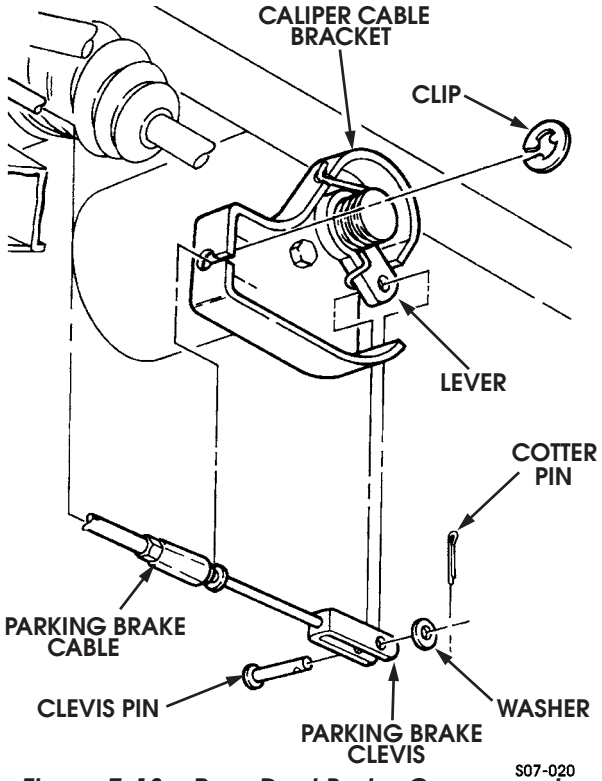


Figure 7-18: Rear Dual Brake Components

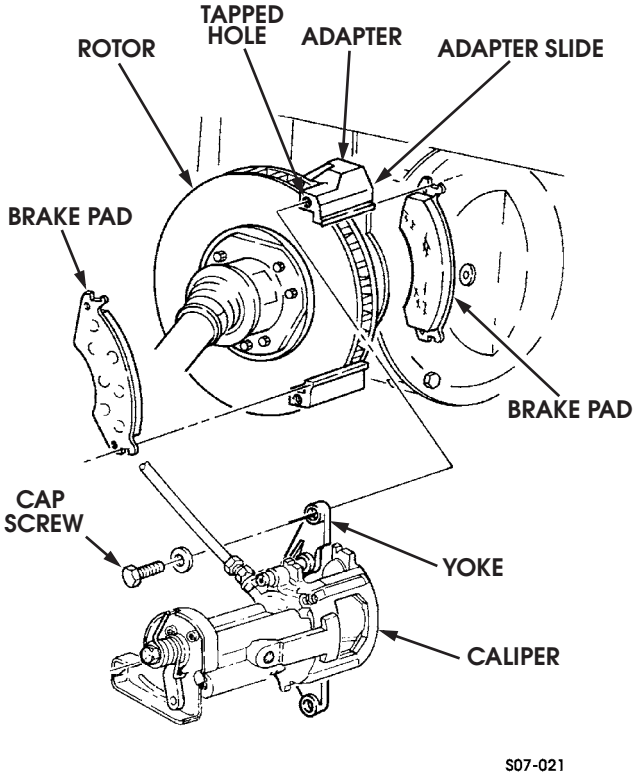


Figure 7-19: Rear Dual Brake Pad and Rotor

2. Inspect the caliper and caliper piston face for pitting or damage (Figure 7-20).
3. Inspect the piston dust boot and bushings for tears or deterioration.

4. Inspect the caliper cable bracket for looseness, damage, and rotation.
5. Thoroughly clean and inspect the rotor for heat checks, discoloration, pitting, or scoring (Figure 7-19).

CAUTION: *Ensure that grease and oil are not in contact with the rotor and/or brake pad friction surface. Failure to do so will result in damage to equipment and poor performance.*

NOTE: Replace the brake pads in sets only. If operation in wet and muddy conditions is expected, replace the brake pads if the brake lining thickness is less than 1/8 in. (3.2 mm).

6. Inspect the brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if the brake lining thickness is less than 1/8 in. (3.2 mm), replace both of the pads and the pads on opposite caliper.

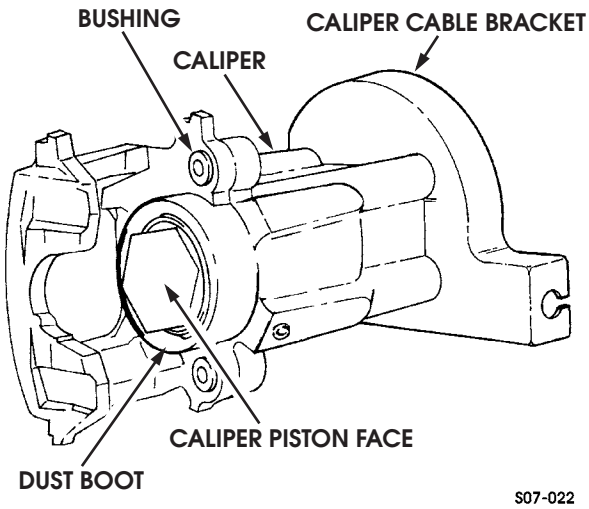


Figure 7-20: Rear Dual Brake Caliper

Installation

WARNING: Ensure the brake pads are installed with the linings facing the rotor. Failure to do this will cause poor performance and damage to the equipment and may result in injury.

1. Check the brake pad backing plate notches for burrs or excess coating and ensure that the pad will fit the adapter slide with enough clearance to afford stick-free movement.

CAUTION: *Remove any excess lubricant that may have squeezed out from between mating surfaces. Do not allow any lubricant to come in contact with the brake pad friction material or brake rotor surfaces.*

2. Lubricate the caliper guide pins, sleeves and adapter slides with Permatex® Ultra Disc Brake Caliper Lube prior to installation.

NOTE: Always apply thread-locking compound to the tapped holes.

3. Apply thread-locking compound to the tapped holes of adapter.
4. Using special tool J–42553, rotate the caliper piston in a clockwise direction, and at the same time apply force on the outer piston face until the caliper piston is seated in the piston bore (Figure 7-20).
5. Position the caliper and the yoke on the adapter and rotor. Secure the yoke to the adapter with the two washers and capscrews. Using a crowsfoot, tighten the capscrews to 40 lb-ft (54 N•m) (Figure 7-19).
6. Install the parking brake cable to the caliper cable bracket and secure with the clip (Figure 7-21).

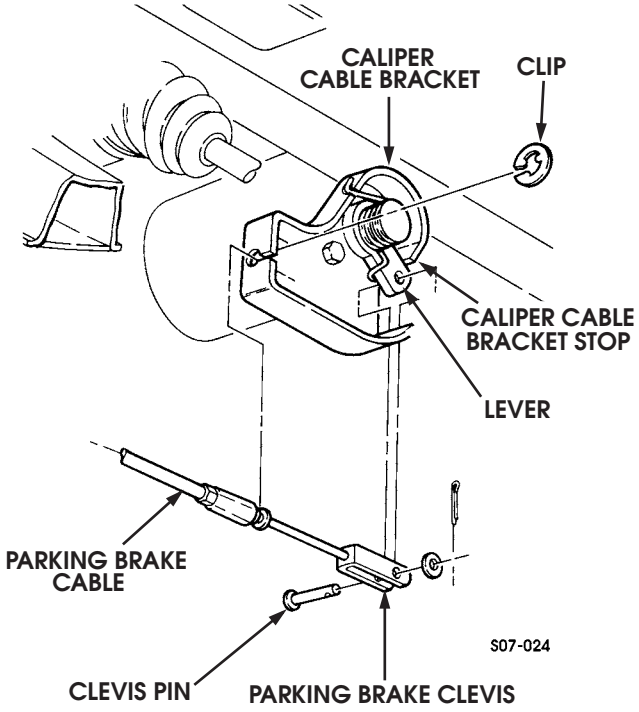


Figure 7-21: Rear Dual Brake Caliper Cable

CAUTION: *Ensure the lever is in contact with the caliper cable bracket stop. Damage to the equipment and poor performance will result if not aligned properly. Ensure that the clevis and clevis pin are aligned to the lever. Do not move the lever to accommodate a maladjusted clevis. Damage to the equipment and poor performance will result.*

7. Install the parking brake clevis to the lever with the clevis pin, washer, and cotter pin. Check the position of the lever and ensure it is in contact with the caliper cable bracket stop.
8. Adjust the rear dual service/parking brake.

REAR DUAL SERVICE/PARKING BRAKE CALIPER REPLACEMENT

Removal

1. Release the parking brake.
2. Remove the cotter pin, washer, and clevis pin securing the parking brake clevis to the lever. Discard the cotter pin (Figure 7-21).
3. Remove the clip and parking brake cable from the caliper cable bracket. Discard the clip.
4. Disconnect the brake line from the coupling (Figure 7-22).
5. Remove the coupling and copper washer from the caliper.

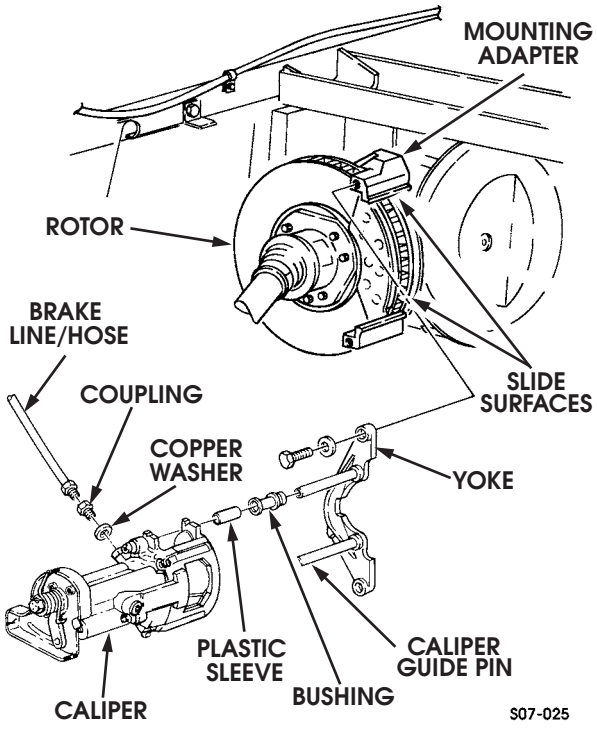


Figure 7-22: Rear Dual Brake Components

CAUTION: *The caliper must be supported during removal to prevent damage to the brake line.*

6. Remove the two capscrews, washers, yoke, and caliper from the adapter.
7. Slide the yoke and the caliper guide pins out from the caliper.

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage, and replace if necessary.

1. Clean the mating surfaces of the caliper, adapter, guide pins and the sleeves (Figure 7-19).
2. Inspect the caliper and the caliper piston face for pitting or damage (Figure 7-24).
3. Inspect the caliper cable bracket for looseness, damage, and for rotation
4. Inspect the piston dust boot and the bushing for tears or deterioration.
5. Clean the cooling fins of the rotor (Figure 7-22).
6. Inspect the rotor for heat checks, discoloration, pitting, or damage.
7. Inspect the yoke and the caliper guide pins for corrosion. Perform step 8 if corroded, if not, perform step 9.
8. Remove the caliper guide pins from the yoke. Discard the caliper guide pins.
9. Inspect the brake pads for glazing, oil saturation, or wear. If glazed, oil saturated, or if the brake lining thickness is less than 1/8 in. (3.2 mm), replace both of the pads and the pads on opposite caliper.

CAUTION: *Ensure that grease and oil are not in contact with rotor and/or the brake pad friction surfaces. Failure to do so will result in damage to the equipment and poor performance.*

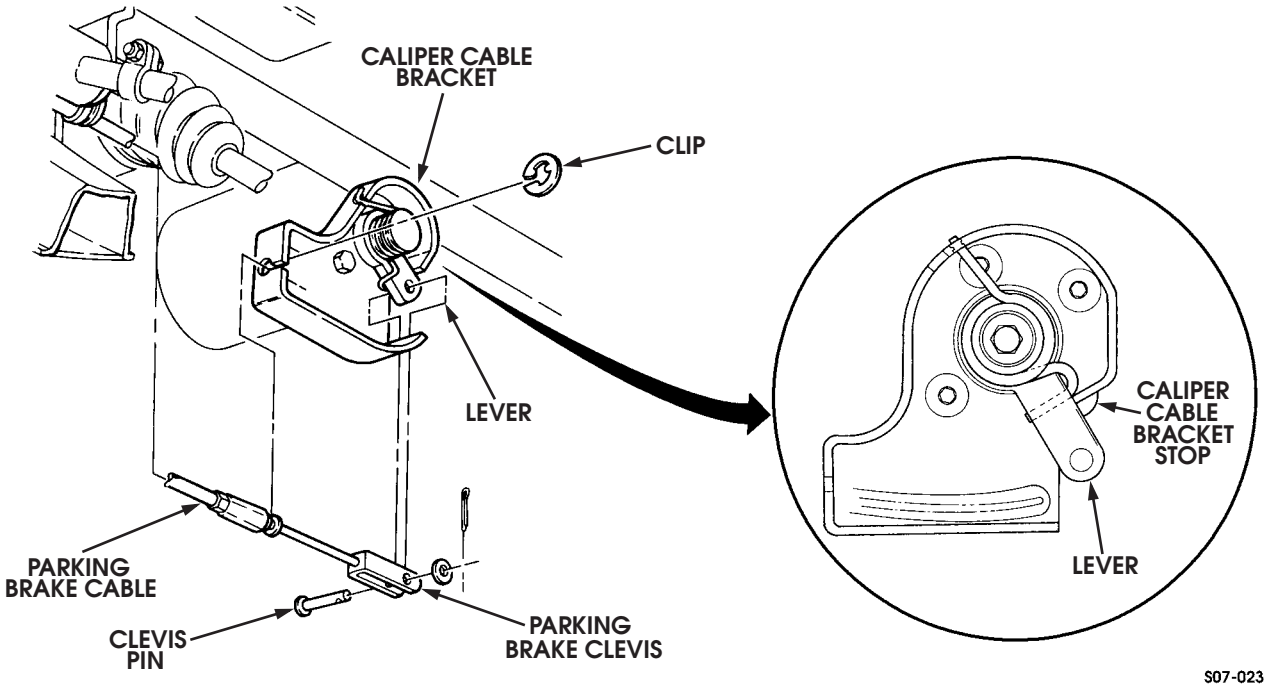


Figure 7-23: Rear Dual Service/Parking Brake Caliper Cable Bracket

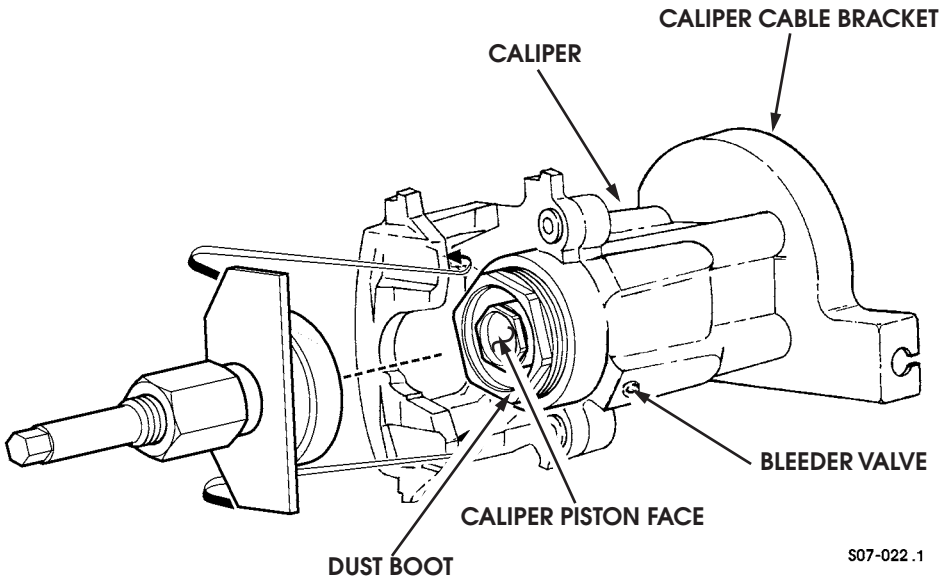


Figure 7-24: Rear Caliper and Bleeder Valve

Installation

1. Open the bleeder valve and depress the piston into the caliper while rotating the piston in a clockwise direction, and at the same time apply pressure until the piston is seated in the piston bore (Figure 7-24).

NOTE: Perform step 2 only if the caliper guide pins were replaced.

2. Apply thread-locking compound to the threads of the caliper guide pins and install the caliper guide pins in the yoke. Tighten the caliper guide pins to 30 lb-ft (41 N•m) (Figure 7-25).
3. Lubricate the caliper guide pins, sleeves and the adapter slides with Permatex® Ultra Disc Brake Caliper Lube prior to installation. Slide the yoke and the caliper guide pins into the caliper

4. Apply thread-locking compound to the tapped holes of the adapters.
5. Position the caliper and the yoke on the adapter and the rotor. Install the caliper and the yoke on the adapter with two washers and capscrews. Using a crowfoot, tighten the capscrews to 40 lb-ft (54 N•m).
6. Install the copper washer and the coupling on the caliper and connect the brake line to the coupling.
7. Install the parking brake cable on the caliper cable bracket and secure with the clip (Figure 7-23).

CAUTION: *Ensure the lever is in contact with the caliper cable bracket stop. Damage to the equipment and poor performance will result if it is not aligned properly. Ensure that the clevis and the clevis pin are aligned to the lever. Do not move the lever to accommodate a misadjusted clevis, or damage to the equipment and poor performance will result.*

8. Install the parking brake clevis on the lever and secure with the clevis pin, washer, and the cotter pin.
9. Check the position of the lever and ensure it is in contact with the caliper cable bracket stop.
10. Bleed the brake system.
11. Adjust the rear dual service/parking brake.

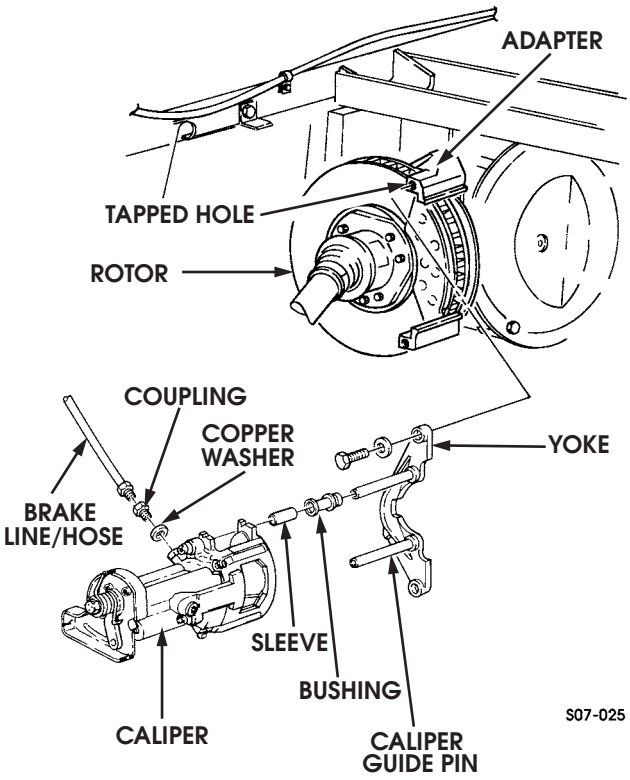


Figure 7-25: Rear Brake Components

RIGHT PARKING BRAKE CABLE REPLACEMENT

Removal

1. Put the transmission in PARK, chock the wheels, and release the parking brake.
2. Remove the cotter pin, washer, clevis pin, and the brake clevis from the lever. Discard the cotter pin (Figure 7-26).
3. Remove the clip securing the cable sleeve to the caliper cable bracket and remove the parking brake cable assembly from the caliper cable bracket. Discard the clip.
4. Slide the parking brake cable through the parking brake cable assembly. Remove the clip securing the cable sleeve to the C-beam. Disconnect the parking brake cable from the equalizer bar. Discard the clip.
5. Remove the two capscrews securing the two clamps and parking brake cable assembly to the frame.
6. Remove the capscrew, lockwasher, and the clamp from the bracket. Discard the lockwasher.

NOTE: Perform step 7 if the bracket is damaged. If not replacing the bracket, proceed to installation. Note the position of the cable, bracket, and the clamp prior to removal.

7. Remove the two capscrews and bracket from the support bracket.

Installation

NOTE: Perform step 1 if the clamp bracket was removed, if not, proceed to step 2.

1. Rotate the bracket inward on the support bracket and secure with the two capscrews.
2. Install the clamp on the parking brake cable assembly and install the clamp to the bracket with the lockwasher and the capscrew.
3. Install the two clamps on the parking brake cable assembly and install the clamps on the frame with the two capscrews.
4. Install the cable sleeve on the C-beam and parking brake cable on the equalizer bar and secure with the cable clip.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

5. Install the cable sleeve on the caliper cable bracket with the brake cable clip.
6. Install the brake clevis on the lever with the clevis pin, washer, and the cotter pin.
7. Adjust the parking brake lever.

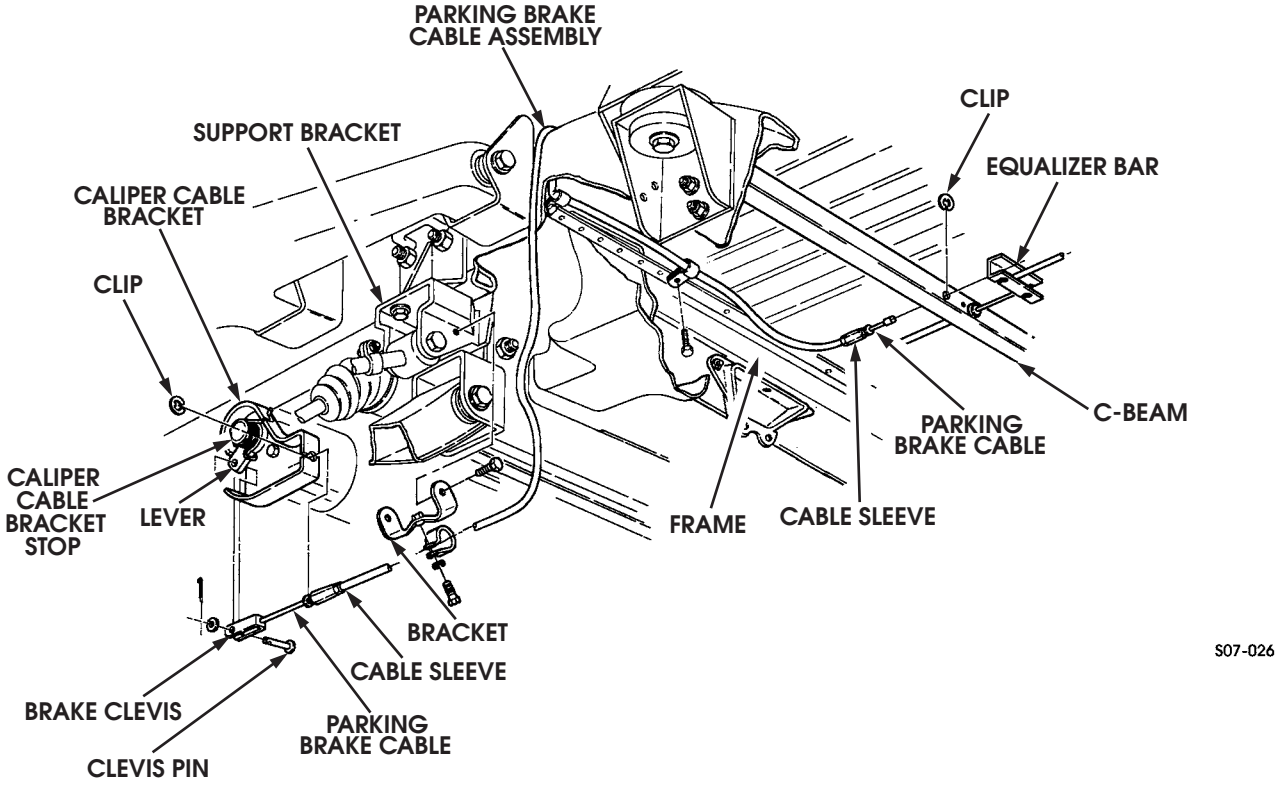


Figure 7-26: Right Parking Brake Cable Components

LEFT PARKING BRAKE CABLE REPLACEMENT

Removal

1. Put the transmission in PARK, chock the wheels, and release the parking brake.
2. Remove the cotter pin, washer, clevis pin, and the brake clevis from the lever. Discard the cotter pin (Figure 7-27).
3. Remove the clip and cable sleeve from the caliper cable bracket. Discard the clip.

4. Slide the parking brake cable through the parking brake cable assembly. Remove the clip securing the cable sleeve to the C-beam. Disconnect the parking brake cable from the equalizer bar. Discard the clip.
5. Remove the capscrew, washer, nut and lockwasher assembly and the washer securing the clamp to the mounting bracket and the parking brake cable assembly. Discard the nut and the lockwasher assembly.
6. Remove the capscrew, lockwasher, clamp, and the parking brake cable assembly from the bracket. Discard the lockwasher.

NOTE: Perform step 7 if the clamp bracket is damaged. If not replacing the bracket, proceed to installation. Note the position of the cable, bracket, and the clamp prior to removal.

7. Remove the two capscrews and the bracket from the support bracket.

Installation

NOTE: Perform step 1 if the clamp bracket was removed. If not, proceed to step 2.

1. Rotate the bracket inward on the support bracket and secure with the two capscrews (Figure 7-27).
2. Install the clamp on the parking brake cable assembly and bracket with the lockwasher and the capscrew.
3. Install the clamp on the parking brake cable assembly and the mounting bracket with the washer, capscrew, washer, nut, and the lockwasher assembly.
4. Install the cable sleeve on the C-beam and the parking brake cable to the equalizer bar and secure with the clip.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

5. Install the cable sleeve on the caliper cable bracket with the clip.
6. Install the brake clevis on the lever with the clevis pin, washer, and the cotter pin.
7. Adjust the parking brake lever.

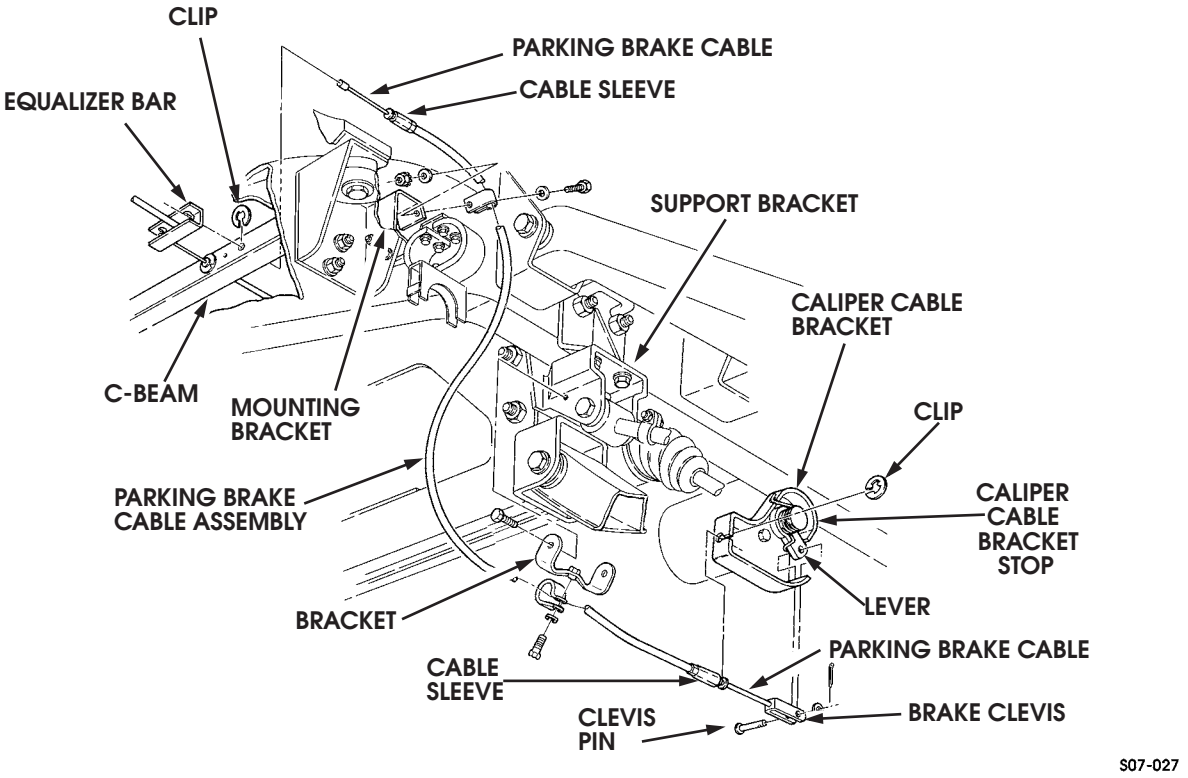


Figure 7-27: Left Parking Brake Cable Components

PARKING BRAKE ROD REPLACEMENT

Removal

1. Put the transmission in PARK, chock the wheels, and release the parking brake.
2. Remove the cotter pin, washer, clevis pin, and the brake clevis from the lever. Discard the cotter pin (Figure 7-28).
3. Remove the six clips and spread the boot to allow access to the cotter pin (Figure 7-29).
4. Remove the cotter pin, washer, clevis pin, and the clevis securing the brake rod to the bellcrank. Discard the cotter pin.
5. Disconnect the spring from the bracket (Figure 7-29).
6. Remove lthe ocknut from the conical washer, and the brake rod from the equalizer bar. Discard the locknut.
7. Remove the clevis, nut and the spring from the brake rod.

Installation

1. Install the spring, nut, and the clevis on the brake rod.
2. Install the brake rod on the equalizer bar with the conical washer and the locknut. Tighten the locknut far enough to expose 3-5 threads on the end of the brake rod.
3. Connect the spring to the bracket.
4. Spread the boot and install the clevis to the bellcrank with the clevis pin, washer and the cotter pin.
5. Install the six clips on the boot.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop.*

6. Install the brake clevis on the lever with the clevis pin, washer, and the cotter pin (Figure 7-30).
7. Adjust the parking brake.

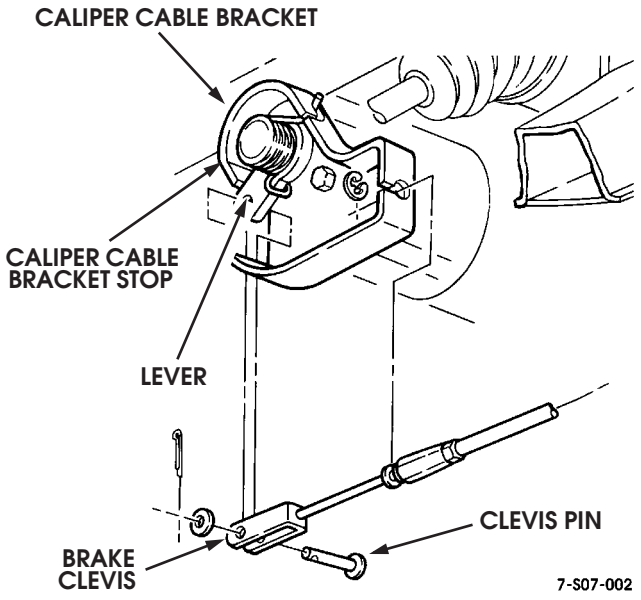


Figure 7-28: Parking Brake Rod Attachment at Caliper

PARKING BRAKE ADJUSTMENT

NOTE: The integral parking/service brake mechanism has an automatic adjusting feature and does not require periodic manual adjustment. When parking brake components or rear brake pads are replaced, the parking brake linkage must be initially positioned to ensure proper parking brake system operation. The only additional adjustment necessary is accomplished with the parking brake hand lever.

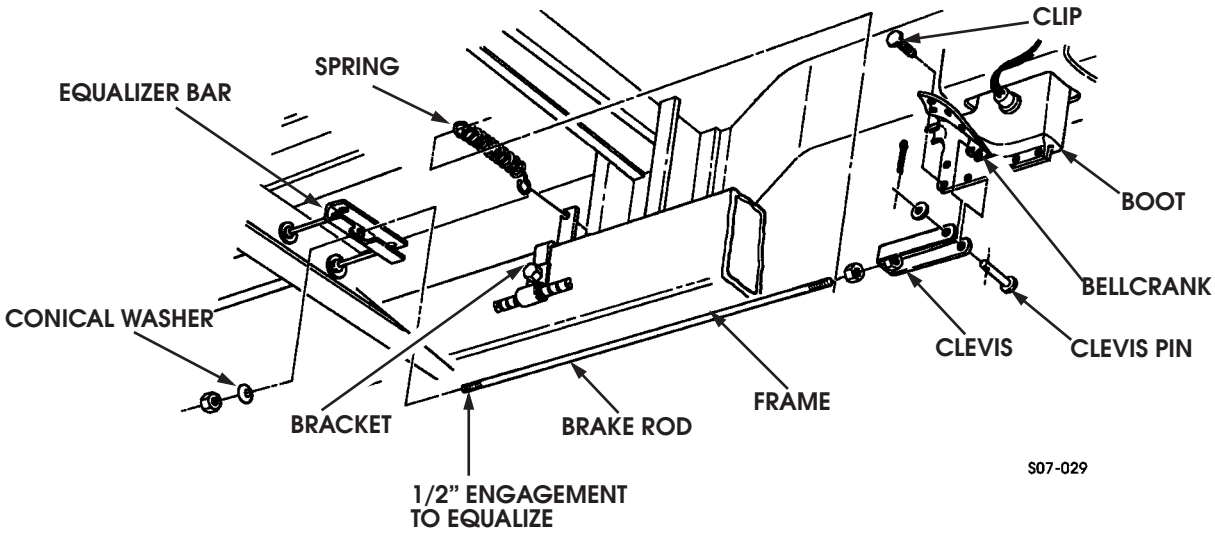


Figure 7-29: Parking Brake Rod Location

Adjustment

1. Put the transmission in PARK, chock the wheels, and release the parking brake.
2. Remove the six clips and spread the boot to allow access to the cotter pin (Figure 7-30).
3. Remove the cotter pin, washer, and the clevis pin securing the clevis to the bellcrank. Discard the cotter pin.
4. Repeatedly apply and adjust the parking brake hand lever until the bellcrank linear travel is 0.75 in. (19 mm).

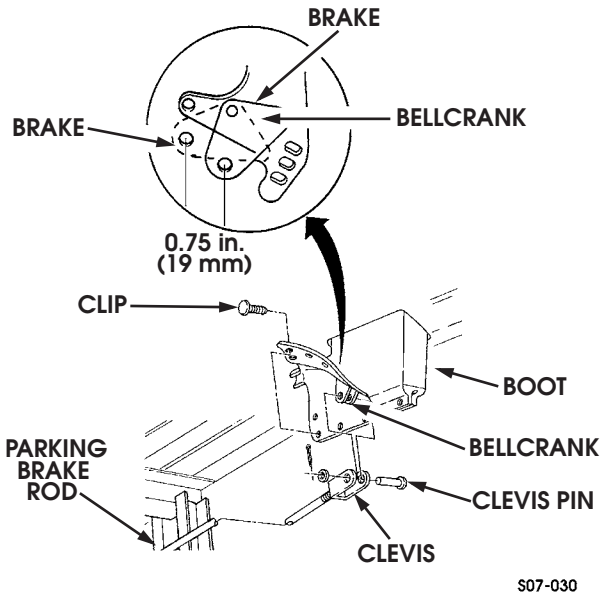


Figure 7-30: Parking Brake Adjustment

CAUTION: *The holes in the parking brake clevis must align with the holes in the adjusting bellcrank without force for proper parking brake adjustment. Failure to do this may result in damage to the equipment and poor performance.*

5. Release the parking brake. Loosen the nut and adjust the clevis so the holes in the clevis align with the holes in the bellcrank. Secure the clevis to the bellcrank with the clevis pin, washer, and the cotter pin.

CAUTION: *Do not overtighten the parking brake rod. Overtightening the parking brake rod may result in dragging brakes.*

6. If necessary, remove the excess slack in the parking brake cables by turning the parking brake rod clockwise or counterclockwise into the clevis.

CAUTION: *Ensure that the caliper cable bracket is secure with no signs of looseness and the lever is in contact with the caliper cable bracket stop. Damage to equipment and poor performance will result if not aligned properly.*

NOTE: Perform step 7 on both sides of the vehicle.

7. The parking brake rod is properly adjusted if the lever is in contact with the caliper cable bracket stop (Figure 7-31).
8. Tighten the nut against the clevis.
9. Install the six clips in the boot (Figure 7-30)
10. Adjust the parking brake lever.

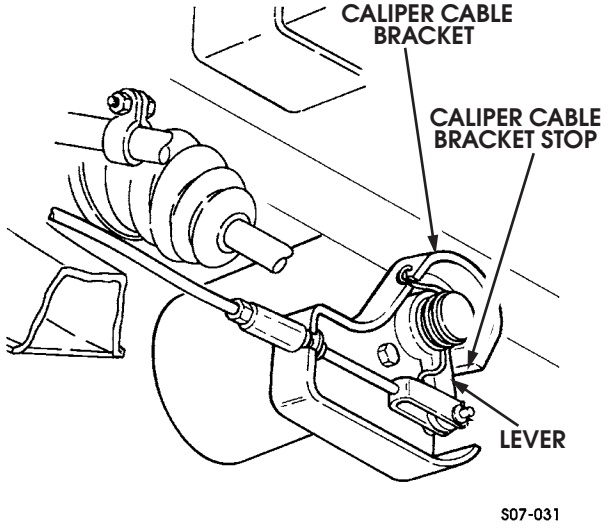


Figure 7-31: Caliper Cable Bracket Stop

PARKING BRAKE HAND LEVER REPLACEMENT

Removal

1. Put the transmission in PARK, chock the wheels, and release the parking brake.
2. Remove the parking brake switch.
3. Remove the six clips and open the lower boot to allow access to the clevis pin. Discard the clips (Figure 7-32).
4. Remove the cotter pin, washer, and the clevis pin from the clevis and the bellcrank. Discard the cotter pin.
5. Remove the nut and lockwasher assembly, wiring harness clamp, nut and the lockwasher assembly, and the bolt securing the parking brake hand lever to the body. Discard the nut and the lockwasher assemblies (Figure 7-33).
6. Remove the three locknuts, washers, and the bolts securing the parking brake hand lever to the body. Discard the locknuts.
7. Remove the two locknuts, washers, bolts, and the washers securing the parking brake hand lever to the body and remove the parking brake lever. Discard the locknuts.
8. Remove the upper boot from the parking brake hand lever.
9. Remove the boot from the body.

Installation

1. Install the boot on the body. Install the upper boot on the parking brake hand lever.
2. Install the parking brake hand lever on the body and secure with the two washers, bolts, washers, and the locknuts.
3. Secure the parking brake hand lever on the body with the bolt, nut and the lockwasher assembly, wiring harness clamp, nut, and the lockwasher assembly.
4. Secure the parking brake hand lever on the body with three bolts, washers, and the locknuts.

5. Apply the parking brake hand lever and tighten the three bolts to 96 lb-in. (11 N•m).
6. Install the clevis on the bellcrank with the clevis pin, washer, and the cotter pin (Figure 7-32).

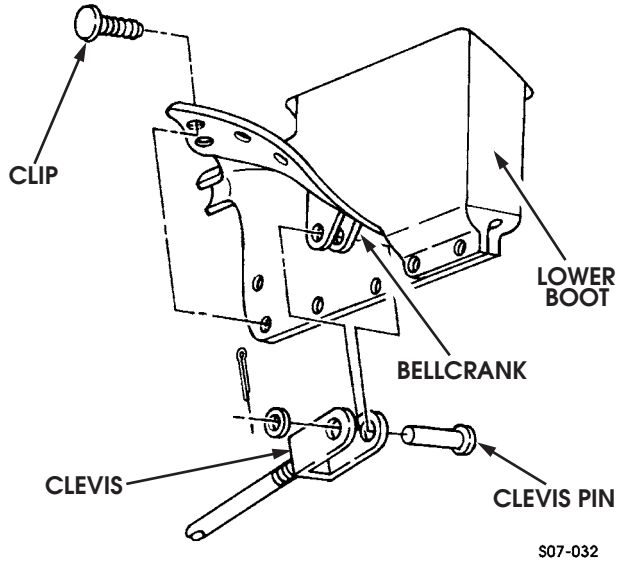


Figure 7-32: Parking Brake Rod Attachment at Hand Lever

7. Install the six clips and close the lower boot.
8. Install the parking brake switch.
9. Adjust the parking brake lever.

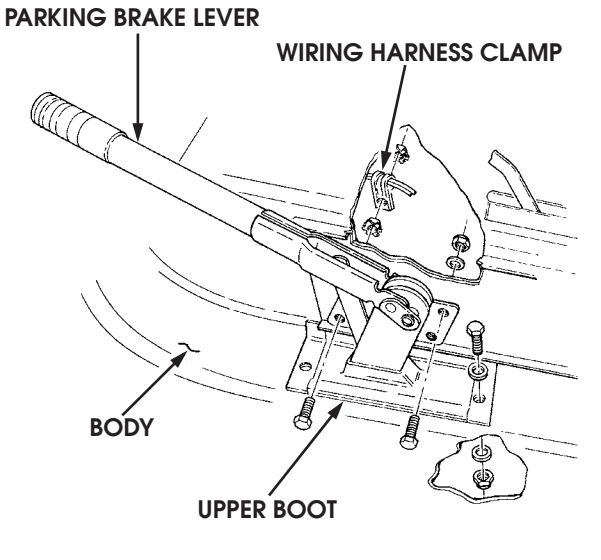


Figure 7-33: Parking Brake Hand Lever Mounting

FRONT DISC BRAKE CALIPER REPAIR

Disassembly

1. Remove the disc brake caliper.
2. Insert a wood block between the jaw of the caliper and the piston (Figure 7-34).

WARNING: To avoid injury, hold the caliper so the piston is facing away from your body and keep fingers out of the space between the piston and the wood block. Compressed air used for cleaning should not exceed 30 psi (207 kPa).

3. Remove the piston from the caliper by applying air pressure to the hose inlet of the caliper.
4. Remove the piston dust boot and the seal from the caliper bore. Discard the dust boot and the seal (Figure 7-35).
5. Remove the bleeder screw from the caliper.

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage, and replace if necessary (Figure 7-35).

1. Inspect the caliper bore for scoring, nicks, or corrosion. Minor corrosion can be polished with abrasive crocus cloth or hone. Replace the caliper if the bore is not repairable.
2. Inspect the pistons outside diameter for scoring, nicks, corrosion, and worn or damaged chrome plating. Replace the piston if there are any surface defects.
3. Inspect the bleeder screw for damage or stripped threads. Replace if damaged.
4. Inspect the bushing for damage. Replace if damaged.

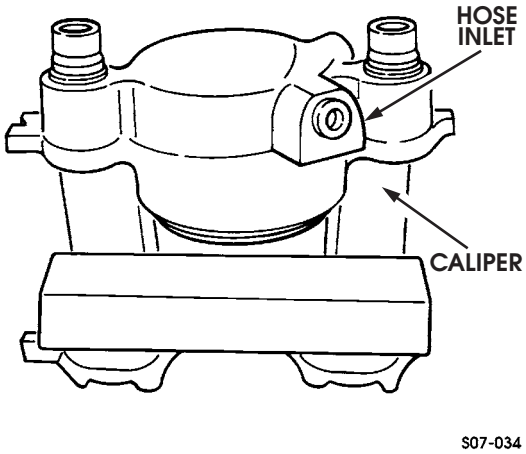


Figure 7-34: Front Disc Brake Caliper

Assembly

CAUTION: *The HUMMER H1 is equipped with DOT 3 fluid.* ***Do not mix with other brake fluids****. Failure to use the proper brake fluid will damage the brake system.*

1. Lubricate thee caliper bore and seal with DOT 3 brake fluid (Figure 7-35).
2. Install the seal in the groove of the caliper bore.
3. Lubricate the piston with DOT 3 brake fluid, install the dust boot on the piston.
4. Work the piston and the dust boot into the caliper bore.
5. Seat the dust boot in the caliper.
6. Install the bleeder screw in the caliper finger tight.
7. Lubricate the caliper guide pins, sleeves and the adapter slides with Permatex® Ultra Disc Brake Caliper Lube (Permatex PN 20356) prior to installation.
8. Install the disc brake caliper.

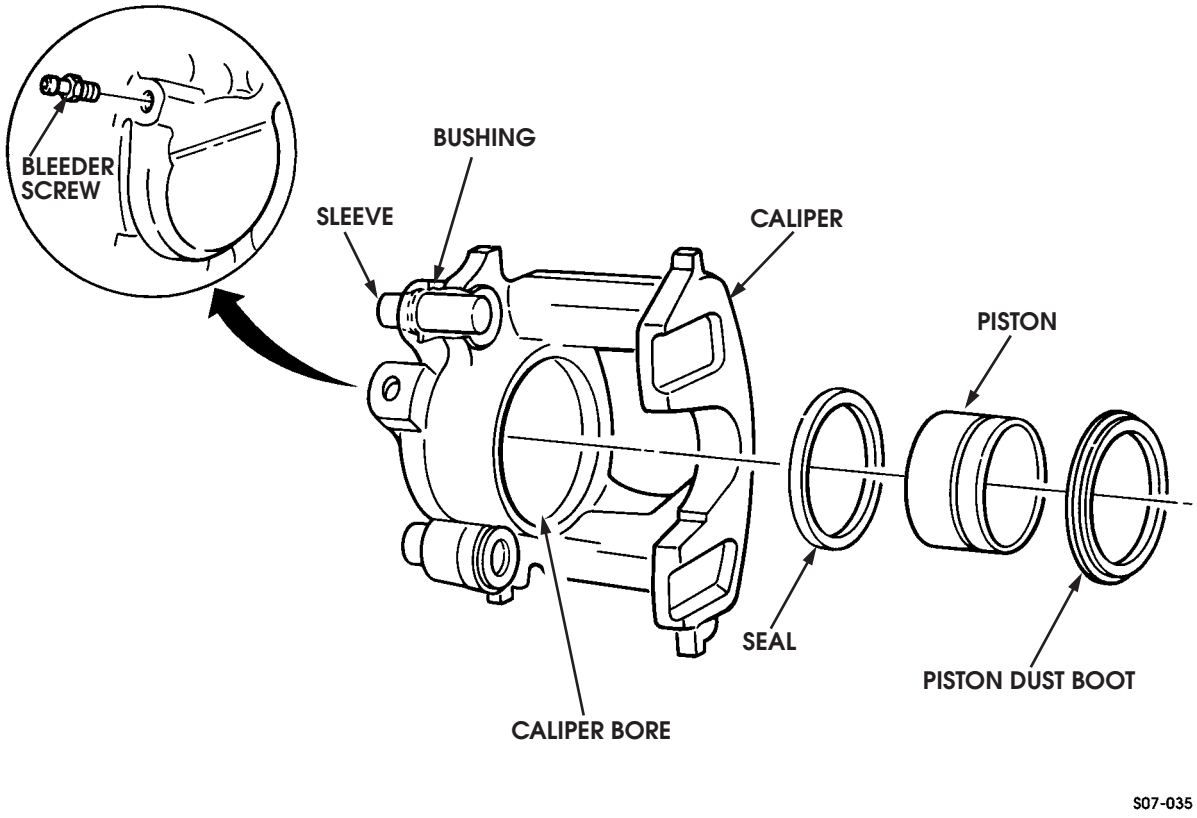


Figure 7-35: Front Disc Brake Caliper Assembly

REAR CALIPER OVERHAUL

Rear Caliper Disassembly (Figure 7-37)

1. Mount the caliper in a vise so the parking brake lever and the spring are facing upward.
2. Unseat and remove the parking brake lever spring. Use large slip joint pliers.
3. Remove the bolt that secures the lever retainer to the thrust screw. Then remove the retainer, but do not remove the parking brake lever at this time.
4. Remove the caliper piston as follows:

   a. Remove the piston retaining screw with hex key and pencil magnet. Use magnet to withdraw the screw after loosening it.

   b. Extend the piston by rotating the parking brake lever.

   c. Rotate the caliper piston in a counter-clockwise direction until it comes off the thrust screw. Rotate the piston by hand, or use the piston retraction tool J-42553 (Figure 7-36).

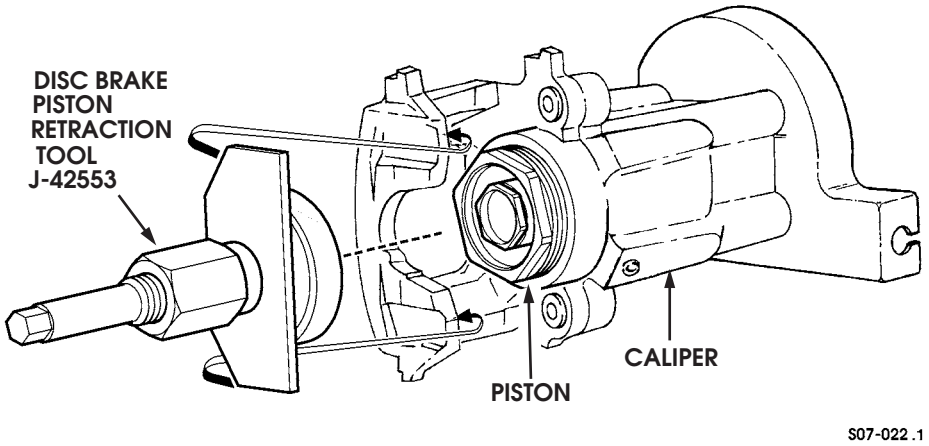


Figure 7-36: Piston Removal

d. Pull the piston out of the dust boot and remove it from the caliper.

5. Remove the piston dust boot with a pry tool.

CAUTION: *Exercise care when removing the boot. Do not allow the pry tool to scratch the caliper piston bore.*

6. Remove the thrust screw retaining ring. Carefully unseat the ring with a long, thin, flat blade screwdriver. Apply a single wrap of electrical tape around the screwdriver blade to avoid scratching the bore, or the thrust screw spring shield.
7. Grasp the thrust screw and slide the screw, shield, and the spring out of the bore as an assembly. Rotate the brake lever to assist the removal.
8. Remove the parking brake lever from the actuator shaft.
9. Remove the actuator shaft bearing balls with a pencil magnet.
10. Remove the thrust screw centering pin plug and the spacer. Then reach inside the caliper piston bore and push the centering pin out of the caliper with finger pressure.
11. Push the bearing plate and the actuator shaft out of the caliper bore using finger pressure.
12. Remove the caliper piston seal from the groove in the piston bore. Use a wood pencil to remove the seal. Do not use metal tools that will scratch the bore.
13. Remove and discard the actuator shaft dust seal. Discard the seal.
14. Remove and discard the centering pin plug O-ring.
15. Remove and discard the centering pin O-ring.
16. Remove the O-ring from the actuator shaft. Then remove the thrust bearing and the race from the shaft. Discard the O-ring but retain the bearing and the race if it is in good condition.
17. Disassembly of the caliper piston as follows:
    a. Remove the retaining ring with internal type ring pliers.
    b. Remove the wave washer.
    c. Remove the thrust washer and the bearing.
    d. Remove the cone clutch.

Caliper Cleaning and Inspection

Clean the caliper parts in standard parts cleaning solvent, or denatured alcohol. Dry the parts with compressed air or lint free shop towels.

Replace the caliper piston if corroded, rusted, or scored. Do not attempt to salvage any piston where rust or scoring has broken through the piston plating. Also, do not use any type of abrasive material on the piston surface. This practice will damage the plating and cause the piston to stick or seize in the bore.

Check condition of the caliper piston bore. Moderate surface discoloration is normal and not a cause for replacement. However, the caliper should be replaced if the bore is corroded, pitted, or scored. The bore can be lightly polished with crocus cloth but must not be honed or sanded.

Inspect the thrust screw and actuator shaft parts. Replace the thrust screw, spring shield, and retaining ring if damaged, or distorted. Replace the actuator shaft, bearing plate, and bearing balls if scored, cracked, worn, corroded, or pitted. Also replace the shaft bearing and race as a set if either part is worn, rough, pitted, or scored.

Replace the caliper piston cone clutch, bearing and race, or wave washer if worn, scored, or damaged.

Assembly (Figure 7-37)

1. Install the new actuator shaft dust seal in the caliper. Use one-inch socket to seat the seal in the housing. The open portion of the seal metal retainer faces out. Lubricate the seal lip with DOT 3 brake fluid afterward.
2. Lubricate the actuator shaft, bearings, race, and the plate with DOT 3 brake fluid. Then install the thrust bearing and race on the shaft and secure with the new O-ring.
3. Install the actuator shaft in the caliper. Then install the plastic bearing plate and the three ball bearings.
4. Install the new O-ring on the thrust screw centering pin and install the pin in the caliper. Position the pin so the blade will align with the slot in the thrust screw.
5. Lubricate the thrust screw with DOT 3 brake fluid. Then install the spring and the retaining ring on the thrust screw.
6. Install the thrust screw as follows:
   a. Align the slot in the thrust screw with the centering pin.
   b. Insert the thrust screw in the caliper and seat it on the centering pin and on the ball bearings.
   c. Compress the thrust screw retaining ring with fingers and install it in the caliper bore below the piston seal groove.

CAUTION: *Do not use metal tools to install the retaining ring. Metal tools will score or scratch the caliper bore.*

   d. Push the assembly into the bore as far as possible.
   e. Seat the retaining ring using a unassembled caliper piston. Lightly coat the piston with DOT 3 brake fluid and insert it in the bore. Then push the piston sharply downward two or three times to seat the retaining ring. Remove the piston after the ring is seated.
7. Install the new O-ring on the centering pin plug. Then position the spacer on the top of the centering pin and install the plug. Tighten the plug securely with a hex wrench or a socket.
8. Install the new caliper piston seal. Start the square cut seal into the groove at the top of the bore and work it into place with your fingers. Lubricate the seal and bore with fresh DOT 3 brake fluid.
9. Assembly the caliper piston as follows;
   a. Install the cone clutch in the piston.
   b. Lubricate the bearing and race with DOT 3 brake fluid and install them on the cone clutch. The open side of the bearing goes toward the race.
   c. Install the wave washer (either side up).
   d. Install the retaining ring with internal-type ring pliers. Flat side of the ring goes toward the wave washer.
10. Install the caliper piston as follows:
   a. Install the new dust boot on the caliper piston.
   b. Lubricate the caliper piston with fresh brake fluid. Then insert it through the dust boot, into the caliper bore, and onto the thrust screw.
   c. Install the parking brake lever on the actuator shaft and rotate the lever to extend the thrust screw.
   d. Rotate the piston onto the hrust screw by hand, then with a suitable size socket.
   e. Turn the parking lever to normal (non-applied) position and complete the piston installation as needed.
   f. Seat the piston dust boot in the groove at the top of the caliper bore. Use a suitable size boot installer tool or a flat punch.
11. Install a new O-ring on the piston retaining screw and install the screw. Tighten the screw securely.
12. Install the parking brake lever retainer and the bolt. Apply 1-2 drops of Loctite to the bolt threads before installation.
13. Install and seat the parking brake lever return spring in the cable housing slot.
14. Install the bleed screw, if removed Apply anti-seize compound to the screw threads beforehand.

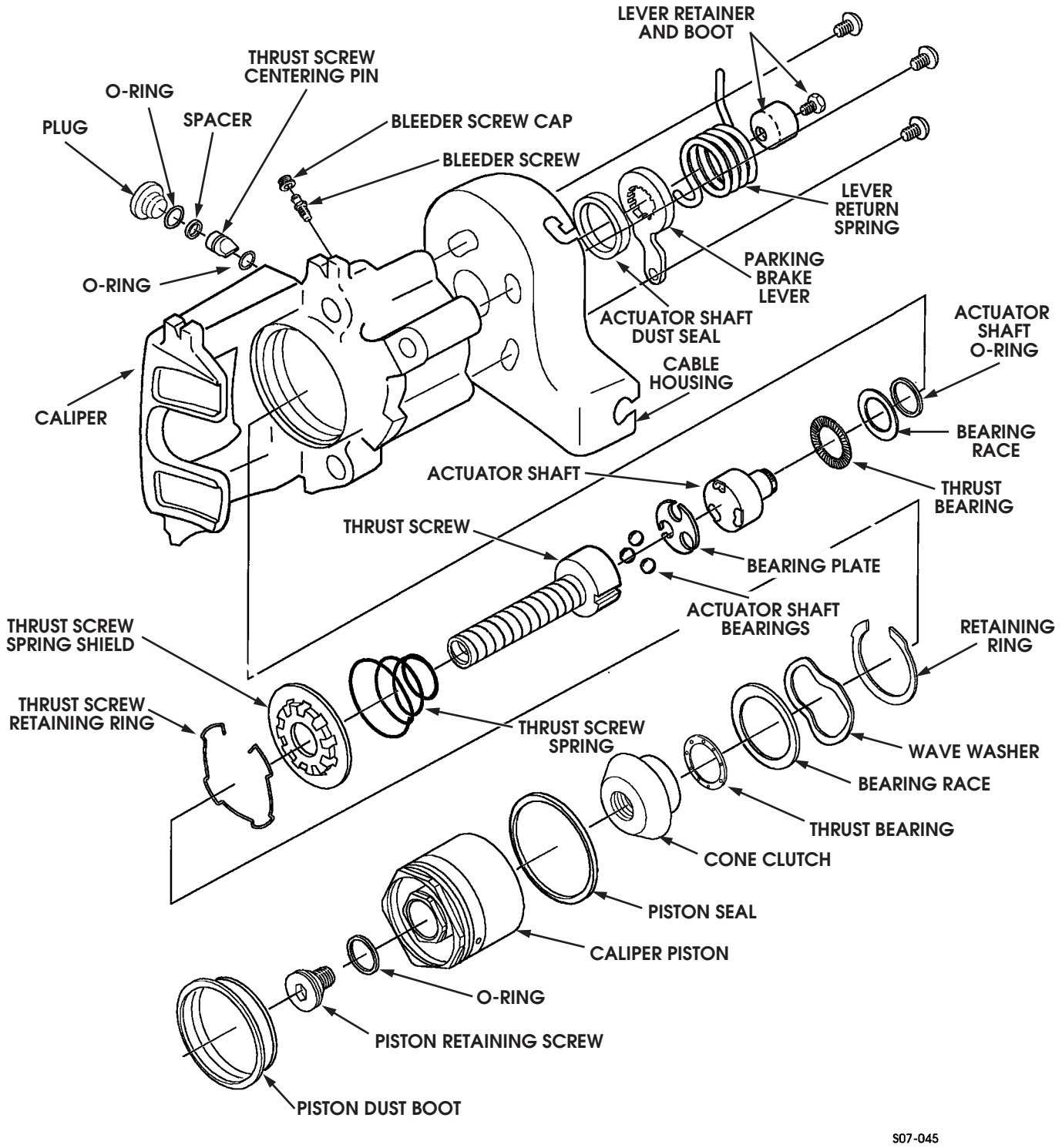


Figure 7-37: Rear Caliper

BRAKE ROTOR

Removal and Inspection

NOTE: Clean all the components, examine for wear or damage, and replace if necessary.

1. Remove the half shaft bolts at the rotor and position the half shaft out of the way (Figure 7-38).
2. Reinstall one of the half shaft bolts just enough so when the yoke bolts are removed the rotor does not fall (Figure 7-38).
3. Remove the two yoke bolts and move the calliper assembly (with pads and rotor) outward enough to slide the brake pad out from between the rotor and the caliper (Figure 7-39).
4. Once the brake pads are out, remove the calliper from the rotor (Figure 7-39).
5. Remove the half shaft bolt and the brake rotor.

Installation

1. Position the inside brake pad on the brake adapter (Figure 7-39).
2. Position the rotor to be installed on the axle flange and start a half shaft bolt just enough to keep the rotor from falling.
3. Instal the caliper over the rotor and the inside brake pad.
4. Slide the outside brake pad in between the rotor and the caliper.
5. Move the caliper assembly (with pads and rotor) in to position.
6. Secure the caliper with the two yoke bolts using medium strength loctite (blue) and tighten the bolts to 40 lb-ft (54 N.m).
7. Remove the half shaft bolt holding the rotor in place and position the half shaft against the rotor.

NOTE: The half shaft bolts can be reused but high strength loctite (red) must be used and the nordlock washers must be replaced.

8. Install the half shaft bolts using high strength loctite (red) and new nordlock washers, tighten the bolts to 57 lb-ft (77 N.m) (Figure 7-38).

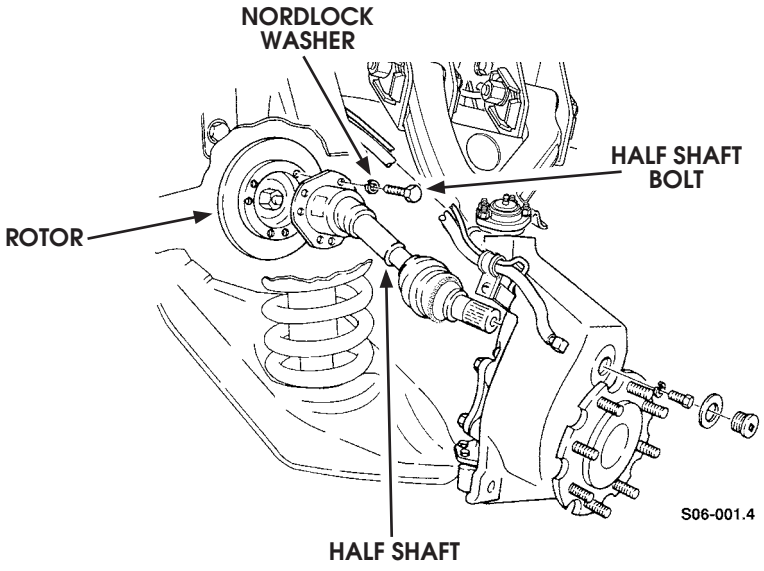


Figure 7-38: Half Shaft

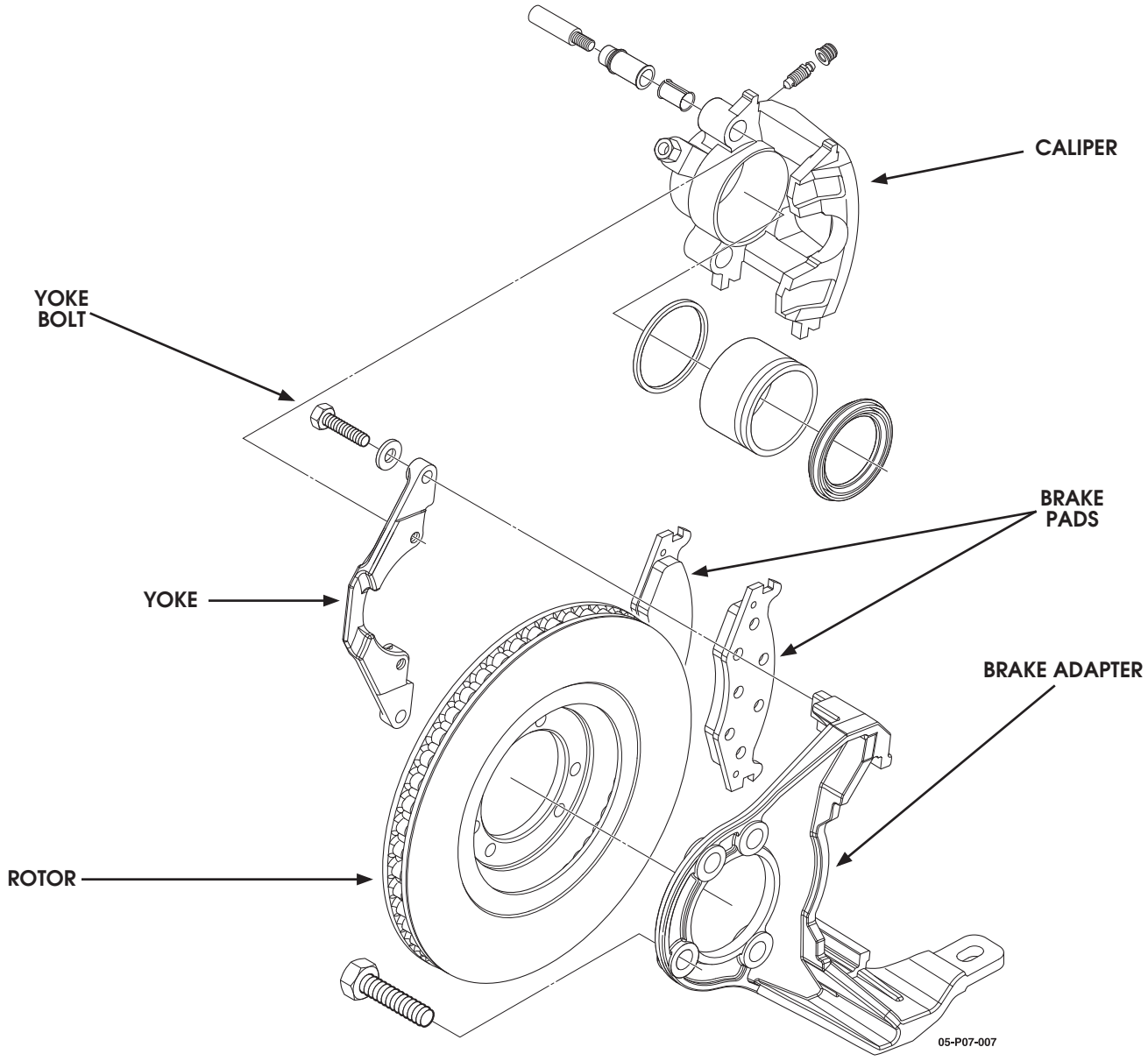


Figure 7-39: Front Brake Assembly

ROTOR INSPECTION

NOTE: Clean any rusted or scaled rotor braking surfaces before attempting inspection or measurement.

1. Mount the rotor in the brake lathe and turn while cleaning the surfaces with an abrasive crocus cloth.
2. Inspect the rotor for heat checks, nicks, broken cooling fins, scoring, discoloration and pitting. It is not recommended that the rotors be turned when spotted or heat checked.

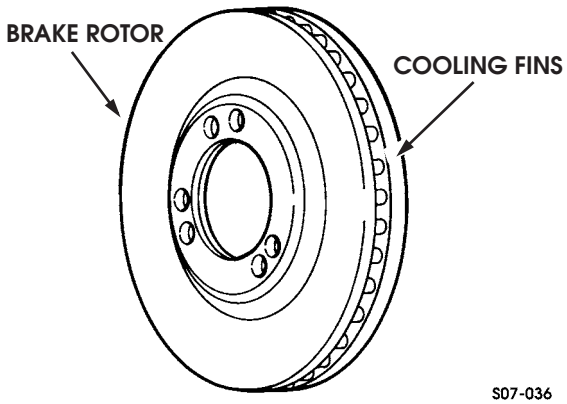


Figure 7-40: Brake Rotor and Cooling Fins

NOTE: Clean debris from the cooling fins if necessary.

REFINISHING BRAKE ROTORS

Refinish the rotors only under the following circumstances:

1. There is a complaint of brake pulsation.
2. There is excessive scoring.

Brake rotors have a minimum thickness dimension cast into them. Do not use a brake rotor that will not meet the dimensions shown in the specifications. Original equipment rotors are surface finished to 0.25-1.27 micrometers (10-50 microinches).

Accurate control of rotor tolerances is necessary for the proper performance of disc brakes. Machining should be done only with precision equipment. Service the machining equipment on a regular basis following the manufacturer's recommended maintenance procedures.

When you refinish rotors, make sure the attaching adapters, tool holders, vibration dampeners, and tool bits are in good condition. Always use sharp cutting tools or bits and use only replacement cutting bits recommended by the equipment manufacturer. Dull or worn tools leave a poor surface finish that will affect initial brake performance. Vibration dampening attachments should always be used when refinishing braking surfaces. These attachments eliminate tool chatter to allow for a better surface finish. Make sure these adaptors are clean and free of nicks. The optional swirl pattern finish will provide the best initial braking effectiveness. For this, use a sanding disc power tool with 120 grit disc for about 10 seconds per side.

Checking Lateral Runout

1. Mount the dial indicator with the stylus contacting the rotor surface 1 in. (25 mm) in from the outer edge (Figure 7-41).
2. Turn the rotor 360° and note the total indicator reading (TIR).

If lateral runout exceeds 0.004 in. (0.10 mm) TIR, replace or refinish the rotor.

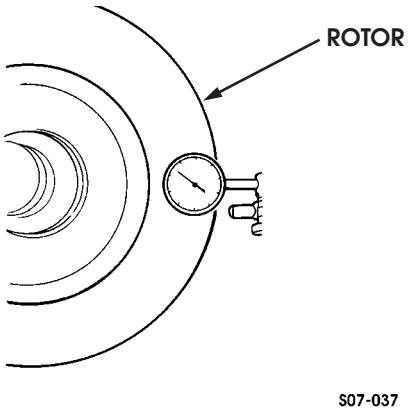


Figure 7-41: Checking Rotor for Lateral Runout

Checking Thickness Variation

1. Measure thickness variation of rotor with micrometer at four equally-spaced points around rotor. Measure 1 in. (25 mm) in from outer edge (Figure 7-42).
2. If thickness variation exceeds 0.005 in. (0.13 mm), replace or refinish rotor.

Refinishing

1. Mount the rotor on the brake lathe and refinish the the surface.
2. Replace the rotor if refinishing causes the rotor to fall below the minimum thickness of 0.815 in. (20.7 mm).
3. Install the brake rotor.

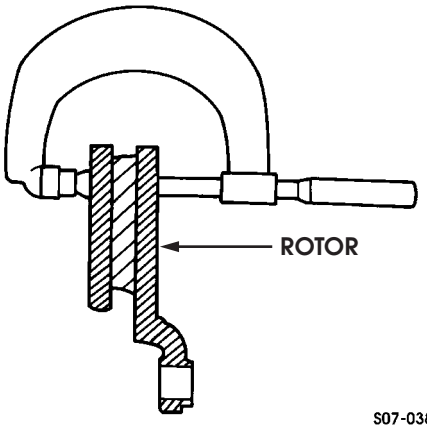


Figure 7-42: Checking Rotor Thickness

PARKING BRAKE LEVER ADJUSTMENT

Adjustment

1. Adjust the linkage.
2. Put the transmission in PARK, chock the wheels, and release the parking brake handle.
3. Turn the adjusting knob clockwise as tightly as possible by hand (Figure 7-43).

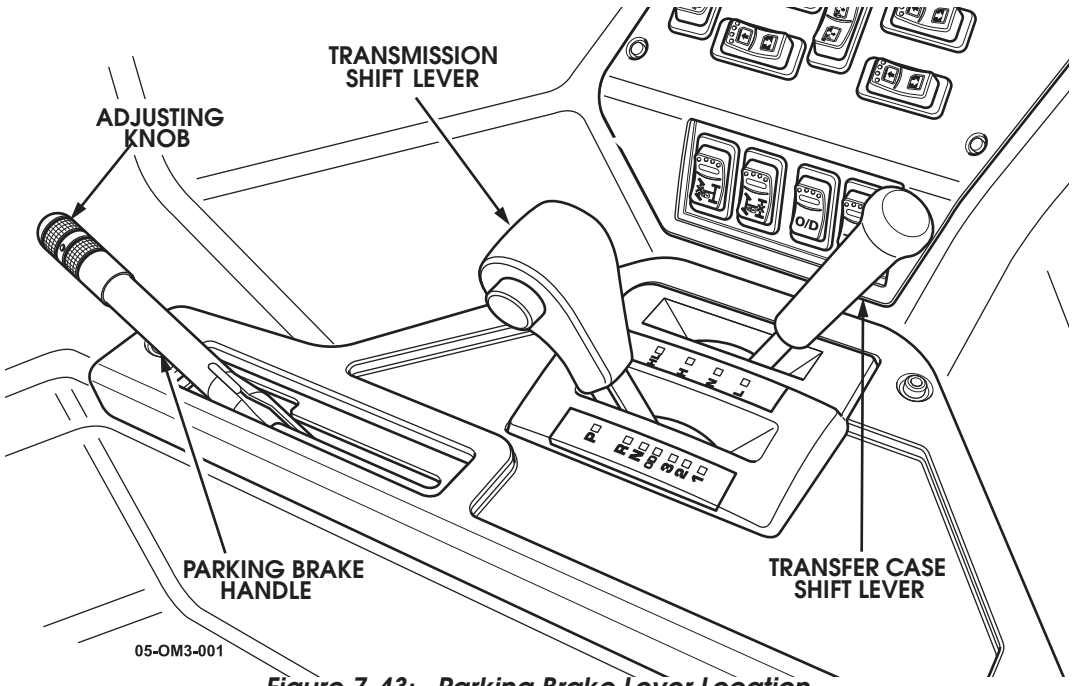


Figure 7-43: Parking Brake Lever Location

4. Apply the parking brake handle.
5. If the parking brake cannot be applied, turn the adjusting knob counterclockwise until the parking brake can be applied.
6. Test the parking brake.
   a. Remove the chocks.
   b. Depress the service brake pedal and start the engine.
   c. Place the transfer case shift lever in “H” (high) and the transmission shift lever in “D” (drive).
   d. Slowly let up on the service brake pedal. Parking brake should hold the vehicle stationary.

CAUTION: *The HUMMER H1 is equipped with DOT 3 brake fluid.* ***Do not mix with other brake fluids****. Failure to use the proper brake fluid will damage the brake system.*

NOTE: After operating in mud or sand, use a low pressure water source to ensure that the parking brake pads, rotor, pad-rotor contact areas, actuating lever, and spring are thoroughly cleaned of mud, sand, or other debris. Lubricate actuating lever as soon as possible (Figure 7-44).

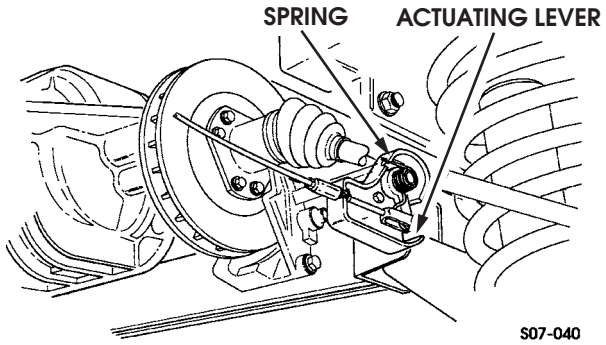


Figure 7-44: Spring and Actuating Lever for Parking Brake

PARKING BRAKE SWITCH REPLACEMENT

Removal

1. Disconnect the two harness leads from the switch leads (Figure 7-45).
2. Remove the switch from the parking brake lever.

Installation

1. Install the switch on the parking brake lever (Figure 7-45).
2. Connect the two switch leads to the harness leads.
3. Ensure the parking brake switch operates properly.

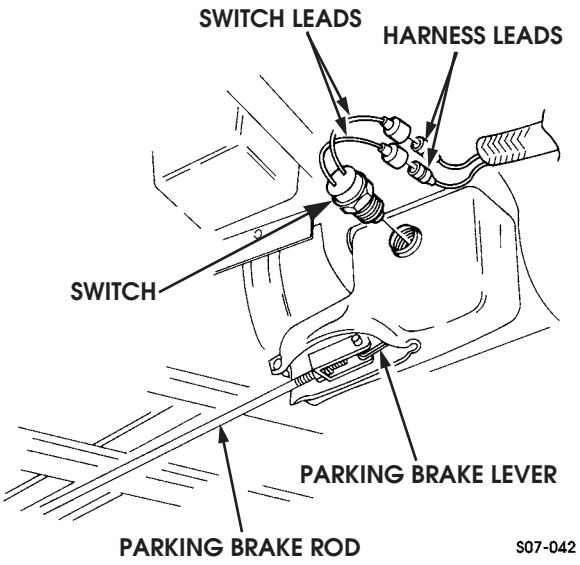


Figure 7-45: Parking Brake Switch

ANTI-LOCK BRAKE SYSTEM (ABS) AND AUTOMATIC TRACTION CONTROL, TORQTRAC 4™ (TT4™)

System Description

The ABS/TT4 is a hydraulic add-on system consisting of:

- Hydraulic modulator and pump assembly
- Electronic control unit
- Four wheel speed sensors
- ABS and TT4 warning lights

The add-on ABS/TT4 system is a four channel brake pressure modulation system fitted additional to the standard brake system. TT4 uses ABS and standard brake components to automatically control traction at the wheels when accelerating on low friction surfaces.

System Operation

ABS/TT4 system warning lights located in the status center of the instrument panel illuminate when there is a problem with the system. The lamps also illuminate during the initial key-on for a system self check and bulb test sequence. After key-on the ABS lamp will shine for approximately three seconds then go out and remain out unless there is a fault in the system or the ignition is cycled. The TT4 lamp will shine for three seconds then go out until there is a problem with the system (Figure 7-46). The TT4 lamp will flash during an overheat period due to extended continuous use. Whenever a lamp is lit due to a failure in the system, ABS and TT4 will be shut down partially or wholly, depending on the nature of the fault.

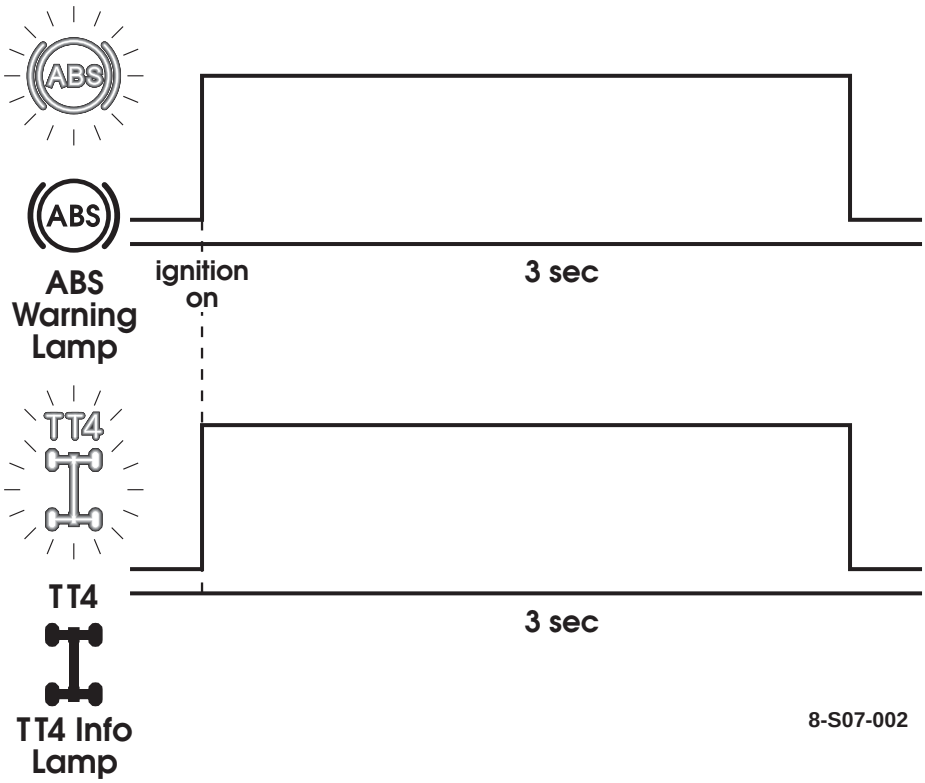


Figure 7-46: ABS/TT4 Warning Light Sequence.

Anti-lock braking operates by continually sensing the speed of each wheel. Wheel speed information is transmitted to an Electronic Control Unit (ECU) which evaluates the information to determine when any wheel is about to lock. If locking commences, the ECU transmits a control signal to the appropriate solenoid valve in the modulator controlling hydraulic pressure to the brake, thus, brake pressure is adjusted to maintain wheel rotation.

The TorqTrac 4 system uses many of the same components as the ABS to control wheel spin when accelerating the vehicle on low friction surfaces. Information from the wheel speed sensors is evaluated by the ECU which determines if a wheel is loosing traction and spinning. The ECU actuates the modulator pump to provide hydraulic pressure which is modulated by the solenoid valves and sent to the brake of the spinning wheel. This has the effect of transferring the torque to the non-spinning wheel on the higher friction surface. The system has an overheat protection feature which disables TT4 after 60 seconds of continuous use. This will be indicated by a blinking TT4 lamp. TT4 will automatically return to normal operation after a 60 second cool down period.

ABS/TT4 DIAGNOSTICS

Fault Diagnostic Procedure

Faults are stored in the ECU memory in code form. The information can be retrieved by initiating and reading a series of flash and pause sequences (blink codes) on the ABS warning light or with the Wabco Diagnostic Controller.

Use of the blink code procedure will determine the location of the fault prior to performing physical wiring and component tests, thus reducing diagnostic time.

NOTE: An attempt to initiate the blink code diagnostic may result in a solid “on” ABS warning lamp without progressing to the start phase of the diagnostic. If the above condition is present, remove the ABS Warning Lamp Relay from the exterior fuse box and perform the blink code diagnostic (See Figure 7-61). After repairs are completed, replace the warning lamp relay in the socket.

Blink Code Procedure

To initiate the blink code procedure, connect the blink code switch jumper J–44237 to the Diagnostic Link Connector (DLC) of the vehicle. The jumper allows you to short pin 4 to pin 15 of the DLC.

1. Switch on the ignition, the ABS warning light will illuminate and extinguish if there are no active faults.

2. Five seconds after connecting the switch jumper, the ABS warning light will extinguish, indicating the start of the blink code cycle.
3. The *start phase* consists of the ABS warning light flashing in the following sequence (Figure 7-47):
   - Pause = 2.5 seconds (long)
   - Flash = 2.5 seconds (long)
   - Pause = 2.5 seconds (long)
   - Flash = 0.5 seconds (short)

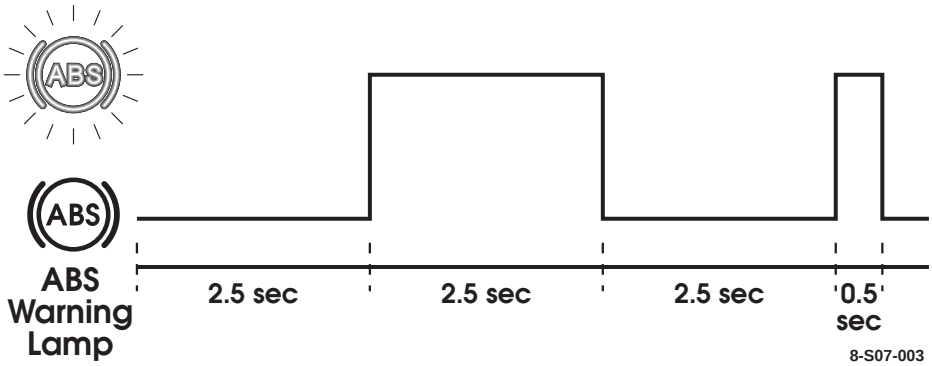


Figure 7-47: Blink Code Sequence For Start Phase.

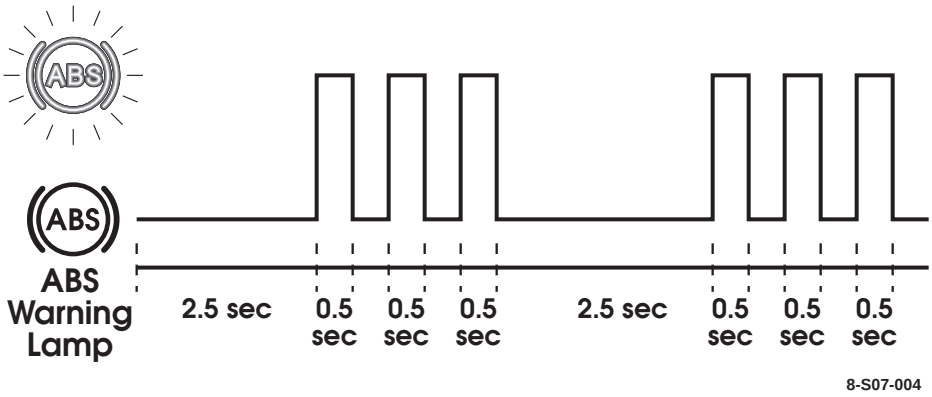


Figure 7-48: Blink Code Sequence For Code 3.3.

4. The *first part* of the code number (Figure 7-48:): A pause of 2.5 seconds precedes a series of short flashes. Count the flashes until the next long pause occurs. The number of short flashes obtained is the first part of the code number.
5. The *second part* of the code number: A pause of 2.5 seconds occurs between the first and second parts, before a series of short flashes occurs. The number of short flashes forms the second part of the code number.
6. The sequence of the *start phase, first and second parts* will continue until the switch jumper is deactivated.

NOTE: If you are unsure of the code, do not deactivate the switch jumper from the DLC because the code for that fault will be cleared from the memory.

7. It is possible to have more than one fault with the system at a time. However, the first indicated fault must be repaired then cleared by reconnecting the jumper and awaiting the next start phase before the next fault code can be extracted.
8. Repeat the procedure until no further faults are stored in the memory. The memory is cleared when a long pause of 7.5 seconds occurs after the start phase.

Clearing Fault Codes

At the end of a fault code cycle, deactivate the blink code jumper. The fault code will cycle one more time before the lamp remains on solid. Turn off the ignition and the fault code will be cleared from memory.

The fault codes, their causes and repair actions are listed in the following table.

Fault Code List - Ignition key "OFF" to test system (except where noted) Test pin locations refer to ABS Pinout Box J–35592

Fault Code	Problem Area	Test Pin Locations	Values	Check/Repair
2-0	ECU internal failure.	-	-	Replace ECU.
2-1	ECU internal failure.	-	-	Replace ECU.
2-2	Recirculating Pump (RCP) operates continuously.	12 and 27 30 and 27	Ignition "ON" 0 volts	Check the RCP wiring, the pump relay and the wiring connections. Repair or replace as required.
2-2	RCP does not operate.	Jumper 9 and 11 27 and 30	Ignition "ON" approximate battery + voltage.	Check the RCP wiring, the pump relay and fuse and pump connections. Repair or replace as required.
2-4	RCP failure (motor locked).	Jumper 9, 11 and 12	Ignition "ON" RCP motor running.	Excessive current failure. If pump does not run with pins linked, check wiring and relays, if OK, replace modulator.
2-6	Shuttle valve switch failure.	25 and 27	Brake pedal at rest 3k Ω. Brake pedal 1/2 down 2k Ω. Brake pedal full down 1k Ω.	If wiring and connections OK, replace modulator.
2-7	Continuous power to ECU with ignition "OFF".	9 and 27	0 volts. Less than 0.2 Ω to chassis ground.	Check for proper wiring connections, repair as necessary.
2-8	No voltage to ABS solenoid valves.	Jumper 8 and 9 19 and 27 1 and 27 9 and 27	Ignition "ON" approximate battery + voltage.	Check the valve relay, fuse and wiring. Repair as necessary.
2-9	Inlet valve supervision time exceded.	-	-	Check system voltage for normal function. Clear fault.
2-10	Reference ground interrupted.	31	Less than 0.2 Ω to chassis ground.	Repair wiring or connection as necessary.
2-11	Excessive recirculation pump cycle time.	Ignition "ON" jumper 9, 11 and 12	RCP running	Check RCP function. Clear fault.
2-12 2-13 2-14 2-15	RF sensor weak LR sensor weak LF sensor weak RR sensor weak	17 and 34 18 and 35 15 and 32 16 and 33	Greater than 0.9 volts AC at one tire revolution per second.	Check sensor adjustment. Check geared hub bearing play at halfshaft. Adjust or repair as necessary.

Fault Code List - Ignition key "OFF" to test system (except where noted)
Test pin locations refer to ABS Pinout Box J–35592

Fault Code	Problem Area	Test Pin Locations	Values	Check/Repair
3-0	Open circuit between ECU and **right front inlet** solenoid valve or wiring.	6 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-1	Open circuit between ECU and **right front outlet** solenoid valve or wiring.	7 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-2	Open circuit between ECU and **left front inlet** solenoid valve or wiring.	23 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-3	Open circuit between ECU and **left front outlet** solenoid valve or wiring.	24 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-4	Open circuit between ECU and **right rear inlet** solenoid valve or wiring.	4 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-5	Open circuit between ECU and **right rear outlet** solenoid valve or wiring.	5 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-6	Open circuit between ECU and **left rear inlet** solenoid valve or wiring.	21 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-7	Open circuit between ECU and **left rear outlet** solenoid valve or wiring.	22 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at the ECU connector and at the modulator connector. Repair wiring or replace modulator as necessary.
3-8	Open circuit between ECU and RCP relay 1.	Jumper 9 and11 30 and 27	Ignition "ON" approximate battery + voltage.	If no voltage, check RCP relay 1 circuit and relay.
3-9	Open circuit between ECU and RCP relay 2.	Pin 12, Circuit 610	< 0.2 Ω	Remove relay, check circuit 610 from pin 12 to relay socket.

Fault Code List - Ignition key "OFF" to test system (except where noted)
Test pin locations refer to ABS Pinout Box J–35592

Fault Code	Problem Area	Test Pin Locations	Values	Check/Repair
4-0	Short circuit to ground between ECU and **right front inlet** solenoid valve.	6 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-1	Short circuit to ground between ECU and **right front outlet** solenoid valve.	7 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-2	Short circuit to ground between ECU and **left front inlet** solenoid valve.	23 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-3	Short circuit to ground between ECU and **left front outlet** solenoid valve.	24 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-4	Short circuit to ground between ECU and **right rear inlet** solenoid valve.	4 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-5	Short circuit to ground between ECU and **right rear outlet** solenoid valve.	5 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-6	Short circuit to ground between ECU and **left rear inlet** solenoid valve.	21 and 27	5.0-7.5 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-7	Short circuit to ground between ECU and **left rear outlet** solenoid valve.	22 and 27	3.0-5.0 Ω	Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly as necessary.
4-8	Short circuit to ground between ECU and RCP relay 1.	Remove Relay 1 11 or 30 and 27	Open circuit	Check wiring to pump relay and pump connector through pump. Repair wiring or replace modulator as necessary.

Fault Code List - Ignition key "OFF" to test system (except where noted)
Test pin locations refer to ABS Pinout Box J–35592

Fault Code	Problem Area	Test Pin Locations	Values	Check/Repair
4-9	Short circuit to ground between ECU and RCP relay 2.	Remove Relay 2 12 and 27	Open circuit	Check wiring to pump relay and pump connector through pump. Repair wiring or replace modulator as necessary.
4-12	**Right front** wheel speed sensor open circuit.	17 and 34	500-2000 Ω	Check electrical resistance of affected sensor and wiring at ECU connector and at harness plugs. Repair wiring or replace sensor as necessary.
4-13	**Left rear** wheel speed sensor open circuit.	18 and 35	500-2000 Ω	Check electrical resistance of affected sensor and wiring at ECU connector and at harness plugs. Repair wiring or replace sensor as necessary.
4-14	**Left front** wheel speed sensor open circuit.	15 and 32	500-2000 Ω	Check electrical resistance of affected sensor and wiring at ECU connector and at harness plugs. Repair wiring or replace sensor as necessary.
4-15	**Right rear** wheel speed sensor open circuit.	16 and 33	500-2000 Ω	Check electrical resistance of affected sensor and wiring at ECU connector and at harness plugs. Repair wiring or replace sensor as necessary.
5-0	Short circuit to battery between ECU and **right front inlet** valve solenoid or wiring.	6 and 27	0 volts 5.0-7.5 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.
5-1	Short circuit to battery between ECU and **right front outlet** valve solenoid or wiring.	7 and 27	0 volts 3.0-5.0 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.
5-2	Short circuit to battery between ECU and **left front inlet** valve solenoid or wiring.	23 and 27	0 volts 5.0-7.5 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.
5-3	Short circuit to battery between ECU and **left front outlet** valve solenoid or wiring.	24 and 27	0 volts 3.0-5.0 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.
5-4	Short circuit to battery between ECU and **right rear inlet** valve solenoid or wiring.	4 and 27	0 volts 5.0-7.5 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.

Fault Code List - Ignition key "OFF" to test system (except where noted)
Test pin locations refer to ABS Pinout Box J–35592

Fault Code	Problem Area	Test Pin Locations	Values	Check/Repair
5-5	Short circuit to battery between ECU and **right rear outlet** valve solenoid or wiring.	5 and 27	0 volts 3.0-5.0 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.
5-6	Short circuit to battery between ECU and **left rear inlet** valve solenoid or wiring.	21 and 27	0 volts 5.0-7.5 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.
5-7	Short circuit to battery between ECU and **left rear outlet** valve solenoid or wiring.	22 and 27	0 volts 3.0-5.0 Ω	Check voltages at wiring harness including connectors. Check electrical resistance of affected valve wiring to ground at ECU connector and at modulator assembly plug. Repair wiring or replace as necessary.
5-8	Short circuit to battery + between ECU and RCP relay 1.	11 and 27	0 volts	Check wiring harness between ECU and relay and pump ground connections. Repair wiring as necessary.
5-9	Short circuit to battery + between ECU and RCP relay 2.	12 and 27	0 volts	Check wiring harness between ECU and relay and pump ground connections. Repair wiring as necessary.
5-12	**Right front** wheel speed signal is erratic.	17 and 34	Greater than 0.9 volts AC at one tire revolution per second.	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.
5-13	**Left rear** wheel speed signal is erratic.	18 and 35	Greater than 0.9 volts AC at one tire revolution per second.	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.
5-14	**Left front** wheel speed signal is erratic.	15 and 32	Greater than 0.9 volts AC at one tire revolution per second.	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.
5-15	**Right rear** wheel speed signal is erratic.	16 and 33	Greater than 0.9 volts AC at one tire revolution per second	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.

Fault Code List - Ignition key "OFF" to test system (except where noted)
Test pin locations refer to ABS Pinout Box J–35592

Fault Code	Problem Area	Test Pin Locations	Values	Check/Repair
6-0	Short circuit between two solenoid valve leads of **right front inlet** solenoid valve.	6 and 4, 5, 7, 21, 22, 23, 24	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.
6-1	Short circuit between two solenoid valve leads of **right front outlet** solenoid valve.	7 and 4, 5, 6, 21, 22, 23, 24	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.
6-2	Short circuit between two solenoid valve leads of **left front inlet** solenoid valve.	23 and 4, 5, 6, 7, 21, 22, 24	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.
6-3	Short circuit between two solenoid valve leads of **right front outlet** solenoid valve.	24 and 4, 5, 6, 7, 21, 22, 23	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.
6-4	Short circuit between two solenoid valve leads of **right rear inlet** solenoid valve.	4 and 5, 6, 7, 21, 22, 23, 24	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.
6-5	Short circuit between two solenoid valve leads of **right rear outlet** solenoid valve.	5 and 4, 6, 7, 21, 22, 23, 24	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.
6-6	Short circuit between two solenoid valve leads of **left rear inlet** solenoid valve.	21 and 4, 5, 6, 7, 22, 23, 24	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.

Fault Code List - Ignition key "OFF" to test system (except where noted)
Test pin locations refer to ABS Pinout Box J–35592

Fault Code	Problem Area	Test Pin Locations	Values	Check/Repair
6-7	Short circuit between two solenoid valve leads of **left rear outlet** solenoid valve.	22 and 4, 5, 6, 7, 21, 23, 24	6.0-15.0 Ω	Check electrical resistance of affected valves and wiring at ECU connector and at modulator assembly plug. Repair or replace wiring as necessary and replace modulator if short is internal. Note: Fault code for both affected valves will be stored in memory.
6-8	Short circuit between solenoid valve and RCP relay 1.	11 and 4, 5, 6, 7, 21, 22, 23, 24	55.0-65.0 Ω	Check wiring harness at ECU connector to pump relay. Repair or replace as necessary.
6-9	Short circuit between solenoid valve and RCP relay 2.	12 and 4, 5, 6, 7, 21, 22, 23, 24	55.0-65.0 Ω	Check wiring harness at ECU connector to pump relay. Repair or replace as necessary.
6-12	**Right front** wheel speed signal missing.	17 and 34	Greater than 0.9 volts AC at one tire revolution per second.	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.
6-13	**Left rear** wheel speed signal missing.	18 and 35	Greater than 0.9 volts AC at one tire revolution per second.	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.
6-14	**Left front** wheel speed signal missing.	15 and 32	Greater than 0.9 volts AC at one tire revolution per second.	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.
6-15	**Right rear** wheel speed signal missing.	16 and 33	Greater than 0.9 volts AC at one tire revolution per second.	Check for damaged tone wheel, incorrect sensor adjustment, excessive tone wheel runnout (> .041"), excessive geared hub input bearing play and tire size mismatch. Repair or replace as necessary.

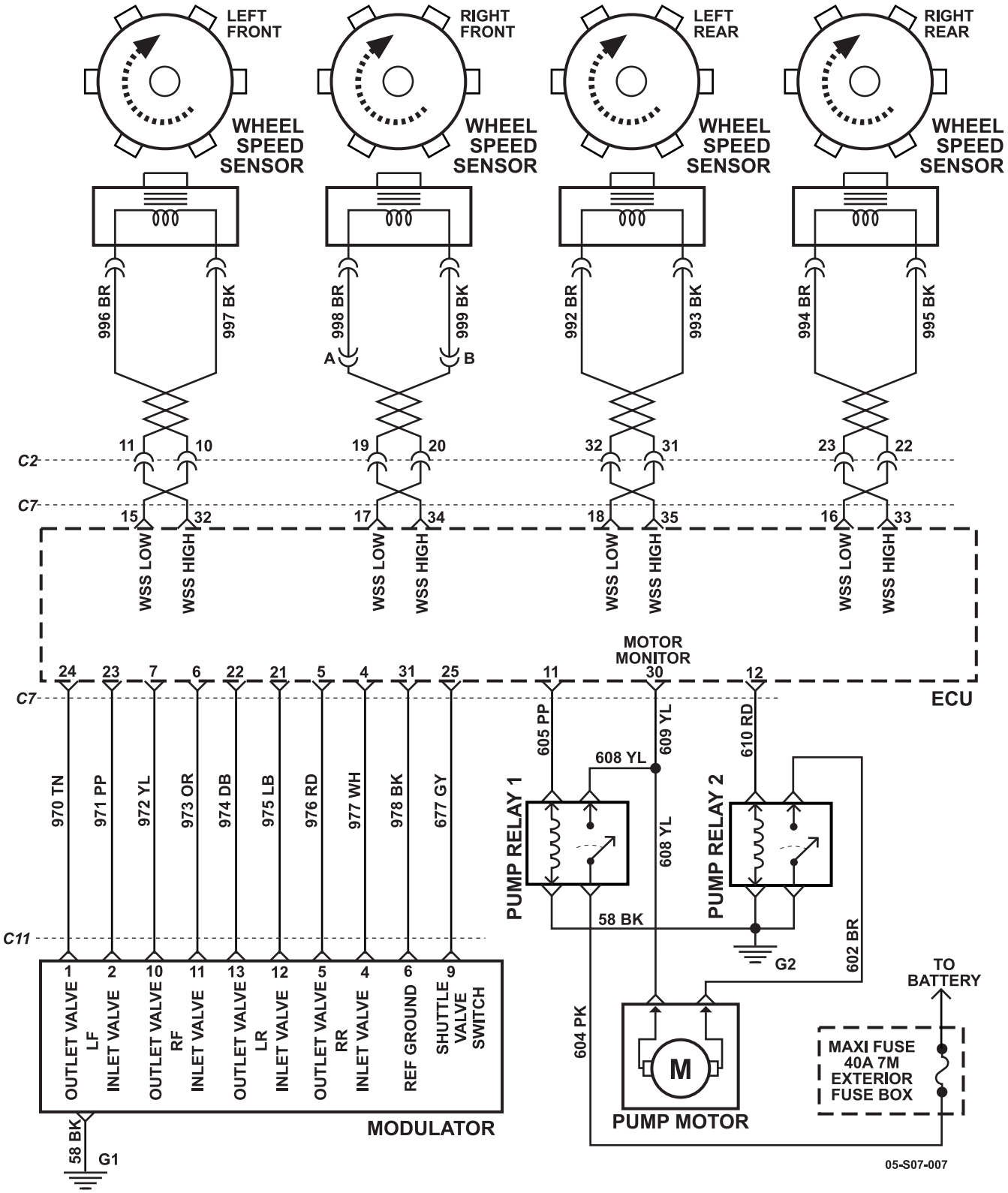


Figure 7-49: ABS/TT4 Main System Diagram.

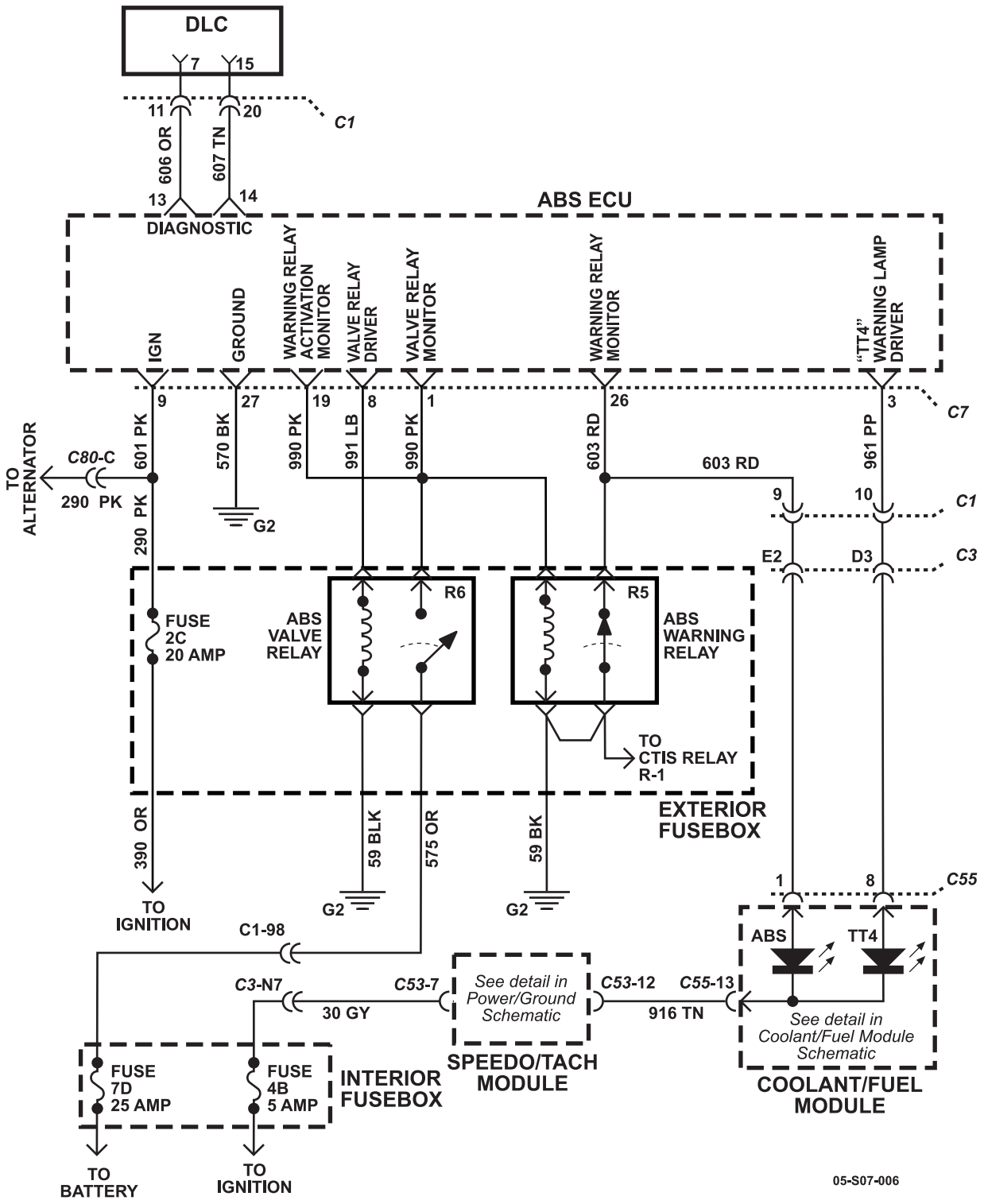


Figure 7-50: ABS/TT4 Power, Ground and Warning Lamp Circuit.

C7 FEMALE ONLY

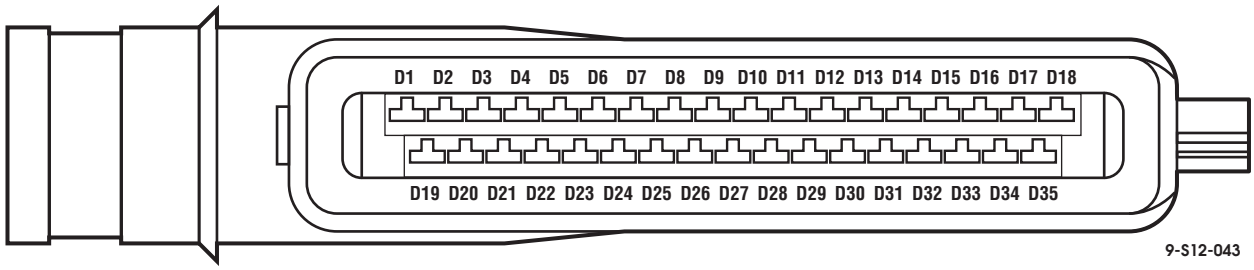


Figure 7-51: 35 Pin ECU Connector Female Half

PIN	CKT	COLOR	DESCRIPTION
1	990	PK	ABS valve relay input
3	961	PP	TT4 lamp activation
4	977	WH	Right rear inlet valve activation
5	976	RD	Right rear outlet valve activation
6	973	OR	Right front inlet valve activation
7	972	YL	Right front outlet valve activation
8	991	LB	ABS valve relay activation
9	601	PK	Ignition feed
11	605	PP	Positive pump relay activation
12	610	RD	Negative pump relay activation
13	606	OR	Diagnostic line
14	607	TN	Diagnostic line
15	997	BK	Left front wheel speed sensor low
16	995	BK	Right rear wheel speed sensor low
17	999	BK	Right front wheel speed sensor low
18	993	BK	Left rear wheel speed sensor low
19	990	PK	ABS valve relay redundant input
21	975	LB	Left rear inlet valve activation
22	974	DB	Left rear outlet valve activation
23	971	PP	Left front inlet valve activation
24	970	TN	Left front outlet valve activation
25	677	GY	Shuttle valve switch signal
26	603	RD	ABS warning lamp activation
27	570	BK	Ground
30	609	YL	Pump motor monitor
31	978	BK	Reference ground
32	996	BR	Left front wheel speed sensor high

PIN	CKT	COLOR	DESCRIPTION
33	994	BR	Right rear wheel speed sensor high
34	998	BR	Right front wheel speed sensor high
35	992	BR	Left rear wheel speed sensor high

C11 FEMALE ONLY

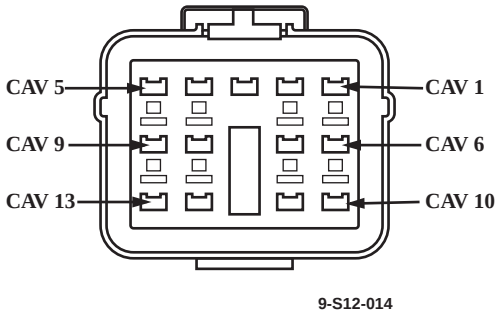


Figure 7-52: 13 Pin Modulator Connector Female Half

PIN	CKT	COLOR	DESCRIPTION
1	970	TN	Left front outlet valve activation
2	971	PP	Left front inlet valve activation
4	977	WH	Right rear inlet valve activation
5	976	RD	Right rear outlet valve activation
6	978	BK	Reference ground
9	677	GY	Shuttle valve switch signal
10	972	YL	Right front outlet valve activation
11	973	OR	Right front inlet valve activation
12	975	LB	Left rear inlet valve activation
13	974	DB	Left rear outlet valve activation

C2 MALE

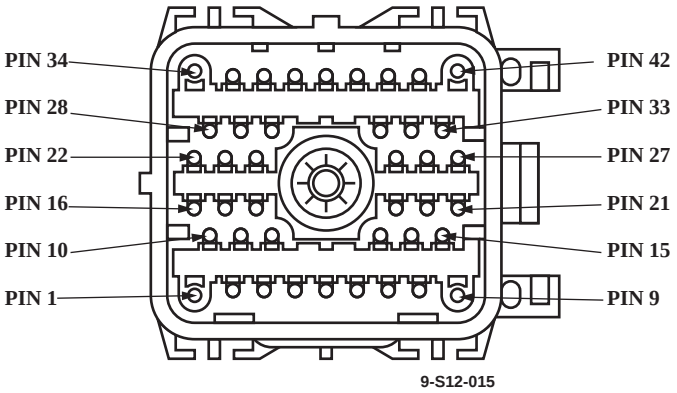


Figure 7-53: 42 Pin Underbody Connector Male Half

C2 FEMALE

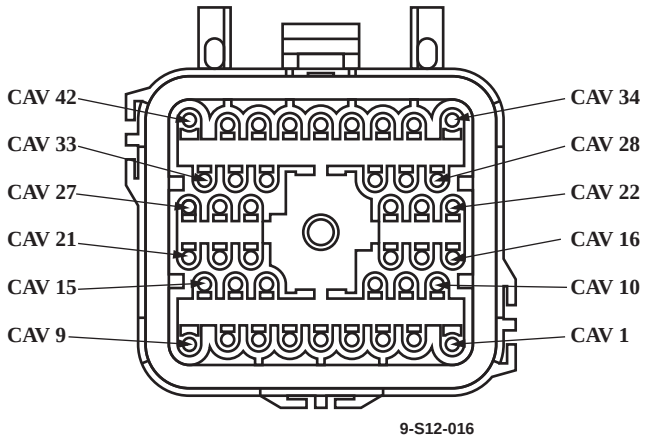


Figure 7-54: 42 Pin Underbody Connector Female Half

PIN	CKT	COLOR	DESCRIPTION
10	996	BR	Left front wheel speed sensor low signal
11	997	BK	Left front wheel speed sensor high signal
19	999	BK	Right front wheel speed sensor high signal
20	998	BR	Right front wheel speed sensor low signal
22	994	BR	Right rear wheel speed sensor low signal
23	995	BK	Right rear wheel speed sensor high signal
31	992	BR	Left rear wheel speed sensor low signal
32	993	BK	Left rear wheel speed sensor high signal

ABS MODULATOR REPLACEMENT

Removal

WARNING: Batteries must be disconnected when the brake hydraulic system is being serviced and bled. If the ABS motor pump runs when air is in the hydraulic system, air can get trapped behind the valves in the modulator causing a spongy brake pedal.

1. Disconnect the batteries.
2. Remove the left front splash shield.
3. Remove the horn bracket and horns (Figure 7-55).

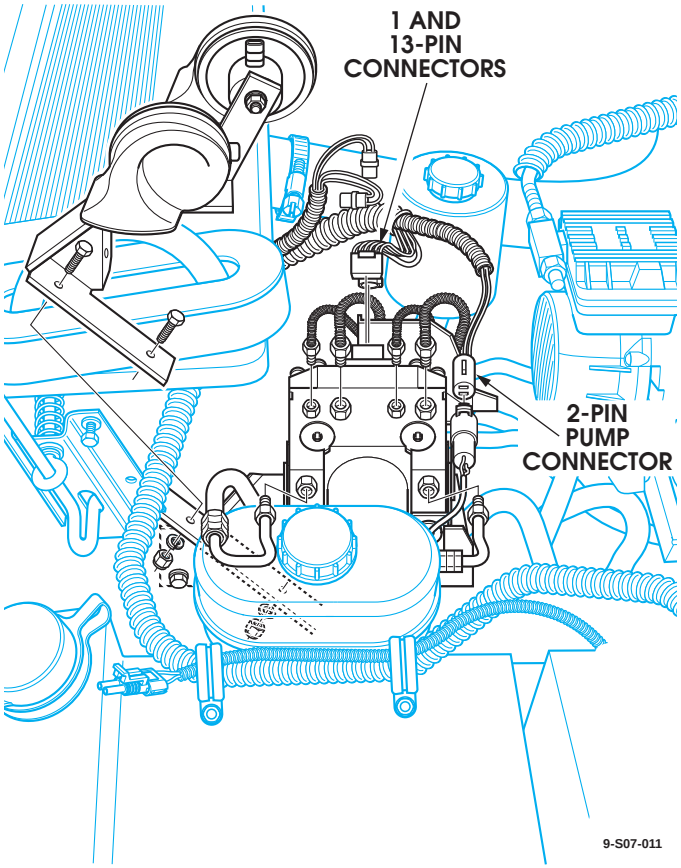


Figure 7-55: Brake Line And Wire Connections

4. Remove the thirteen-pin, the two-pin and the one-pin wire connectors from the modulator assembly.
5. Remove the master cylinder brake hoses at the modulator and cap off (note the position of the lines in the modulator for installation).
6. Remove the four wheel brake lines from the modulator and cap off (note the position of the lines in the modulator for installation).
7. Remove the “P” clamp securing the oil cooler lines to the modulator mounting bracket.
8. Remove the four bolts, washers and lock washers securing the modulator bracket to the air lift bracket (Figure 7-56).

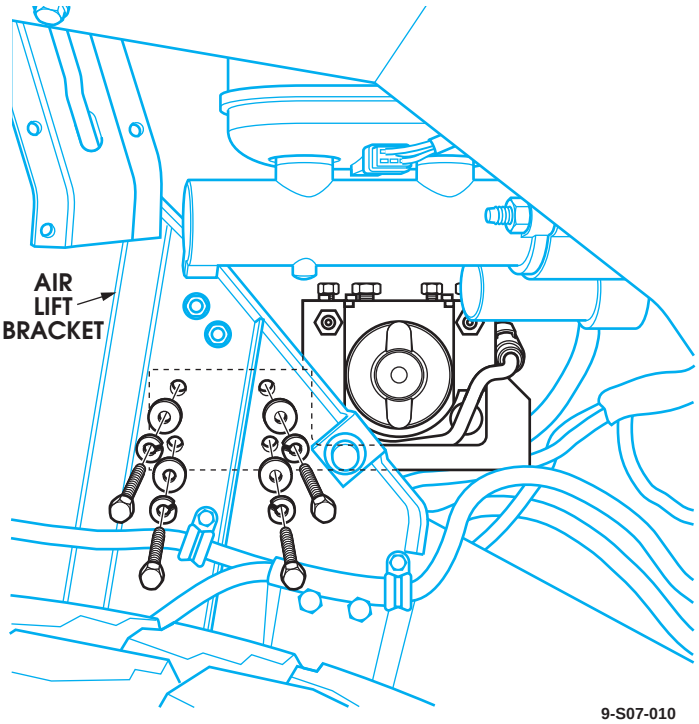


Figure 7-56: Modulator and Bracket AssemblyMounting

9. Remove the modulator, mounting bracket and shield from the vehicle.
10. Remove the motor pump wire connector from the modulator bracket and the two bolts securing the modulator to the bracket.

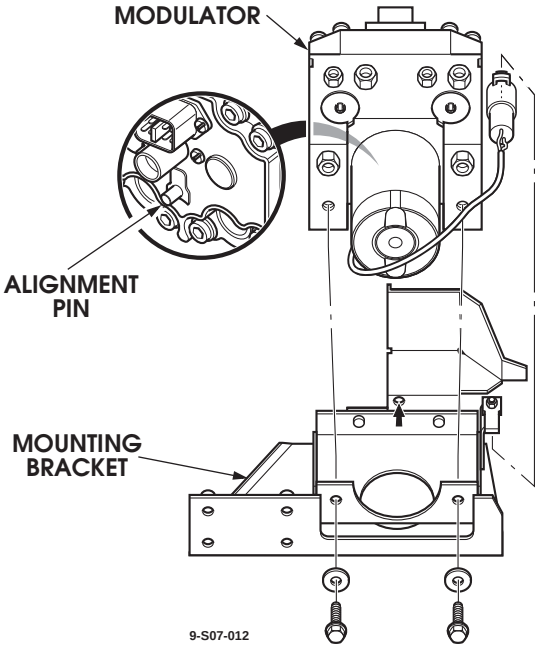


Figure 7-57: Modulator Mounting

11. Disengage the modulator alignment pin from the mounting bracket and remove the modulator from the mounting bracket.
12. Remove the brake line adapters, noting the position for reinstallation

Installation

1. Install the brake line adapters in the same position as in the original modulator. Torque the 12 mm threaded adapter to 11 lb-ft (15 N•m) and the 10 mm adapter to 9 lb-ft (12 N•m).
2. Place the modulator alignment pin in the hole in the mounting bracket, install the two mount bolts and torque to 5 lb-ft (7 N•m).
3. Connect the motor pump wire connector to the mounting bracket and install the assembly on the left air lift bracket with four bolts, washers and lock washers. Torque the bolts to 28 lb-ft (38N•m).
4. Connect the four wheel brake lines in their respective positions on the modulator and torque to 11 lb-ft (15 N•m).
5. Connect the master cylinder hoses in their respective positions on the modulator and torque to 11 lb-ft (15 N•m).
6. Connect the thirteen-pin, the two-pin and the one-pin wire connectors to the modulator assembly.
7. Install the horn bracket and horns.
8. Install the left front splash shield.
9. Bleed the complete brake system.
10. Connect the batteries.

SPEED SENSOR REPLACEMENT

NOTE: The procedure for speed sensor replacement is basically the same for all four wheel ends.

WARNING: Connect speed sensors to the proper harness connectors. Connecting speed sensors to incorrect harness connectors can cause the ABS/TT4 to malfunction.

Removal

1. Rotate and pull the speed sensor head from the speed sensor mounting bracket and retaining sleeve (Figure 7-58).
2. Remove and discard the speed sensor retaining sleeve.

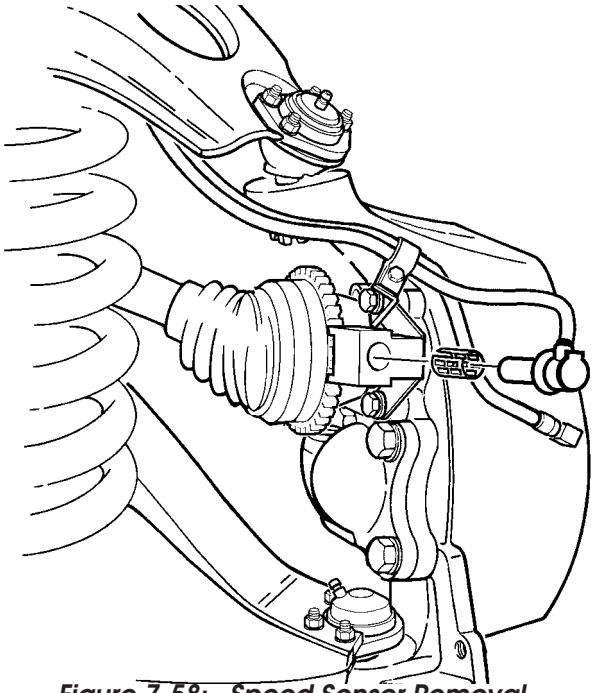


Figure 7-58: Speed Sensor Removal

3. Remove the speed sensor connector from the retaining clip near the top of the upper A-arm and disconnect the speed sensor lead from the speed sensor harness (Figure 7-59).
4. Remove the capscrews and clips securing the speed sensor lead to the A-arm and geared hub, and remove the sensor from the vehicle.

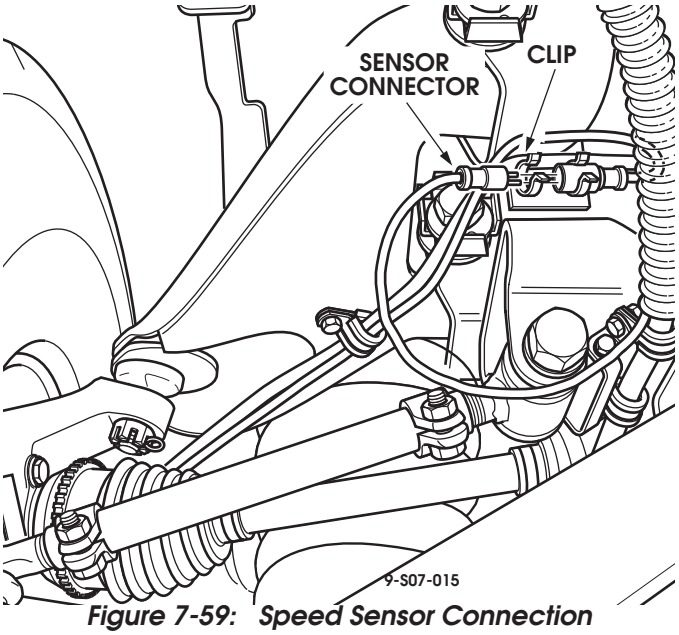


Figure 7-59: Speed Sensor Connection

Installation

NOTE: The left side speed sensor leads route across above the halfshaft cv-joint. care must be taken to ensure that the lead does not come in contact with the cv-joint.

1. Clean all grease, rust and debris from the speed sensor cavity in the speed sensor mounting bracket.

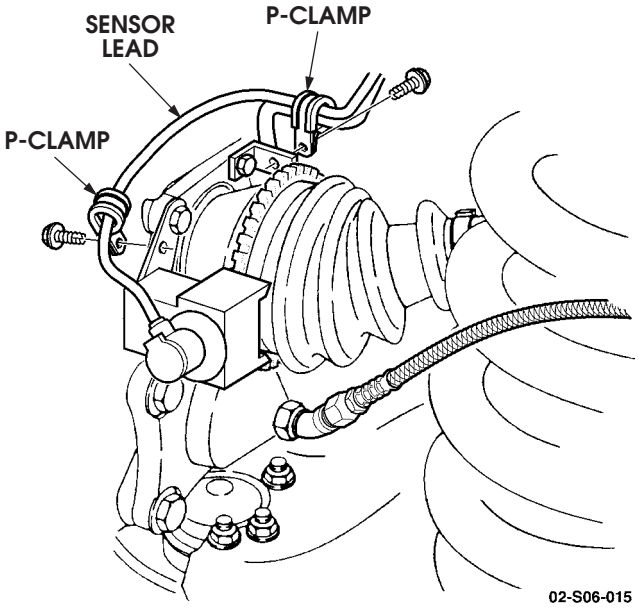


Figure 7-60: Left Side Sensor Lead Routing

2. Install a new speed sensor retainer sleeve in the speed sensor mounting bracket.
3. Lubricate the head of the speed sensor with chassis lube and install in the speed sensor mounting bracket. Push the speed sensor all the way in until it touches the tone wheel on the CV joint.
4. Route the speed sensor lead away from the halfshaft and secure with the clips and capscrews (do not kink the speed sensor lead).

5. Connect the speed sensor connector to the speed sensor harness connector and install into the connector retaining clip.

TONE WHEEL REPLACEMENT

NOTE: The tone wheel is pressed onto the outer CV joint of the halfshaft and requires halfshaft replacement when servicing the tone wheel. See section 9.

ABS ECU REPLACEMENT

1. Turn ignition switch “OFF”.
2. Remove the ECU enclosure hold-down bracket and lift the top half of the ECU enclosure up and out of the pocket in the windshield washer fluid reservoir.
3. Pull the ECU and ECU harness out of the lower half of the ECU enclosure, depress the lock tabs on the 35 pin harness connector and swing the connector around until the hook on the end opposite of the lock tab disconnects from the ECU.
4. Reverse the procedure for installation.

FUSE AND RELAY REPLACEMENT

The ABS TT4 system has two fuses located in the under-hood fuse/relay center (Figure 7-61):

1. A 5 ampere ignition power fuse.
2. A 40 ampere motor pump fuse.

The ABS TT4 system has four relays:

1. Valve relay.
2. Warning relay.
3. Pump relay 1.
4. Pump relay 2.

The valve relay and the warning relay are located in the under-hood fuse/relay center (Figure 7-61). The valve and warning relays are accessible after removal of the under-hood fuse/relay center cover. The two pump relays are located forward of the fuse-relay center and can be accessed after removing the ABS ECU enclosure hold-down bracket.

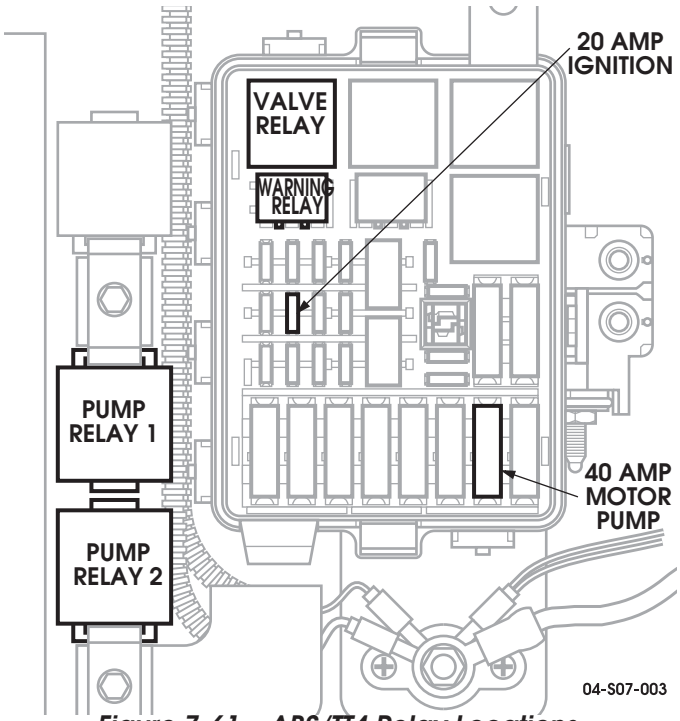
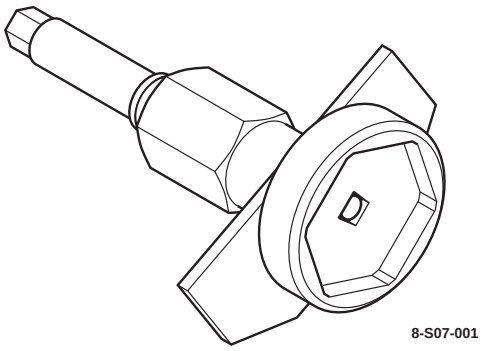
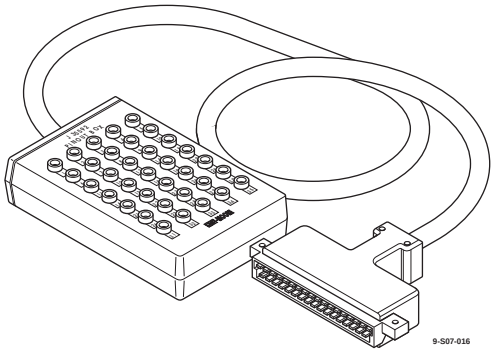


Figure 7-61: ABS/TT4 Relay Locations.

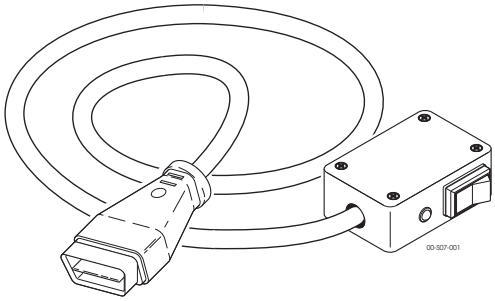
ESSENTIAL TOOLS



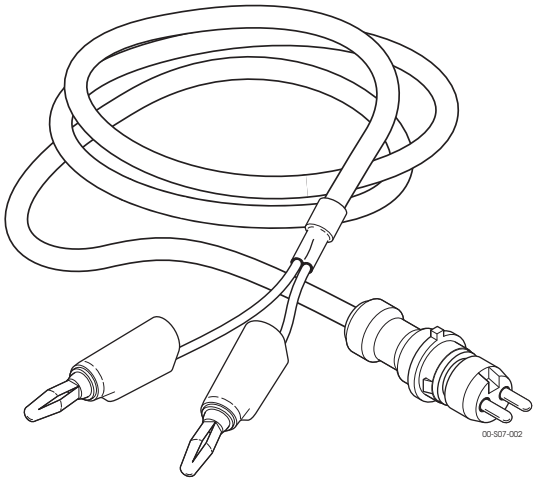
J–42553



J–35592



J-44237



J-42883

Tool No.	Description
J–35592	ABS Pinout Box
J–42553	Disc Brake Piston Retraction Tool
J–42883	Wheel Speed Sensor Test Cable
J–44237	ABS Blink Code Jumper
J–44238	Master Cylinder Bleed Adapter (not shown)
J–45405	Brake Line Flaring Kit (not shown)
J–45761	T-Handle Rachet Wrench (9/16") (not shown)

Procure from Kent-Moore.

SPECIAL TOOLS

Tool No.	Description
J–29532-A	Diaphragm Brake Bleeder

THIS PAGE INTENTIONALLY BLANK.

Section 8 Steering System

TABLE OF CONTENTS

Cylinder Head O-Ring Replacement 8-23
Input Seal Replacement 8-22
Intermediate Steering Shaft
- Dust Boot Replacement 8-25
- Installation 8-25
- Removal 8-25
- Replacement 8-25

Steering Gear Seal Replacement 8-21
Steering Specifications
- Steering Pump Flow Rates and Operating Pressures 8-37

Steering System
- Center Link Replacement 8-4
- Description 8-2
- Essential Tools 8-38
- Idler Arm Replacement 8-9
- Pitman Arm Replacement 8-3
- Power Steering
  - Cooler and Hose Replacement 8-29
  - Fluid Reservoir Replacement 8-28
  - Hydraulic System Pressure and Return Hose Replacement 8-27
  - Power Steering Gear Service 8-31
  - Pressure Test 8-35
  - Pump and Pulley Replacement 8-26
  - Purging Air from the System 8-35
  - System Diagnosis Charts 8-31
  - System Flushing 8-37
- Special Tools 8-38
- Steering Column
  - Ignition Interlock Cable Replacement 8-18
  - Ignition Switch Lock Cylinder 8-16
  - Lock and Switch Housing 8-13
  - Multi-Switch Replacement 8-12
  - Steering Column Repair 8-14
  - Steering Column Replacement 8-11
  - Steering Gear Replacement 8-19
  - Steering Wheel Hub/ Column Shroud 8-16
- Steering Wheel Replacement 8-10
- Tie Rod End Replacement 8-6
- Tie Rod Replacement 8-8

STEERING SYSTEM DESCRIPTION

The power steering system consists of the power steering pump, reservoir, steering gear, fluid cooler, and interconnecting lines (Figure 8-1). The purpose of the system is to reduce steering effort at all vehicle speeds and during parking maneuvers.

The steering pump used on all models is a constant displacement, rotary pump. The pump supplied by Delphi Saginaw Steering Systems uses a remote reservoir (Figure 8-1).

The steering pump on all HUMMER H1 vehicles performs two functions. The first function is to provide the necessary fluid pressure for power brake boost to the hydro-boost unit, the second is to provide fluid pressure for steering assist.

A recirculating ball-type steering gear is used for all applications. The gear is supplied by the Sheppard Company.

A steering fluid cooler is used on all models. The vertical mount cooler is located on the drivers side front hood hinge mount.

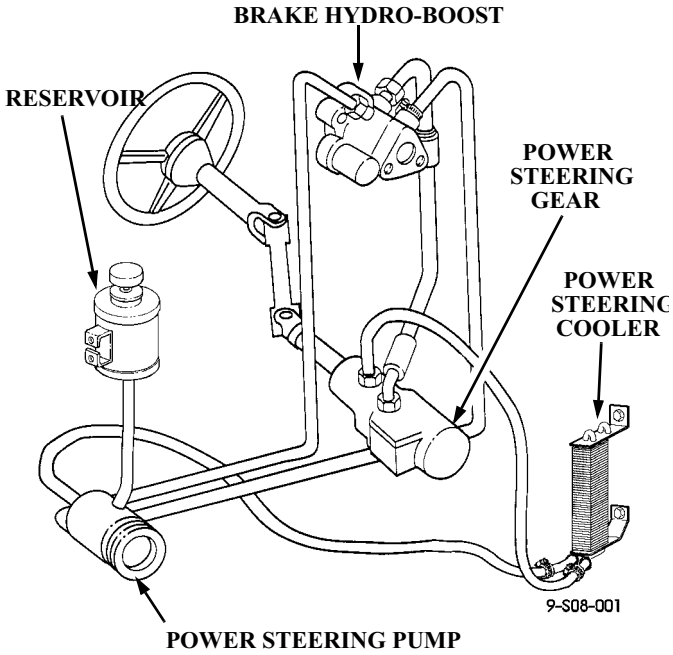


Figure 8-1: Steering System

Power Steering Fluid

Recommended fluid for the power steering system is Dexron III.

Power Steering Component Service

Most of the power steering components are serviceable. The pump can be replaced as an assembly.

The steering gear housing seals are serviceable with the exception of the sector shaft seal that requires unit replacement. Mechanical failure of the steering gear components require unit replacement

The fluid cooler and fluid lines are also replaced as assemblies when diagnosis indicates this is necessary.

Steering Linkage

The steering linkage consists of a steering (Pitman) arm, center link, idler arm, and left/right tie rods (Figure 8-3). The tie rods connect the center link to steering arms on the left and right side geared hubs. The idler arm stabilizes the center link and is attached to the vehicle frame. The steering arm connects the center link to the steering gear.

Steering Linkage Lubricant

Recommended lubricant for linkage lubrication points is NLGI-LB grade lubricating grease. Quality lubricants are available from suppliers such as Mobil, Kendall, and Valvoline.

STEERING (PITMAN) ARM REPLACEMENT

NOTE: Ensure that the front wheels are in the straight-ahead position while the pitman arm is removed and installed.

Removal

1. Raise and support the front of the vehicle.
2. Remove the drive line protection.
3. Remove the four 17mm sway bar to frame bolts and move the bar for clearance.
4. Lift the locking tabs on the steering gear shaft bolt.
5. Remove the 14mm socket head bolt from the steering gear shaft (Figure 8-2). Using puller CH-47965, remove the pitman arm from the steering gear shaft.
6. Remove the cotter pin and slotted nut from the center link end of the pitman arm.
7. Using puller CH-47975, remove the pitman arm from the center link.
8. Loosen the idler arm to frame mount bolts to allow movement of the idler arm when the pitman arm is tightened to the center link.

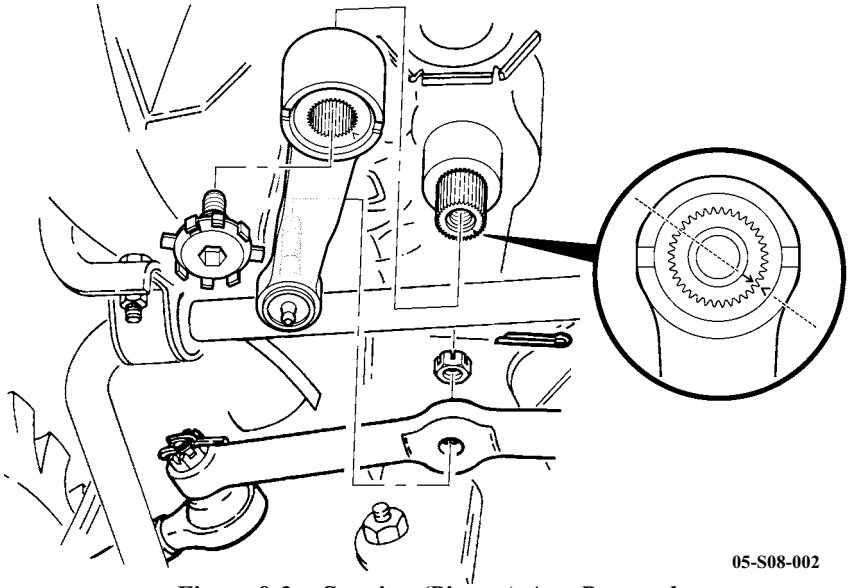


Figure 8-2: Steering (Pitman) Arm Removal

Installation

1. Apply anti-seize compound to the threads of the 14mm socket head bolt and both sides of the friction washer.
2. Align the arrows on the gear box and pitman arm, install the pitman arm on the shaft with the 14mm socket head bolt.
3. Secure the pitman arm to the steering gear shaft with the 14mm allen bolt. Tighten the bolt to 225 lb-ft (305 N•m).
4. If the locking tabs do not line up when proper torque is reached, continue to tighten bolt until the tabs line up. DO NOT loosen the bolt to align the tabs.
5. Bend the tabs into the retainer (Figure 8-21).

NOTE: Refer to torque adapter in section 8 for proper use of tool J-45764-2.

6. Secure the pitman arm to the center link with the slotted nut. Tighten the slotted nut to 110-130 lb-ft (149-176 N•m) using torque adapter J-45764-2 and an extension (Figure 8-5).
7. Install the cotter pin through the slotted nut. If necessary, tighten the slotted nut to align the holes for cotter pin insertion. DO NOT back off the slotted nut to align the holes.
8. Place the wheels in the straight ahead position and tighten the idler arm to frame bolts to 90-100 lb-ft (122-136 N•m).
9. Install the sway bar bolts and torque to 60 lb-ft (81 N•m).

10. Install the drive line protection.
11. Lubricate the pitman arm and lower the vehicle.

CENTER LINK REPLACEMENT

Removal

1. Raise and support the front of the vehicle.
2. Remove the cotter pin and the slotted nut securing the pitman arm to the center link (Figure 8-3).
3. Remove the cotter pin and the slotted nut securing the idler arm to the center link.
4. Loosen, but do not remove, the bolts and locknuts securing the idler arm to the frame.
5. Remove the two cotter pins and slotted nuts securing the right and left tie rods to the center link.
6. Using puller J-24319-B remove the center link from both tie rods.
7. Using puller CH-47975 remove the idler arm and the pitman arm from the center link.

Installation

NOTE: Refer to torque adapter in section 8 for proper use of tool J-45764-2.

1. Secure the center link to the pitman arm and the idler arm with two slotted nuts and tighten to 110 - 130 lb-ft (149-176 N•m) using torque adapter J-45764-2 and an extension (Figure 8-5).
2. Install a cotter pin in each slotted nut. If necessary, tighten the slotted nuts to align the holes for cotter pin insertion. DO NOT back off the slotted nuts to align the cotter pin holes.
3. Secure the right and left tie rods to the center link with two slotted nuts and tighten to 63-77 lb-ft (85-104 N•m).
4. Install a cotter pin in each slotted nut. If necessary, tighten the slotted nuts to align the holes for cotter pin insertion. DO NOT back off the slotted nuts to align the cotter pin holes.
5. Place the front wheels in the straight ahead position and tighten the idler arm to frame bolts and locknuts to 90-100 lb-ft (122-136 N•m).
6. Lower the vehicle.

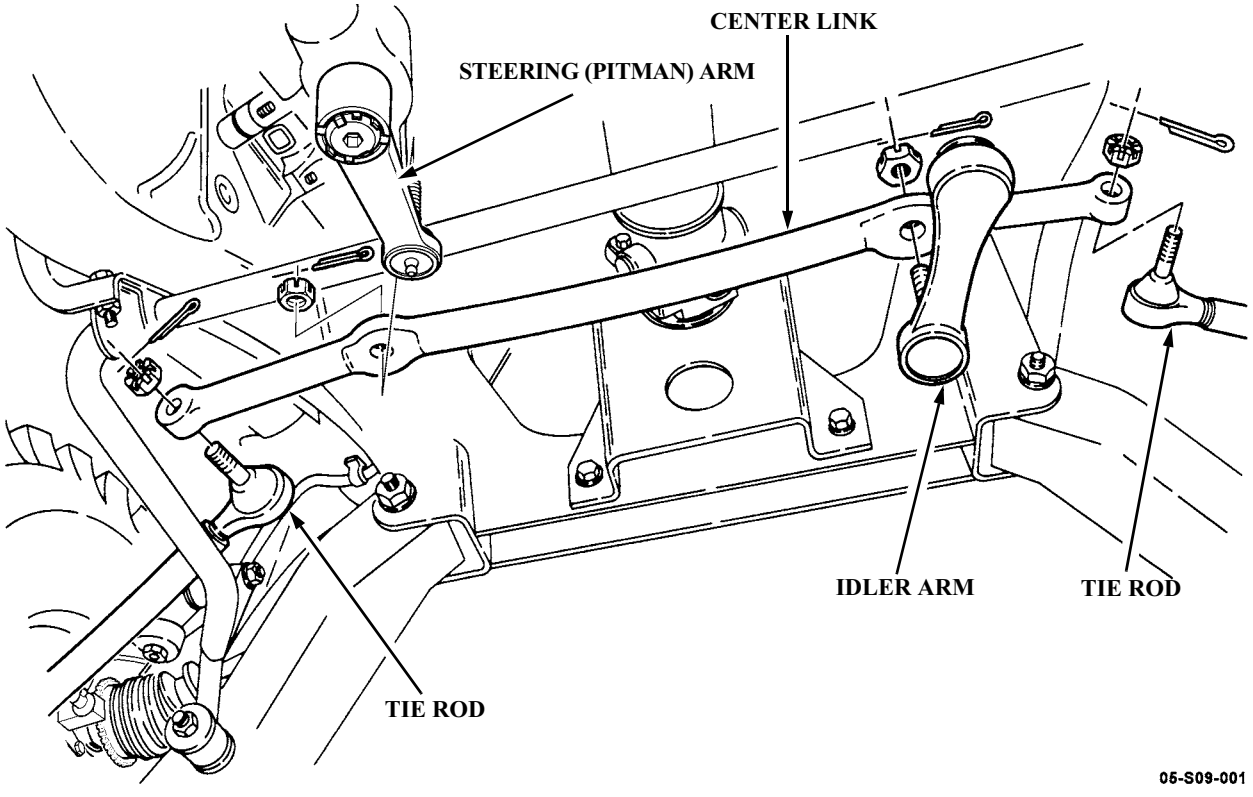


Figure 8-3: Center Link Removal

TORQUE ADAPTER

1. Determine the effective length of the torque wrench (A) by measuring the distance from the center of the square drive to the center of the area covered by the operator's hand (Figure 8-4).
2. The length of the torque adapter (B) (J–45764-2) is 4 inches.
3. When used in the straight or180 degree position, the following formula must be used:

$$\frac{\text{Specified Torque x Wrench Length (A)}}{\text{Wrench Length (A) + Adapter Length (B)}}$$

Example: 260 (Specified Torque) x 18.5 (Wrench Length) ÷ by 18.5 (Wrench Length) + 4 (Adapter Length) = 213.7 lb-ft.

4. When the adapter is used at 90 degrees to the torque wrench the specified torque will be the same as the wrench setting.
5. Using the adapter at any other angle to the torque wrench requires the above formula with the adjusted or effective length of the adapter (B), which will be a value between 0 and 4 inches.

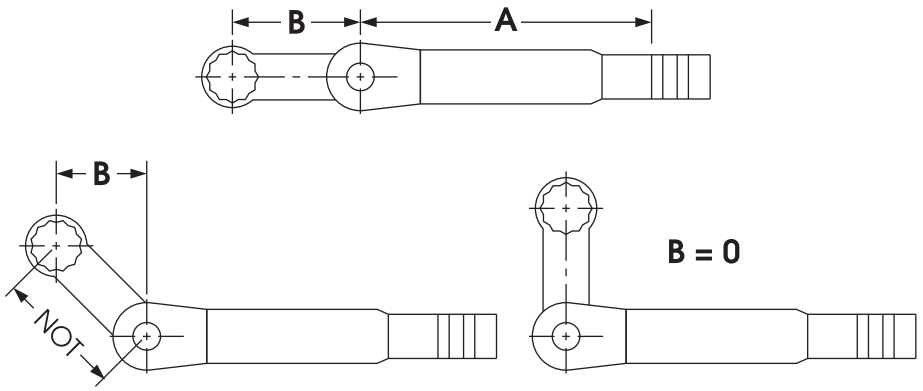


Figure 8-4: Torque Adapter

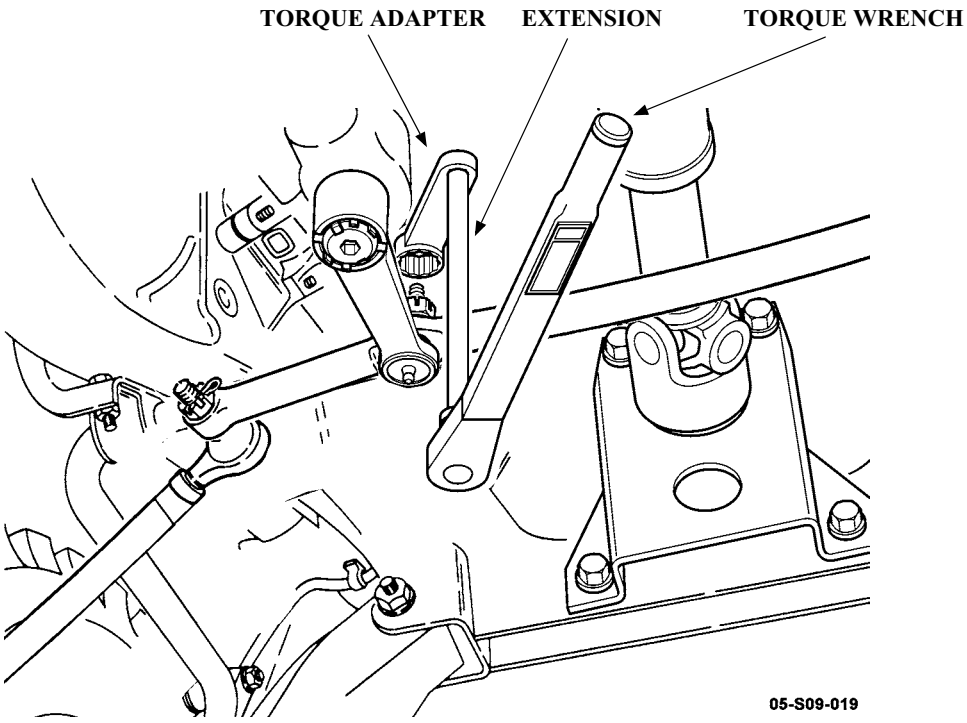


Figure 8-5: Torque Adapter, Extension and Torque Wrench

TIE ROD END REPLACEMENT

Removal

1. Raise and support the front of the vehicle.
2. Remove the cotter pin and slotted nut from the geared hub end or center link end of the tie rod assembly (Figures 8-6 and 8-8).
3. Using puller J-24319-B remove the tie rod end from the geared hub, or center link.

Disassembly

1. Loosen the locknut on the clamp securing the tie rod end to the adjusting sleeve.

NOTE: Count the number of turns required to remove the tie rod end from the adjusting sleeve.

2. Remove the tie rod end from the adjusting sleeve.

Assembly

1. Apply anti-seize compound to the threads in the adjusting sleeve.
2. Thread the tie rod end into the adjusting sleeve, turning the same number of revolutions that were required for removal.

Installation

1. Secure the tie rod to the geared hub, or center link with the washer and slotted nut. Tighten the slotted nut to 63-77 lb-ft (85-104 N•m).
2. Install a cotter pin in the slotted nut. If necessary, tighten the slotted nut to align the holes for cotter pin insertion. DO NOT back off the slotted nut to align the cotter pin holes.

CAUTION: *Ensure that the outboard clamp faces the halfshaft and the inboard clamp faces away from the stabilizer bar (front only) or damage to equipment may result.*

3. Before final tightening of the sleeve clamp hardware, center both tie rod end studs in their sockets (Figure 8-7).

CAUTION: *If the stud and socket are not properly aligned, a partial or complete lockout of stud swing could result. Limiting stud swing can increase component wear and a complete lockout can cause component damage.*

4. Lubricate the tie rod ends.

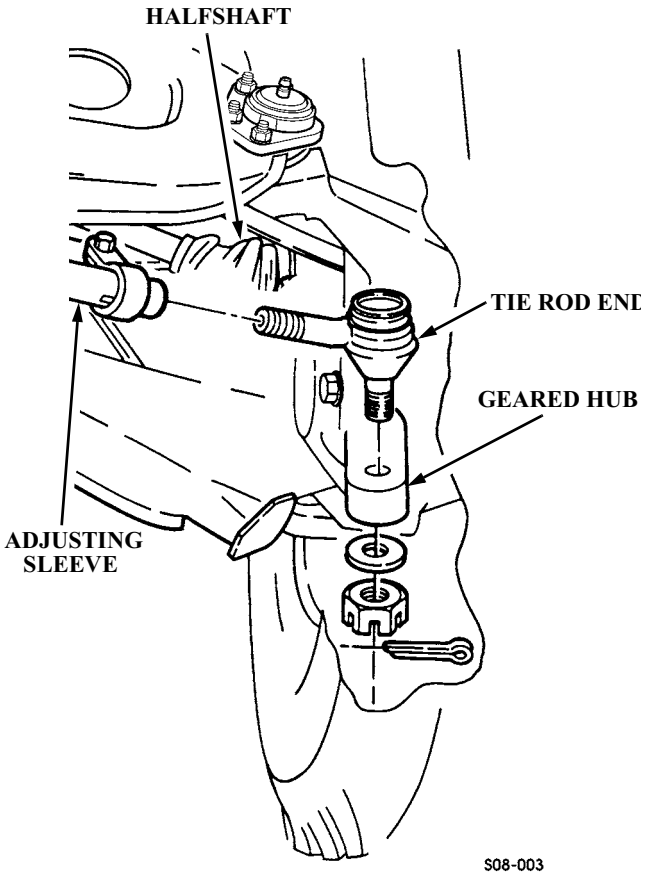


Figure 8-6: Tie Rod End Removal

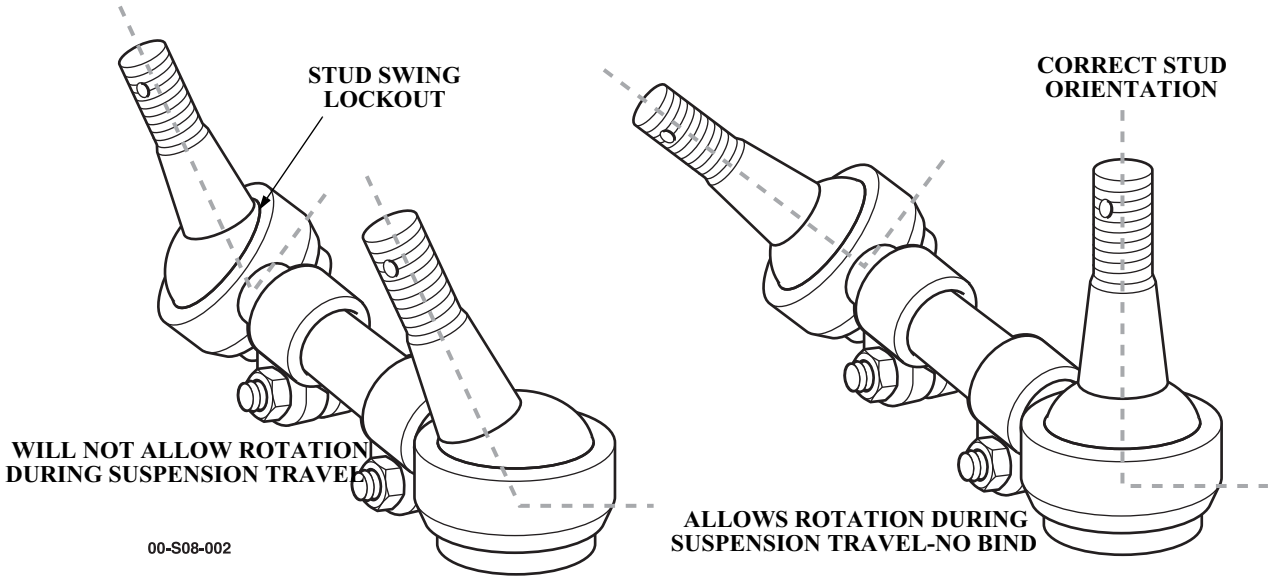


Figure 8-7: Tie Rod End Stud and Socket Orientation

TIE ROD ADJUSTING SLEEVE REPLACEMENT

Removal

1. Raise and support the front of the vehicle.
2. Remove the cotter pins and slotted nuts from the center link end and the geared hub end of the tie rod (Figure 8-8).
3. Using puller J-24319-B remove the tie rod from the center link and the geared hub.

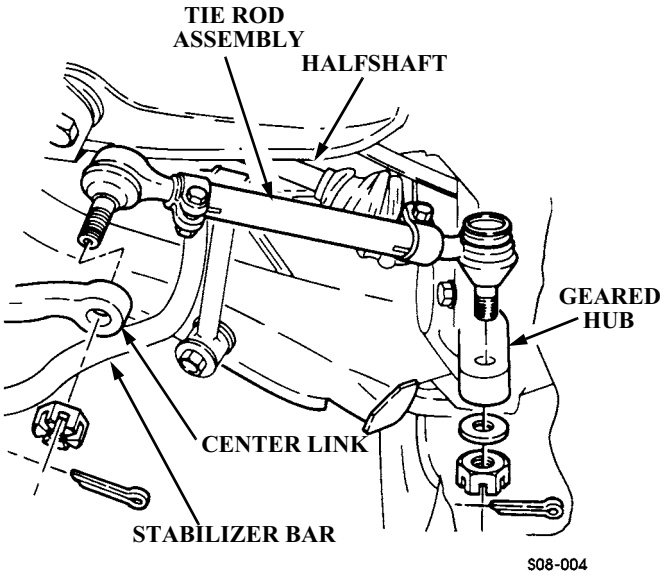


Figure 8-8: Tie Rod Removal

Disassembly

1. Loosen the two locknuts and clamps securing the tie rod ends to the adjusting sleeve (Figure 8-9).

NOTE: Note: Count the number of turns required to remove each tie rod end from the adjusting sleeve.

2. Remove both tie rod ends from the adjusting sleeve.

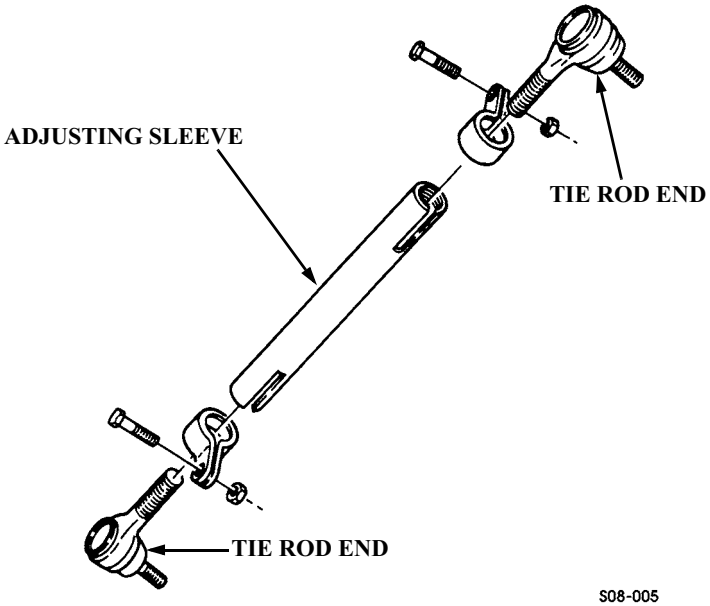


Figure 8-9: Tie Rod Component Parts

Assembly

1. Apply anti-seize compound to the threads in the adjusting sleeve.
2. Thread the two tie rod ends into the adjusting sleeve, turning them the same number of revolutions that were required for removal.

Installation

1. Secure the tie rod to the center link with the slotted nut and tighten to 63-77 lb-ft (85-104 N•m).
2. Secure the tie rod to the geared hub with the washer and slotted nut. Tighten the slotted nut to 63-77 lb-ft (85-104 N•m).
3. Install a cotter pin in each slotted nut. If necessary, tighten the slotted nuts to align the holes for cotter pin insertion. DO NOT back off the slotted nuts to align the cotter pin holes.

CAUTION: *Ensure that the outboard clamp faces the halfshaft and the inboard clamp faces away from the stabilizer bar (front only) or damage to equipment may result.*

4. Before final tightening of the sleeve clamp hardware, center both tie rod end studs in their sockets(Figure 8-7).

CAUTION: *If the stud and socket are not properly aligned, a partial or complete lockout of stud swing could result. Limiting stud swing can increase component wear and a complete lockout can cause component damage.*

5. Lubricate the tie rod ends.
6. Lower the vehicle and align the toe-in.

CAUTION: *The sleeve clamps must be positioned between 3/16" and 5/16" from the end of the sleeve and the bolt and nut tightened to 30 lb-ft (41 N•m).*

7. Align the sleeve clamps and tighten the bolt and nut assemblies to 30 lb-ft (41 N•m)(Figure 8-10).

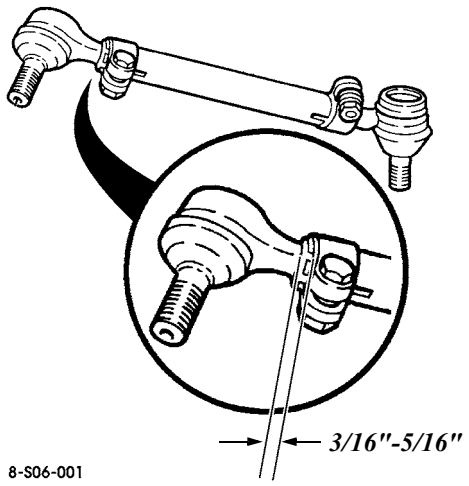


Figure 8-10: Tie Rod Sleeve Clamp Position

IDLER ARM REPLACEMENT

Removal

1. Raise and support the front of the vehicle.
2. Remove the cotter pin and the slotted nut securing the idler arm to the center link(Figure 8-11).
3. Using puller CH-47975 disconnect the idler arm from the center link.
4. Remove the bolts, washers and locknuts securing the idler arm to the frame and remove the idler arm.

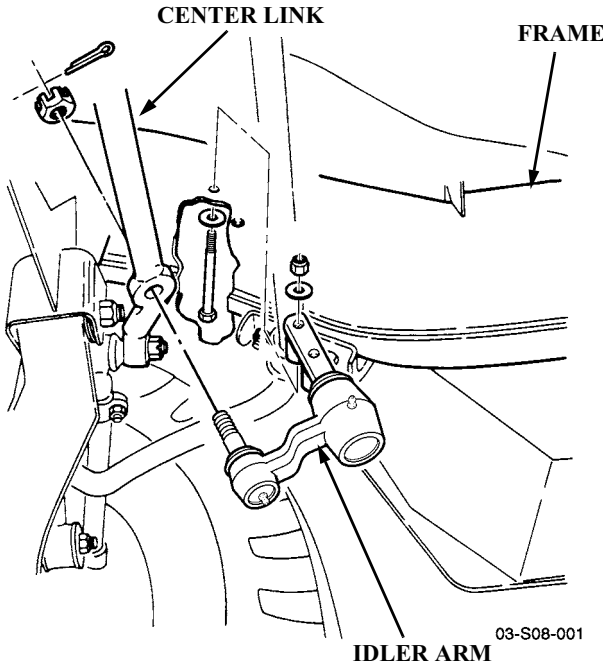


Figure 8-11: Idler Arm Removal

Installation

1. Position the idler arm in the center link and loosely install the bolts, washers and nuts through the frame and idler arm. The head of the bolts should be on the frame side and the nuts on the idler arm side.

NOTE: Refer to torque adapter in section 8 for proper use of tool J-45764-2.

2. Secure the idler arm to the center link with the slotted nut and tighten to 110-130 lb-ft (149-176 N•m) using torque adapter J-45764-2 and an extension (Figure 8-5).
3. Install the cotter pin through the slotted nut. If necessary, tighten the slotted nut to align the holes for cotter pin insertion. DO NOT back off the slotted nut to align the holes.
4. Place the front wheels in the straight ahead position and tighten the idler arm to frame bolts and locknuts to 90-100 lb-ft (122-136 N•m).
5. Lubricate the idler arm and lower the vehicle.

STEERING WHEEL REPLACEMENT

NOTE: Ensure the front wheels are in the straight ahead position.

Removal

1. Remove the horn button by pulling it out of the wheel with your fingers.
2. Disconnect both wire leads to the horn button, and set aside.
3. Remove the five allen screws securing the wheel to the collar, remove the wheel and the collar.
4. Remove the main shaft nut.

Installation

1. Align the splines on the steering wheel with the splines on the shaft.
2. Secure the steering wheel to the shaft with the nut. Tighten nut to 35 lb-ft (47 N•m).
3. Position the horn button retainer ring and wheel onto the collar secure with the five allen screws, tighten to 12-15 in./lb.
4. Connect the wire leads to the terminals on the back of the horn button and reinstall the button into the center of the wheel. test the horn for proper operation.

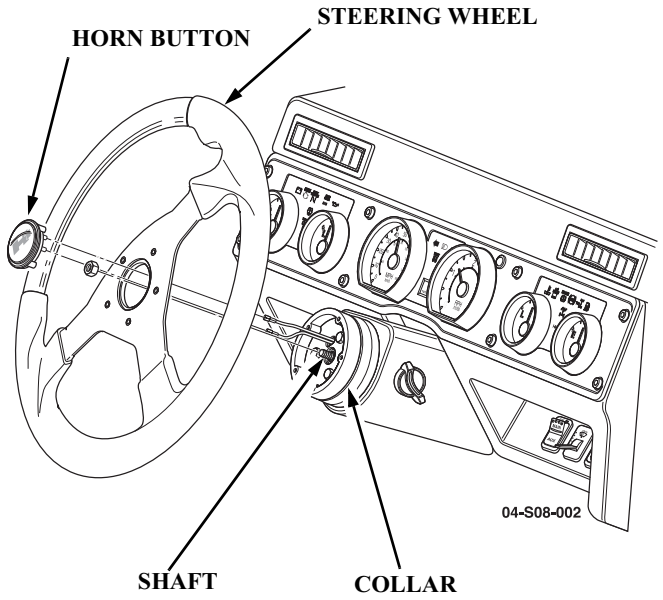


Figure 8-12: Steering Wheel Removal

STEERING COLUMN REPLACEMENT

Removal

NOTE: Before removing the steering wheel, turn the steering column to gain access to the intermediate shaft mounting hardware.

1. Remove the steering wheel.
2. Remove the close-out panel.
3. Remove the locknut, lockwasher, three washers, and the thru-bolt from the mounting bracket and loosen the pivot bolts. The column will drop down as it pivots in the bracket (Figure 8-13).

NOTE: Before performing step 4, be certain to put scribe marks that indicate the position of the intermediate shaft yoke relative to the splines.

4. Remove the bolt on the intermediate shaft yoke and pull the yoke from the splines (Figure 8-13).
5. Remove the five screws and shroud (two halves) from the steering column.
6. Disconnect the ground wires from the steering column.
7. Disconnect the two multi-switch connectors from the multi-switch.
8. Disconnect the two ignition switch connectors from the ignition switch.
9. Remove the screw attaching the interlock cable to the ignition switch, move the interlock cable out of the way.
10. Remove the multi-switch and the ignition switch from the steering column.
11. Remove the two locknuts, washers, pivot bolts, and steering column from the mounting bracket.

Installation

1. Hang the steering column from the mounting bracket with the two pivot bolts, washers, and the locknuts. Finger tighten the locknuts.
2. Install the ignition switch and the multi-switch on the steering column (Figure 8-13).
3. Install the interlock cable and tighten the screw.
4. Connect the two ignition switch connectors to the ignition switch.
5. Connect the two multi-switch connectors to the multi-switch.
6. Secure the shrouds to the steering column with the five screws.
7. Secure the ground wires to the steering column with the bolt and the nut/lockwasher assembly.

8. Raise the steering column to the mounting bracket. Insert the thru-bolt, three washers, lockwasher, and the locknut. Finger tighten the locknut.
9. Slide the intermediate shaft yoke onto the splines while carefully aligning the scribe marks. Insert the bolt and tighten the locknut to 60 lb-ft (81 N•m).
10. Tighten the thru-bolt and the locknut to 31 lb-ft (42 N•m).
11. Tighten the pivot bolt and the locknuts to 10 lb-ft (14 N•m).
12. Install the steering wheel.
13. Install the close-out panel.
14. Operate the vehicle to verify the steering wheel alignment.

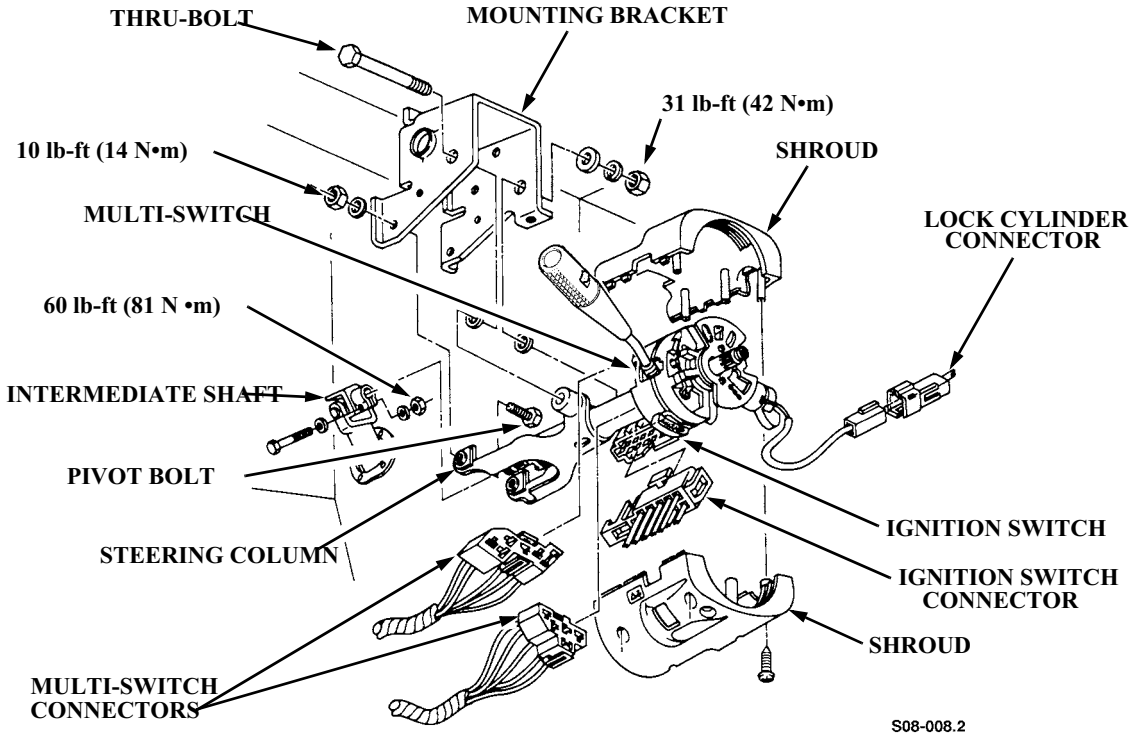


Figure 8-13: Steering Column Components

STEERING COLUMN MULTI-SWITCH REPLACEMENT

NOTE: This procedure covers the directional signal, horn, high beam, and hazard light switches.

Removal

1. Remove the close-out panel.
2. Remove the locknut, lockwasher, three washers, and the thru-bolt from the mounting bracket and loosen the pivot bolts. The column will drop down as it pivots in the bracket (Figure 8-13).
3. Remove the five screws and shroud (two halves) from the steering column.
4. Disconnect the ground wires from the steering column.
5. Remove the two screws and the multi-switch from the steering column (Figure 8-14).
6. Remove the control handle from the multi-switch by pulling outward.

Installation

1. Attach the control handle to the multi-switch (Figure 8-14).
2. Secure the multi-switch to the steering column with the two screws.
3. Connect the ground wires to the steering column.
7. Secure the shroud (two halves) to the steering column with the five screws.

4. Raise the steering column to the mounting bracket. Insert the thru-bolt, three washers, lockwasher and the locknut. tighten the locknut to 10 lb-ft (14 N•m).
5. Install the close-out panel.

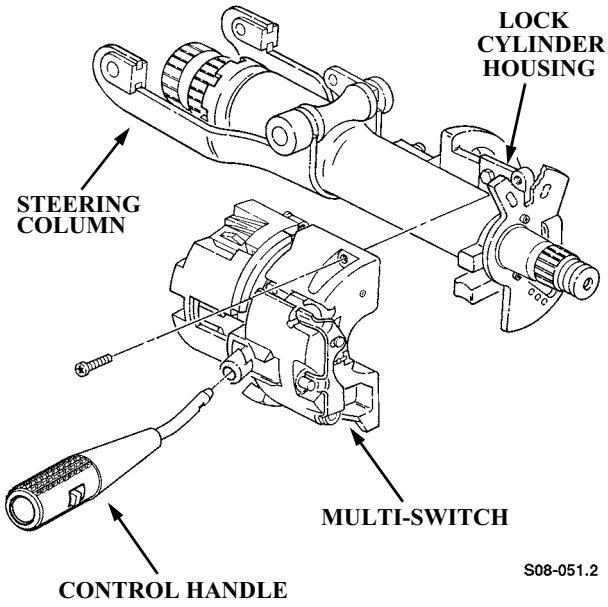


Figure 8-14: Steering Column Multi-Switch Replacement

LOCK AND SWITCH HOUSING ASSEMBLY REPLACEMENT

Removal

1. Disconnect the battery ground cable.
2. Remove the close-out panel.
3. Remove the locknut, lockwasher, three washers and the thru-bolt from the mounting bracket and loosen the pivot bolts. The column will drop down as it pivots in the bracket (Figure 8-13).
4. Remove the five screws and shroud (two halves) from the steering column.
5. Disconnect the ground wires from the steering column
6. Remove the two screws and the multi-switch from the steering column (Figure 8-14).
7. Remove the screw and the interlock cable from the ignition switch.
8. Remove the two bolts, the lock and switch housing assembly from the steering column.

Installation

1. Apply thread-locking compound to the bolt threads and secure the lock and switch housing assembly on the steering column with the two bolts.
2. Secure the interlock cable to the ignition switch with the screw.
3. Install the multi-switch.
4. Connect the ground wires to the steering column.
5. Secure the shroud (two halves) to the steering column with the five screws.
6. Raise the steering column to the mounting bracket. Insert the thru-bolt, three washers, lockwasher and the locknut. Tighten the locknut to 10 lb-ft (14 N•m).
7. Install the close-out panel.
8. Connect the battery ground cable.
9. Verify that the ignition switch operates properly.

STEERING COLUMN REPAIR

Lock and Switch Housing Assembly

Disassembly

NOTE: The key must stay in the ignition switch at all times.

1. Remove the lock cylinder and key assembly from the lock cylinder housing (Figure 8-15).
2. Remove the two screws securing the upper retainer plate to the lock cylinder housing. Remove the retainer plate, the upper bearing assembly and upper bearing sleeve from the lock cylinder housing.
3. Remove the two screws and the multi-switch assembly from the lock cylinder housing (Figure 8-14).
4. Remove the two screws securing the ignition switch assembly to the lock cylinder housing. Remove the ignition switch assembly (Figure 8-15).
5. Remove the six stakes from the tube and bracket assembly (Figure 8-16).
6. Remove the two screws and remove the lock cylinder housing from the tube and bracket assembly.
7. Remove the retainer ring, shaft and bearing from the tube and bracket assembly.

Assembly

1. Install the shaft, bearing and retainer ring into tube and bracket assembly (Figure 8-16).
2. Secure the lock cylinder housing to the tube and bracket assembly with two screws. Tighten screws to 6-7 lb-ft (8.1-9.4 N•m).
3. Stake the bearing securely in six (6) places(Figure 8-16).
4. Secure the ignition switch assembly to the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m)(Figure 8-15).
5. Secure the multi-switch assembly to the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m)(Figure 8-14).
6. Install the upper bearing assembly and upper bearing sleeve in the lock cylinder housing (Figure 8-15).
7. Install the retainer plate on the lock cylinder housing with two screws. Tighten screws to 35-40 lb-in. (3.9-4.5 N•m).
8. Install the lock cylinder and key assembly in the lock cylinder housing assembly.
9. Verify that ignition switch operates properly.

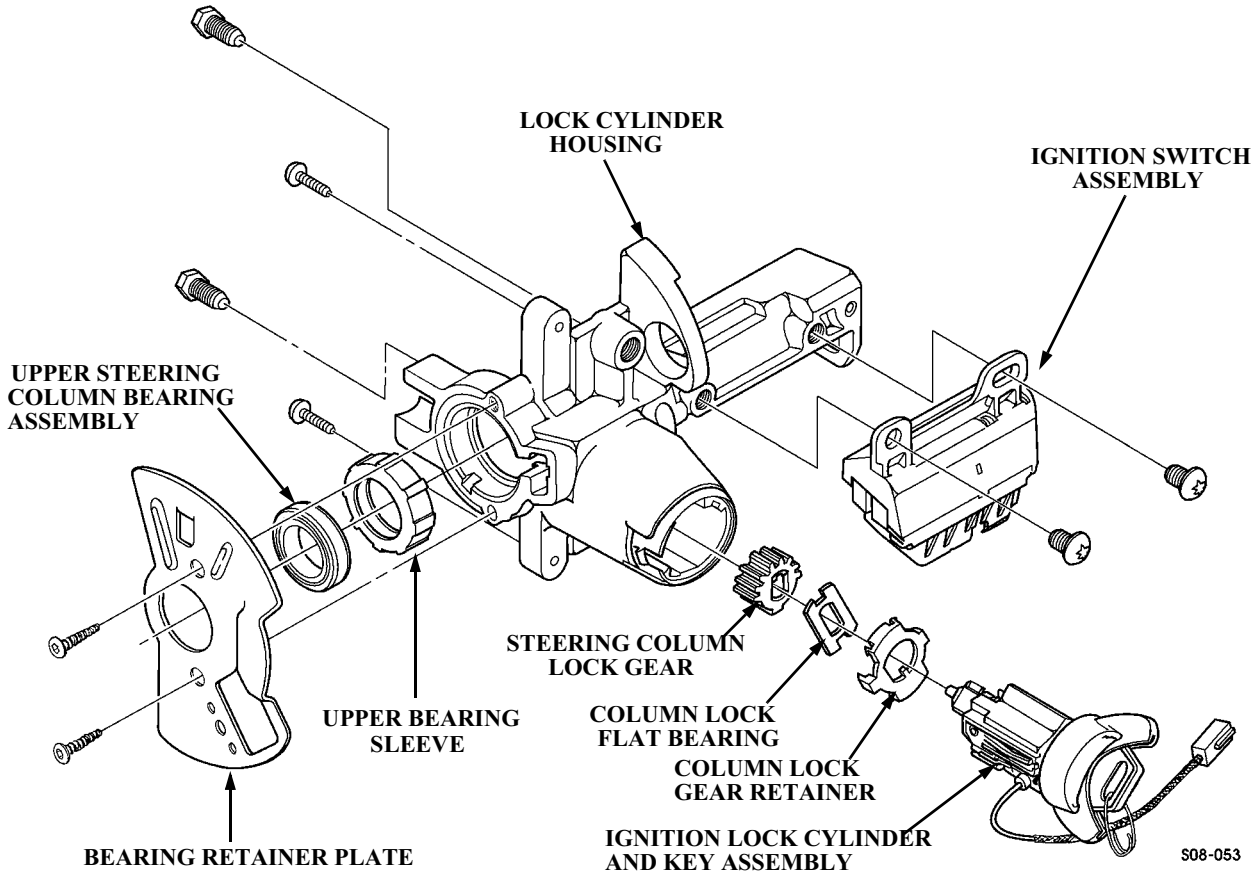


Figure 8-15: Lock and Switch Housing Components

Steering Column and Shaft

Disassembly

1. Remove the two screws and the multi-switch assembly from the lock and switch housing (Figure 8-14).
2. Remove the two screws, lock and the switch housing assembly from the steering column.
3. Remove the six stakes from the tube and bracket assembly (Figure 8-16).
4. Remove the shaft, retainer ring, and bearing from the tube and bracket assembly.
5. Remove the retainer ring and the bearing from the shaft.

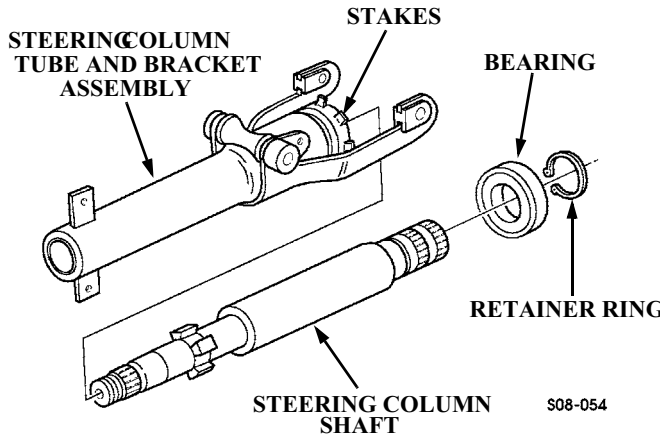


Figure 8-16: Steering Column and Shaft

Assembly

1. Slide the bearing onto the shaft and secure it with the retaining ring (Figure 8-16).
2. Slide the shaft into the tube and bracket assembly.
3. Install the six stakes into the tube and bracket assembly.
4. Secure the lock and the switch housing assembly to the steering column with the two screws.
5. Connect the multi-switch assembly to the lock and switch housing with the two screws (Figure 8-14).

STEERING WHEEL HUB COVER AND STEERING COLUMN SHROUD REPLACEMENT

Removal

1. Remove the three screws holding the front half of the steering wheel hub cover to the rear half.
2. Remove the steering wheel.
3. Remove the rear half of the cover.
4. Remove the five screws holding the lower steering column shroud to the upper shroud.
5. Loosen the two pivot bolts at the rear of the steering column mounting bracket.
6. Remove the thru-bolt from the front of the mounting bracket. The steering column will pivot downward.
7. Remove the upper shroud.

Installation

1. Place the upper shroud in position over top of the steering column.
2. Pivot the steering column upward and secure with the thru-bolt, three washers, lockwasher and the locknut.
3. Tighten the locknuts on the pivot bolts.
4. Secure the lower shroud to the upper shroud with the five screws.
5. Place the rear half of the steering wheel hub cover over the shaft.
6. Install the steering wheel.
7. Secure the front half of the shroud to the rear half with the three screws.

IGNITION SWITCH LOCK CYLINDER REPLACEMENT

Removal

1. Disconnect the battery ground cable.
2. Remove the close-out panel.
3. Remove the five screws and lower the steering column shroud (Figure 8-17).
4. Disconnect the lock cylinder connector from the ignition switch connector.
5. Turn the ignition switch to the RUN position.
6. Depress the lock cylinder detente pin through the detente pin hole and remove the lock cylinder from the steering column.

Installation

1. Insert the lock cylinder into the steering column (Figure 8-17).
2. Turn the ignition switch to the LOCK position.
3. Connect the lock cylinder connector to the ignition switch connector.
4. Secure the lower steering column shroud to the steering column with the five screws.
5. Install the close-out panel.
6. Connect the battery ground cable.
7. Verify that the ignition switch lock cylinder operates properly.

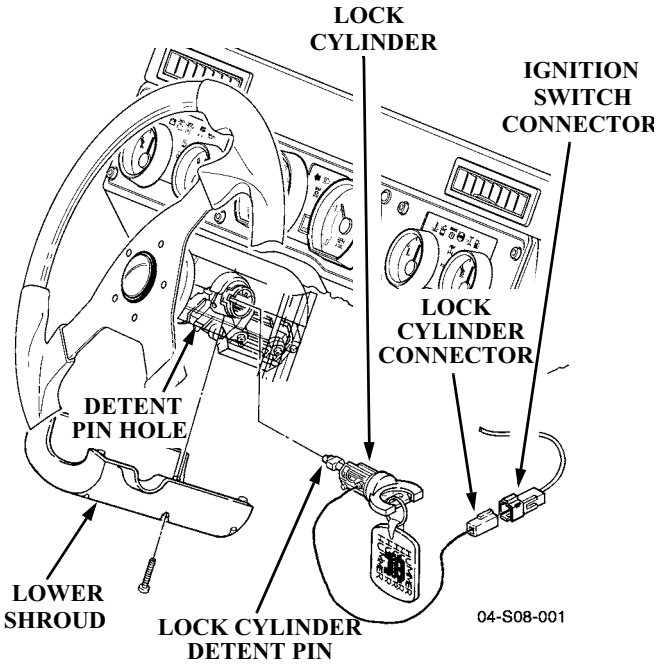


Figure 8-17: Ignition Switch Lock Cylinder Replacement

IGNITION INTERLOCK CABLE AND SOLENOID REPLACEMENT

Removal

1. Remove the five screws and the lower shroud from the steering column (Figure 8-18).

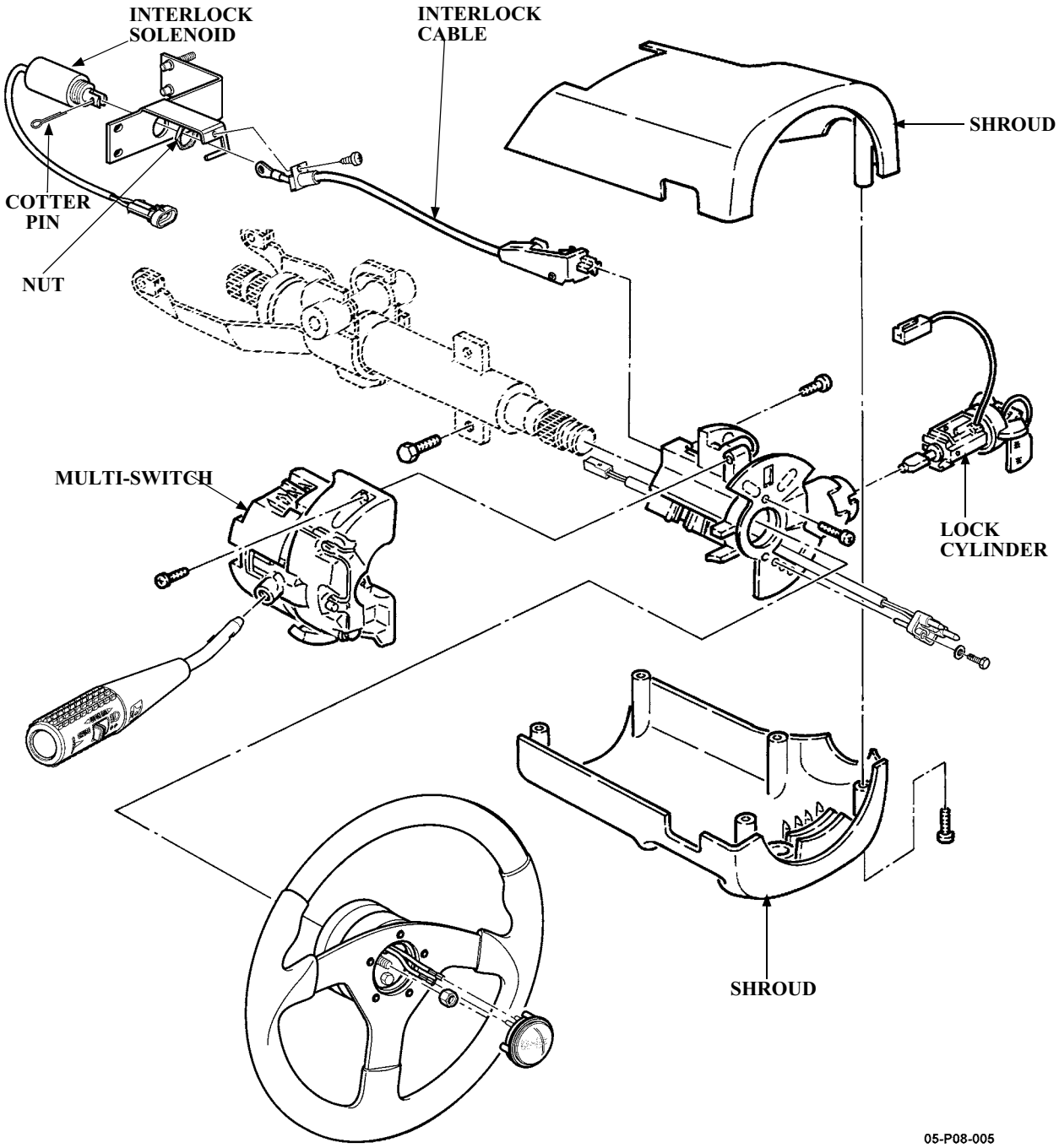


Figure 8-18: Steering Column Shrouds

2. Loosen the two locknuts securing the steering column to the mounting bracket.
3. Remove the locknut, lockwasher, three washers and the bolt securing the steering column to the mounting bracket.
4. Lower the steering column and remove the upper shroud.
5. Remove the screw and the cotter pin at the interlock cable solenoid, remove the screw from the ignition switch.
6. Remove the interlock cable.

7. Remove the nut from the front of the interlock solenoid, disconnect the electrical connector and remove the solenoid.

Installation

1. Install the interlock solenoid, secure with the nut, connect the electrical connector.
2. Install and secure the interlock cable to the ignition switch and the solenoid bracket with the screws.
3. Install the cotter pin.
4. Position the upper steering column shroud on the steering column (Figure 8-18).
5. Raise the steering column and secure the steering column on the mounting bracket with the bolt, three washers, lockwasher, and the locknut. Tighten the locknut to 31 lb-ft. (42 N•m).
6. Tighten the two locknuts securing the steering column to the mounting bracket. Tighten the locknuts to 10 lb-ft (14 N•m).
7. Secure the lower steering column shroud to the upper shroud with the five screws.

Test

1. With the transmission lever in P, turn the ignition key to the run position.
2. Activate the brake switch and move the transmission lever to N.
3. Without turning the ignition key off, move the transmission shift lever to P.
4. Turn the ignition key off. To pass the test, it should not be possible to move the transmission lever out of P unless an extremely high effort is applied.
5. Turn the ignition key on. To pass the test, it should not be possible to move the transmission lever out of P unless an extremely high effort is applied.
6. Activate the brake switch. To pass the test, the transmission lever should be moved from P to N with normal shift effort.
7. Turn the ignition key off. To pass the test, it should not be possible to remove the ignition key while the transmission lever is in N.
8. Move the transmission lever to P. To pass the test, it must be possible to remove the ignition key with normal effort applied to the ignition key.

STEERING GEAR REPLACEMENT

Removal

NOTE: Ensure the front wheels are in the straight-ahead position. Have a drainage container ready to catch fluid.

1. Disconnect the two power steering lines from the steering gear.
2. Raise and support the front of the vehicle.
3. Turn the steering wheel left and right several times to bleed off the power steering fluid.
4. Remove the bolt and nut on the intermediate shaft yoke at the steering gear and disconnect the intermediate shaft from the steering gear.
5. Remove the drive line protection.
6. Remove the four 17mm sway bar to frame bolts and move the bar for clearance.
7. Lift the locking tabs on the steering gear shaft bolt.
8. Remove the 14mm socket head bolt from the steering gear shaft (Figure 8-2). Using puller CH-47965, remove the pitman arm from the steering gear shaft (Figure 8-20).
9. Remove the three bolts, lockwashers, washers, and the steering gear from the frame.

Installation

WARNING: The gear box mounting bolts, washers and the spacer must be installed in the proper position or gear box damage could result.

1. Clean all the loctite residue from the bolts and the gear box if the original gear box is reused. Apply loctite 242 liberally to the bolt mounting holes in the gear box.

NOTE: The upper bolt with the spacer DOES NOT use a flat washer, only a lockwasher.

2. Align the steering gear with the mounting holes in the frame and secure with the reinforcement bracket, three lock washers, bolts, two flat washers and the spacer (Figure 8-19). Hand start all three bolts to ensure proper thread engagement and tighten the bolts to 160-190 lb-ft (220-260 N•m).
3. Align the hole in the yoke with the notch on the steering gear splines and slide the intermediate shaft on the steering gear splines.
4. Insert the bolt in the yoke and tighten the locknut to 60 lb-ft (81 N•m).
5. Connect the two power steering lines to the steering gear and tighten to 20 lb-ft (28 N•m)

NOTE: Ensure the front wheels are in the straight ahead position.

6. Apply anti-seize compound to the threads of the 14mm socket head bolt and both sides of the friction washer. Align the arrows on the gear box and pitman arm, and install the pitman arm on the shaft with the 14mm socket head bolt.
7. Tighten the bolt to 225 lb-ft (251 N•m). If locking tabs do not line up when proper torque is reached, continue to tighten the bolt until the tabs line up. DO NOT loosen the bolt to align the tabs.
8. Bend the tabs into the retainer (Figure 8-21).
9. Fill the power steering reservoir.
10. Purge the air from the power steering system (Refer to section 8)
11. Inspect the wheel alignment and set the internal limit plungers (Refer to section 8).

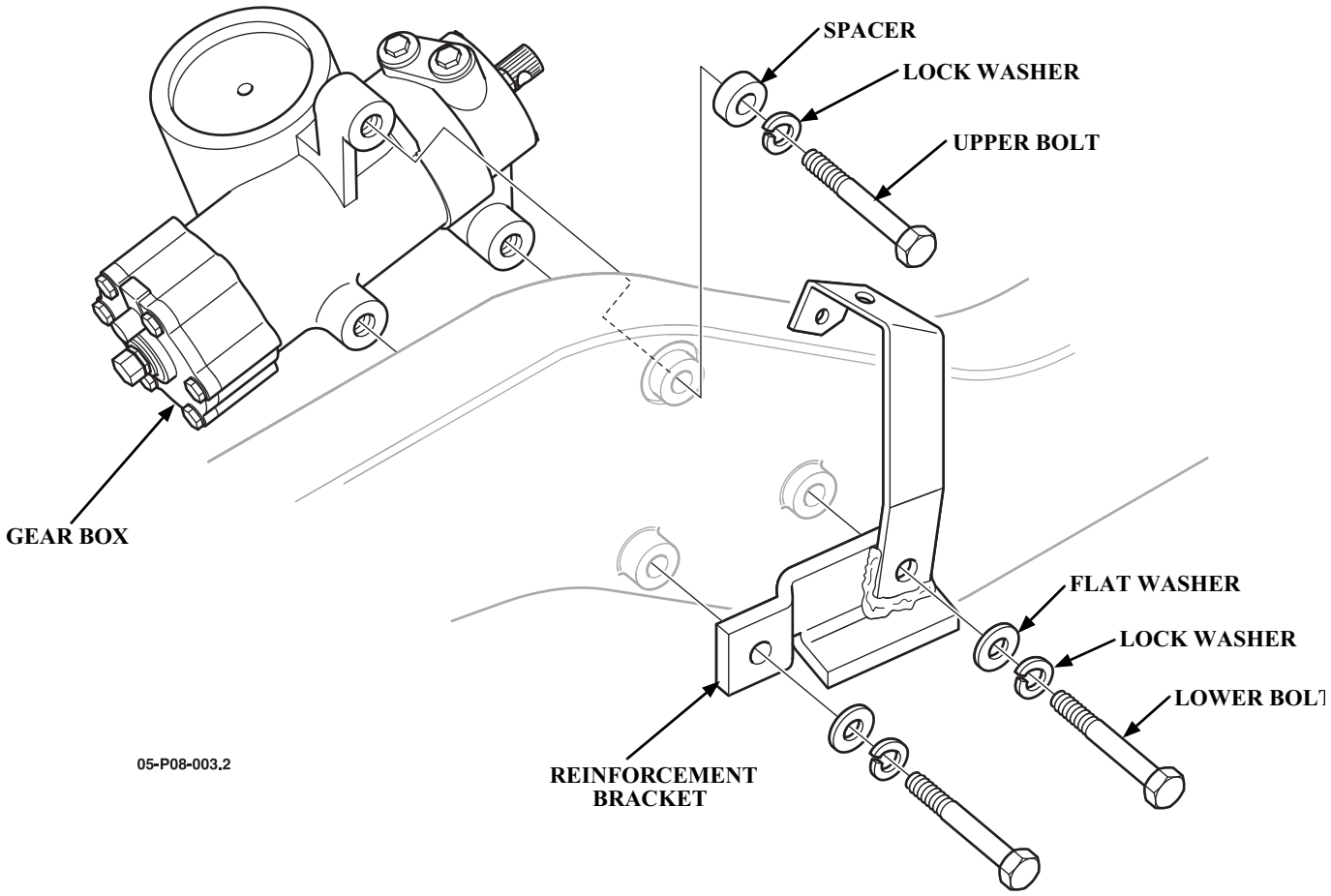


Figure 8-19: Gear Box Mounting Hardware

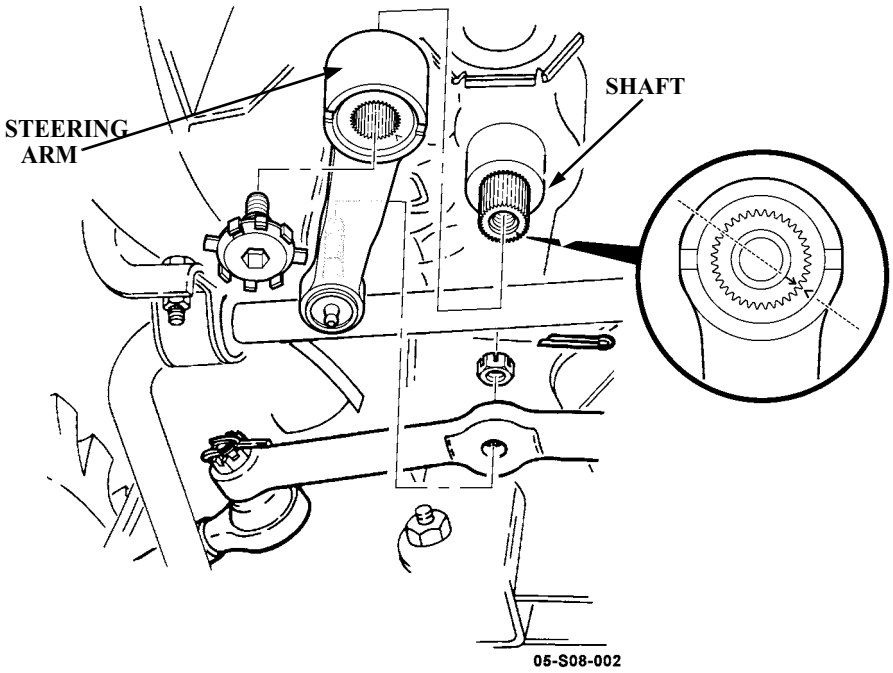


Figure 8-20: Pitman Arm Removal

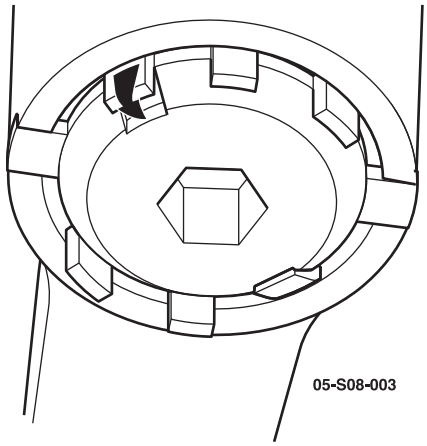


Figure 8-21: Locking Tab

STEERING GEAR SEAL REPLACEMENT

1. Remove the steering gear from the vehicle following the procedure outlined previously.
2. Inspect the steering gear fasteners and the steering gear for any damage to threads or mounting points that would render the unit unsafe for installation after seal replacement. Should any such damages be noted on inspection, the appropriate repairs or replacement of the steering gear should be performed prior to installation of the steering gear.

NOTE: Do Not Move The Piston Or Rotate The Input Shaft Of The Steering Gear After Removal Of Either The Input End Cap Or The Cylinder Head Cap. Movement Of These Components May Damage The Internal Control Valve Assembly Requiring Replacement Of The Unit.

INPUT SEAL REPLACEMENT

3. Mark the input end cap and the steering gear housing to enable proper orientation of the cap to the steering gear when assembling the unit after replacing the seals.
4. Remove the input shaft dust boot (See Figure 8-22).
5. Remove the limit plunger adjustment access plug.
6. Remove the input end cap by removing the four retaining bolts and removing the input end cap.

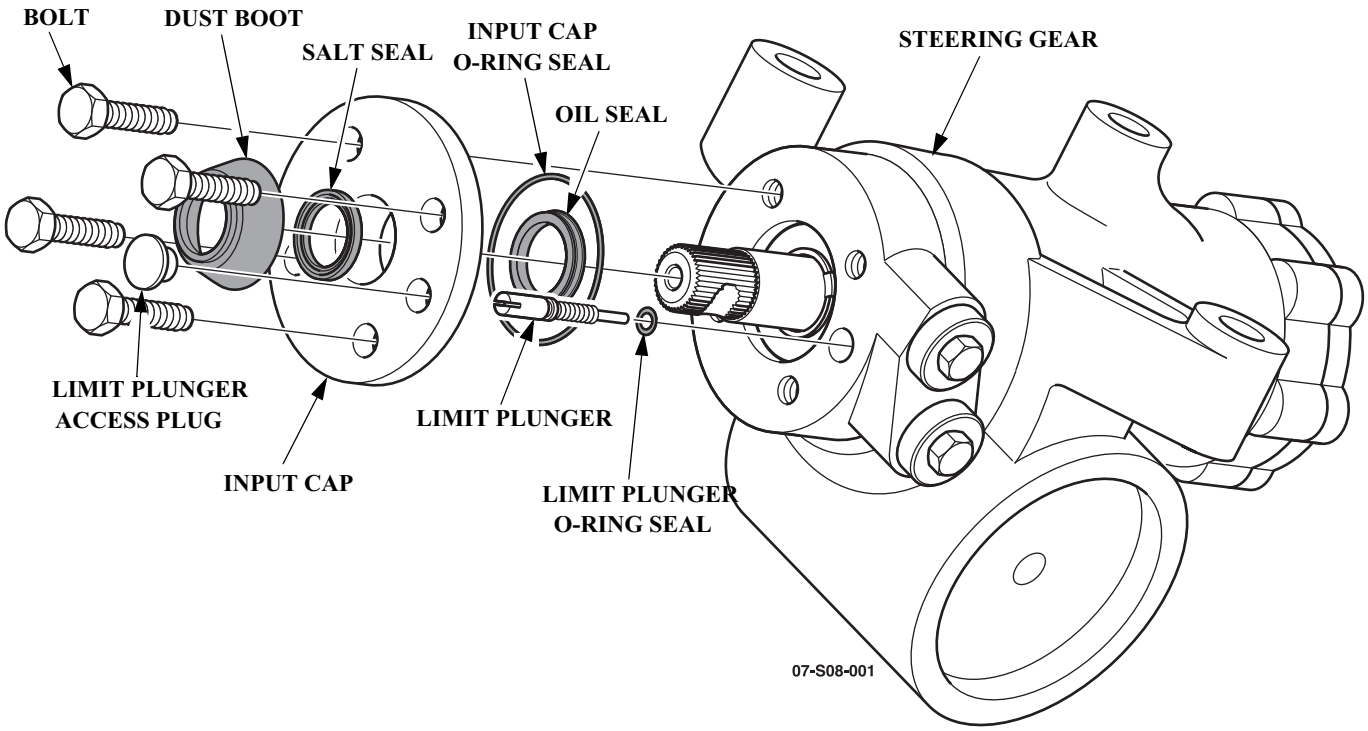


Figure 8-22: Input Cap and Seals

7. Place the input cap on a clean work surface and gently pry the salt seal out of the cap.
8. Press the oil seal out of the end cap with a suitable size socket or seal driver. Use of an arbor press is recommended.
9. Remove the cap-to-housing o-ring seal from the cap.
10. Clean and inspect the cap for any damage to the seal or o-ring sealing surfaces.
11. Press the new oil seal into position with the proper size seal driver or socket.
12. Install the new salt seal with the seal driver or socket until flush with the edge of the end cap.
13. Place the new cap o-ring seal onto the cap.
14. Wrap the input shaft splines with a piece of tape to protect the seals from any burrs or nicks in the input shaft splines.
15. Lightly grease the new o-ring and shaft seals with grease.
16. Install the input cap onto the housing, aligning the marks previously made.
17. Secure the cap to the steering gear housing with the previously removed bolts, torque the bolts to 53-64 lb.ft. (72-87 N•m). Remove the protective tape and install the new input shaft dust boot.
18. Counting the number of turns, remove the travel limit plunger from the end cap and install a new o-ring onto the plunger and lubricate the o-ring with grease.
19. Install the travel limit plunger, do not install any farther then the previously noted number of turns to ease in final adjustments.

CYLINDER HEAD O-RING REPLACEMENT

20. Mark the cylinder head and the steering gear housing to enable proper orientation of the cylinder head to the gear housing when assembling the unit after replacing the seals.
21. Remove the limit plunger adjustment access plug.
22. Remove the input shaft end play adjustment cap and loosen the lock nut to allow easier removal of the thrust button (See Figure 8-23).

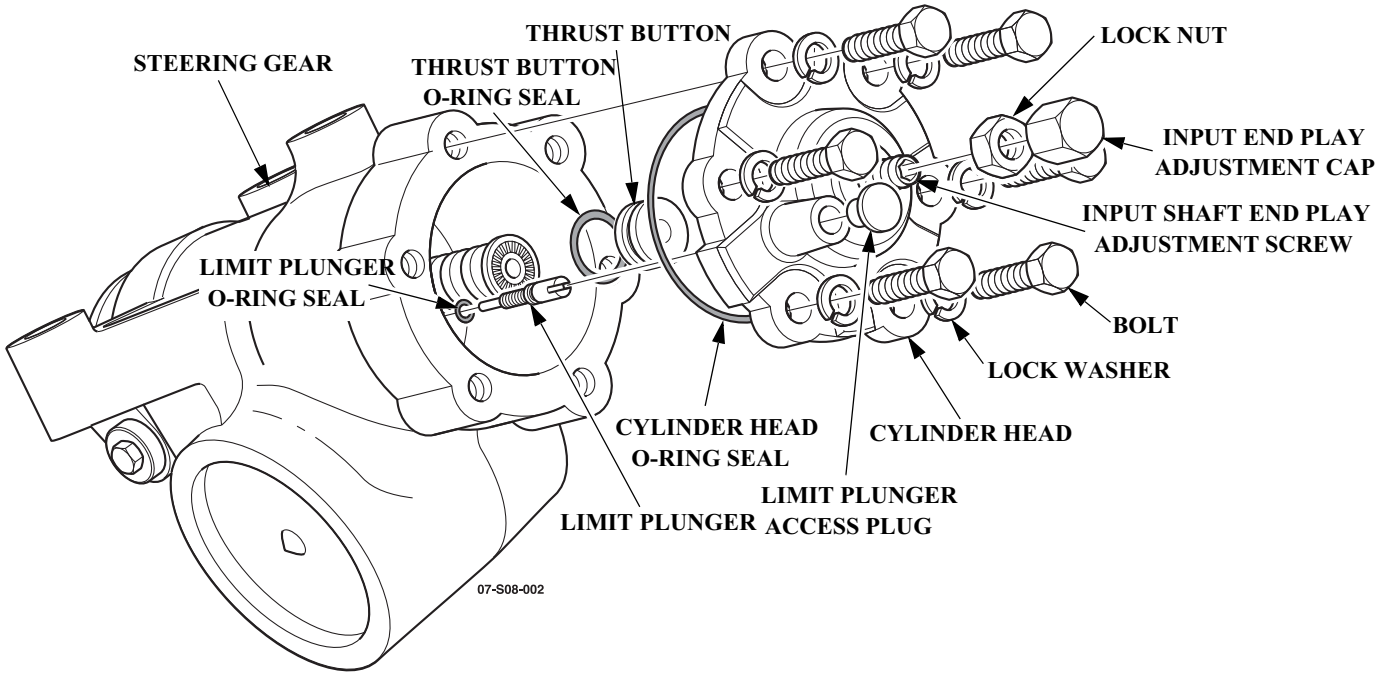


Figure 8-23: Cylinder Head Components

23. Remove the six bolts and lock washers retaining the cylinder head to the steering gear housing and remove the cylinder head.
24. Remove the input shaft end play thrust button by turing the adjustment screw in to push the thrust button out of the cap. Count the number of turns required to push the cap out. After the thrust button is forced out of the cap, back the adjustment screw out one more turn than the number of turns noted to allow clearance for assembly.
25. Remove the cylinder head to housing and thrust button o-ring seals.
26. Clean and inspect the sealing surfaces of the housing, thrust button, and the cylinder head.
27. Lubricate the new o-ring seal with grease and install the o-ring seal on the cylinder head.
28. Lubricate the new o-ring seal with grease and install the o-ring seal on the thrust button.
29. Push the thrust button into the cap with the indentation against the adjustment screw.
30. Install the cylinder head onto the housing, aligning the marks previously made.
31. Secure the cylinder head with the previously removed bolts and lock washers, torque the bolts to 53-64 lb.ft. (72-87 N•m).
32. Counting the number of turns, remove the travel limit plunger from the cylinder head and install a new o-ring onto the plunger and lubricate the o-ring with grease.
33. Install the travel limit plunger, do not install any farther then the previously noted number of turns to ease in final adjustments.

INPUT SHAFT PRELOAD ADJUSTMENT

1. Remove the input shaft adjustment screw cap and loosen the locknut to allow free movement of the screw.
2. With an inch pound torque wrench, tighten the adjustment screw to 100 lb-in. (11 N•m) to preload the bearing.
3. Back off the adjustment screw then retorque the adjustment screw to 30 lb-in. (3 N•m)
4. While holding the adjustment screw in position to prevent movement, tighten the lock nut to 25 lb-ft. (34 N•m).
5. Install the adjustment screw cap and torque to 20 lb-ft. (41 N•m).

INSTALLATION AND SYSTEM BLEEDING

1. Install the steering gear into the vehicle (Refer to section 8).

NOTE: Should The Front Geared Hubs Contact The Stops Under Pressure, Release The Wheel Immediately! Damage To The Steering System May Result From Operating Against The Stops Under Pressure.

2. Refill the steering system and start the engine, gently cycle the steering from side to side without hitting the stops to assist in removing the air from the system. The brake pedal should also be depressed several times to purge any trapped air from the brake hydroboost assembly.
3. After several cycles of the steering and brake system, stop the engine and refill the reservoir as required.
4. Check the adjustment of the vehicle steering stops on the front geared hubs (Refer to section 6).
5. With the vehicle on a smooth level surface, start the vehicle and while in Park, turn the wheel full to the left then right and note the clearance to the steering stops. The steering gear should stop wheel travel with 1/8 inch clearance to the stop. Should the geared hub stop hit the control arm or the clearance be greater than 1/8 inch, the limit plunger requires adjustment.

LIMIT PLUNGER ADJUSTMENT

1. Locate the limit plungers on each end of the steering gear, remove any dust caps to access the plunger ends.
2. Position the steering wheel straight ahead and release the steering wheel.
3. Using a small straight bladed screwdriver, turn the limit plunger in to reduce travel or out to bring the hub closer to the stop. Do not turn the plunger with pressure on the system as damage to the seals may result.
4. After adjusting the plunger turn the wheel full left and right again. Note the clearance to the steering stops and adjust the plungers accordingly to obtain the correct 1/8 inch clearance.
5. After proper clearance is obtained, install any dust caps removed to adjust the plungers.

INTERMEDIATE STEERING SHAFT REPLACEMENT

NOTE: Ensure the front wheels are in the straight-ahead position while removing and installing the intermediate steering shaft.

Removal

1. Remove the close-out panel.
2. Remove the three nuts, six washers, and the three screws from the dust boot (Figure 8-24).
3. Remove the bolt on the intermediate steering shaft yoke at the steering gear.

NOTE: Before performing step 4, put scribe marks showing the position of the yoke relative to the splines.

4. Remove the bolt on the intermediate steering shaft yoke at the steering column and remove the shaft.

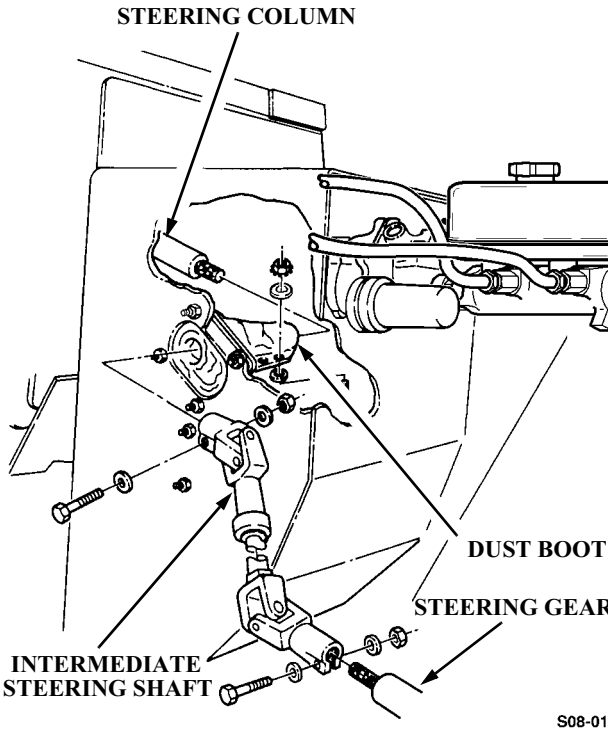


Figure 8-24: Intermediate Steering Shaft Removal

Installation

1. Align the hole in the yoke with the notch on the steering gear splines. Insert the bolt through the yoke and tighten the locknut to 60 lb-ft (81 N•m) (Figure 8-24).
2. Align the scribe marks and slide the yoke onto the steering column splines. Insert the bolt through the yoke and tighten the locknut to 60 lb-ft (81 N•m).
3. Apply silicone spray or equivalent to the end of the steering shaft. Secure the dust boot with three screws, six washers and the three nuts.
4. Lubricate the steering shaft at the universal joints.
5. Install the close-out panel.

INTERMEDIATE STEERING SHAFT DUST BOOT REPLACEMENT

Removal

1. Remove the close-out panel.
2. Remove the three nuts, six washers, and the three screws from the dust boot (Figure 8-25).

NOTE: Before performing step 3, put scribe marks showing the position of the yoke relative to the splines.

3. Remove the bolt on the yoke and pull the intermediate steering shaft from the steering column.
4. Remove the four locknuts, eight washers, four screws, spacer, and the dust boot from the cowl panel and the intermediate steering shaft.

Installation

1. Secure the spacer and the dust boot to the cowl panel with the four screws, eight washers and the four locknuts. Tighten the locknuts to 60 lb-ft (81 N•m) (Figure 8-25).
2. Insert the intermediate steering shaft through the dust boot. Align the scribe marks and slide the yoke onto the steering column splines. Tighten the locknut on the yoke to 60 lb-ft (81 N•m).
3. Apply silicone spray or equivalent to the end of the steering shaft. Install the three screws, six washers, and the three nuts on the dust boot.
4. Install the close-out panel.

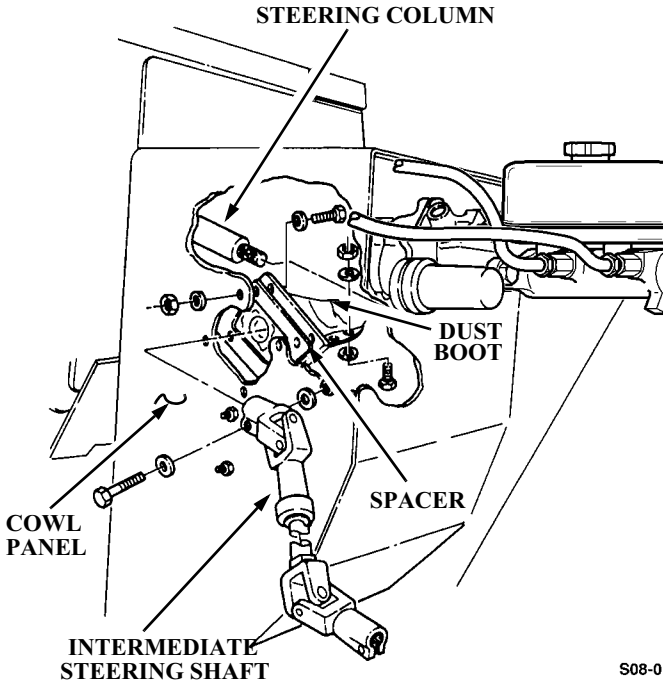


Figure 8-25: Intermediate Steering Shaft Dust Boot Replacement

POWER STEERING PUMP AND PULLEY REPLACEMENT

Removal

1. Disconnect the return lines and the high pressure line from the back of the pump (Figure 8-26).
2. Remove the serpentine belt from the power steering pump pulley.
3. Remove the three bolts holding the mounting bracket to the block.
4. Remove the pump assembly.
5. Using puller J–25034-C or equivalent, remove the pulley from the pump.
6. Remove the three bolts going through the mounting bracket into the front of the pump.

Installation

1. Install the three bolts going through the mounting bracket into the front of the pump.

CAUTION: *In next step, do not attempt to drive the pulley onto the pump shaft with a hammer. The pulley and pump ring will be damaged.*

2. Press the pulley onto the pump using pulley installer J–25033-C or equivalent. The pulley should be flush +/- 0.25 mm (0.010 inch) with the end of the power steering pump shaft.
3. Apply a non-hardening thread sealant to the studs on the back of the pump and secure the support bracket with the two nuts. Tighten the nuts to 45 lb-ft (61 N•m).
4. Maneuver the pump into position behind the power steering bracket.
5. Secure the pump to the mounting bracket with the three bolts.
6. Secure the support bracket to the block with the bolt.
7. Connect the two return lines to the power steering pump.
8. Check the condition of the O-ring seal and connect the high pressure line to the back of pump.
9. Purge the air from the power steering system.
10. Start the engine and check for leaks.

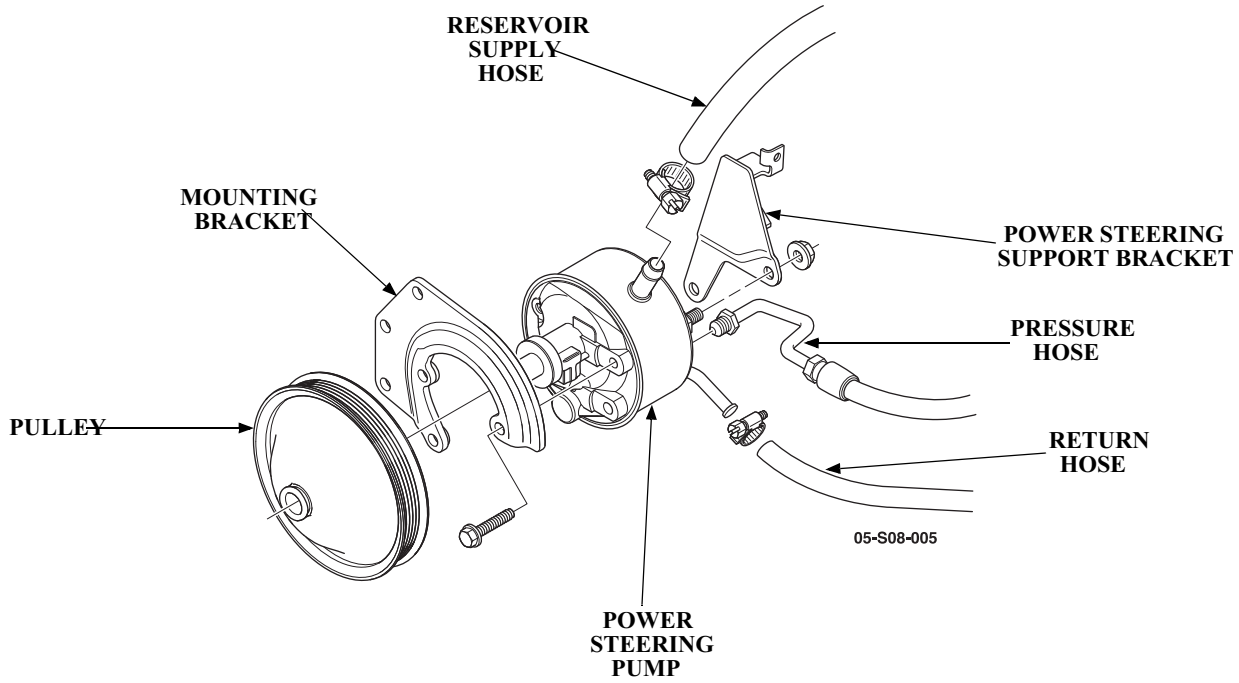


Figure 8-26: Power Steering Pump and Pulley

POWER STEERING HYDRAULIC SYSTEM PRESSURE AND RETURN HOSE REPLACEMENT

NOTE: Removal and installation procedures are basically the same for all hydraulic system pressure and return hoses. This procedure covers the power steering pump to hydro-boost return hose and the steering gear to hydro-boost pressure hose.

Removal

1. Disconnect the return hose from the power steering pump and the hydro-boost.
2. Remove the locknut, washer, bolt and the two clamps from the control valve hose and the return hose.
3. Remove the locknut, two washers and the bolt securing the two clamps and the harness clamp to the power steering line bracket.
4. Disconnect the pressure hose from the hydro-boost and the steering gear and remove the pressure hose. Remove the O-ring seal from the pressure hose. Check the condition of the O-ring seal and replace if necessary (Figure 8-27).

Installation

1. Connect the pressure hose to the steering gear and the hydro-boost (Figure 8-28).
2. Connect the return hose to the power steering pump and the hydro-boost with the two clamps.

3. Install the two clamps on the return hose and the control valve hose. Secure the return hose, control valve hose and the two clamps together with the bolt, washer and the locknut.
4. Install the harness clamp and the two clamps on the power steering line bracket with the bolt, two washers and the locknut.
5. Purge the air from the power steering system. Refer to "Purging Air From the Power Steering System" on page 8–35 .

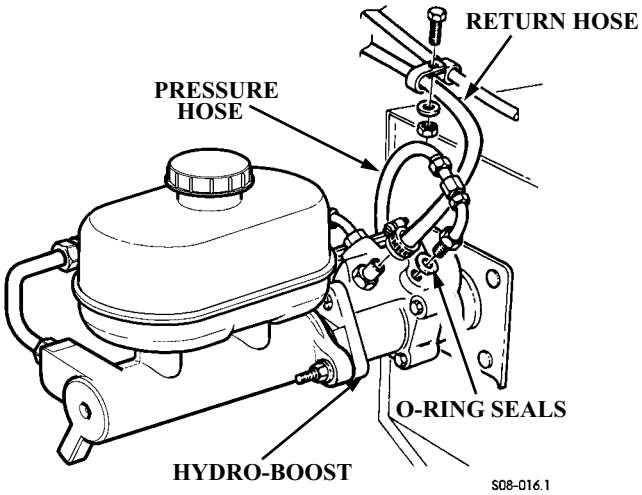


Figure 8-27: Power Steering Hose Replacement at Brake Hydro-Boost

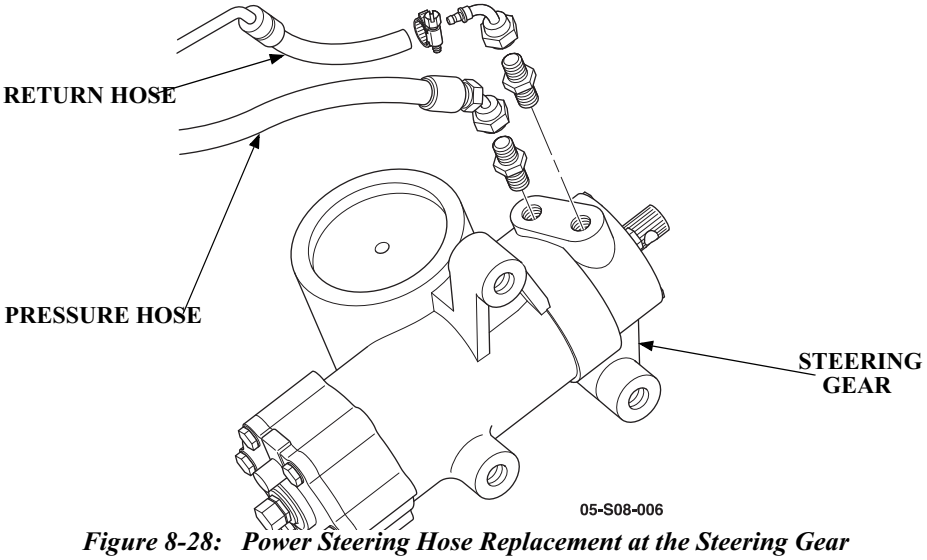


Figure 8-28: Power Steering Hose Replacement at the Steering Gear

POWER STEERING FLUID RESERVOIR REPLACEMENT

Removal

1. Suction the power steering fluid from the reservoir.
2. Loosen the hose clamps and disconnect the power steering hoses from the reservoir (Figure 8-29).
3. Remove the two bolts and washers securing the reservoir to the bracket and remove the reservoir.

Installation

1. Secure the reservoir to the bracket using the two washers and bolts.
2. Secure the two power steering hoses to the reservoir using the hose clamps.
3. Fill the reservoir and purge the air from the power steering system.
4. Start the engine and check for leaks.

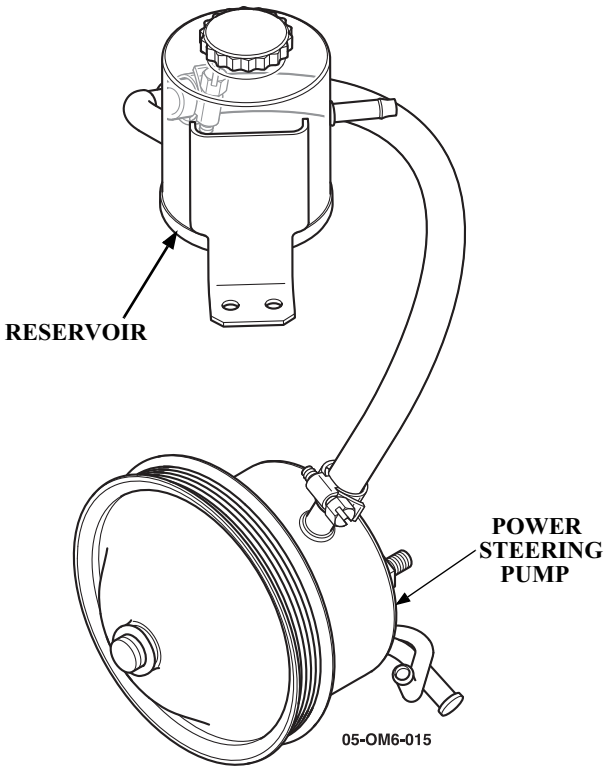


Figure 8-29: Reservoir Replacement

POWER STEERING COOLER AND COOLER HOSE REPLACEMENT

Removal

1. Loosen the clamps and disconnect the two hoses from the cooler, one from the gear box and one from the power steering pump. (Figure 8-30).
2. Remove the hoses through the fender opening.
3. Remove the two bolts and washers from the power steering cooler.
4. Remove the cooler.

Installation

1. Secure the power steering oil cooler with the two bolts (Figure 8-30).
2. Connect the hoses to the cooler and secure with the clamps.
3. Purge the air from the system.

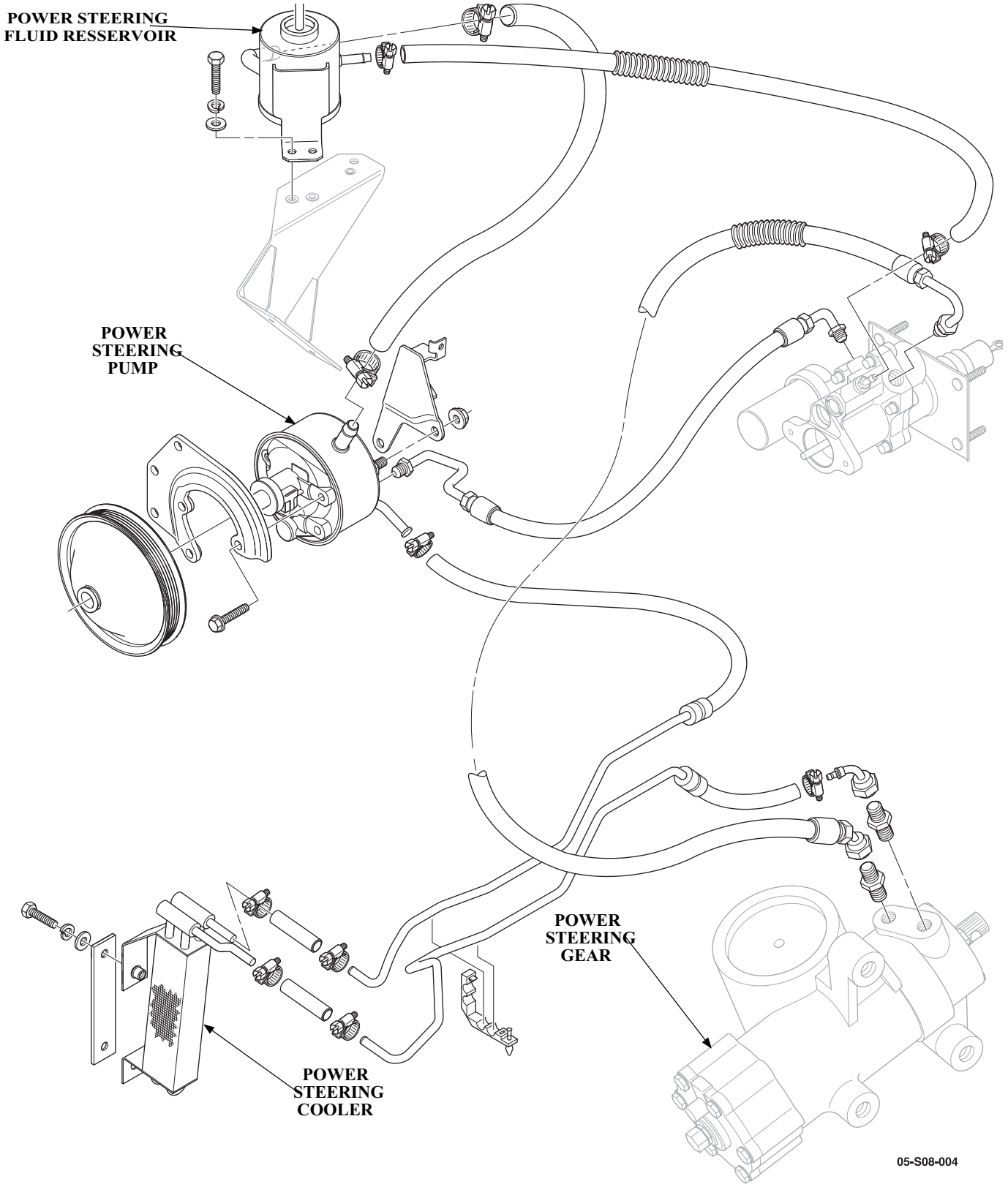


Figure 8-30: Power Steering Cooler and Cooler Hoses

POWER STEERING SYSTEM DIAGNOSIS CHARTS

The diagnosis charts are guidelines to potential system faults. The charts list potential faults in order of probability (most probable to least probable).

While the charts outline common faults, they may not cover all possible problem causes. Inspection and diagnosis with analyzer set J–44721 should be used to confirm a pump or gear problem.

Power Steering Diagnosis Chart - part 1

Problem	Possible Cause	Correction
Poor Return of Steering	1. Tires under-inflated.	1. Inflate to specified pressure.
	2. Lower coupling flange rubbing against the steering gear adjuster plug.	2. Loosen the pinch bolt and assemble properly.
	3. Steering wheel rubbing against directional signal housing.	3. Adjust the steering jacket.
	4. Binding steering linkage, or ball joints.	4. Replace the affected parts.
	5. Steering gear to column misalignment.	5. Align the column.
	6. Tie rod not centralized.	6. Adjust tie rod ends as required.
	7. Lack of lubricant in the suspension ball joints and steering linkage.	7. Lubricate.
	8. Stuck or plugged valve spool.	8. Replace the steering gear.
	9. Improper front wheel alignment.	9. Check and adjust to specifications.
	10. Steering gear adjusted too tightly.	10. Replace the steering gear.
	11. Kink in return hose.	11. Replace the hose.
Steering Wheel Surges or Jerks When Turning With Engine Running Especially During Parking	1. Low oil level in pump.	1. Add power steering fluid as required.
	2. Loose pump drive belt.	2. Adjust bolt.
	3. Sticky flow control valve.	3. Replace pump.
	4. Insufficient pump pressure.	4. Test system with analyzer.
Hard Steering Effort in Both Directions	1. Low tire pressure.	1. Adjust the tire pressure.
	2. Lack of lubricant in suspension or ball joints (Worn/contaminated joints).	2. Lubricate and relubricate at proper intervals or replace joints.
	3. Binding of steering linkage, or ball joints.	3. Replace all affected parts.
	4. Steering gear to column misalignment.	4. Align the steering column.
	5. Pump belt slipping.	5. Adjust belt.
	6. Low fluid level in reservoir.	6. Fill to proper level. Inspect lines and joints for external leakage.
	7. High internal leakage (steering gear or pump).	7. Test system with analyzer.

Power Steering Diagnosis Chart - part 1

Problem	Possible Cause	Correction
	8. Sticky flow control valve.	8. Replace pump.
	9. Steering gear adjusted too tight.	9. Replace the steering gear.
	10. Improper front wheel alignment.	10. Check and adjust to specifications.
Foaming Milky Looking Power Steering Fluid, Low Level and Possible Low Pressure	1. Air in the fluid and loss of fluid due to internal pump leakage causing overflow.	1. Check for leak and correct. Bleed system. Extremely cold temperatures will cause system aeration should the oil level be low. If oil level is correct and pump still foams, remove pump from vehicle and separate reservoir from housing.
	2. Hose or air leakage in reservoir line.	2. Check welsh plug and housing for cracks. If plug is loose or housing is cracked, replace housing.

Power Steering Diagnosis Chart - part 2

Problem	Possible Cause	Correction
"Hiss" Noise	1. Noisy relief valve in the pump.	1. There is some noise in all power steering systems. One of the most common is a hissing sound most evident at standstill parking. "Hiss" is a high frequency noise. The noise is present in every valve and results from high velocity fluid passing valve orifice edges. There is no relationship between this noise and steering performance. "Hiss" may be expected when the steering wheel is at end of travel or when slowly turning at standstill. Do not replace the pump unless "hiss" is extremely loud and continuous. A replacement pump will also exhibit slight noise and is not always a cure for hiss.
Rattle or Chuckle Noise in Steering Gear	1. Gear loose on the frame.	1. Check the gear mounting bolts. Torque the bolts to specifications.
	2. Steering linkage wear, play, looseness.	2. Check linkage pivot points for wear. Replace if necessary.
	3. Pressure hose touching other parts of vehicle.	3. Adjust the hose position. Do not bend tubing by hand.
	4. Loose steering arm.	4. Tighten the steering arm bolt.

Power Steering Diagnosis Chart - part 2

Problem	Possible Cause	Correction
	5. Improper over-center adjustment. A slight rattle may occur on turns because of increased clearance off the "high pint". This is normal and clearance must not be reduced below specified limits to eliminate this slight rattle.	5. Replace the steering gear.
Excessive Wheel Kickback or Loose Steering	1. Air in system.	1. Add oil to the pump reservoir and bleed. Check hose connectors for proper torque.
	2. Steering gear mounting loose.	2. Tighten attaching bolts to specified torque.
	3. Steering linkage joints worn.	3. Replace loose parts.
	4. Front wheel bearings incorrectly adjusted or worn.	4. Adjust the bearings or replace with new parts as necessary.
	5. Steering gear improperly adjusted.	5. Adjust to specifications.
	6. Damaged or worn steering gear.	6. Replace the steering gear.
Vehicle Leads to One Side or the Other	1. Keep in mind the road and wind conditions.	1. Test the vehicle, going in both directions, on a flat road.
	1. Front wheels misaligned.	1. Adjust to specifications.
	2. Unbalanced steering gear valve. If this is the cause, steering effort will be very light in direction of lead and heavy in opposite direction.	2. Replace the steering gear.
	3. Steering shaft binding.	3. Align the column.
Momentary Increase in Effort when Turning the Wheel Quickly to the Right or Left	1. Low oil level in the pump.	1. Add power steering fluid as required.
	2. Pump belt slipping.	2. Adjust belt pressure.
	3. High internal leakage (steering gear or pump).	3. Refer to "Power Steering System Pressure Test" in this section. Repair as needed.

Power Steering Diagnosis Chart - part 3

Problem	Possible Cause	Correction
Low Oil Pressure Due to Restriction in the Hose	1. Check for kinks in hose.	1. Remove the kinks or replace the hose.
	2. Foreign object stuck in the hose.	2. Remove the foreign object or replace the hose.
Low Oil Pressure Due to Steering Gear. Refer to "Power Steering System Test" in this Section.	1. Pressure loss in cylinder due to worn rack piston ring or scored housing bore.	1. Replace the steering gear.
	2. Leakage at the valve rings and valve body to the worm seal.	2. Replace the steering gear.

Power Steering Diagnosis Chart - part 3

Problem	Possible Cause	Correction
	3. Leakage at the valve body or a loose fitting spool.	3. Replace the steering gear.
Low Oil Pressure Due to Steering Pump. Refer to "Power Steering System Test" in this Section.	1. Flow control valve stuck or inoperative. 2. Pressure plate not flat against the cam ring. 3. Extreme wear of cam ring. 4. Scored pressure plate, thrust plate, or rotor. 5. Vanes sticking in rotor slots. 6. Vanes not installed properly. 7. Air in oil. 8. Low oil level. 9. Pump belt slipping. 10. Damaged hoses or steering gear.	1. Replace pump. 2. Replace pump. 3. Replace pump and flush system. 4. Replace pump. Flush the system. 5. Replace pump. 6. Replace pump. 7. Locate source of leak and correct. Bleed the system. 8. Add power steering fluid as required. 9. Adjust belt. 10. Replace as necessary.
Chirp Noise in Steering Pump or Belt Squeal (Particularly Noticeable At Full Wheel Travel and Standstill Parking)	1. Pump belt slipping.	1. Replace belt.
Growl Noise in Steering Pump	1. Excessive back pressure in hoses or steering gear caused by restriction.	1. Locate restriction and correct.
Growl Noise in Steering Pump (Particularly Noticeable Standstill Parking)	1. Scored pressure plates, thrust plate, or rotor. Extreme wear of cam ring.	1. Replace pump and flush system.
Groan Noise in Steering Pump	1. Low oil level. 2. Air in the oil. Poor pressure hose connection.	1. Add power steering fluid as required. 2. Torque the connector. Bleed the system.
Rattle or Knock Noise in Steering Pump	1. Loose pump pulley. 2. Pump vanes sticking in rotor slots. 3. Pressure hose touching other parts of vehicle.	1. Replace pulley or pump. 2. Replace pump. 3. Adjust hose position.
Swish Noise in Steering Pump	1. Faulty flow control valve.	1. Replace pump.
Whine Noise in Steering Pump	1. Pump shaft bearing scored.	1. Replace pump.

PURGING AIR FROM THE POWER STEERING SYSTEM

Air must be bled from the system before pressure testing and anytime the hoses are disconnected or the pump and/or gear is removed for service. Procedure is as follows:

1. All the hose connections must be tight. Loose connections might not leak but could allow air into the system.
2. Switch the ignition off.
3. Turn the steering wheel full left.
4. Top off the reservoir fluid level to “FULL COLD” but do not replace the reservoir filler cap. If fluid was added to the reservoir, allow it to settle for 2-3 minutes before proceeding.
5. Raise and support the vehicle front end. The front tires only have to clear the shop floor.
6. Shift the transmission into Park.
7. With an assistant checking the fluid level and condition, turn the steering wheel lock-to-lock at least 40 times. The engine remains off.
   - Trapped air may cause fluid to overflow. Thoroughly clean any spilled fluid to allow for leak check.
   - Keep the fluid level at “FULL COLD”.
8. While turning the wheel, check the fluid constantly.
   - There should be no bubbles.
   - If there are any bubbles, recheck the connections and repeat step 7.
9. Start the engine. With the engine idling, maintain fluid level. Install the reservoir cap.
10. Return the wheels to the center. Lower the front wheels to the ground.
11. Keep the engine running for two minutes.
12. Continue turning the wheels back and forth until the bubbles no longer appear in fluid.
13. Verify the following conditions:
    - smooth power assist
    - noiseless operation
    - proper fluid level
    - no system leaks
    - proper fluid condition
14. If all conditions apply, the procedure is complete.

POWER STEERING SYSTEM PRESSURE TEST

Power steering system performance can be checked with analyzer set J–44721 and hose fitting adapters J-44721-15. The analyzer checks flow in gallons per minute (gpm) and min/max pressure in psi. Analyzer hose connection is shown in (Figure 8-31). Procedure is as follows.

Pressure Test Procedure

NOTE: The fluid must be at operating temperature.

1. Purge the air from power steering system. Refer to procedure in this section.
2. Position a drain pan under the pump and the gear to catch spilled fluid.
3. Connect J–44721 analyzer hoses to the pump and the gear (Figure 8-31). Use fitting adapters J-44721-15 to connect the hoses to the gear and the pump as needed.
4. Add power steering fluid to the reservoir as required.
5. Shift the transmission into Park.
6. Open the analyzer valve.
7. Start and run the engine at curb idle speed.
8. Note and record the flow rate and the pressure indicated on the analyzer gauge.
   a. If the flow is less than 1.7 gpm (6.4 liters/min.), the pump is faulty.

b. If the pressure is above 230 psi, (1585 kPa), either a hose is restricted or a problem exists within the gear.

c. If the flow is greater than 1.7 gpm and the pressure is less than 230 psi, continue the test.

9. Partially close the analyzer valve, allow pressure to build to 700 psi (4827 kPa), and record the flow rate.
   a. If the flow rate decreases by more than 1 gpm (3.7 L/minute) from the reading in step 8, the pump is at fault.
   b. If the flow rate remains about the same, continue test.
10. Completely close and partially open the analyzer valve three times in succession. Note and record the maximum pressures each time.

CAUTION: *Do not close the analyzer valve for more than 3-4 seconds at a time. Longer periods will result in rapid fluid overheat and pump damage.*

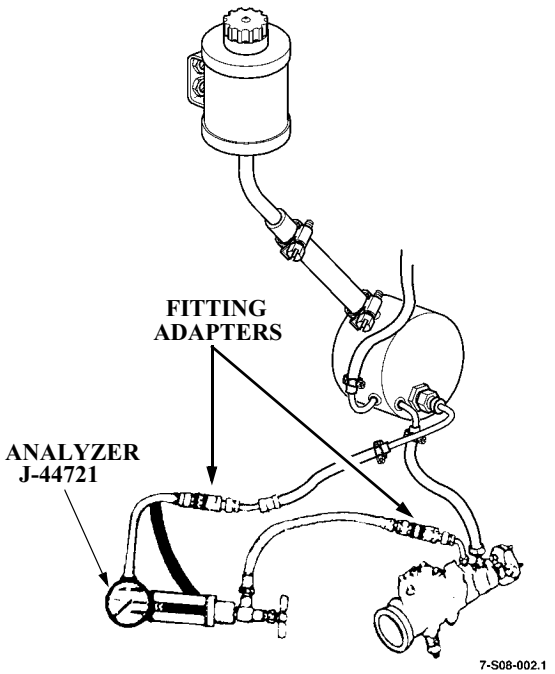


Figure 8-31: Analyzer Pressure Test Connections

11. If the pump maximum pressures recorded in step 10 were less than 1200 psi (8274 kPa), the pump is at fault. However, if the pressures are at, or above the specified limit, continue with the test.
12. Increase the engine speed to 1500 rpm and record the flow rate.
   a. If the flow rate remains within 1 gpm of flow recorded in step 8, continue the test.
   b. If the flow rate drops by more than 1 gpm (3.7L/ minute), the pump control valve is faulty.
13. Turn the steering wheel lightly against each of the stops and record the maximum pressure.
   a. If the pressure at each of the stops is about the same as recorded in step 10, and the flow drops to 0.5 gpm (1.85 L/min.), the internal limit plungers must be adjusted. These limit plungers act as a pressure relief just prior to system contact with the mechanical stops.
14. Turn the steering wheel to the right, release it., and observe the analyzer gauge. Then turn the wheel to the left, release it, and observe the gauge again.
   a. If the gauge needle indicates normal pressure then snaps back as the wheel is released. Continue the test.
   b. If the gauge indicates normal pressure but the needle is slow to return when the wheel is released, the steering gear valve body or the spool is sticking. A overhaul will be required to correct the problem.
15. If the gear and the pump test OK but a problem still exists, check for fluid contamination. Draw off a sample with a suction gun and empty the sample in a glass container. Look for burned fluid, foreign material, fluid layering (fluid separates into two layers), foreign material/metal particles in the fluid. Any of these conditions will cause gear and pump problems. Flushing the system with new fluid may correct the problem.

16. If the fluid condition is OK but a problem still exists, a problem may exist in the steering linkage, tires/wheels, or suspension part. Further diagnosis will be required.

POWER STEERING SYSTEM FLUSHING

The power steering system can be flushed but only when the fluid does not contain metal particles, foreign material, or debris from a gear or pump failure. Flushing is recommended only under the following circumstances:

- incorrect fluid added to system
- system filled with incorrect fluid
- water in the fluid
- burned, overheated fluid

Flushing Procedure

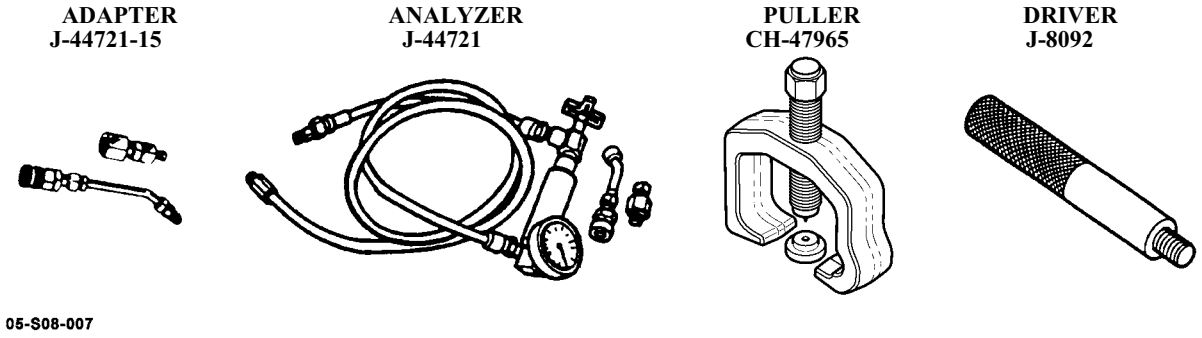
1. Raise the front wheels just enough for them to turn freely.
2. Disconnect the fluid return line at the pump. Then plug the pump return port with a rubber cap and the hose clamp.
3. Position and secure the pump return line in a drain pan.
4. Have a container of fresh power steering fluid handy. The pump reservoir will need refilling as the old fluid is pumped into the drain pan.
5. Start and run the engine at curb idle speed.
6. Have a helper slowly turn the steering wheel back and forth about 3/4 turn in each direction.
7. Continue the procedure until only the fresh fluid comes out of the return line.
8. Stop the engine, reconnect the pump return line, and add power steering fluid as needed.
9. Purge the air from the system. Refer to the procedure in this section.
10. Stop the engine and check the fluid level and condition. Repeat the flushing procedure if any old fluid is still evident in reservoir fluid.

Steering Pump Flow Rates and Operating Pressures

Minimum Flow Rate In Gallons/Liters Per Minute =	1.7gpm 6.4 liters/min) @ 465 rpm
Maximum Flow Rate In Gallons/Liters Per Minute =	3.5 to 3.9 gpm (13.2 to 14.7 liters/min) @ 1500 rpm
Minimum Pump Output Pressure	1200 psi (8274 kPa)
Maximum Pump Output Pressure:	1575 psi (10859 kPa)

NOTE: The pump output pressures are controlled by the pump relief valve setting

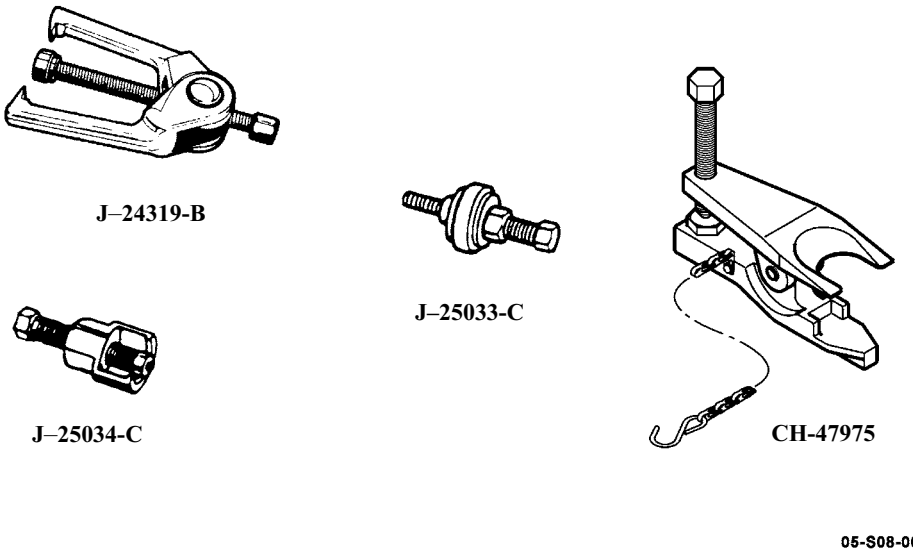
ESSENTIAL TOOLS



Tool	Description
J-44721-15	Adapter Fittings (used with J–44721)
CH-47965	Puller, Pitman Arm
J–44721	Power Steering System Analyzer
J–8092	Universal Driver Handle

Procure from Kent-Moore.

SPECIAL TOOLS



Tool No.	Description
J–24319-B	Universal Steering Linkage Puller
J–25033-C	Pump Pulley Installer
J–25034-C	Pump Pulley Remover
CH-47975	Steering Linkage Separator

Procure from Kent-Moore.

Section 9 Axles, Suspension and Frame

TABLE OF CONTENTS

Axles 9-3–9-38

- Assembly and Differential 9-3
  - Assembly Repair 9-10
  - Assembly Replacement , Front 9-8
  - Assembly Replacement , Rear 9-10
  - Axle Assembly Repair
    - Pinion Depth Setting 9-17
  - Cover Service 9-6
  - ELockerTM (Option) Normal Operation 9-3
  - General Information 9-3
    - Specifications 9-3
  - Output Shaft Seal Replacement 9-6
  - Pinion Seal Replacement 9-7
  - Vent Line Replacement 9-31
- Halfshaft
  - Boot Replacement 9-32
- Propeller Shaft
  - Front 9-35
  - Rear 9-37
  - U-Joint Replacement 9-38

Driveline Protection

- Front Shield Replacement 9-80
- Intermediate Shield Replacement 9-81
- Rear Shield Replacement 9-83
- Skid Plate Replacement 9-79
- Transfer Case Shield Replacement 9-82

Frame 9-73–9-110

- Airlift Brackets
  - Left 9-87
  - Right 9-88
- Axle Support and Side Mounting Brackets 9-100
- Brushguard 9-78
- Bumper
  - Front Bumper and Towing Brackets 9-83
  - Front Bumper Mounting Bracket 9-85
  - Rear Bumper Outer Mounting Bracket and Tie Down Bracket 9-109
- Control Arm Bracket, Upper Rear 9-98
- Crossmember, Front, Front Suspension 9-101, 9-105
- Crossmember, Rear, Front Suspension 9-104
- Engine Mount Bracket
  - Left 9-92
  - Right 9-93
- Frame Extension Replacement 9-86
- Front Body Mount Bracket
  - Right 9-94
- Front Suspension
  - Brace Replacement 9-89



Inspection 9-73
Intermediate Body Mount Bracket
Left 9-97
Right 9-96
Lifting Shackle 9-109
Radiator Front Mount Bracket 9-86
Rear Bumper 9-108
Rear Suspension Rear Crossmember 9-107
Repairs 9-77
Splash Shield Support Bracket 9-91
Tiedown Bracket
Rear-Front 9-100
Rear-Rear 9-98
Transmission Crossmember Support 9-95
Transmission Mount Crossmember 9-94
Transmission Mount Replacement 9-95

Suspension System 9-39–9-72
Ball Joint Replacement
Lower 9-65
Upper 9-63
Coil Spring 9-70
Control Arm Replacement
Bushing 9-67
Lower 9-68
Upper 9-65
Frame Extension Replacement 9-86
Geared Hub 9-40
Input Seal Replacement 9-44
Repair 9-46
Side Cover Replacement 9-44
Spindle Bearing Adjustment 9-57
Spindle Seal Replacement 9-54
Spindle Stud Replacement 9-60
Vent Line Replacement 9-60
General Description 9-39
Specifications 9-39
Radius Rod 9-72
Shock Absorber 9-71
Stabilizer Bar 9-61
Link Replacement 9-62

Tools
Essential 9-111
Special 9-112

AXLE ASSEMBLY AND DIFFERENTIAL

General Information

The H1 standard differential is a ZEXEL Torsen® II with a 2.56:1 ring and pinion ratio. Both front and rear axle housings contain this differential. The Torsen II differential provides full time differentiation, full time maximum traction and "Torque and Load Sensing" capabilities. These features provide improved handling, steering and enhanced off-road mobility.

The H1 optional ELocker™ differential is housed in the same axle assembly and has the same ratio of 2.56:1. The main difference is the drivers ability to "Lock" the differential electronically before entering an obstacle.

Specifications

Standard Differential: Torsen II

Lubrication	75/90 Synthetic Gear Oil
Ratio:	2.56:1
Torque Bias:	2.3:1

Optional Differential: ELocker

Lubrication:	75/90 Synthetic Gear Oil
Ratio:	2.56:1

General Diagnostics

PROBLEM	POTENTIAL CAUSE	CORRECTION
CLUNKING	1. Broken ring or pinion tooth 2. Worn pinion bearing 3. Worn carrier bearing 4. Excessive backlash	1. Replace ring and pinion 2. Replace pinion bearing 3. Replace carrier bearing 4. Inspect and adjust backlash
WHINING	1. Mis adjusted or worn carrier bearing 2. Mis adjusted or worn pinion bearing 3. Improper ring to pinion interface	1. Inspect, adjust and/or replace the carrier bearing 2. Inspect, adjust and/or replace the pinion bearings 3. Set the ring to pinion interface
VIBRATION at low speeds when turning	Improper lubrication or lack of friction modifier	Replace the lubrication and add friction modifier as needed (*Torsen differentials)*

ELocker™ (Option) Normal Operation

To lock the rear differential the driver must first place the transfer case in "L" low range. With the vehicle speed below 3 mph the ELocker switch must be pressed "ON". This will cause the module to command the ELocker activation.

The front differential coil will only lock when the rear has met suitable conditions and is engaged. Axle engagement is represented with a solid illumination of the light on the corresponding switch.

If the coil engagement is prohibited due to any of a number of reasons (excessive vehicle speed, "L" low range not selected, mechanical problems etc.) the switch mounted light will flash. The light will continue to flash for 15 seconds, if the criterion to engage the ELocker is not met in this time the lock request will be discarded.

The front differential coil will only remain engaged for a three minute time period. At 2.5 minutes the indicator light on the instrument panel will begin to flash. If the switch is not activated within 30 seconds of the flashing indicator light, the front differential will unlock. If the rear differential is unlocked for any reason, the front ELocker will be commanded to unlock.

Either differential coil can be disengaged by pressing the "OFF" side of the operator switch and releasing it (Figure 9-1) . If the ELocker module sees that the vehicle has been shift.ed out of "L" low range or if the vehicle has been turned off, the module will automatically release the front and rear differential coil.

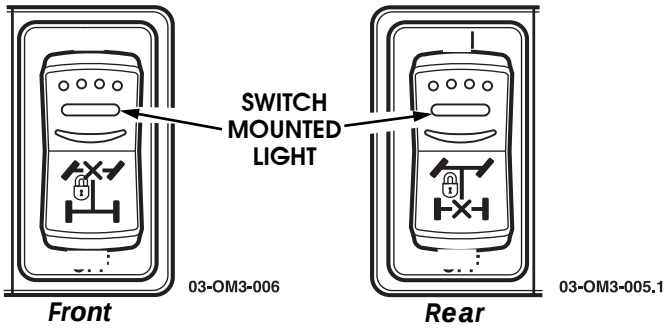


Figure 9-1: ELocker Switches

Diagnostic Trouble Codes

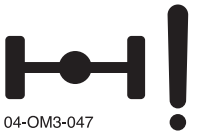


Figure 9-2: ELocker Warning Light

Codes

Codes are retrieved using flash technology. When activated, the locker warning light (Figure 9-2) on the coolant/fuel module will flash a series of pulses. These pulses are used to determine which code is present in the ELocker module memory.

Two types of codes can be retrieved from the ELocker module.

Configuration code: Two-digit blink codes that indicate the number of coils and hall effect sensors present in the system and where these devices are located. These codes can be retrieved by pressing the "ON" side of either operator switch and holding for 10 seconds before releasing. Trucks equipped with a rear ELocker only will have configuration code 3-1, if both front and rear are present the code will be 4-1. The configuration code will be followed by the software version.

Fault Codes are also two-digit blink codes that indicate a problem that the ELocker module has detected. These codes can be retrieved by pressing the "OFF" side of either operator switch and holding for 10 seconds before releasing. Codes are listed below.

Erasing Fault Codes is accomplished by performing the configuration code retrieval procedure.

ELocker™ Fault Codes

Front	Rear	General	Time to Log	Description
1-1	2-1		300 mSec	Coil shorted to ground or short to voltage
1-2	2-2		60 Sec.	Coil open or short to ground
1-3	2-3		60 Sec.	Operator switch stuck "ON"
1-4	2-4		60 Sec.	Operator switch stuck "OFF"
		3-1	60 Sec.	Transfer case range switch shorted to ground
		3-2	60 Sec.	Battery not connected
		3-3	60 Sec.	Low battery voltage
		4-4	60 Sec.	No trouble found

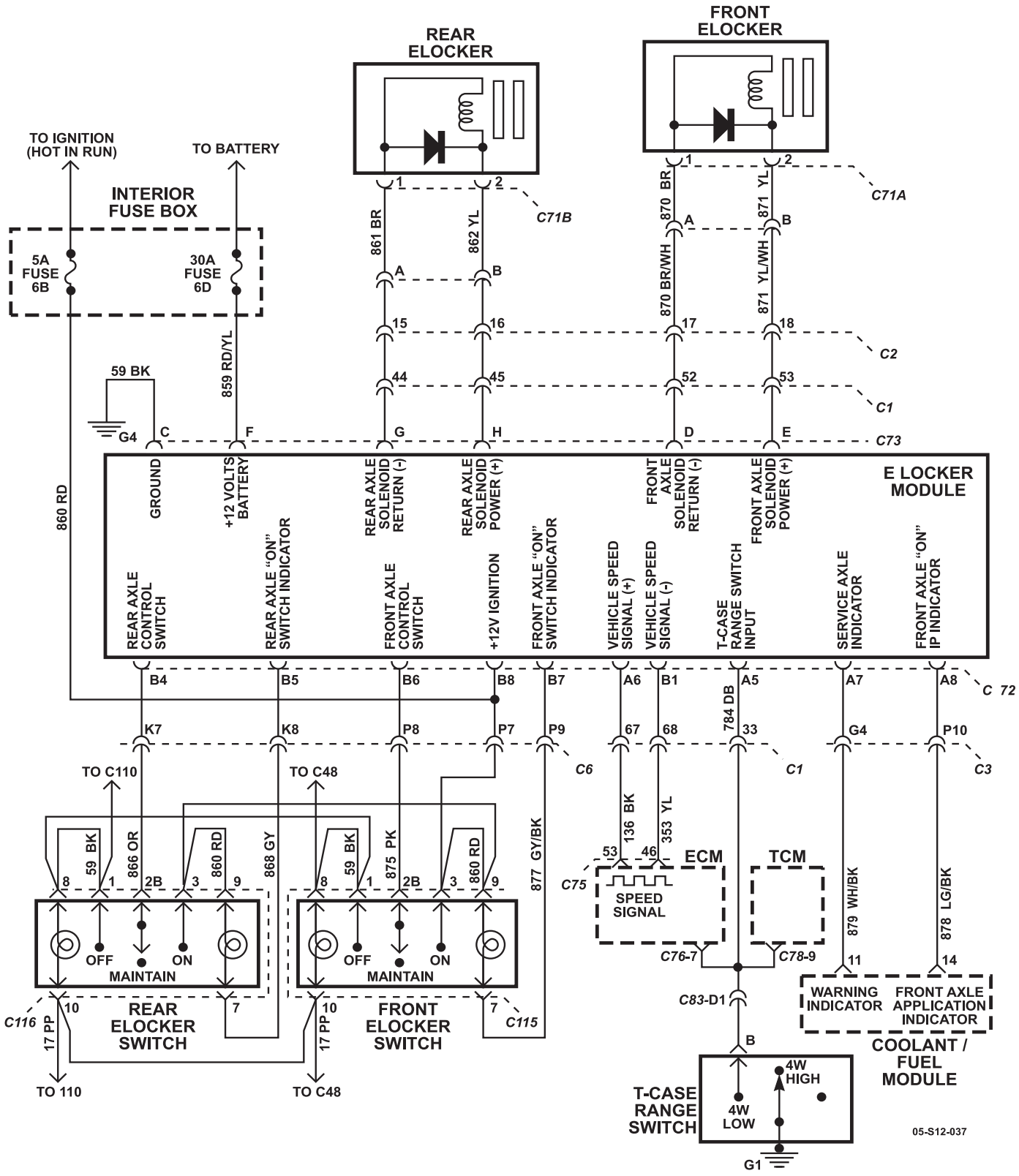


Figure 9-3: ELocker Circuit

Cover Service

Removal

1. Remove the drain plug from the axle assembly and drain the axle assembly (Figure 9-4).
2. Remove the twelve bolts and cover from the axle assembly.

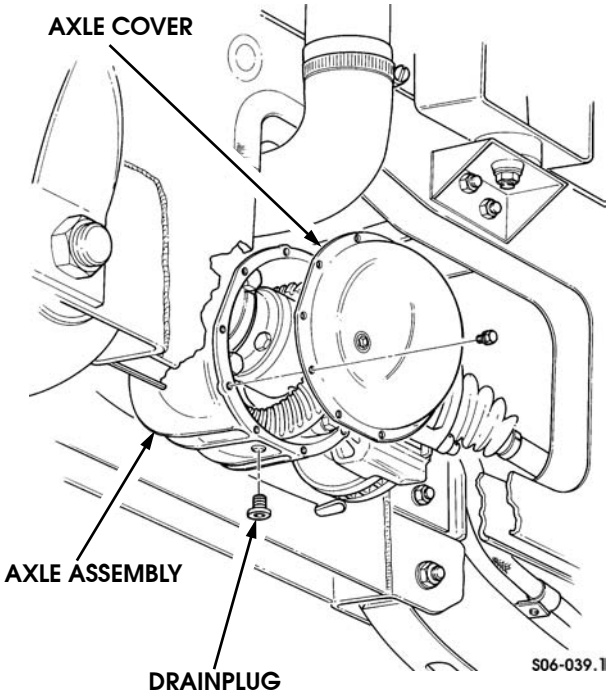


Figure 9-4: Axle Assembly Cover Service

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage, and replace if necessary.

1. Clean the axle assembly cover, bolts, and the axle assembly with solvent (Figure 9-4).
2. Inspect the axle assembly cover for cracks, wear or breaks.

Installation

1. Apply RTV sealant to the cover sealing surface and secure the cover to the axle assembly with the twelve bolts. Tighten the bolts to 16 lb-ft. (22 N•m).
2. Thread the drain plug into the axle assembly and tighten to 13-18 lb-ft. (18-25 N•m) (Figure 9-4).
3. Fill the axle assembly to the proper oil level (Refer to section 1).

Output Shaft Seal Replacement

Removal

1. Remove the brake caliper and the yoke from the caliper adapter (disconnect the park brake cable from the rear calipers) and support the caliper to the side being careful not to kink the brake line.
2. Disconnect the halfshaft at the axle flange and swing it off to the side.
3. Remove the brake rotor.
4. Remove the axle output flange retaining nut and the flange.
5. Support the axle assembly, disconnect and move the axle assembly support bracket over to gain access to the output seal.
6. Remove the output shaft seal from the axle (Figure 9-5).

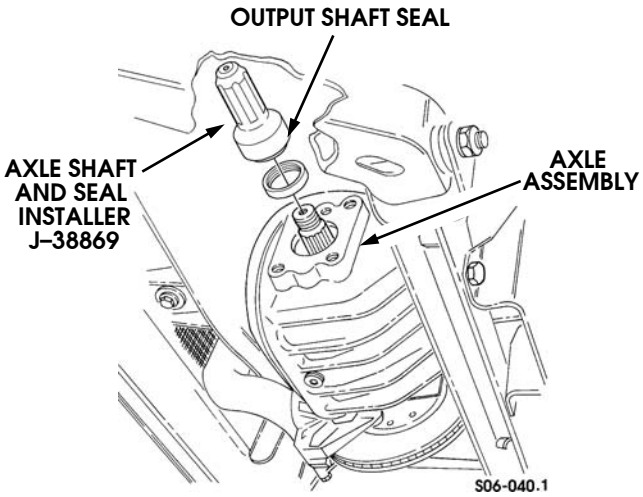


Figure 9-5: Axle Output Shaft Seal Replacement

Installation

1. Using seal installer J–38869, install the output shaft seal in the axle assembly (Figure 9-5).
2. Install the axle assembly support bracket.
3. Install the axle output shaft flange and the nut using Loctite 242 (or equivalent) and torque to 166-196 lb-ft. (224-265 N.m).
4. Install the brake rotor and the halfshaft. Use the bolts with pre applied Loctite or the original bolts with Loctite 272 (or equivalent), cam-lock washers and torque to 57 lb-ft. (77 N.m).
5. Install the brake caliper and the yoke using Loctite 272 (or equivalent) (connect the park brake cable on the rear calipers) and torque to 40 lb ft. (54 N.m).

Pinion Seal Replacement

NOTE: Removal and installation procedures for pinion seals are basically the same for front and rear axle assemblies. This procedure covers the rear axle assembly pinion seal.

Removal

1. Remove the six bolts, cam-lock washers, and the halfshaft from each output flange rotor.
2. Remove the four bolts, two straps, and the rear propeller shaft. from the pinion yoke (Figure 9-6).
3. Using a lb-in. torque wrench, measure the torque required to rotate the pinion and record the measurement.
4. Count and record the number of exposed threads on the end of the pinion and mark the locknut and the pinion for assembly.
5. Remove the locknut and the pinion yoke from the pinion.
6. Remove the pinion seal from the pinion.

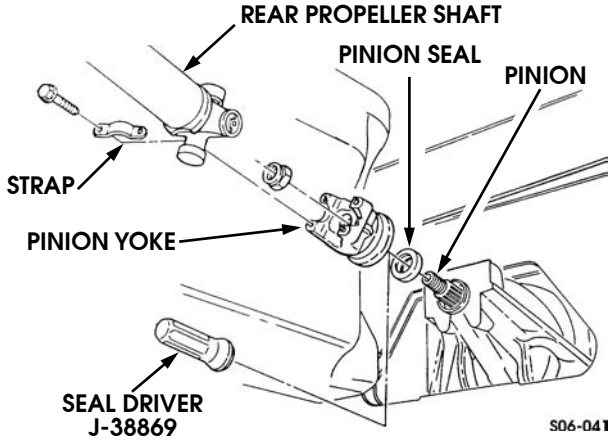


Figure 9-6: Pinion Seal Replacement

Installation

1. Using a yoke seal installer J–38869, install the pinion seal on the pinion (Figure 9-6).
2. Secure the pinion yoke to the pinion with the locknut.
3. Tighten the locknut to the original position.
4. Tighten the locknut in small increments, until the torque required to rotate the pinion exceeds the original measurement by 2 lb-in (0.2 N•m).
5. Secure the rear propeller shaft. to the pinion yoke with the four bolts and the two straps. Tighten the bolts to 27 lb-ft. (37 N•m).
6. Apply Loctite 272 to the halfshaft. mounting bolts.
7. Secure the halfshaft to each output flange and the rotor with the twelve cam-lock washers and the six bolts. Tighten to 57 lb-ft. (77 N•m).

Front Axle Assembly Replacement

Removal

CAUTION: *Due to a torque bias ratio change, axle assemblies from previous model year vehicles must not be mixed with the current assemblies.*

1. Remove the brake callipers and rotors (Refer to section 7).
2. Remove the drain plug from the axle assembly. Allow the oil to drain and reinstall the drain plug.
3. Remove the four bolts and the front propeller shaft from the pinion yoke.

WARNING: Axle assembly must be supported during removal and installation. Failure to do this may cause personal injury or damage to equipment.

NOTE: If the axle assembly is being reused and not replaced it is NOT necessary to remove the output flanges or the caliper support bracket assemblies

4. Remove the two output flanges and the two washer seals on the axle assembly.
5. Support the axle assembly.
6. Remove the two bolts and washers securing the axle assembly to the upper mounting bracket.
7. Remove the two bolts and nuts from the caliper support bracket assemblies.
8. Lower the axle assembly slightly and disconnect the vent line from the axle assembly.
9. Remove the axle assembly.
10. Remove the eight bolts and the two brake caliper support bracket assemblies from the axle assembly.

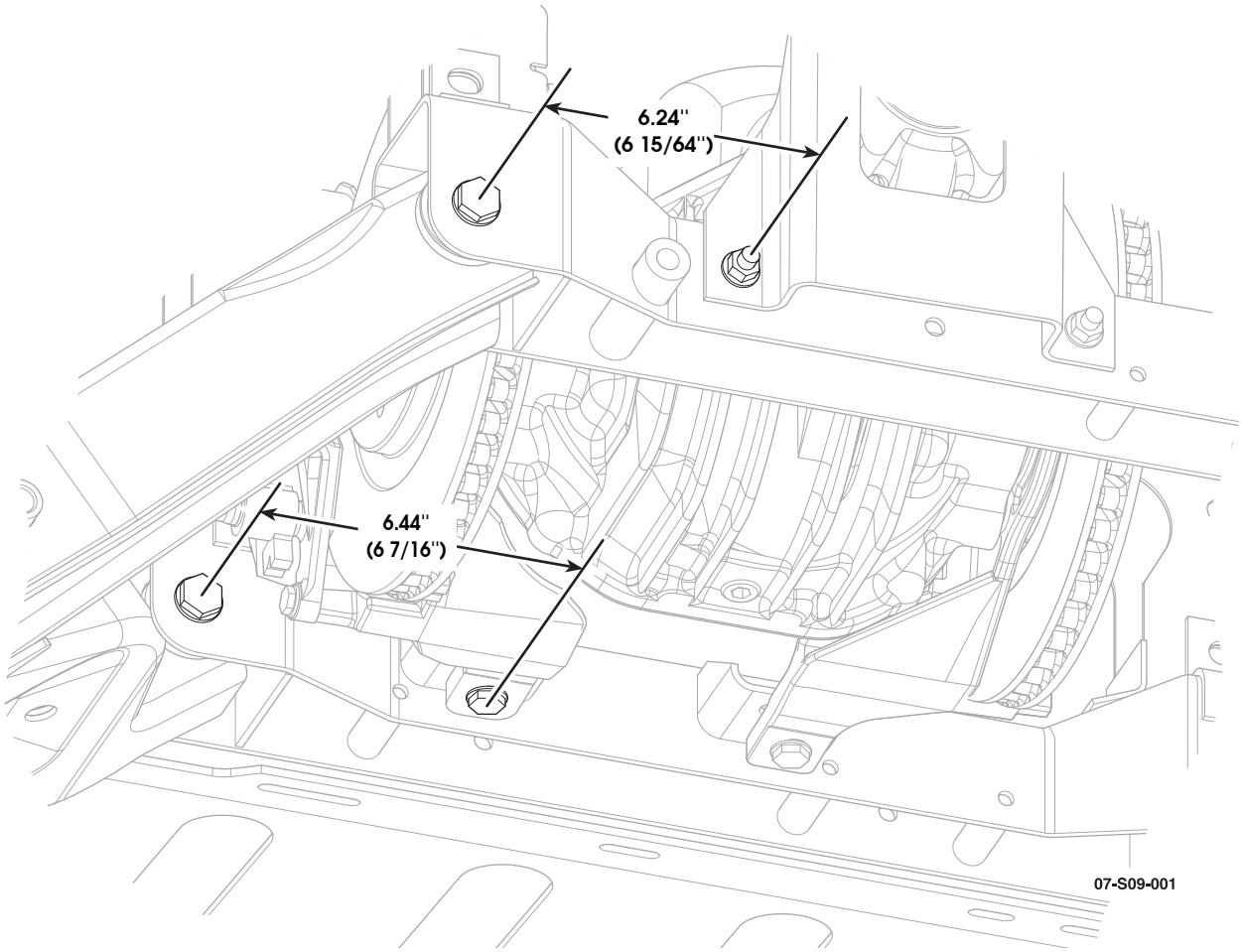


Figure 9-7: Front Axle Location

Front Axle Installation

1. Apply Loctite 272 (or equivalent) thread-locking compound to the axle assembly tapped holes. Secure the two brake caliper adapters to the axle assembly with the eight bolts. Tighten the bolts to 125-150 lb-ft. (169-203 N•m) (Figure 9-8).
2. Raise the axle assembly into place and connect the vent line.

NOTE: Positioning of the front axle is important, refer to front axle location (Figure 9-7).

3. Apply Loctite 272 (or equivalent) thread-locking compound to the tapped holes of the upper mounting point. Install the two washers, bolts and the axle assembly to the mounting bracket and torque to 125-150 lb-ft. (169-203 N•m).
4. Install the lower mounting bolts, nuts and washers and torque to 125-150 lb-ft. (169-203 N•m).
5. Secure the two output flanges and the two washer seals to the axle assembly with the two locknuts. Tighten the locknuts to 165-195 lb-ft. (224-264 N•m).
6. Install the propeller shaft at the transfer case (Figure 9-7).
7. Secure the propeller shaft to the pinion yoke with the four bolts and the two straps. Tighten the bolts to 12 lb-ft. (16 N•m) (Figure 9-7).
8. Install the service brake rotors (Refer to section 7).
9. Fill the axle assembly to the proper oil level (Refer to section 1).

Rear Axle Removal

CAUTION: *Due to a torque bias ratio change, axle assemblies from previous model year vehicles must not be mixed with the current assemblies.*

1. Remove the service brake rotors (Section 7).
2. Remove the drainplug from the axle assembly. Allow the oil to drain and install the drainplug (Figure 9-8).

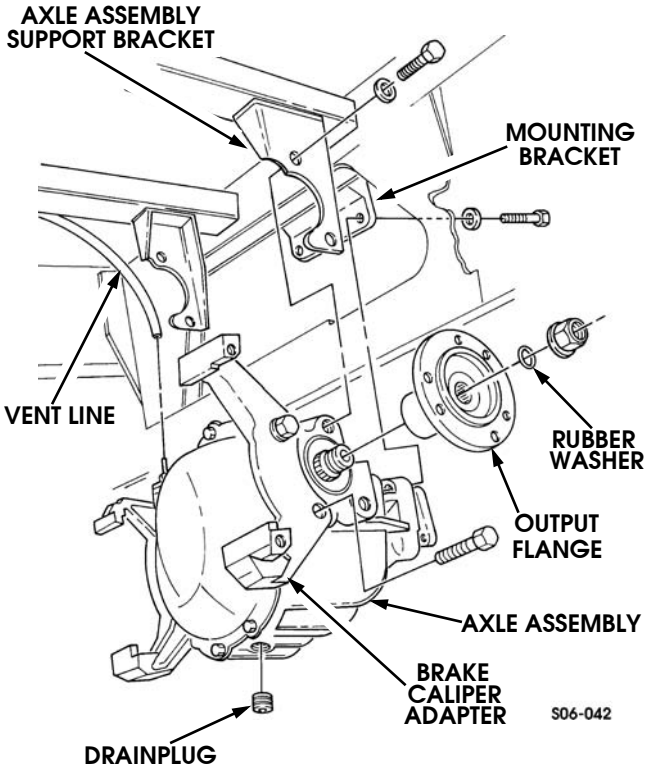


Figure 9-8: Rear Axle Assembly Mounting

3. Remove the four bolts, two straps, and the rear propeller shaft from the pinion yoke.
4. Remove the rear propeller shaft from the transfer case (Figure 9-9).
5. Remove the two bolts and washers securing the axle assembly to the mounting bracket (Figure 9-8).

NOTE: If the axle assembly is being reused and not replaced it is NOT necessary to remove the output flanges or the caliper support bracket assemblies.

6. Remove the two locknuts, four O-ring seals and the two output flanges from the axle assembly. Discard the locknuts and the O-ring seals.

WARNING: Axle assembly must be supported during removal and installation. Failure to do this may cause personal injury or damage to equipment.

7. Support the axle assembly.
8. Remove the four bolts and washers securing the axle assembly to the side mounting brackets.
9. Lower the axle assembly slightly and disconnect the vent line from the axle assembly.
10. Remove the axle assembly.
11. Remove the four bolts and the two brake caliper adapters from the axle assembly.

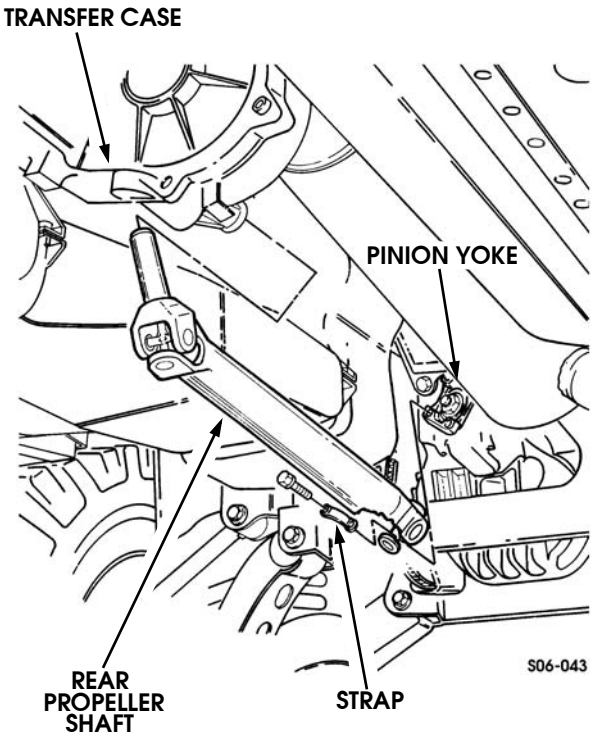


Figure 9-9: Rear Propeller Shaft Removal

Rear Axle Installation

1. Raise the axle assembly into place and connect the vent line.

NOTE: Washers are required when securing the rear axle assembly to the mounting bracket.

2. Apply Loctite 272 (or equivalent) thread-locking compound to the tapped holes of the upper mounting point. Install the two washers, bolts and the axle assembly to the mounting bracket and torque to 125-150 lb-ft. (169-203 N•m).
3. Install the lower mounting bolts, nuts and washers and torque to 125-150 lb-ft. (169-203 N•m).
4. Secure the two output flanges and the two washer seals to the axle assembly with the two locknuts. Tighten the locknuts to 165-195 lb-ft. (224-264 N•m).
5. Install the rear propeller shaft in the transfer case Figure 9-9.
6. Secure the rear propeller shaft to the pinion yoke with the four bolts and the two straps. Tighten the bolts to 12 lb-ft. (16 N•m) Figure 9-9.
7. Install the service brake rotors (Refer to section 7).
8. Fill the axle assembly to the proper oil level (Refer to section 1).

Axle Assembly Repair

CAUTION: *Due to a torque bias ratio change, differentials from previous model year vehicles must not be mixed with the current assemblies.*

Disassembly

1. Remove the axle assembly.
2. Loosen the locknut on the output shaft assembly (Figure 9-10).

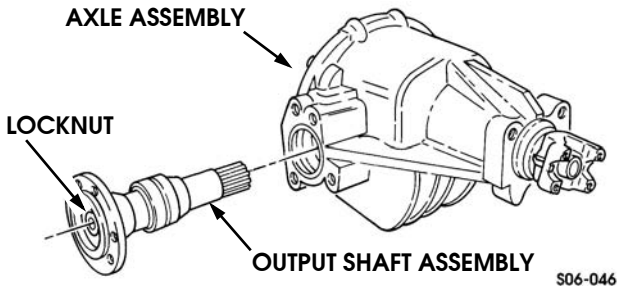


Figure 9-10: Output Shaft Assembly Removal

3. Using a slide hammer, remove the output shaft assembly from the axle assembly.
4. Remove the locknut, seal washer, output flange and the output shaft seal from the output shaft Discard the seal washer, output shaft seal and the locknut (Figure 9-11).

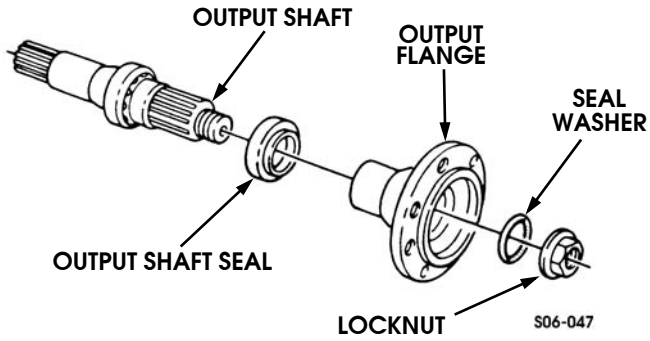


Figure 9-11: Output Shaft Assembly Breakdown

5. Repeat steps 2 through 4 for the opposite side.
6. Secure the two axle holding fixture adapters to the housing with the four bolts. Place the housing in the holding stand (Figure 9-12).

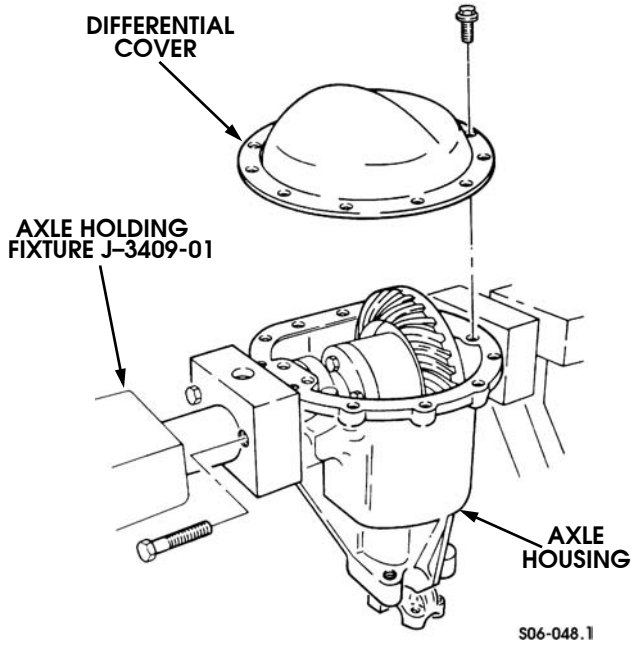


Figure 9-12: Axle Mounted In Holding Fixture

7. Position the housing so the cover faces up. Remove the twelve bolts and the cover from the housing (Figure 9-12).
8. Mark the bearing caps and the housing for assembly and remove the bearing caps (Figure 9-13).

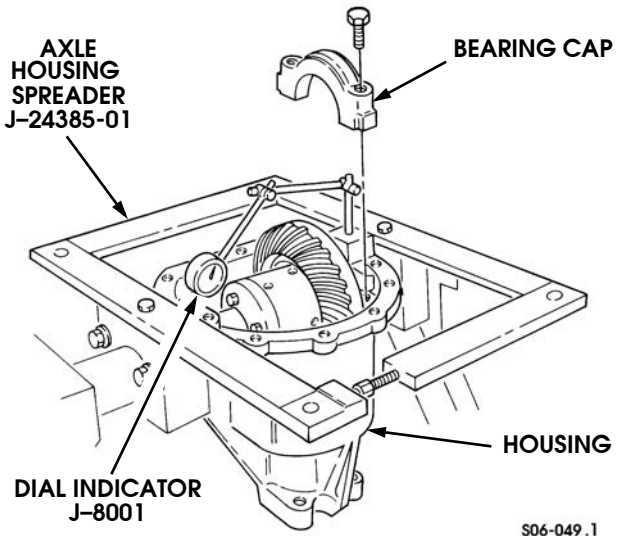


Figure 9-13: Housing Spreader Mounting

9. Install the axle housing spreader J–3409-01 into the holes in the axle holding fixture adapters and install the dial indicator J–8001 to read from each end of the housing as shown. Then set the dial indicator at 0.020 in. (0.5 mm).

CAUTION: *Over-tightening of the axle housing spreader will damage the axle housing.*

10. Spread the housing 0.010 in. (0.25 mm) and remove the dial indicator.
11. Remove the differential assembly, two bearing cups, and the shims from the housing (Figure 9-14). Tag the bearing shims and the bearing cups for assembly.

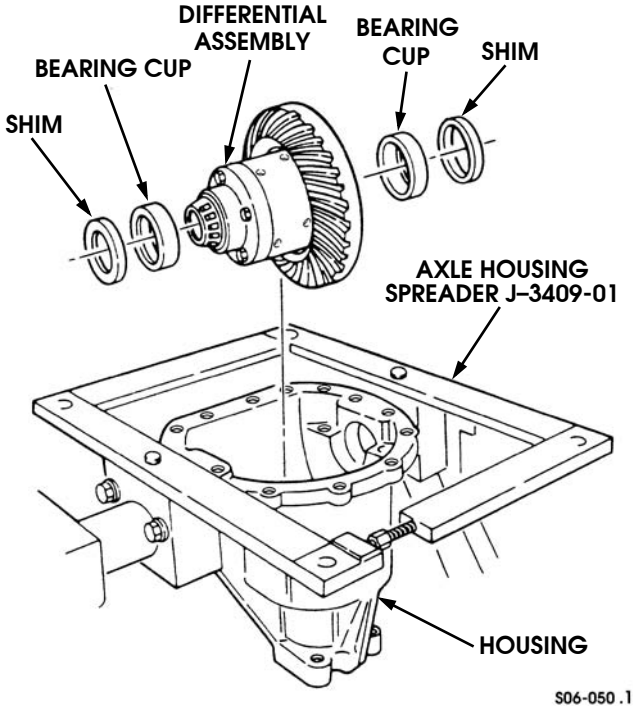


Figure 9-14: Differential Assembly

12. Relieve the pressure on the axle housing spreader and remove from the housing.

CAUTION: *To avoid damage, do not chisel or wedge the ring gear from the axle assembly.*

13. Remove the eight bolts and ring gear from the differential assembly (Figure 9-15).

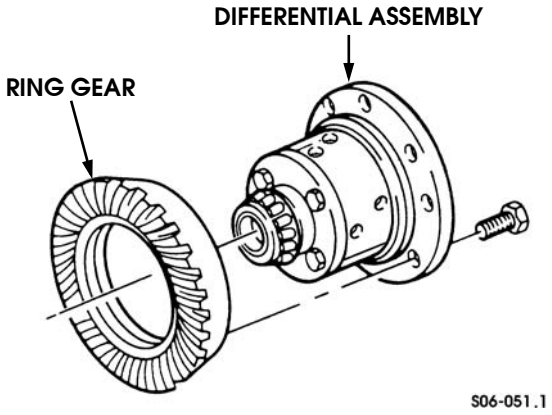


Figure 9-15: Ring Gear Removal

14. Rotate the housing 90 degrees. Secure the cover to the housing with two bolts (Figure 9-16).
15. Remove the pinion nut and the pinion yoke from the pinion gear.
16. Drive the pinion gear out of the front pinion bearing.
17. Remove the cover, pinion gear, and the collapsible spacer from the housing. Discard the collapsible spacer.
18. Remove the pinion seal and the front pinion bearing from the housing. Discard the pinion seal.

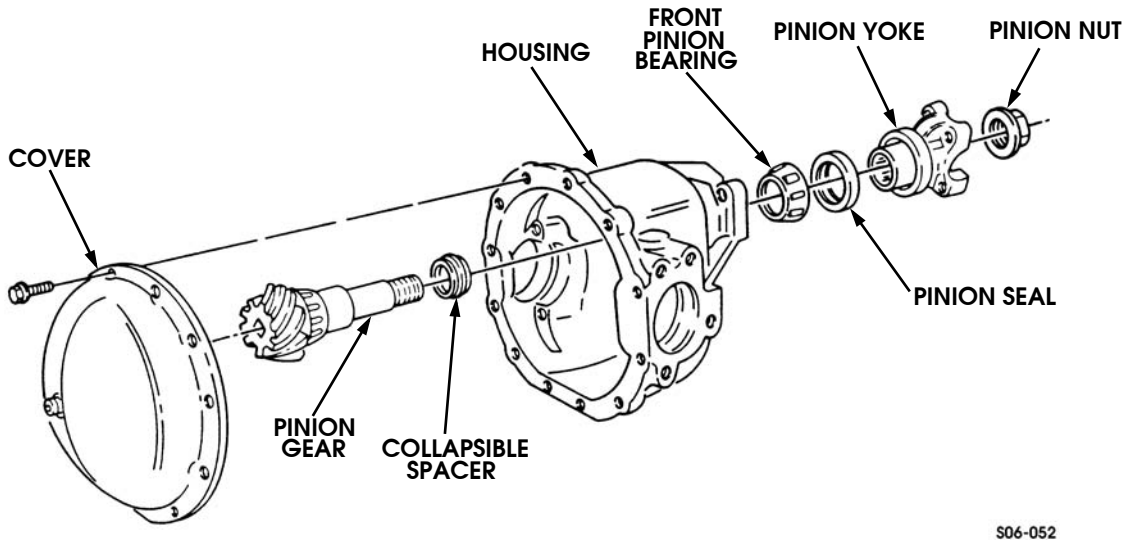


Figure 9-16: Axle Housing

19. Rotate the front of the housing upward 90 degrees. Using the driver handle J–8092 and the bearing cup remover J–21786, remove the pinion rear bearing cup and the pinion depth shim from the housing (Figure 9-17).

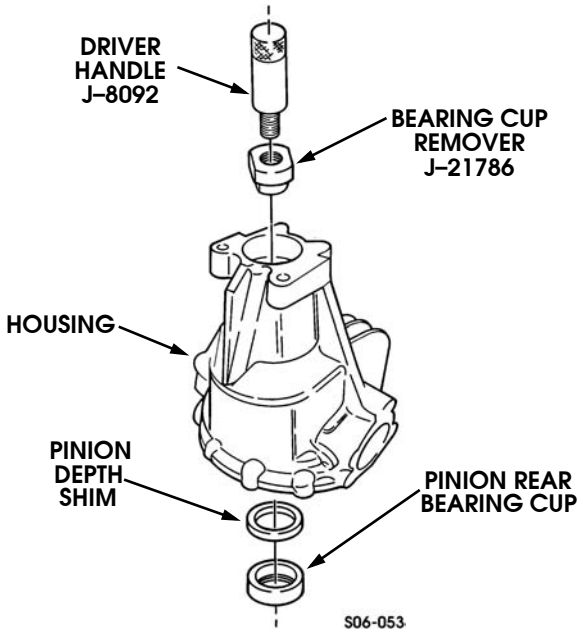


Figure 9-17: Pinion Rear Bearing Cup Removal

20. Rotate the housing 180 degrees. Using the driver handle J–8092 and the pinion front bearing cup remover J–21787, remove the front pinion bearing cup from the housing (Figure 9-18).

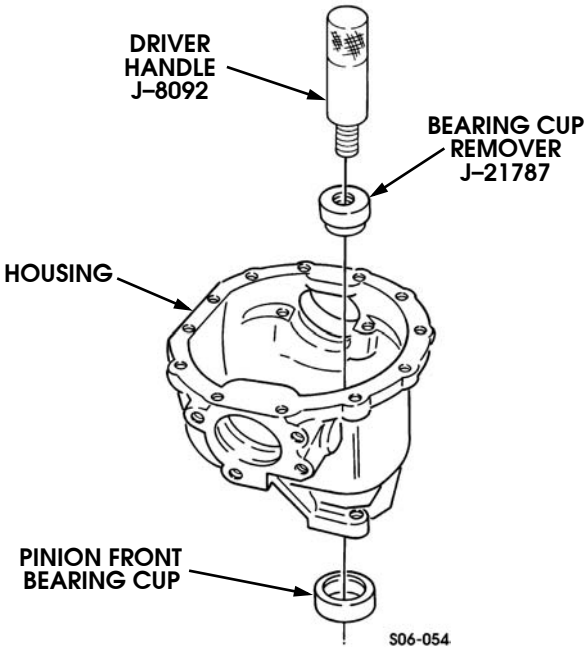


Figure 9-18: Pinion Front Bearing Cup Removal

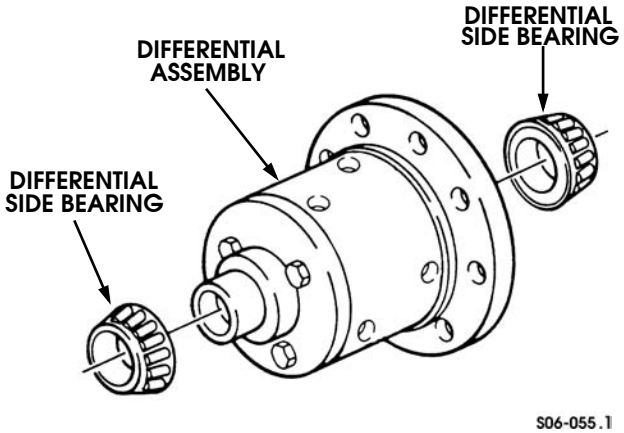


Figure 9-19: Differential Side Bearing Removal

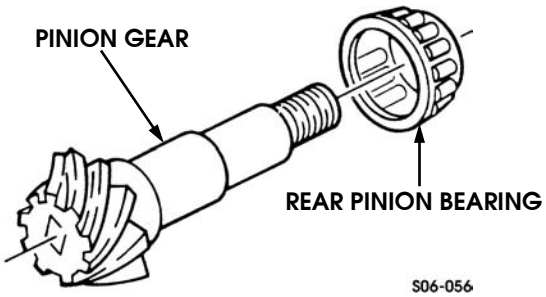


Figure 9-20: Pinion Bearing Removal

21. Remove the two differential side bearings from the differential assembly (Figure 9-19).
22. Remove the rear pinion bearing from the pinion gear (Figure 9-20).
23. Remove the bearing from the output shaft (Figure 9-21).

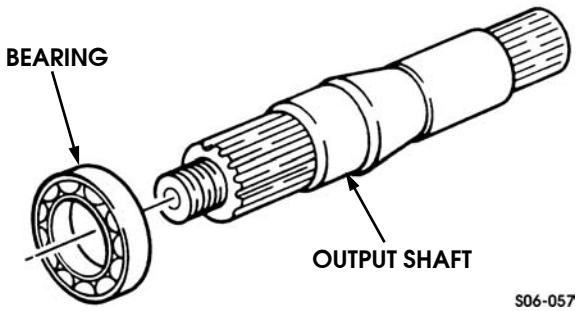


Figure 9-21: Output Shaft Bearing Removal

Cleaning and Inspection

NOTE: Clean all the components. Examine for wear or damage and replace if necessary.

1. Inspect the housing and all the threaded holes for damage. Repair any damaged threads with thread repair inserts. Replace the axle assembly if the housing is damaged (Figure 9-22).

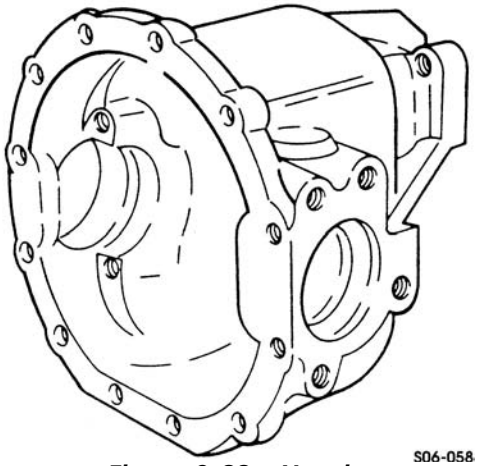


Figure 9-22: Housing

NOTE: The ring and pinion gears must be replaced as a matched set.

2. Inspect the splines and gear teeth on the pinion gear and the ring gear for damage. Replace both pinion gear and ring gear if either is damaged (Figures 9-23, and 9-24)

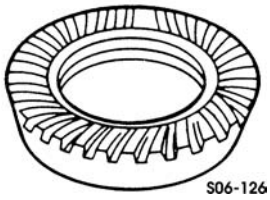


Figure 9-23: Ring Gear

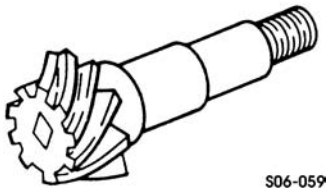


Figure 9-24: Pinion Gear

3. Inspect the splines and the sealing surfaces on the output flanges, pinion yoke and the output shaft for damage (Figures 9-25 9-26, and 9-27).



Figure 9-25: Output Flange



Figure 9-26: Pinion Yoke

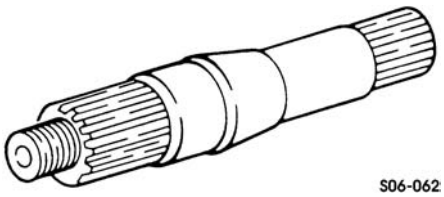


Figure 9-27: Output Shaft.

4. Inspect all the bearings and the bearing cups for damage (Figure 9-28).



Figure 9-28: Bearing and Bearing Cup

5. Inspect the differential assembly case for damage (Figure 9-29).

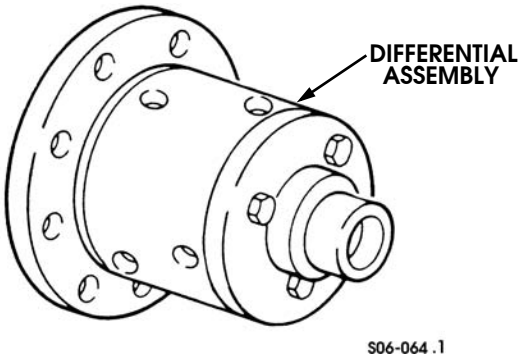


Figure 9-29: Differential Assembly

Pinion Depth Setting

NOTE: Pinion gear depth is the distance from the end face of the pinion to the center line of the output shafts. The dimension is controlled by shims between pinion gear rear bearing cup and differential housing. The pinion gear is etched with two identifying numbers. The first number identifies ring gear and pinion gear as a matched set, and the second number represents pinion depth variance. The second number is preceded by a plus (+) or minus (-) which represents the amount the gear set varies from the standard setting of 2.547 in. (6.46 cm). If using original gear set, use original pinion depth shim as a starter shim and proceed to step 4.

1. Measure the thickness of the original pinion depth shim and record for reference (Figure 9-30).

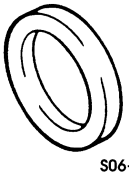


Figure 9-30: Pinion Depth Shim

2. Check the pinion depth variance number marked on the old and the new pinion gears and record (Figure 9-31).

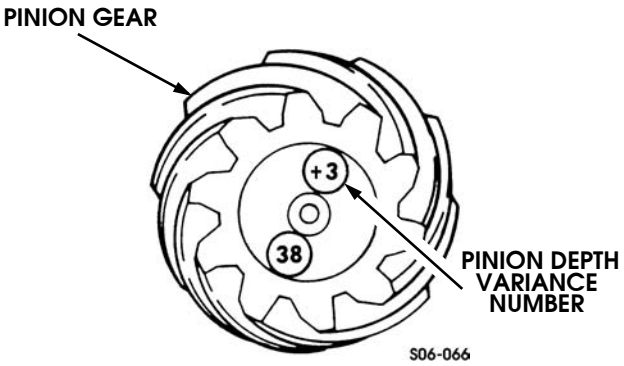


Figure 9-31: Pinion Depth Variance Number Location

NOTE: If the old pinion is marked -3 and the new pinion is marked +2, the procedure would be as follows: Refer to Old Pinion Marking column at left. side of table and locate -3 in this column. Then read to right, across table, until under +2 in New Pinion Marking column. The box where two columns intersect is amount of shim thickness change required. In this case, the number in the intersecting box is -0.005 in. (0.13 mm) which represents the amount to be subtracted from the old shim thickness. If the box number had been a (+) figure, this amount would be added to the old shim thickness. The actual pinion depth measurement must be performed and final shim thickness adjusted as necessary. Pinion shims are available from 0.084-0.111 in. (2.13-2.82 mm) in increments of 0.0005 in. (0.0127 mm).

3. Refer to the Old and the New Pinion Marking columns on the pinion variance table (Figure 9-33). Note on the table where the old and new pinion depth variances intersect. This will determine amount to be added or subtracted from the original pinion depth shim for desired pinion depth starter shim.
4. Rotate the housing so the front pinion bearing cup bore faces up (Figure 9-32).

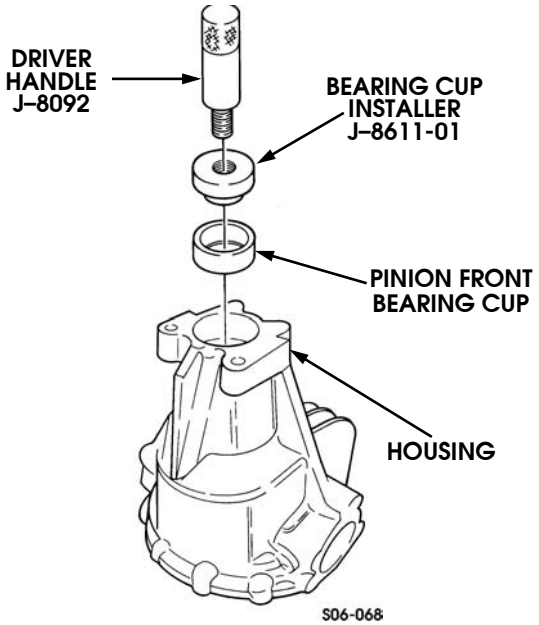


Figure 9-32: Pinion Front Bearing Cup Installation

Pinion Variance Table - Inches (millimeters)

OLD PINION MARKING	NEW PINION MARKING								
	-4	-3	-2	-1	0	+1	+2	+3	+4
+4	+0.008 (0.20)	+0.007 (+0.18)	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0
+3	+0.007 (+0.18)	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)
+2	+0.006 (+0.15)	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)
+1	+0.005 (+0.13)	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)
0	+0.004 (+0.10)	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)
-1	+0.003 (+0.08)	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)
-2	+0.002 (+0.05)	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)
-3	+0.001 (+0.03)	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)	-0.007 (-0.18)
-4	0 0	-0.001 (-0.03)	-0.002 (-0.05)	-0.003 (-0.08)	-0.004 (-0.10)	-0.005 (-0.13)	-0.006 (-0.15)	-0.007 (-0.18)	-0.008 (-0.20)

Figure 9-33: Pinion Variance Table

5. Lubricate the outside diameter of the front pinion bearing cup with lubricating oil. Using the driver handle J–8092 and the bearing cup installer J–8611-01, to install the cup in the housing.
6. Install the rear pinion bearing on the pinion gear (Figure 9-34) with installer tool J-35237.

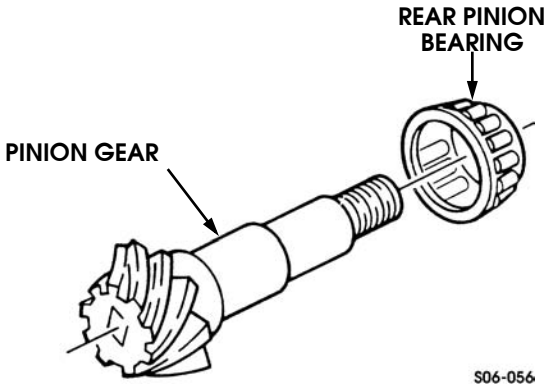


Figure 9-34: Pinion Rear Bearing and Pinion Gear Installation

7. Using the pinion setting gauge set, install the gauge block, rear pinion bearing cup, rear pinion bearing and the pilot washer on the stud and secure with the gauge block from the set J–39524 (Figure 9-35).

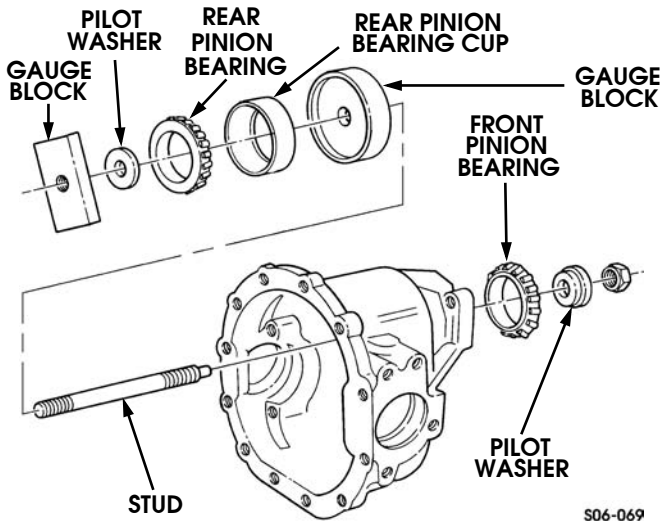


Figure 9-35: Pinion Depth Setting Gauge Installation

8. Position the stud assembly in the housing and secure with the front pinion bearing, pilot washer and the nut. Tighten the nut to 10 lb-in (1.1 N•m). Rotate the assembly several revolutions to seat the bearing and recheck the torque.
9. Rotate the front of the housing downward 90 degrees. Assemble the arbor and the two discs and install in the housing (Figure 9-36).
10. Install the two bearing caps and the four bolts in the housing finger tight.
11. Install the dial indicator on the arbor post. Push the dial indicator downward until the needle rotates approximately one full turn clockwise. Tighten the dial indicator in this position and recheck.

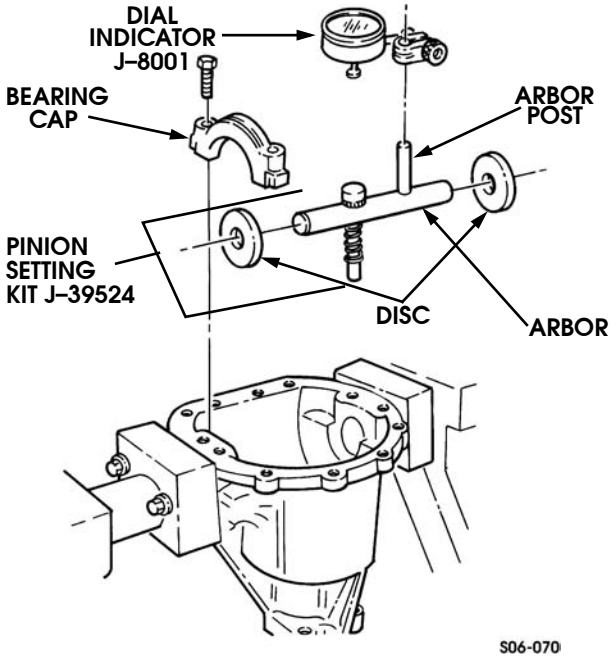


Figure 9-36: Positioning J–39524 Arbor and Discs In Housing

12. Rotate the gauge shaft slowly back and forth until the dial indicator reads the greatest deflection. At the point of greatest deflection, set the dial indicator to zero. Repeat the rocking action of the gauge shaft to verify the gauge setting (Figure 9-37).

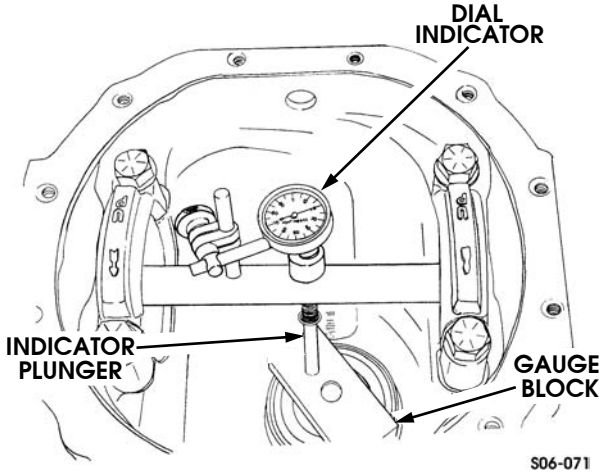


Figure 9-37: Gauge Setting

13. After the zero setting is obtained, rotate the gauge shaft until the dial indicator plunger does not touch the gauge block.
14. Record the dial indicator reading. Example: If the pointer moved counterclockwise and stops between 0 and 11, add 100 inches to measurement for shim thickness. If the pointer moves counterclockwise and stops between 84 and 99, correct shim thickness is indicated.
15. This reading indicates the shim thickness required for a pinion etched with a zero (0) on the pinion head. If the pinion being installed has a plus (+) or minus (-) etching, then an adjustment of the shim thickness is required. Example: If a pinion is etched +3, then 0.003 inches less shim thickness is required. Subtract 0.003 inches from the indicator reading. If a pinion is etched -3, then 0.003 inches more shim thickness is required. Add 0.003 inches to the indicator reading.
16. Remove the dial indicator from the arbor (Figure 9-36).
17. Remove the four bolts, two bearing caps, discs and the arbor from the housing.
18. Remove the nut, pilot washer, front the pinion bearing and stud assembly from the housing (Figure 9-38).

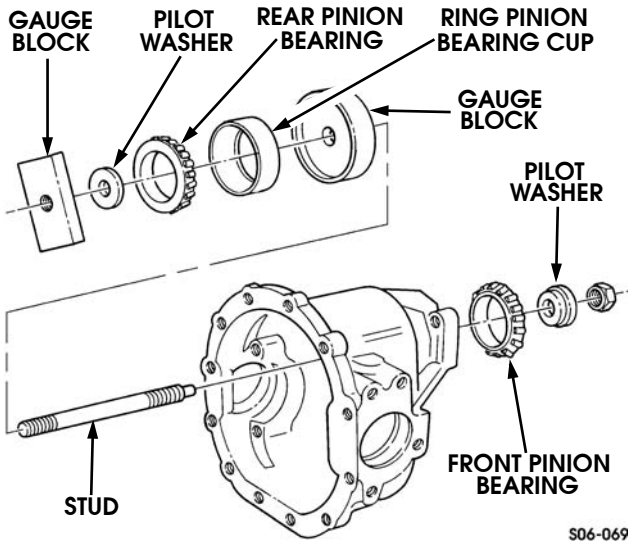


Figure 9-38: Pinion Front Bearing and Depth Tool Removal

19. Remove the gauge block, pilot washer, rear pinion bearing, rear pinion bearing cup and the gauge block from the stud.
20. Note the pinion depth variance marked on the pinion gear. If number is preceded by a plus (+) sign, add that amount in thousands to the standard setting of 2.547 in. (6.46 cm). If the number is preceded by minus (-) sign, subtract that amount in thousands from the standard setting of 2.547 in. (6.46 cm). The result of this addition or subtraction is the desired pinion depth. Record for reference (Figure 9-39).

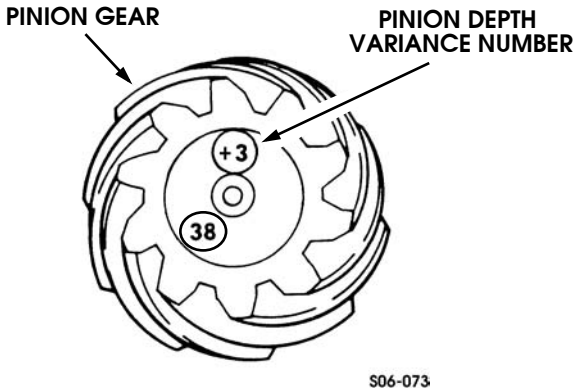


Figure 9-39: Pinion Depth Variance Number Location

21. Subtract the desired pinion depth (step 14) from the total measured pinion depth (step 15). Result of this subtraction is the correct pinion depth shim thickness.
22. Lubricate the front pinion bearing and the pinion seal with gear oil. Using the yoke seal installer, to install the front pinion bearing and the pinion seal in the housing (Figure 9-40).

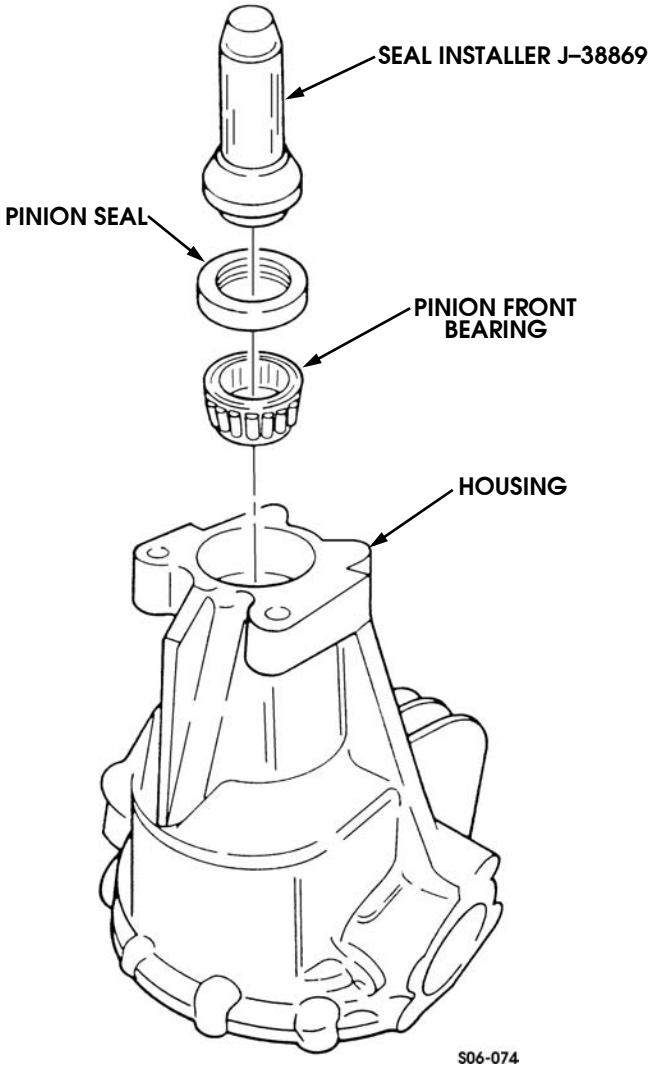


Figure 9-40: Pinion Seal Installation

23. Rotate the housing 180 degrees. Lubricate the outside diameter of the pinion rear bearing cup with gear oil (Figure 9-41).

NOTE: If the pinion shim is beveled, be sure the beveled side faces the bottom of the bearing cup bore.

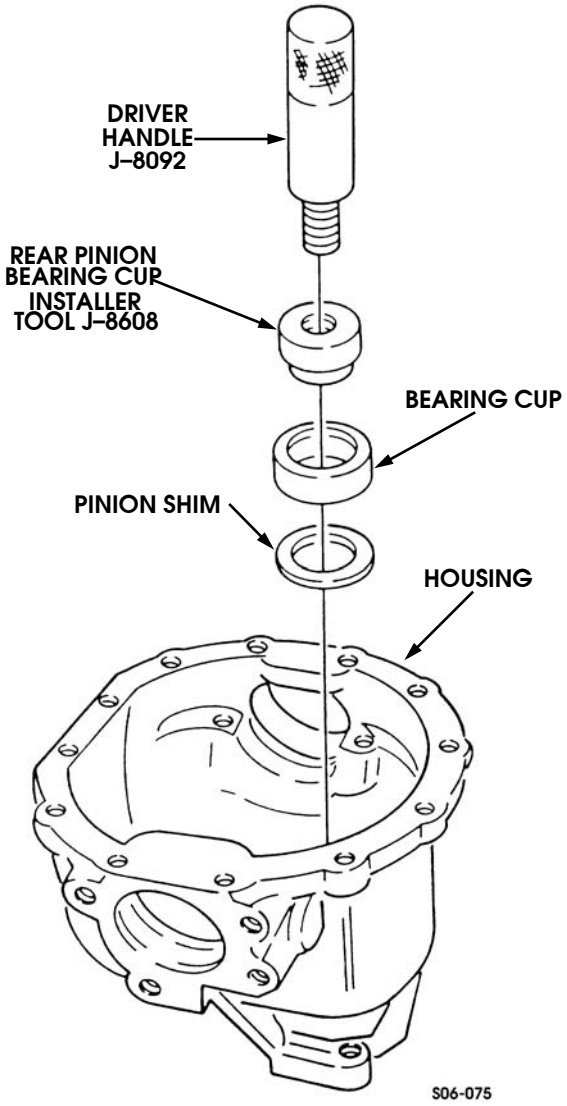


Figure 9-41: Pinion Rear Bearing Installation

24. Using the driver handle J–8092 and the bearing cup installer J–8608, install the correct thickness pinion shim and the pinion rear bearing cup in the housing.
25. Rotate the housing 90 degrees. Lubricate the rear pinion bearing with gear oil (Figure 9-42).

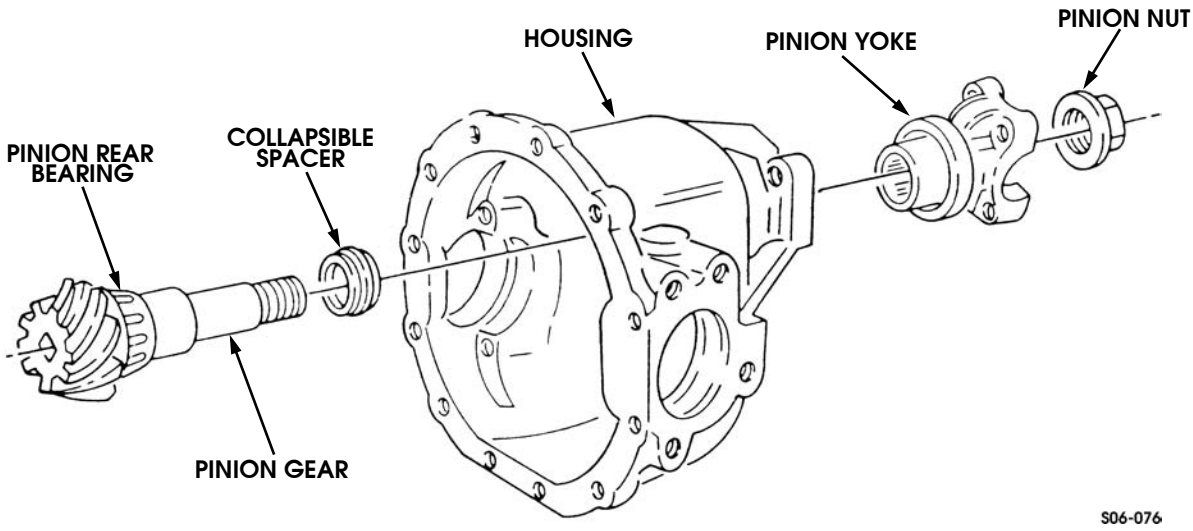


Figure 9-42: Rear Pinion Bearing Location

CAUTION: *Collapsible spacer controls the pinion bearing preload. Do not reuse the old spacer, or pinion bearing damage may result.*

26. Install the collapsible spacer on the pinion gear and install the pinion gear in the housing.
27. Install the pinion yoke on the pinion gear with the pinion nut.

CAUTION: *Do not exceed specified preload torque on pinion bearings. Do not loosen locknut to relieve the preload torque or pinion bearing damage may result. If specified torque is exceeded, remove pinion gear and replace collapsible spacer and locknut and adjust preload again.*

28. Using tool J-8614-01 with bolt kit J-8614-5 to hold the pinion yoke, tighten the pinion nut only enough to remove the end play and seat the pinion bearings in the housing. Rotate the pinion yoke while tightening to seat the bearings evenly.
29. Measure the torque required to rotate the pinion gear. The correct pinion bearing preload torque is 17-25 lb-in. (2-3 N•m) with a new bearings and 10-15 lb-in. (1-2 N•m) with a used bearings.
30. Continue to tighten the pinion nut in small increments until the pinion bearing preload torque meets specifications.
31. Install the two side bearings on the differential assembly (Figure 9-43).

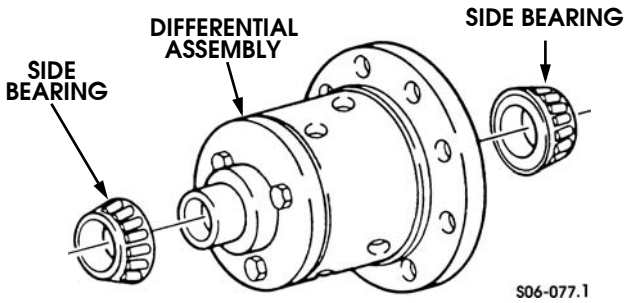


Figure 9-43: Side Bearing Installation

NOTE: Side bearing shims are available in thickness from 0.077-0.117 in. (1.96-2.97 mm) in increments of 0.001 in. (0.025 mm).

32. Rotate the housing downward 90 degrees. Install the side bearing cups and the side bearing shims on the side bearings. Use 0.080 in. (2 mm) shims as a starting point (Figure 9-44).

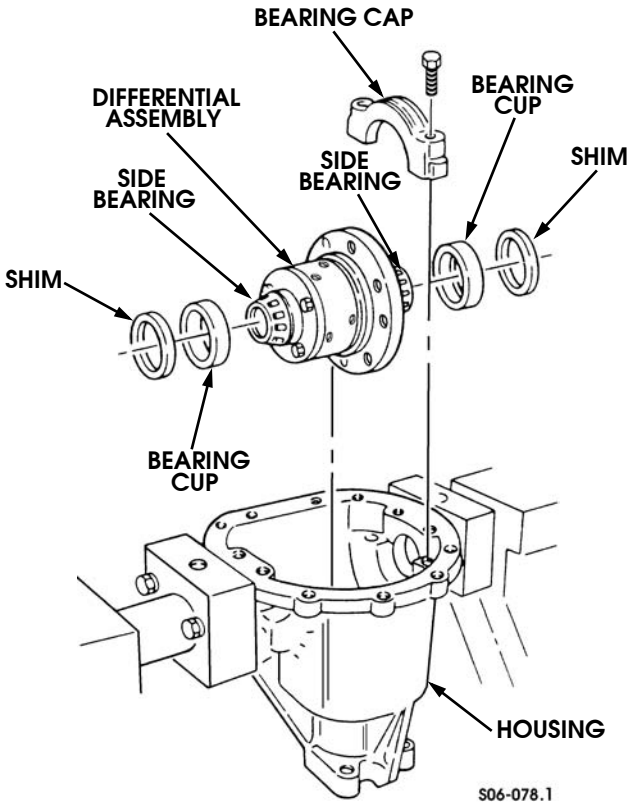


Figure 9-44: Side Bearing Cup and Shim Installation

33. Install the differential assembly, bearing cups and the shims in the housing.
34. Install the two bearing caps and the four bolts in the housing. Snug the bolts.
35. Mount the dial indicator on the housing and position the indicator to read off the ring gear mounting surface of the differential assembly (Figure 9-45).

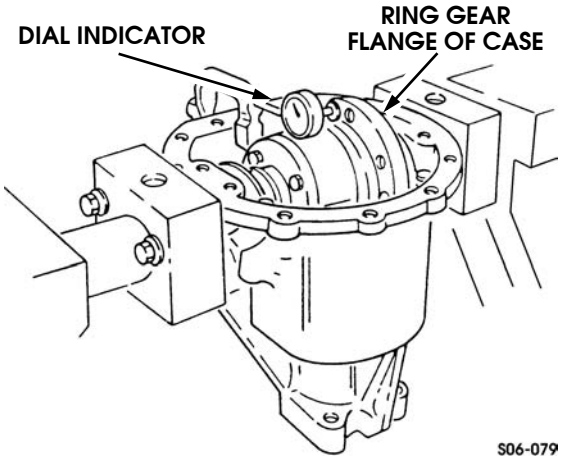


Figure 9-45: Dial Indicator Positioning For Case Runout Check

36. Pry between the differential assembly and the bearing cap on one side of the indicator. Pry on the opposite side to read the end play.

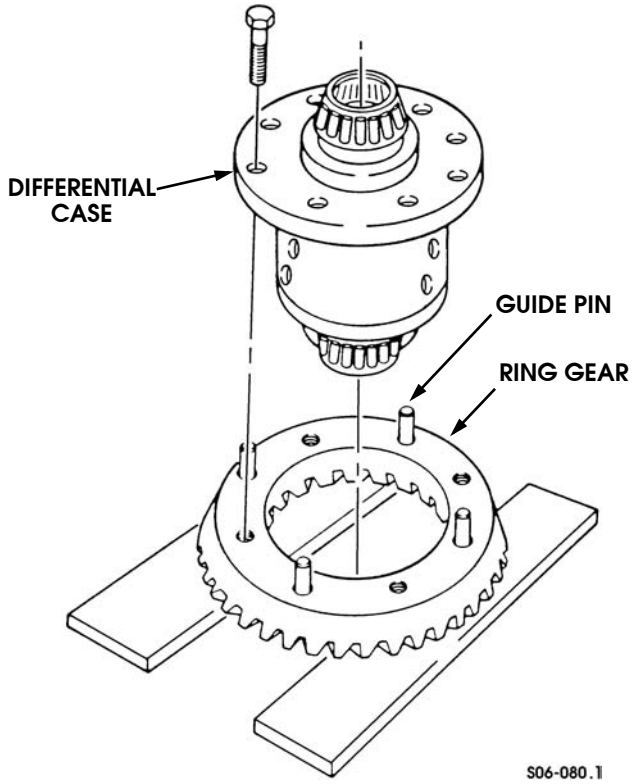


Figure 9-46: Ring Gear Guide Pin Installation

37. The amount read on the indicator is the shim thickness that should be added to the side bearing shims to arrive at zero end play. Add the necessary shims and repeat the procedure to ensure accuracy.
38. Tighten the four bolts to 55-70 lb-ft. (75-95 N•m).
39. Rotate the differential assembly and check the runout. Runout should not exceed 0.002 in. (0.05 mm).
40. Remove the dial indicator from the housing.

NOTE: Tag the shims and the bearing cups for assembly.

41. Remove the four bolts, two bearing caps, bearing cups, shims and the differential assembly from the housing (Figure 9-47).
42. Install the four guide pins in the ring gear (Figure 9-46).

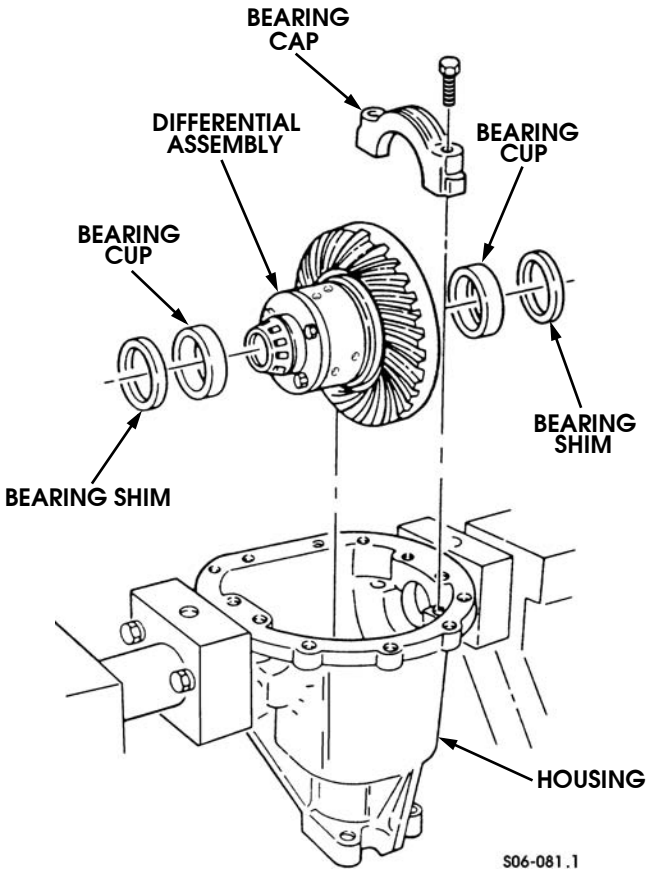


Figure 9-47: Differential Assembly Mounting

43. Support the ring gear with wood blocks in the press.
44. Press the differential assembly on the ring gear.
45. Remove the four guide pins from the ring gear.
46. Install the ring gear on the differential assembly with the eight bolts. Tighten the bolts to 95-115 lb-ft. (129-156 N•m).
47. Install the side bearing shims, previously selected to remove the differential assembly side play, slide the bearing cups and the differential assembly in the housing (Figure 9-47).
48. Install the two bearing caps in the housing with the four bolts. Tighten the bolts to 55-70 lb-ft. (75-95 N•m).
49. Attach the dial indicator to the housing and position the indicator to read off the drive side of the ring gear tooth at a right angle (Figure 9-48).

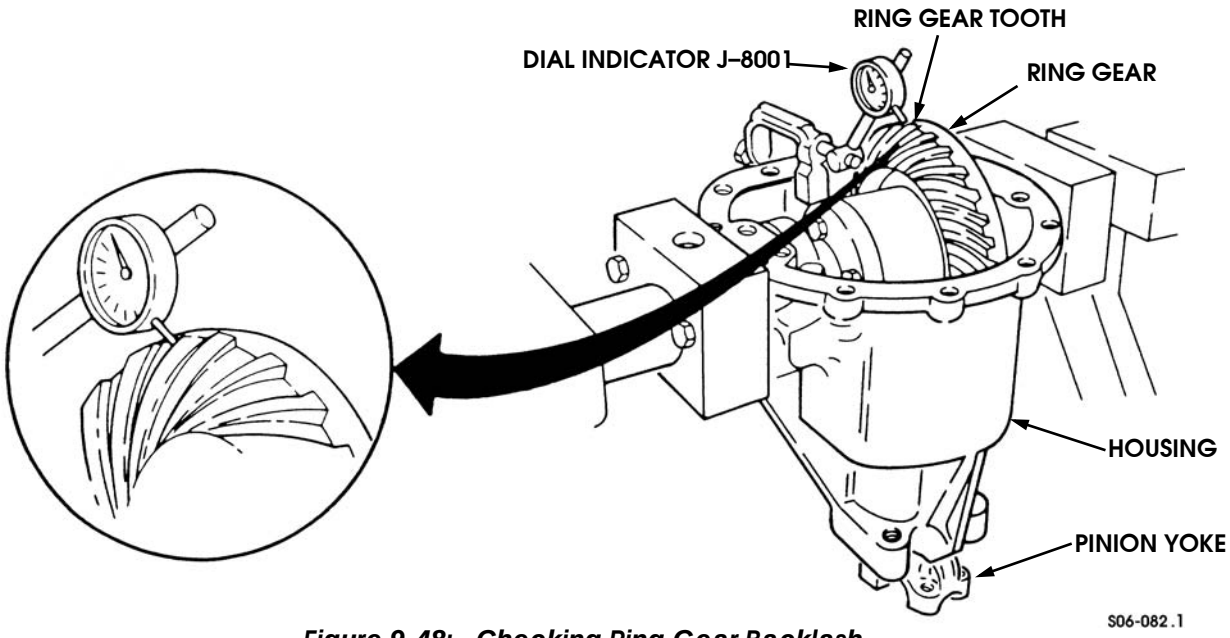


Figure 9-48: Checking Ring Gear Backlash

NOTE: Backlash must be checked at four equally spaced points on ring gear and must not vary more than 0.002 in. (0.05 mm) between four points checked.

50. Move the ring gear back and forth while holding the pinion yoke stationary. Note the backlash registered on the indicator.
51. Ring gear backlash should be 0.005-0.009 in. (0.13-0.23 mm) with 0.008 in. (0.20 mm) desired. If the backlash must be adjusted perform steps 52 through 55, if not go to step 56.

NOTE: Tag the shims and bearing cups for assembly.

52. Remove the four bolts, two bearing caps, bearing cups, shims and the differential assembly from the housing (Figure 9-47).

NOTE: The following example will explain the procedure for adjusting backlash: If side play was removed using 0.090 in. (2.29 mm) shims on each side totaling 0.180 in. (4.57 mm) and backlash, when checked, is found to be 0.011 in. (0.28 mm), add 0.004 in. (0.10 mm) to shim on ring gear side and subtract 0.004 in. (0.10 mm) from shim on opposite side to correct backlash. This will result in 0.094 in. (2.39 mm) shim on ring gear side and 0.086 in. (2.18 mm) shim on other side. Backlash will be approximately 0.007-0.008 in. (0.18 to 0.20 mm). Total Shim Thickness remains 0.180 in. (4.57 mm).

53. To increase the backlash, install a thinner shim on the ring gear side and a thicker shim on the opposite side. To decrease the backlash, install a thicker shim on the ring gear side and a thinner shim on the opposite side. Do not change the total shim thickness.
54. Install the shims, bearing cups, differential assembly and the bearing caps in the housing and secure with the four bolts. Tighten the bolts to 55-70 lb-ft. (75-95 N•m).
55. Mount the dial indicator and recheck the backlash. If necessary, repeat steps 52 through 54.
56. Remove the four bolts, bearing caps, bearing cup, shims and the differential assembly from the housing. Tag the shims and the bearing cup for assembly.
57. Install the axle housing spreader into the holes in the axle holding fixture adapters and install the dial indicator to read from each end of the housing. The indicator must have preload setting of 0.020 in. (0.50 mm) (Figure 9-49).

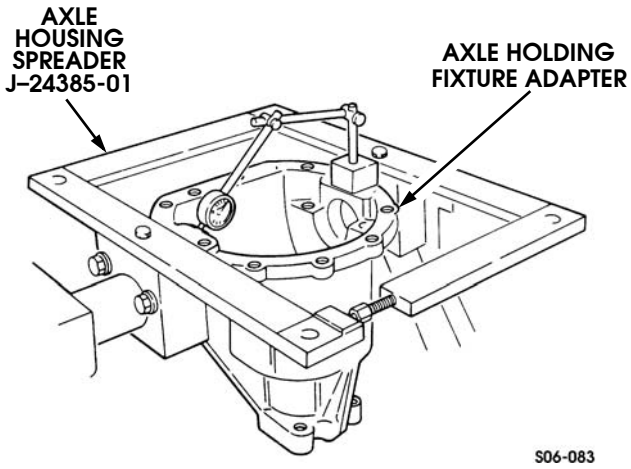


Figure 9-49: Axle Housing Spreader Mounting

CAUTION: *Over-spreading of the axle housing will damage the housing.*

58. Spread the housing 0.010 in. (0.25 mm) and remove the dial indicator.

NOTE: Differential bearings must be preloaded to compensate for heat and loads during operation.

59. Preload the differential side bearings by increasing the shim thickness at each side of the differential assembly by 0.004 in. (0.10 mm) for a total bearing preload of 0.008 in. (0.20 mm) (Figure 9-47).
60. Lubricate the side bearings with gear oil and install the differential assembly, bearing cups, shims and the bearing caps in the housing and secure with the four bolts (Figure 9-47).

NOTE: Preloaded differential bearings may change the backlash setting. Check and correct the backlash if necessary.

61. Remove the housing spreader and tighten the bolts to 55-70 lb-ft. (75-95 N•m).
62. Apply silicone sealant to the cover sealing surface and secure the cover to the housing with the twelve bolts. Tighten the bolts to 16 lb-ft. (22 N•m) (Figure 9-50).

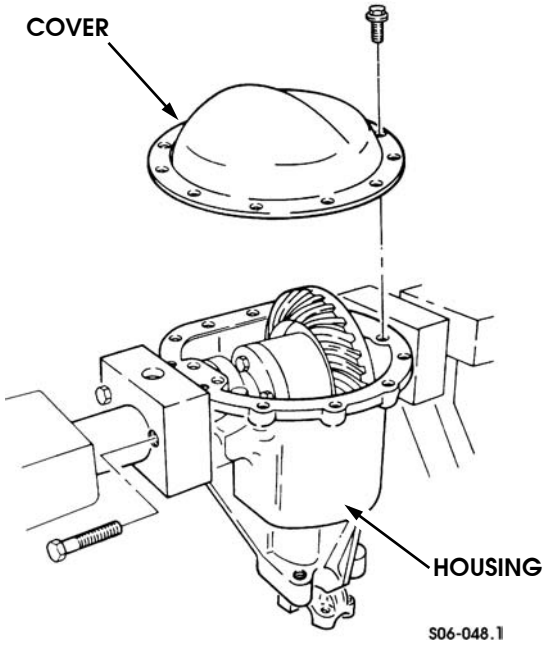


Figure 9-50: Housing Cover Installation

63. Remove the housing from the holding fixture.

64. Remove the four bolts and the two axle holding fixture adapters from the housing.
65. Using the press, install the output shaft bearings on the output shafts (Figure 9-51).

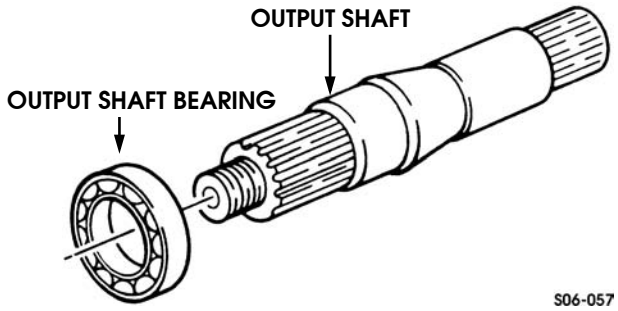


Figure 9-51: Bearing Installation

66. Using the axle shaft and the seal installer J–33142, install the output shaft assemblies into the axle assembly (Figure 9-52).

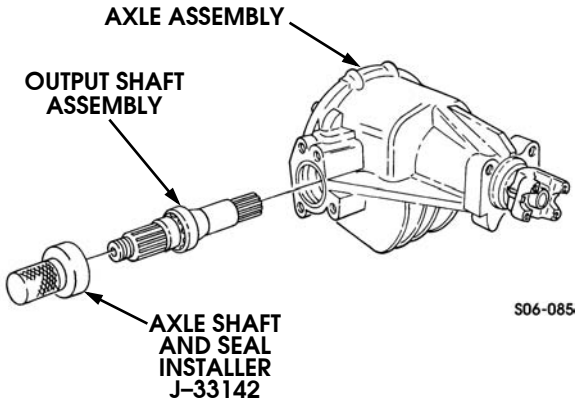


Figure 9-52: Axle Shaft And Seal Installer Usage

67. Using the axle shaft and the seal installer J–33142, install the output shaft seals in the axle assembly (Figure 9-53).

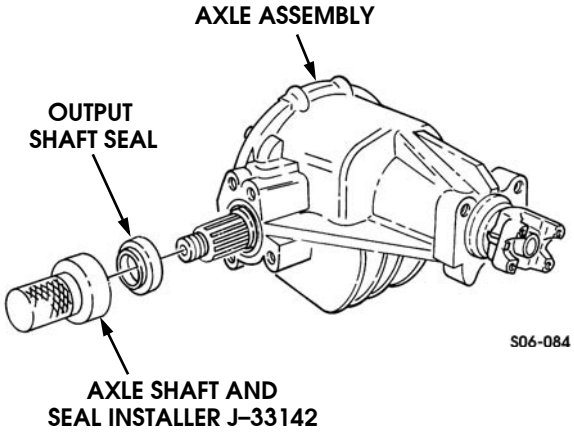


Figure 9-53: Output Shaft Seal Installation

68. Lubricate the sealing surface on the output flanges with lubricating oil (Figure 9-54).

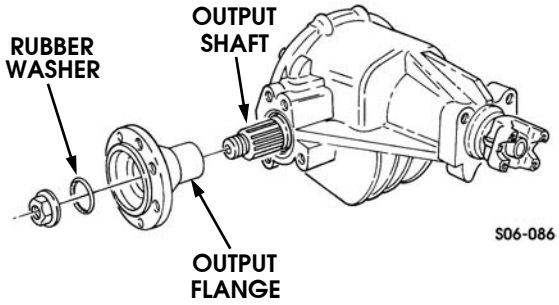


Figure 9-54: Output Shaft Seal Installation

69. Install the two output flanges, two seals and the two locknuts on the output shafts. Finger tighten the locknuts.
70. Install the axle assembly.
71. Torque the two locknuts to 166-196 lb-ft. (224-265 N.m).

Axle Vent Line Replacement

NOTE: Axle vent line replacement procedures are basically the same. This procedure covers the rear axle vent line.

Removal

1. Disconnect the vent line from the axle fitting and the tee fitting and remove the vent line (Figure 9-55).
2. Remove the two line clips and the vent line from the brake line.
3. Disconnect the vent line from the two tee fittings and remove the vent line.

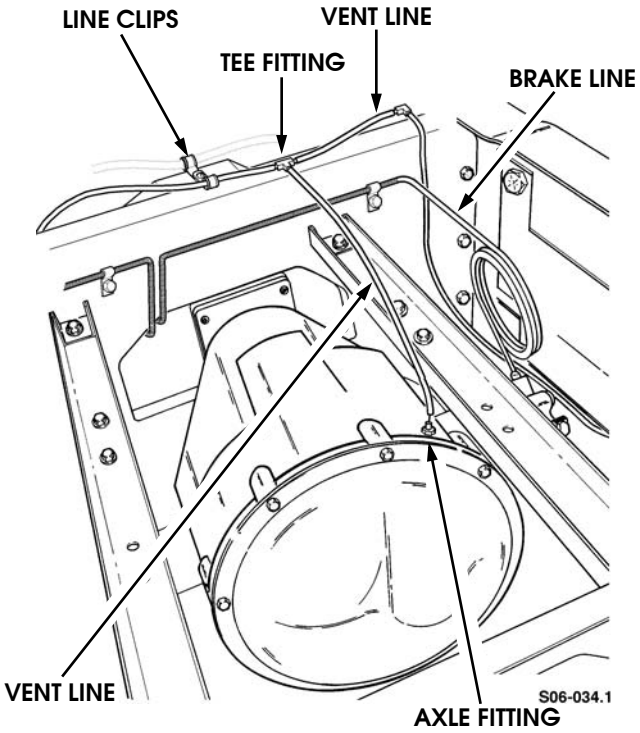


Figure 9-55: Axle Vent Line Location

Installation

1. Install the vent line and connect to the two tee fittings (Figure 9-55).
2. Secure the vent line to the brake line with the two line clips.
3. Connect the vent line to the axle fitting and tee fitting.

HALF SHAFT

Boot Replacement

Removal

NOTE: Inner and outer boots are replaced together. The inner CV joint is disassembled to gain access to the half shaft boots.

1. Remove the wheel.
2. Remove the access plug and washer from the geared hub (Figure 9-56).
3. Remove the six bolts, lock washers and the half shaft from the rotor using tool J-45762.
4. Remove the half shaft retaining bolt, lock washer and the half shaft from the geared hub.

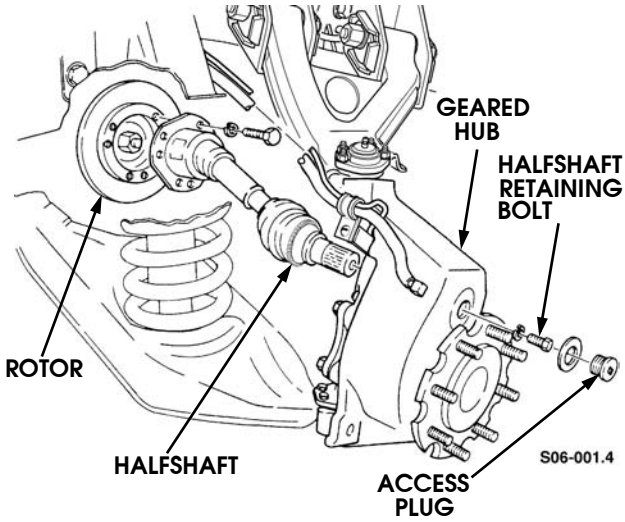


Figure 9-56: Half shaft Retaining Bolt

5. Loosen the two clamps securing the inner boot to the inner joint housing and the shaft (Figure 9-57).
6. Slide the inner boot toward the outer joint along the shaft.

NOTE: Remove the excess grease from the bearing assembly.

7. Clamp the shaft in a soft-jawed vise.
8. Remove the retaining ring from the inner joint housing by forcing the clip up the chamfer on the inside of the housing.
9. Remove the housing and the six ball bearings from the bearing assembly.
10. Move the outer race up on the shaft to allow for better access to the inner race (Figure 9-58).
11. Locate the snap ring adjacent to the inner race. Remove the snap ring from the groove and slide it up on the shaft (Figure 9-59).
12. Tap the inner race up on the shaft to expose the retaining clip.
13. Remove the retaining clip and the inner race from the shaft.
14. Remove the outer race, snap ring and the inner boot from the shaft (Figure 9-59).
15. Remove the two clamps and the outer boot from the shaft.

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage and replace half shaft if necessary.

1. Clean all the metallic parts with solvent.
2. Inspect the halfshaft. assembly for damage or wear and replace if damaged or worn.

Installation

1. Position the outer boot and the two clamps on the shaft near the outer joint.
2. Apply a packet of grease to the outer joint.
3. Position the outer boot over the outer joint housing and secure the clamp with the boot banding tool J–22610.
4. Secure the smaller clamp on the boot and shaft with tool J–22610.
5. Clamp the shaft in a vise with protective jaws.
6. Position the two clamps on the shaft (Figure 9-60).
7. Install the inner boot on the shaft. Push the boot past the groove on the shaft.
8. Install the snap ring and retaining clip into the grooves on the shaft (Figure 9-59).
9. Align the chamfer splines of the inner bearing assembly with the spline of the shaft. Use a press or a rawhide hammer to install the inner race until it snaps in place - flush against the spacer ring.
10. Position the six ball bearings into the bearing assembly and retain with a slight amount of grease (Figure 9-57).

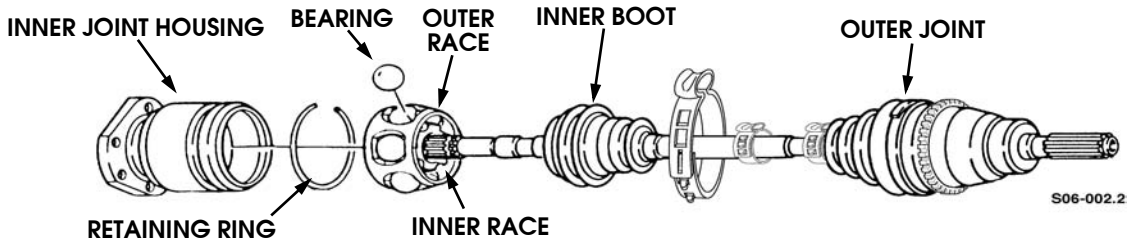


Figure 9-57: Halfshaft Boot Replacement

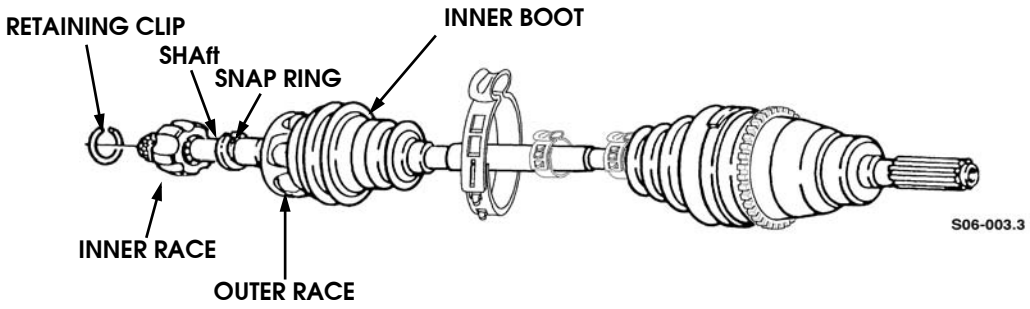


Figure 9-58: Halfshaft Boot Replacement

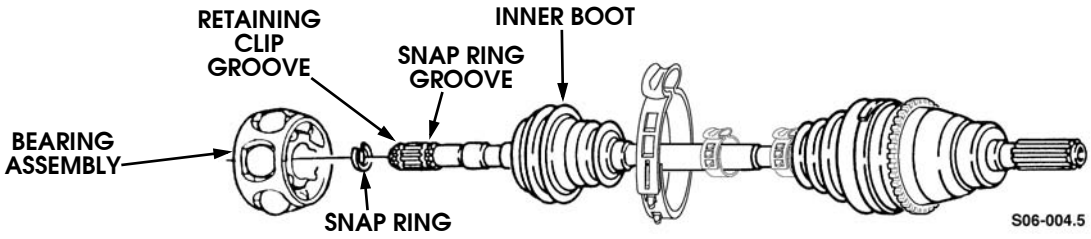


Figure 9-59: Halfshaft Boot Replacement

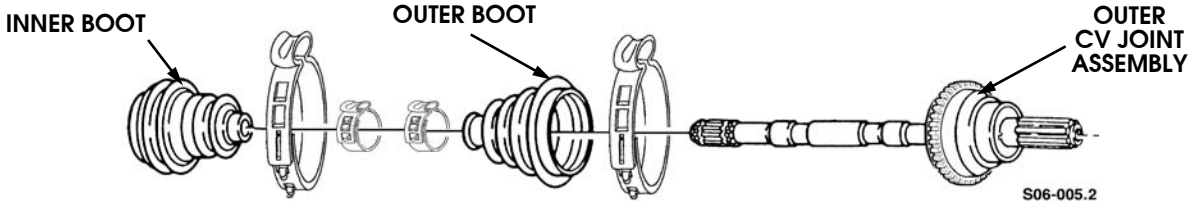


Figure 9-60: Halfshaft Boot Replacement

11. Position the joint inner housing over the bearing assembly.

NOTE: Ensure all the ball bearings are in the tracks of the inner joint.

12. Secure the retainer ring in the groove of the inner joint housing.
13. Fill the inner joint with grease from the grease packet.
14. Move the inner boot on the shaft until the boot seats in the groove of the shaft and the inner joint housing.
15. Secure the inner boot on the shaft and the housing with the clamps. Tighten the clamps with the crimping tool J–22610.
16. Slide the halfshaft splines into the geared hub.
17. Apply thread-locking compound to the halfshaft retaining bolt and secure the halfshaft to the geared hub with the lockwasher and the halfshaft retaining bolt. Tighten the halfshaft retaining bolt to 37 lb-ft. (50 N•m) (Figure 9-56).
18. Install the washer and the access plug into the geared hub. Tighten the access plug to 8-13 lb-ft. (11-18 N•m).

NOTE: Ensure all six bolt holes in the rotor align with the holes in the output flange. Make sure the mounting holes and bolts are cleared of old Loctite.

19. Apply Loctite 272 to the six bolts. Secure the halfshaft to the rotor with the twelve lock washers and the bolts. Tighten the bolts to 48 lb-ft. (65 N•m).
20. Install the wheel.

PROPELLER SHAFT

Front Propeller Shaft

The front propeller shaft is balanced at the factory and only serviced as an assembly.

Front Shaft Removal

CAUTION: *Care must be taken to ensure that the front propeller shaft is not seperated at the slip yoke spline. The shaft is balanced at the factory and if seperated it will need to be replaced.*

1. Remove the four bolts and disconnect the shaft yoke (Figure 9-61).

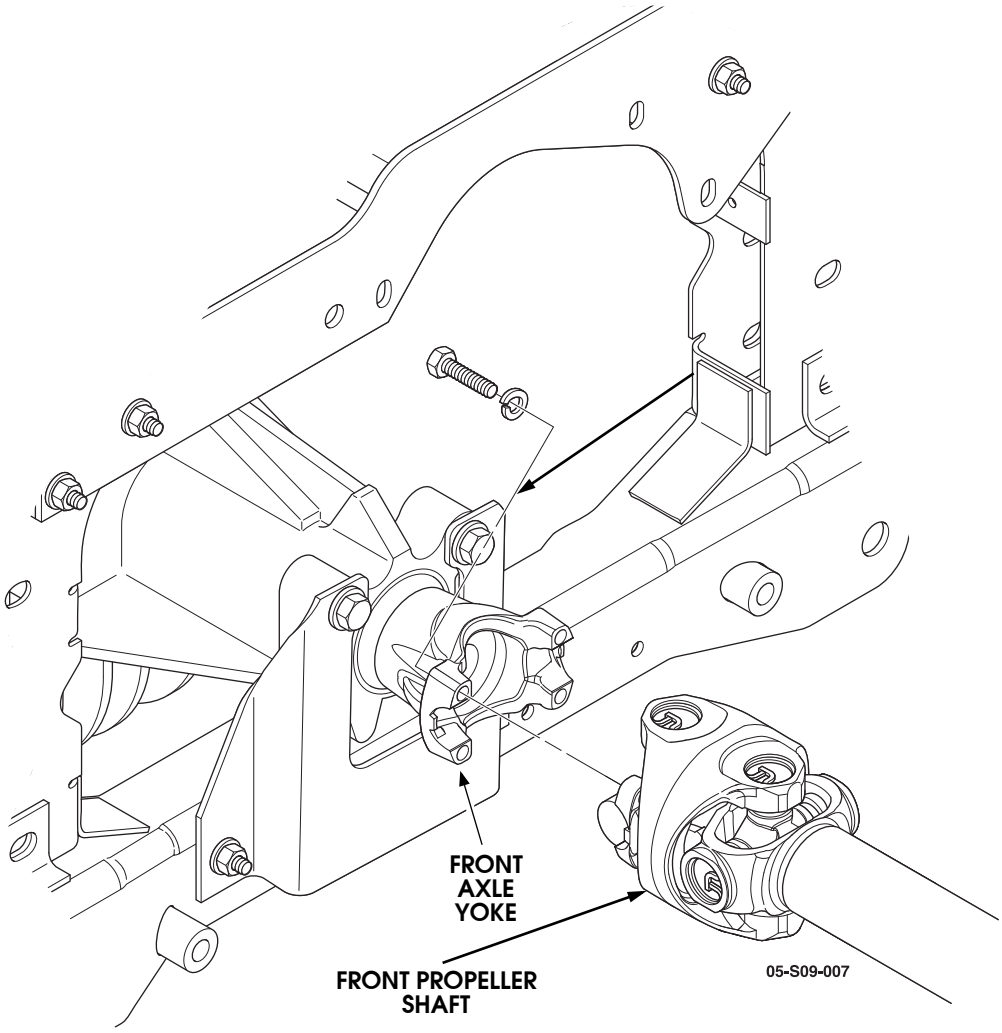


Figure 9-61: Front Propeller Shaft Attachment at Axle

2. Remove the U-joint clamp bolts and the straps and disconnect the front shaft from the transfer case output yoke (Figure 9-62).

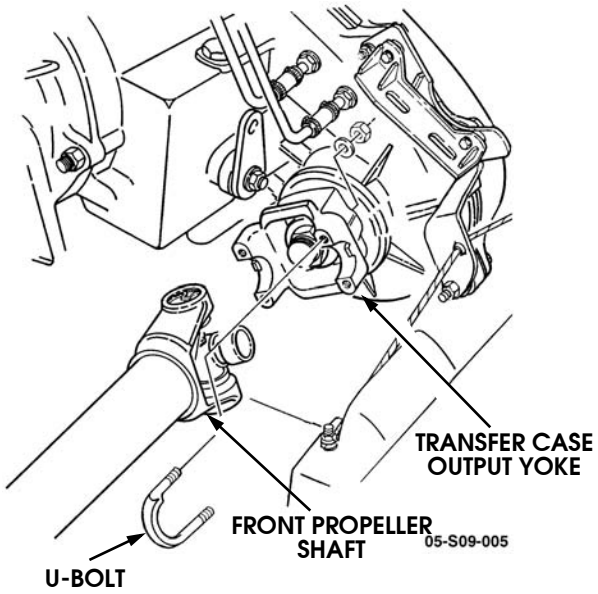


Figure 9-62: Front Propeller Shaft Attachment at Transfer Case

3. Remove the bolts attaching the center bearing to the engine mount (Figure 9-63).

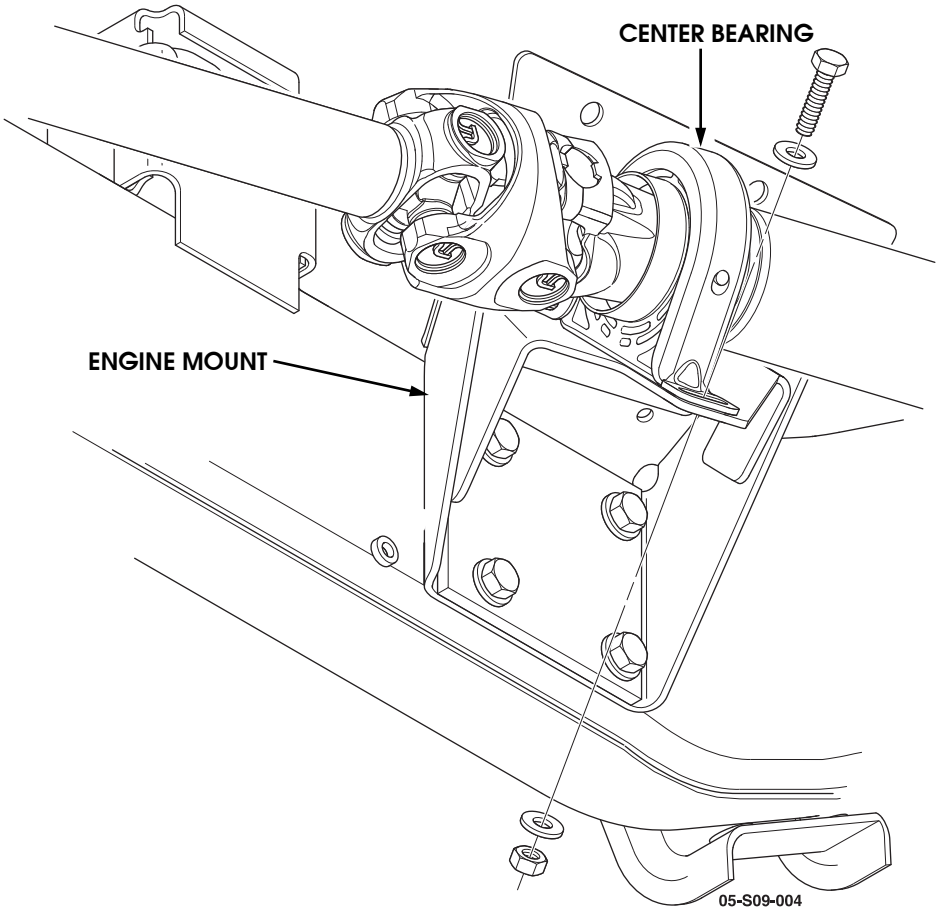


Figure 9-63: Center Bearing Attachment

4. Move the front shaft forward, then rearward over the top of the transfer case and remove from the vehicle.

Front Propshaft Installation

1. Position the front shaft on the engine mount, axle yoke and the transfer case yoke.
2. Connect the front shaft to the transfer case yoke with the U-bolts and the nuts. Tighten the nuts to 13-18 lb-ft. (18-24 N•m).
3. Connect the front shaft to the front axle yoke with the bolts. Tighten the bolts to 13-18 lb-ft. (18-24 N•m).
4. Secure the center bearing to the engine mount with the bolts, washers and the locknuts. Tighten the bolts to 60 lb-ft. (81 N•m).
5. Lubricate the propeller shaft U-joints and the slip yokes with chassis grease.

Rear Propeller Shaft Service

Removal

1. Remove the 4 bolts and the two straps attaching the rear drive shaft to the rear axle yoke (Figure 9-64).
2. Slide the shaft slip yoke out of the transfer case extension housing and remove the shaft from the vehicle.

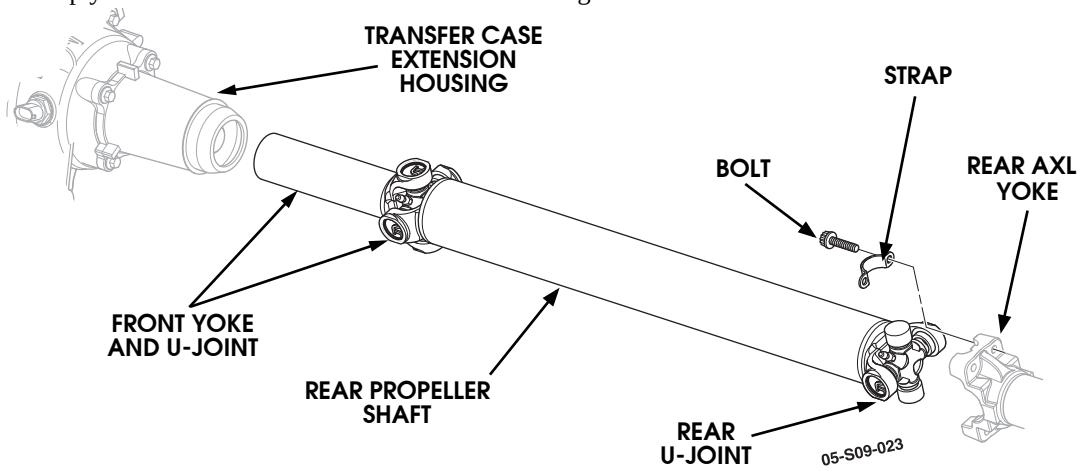


Figure 9-64: Rear Propeller Shaft Attachment

3. Inspect the condition of the U-joint cross and the bearings at each end of the shaft (Figure 9-65). Replace either U-joint if worn, loose or seized. Refer to U-joint replacement in this section.

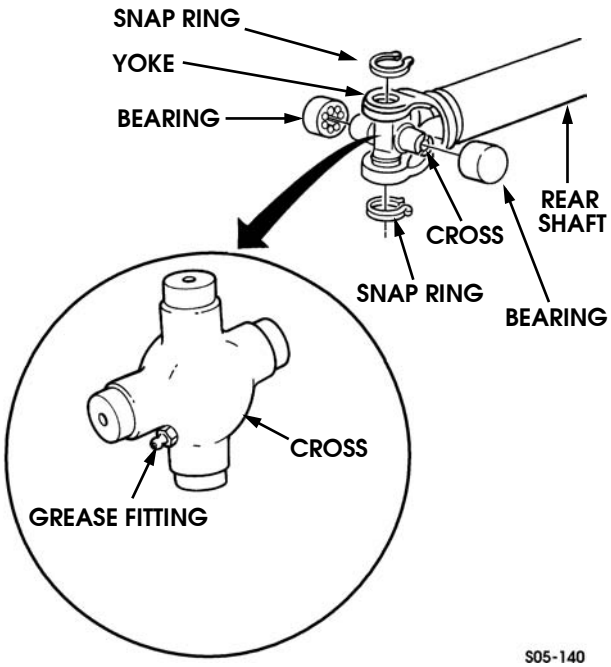


Figure 9-65: U-joint Components (Typical)

Installation

1. Slide the propeller shaft slip yoke into the extension housing.
2. Connect the shaft to the axle yoke with the two straps and the 4 bolts. Tighten the bolts to 13-18 lb-ft. (18-24 N•m).
3. Lubricate the propeller shaft U-joints.

U-Joint Replacement

1. Remove the propeller shaft.
2. Remove the grease fitting from the cross (Figure 9-66).
3. Remove the two bearing cups from the cross (rear shaft only).
4. Remove the snap rings from the bearings in the yoke.
5. Position the propeller shaft in a vise with a 1-1/8 socket between the vise jaw and the bearing being removed. Be sure the open end of the socket is facing the bearing cup (Figure 9-66).

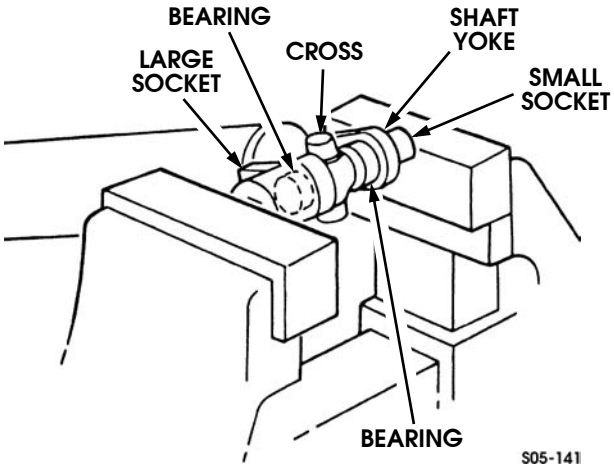


Figure 9-66: U-Joint Cross and Bearing Installation

6. Place a 11/16 socket between the opposite bearing and the vise jaw. Be sure the open end of the socket is facing the vise jaw.
7. Tighten the vise to press the bearing cup out of the yoke. Then remove the bearings from the cross.
8. Reverse the position of the sockets and press the remaining bearing out of the yoke.
9. Remove the cross from the yoke.
10. Pack bearing grease into the bearings to hold the needle rollers in place.

CAUTION: *Be sure the grease fitting on the cross faces the yoke. Damage to fitting will result if improperly installed.*

11. Position the cross in the yoke.
12. Install the first bearing in the yoke. Verify the bearing cup is aligned with the yoke before pressing in with the vise. Damage to the cross and the bearing will result if misaligned.
13. Place the yoke in a vise with a 11/16 socket between the vise jaw and the bearing cup. Then press the bearing cup into the yoke far enough to install the snap ring.
14. Install the remaining bearing in the yoke.
15. Place the yoke in a vise with a 11/16 socket between the bearing cup and the vise jaw.
16. Press the bearing cup into the yoke far enough to install the snap ring.
17. Press the remaining two bearings in the slip yoke and install the snap rings.
18. Install the two additional bearing cups on the cross (rear shaft only).
19. Install the grease fitting in the cross.
20. Lube the joints and the yokes as required.

SUSPENSION SYSTEM

General Description

The HUMMER H1 suspension system consists of a heavy-duty coil spring, a heavy-duty hydraulic shock absorber, and an upper and lower control arm at each wheel. This suspension system provides for a smoother ride and allows for more positive control of the vehicle.

Ball joints allow the control arms and geared hubs to change angles for smooth steering during turns. A stabilizer bar is located on the front suspension to aid in stabilizing the vehicle when it is turning. Each end of the stabilizer bar is attached to the lower control arms (Figure 9-67).

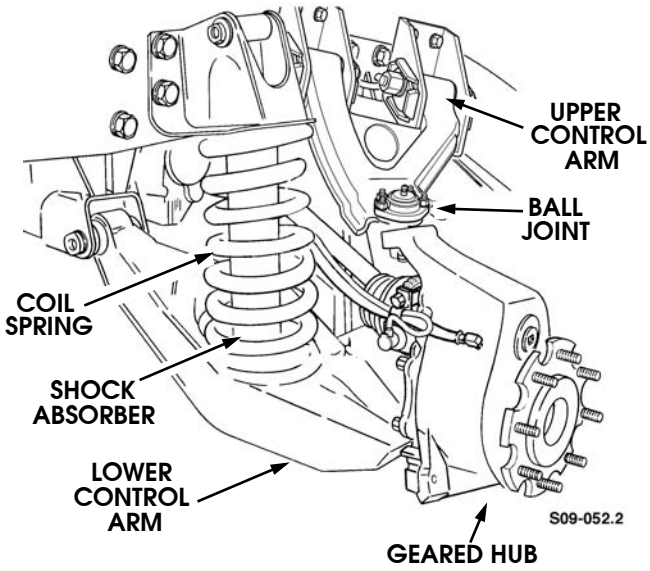


Figure 9-67: Suspension System

Specifications

Upper Ball Joint Slotted Nut	65 lb-ft. (88 N•m)
Lower Ball Joint Slotted Nut	73 lb-ft. (99 N•m)
Control Arm Bracket	90 lb-ft. (122 N•m)
Control Arm Bushing	260 lb-ft. (354 N•m)
Shock Absorber Bottom Bracket	178 lb-ft. (242 N•m)
Shock Pin-Top/Bottom	300 lb-ft. (408 N•m)

Geared Hubs

Access Cover	15 lb-ft. (20 N•m)
Access Plug, Halfshaft. Bolt	8-13 lb-ft. (11-18 N•m)
Drain or Fill Plug	8-13 lb-ft. (11-18 N•m)
Halfshaft to Drive Gear Bolt	37 lb-ft. (50 N•m)
Input Seal Plate	30 lb-ft. (40 N•m)
Steering Cover	65 lb-ft. (88 N•m)

Suspension Height Measurement

NOTE: Before checking suspension height, check the following items:

a. Broken spring coil or shock absorber.
b. Winch plus other aftermarket accessories installed on the front end of the vehicle.
c. Worn out control arm bushings.

d. Worn out ball joints.

e. Damaged frame or suspension components.

1. Check the tire pressure, the front tires should be at 26 psi and the rear tires at 28 psi, curb weight.
2. Ensure that the tires and the rims are original equipment as supplied by AM General.
3. Position the vehicle on a level surface.
4. Remove any load from the vehicle interior or the roof rack. Tools, luggage, recreational equipment or similar items may produce faulty measurements if left in the vehicle.
5. Jounce the vehicle front and rear 2-3 times and allow the suspension to settle.
6. Check the suspension height by measuring the distance between the bottom edge of each lower control arm front crossmember bracket and the shop floor as indicated by dimension "X" (Figure 9-68).

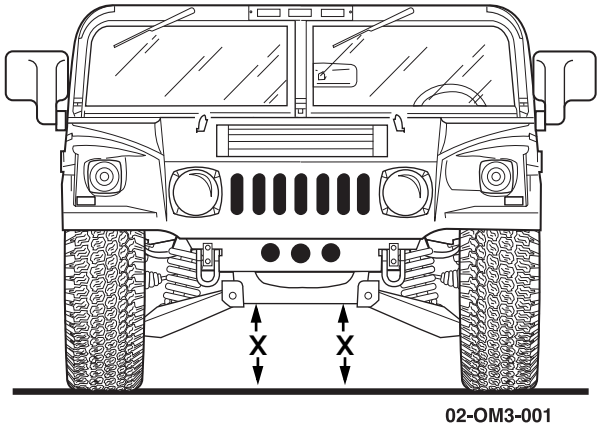


Figure 9-68: Suspension Height Measurement

a. Suspension height is acceptable if the height measured at each side is 16 inches (40.6 cm) or greater and the left right measurements do not differ more than 3/4" (19mm).

b. Replace the springs only if the height measured is less than 16 inches (40.6 cm) at either side, or if the right-left variation exceeds 3/4" (19mm).

GEARED HUB

NOTE: Replacement procedures are basically the same for the front and rear geared hubs. This procedure covers the front geared hub.

Removal

1. Remove the wheel.
2. Remove the drain plug from the geared hub and drain the geared hub (Figure 9-69).

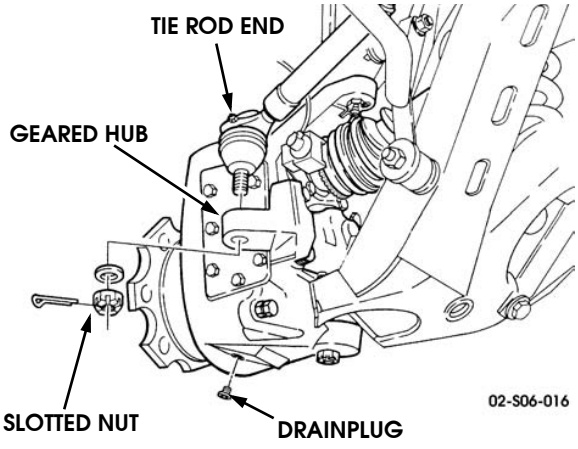


Figure 9-69: Geared Hub Drain plug Location

3. Install the drain plug in the geared hub.
4. Remove the bolt, washer and the vent line/speed sensor lead bracket from the geared hub (Figure 9-70).
5. Disconnect the vent line from the geared hub fitting.
6. Remove the speed sensor from the sensor bracket on the geared hub.
7. Remove the cotter pin, slotted nut and the washer from the tie rod end (Figure 9-69).
8. Using puller J–24319–B, disconnect the tie rod end from the geared hub.
9. Remove the access plug, washer, halfshaft retaining bolt, lockwasher and the halfshaft from the geared hub (Figure 9-70).

WARNING: Geared hub must be supported during removal and installation. Failure to support the geared hub may cause personal injury or damage to the equipment.

10. Remove the cotter pin and the slotted nut from the upper ball joint. Remove the ball joint stud from the geared hub.
11. Remove the cotter pin and the slotted nut from the lower ball joint. Remove the ball joint stud from the geared hub.
12. Lower the support and remove the geared hub.

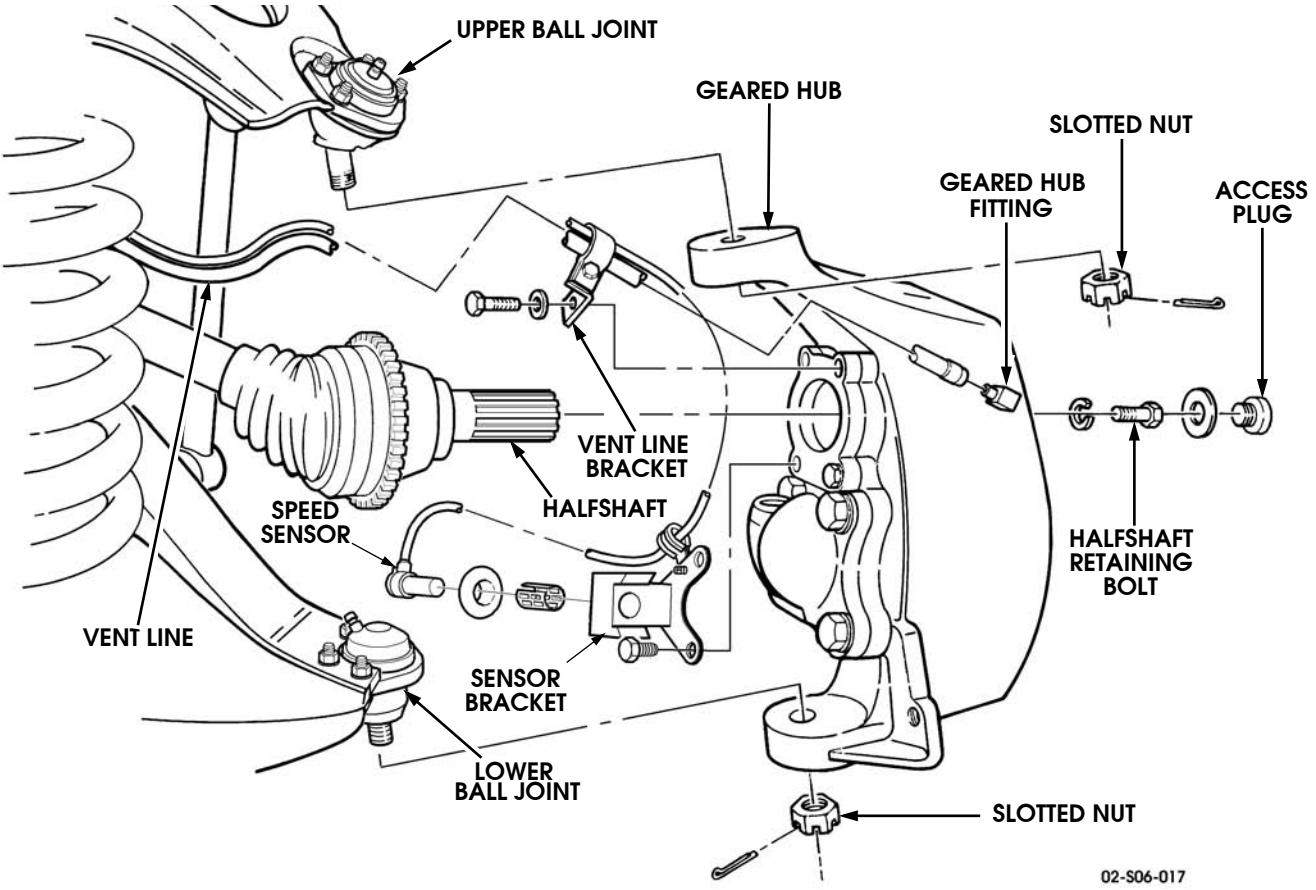


Figure 9-70: Geared Hub Replacement

Installation

WARNING: To avoid injury and damage to the equipment, support the geared hub during removal and installation.

1. Position the geared hub between the upper and the lower control arms and secure the upper ball joint to the geared hub with the slotted nut, but do not tighten (Figure 9-70).
2. Secure the lower ball joint to the geared hub with the slotted nut, but do not tighten.

NOTE: If necessary, tighten the slotted nut to install the cotter pin. When the slotted nuts are tightened to the prescribed torque values, the cotter pins must have a minimum of 50% engagement with the nut slots.

3. Tighten the slotted nut securing the upper ball joint to the geared hub to 65 lb-ft. (88 N•m). Install the cotter pin.
4. Slide the halfshaft into the geared hub.

NOTE: Make sure the mounting hole and the bolt are cleared of old Loctite.

1. Apply thread-locking compound to the halfshaft. retaining bolt and secure the halfshaft to the geared hub with the washer and the halfshaft retaining bolt. Tighten the halfshaft retaining bolt to 37 lb-ft. (50 N•m).
5. Secure the washer and access plug to the geared hub. Tighten the access plug to 8-13 lb-ft. (11-18 N•m).

NOTE: If necessary, tighten the slotted nut to install the cotter pin.

6. Tighten the slotted nut securing the lower ball joint to the geared hub to 73 lb-ft. (99 N•m). Install cotter pin.
7. Insert the tie rod end into the geared hub and secure with the washer and the slotted nut. Tighten the slotted nut to 70 lb-ft. (95 N•m). Install the cotter pin (Figure 9-71).
8. Connect the vent line to the geared hub fitting (Figure 9-72).
9. Install the speed sensor in the sensor bracket and push in until the sensor contacts the tone wheel on the halfshaft.
10. Secure the vent line, speed sensor lead and the clamp to the geared hub with the washer and the bolt. Tighten the bolt to 38 lb-ft. (52 N•m) (the left side of vehicle uses two p-clamps to secure the speed sensor lead to the geared hub).

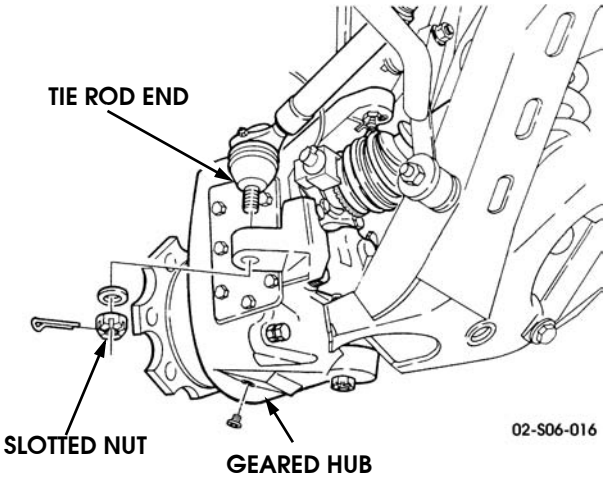


Figure 9-71: Tie Rod End Into Geared Hub

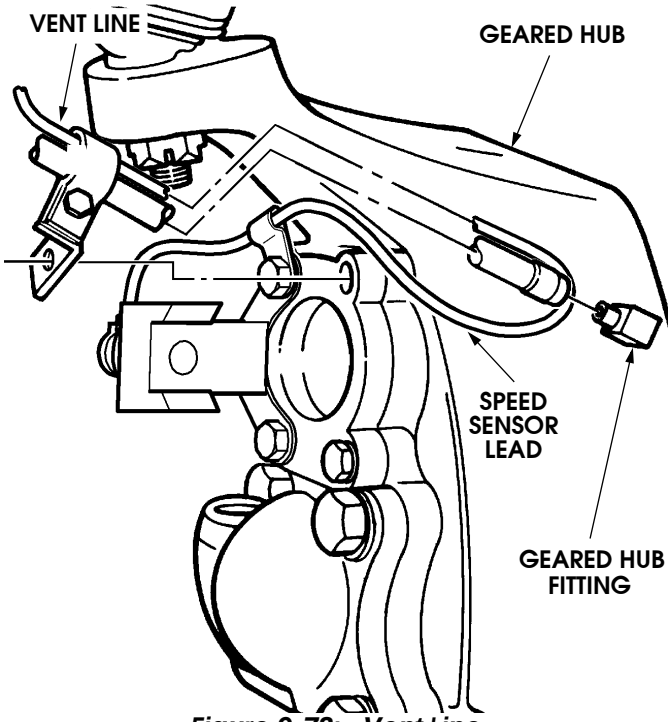


Figure 9-72: Vent Line

11. Install the speed sensor and the retaining sleeve into the speed sensor bracket and push in until the sensor touches the tone wheel.
12. Remove the fill plug and the washer from the geared hub (Figure 9-73).

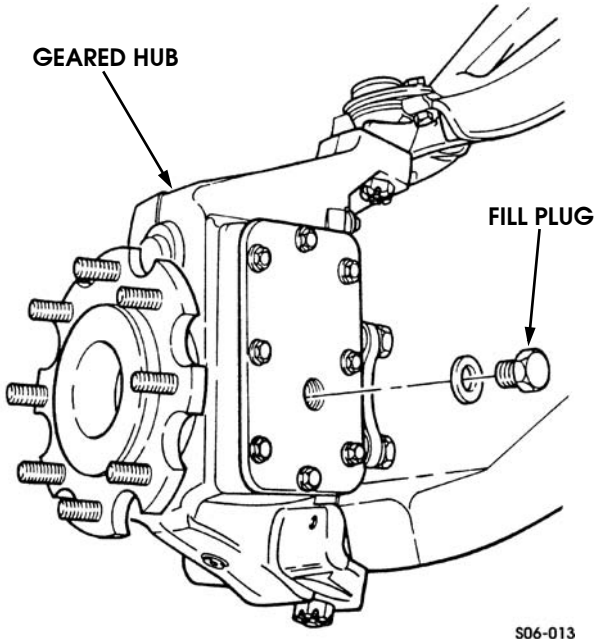


Figure 9-73: Geared Hub Fill Plug

13. Fill the geared hub to the proper oil level (Refer to section 1).
14. Install the washer and the fill plug on the geared hub. Tighten the fill plug to 8-13 lb-ft. (11-18 N•m).
15. Install the wheel.
16. Check the alignment.

Geared Hub Side Cover Replacement

NOTE: Geared hub side cover replacement procedures are basically the same for the front and the rear covers. This procedure covers the front side cover.

Removal

1. Remove the wheel.
2. Remove the drain plug from the geared hub and drain the geared hub (Figure 9-74).
3. Install the drain plug in the geared hub.
4. Remove the eight bolts, washers and the side cover from the geared hub.

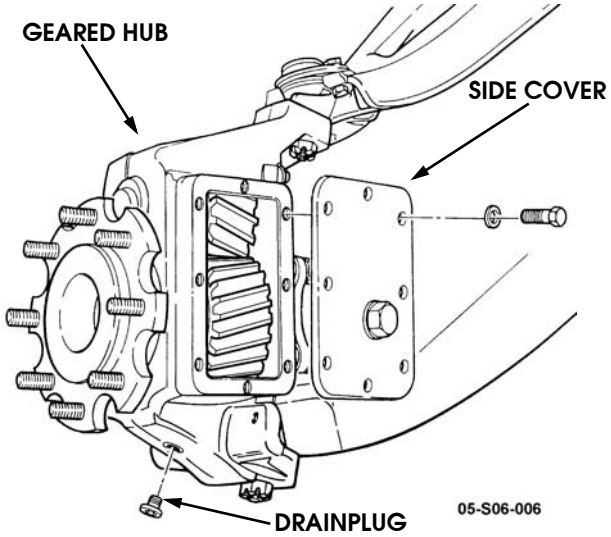


Figure 9-74: Geared Hub Side Cover Replacement

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage and replace if necessary.

1. Using solvent, clean and dry the side cover.
2. Inspect the side cover for damage.

Installation

1. Apply anaerobic sealant to the side cover and allow to set until tacky.
2. Apply thread-locking compound to the bolts and install the side cover to the geared hub with the eight washers and the bolts. Tighten the bolts to 15 lb-ft. (20 N•m).
3. Fill the geared hub to the proper oil level (Refer to section 1).
4. Install the wheel.

Geared Hub Input Seal Replacement

Removal

1. Remove the wheel.
2. Remove the access plug and the washer from the geared hub (Figure 9-70).
3. Remove the halfshaft retaining bolt, lockwasher and the halfshaft from the geared hub. Remove the v-seal from c-v joint (Figure 9-77).

CAUTION: *Shim gaskets must be reused to maintain proper drive gear bearing adjustment.*

4. Remove the bolt, washer and the vent line/speed sensor lead bracket from the drive gear retainer (Figure 9-75).

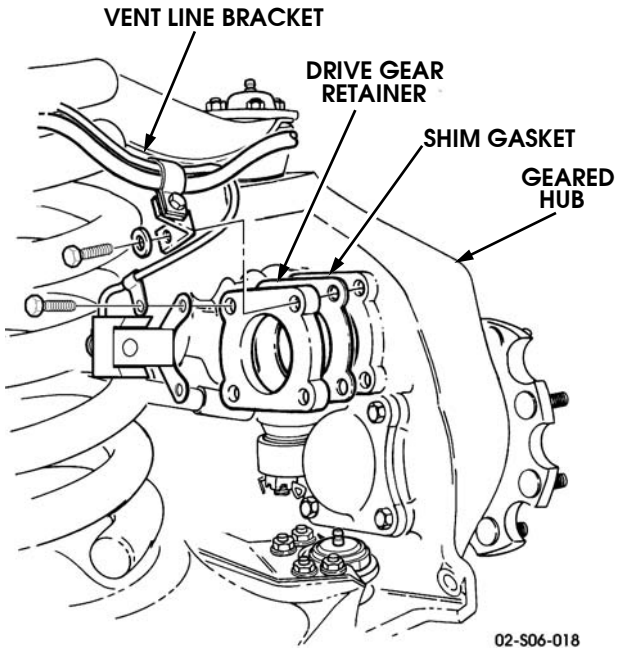


Figure 9-75: Geared Hub Shim Gasket Location

5. Remove the remaining bolts, washers, speed sensor bracket, drive gear retainer and the shim gasket(s) from the geared hub.
6. Secure the drive gear retainer in a vise with inserts and remove the input seal. Discard the input seal (Figure 9-76).

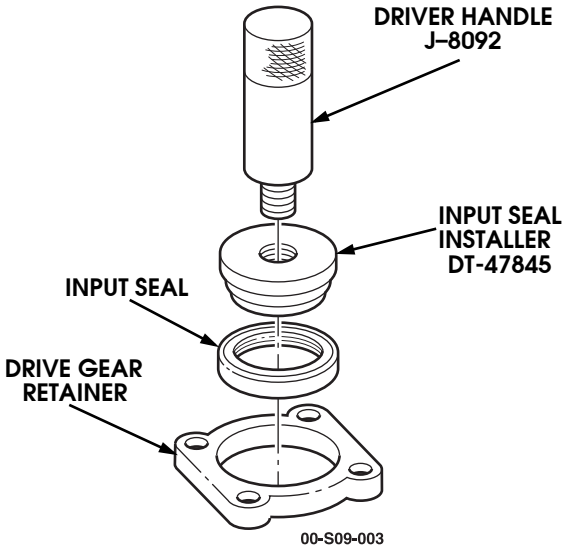


Figure 9-76: Input Seal Installation

Installation

1. Using driver handle J–8092 and input seal installer DT-47845, install the input seal in the drive gear retainer. Place the new primary seal on the installer with the open side of the seal facing toward the drive gear retainer. Drive the seal in until the installer bottoms against the drive gear retainer. The seal will be recessed in the drive gear retainer approximately 0.200". This dimension is critical and must be achieved using the special tool (Figure 9-76).
2. Secure the shim gasket(s) and the drive gear retainer to the geared hub with the washers and the bolts (Figure 9-75).
3. Secure the vent line bracket and the speed sensor bracket to the drive gear retainer with the washers and the bolts. Tighten all four bolts to 38 lb-ft. (52 N•m).
4. Coat the lip of the input seal with gear oil (Figure 9-76).

5. Stretch the v-seal over the seal area of the halfshaft with the thick side against the c-v joint (Figure 9-77). Lubricate the thin side of the v-seal with an all purpose grease. This portion of the v-seal will contact the stainless steel portion of the primary seal when the halfshaft is installed.

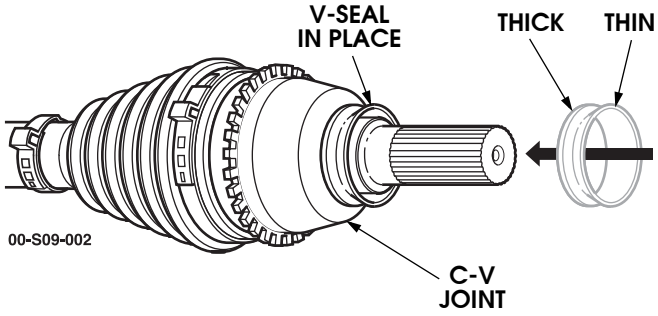


Figure 9-77: V-Seal Replacement

NOTE: Be sure that the bolt and the bolt hole are cleaned of old Loctite.

6. Apply thread-locking compound to the halfshaft retaining bolt and secure the halfshaft to the geared hub with the lockwasher and the halfshaft retaining bolt. Tighten the halfshaft retaining bolt to 37 lb-ft. (50 N•m) (Figure 9-78).
7. Secure the washer and the access plug onto the geared hub. Tighten the access plug to 8-13 lb-ft. (11-18 N•m).
8. Install the wheel.

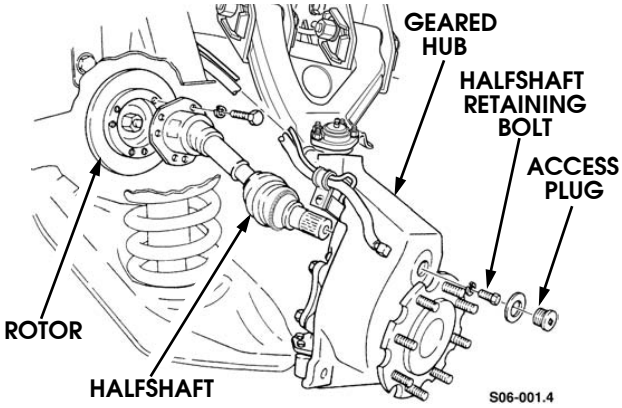


Figure 9-78: Halfshaft and Geared Hub

Geared Hub Repair

Disassembly

1. Remove the geared hub.
2. Position the geared hub with the spindle supporting the geared hub (Figure 9-79).

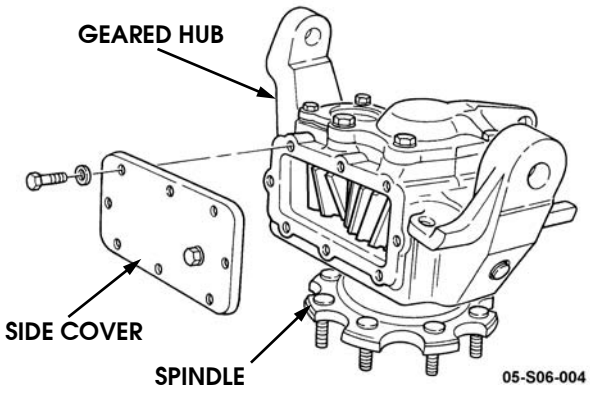


Figure 9-79: Geared Hub Disassembly

3. Remove the eight bolts, washers and the side cover from the geared hub.

CAUTION: *If backlash between the drive and the driven gears is more than 0.018 in. (0.46 mm), both gears must be replaced.*

4. Mount the dial indicator J–8001 on the geared hub and index the indicator to register from one drive gear tooth. Move drive gear back and forth while holding the driven gear stationary to read the backlash (Figure 9-80).

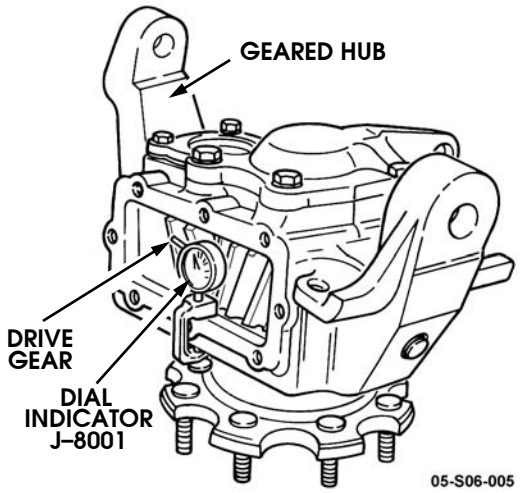


Figure 9-80: Dial Indicator Positioning

5. Remove the four bolts, washers and the steering arm cover from the geared hub (Figure 9-81).
6. Remove the clamp nut lock screw from the clamp nut.
7. Using the clamp nut socket J-42545, remove the clamp nut and keyed washer from the spindle.

NOTE: It may be necessary to lightly tap the threaded end of the spindle to release it from the inner spindle bearing.

8. Lift the geared hub off the spindle.
9. Remove the inner bearing, bearing spacer and the driven gear from the geared hub.
10. Remove the outer bearing spacer from the spindle.
11. Remove the four bolts, washers, drive gear retainer, shim gasket, inboard bearing cup and the drive gear from the geared hub (Figure 9-82).
12. Remove the retaining washer from the inside drive gear or the geared hub.
13. Remove the spindle seal from the geared hub. Discard the seal.
14. Remove the input seal from the drive gear retainer. Discard the seal (Figure 9-83).

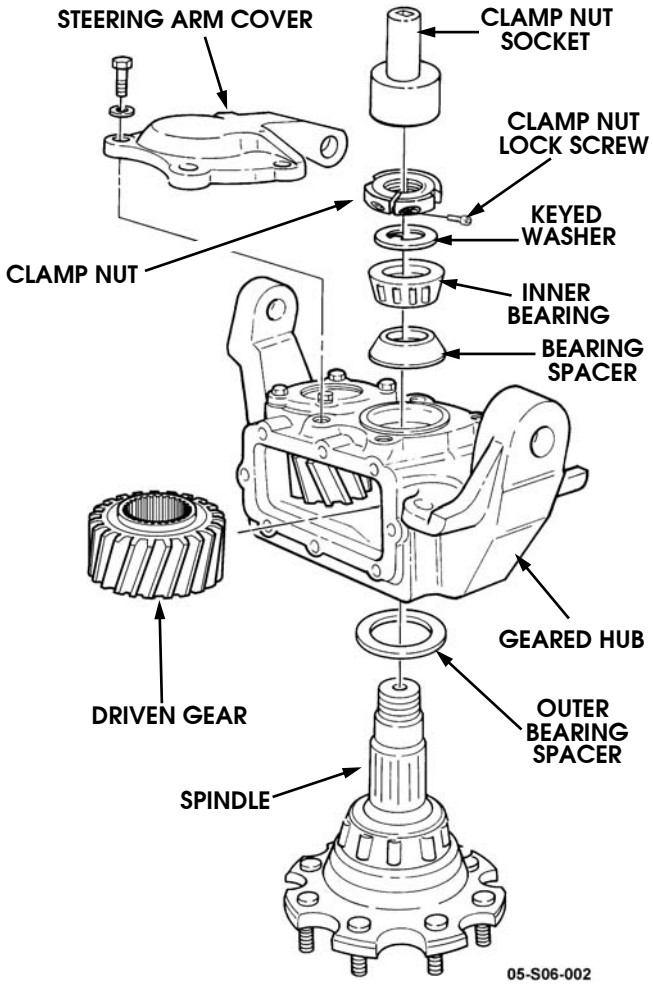


Figure 9-81: Geared Hub Breakdown

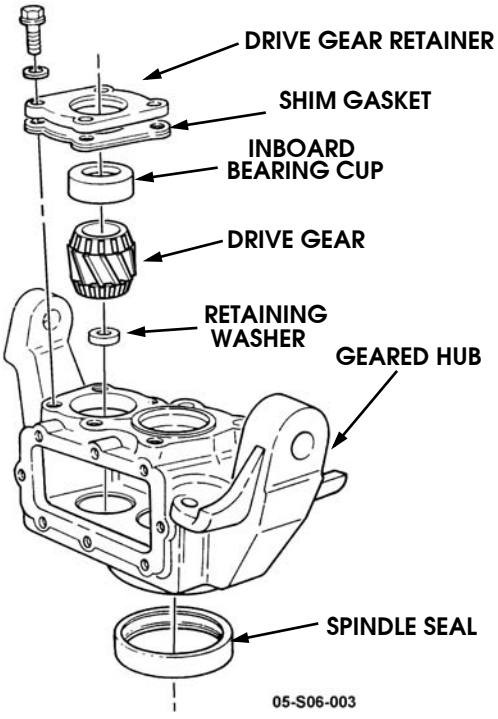


Figure 9-82: Drive Gear Removal

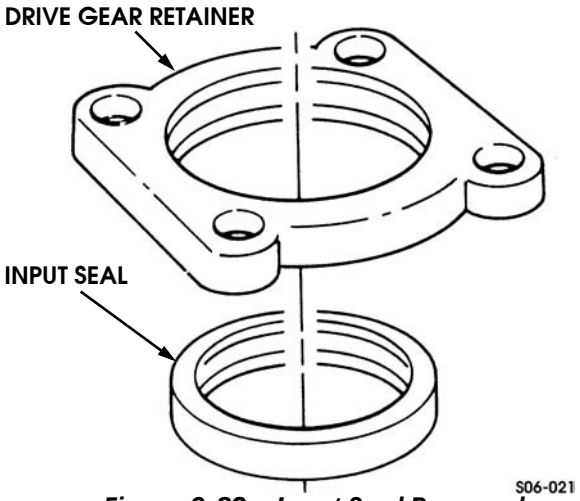


Figure 9-83: Input Seal Removal

Inspection

NOTE: Clean all the components, examine for wear or damage and replace if necessary. The drive and the driven gears must be replaced as matched set (Figure 9-84).

1. Inspect the splines and the gear teeth on the drive gear and the driven gear for damage.
2. Inspect the spindle for damage and rough or corroded sealing surface.
3. Inspect all the bearings and the bearing races for damage.
4. Inspect the steering arm cover for damage.
5. Inspect the geared hub and all the threaded holes for damage. Repair any damaged holes using thread repair inserts.

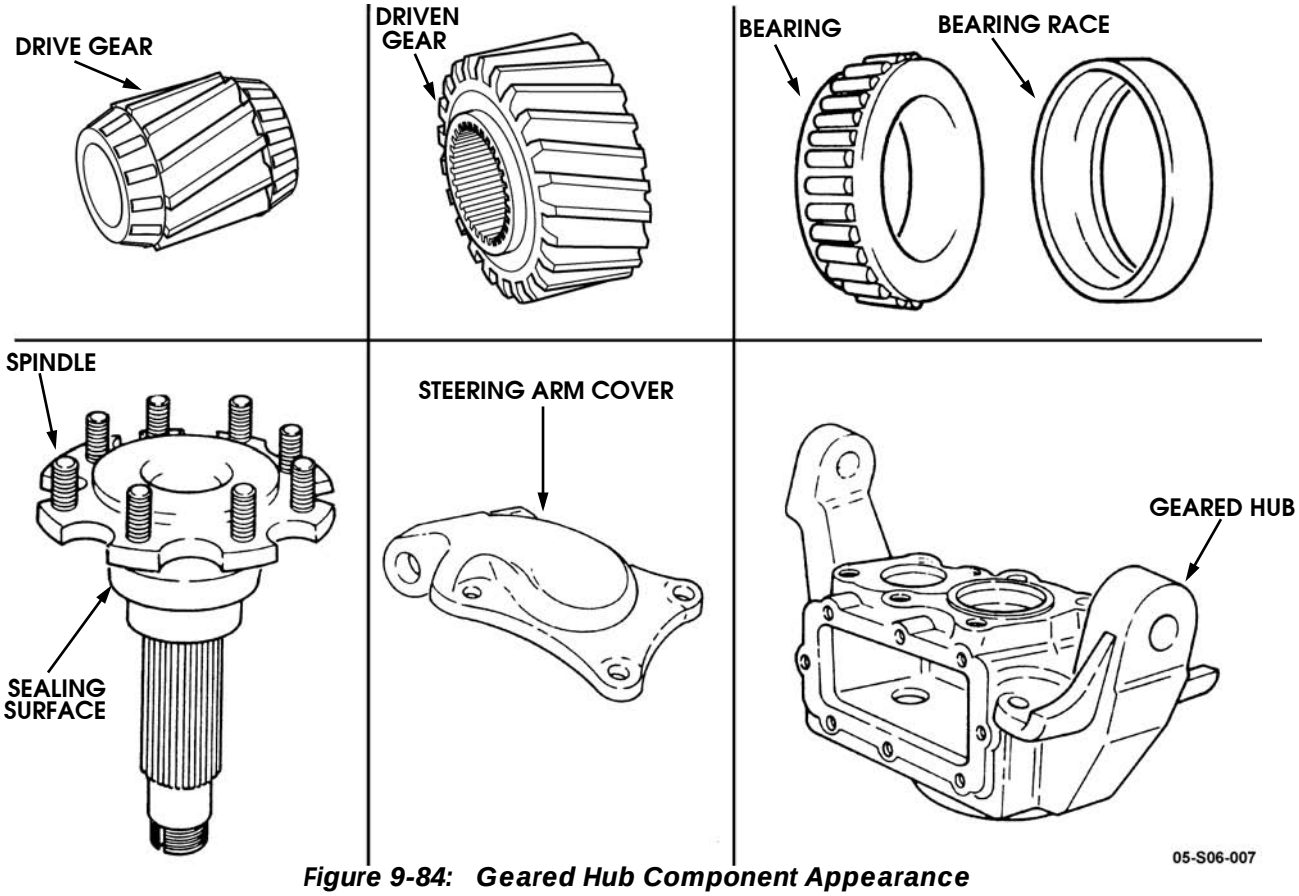


Figure 9-84: Geared Hub Component Appearance

Assembly

1. Place the new output seal on the installer DT-47846 with the seam in the perimeter facing the geared hub and drive the seal in until the seal bottoms out on the geared hub surface. The seal will be bottomed out in the recess of the geared hub. (Figure 9-85).

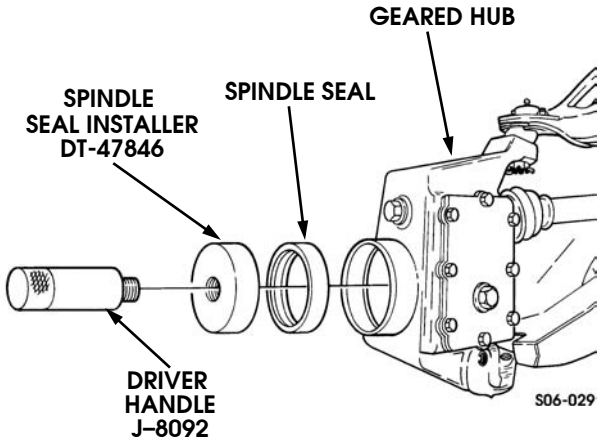


Figure 9-85: Spindle Seal Installation

2. Using driver handle J–8092 and input seal installer DT-47845, install the input seal in the drive gear retainer. Place the new primary seal on the installer with the open side of the seal facing toward the drive gear retainer. Drive the seal in until the installer bottoms against the drive gear retainer. The seal will be recessed in the drive gear retainer approximately 0.200". This dimension is critical and must be achieved using the special tool (Figure 9-86).

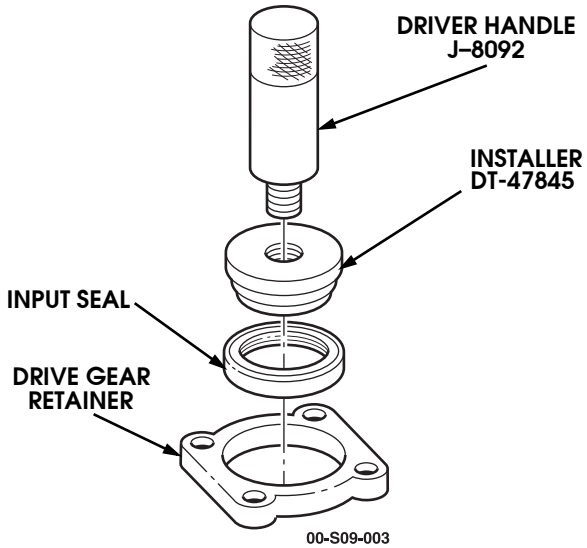


Figure 9-86: Input Seal Installation

3. Install the retaining washer in the shallow end of the drive gear (Figure 9-87).

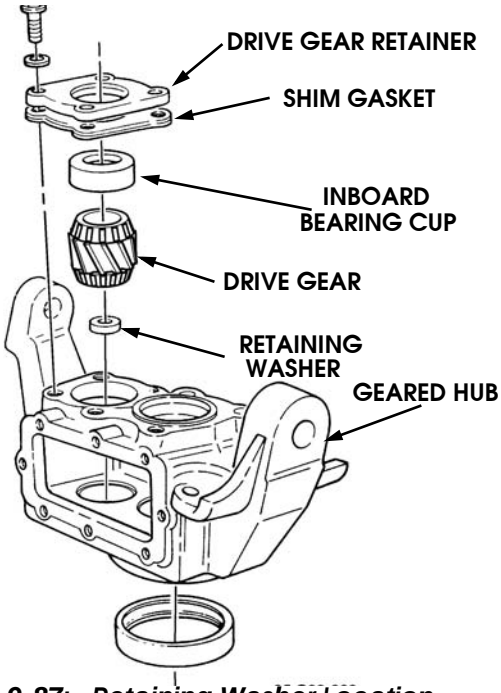


Figure 9-87: Retaining Washer Location

4. Install the drive gear and the inboard bearing cup in the geared hub.
5. Apply thread-locking compound on the bolts. Secure the shim gasket and the drive gear retainer to the geared hub with the four washers and the bolts. Tighten the bolts to 25-35 lb-ft. (40-48 N•m).
6. Mount the dial indicator on the geared hub and index the indicator to register on the end of the drive gear (Figure 9-88).

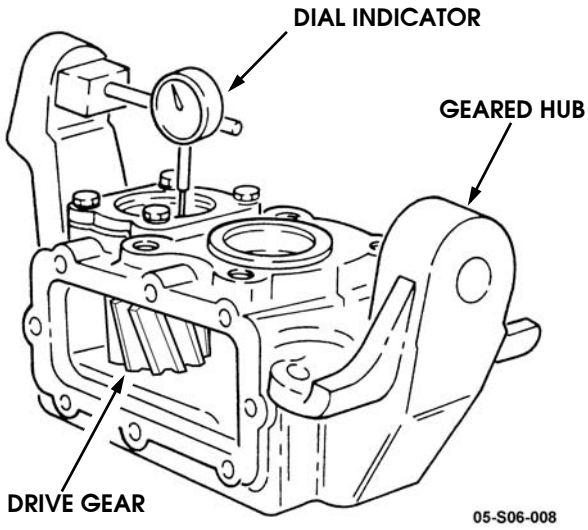


Figure 9-88: Dial Indicator Positioning

7. Move the drive gear up and down to read the end play. End play should be 0.001-0.006 in. (0.03-0.15 mm). If end play is incorrect, add or subtract the shim gaskets and recheck the end play.
8. Install the driven gear and the bearing spacer in the geared hub (Figure 9-89).

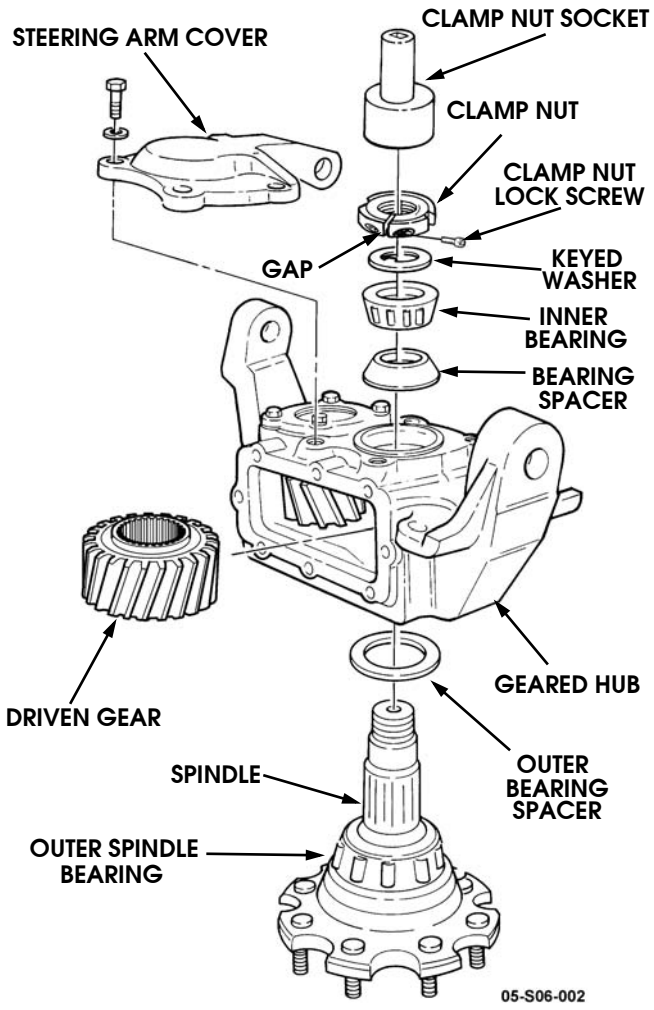


Figure 9-89: Geared Hub Driven Gear Installation

9. Install the outer bearing spacer on the spindle.
10. Lower the geared hub onto the spindle and align the splines on the driven gear with the splines on the spindle. Ensure the outer spindle bearing seats in the bearing cup.
11. Install the inner bearing and keyed washer on the spindle.

NOTE: After the clamp nut lock screw is installed into the clamp nut, the clamp nut must be completely installed on the spindle within a ten minute limit.

12. Tighten the clamp nut lock screw three to five turns into the clamp nut.

CAUTION: *Ensure the clamp nut is installed on the spindle with boss (protruding side) facing inward toward the bearing and the large chamfer side with engraved part number facing away from the bearing.*

13. Apply a thin coat of grease to the boss (protruding side) of clamp nut and install the clamp nut on the spindle.

NOTE: If an excessive amount of torque 18-26 lb-in. (2-3 N•m) is required to tighten the clamp nut lock screw to remove clamp nut wobble, remove the screw. Ensure the threads of the clamp nut are clean and free of Loctite. Replace the screw with a new one or remove all the previously applied Loctite from the threads of the old screw and apply fresh Loctite 272 to the old screw threads prior to reinstallation. Use a hexagon head socket with a calibrated torque wrench J-42546 to tighten and check the torque of the screw.

14. Tighten the clamp nut lock screw until all the clamp nut wobble is removed and the clamp nut can still be rotated by hand.

15. Using the clamp nut socket J–42545, tighten the clamp nut to 40 lb-ft. (54 N•m). Rotate the spindle five revolutions both clockwise and counterclockwise to seat the bearings.
16. Loosen and retighten the clamp nut to 25 lb-ft. (34 N•m).

NOTE: Ensure that the clamp nut does not move while the clamp nut lock screw is being tightened.

17. Using a hexagon-head socket and a pre-set calibrated torque wrench J-42546, tighten the clamp nut lock screw to 90 lb-in. (10 N•m).
18. Mark a temporary line across the end of the spindle and the clamp nut.

NOTE: Using a feeler gauge, ensure a gap exists between the clamp nut gap surfaces. If no gap exists, remove and discard the clamp nut lock screw and the clamp nut. Acquire a new screw and nut and repeat steps 12-18.

19. Using a preset torque wrench J-42547, apply pressure to the clamp nut in a counterclockwise direction until the torque wrench clicks, indicating 90 lb-ft. (122 N•m) of loosening torque was applied to the complaint.

NOTE: The clamp nut should not move. To verify no movement occurred, check the temporary mark across the spindle and clamp nut. If the clamp nut moves, remove and discard the clamp nut lock screw and the clamp nut. Repeat steps 12-19 with a new screw and nut.

20. Paint or scribe a permanent line across the end of the spindle and the clamp nut.

NOTE: Immediately install the steering arm cover after application of sealer.

21. Clean the sealing surfaces on the geared hub and the steering arm cover. Apply anaerobic sealer to the steering arm cover and secure the steering arm cover to the geared hub.

NOTE: Make sure the bolts and the holes are free of old Loctite.

22. Apply thread-locking compound to the bolts. Secure the steering arm cover to the geared hub with the four washers and the bolts. Tighten the bolts to 65 lb-ft. (88 N•m).
23. Clean the sealing surfaces on the geared hub and the side cover. Apply anaerobic sealer to the side cover and install on the geared hub (Figure 9-90).

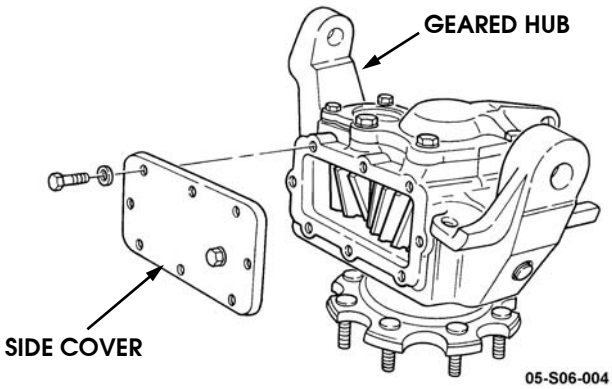


Figure 9-90: Geared Hub Side Cover Removal

NOTE: Make sure the bolts and the holes are free of old Loctite.

24. Apply thread-locking compound to the bolts. Secure the side cover to the geared hub with the eight washers and the bolts. Tighten the bolts to 8-13 lb-ft. (11-18 N•m).
25. Install the geared hub.

Geared Hub Spindle Seal Replacement

Removal

1. Remove the wheel.
2. Remove the drain plug from the geared hub and drain the geared hub oil. Install the drain plug in the geared hub. Tighten the drain plug to 8-13 lb-ft. (11-18 N•m) (Figure 9-91).

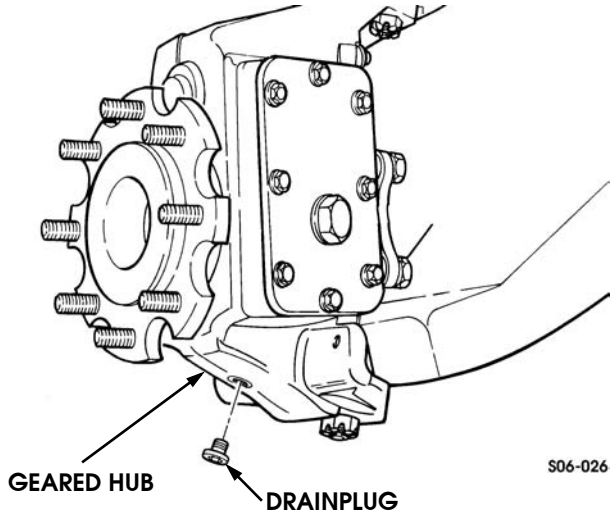


Figure 9-91: Geared Hub Drain plug Removal

3. Remove the four bolts, washers and the steering arm cover from the geared hub (Figure 9-92).

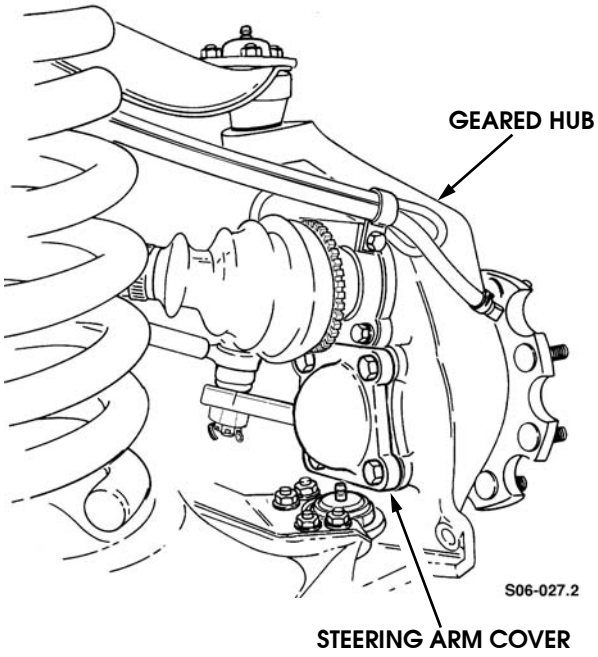


Figure 9-92: Geared Hub Steering Arm Cover Removal

4. Remove the clamp nut lock screw from the clamp nut (Figure 9-93).

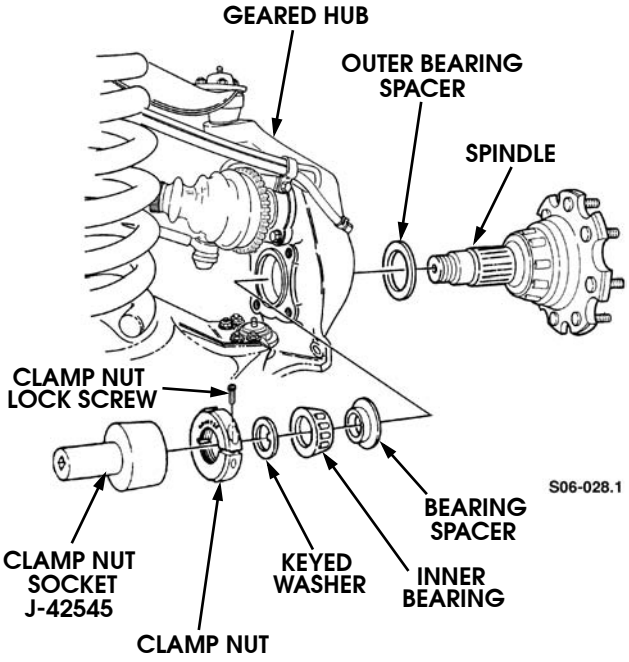


Figure 9-93: Clamp Nut Removal

5. Using the clamp nut socket J–42545, remove the clamp nut and the keyed washer from the spindle.
6. Remove the spindle, bearing spacer, inner bearing and the outer bearing spacer from the geared hub.
7. Remove the spindle seal from the geared hub. Discard the spindle seal (Figure 9-94).

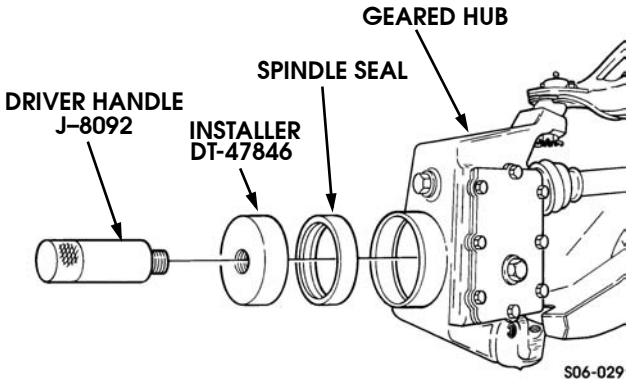


Figure 9-94: Spindle Seal Removal

Cleaning and Inspection

1. Inspect the spindle for rough or corroded sealing surface. Replace if damaged (Figure 9-93).
2. Inspect the bearings for damage. Replace if damaged.

Installation

1. Place the new output seal on the installer DT-47846 and drive the seal in until the seal bottoms out in the recess of the geared hub (Figure 9-94).
2. Coat the seal with lubricating oil.
3. Install the outer bearing spacer and the spindle in the geared hub (Figure 9-93).
4. Install the bearing spacer, inner bearing and the keyed washer on the spindle.

NOTE: After the clamp nut lock screw is installed into the clamp nut, the clamp nut must be completely installed on the spindle within a ten minute limit.

5. Tighten the clamp nut lock screw three to five turns into the clamp nut.

CAUTION: *Ensure the clamp nut is installed on the spindle with the boss (protruding side) facing inward toward the bearing and the large chamfer side with the engraved part number facing away from the bearing.*

6. Apply a thin coat of grease to the boss (protruding side) of the clamp nut and install the clamp nut on the spindle.
7. If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten the clamp nut lock screw to remove the clamp nut wobble, remove the clamp nut lock screw. Ensure the threads of the clamp nut are clean and free of Loctite. Replace the screw with a new one or remove all the previously applied Loctite from the threads of the old screw and apply fresh Loctite 272 to the old screw threads prior to reinstallation. Use a hex socket and a torque wrench to tighten and check the screw torque.
8. Tighten the clamp nut lock screw until all the clamp nut wobble is removed but clamp nut can still be rotated by hand.
9. Using the clamp nut socket J–42545, tighten the clamp nut to 40 lb-ft. (54 N•m) (Figure 9-95). Rotate the spindle five revolutions both clockwise and counterclockwise to seat bearings.
10. Loosen and retighten the clamp nut to 25 lb-ft. (34 N•m).

NOTE: Ensure the clamp nut does not move while the clamp nut lock screw is being tightened.

11. Tighten the clamp nut lock screw to 90 lb-in. (10 N•m) with pre set torque wrench J-42546.
12. Mark a temporary line across the end of the spindle and the clamp nut. Then, using a feeler gauge, ensure a gap exists between the clamp nut gap surfaces. If no gap exists, remove and discard the clamp nut lock screw and the clamp nut. Acquire a new screw and nut and repeat steps 5-12.
13. Apply 90 lb-ft. (122 N•m) of loosening torque to the clamp nut with pre set torque wrench J-42547. The clamp nut should not move. To verify no movement occurred, check the temporary mark across the spindle and the clamp nut. If the clamp nut moved, remove and discard the clamp nut lock screw and the clamp nut. Repeat steps 5-13 with a new screw and nut.

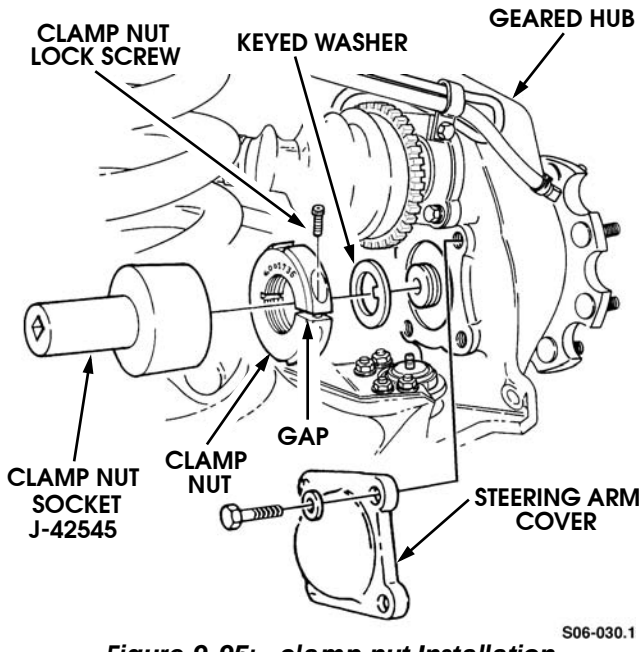


Figure 9-95: clamp nut Installation

14. Paint or scribe a permanent line across the end of the spindle and the clamp nut.
15. Clean the sealing surfaces on the geared hub and the steering arm cover. Apply Loctite 518 sealant to the steering arm cover and install on the geared hub.
16. Apply thread-locking compound to the bolt threads and install the steering arm cover on the geared hub with the four washers and the bolts. Tighten the bolts to 65 lb-ft. (88 N•m).
17. Remove the fill plug and the washer from the geared hub (Figure 9-96).

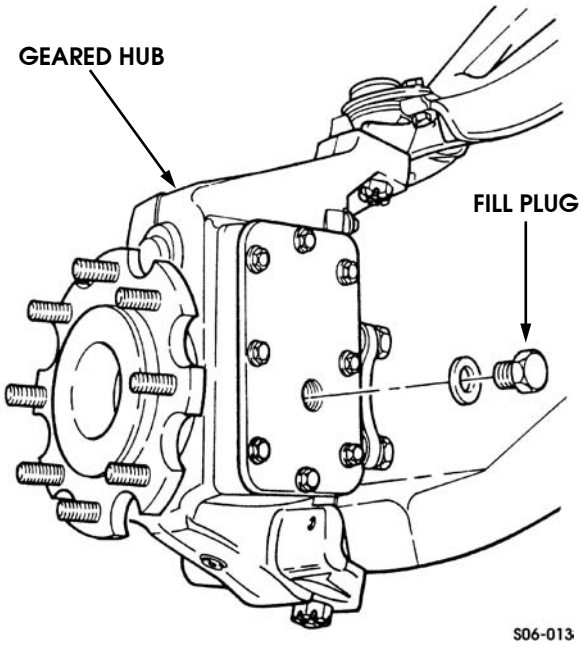


Figure 9-96: Geared Hub Fill Plug Location

18. Fill the geared hub to the proper oil level (Refer to section 1).
19. Secure the washer and the fill plug to the geared hub. Tighten the fill plug to 8-13 lb-ft. (11-18 N•m).
20. Install the wheel.

Geared Hub Spindle Bearing Adjustment

Adjustment

1. Remove the wheel.
2. Remove the drain plug and drain the geared hub oil. Install the drain plug into the geared hub. Tighten the drain plug to 8-13 lb-ft. (11-18 N•m) (Figure 9-97).
3. Remove the four bolts, washers and the steering arm cover from the geared hub. Push the steering arm cover away from the geared hub (Figure 9-99).
4. Remove the clamp nut lock screw from the clamp nut.
5. Using the clamp nut socket, remove the clamp nut and the keyed washer from the spindle.
6. After the clamp nut lock screw is installed into the clamp nut, the clamp nut must be completely installed on the spindle within a ten minute limit.

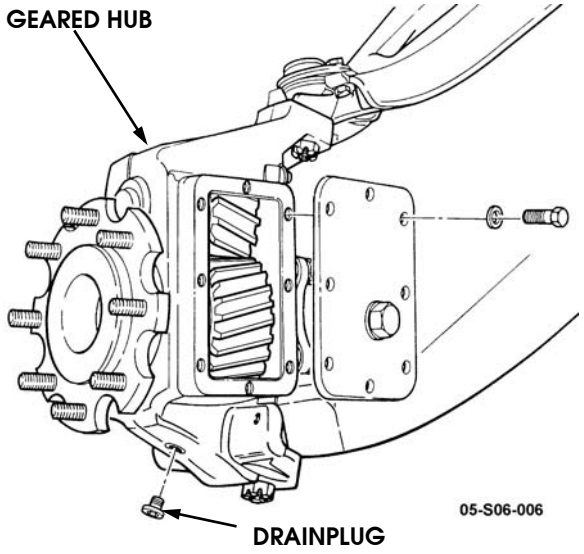


Figure 9-97: Geared Hub Drain plug Location

7. Tighten the clamp nut lock screw three to five turns into the clamp nut.

CAUTION: *Ensure the clamp nut is installed on the spindle with the boss (protruding side) facing inward toward the bearing and the large chamfer side with the engraved part number is facing away from the bearing.*

8. Apply a thin coat of grease to the boss (protruding side) of the clamp nut and install the clamp nut on the spindle.

NOTE: If an excessive amount of torque (18-26 lb-in. (2-3 N•m)) is required to tighten the clamp nut lock screw to remove the clamp nut wobble, remove the screw. Ensure the threads of the clamp nut are clean and free of Loctite. Replace the screw with a new one or remove all the previously applied Loctite from threads of the old screw and apply fresh Loctite 272 to the old screw threads prior to reinstallation. Use a hex socket and a torque wrench to tighten and check the screw torque.

9. Tighten the clamp nut lock screw until all the clamp nut wobble is removed and the clamp nut can still be rotated by hand.
10. Using the clamp nut socket J-42547, tighten the clamp nut to 40 lb-ft. (54 N•m). Rotate the spindle five revolutions both clockwise and counterclockwise to seat the bearings (Figure 9-98).

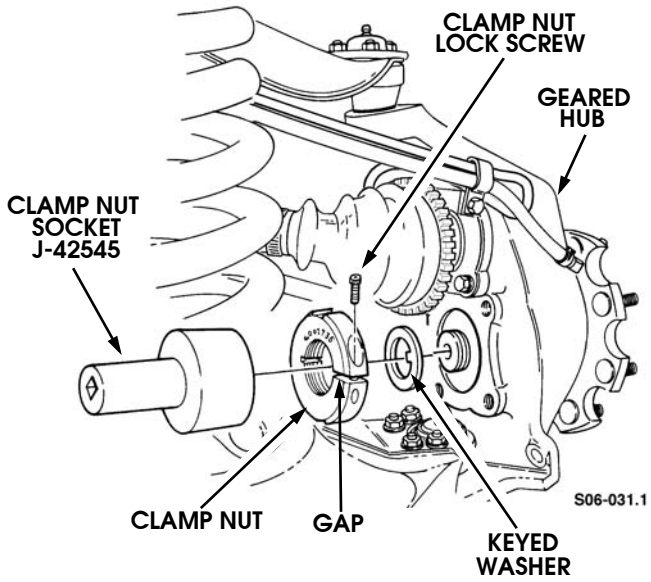


Figure 9-98: Clamp Nut Installation

11. Loosen and retighten the clamp nut to 25 lb-ft. (34 N•m).

NOTE: Ensure the clamp nut does not move while the clamp nut lock screw is being tightened.

12. Using a hexagon-head socket and a pre-set calibrated torque wrench J-42546, tighten the clamp nut lock screw to 90 lb-in. (10 N•m).
13. Mark a temporary line across the end of the spindle and the clamp nut.

NOTE: Using a feeler gauge, ensure a gap exists between the clamp nut gap surfaces. If no gap exists, remove and discard the clamp nut lock screw and the clamp nut. Acquire a new screw and nut and repeat steps 6-12.

14. Using a pre-set torque wrench J-42547, apply pressure to the clamp nut in a counterclockwise direction until the torque wrench clicks, indicating 90 lb-ft. (122 N•m) of loosening torque was applied to the clamp nut.

NOTE: The clamp nut should not move. To verify no movement occurred, check the temporary mark across the spindle and the clamp nut. If the clamp nut moved, remove and discard the clamp nut lock screw and the clamp nut. Repeat steps 6-13 with a new screw and nut.

15. Paint or scribe a permanent line across the end of the spindle and the clamp nut.

NOTE: Immediately install the steering arm cover after application of sealant.

16. Clean the sealing surfaces on the geared hub and the steering arm cover. Apply anaerobic sealant to the steering arm cover and install it on the geared hub (Figure 9-99).

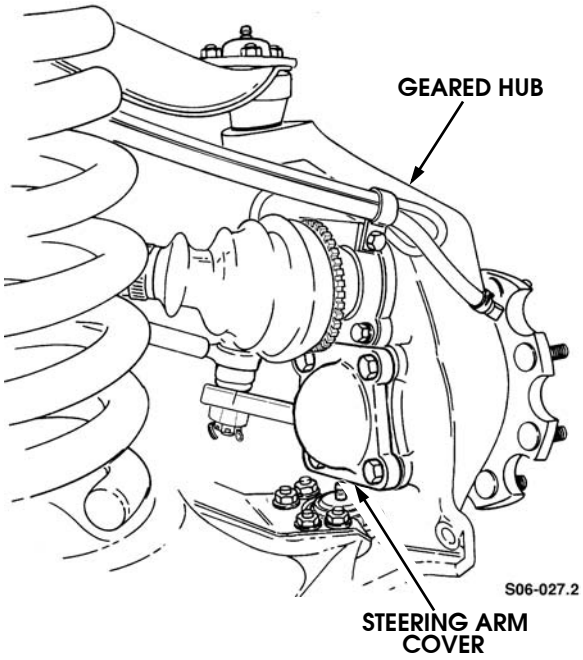


Figure 9-99: Steering Arm Cover Installation

NOTE: Thoroughly clean the old Loctite before applying fresh Loctite.

17. Apply thread-locking compound to the bolt threads and secure the steering arm cover to the geared hub with the four washers and the bolts. Tighten the bolts to 65 lb-ft. (88 N•m).
18. Remove the fill plug and washer from the geared hub (Figure 9-96).
19. Fill the geared hub to the proper oil level (Refer to section 1).
20. Secure the washer and the fill plug to the geared hub. Tighten the fill plug to 8-13 lb-ft. (11-18 N•m).

Geared Hub Spindle Stud Replacement

WARNING: Always wear eye protection when replacing spindle studs. Severe eye injury may result if metal chips contact eyes.

Removal

1. Remove the wheel.
2. Rotate the spindle to allow clearance for removal of the stud from the spindle (Figure 9-100).
3. Drive the stud from the spindle. Discard the stud.

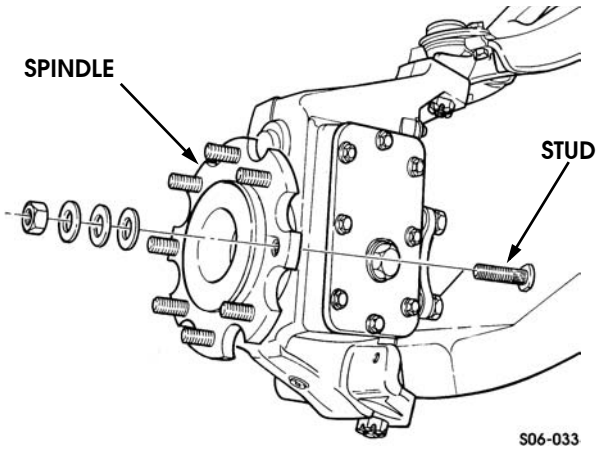


Figure 9-100: Geared Hub Spindle Stud Removal

Installation

1. Install the stud in the spindle (Figure 9-100).
2. Install three flat washers and a hex nut on the stud.
3. Tighten the hex nut until the head on the stud seats against the spindle.
4. Remove and discard the hex nut and the three flat washers.

Geared Hub Vent Line Replacement

NOTE: All the geared hub vent line replacement procedures are basically the same. This procedure covers the right rear geared hub vent line.

Removal

NOTE: The speed sensor lead is retained by the vent line clamps and should be removed and reinstalled with care when replacing the vent line.

1. Disconnect the vent line from the geared hub fitting (Figure 9-102).
2. Remove the bolt, clamp and the vent line from the bracket.
3. Remove the bolt, clamp and the vent line from the control arm.
4. Remove the bolt, clamp and the vent line from the bracket.
5. Remove the bolt, clamp and the vent line from the frame (Figure 9-101).
6. Disconnect the vent line from the tee fitting.

Installation

1. Secure the vent line to the frame with the clamp and bolt (Figure 9-101).
2. Secure the vent line to the bracket with the clamp and bolt (Figure 9-102).
3. Connect the vent line to the tee fitting and the geared hub fitting.
4. Secure the vent line to control arm the with clamp and bolt.

NOTE: Position the clamp at a 45 degree angle toward the wheel before securing with the bolt.

5. Secure the vent line to the bracket with the clamp and bolt.

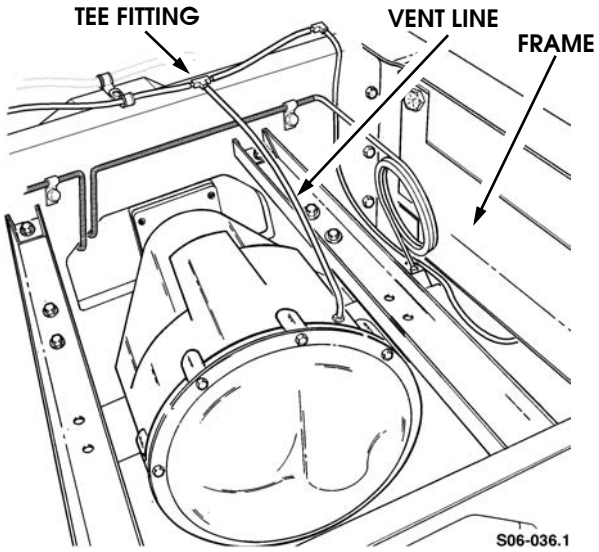


Figure 9-101: Vent Line

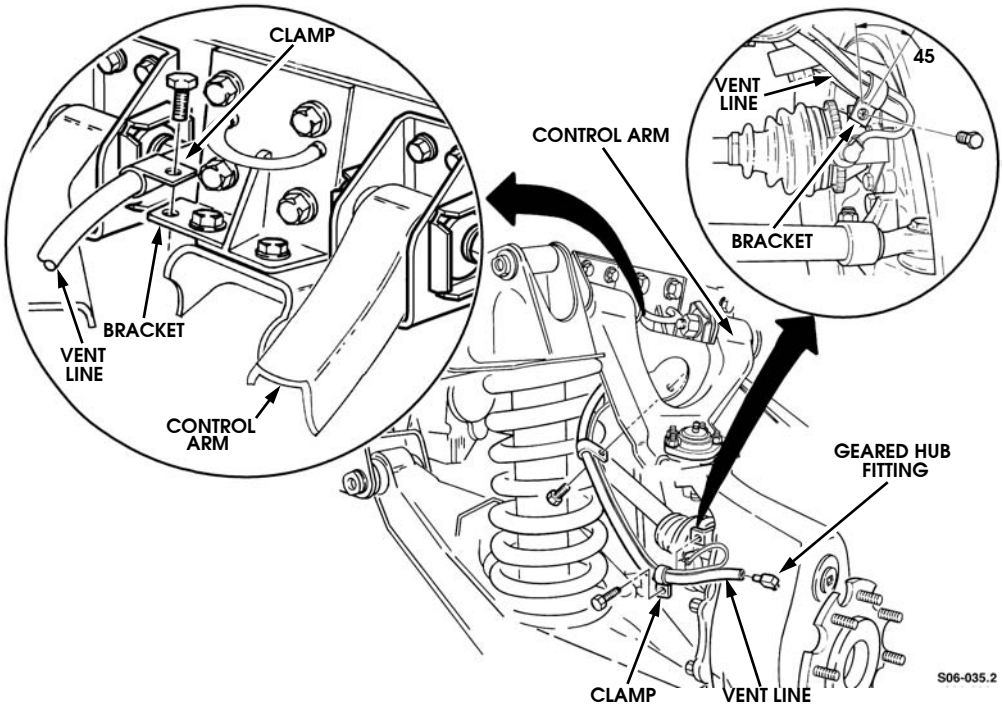


Figure 9-102: Geared Hub Vent Line Positioning

STABILIZER BAR

Removal

1. Remove the two locknuts, three washers and the pin securing the bar link to the stabilizer bar (Figure 9-103).
2. Remove the two locknuts, washers, clamp and the stabilizer bar from the frame bracket.
3. Remove the bushing from the stabilizer bar.

Installation

1. Install the bushing on the stabilizer bar (Figure 9-103).
2. Install the stabilizer bar on the frame bracket with the clamp, two washers and the locknuts. Tighten the locknuts to 60 lb-ft. (81 N•m).
3. Install the stabilizer bar on the bar link with the pin, three washers and the two locknuts. Tighten the locknuts to 75 lb-ft. (102 N•m).

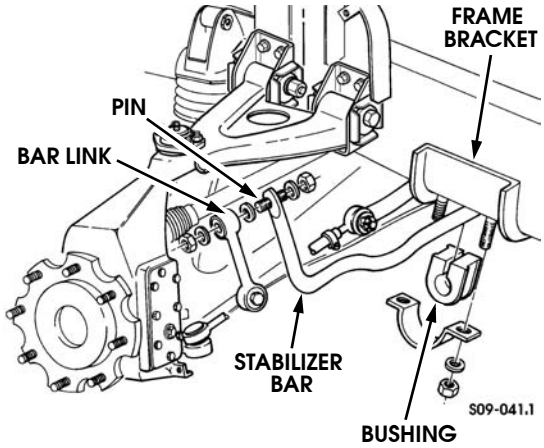


Figure 9-103: Stabilizer Bar Replacement

Stabilizer Bar Link Replacement

Removal

1. Remove the locknut and two the washers securing the bar link to the stabilizer bar (Figure 9-104).
2. Remove the bolt, two washers and the bar link from the lower control arm.

Installation

1. Apply thread-locking compound to the threads of the bolt. Install the bar link to the lower control arm with the two washers and the bolt. Tighten the bolt to 70 lb-ft. (95 N•m) (Figure 9-104).
2. Install the bar link on the stabilizer bar with the two washers and the locknut. Tighten the locknut to 75 lb-ft. (102 N•m).

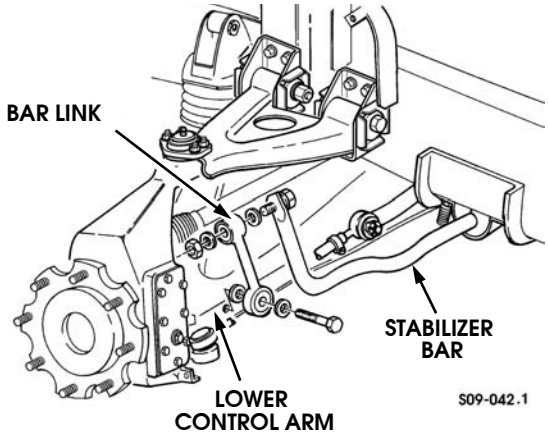


Figure 9-104: Stabilizer Bar Link Replacement

BALL JOINT

NOTE: The upper and lower ball joints are equipped with a grease purge slot to purge old grease out of the ball joint during service. DO NOT replace the ball joint for the boot leaking grease.

Upper Ball Joint Wear Check Procedure

NOTE: If the vehicle was previously lifted off the ground for other service, center the steering wheel, roll the vehicle forward and back to settle the suspension and relieve the tension on the ball joints before beginning the checking procedure.

1. With the vehicle on the ground (being careful not to damage the boot), place the tip of a pry bar between the steering knuckle and the ball joint boot (Figure 9-105).
2. With the shank of the pry bar contacting the upper control arm as shown, pry upward and note the movement of the ball joint against a ruler. Be careful to measure only the ball joint movement and not the flex of the control arm resulting from prying against it.
3. Any upper ball joint with more than 1/16” (1.6 mm) movement should be replaced.

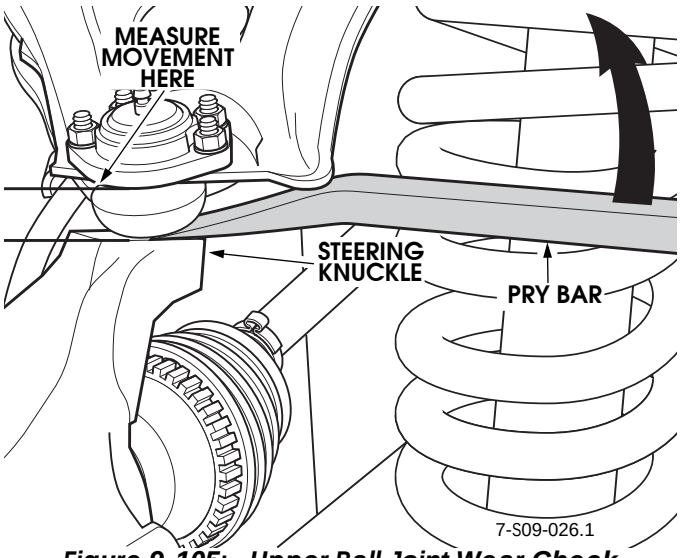


Figure 9-105: Upper Ball Joint Wear Check

Upper Ball Joint Replacement

Removal

1. Remove the wheel.
2. Raise and support the lower control arm.
3. Disconnect the p-clamp securing the vent line and the speed sensor lead to the upper control arm.
4. Remove the cotter pin and the slotted nut from the upper ball joint (Figure 9-106).
5. Remove the four locknuts, bolts, eight washers and the upper ball joint from the upper control arm.
6. Separate the upper ball joint from the geared hub using ball joint remover J–24319-B or equivalent. Remove the ball joint.

Installation

1. Position the upper ball joint on the upper control arm, ensuring the upper ball joint is placed above the upper control arm (Figure 9-106).

NOTE: Check the upper ball joint torque 15 minutes after initial installation. Adjust if necessary.

2. Install the upper ball joint on the upper control arm with the four bolts, locknuts and the eight washers. Tighten the fine thread locknuts to 30 lb-ft. (41 N•m).

NOTE: Do not loosen the slotted nut to install the cotter pin.

3. Install the upper ball joint on the geared hub with the slotted nut. Using a crowfoot and adapter, tighten the slotted nut to 65 lb-ft. (88 N•m). Install cotter pin in slotted nut.
4. Install the p-clamp securing the vent line and the speed sensor lead to the upper control arm.
5. Lubricate the upper ball joint until grease is pushed out of the purge slot and wipe off the excess grease.
6. Install the wheel.

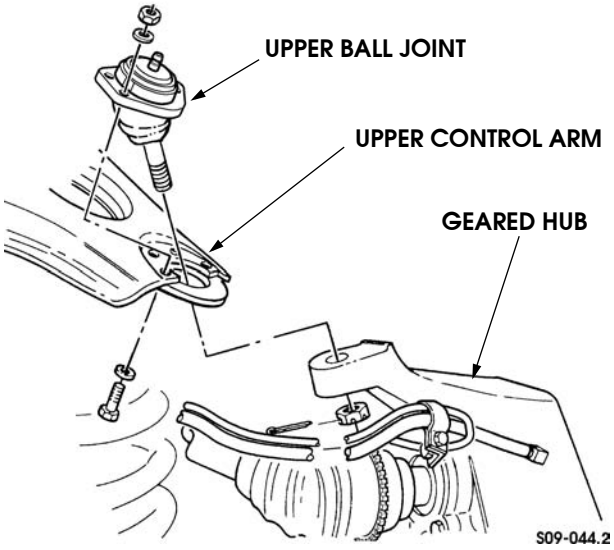


Figure 9-106: Upper Ball Joint Replacement

Lower Ball Joint Wear Check

1. Support the lower control arm with a jack or stand to unload the lower ball joint.
2. Place a pry bar between the lower arm at the ball joint and the geared hub and measure the vertical play obtained by moving the pry bar down (Figure 9-107). Maximum play should not exceed 1/8" (3.5 mm).
3. Replace the ball joint if the end play exceeds the limit.

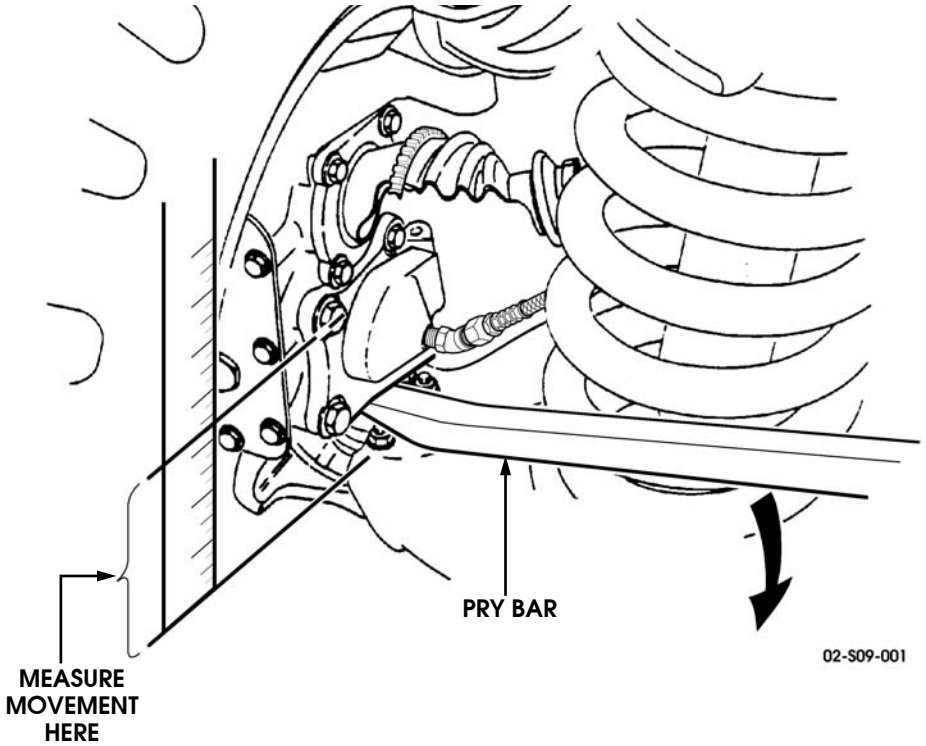


Figure 9-107: Lower Ball Joint Wear Check

Lower Ball Joint Replacement

Removal

1. Remove the wheel.
2. Raise and support the lower control arm (Figure 9-108).
3. Remove the cotter pin and the slotted nut from the lower ball joint. Discard the cotter pin.
4. Remove the four locknuts, bolts, eight washers and the lower ball joint from the lower control arm.
5. Separate the lower ball joint from the geared hub using ball joint remover J–24319-B or equivalent. Remove the lower ball joint.

Installation

1. Install the lower ball joint on the lower control arm, ensuring the lower ball joint is placed below the lower control arm and secure with the four bolts, locknuts and the eight washers. Tighten the 7/16” locknuts to 65 lb-ft. (80 N•m) (Figure 9-108).

CAUTION: *Do not loosen slotted nut to install cotter pin. If necessary, tighten the slotted nuts to align the holes for cotter pin insertion.*

2. Install the ball joint on the geared hub with the slotted nut. Tighten the slotted nut to 73 lb-ft. (99 N•m) and install the cotter pin in the slotted nut.
3. Lubricate the lower ball joint until grease is pushed out of the purge slot and wipe off the excess grease.
4. Install the wheel (Refer to section 6).

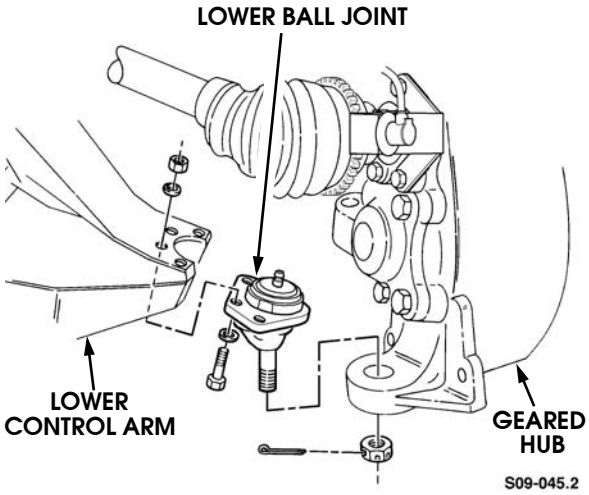


Figure 9-108: Lower Ball Joint Replacement

CONTROL ARM

Upper Control Arm Replacement

NOTE: The procedure for removing and installing the front and rear upper control arms is basically the same. This procedure covers the left front upper control arm.

Removal

1. Remove the wheel (Refer to section 6).
2. Remove the bolt and the washer securing the vent line/speed sensor lead bracket to the geared hub (Figure 9-109).
3. Disconnect the vent line from the fitting.
4. Remove the speed sensor from the sensor mount bracket.
5. Remove the bolt, p-clamp, vent line and the speed sensor lead from the upper control arm (Figure 9-110).

6. Remove the cotter pin and the slotted nut from the upper ball joint.
7. Separate the upper ball joint from the geared hub using a ball joint remover.
8. Remove the four locknuts, bolts and the eight washers securing the upper ball joint to the upper control arm and remove the upper ball joint.
9. Mark the position of the eccentric reference holes on the brackets for installation.
10. Remove the two locknuts, washers, eccentrics, bolts and the upper control arm from the brackets and remove the upper control arm.

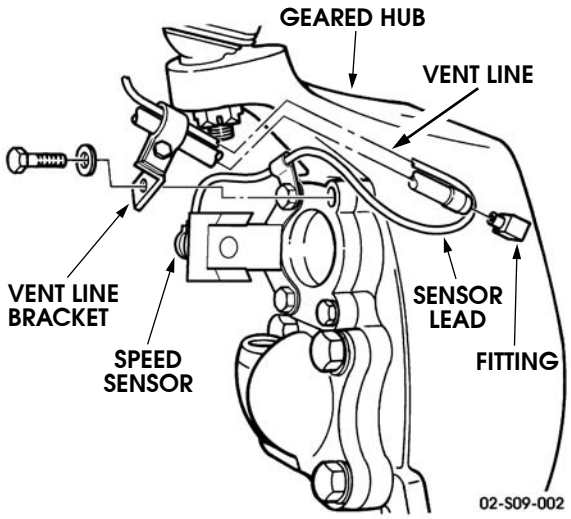


Figure 9-109: Vent Line Connection Replacement

Installation

1. Install the upper control arm on the brackets with the two washers, eccentrics, bolts and the locknuts. Align the reference holes (from removal step 8) on the eccentrics with the marks on the brackets. Do not tighten the locknuts (Figure 9-110).
2. Secure the upper ball joint to the upper control arm with the four washers, bolts and the locknuts. Tighten the locknuts to 37 lb-ft. (50 N•m).

CAUTION: *Do not loosen the slotted nut to install the cotter pin. Doing this may result in damage to the equipment.*

NOTE: When the slotted nuts are tightened to the prescribed torque values, the cotter pins must have a minimum of 50% engagement with the nut slots.

3. Install the upper ball joint on the geared hub with the slotted nut. Using a crowfoot and adapter, tighten the slotted nut to 65 lb-ft. (88 N•m). Install the cotter pin in the slotted nut.
4. Tighten the locknuts on the brackets to 260 lb-ft. (359 N•m).
5. Install the p-clamp, vent line and the speed sensor lead on the upper control arm with the bolt.
6. Connect the vent line to the fitting (Figure 9-109).
7. Install the speed sensor in the sensor bracket.
8. Secure the vent line/speed sensor bracket to the geared hub with the clamp, washer and the bolt. Tighten the bolt to 37 lb-ft. (50 N•m).
9. Install the wheel (Refer to section 6).

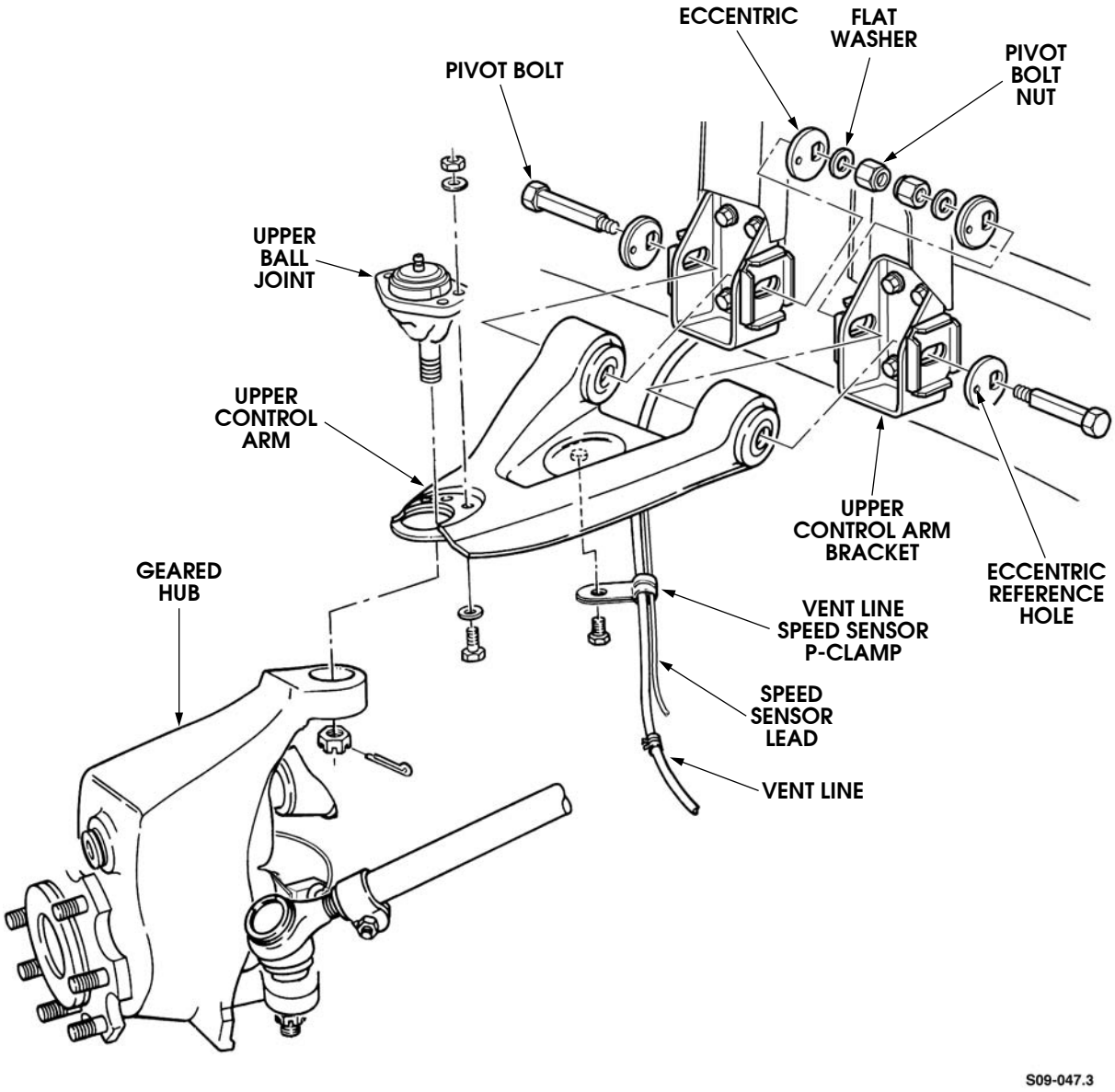


Figure 9-110: Upper Control Arm Assembly Replacement

Control Arm Bushing Replacement

Removal

NOTE: The control arm bushings must be replaced as a set (Figure 9-111).

1. Remove the control arm.
2. Support the control arm and press the bushing out of the control arm.

Installation

1. Lubricate the outside diameter of the bushing with grease.
2. Insert the bushing in the control arm (Figure 9-111).
3. Support the control arm and press the bushing into the control arm until the flange on the bushing seats on the control arm.
4. Install the control arm.
5. Adjust the caster and the camber.

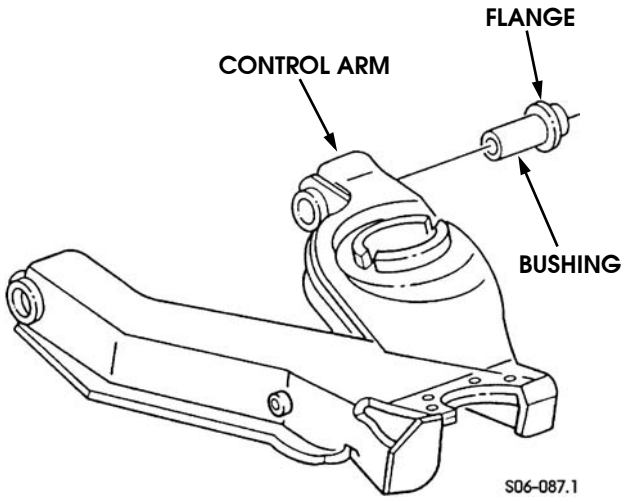


Figure 9-111: Control Arm Bushing Replacement

Lower Control Arm Replacement

NOTE: The procedure for removing and installing the front and rear lower control arms is basically the same. This procedure covers the left front lower control arm.

Removal

WARNING: The lower control arm must be supported during removal and installation. Failure to support the lower control arm may cause personal injury or damage to the equipment.

1. Remove the wheel (Refer to section 6).
2. Remove the shock absorber.
3. Remove the bolt, two washers and the bar link (front only) from the lower control arm (Figure 9-112).
4. Remove the four locknuts, bolts and the eight washers from the lower ball joint and the lower control arm (Figure 9-113).
5. Raise and support the lower control arm. Remove the lower ball joint from the arm.
6. Lower the lower control arm and remove coil the spring.
7. Remove the two locknuts, washers, bolts and the lower control arm from the brackets.

NOTE: Removing the lower ball joint from the geared hub will ease the installation.

8. Remove the cotter pin and the slotted nut from the lower ball joint.
9. Separate the lower ball joint from the geared hub using a ball joint remover. Remove the lower ball joint.

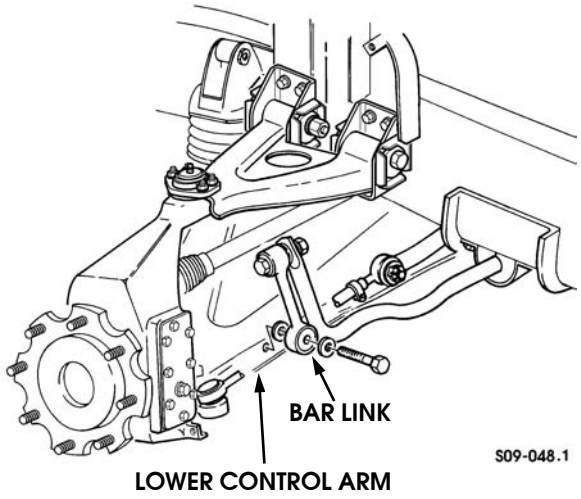


Figure 9-112: Bar Link Replacement

Installation

WARNING: The lower control arm must be supported during the removal and the installation. Failure to support the lower control arm may cause personal injury or damage to the equipment.

NOTE: On the lower control arms, the bolt heads are toward the front of the vehicle.

1. Install the lower control arm on the brackets with the two bolts, washers and the locknuts. Do not tighten the locknuts (Figure 9-113).

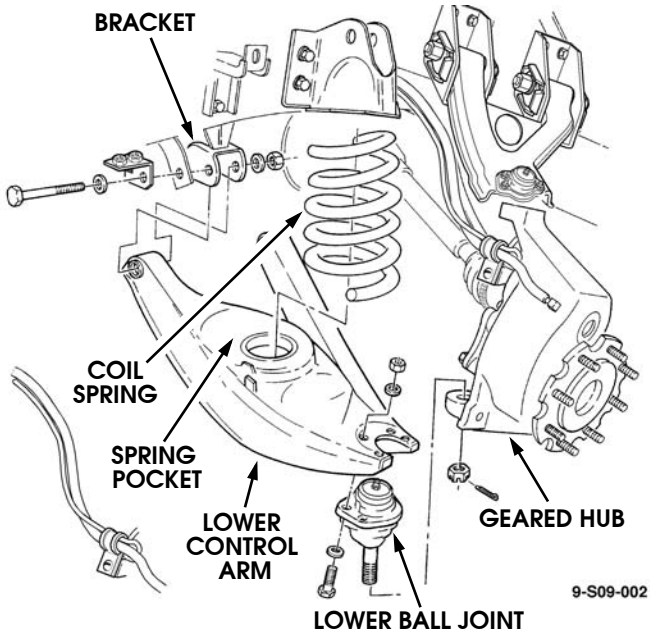


Figure 9-113: Lower Control Arm Replacement

2. Install the coil spring on the lower control arm ensuring the end of the coil spring fits in the spring pocket of the lower control arm.
3. Install the lower ball joint on the lower control arm, ensuring the ball joint is placed below the lower control arm.
4. Secure the lower ball joint to the lower control arm with the four bolts, locknuts and the eight washers. Tighten the locknuts to 65 lb-ft. (80 N•m).

5. Install the lower ball joint on the geared hub with the slotted nut. Tighten the slotted nut to 73 lb-ft. (99 N•m) and install the cotter pin in the slotted nut.
6. Tighten the locknuts on the brackets to 260 lb-ft. (353 N•m).
7. Apply thread-locking compound to the threads of the bolt. Install the bar link on the lower control arm with the two washers and bolt. Tighten the bolt to 70 lb-ft. (95 N•m) (Figure 9-112).
8. Install the shock absorber.
9. Install the wheel (Refer to section 6).

COIL SPRING

Replacement

NOTE: The procedure for removing and installing all four coil springs is basically the same. This procedure covers the left front coil spring.

NOTE: Various load capacity springs are used in the HUMMER H1 based on the powertrain and the option packages. Refer to the parts catalog to select the proper replacement spring for the specific application.

Removal

1. Remove the wheel (Refer to section 6).
2. Remove the bolt, two washers and the bar link from the lower control arm.
3. Remove the four locknuts, washers, bolts, washers, lower ball joint and the geared hub from the lower control arm (Figure 9-114).
4. Place the jack under the lower control arm and raise the lower control arm slightly to relieve the tension on the shock pin.
5. Remove the locknut, shock pin, washer and the shock absorber from the spring seat and collapse shock absorber.

NOTE: It may be necessary to loosen the lower control arm bolts to allow the lower control arm to be lowered.

6. Pull the geared hub and the lower ball joint away from the lower control arm and remove the coil spring from the lower control arm and the shock absorber.

Installation

NOTE: Index the coil spring in the spring pocket for a slight gap 1/16 - 1/8 in. (1.59 - 3.18 mm) when the spring is in position.

1. Install the coil spring over the shock absorber and onto the lower control arm ensuring the end of the coil spring fits in the spring pocket of the lower control arm (Figure 9-114).
2. Ensure that the coil spring is aligned with the spring seat flange, and raise the lower control arm.
3. Extend the shock absorber into the spring seat and install with the washer, shock pin and the locknut. Tighten the locknut to 300 lb-ft. (407 N•m).
4. Install the lower ball joint and the geared hub on the lower control arm ensuring the lower ball joint is placed below the lower control arm. Secure the lower ball joint to the lower control arm with the four washers, bolts, washers and the locknuts. Tighten the front locknuts to 37 lb-ft. (50 N•m) and the rear locknuts to 60 lb-ft. (80 N•m).
5. Apply thread-locking compound to the threads of the bolt. Install the bar link on the lower control arm with the two washers and the bolt. Tighten the bolt to 70 lb-ft. (95 N•m).
6. Install the wheel (Refer to section 6).

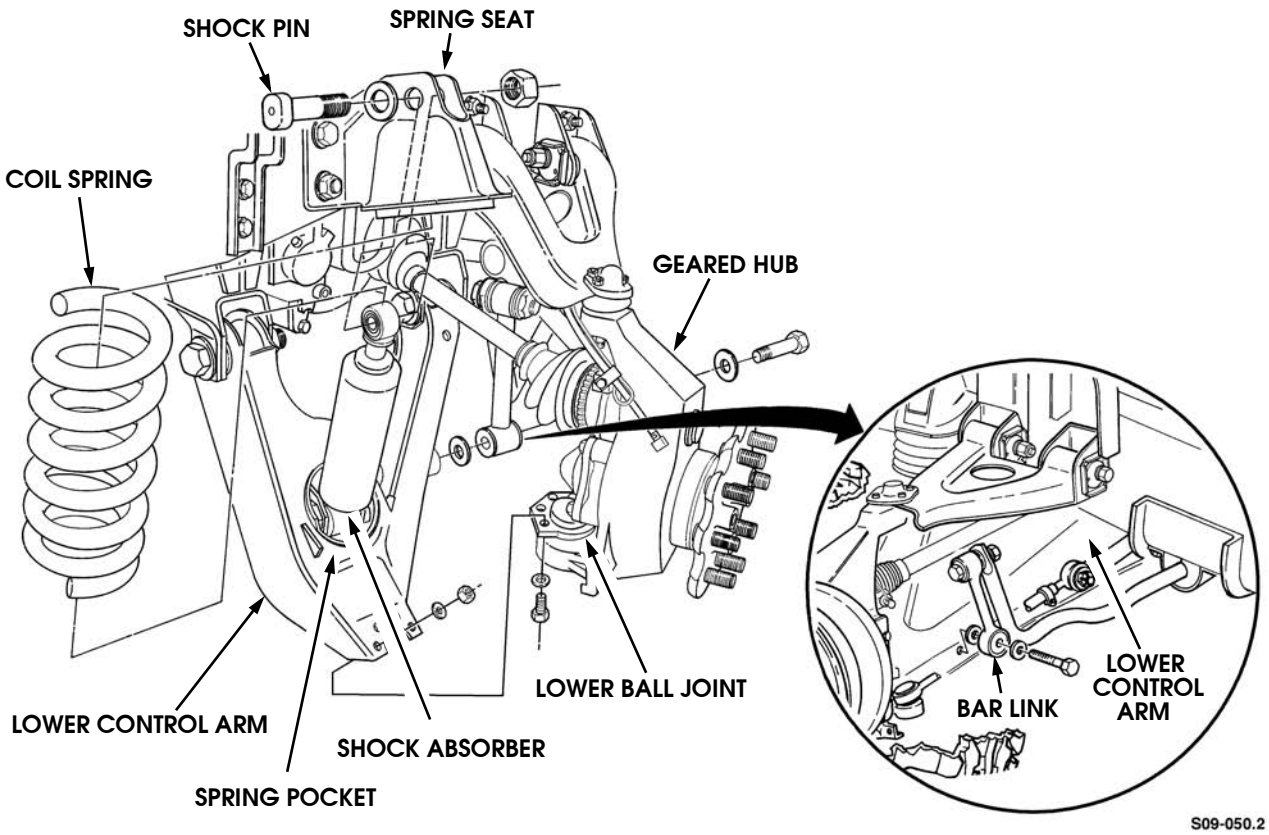


Figure 9-114: Coil Spring Replacement

SHOCK ABSORBER

Replacement

NOTE: The procedure for removing and installing all shock absorbers is the same, except the rear lower shock pins must be installed with the head of the pin facing rearward. This procedure covers the left front shock absorber.

Removal

1. Remove the two bolts, washers, lock washers, shock absorber and the bracket from the lower control arm (Figure 9-115).
2. Remove the locknut, shock pin, washer and the shock absorber from the spring seat. Note the position of the pin for installation.
3. Compress and remove the shock absorber and the bracket.

NOTE: Note the alignment of the shock absorber and the bracket for installation reference.

4. Position the shock absorber in a vise, using tool CH-47505 and a breaker bar to hold the pin in place remove the locknut, pin, washer and the bracket from the shock absorber.

Installation

NOTE: It may be necessary to spread the spring seat to allow installation of the shock absorber.

1. Position the shock absorber in a vise and install the bracket on the shock absorber with the washer, pin and the locknut. Using tool CH-47505 and a breaker bar to hold the pin in place. Tighten the locknut to 300 lb-ft. (407 N•m) (Figure 9-115).

CAUTION: *Do not pry or use sharp tools on the shock absorber piston rod. A damaged rod will cause shock failure.*

2. Install the shock absorber and the bracket through the lower control arm.

3. Extend the shock absorber and secure the piston rod end of the shock absorber to the spring seat with the washer, shock pin and the locknut. Using tool CH-47505 and a breaker bar to hold the pin in place. Tighten the locknut to 300 lb-ft. (407 N•m).
4. Install the bracket on the lower control arm with the two washers, lock washers and the bolts. Tighten the bolts to 178 lb-ft. (241 N•m).

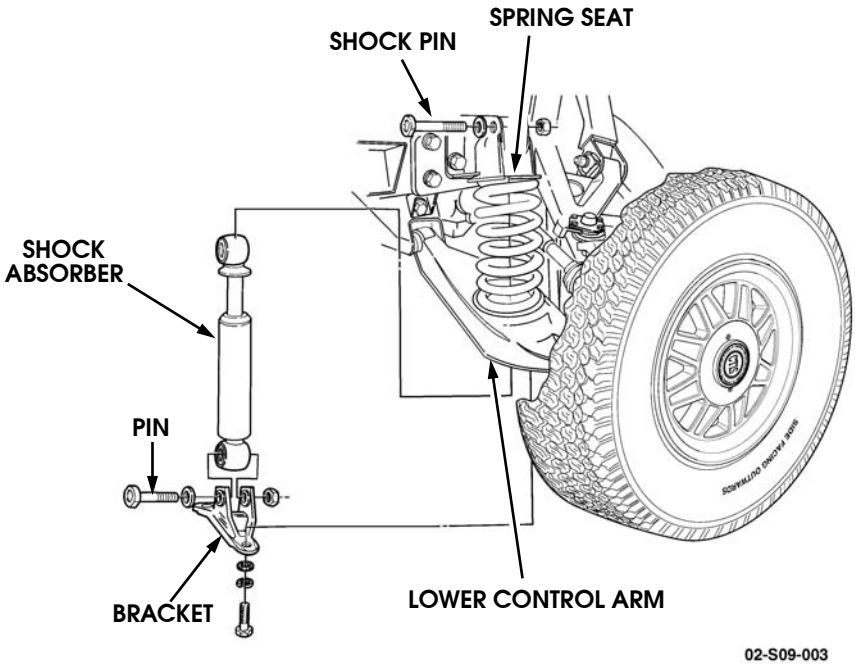


Figure 9-115: Shock Absorber Replacement

RADIUS ROD

Replacement

Removal

1. Remove the wheel.
2. Remove the cotter pin, slotted nut and the washer securing the radius rod to the geared hub (Figure 9-116).
3. Using puller J–24319-B or equivalent, separate the radius rod from the geared hub.
4. Remove the locknut, washers, bolt and the radius rod from the bracket.

Installation

1. Install the radius rod on the bracket with the washer, bolt, washer and the locknut. Tighten the locknut to 260 lb-ft. (353 N•m) (Figure 9-116).

CAUTION: *Do not loosen the slotted nut to install the cotter pin. If necessary, tighten the slotted nuts to align the holes for cotter pin insertion.*

NOTE: When the slotted nuts are tightened to prescribed torque values, the cotter pins must have a minimum of 50% engagement with the nut slots.

2. Install the radius rod on the geared hub with the washer and the slotted nut. Tighten the slotted nut to 70 lb-ft. (95 N•m). Install the cotter pin in the slotted nut.
3. Install the wheel.

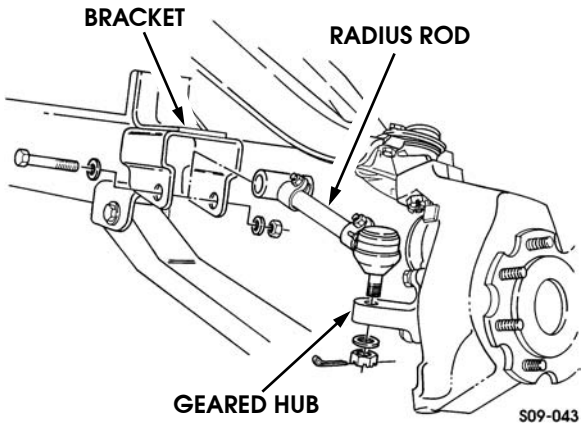


Figure 9-116: Radius Rod Replacement

FRAME

General Information

The frame rails are constructed by arc-welding two “C” channels of preformed steel together to form a box cross section. The frame rails are internally reinforced at bolt hole locations by bushings or full cross-section spacers to prevent channels from collapsing from attaching load. The frame is made by bolting two non-identical frame rails to cross members. Cross members are held to stringent dimensional tolerances and therefore must be replaced if damaged (Figure 9-117).

Inspection

The visual inspection is the first and most critical step in forming a decision of whether to repair or replace a damaged frame component (Figure 9-118). Factors to consider when making a visual inspection are:

1. Twisted frame rails are not repairable and must be replaced.
2. Transverse tears or breaks extending across or into both upper or lower corners are not repairable by welding.
3. Short longitudinal cracks up to 6 inches (15.2 cm) or split welds can be repaired by heli-arc welding.

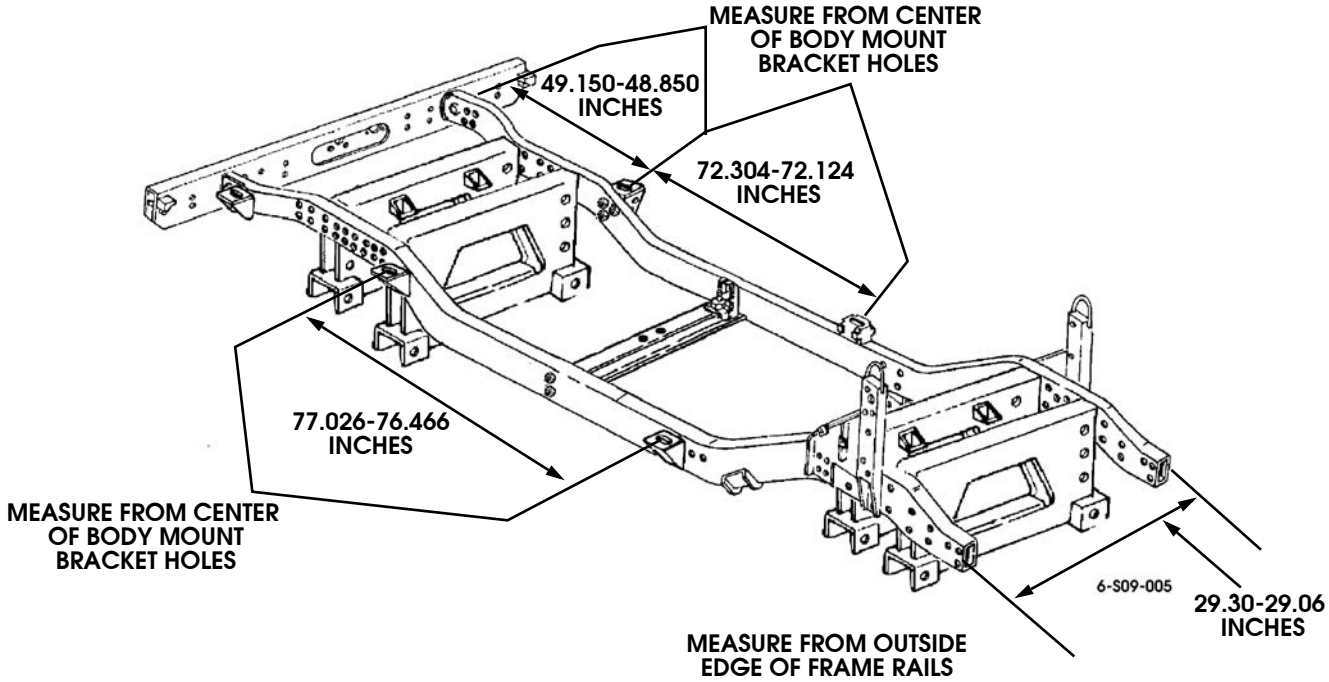


Figure 9-117: Frame Dimensions

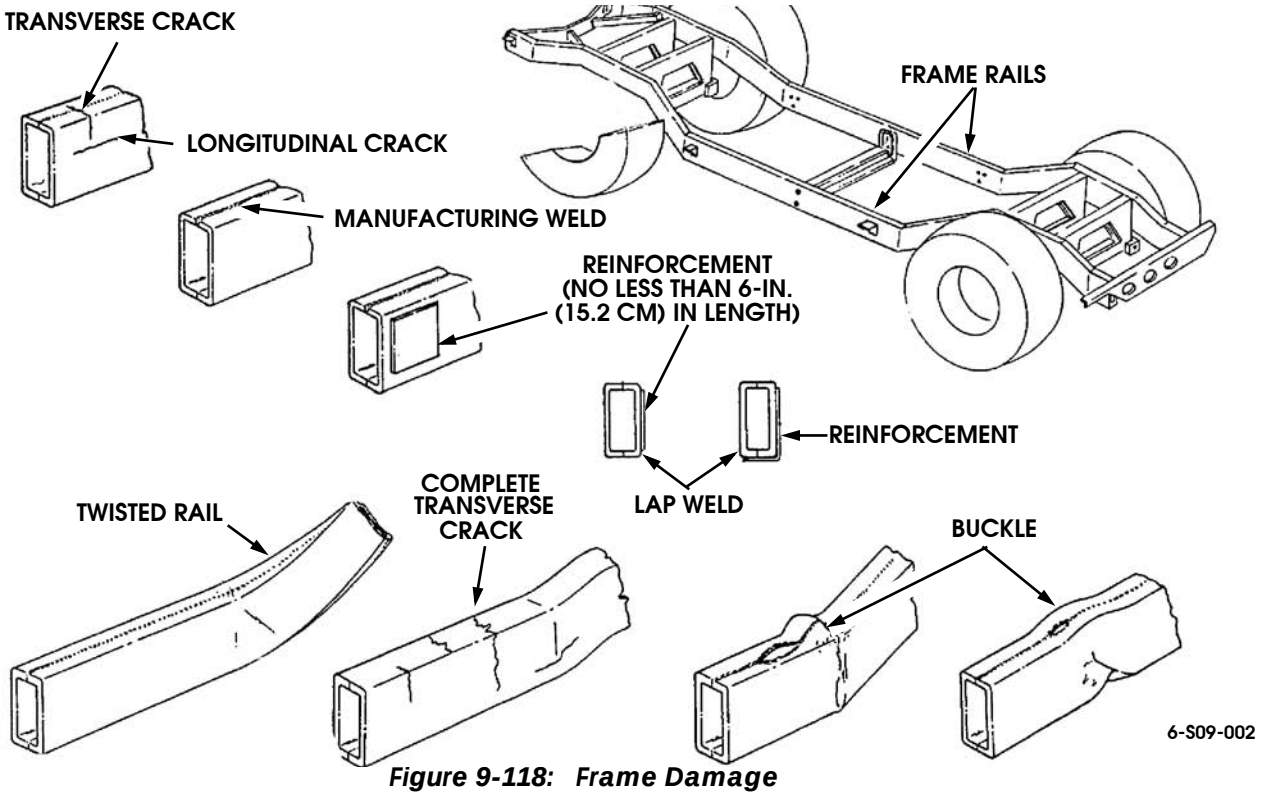


Figure 9-118: Frame Damage

Vertical (Side View) Measurement

1. Select a hard and level surface area 1-1/2 times the size of the vehicle.
2. Raise the vehicle at four points until all four wheels are off the surface.

WARNING: When using shim material with jack stands, the shim material must be placed squarely and firmly under the jack stand. The vehicle could be knocked off the jack stand resulting in personal injury or equipment damage if shim material is placed on top of jack stand.

3. Measure the distance from the floor to the bottom of the frame near each jack stand. Place a shim(s) under the jack stands as necessary until the floor-to-frame distances are equal at each jack stand.

NOTE: Measurements must be taken at identical locations on the left and right frame rails. Failure to do so will result in a faulty indication.

4. Select, measure and record the distance from the floor to the frame rail at several different points on either frame rail.
5. Measure and record the frame rail height at the corresponding points on opposite frame rail.
6. Compare the measurements from both of the frame rails. Measurements from comparable points deviating more than 1/8-inch (3 mm) for each 2 feet of linear distance indicates a vertically bent frame.
7. Lower the vehicle from the jack stands.

Horizontal (Bowing) Measurement

1. Position the vehicle on a smooth level surface.
2. Measure the height of the frame rails at each end near center of cross members. If the heights vary by more than 1/8-5/16-inch (3-8 mm), raise the frame rail and install jack stands to bring the frame to level (Figure 9-119).

WARNING: When using shim material with jack stands, the shim material must be placed squarely and firmly under the jack stand. The vehicle could be knocked off the jack stand resulting in personal injury damage if shim material is placed on top of jack stand.

3. Hang a plumb bob at the corner of one frame rail where the frame rail intersects the crossmember. Tape a piece of paper to the floor under plumb bob and mark location where plumb bob stops moving. Repeat procedure for each corner of the frame (Figure 9-121).

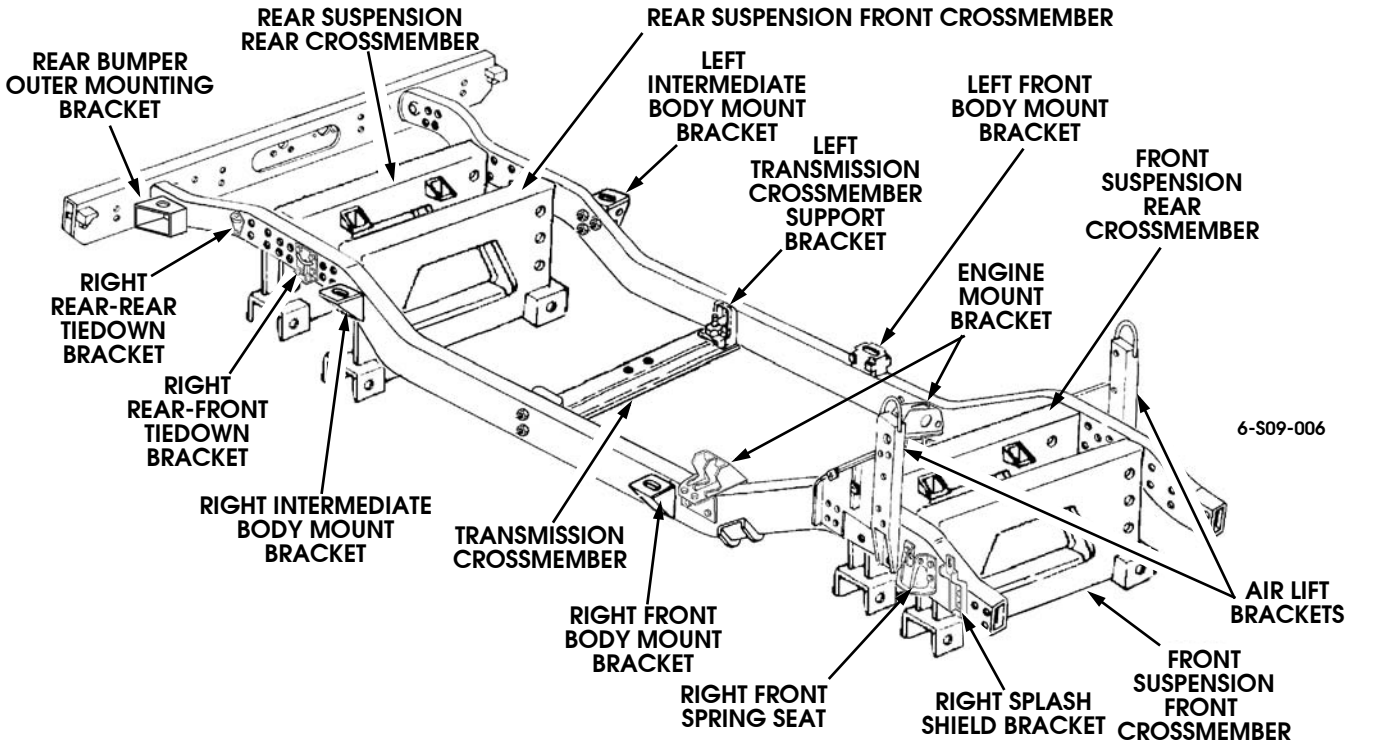


Figure 9-119: Frame Components

NOTE: Strings used for this horizontal bow measurement will remain in place until the next measurement (Frame Skew) is completed. To maintain the integrity of the measurements, the string must be pulled tight and secured.

4. Stretch the string tightly on the floor between the front and the rear plumb bob marks under each frame rail (Figure 9-121).
5. Measure the front and the rear cross members to determine the center point. Drop a plumb bob from the crossmember center points to the floor. Mark location where the plumb bob stops moving (Figure 9-121).
6. Stretch a string tightly on the floor between the front and the rear plumb bob marks under the cross members to determine the center line (Figure 9-121).
7. Select measuring points an equal distance apart along the right and left strings. Measure from the right and the left points to the center string. Mark the center string. The distance from the right and left points to the center string should be within 1/4-inch (6 mm) of being equal. If the measurements are not equal, one frame rail is bowed.

Diagonal (Skew Measurement) Method 1

1. Measure diagonally from one point on the right or the left frame rail string to a point on the opposite frame rail string (Figure 9-120).
2. Compare to an opposite diagonal measurement.
3. If the two measurements differ by more than 1/4-inch (6 mm), the frame rails are skewed.
4. Repeat this procedure at the four other sets of measure points to confirm the skew.

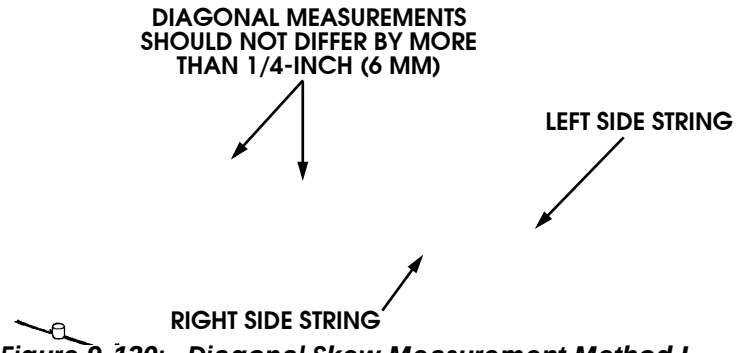


Figure 9-120: Diagonal Skew Measurement Method I

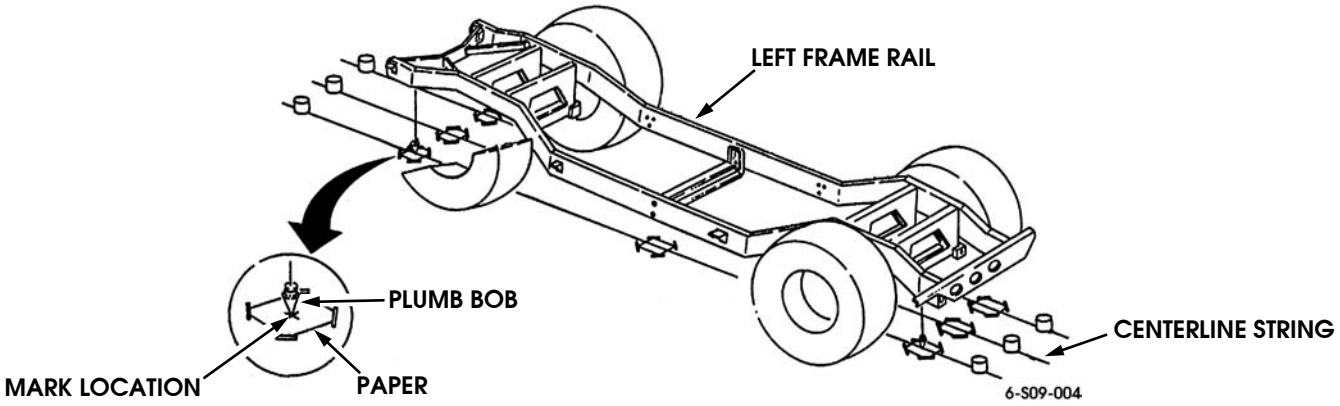


Figure 9-121: Horizontal (Bowing) Measurement

Method 2

1. Position a string across a plumb bob point on each of the frame rail strings (Figure 9-122).
2. Place a square with one leg coincident with a frame rail string (Figure 9-122).
3. Run a line or string along the other leg of the square to the opposite frame rail string (Figure 9-122).
4. Measure the deviation between the string positioned in Step 1 and the square leg line or the string. Any deviation means the two frame rails are skewed and, consequently, the cross members are not at square angles to the frame rails. A deviation of 1/2 inch (12.7 mm) makes a vehicle “dog track” and it is difficult to align the wheels.

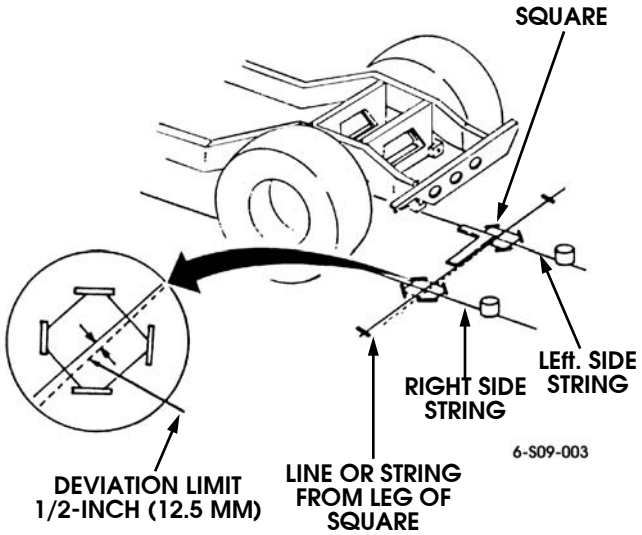


Figure 9-122: Diagonal Skew Measurement Method 2

Frame Repairs

Cracks

NOTE: All frame welding should be heli-arc type.

1. Cracks not extending across two adjacent faces of the frame rail may be welded.
   - Stop-drill crack with 1/8-inch (3 mm) drill (Figure 9-123)
   - Vee-notch crack (Figure 9-123)
   - Heli-arc weld crack with Mig or Tig welder (using a filler metal in accordance with AWS A5.18) (Figure 9-123)
   - If reinforcement or fishplate is to be added, grind weld to a flat surface (Figure 9-123)
   - A reinforcement or fishplate should be added to a frame rail with a crack in the bottom face
   - Longitudinal welding can be performed on any frame rail face
2. Welded reinforcements or fishplates should not be less than 6-inches (15.2 cm) in length along the frame rail.
3. Bolt on reinforcements or fishplates should not be less than 8-inches (20.3 mm) in length. The long bottom edge of the fishplate should be heli-arc lap welded to the frame component.
4. Puncture holes only in the side faces of the frame rails may be repaired with a combinations of a fishplates and/or reinforcements. Welded type should only be used. Puncture holes in the bottom face are not repairable and therefore the frame rail should be replaced.
5. Bolted-on repairs should use grade 8 bolts with hardened washers and nuts. Use the proper torque when tightening the nuts.

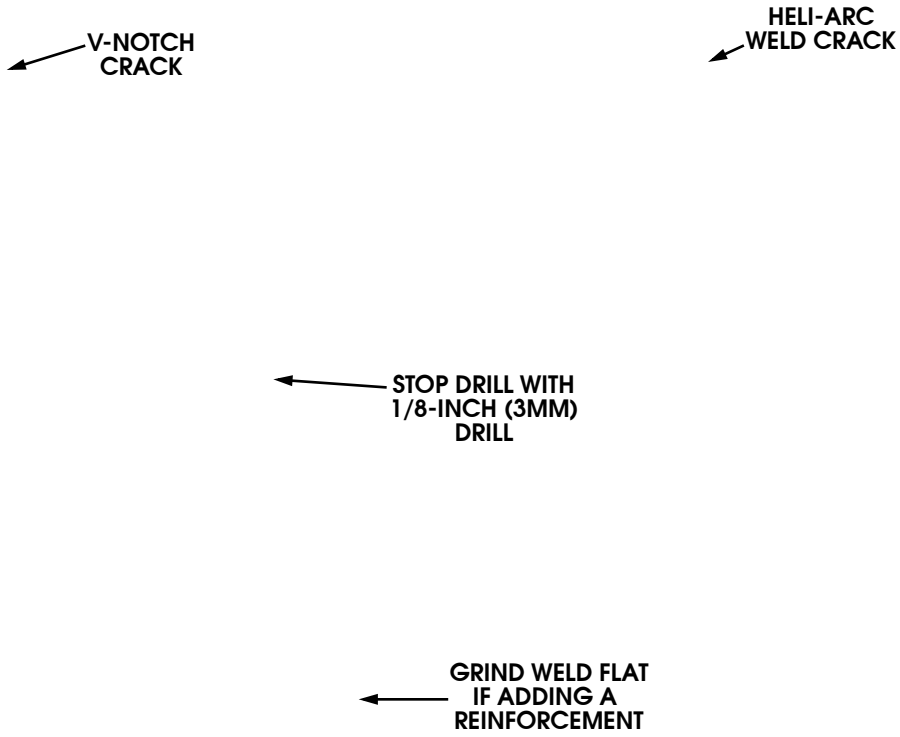


Figure 9-123: Crack Repair

Bends

1. Do not attempt to repair a bend when:
   - Buckling to a height of 1/4-inch (6 mm) on any one face of the frame rail is involved.
   - The bending also includes more than minor twisting.
   - The frame rail is bent in two directions.
   - The bending involves a collapse of one or more faces of the frame rail at a suspension or body attachment point.

Straightening

1. When performing a straightening repairs with the frame on the vehicle:
   - Use spreader plates or wood blocking to distribute chain force to avoid damage to frame box section.
   - Be sure to loosen sufficient length of frame to allow frame force points to move without causing other damage.
   - Restrain vehicle movement in both directions along line of force application.
2. Vertical bends, except at the end sections, require removal of the frame rail from the vehicle.
3. Application of bulk heating to the frame components is not authorized, the metal properties will be irreversibly degraded.
4. At the conclusion of a bend repair, carefully inspect the welds in the vicinity of the repair and area of force application. Any evidence of cracking or chipping of the welds must be repaired.

BRUSHGUARD

Removal

1. Have an assistant hold the brushguard while removing the four bolts, nuts and the eight washers securing the brush guard mount brackets to the frame brackets (Figure 9-124).
2. Remove the brushguard assembly.

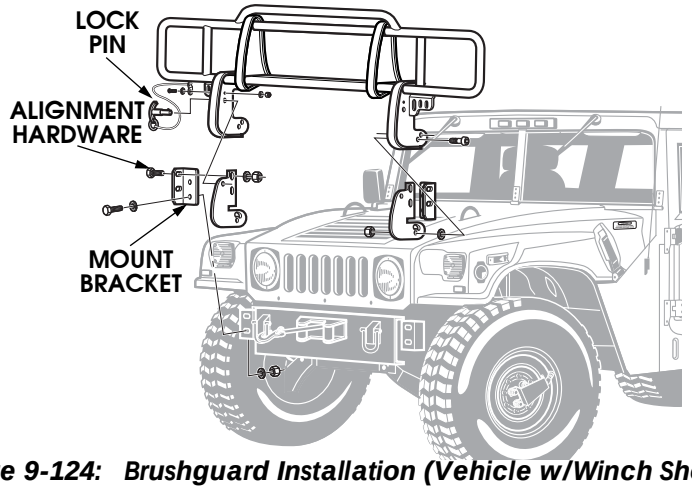


Figure 9-124: Brushguard Installation (Vehicle w/Winch Shown)

Installation

1. Using an assistant, place the brushguard on the frame brackets or the bumper if the vehicle does not have a winch and install the four bolts, nuts and the washers. Torque the hardware to 81-99 lb-ft. (110-134 N•m).
2. Check the brushguard for level and equal, side to side, spacing from the hood. If adjustment is necessary, loosen the four alignment bolts and move the brush guard accordingly. Tighten the alignment hardware to 81-99 lb-ft. (110-134 N•m).
3. Remove the lock pins and check for free movement and clearance to the roller fairlead if equipped. Adjust as needed and reinstall the lock pins.

DRIVELINE PROTECTION

Skid Plate Replacement

Removal

1. Remove the locknuts, washers, bolts and the washers securing the skid plate to the front shield (Figure 9-125).

NOTE: Go to step 3 for vehicles equipped with a winch.

2. Remove the locknuts, washers, bolts, washers and the skid plate from the front bumper.
3. Remove the locknuts, washers, bolts, washers and the winch skid plate from the winch bumper.

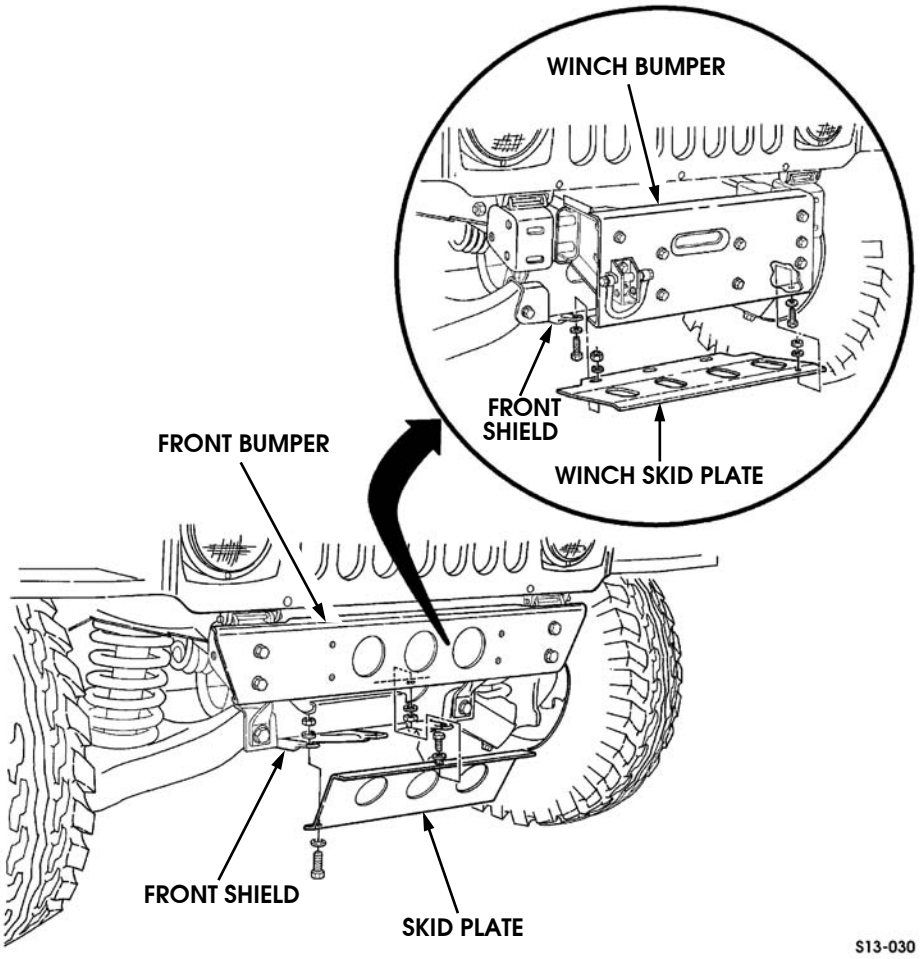


Figure 9-125: Skid Plate Mounting

Installation

NOTE: Go to step 2 for vehicles equipped with a winch.

1. Install the skid plate on the front bumper with the bolts, washers and the locknuts. Tighten the locknuts to 24 lb-ft. (33 N•m) (Figure 9-125).
2. Install the winch skid plate on the winch bumper with the bolts, washers and the locknuts (Figure 9-125). Tighten the locknuts to 24 lb-ft. (33 N•m).
3. Secure the skid plate to the front shield with the bolts, washers and the locknuts. Tighten the locknuts to 24 lb-ft. (33 N•m).

Front Shield Replacement

Removal

1. Remove the locknuts, washers and the bolts securing the front shield to the front crossmember and the intermediate shield (Figure 9-126).
2. Remove the three locknuts, washers and the bolts from the skid plate and the front shield, remove the front shield.

Installation

1. Install the front shield on the skid plate with the bolts, washers and the locknuts. Do not tighten the locknuts (Figure 9-126).
3. Secure the front shield to the front crossmember and the intermediate shield with the bolts, washers and the locknuts.
4. Tighten the locknuts securing the front shield to the skid plate to 24 lb-ft. (33 N•m). Tighten the locknuts securing the front shield to the crossmember and the intermediate shield to 44 lb-ft. (60 N•m).

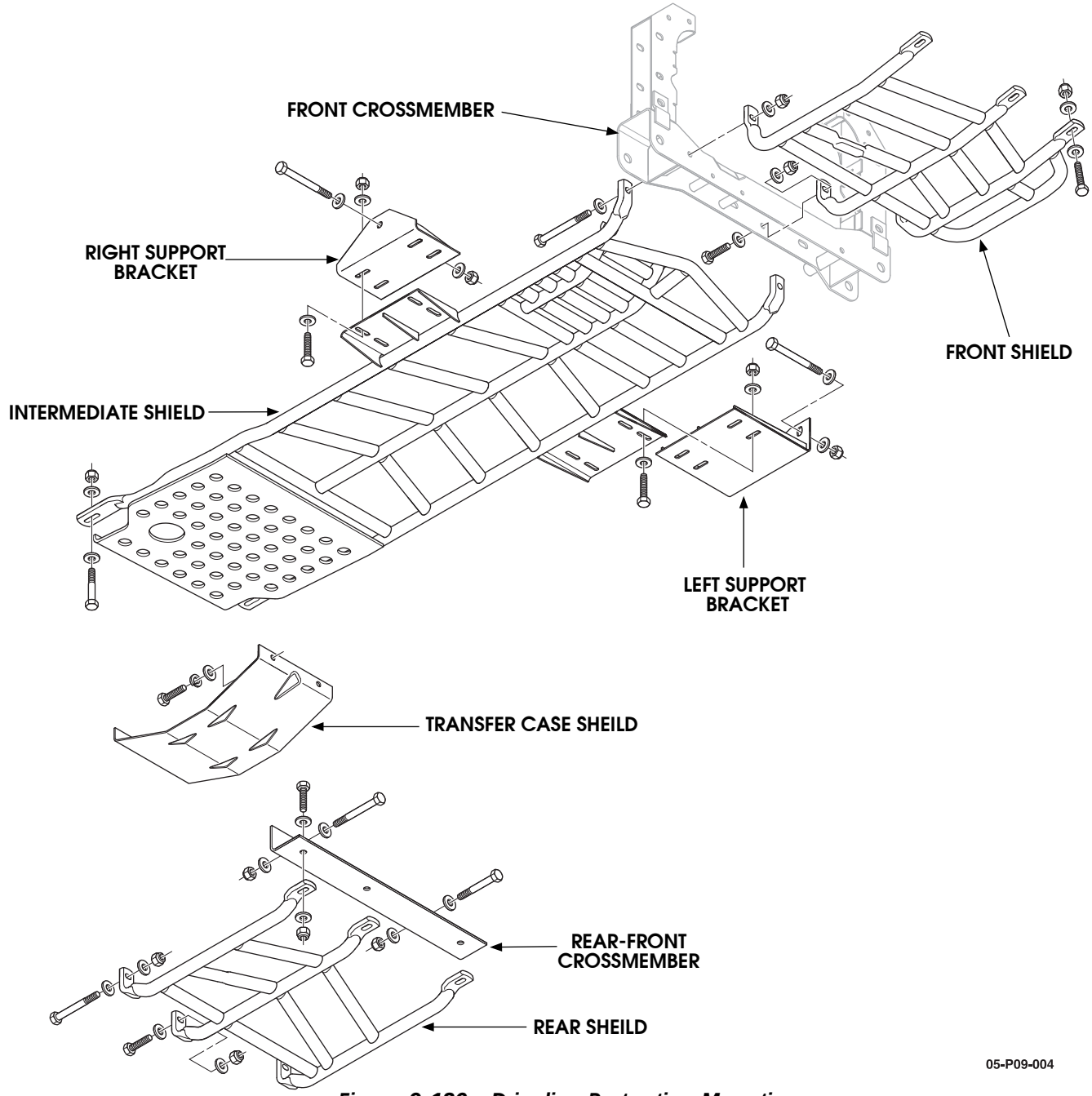


Figure 9-126: Driveline Protection Mounting

Intermediate Shield Replacement

Removal

1. Remove the two locknuts, washers, bolts and the washers to the transmission crossmember. Discard the locknuts.
2. Remove the four locknuts, washers, bolts and the washers from the left mounting bracket. Discard the locknuts.
3. Remove the four locknuts, washers, bolts and the washers from the right mounting bracket. Discard the locknuts.
4. Remove the two locknuts, washers, bolts, washers and the intermediate shield from the front crossmember. Discard the locknuts.

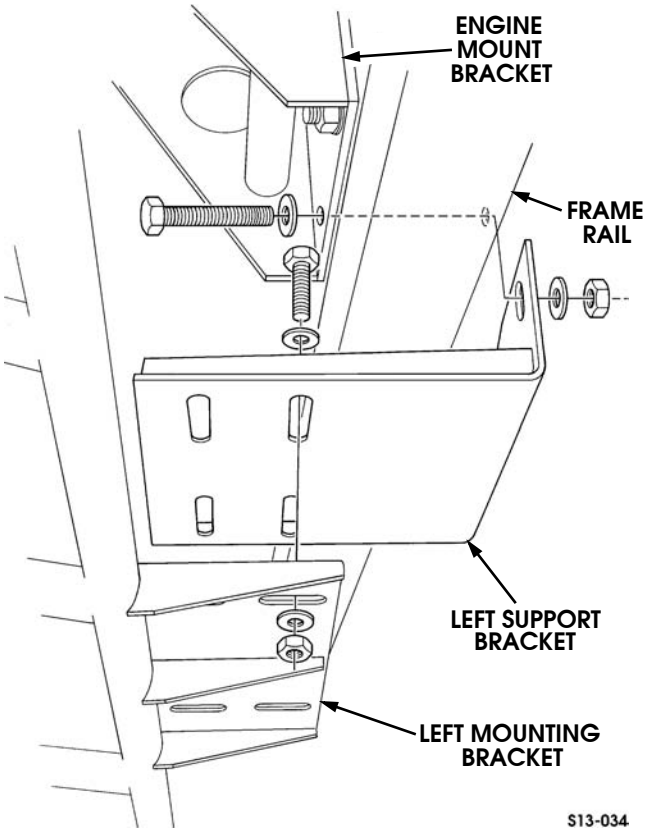


Figure 9-127: Left Support Bracket

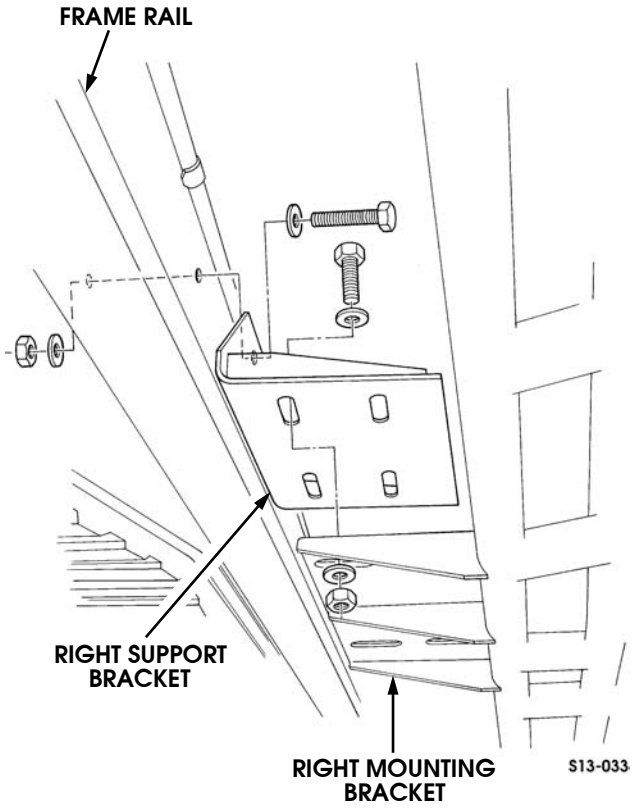


Figure 9-128: Right Support Bracket

Installation

1. Install the intermediate shield to the front crossmember with the two washers, bolts, washers and the locknuts. Tighten the locknuts to 44 lb-ft. (60 N•m) (Figure 9-126).
2. Install the four washers, bolts, washers and the locknuts on the right mounting bracket. Do not tighten the locknuts (Figure 9-128).
3. Install the four washers, bolts, washers and the locknuts on the left mounting bracket. Do not tighten the locknuts (Figure 9-127).
4. Install the two washers, bolts, washers and the locknuts on the transmission crossmember.Tighten the locknuts to 24 lb-ft. (33 N•m).
5. Tighten the locknuts securing the left and right support brackets to the mounting brackets to 24 lb-ft. (33 N•m).

Transfer Case Shield Replacement

Removal

Remove the two bolts, washers and the transfer case shield from the crossmember (Figure 9-129).

Installation

Install the transfer case shield on the crossmember with the two bolts and washers (Figure 9-129).

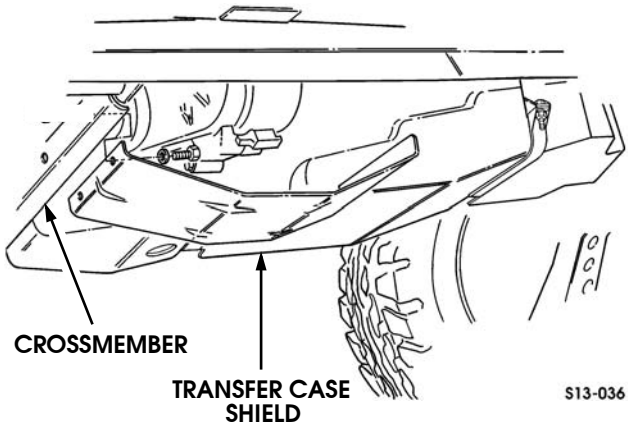


Figure 9-129: Transfer Case Shield

Rear Shield Replacement

Removal

1. Remove the three locknuts, washers, bolts and the washers securing the rear shield to the rear-front crossmember. Discard the locknuts.
2. Remove the three locknuts, washers, bolts, washers and the shield from the rear-rear crossmember. Discard the locknuts.

Installation

1. Position the shield on the rear-rear crossmember and secure with the three washers, bolts, washers and the locknuts. Do not tighten the locknuts.
2. Secure the shield to the rear-front crossmember with the three washers, bolts, washers and the locknuts. Tighten the bolts to 44 lb-ft. (60 N•m).
3. Tighten the locknuts securing the rear shield to the rear-rear crossmember to 24 lb-ft. (33 N•m).

BUMPER

Front Bumper and Towing Brackets Replacement (Vehicles Without Winch)

Removal

1. Remove the brush guard, if equipped.
2. Remove the four locknuts, washers, bolts, washers, two towing brackets and the front bumper from the mounting brackets (Figure 9-130).

Installation

1. Install the front bumper and two towing brackets on the mounting brackets with the four washers, bolts, washers and the locknuts. Tighten the bolts to 90 lb-ft. (122 N•m) (Figure 9-130).
2. Install the brush guard, if removed (Refer to section 10).

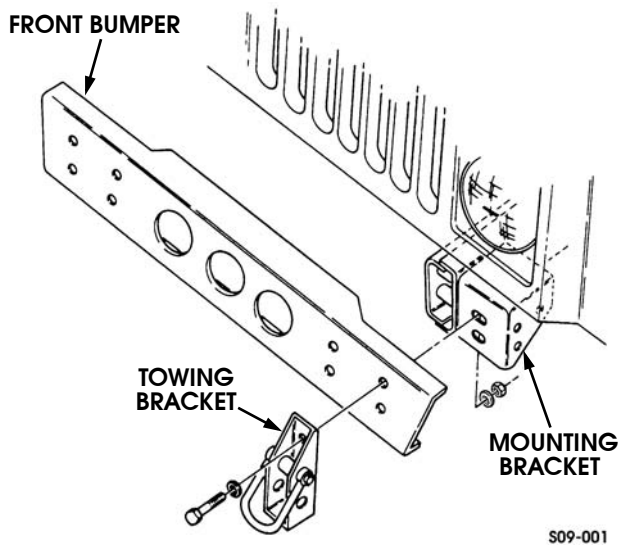


Figure 9-130: Front Bumper and Towing Bracket Replacement for Vehicles Without Winch

Front Bumper and Towing Brackets Replacement (Vehicles With Winch)

Removal

WARNING: The winch must be supported prior to performing step 1. Failure to observe this warning could result in personal injury.

1. Remove the ten bolts, washers and the reinforcement brackets securing the winch to the front bumper (Figure 9-131).
2. Remove the four locknuts, washers, bolts, washers and the two towing brackets from the front bumper and the frame extensions. Discard the locknuts.
3. Remove the five locknuts, washers, six bolts, washers and the front bumper from the frame extensions.

Installation

1. Install the front bumper on the frame extensions with six washers, bolts, five washers and the locknuts. Tighten the bolts to 90 lb-ft. (122 N•m) (Figure 9-131).
2. Install the two towing brackets on the front bumper and the frame extensions with the four washers, bolts, washers and the locknuts. Tighten the bolts to 90 lb-ft. (122 N•m).
3. Install the ten bolts, washers and the reinforcement brackets securing the front bumper to the winch. Tighten the bolts to 60 lb-ft. (81 N•m).

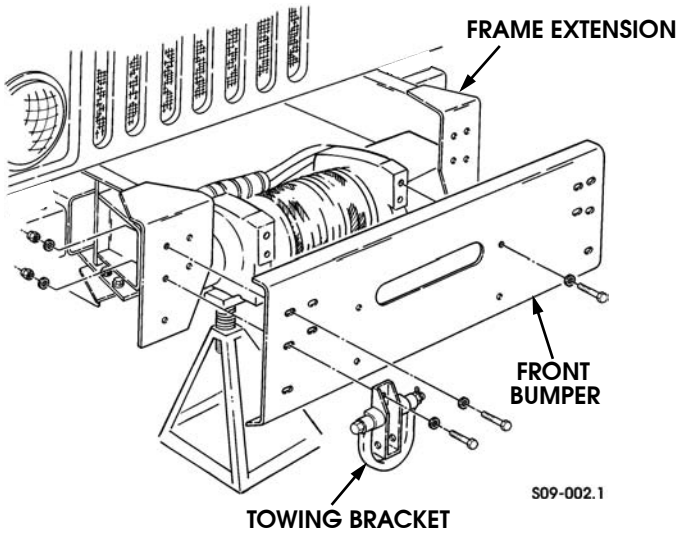


Figure 9-131: Front Bumper and Towing Bracket Replacement for Vehicles With Winch

Front Bumper Mounting Bracket Replacement

Removal

NOTE: Mark the location of the bolts for installation.

1. Remove the front bumper and the towing brackets (Refer to section 9).
2. Remove the three locknuts, washers, bolts and the washers securing the mounting bracket to the frame rail (Figure 9-132).

Installation

1. Install the mounting bracket on the frame rail with the three washers, bolts, washers and the locknuts. Do not tighten the locknuts.
2. Install the mounting bracket and the towing bracket on the front bumper with the eight washers, bolts, washers and the locknuts.
3. Tighten the front bumper locknuts to 90 lb-ft. (122 N•m) and the frame rail locknuts to 178 lb-ft. (241 N•m).

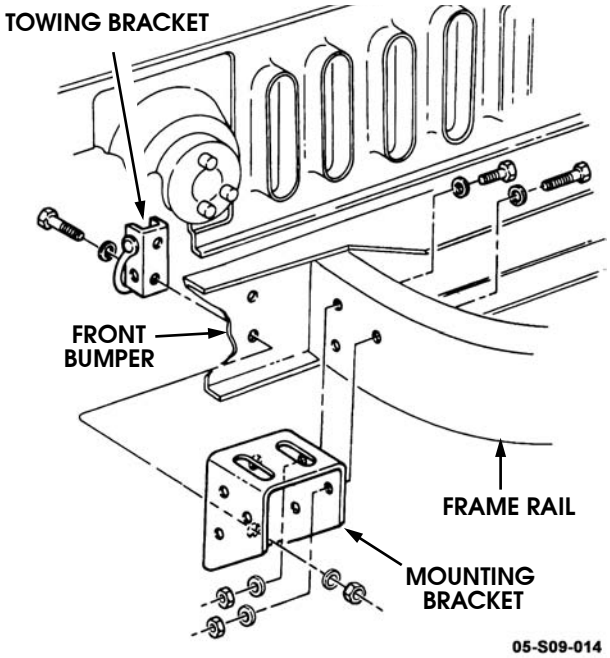


Figure 9-132: Front Bumper Mounting Bracket Replacement

Radiator Front Mount Bracket Replacement

Removal

1. Remove the locknut, washer, bolt, washer and the spacer securing the radiator to the front mount bracket (Figure 9-133).
2. Remove the two locknuts, washers, bolts, washers and the front mount bracket from the suspension crossmember.
3. Remove the mount from the front mount bracket.

Installation

1. Install the mount in the front mount bracket (Figure 9-133).
2. Install the front mount bracket on the suspension crossmember with the two washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m).
3. Install the radiator on the front mount bracket with the spacer, washer, bolt, washer and the locknut. Tighten the locknut to 30 lb-ft. (41 N•m).

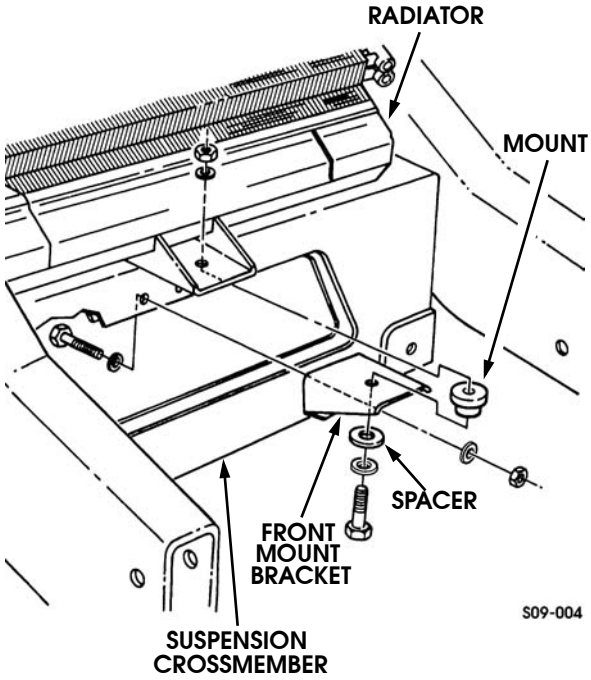


Figure 9-133: Radiator Front Mount Bracket Replacement

Frame Extension Replacement

Removal

1. Remove the front bumper.
2. Remove the hood and the hinge (Refer to section 10).
3. Remove the two locknuts, washers, bolts and the washers securing the front suspension brace to the frame extension (Figure 9-134).

NOTE: Note the position of the winch cable bracket for installation.

4. Remove the three locknuts, washers, bolts and the washers securing the clamp mounting bracket, frame extension and the bumper mounting bracket to the frame.

Installation

1. Install the bumper mounting bracket, frame extension and the clamp mounting bracket on the frame with the three washers, bolts, washers and the locknuts. Do not tighten the locknuts (Figure 9-134).
2. Secure the front suspension brace to the frame extension with the two washers, bolts, washers and the locknuts.

3. Tighten all the locknuts to 178 lb-ft. (241 N•m).
4. Install the hinge and the hood.
5. Install the front bumper.

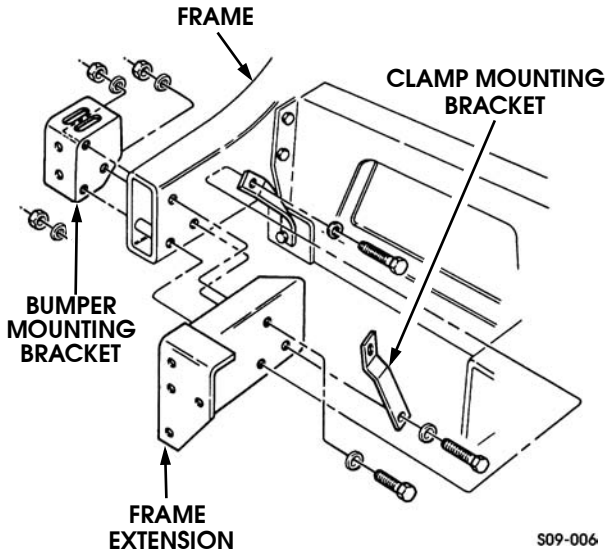


Figure 9-134: Frame Extension Replacement

Left Airlift Bracket and Front Upper Control Arm Brackets Replacement

Removal

1. Remove the left engine splash shield (Refer to section 10).
2. Raise and support the front of the vehicle.
3. Remove the three screws and the clamps securing the harness to the airlift bracket (Figure 9-135).
4. Remove the two locknuts, washers and the bolts securing the radiator support to the airlift bracket.

WARNING: To avoid personal injury or equipment damage, support the lower control arm during removal and installation.

5. Remove the two locknuts, washers, bolts, washers and the upper control arm from the two control arm brackets.

NOTE: Note the direction of the bolts for installation.

6. Remove the eight locknuts, washers, bolts, washers, two control arm brackets and the shim(s) from the airlift bracket.
7. Remove the two bolts, washers and the airlift bracket from the frame rail.

Installation

1. Install the airlift bracket, shim(s) and the two control arm brackets on the frame rail with the eight washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-135).
2. Apply thread-locking compound to the two bolt holes and secure the airlift bracket and the control arm brackets to the frame rail with the two washers and the bolts. Tighten the bolts to 90 lb-ft. (122 N•m).
3. Install the upper control arm on the control arm brackets with the cam washers, bolts, washers and the locknuts. Tighten the locknuts to 260 lb-ft. (353 N•m).
4. Secure the radiator support to the airlift bracket with the two bolts, washers and the locknuts. Tighten the locknuts to 37 lb-ft. (50 N•m).
5. Secure the harness to the airlift bracket with the three clamps and the screws.
6. Lower the front of the vehicle.
7. Install the left engine splash shield.

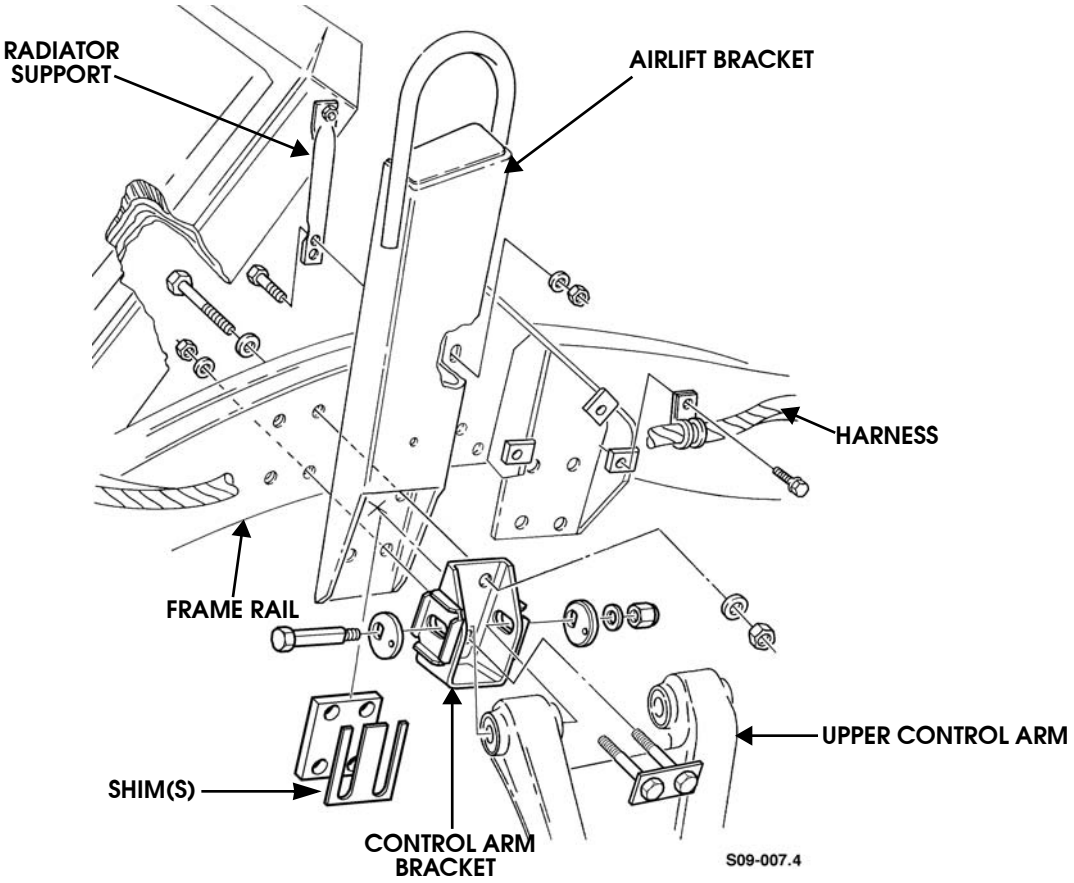


Figure 9-135: Left Airlift Bracket and Front Upper Control Arm Bracket Replacement

Right Airlift Bracket and Front Upper Control Arm Brackets Replacement

Removal

1. Remove the battery tray (Refer to section 12).
2. Raise and support the front of the vehicle.
3. Remove the two locknuts, washers and the bolts securing the radiator support to the airlift bracket (Figure 9-136).

WARNING: To avoid personal injury or equipment damage, support the lower control arm during removal and installation

4. Remove the two locknuts, washers, bolts, washers and the upper control arm from the two control arm brackets.

NOTE: Note the direction of the bolts for installation.

5. Remove the ten locknuts, washers, bolts and the washers securing the control arm brackets, cooler line bracket and the airlift bracket to the frame rail.
6. Remove the two control arm brackets, shim(s) and the airlift bracket from the frame rail.

Installation

1. Install the airlift bracket, shim(s), two control arm brackets and the cooler line bracket on the frame rail with the ten washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-136).
2. Secure the upper control arm to the two control arm brackets with the cam washers, bolts, washers and the locknuts. Tighten the locknuts to 260 lb-ft. (353 N•m).
3. Install the radiator support on the airlift bracket with the two bolts, washers and the locknuts. Tighten the locknuts to 37 lb-ft. (50 N•m).

4. Lower the front of the vehicle.
5. Install the battery tray.

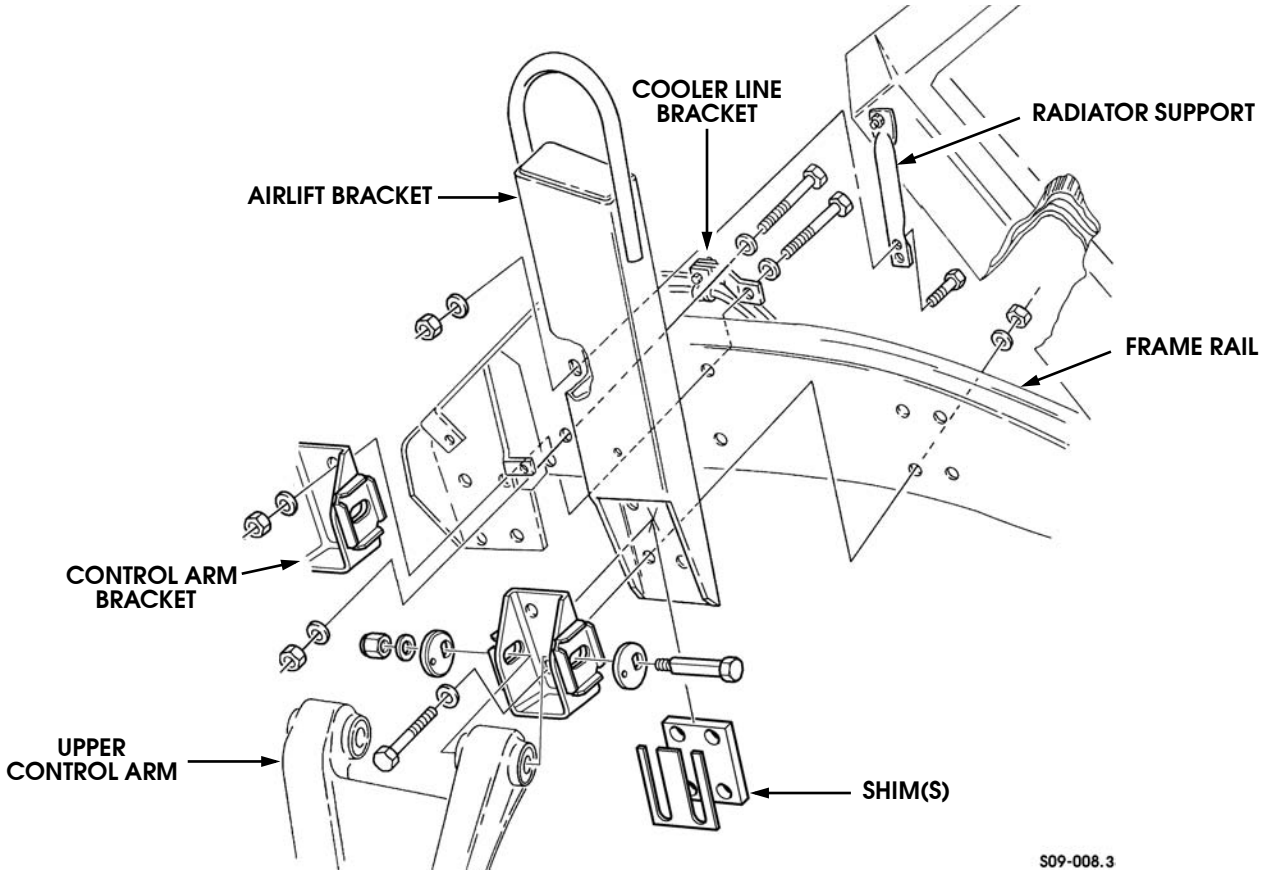


Figure 9-136: Right Airlift Bracket and Front Upper Control Arm Bracket Replacement

Front Suspension Brace Replacement (Vehicles Without Winch)

Removal

WARNING: To avoid personal injury or equipment damage, support the lower control arm during removal and installation.

1. Remove the locknut, washer, bolt and the washer securing the brace to the frame rail (Figure 9-137).
2. Remove the locknut, washer, bolt, washer and the brace from the crossmember and the lower control arm.

Installation

1. Install the brace on the crossmember and the lower control arm with the washer, bolt, washer and the locknut. Do not tighten the locknuts (Figure 9-137).
2. Install the brace on the frame rail with the washer, bolt, washer and the locknut.
3. Tighten the crossmember locknut to 261 lb-ft. (354 N•m) and the frame rail locknut to 178 lb-ft. (241 N•m).

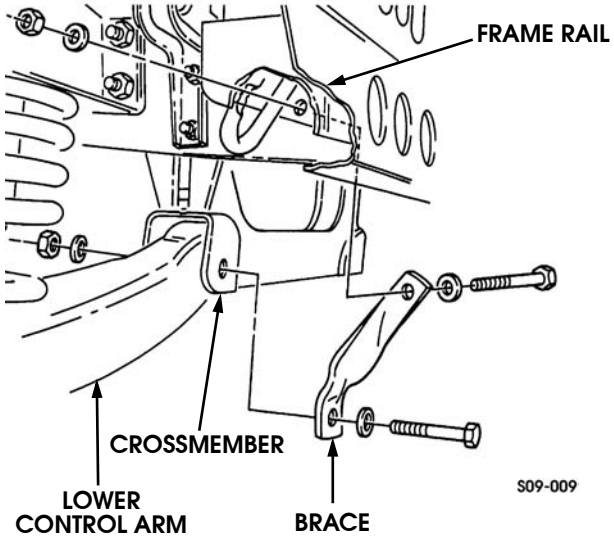


Figure 9-137: Front Suspension Brace Replacement for Vehicles Without Winch

Front Suspension Brace Replacement (Vehicles With Winch)

Removal

WARNING: To avoid personal injury or equipment damage, support the lower control arm during removal and installation.

NOTE: The left and right front suspension braces are replaced basically the same. This procedure covers the left front suspension brace.

1. Remove the two locknuts, washers, bolts and the washers securing the front suspension brace to the frame extension (Figure 9-138).
2. Remove the locknut, washer, bolt, washer and the brace from the crossmember and the lower control arm.

Installation

1. Install the brace on the crossmember and the lower control arm with the washer, bolt, washer and the locknut. Do not tighten the locknut (Figure 9-138).
2. Secure the brace to the frame extension with the two washers, bolts, washers and the locknuts.
3. Tighten the crossmember locknut to 261 lb-ft. (354 N•m) and the frame extension locknuts to 178 lb-ft. (241 N•m).

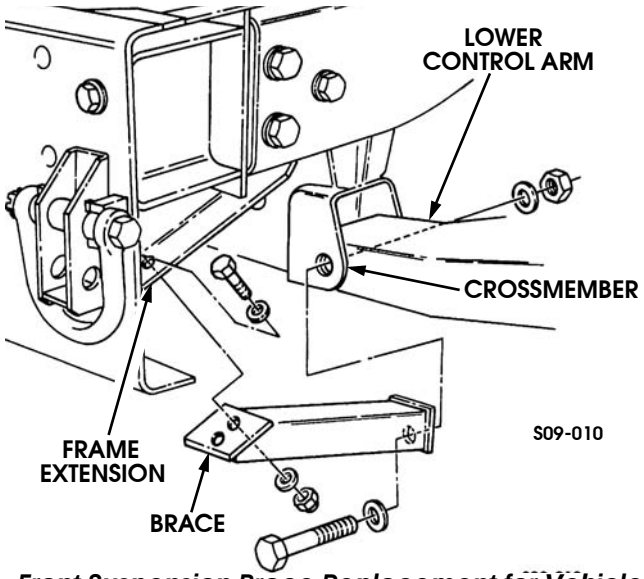


Figure 9-138: Front Suspension Brace Replacement for Vehicles With Winch

Splash Shield Support Bracket Replacement

Removal

1. Remove the locknut, washer, bolt and the washer securing the splash shield to the bracket (Figure 9-139).

NOTE: Note the direction of the bolts for installation.

2. Remove the two locknuts, washers, bolts, washers and the bracket from the frame rail.

Installation

1. Install the bracket on the frame rail with the two washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-139).
2. Install the splash shield on the bracket with the washer, bolt, washer and the locknut. Tighten the bolt to 15 lb-ft. (20 N•m).

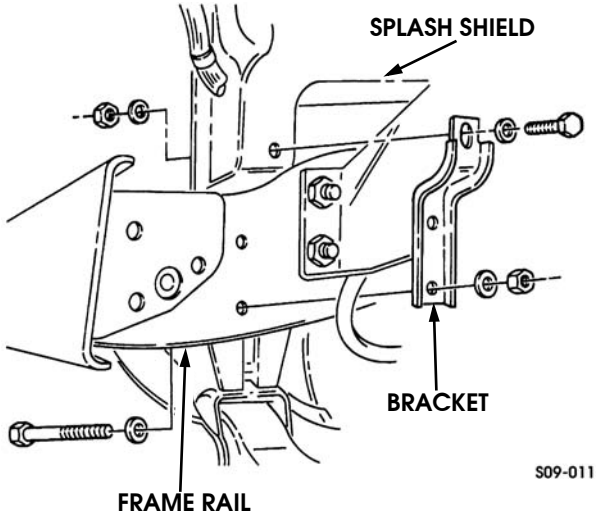


Figure 9-139: Splash Shield Support Bracket Replacement

Spring Seat Replacement

NOTE: Replacement of the four spring seats is basically the same. This procedure covers the right front spring seat.

Removal

1. Remove the coil spring.
2. Remove the four locknuts, washers, bolts, spring bracket and the front spring seat from the frame rail (Figure 9-140).

Installation

1. Install the spring bracket and the front spring seat on the frame rail with the four washers, bolts, washers and the locknuts. Tighten the locknuts to 261 lb-ft. (354 N•m) (Figure 9-140).
2. Install the coil spring.

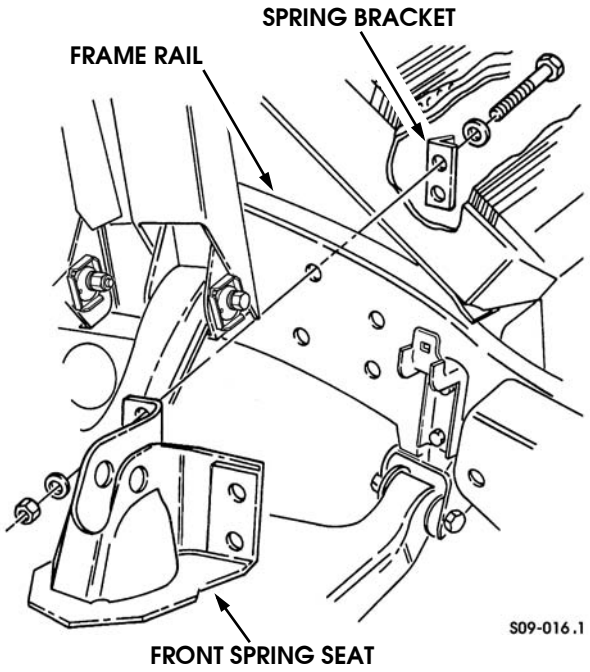


Figure 9-140: Front Spring Seat Replacement

Left Engine Mount Bracket Replacement

Removal

1. Remove the two bolts securing the brake line and the oil line clamps to the engine mount bracket (Figure 9-141).
2. Remove the two locknuts and the washers securing the engine mount bracket to the insulator.

CAUTION: *To avoid engine oil pan damage, a wood block must completely cover the bottom of the oil pan.*

3. Support the engine under the engine oil pan with a wood block and a jack stand (Figure 9-142).
4. Remove the four locknuts, washers, bolts, washers and the engine mount bracket from the frame rail (Figure 9-141).

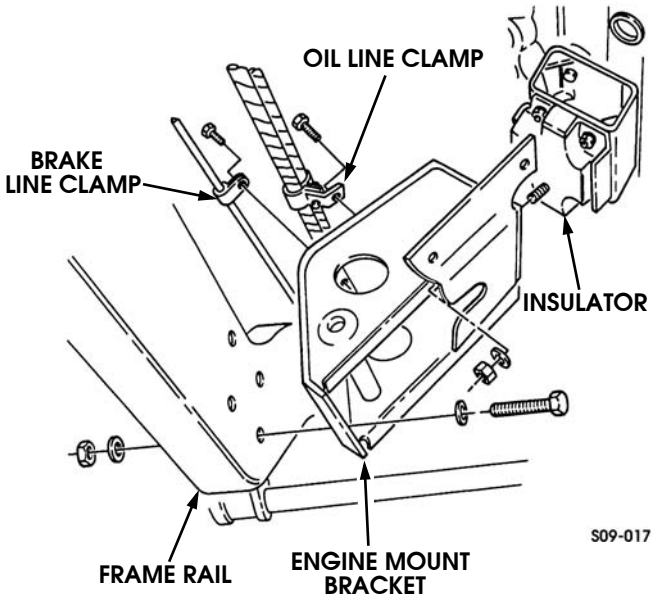


Figure 9-141: Left Engine Bracket Replacement

Installation

1. Install the engine mount bracket on the frame rail with four washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-141).
2. Remove the wood block and the jack stand from under the engine oil pan (Figure 9-142).
3. Secure the engine mount bracket to the insulator with two washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-141).
4. Secure the brake line and the oil line clamps to the engine mount bracket with the two bolts.

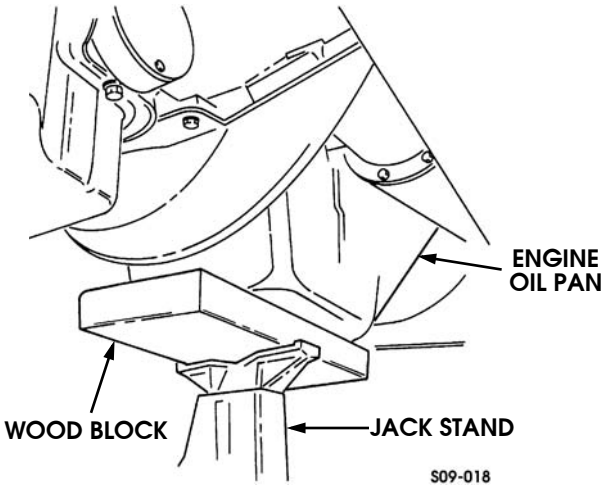


Figure 9-142: Supporting Engine

Right Engine Mount Bracket Replacement

Removal

1. Remove the right engine mount and the insulator (Refer to section 2).
2. Remove the two locknuts, washers, bolts and the washers securing the support bracket to the engine mount bracket (Figure 9-143).
3. Remove the bolt securing the vent tube clamp to the engine mount bracket.
4. Remove the three locknuts, washers, bolts, washers, support bracket and the engine mount bracket from the frame rail.

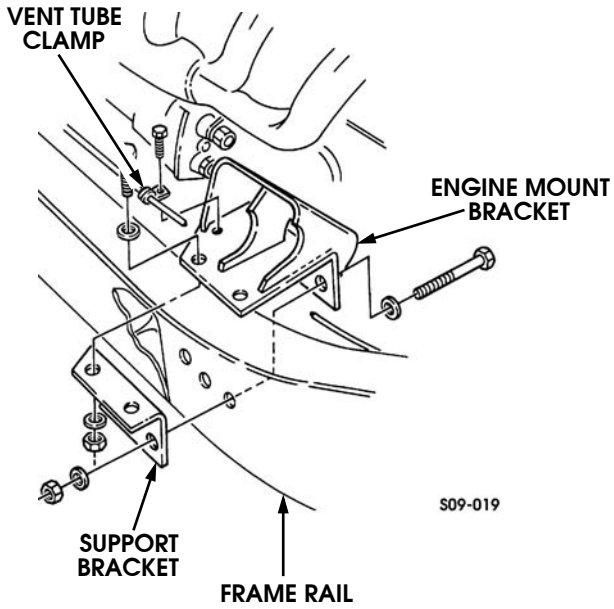


Figure 9-143: Right Engine Mount Bracket Replacement

Installation

1. Install the support bracket and the engine mount bracket on the frame rail with the three washers, bolts, washers and the locknuts (Figure 9-143).
2. Install the support bracket on the engine mount bracket with the two washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m).
3. Install the vent tube clamp on the engine mount bracket with the bolt.
4. Install the right engine mount and the insulator (Refer to section 2).

Right Front Body Mount Bracket Replacement

Removal

1. Remove the right front body mount.
2. Remove the three locknuts, washers, bolts, washers and the right front body mount bracket from the frame rail (Figure 9-144).

Installation

1. Install the right front body mount bracket on the frame rail with the three washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-144).
2. Install the right front body mount (Refer to section 10).

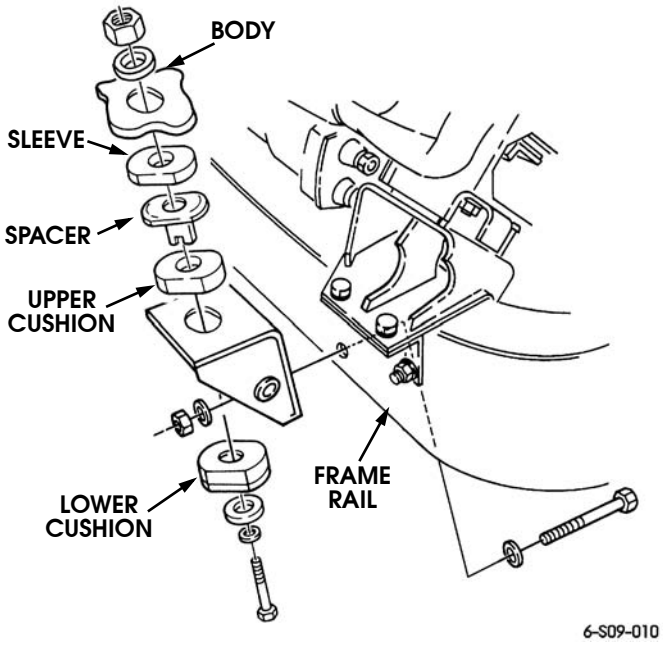


Figure 9-144: Right Front Body Mount Bracket Replacement

Transmission Mount Crossmember Replacement

Removal

CAUTION: *To prevent equipment damage during removal and installation of the transmission mount crossmember, the transmission must be supported.*

1. Remove the intermediate driveline protection shield (Refer to section 9).
2. Remove the guide cable retaining nut from the transmission crossmember support bracket bolt.
3. Remove the transmission crossmember support bracket bolts, nuts and washers from the crossmember.
4. Remove the transmission crossmember support bracket bolts, locknuts and washers from the frame rail and remove the support brackets (Figure 9-145).

5. Remove the two crossmember to transmission mount locknuts and remove the crossmember.

Installation

1. Install the crossmember and the two crossmember to transmission mount locknuts. Tighten the locknuts to 28 lb-ft. (38 N•m).
2. Install the transmission crossmember support bracket on the two bolts and the frame rail with the two washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-145).
3. Install the transmission mount to crossmember bolts, locknuts and washers. Tighten the locknuts to 90 lb-ft. (122 N•m).
4. Install the guide cable and the retaining locknut to the transmission crossmember support bracket bolt. Tighten the locknut to 90 lb-ft. (122 N•m).
5. Install the intermediate driveline protection shield.

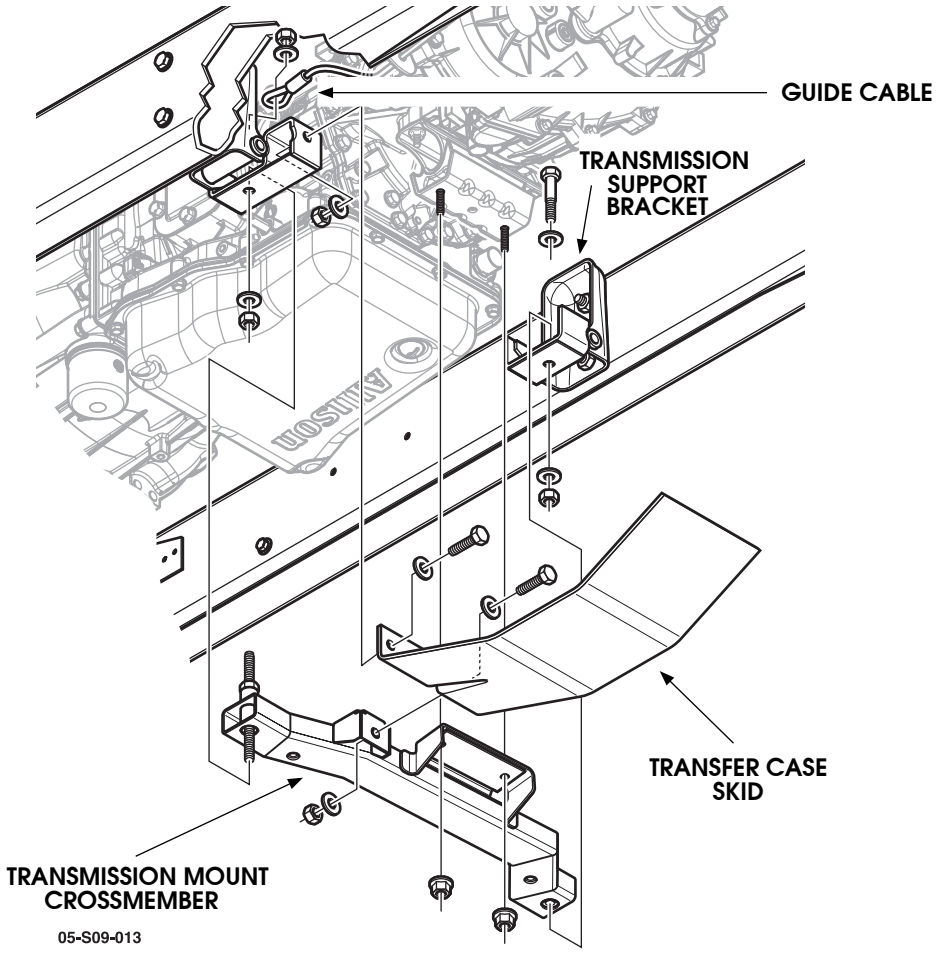


Figure 9-145: Transmission Mount Crossmember Replacement

Transmission Crossmember Support Bracket Replacement

Removal

CAUTION: *To prevent equipment damage during removal and installation of the transmission mount crossmember, the transmission must be supported.*

1. Remove the intermediate driveline protection shield (Refer to section 9).
2. Remove the transfer case skid.
3. Remove the guide cable retaining nut from the transmission crossmember support bracket bolt.
4. Remove the transmission crossmember support bracket bolts, nuts and washers from the crossmember.

5. Remove the transmission crossmember support bracket bolts, locknuts and washers from the frame rail and remove the support brackets (Figure 9-146).

Installation

1. Install the transmission crossmember support bracket on the two bolts and the frame rail with the two washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-146).
2. Install the transmission mount to crossmember bolts, locknuts and washers. Tighten the locknuts to 90 lb-ft. (122 N•m).
3. Install the guide cable and the retaining locknut to the transmission crossmember support bracket bolt. Tighten the locknut to 90 lb-ft. (122 N•m).
4. Install the transfer case skid.
5. Install the intermediate driveline protection shield.

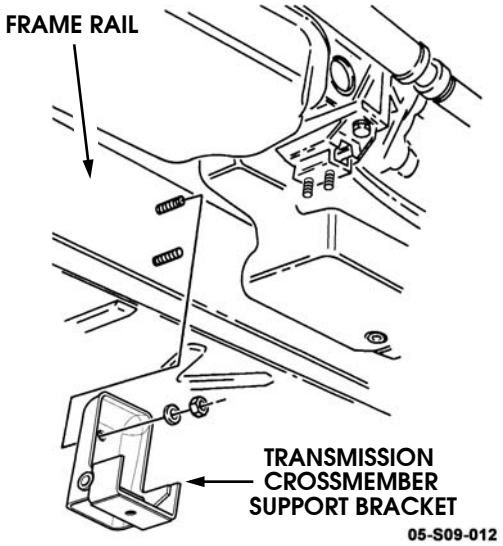


Figure 9-146: Transmission Crossmember Support Bracket Replacement

Right Intermediate Body Mount Bracket Replacement

Removal

1. Remove the right intermediate body mount (Refer to section 10).
2. Remove the three bolts, washers and the body mount bracket from the frame rail (Figure 9-147).

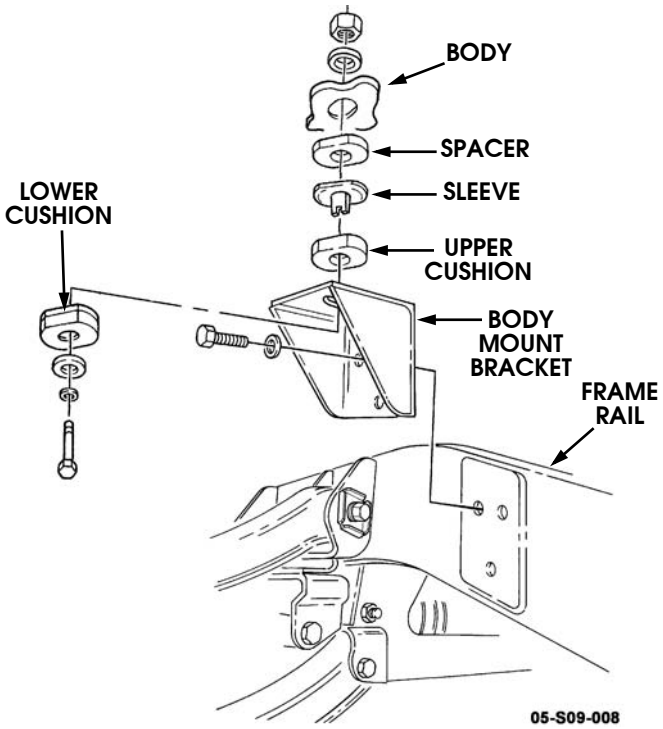


Figure 9-147: Right Intermediate Body Mount Bracket Replacement

Installation

1. Apply thread-locking compound to the three bolts and install the body mount bracket on the frame rail with the three washers and the bolts. Tighten the bolts to 90 lb-ft. (122 N•m) (Figure 9-147).
2. Install the right intermediate body mount (Refer to section 10).

Left Intermediate Body Mount Bracket Replacement

Removal

1. Remove the left intermediate body mount (Refer to section 10).
2. Remove the tailpipe hanger (Refer to section 11).
3. Remove the three locknuts, washers and the body mount bracket from the frame rail (Figure 9-148).

Installation

1. Install the body mount bracket on the three bolts and the frame rail with the three washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-148).
2. Install the tailpipe hanger (Refer to section 11).
3. Install the left intermediate body mount (Refer to section 10).

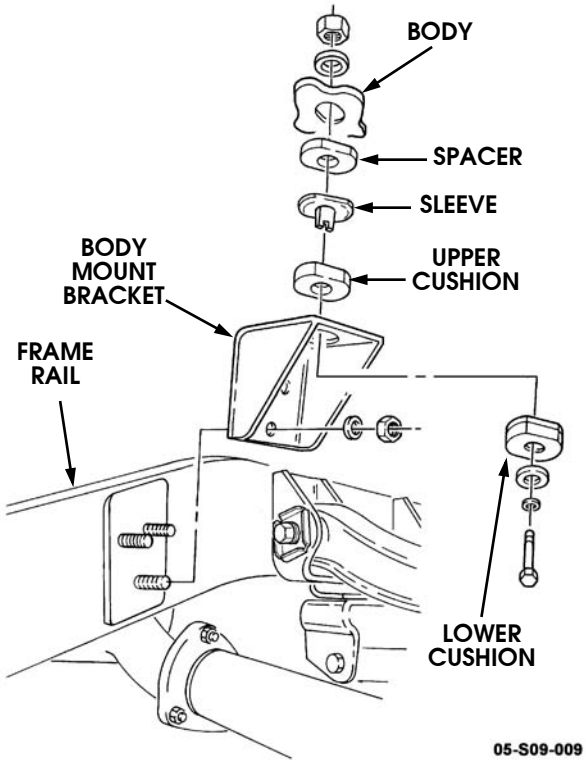


Figure 9-148: Left Intermediate Body Mount Bracket Replacement

Rear-Rear Tie Down Bracket Replacement

Removal

Remove the two locknuts, washers, bolts, washers and the tie-down bracket from the frame rail (Figure 9-149).

Installation

Install the tie down bracket on the frame rail with the two washers, bolts, washers and the locknuts. Tighten the locknuts to 261 lb-ft. (354 N•m) (Figure 9-149).

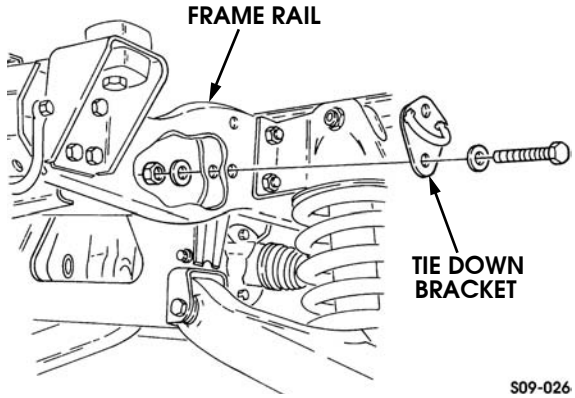


Figure 9-149: Tie Down Bracket Replacement

Rear Upper Control Arm Bracket Replacement

NOTE: The procedure for removing and installing the four rear upper control arm brackets is basically the same. This procedure covers the right rear upper control arm front bracket.

Removal

1. Remove the wheel.
2. Remove the bolt, clamp and the vent line from the bracket, and disconnect the vent line from the fitting (Figure 9-150).
3. Remove the two locknuts, washers, bolts, washers and the upper control arm from the two control arm brackets (Figure 9-151).
4. Remove the four locknuts, washers, bolts, washers, vent line mounting bracket and the control arm bracket from the frame rail.

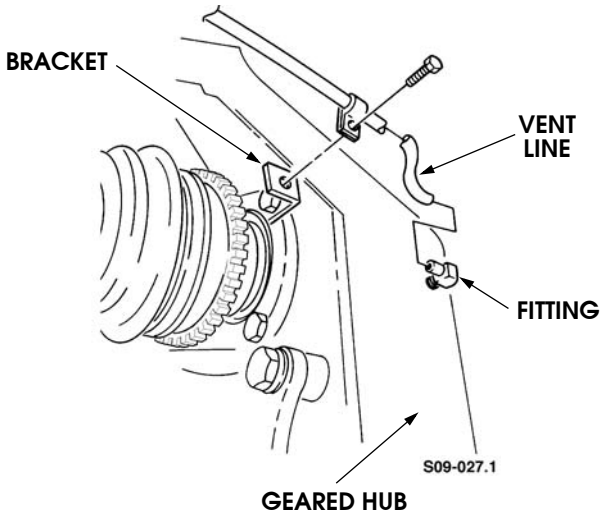


Figure 9-150: Rear Geared Hub Vent Line Location

Installation

1. Install the control arm bracket and the vent line mounting bracket on the frame rail with the four washers, bolts, washers and the locknuts. Tighten the locknuts to 172 lb-ft. (233 N•m) (Figure 9-151).
2. Attach the upper control arm to the two upper control arm brackets with the washers, bolts, washers and the locknuts. Tighten the locknuts to 260 lb-ft. (353 N•m).
3. Connect the vent line to the fitting and secure the clamp and the vent line to the bracket with the bolt (Figure 9-150).
4. Install the wheel.

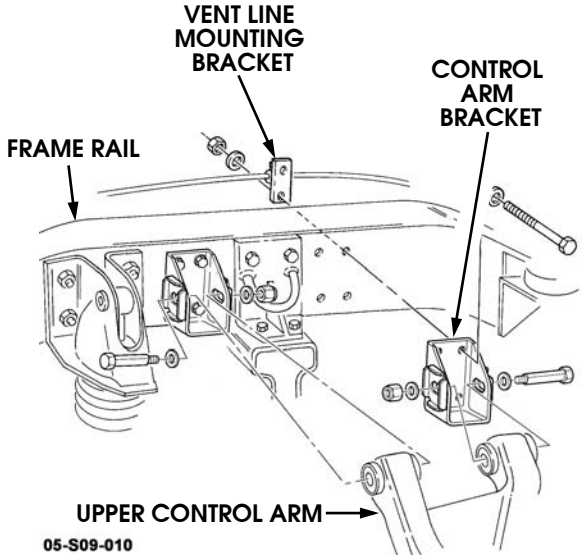


Figure 9-151: Rear Upper Control Arm Bracket Replacement

Rear-Front Tie down Bracket Replacement

Removal

1. Remove the wheel (Refer to section 6).
2. Remove the four locknuts, washers, bolts, washers and the tie down bracket from the frame rail (Figure 9-152).
3. Remove the two locknuts, washers, bolts, washers, vent tube/speed sensor lead mounting bracket and the tie down bracket from the rear suspension front crossmember mounting bracket.

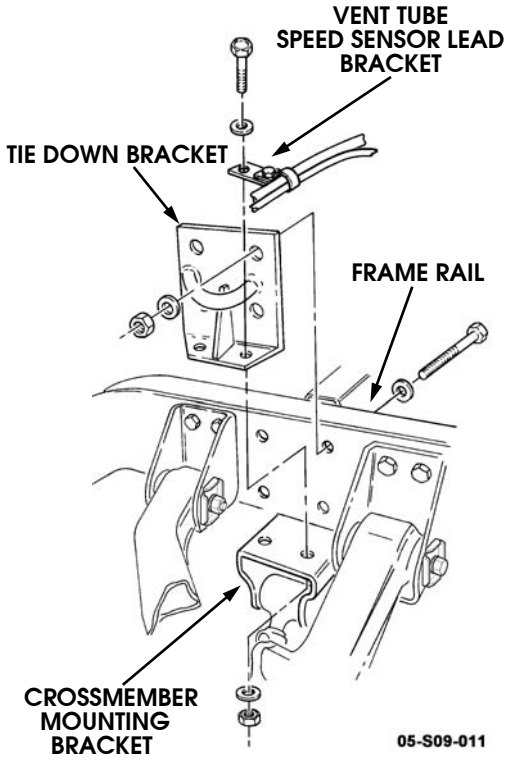


Figure 9-152: Rear-Front Tie Down Bracket Replacement

Installation

1. Install the tie down bracket and the vent tube mounting bracket on the rear suspension front crossmember mounting bracket with the two washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-152).
2. Install the tie down bracket on the frame rail with the four washers, bolts, washers and the locknuts. Tighten the locknuts to 261 lb-ft. (354 N•m).
3. Install the wheel.

Axle Support/Brake Adapter Bracket Replacement

Removal

NOTE: Only remove one support bracket at a time to maintain rear support of the axle assembly.

1. Remove the brake caliper and the rotor (Refer to section 7).
2. Remove the locknut, seal washer and the output flange from the output shaft. Discard the seal washer (Figure 9-153).
3. Remove the four side bolts and the lower support bolt and remove the axle support/brake adapter from the axle assembly.

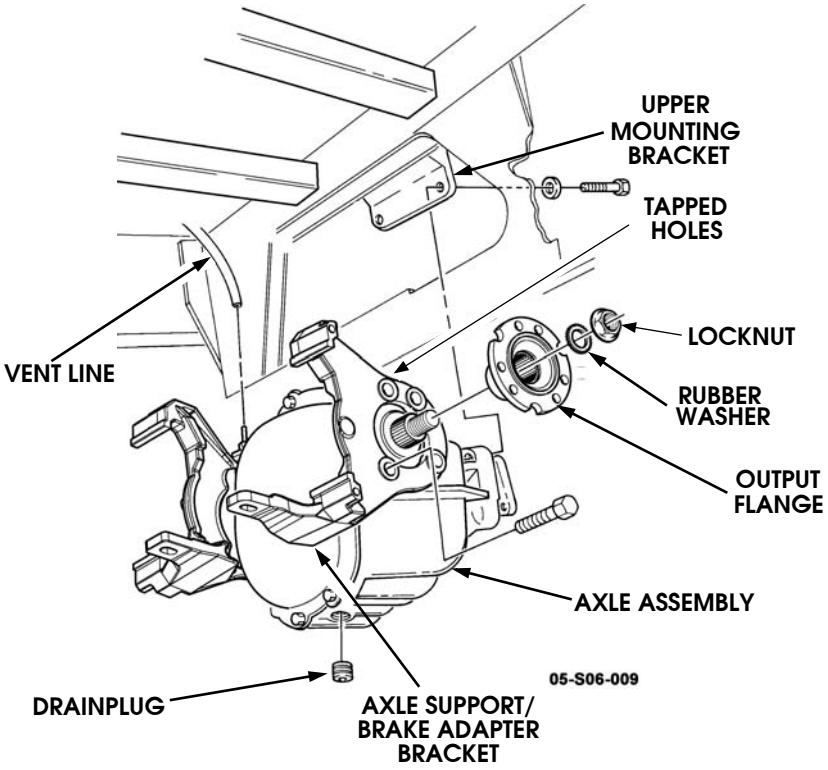


Figure 9-153: Axle Support/Brake Adapter and Output Flange Replacement

Installation

1. Apply Loctite 272 (or equivalent) thread-locking compound to the axle assembly tapped holes. Secure the axle support/brake adapter to the axle assembly with the four bolts. Tighten the bolts to 125-150 lb-ft. (169-203 N•m).
2. Install the lower support bolt and torque to 125-150 lb-ft. (169-203 N•m).
3. Install the output flange on the output shaft with the seal washer and the locknut. Tighten the locknut to 165-195 lb-ft. (224-264 N•m).
4. Install the brake caliper and the rotor.

Front Suspension Front Crossmember Replacement

Removal

1. Drain the cooling system (Refer to section 4).
1. Remove the front lower control arms (Refer to section 9).
2. Remove the lower radiator hose (Refer to section 4).
3. Remove the two bolts, locknuts and the washers from the front crossmember to the front radiator mount and the brake line support bracket (Figure 9-154).

WARNING: Failure to lower and latch the hood could result in personal injury and body damage.

4. Mark the lower hood support bracket position then lower and latch the hood.
5. Remove the four bolts, washers and the locknuts holding lower hood support bracket to the front crossmember (Figure 9-154).

NOTE: Note the direction of the bolts for installation.

6. Remove the four locknuts, washers, bolts and the washers securing the two splash shield brackets to the frame rails (Figure 9-155).

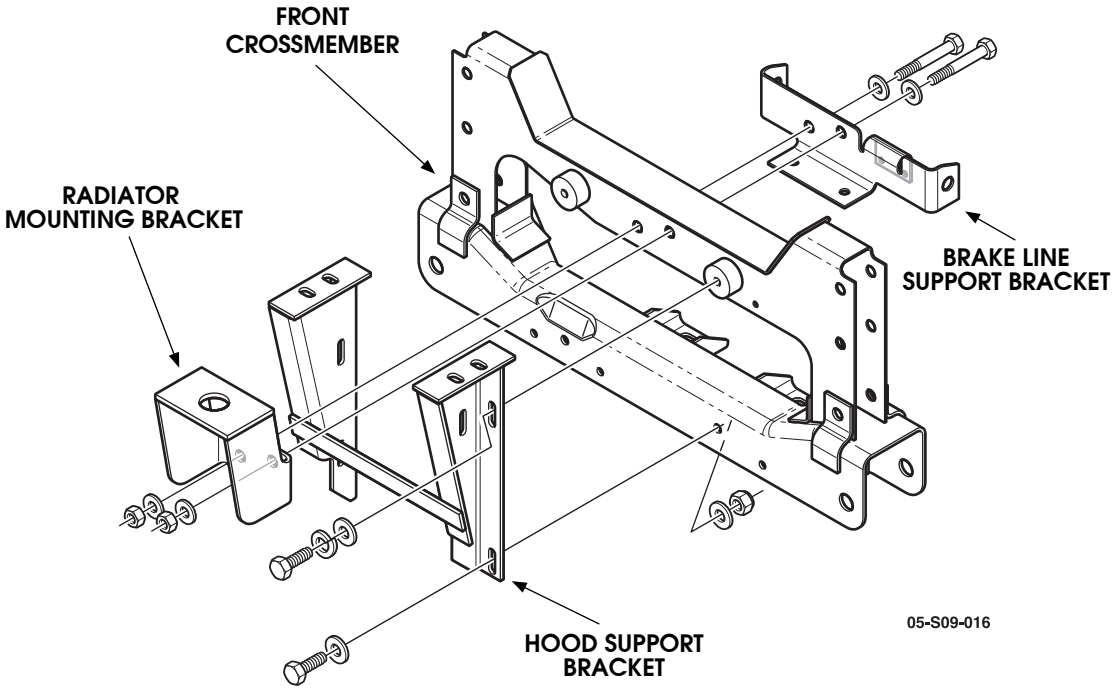


Figure 9-154: Support Brackets

WARNING: To avoid personal injury, support the crossmember during removal.

7. Remove the four bolts, washers and the two locknuts securing the crossmember mounting brackets to the frame rails.
8. Remove the six locknuts, washers, bolts and the washers securing the front crossmember to the left and the right front crossmember mounting brackets.
9. Slide the crossmember down and out from under the vehicle.

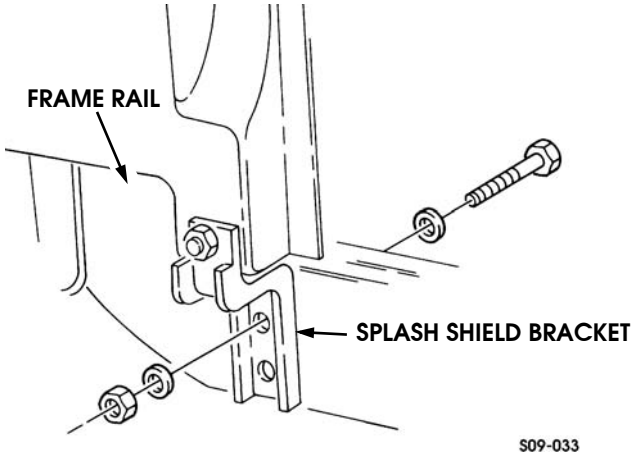


Figure 9-155: Splash Shield Mounting

Installation

1. Position the left and the right crossmember mounting brackets on the crossmember (Figure 9-156).
2. Install the crossmember on the frame rails with the four washers, bolts, washers and the locknuts. Do not tighten the locknuts.
3. Install the six washers, bolts, washers and the locknuts securing the front crossmember to the left and the right mounting brackets. Tighten the bolts to 90 lb-ft. (122 N•m).
4. Tighten the larger rear mounting bracket-to-frame rail locknuts to 261 lb-ft. (354 N•m) and tighten the smaller front locknuts to 90 lb-ft. (122 N•m).

5. Install the four bolts, washers and the locknuts holding lower hood support bracket to the front crossmember and adjust to the bracket to it's original position.
6. Install the four washers, bolts, washers, locknuts and the two splash shield brackets on the frame rails. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-155).
7. Install the bolts, locknuts and the washers to the front crossmember from the radiator front mounting bracket.
8. Install the lower radiator hose.
9. Install the front lower control arms.
10. Fill, bleed and leak test the cooling system.

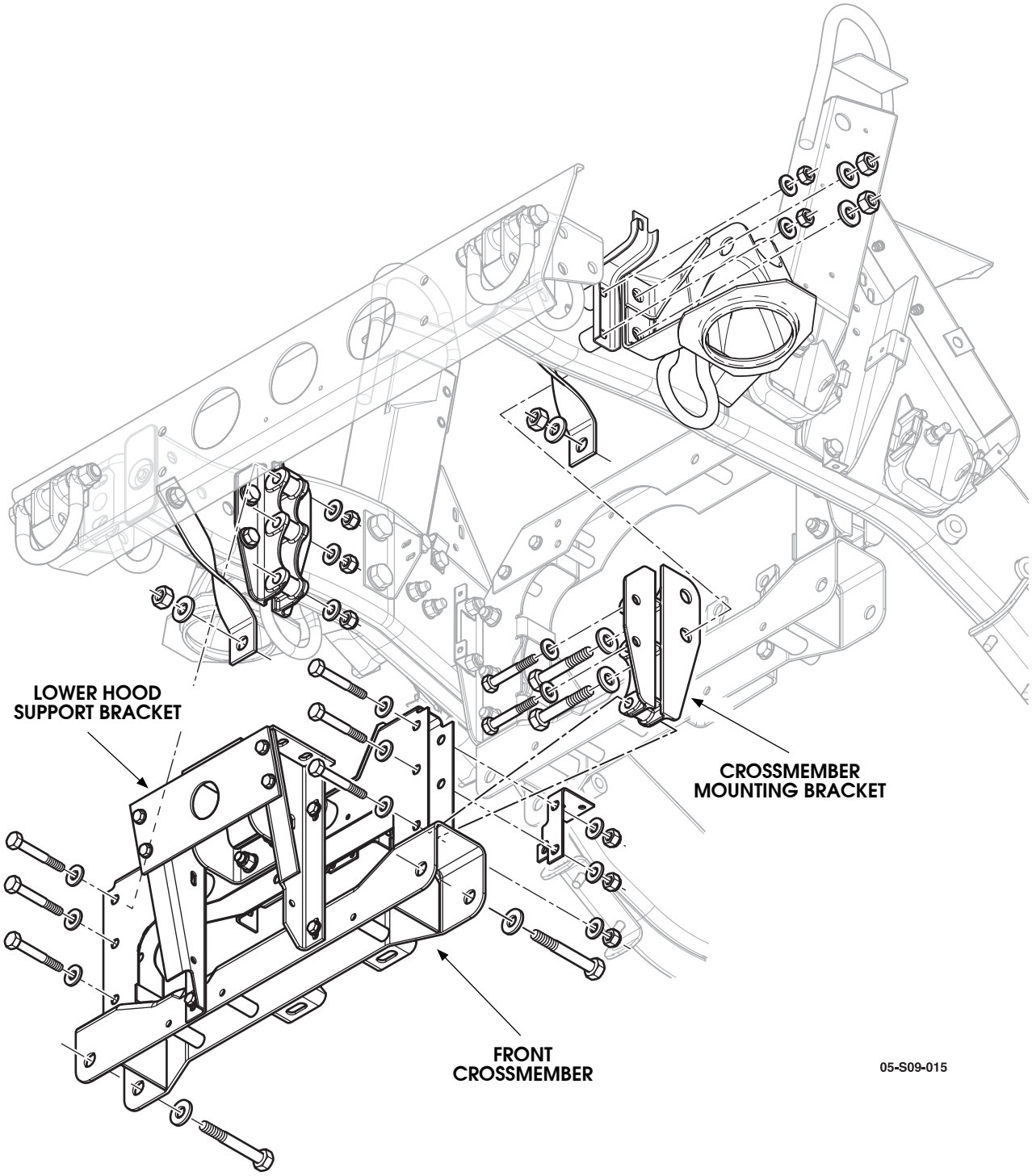


Figure 9-156: Front Suspension Front Crossmember Replacement

Front Suspension Rear Crossmember Replacement

Removal

1. Remove the geared fan drive (Refer to section 4).
2. Remove the right front upper control arm (Refer to section 9).
3. Remove the lower radiator tube.
4. Remove the right front caliper-to-tee brake line.
5. Remove the lower control arms.
6. Remove the three bolts, lock washers, washers and pull the steering gear away from the left frame rail (Refer to section 8).
7. Remove the three bolts and the clamps from the vent line bracket and the crossmember (Figure 9-157).

WARNING: To avoid personal injury, support the crossmember during removal.

NOTE: Note the direction of the bolts for installation.

8. Remove the four locknuts, washers, bolts, washers and the vent line bracket securing the rear crossmember to the right frame rail.
9. Remove the three locknuts, washers, bolts, washers and the vent line bracket securing the rear crossmember to the left frame rail.
10. Remove the three locknuts, washers, bolts, washers securing the rear crossmember to the left frame rail.
11. Remove the six locknuts, washers, bolts and the washers securing the rear crossmember to the left and the right rear crossmember mounting brackets.
12. Slide the rear crossmember and the mounting brackets down and out from under the vehicle.
13. Remove the mounting brackets from the rear crossmember.

Installation

1. Install the left and the right rear crossmember mounting brackets on the rear crossmember (Figure 9-157).
2. Install the rear crossmember and the mounting brackets on the frame rails.
3. Apply thread-locking compound to the hole and secure the crossmember mounting bracket to the left frame rail with the washer and the bolt. Tighten the bolt to 65-78 lb-ft. (88-106 N•m).
4. Secure the crossmember mounting bracket to the left frame rail with the vent line bracket, three washers, bolts, washers and the locknuts. Do not tighten the bolts.
5. Secure the crossmember mounting bracket to the right frame rail with the vent line bracket, four washers, bolts, washers and the locknuts. Do not tighten the bolts.
6. Install the six washers, bolts, washers and the locknuts securing the rear crossmember to the left and the right mounting brackets. Tighten the bolts to 90 lb-ft. (122 N•m).
7. Tighten the four bolts on the mounting bracket and the left frame rail to 90 lb-ft. (122 N•m).
8. Tighten the four bolts on the mounting bracket and the right frame rail to 90 lb-ft. (122 N•m).
9. Secure the vent line to the rear crossmember and the two vent line brackets with the three clamps and the bolts.
10. Secure the steering gear to the left frame rail with the three washers, lock washers and the bolts (Refer to section 8)
11. Install the axle.
12. Install the lower control arms.

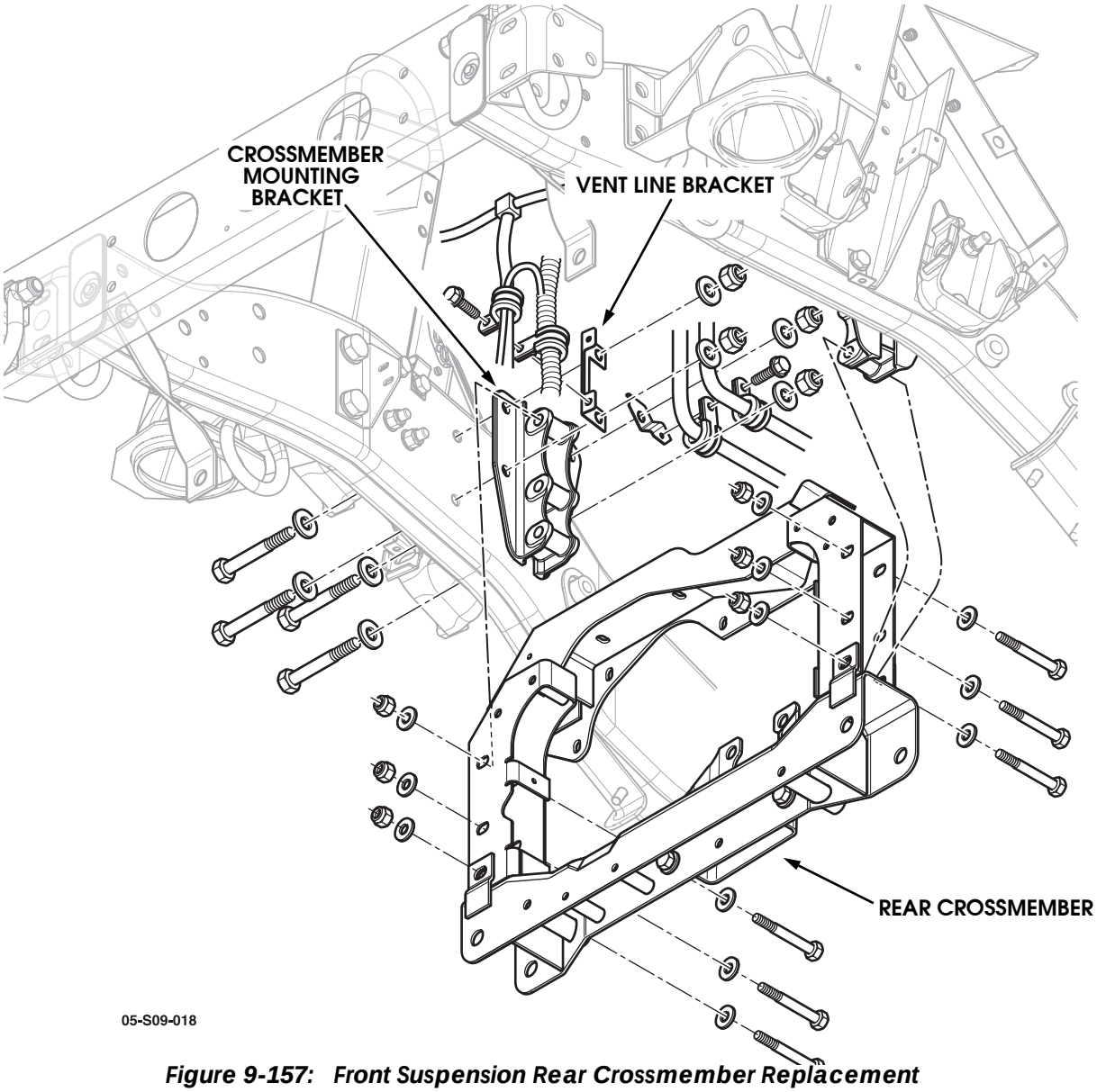


Figure 9-157: Front Suspension Rear Crossmember Replacement

13. Install the right front caliper-to-tee brake line.
14. Install the right front upper control arm.
15. Install the lower radiator tube.
16. Fill, bleed and leak test cooling system.

Rear Suspension Front Crossmember Replacement

Removal

1. Remove the rear-front tie down brackets.
2. Remove the axle (Refer to section 6).
3. Remove the axle support brackets and the side mounting brackets.
4. Remove the rear lower control arms.
5. Remove the three bolts and the clamps securing the brake line and the two vent lines to the front crossmember (Figures 9-158 and 9-160).
6. Remove the brake line from the tee and the tube coupling.

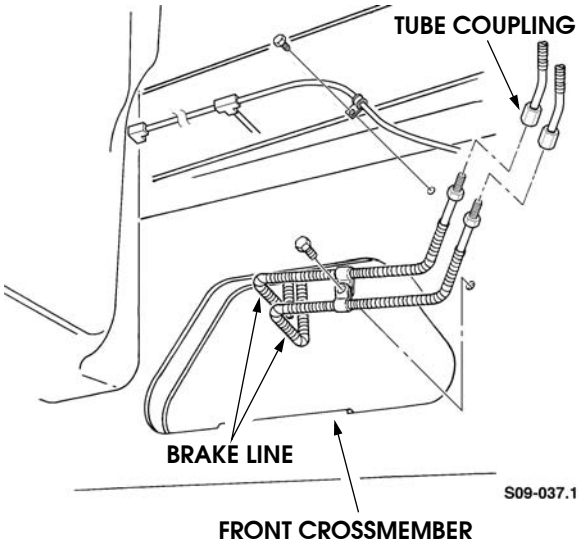


Figure 9-158: Brake Line and Tube Coupling Location

7. Remove the two locknuts, washers, bolts, washers and the two radius rods from the crossmember mounting brackets (Figure 9-160).

WARNING: To avoid personal injury, support the crossmember during removal.

8. Loosen the six locknuts securing the front crossmember to crossmember mounting brackets.
9. Slide the front crossmember down and out from under the vehicle.
10. Remove the six locknuts, washers, bolts, washers and the two crossmember mounting brackets from the front crossmember.

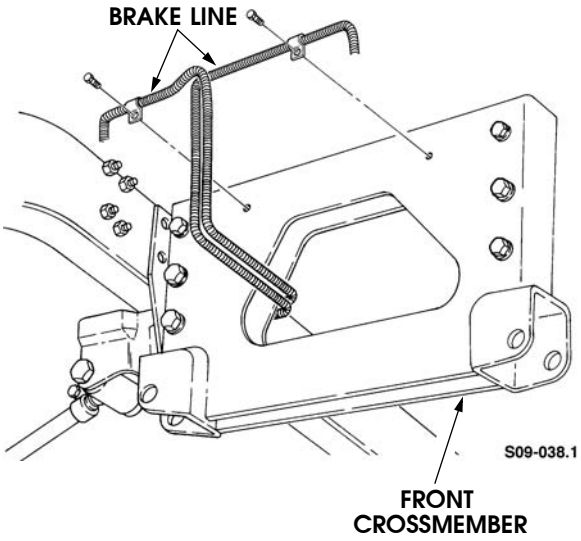


Figure 9-159: Brake Line and Vent Lines Location

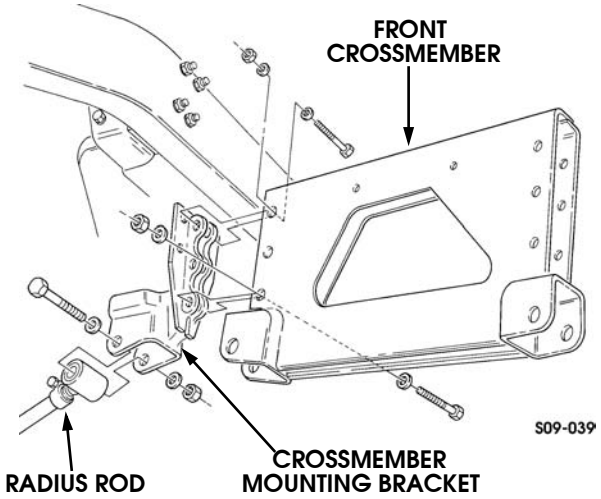


Figure 9-160: Front Crossmember Assembly Replacement

Installation

1. Install the two crossmember mounting brackets on the front crossmember with the six washers, bolts, washers and the locknuts. Tighten the locknuts to 90 lb-ft. (122 N•m) (Figure 9-160).
2. Install the front crossmember on the frame rails.
3. Install the rear-front tie down brackets.
4. Install the radius rods in the crossmember mounting brackets with the two washers, bolts, washers and the locknuts. Tighten the locknuts to 260 lb-ft. (353 N•m).
5. Install the brake line on the tee and the tube coupling (Figures 9-158, and 9-160).
6. Secure the brake line and the two vent lines to the front crossmember with the three clamps and the bolts (Figure 9-159).
7. Install the axle support brackets and the side mounting brackets.
8. Install the axle.
9. Install the rear lower control arms.
10. Bleed the rear brakes.

Rear Bumper Replacement

Removal

1. Remove the rear license plate bracket (Refer to section 10).
2. Remove the trailer hitch, if equipped (Refer to section 13).
3. Remove the two locknuts, washers, bolts and the washers securing the trailer harness to the rear bumper (Figure 9-161).
4. Disconnect the trailer harness from the body harness and pull the trailer harness through the hole in the rear bumper.
5. Remove the four locknuts, washers, bolts and the washers securing the two tie down brackets to the rear bumper, two mounting brackets and the outer mounting brackets.
6. Remove the eight bolts, washers and the rear bumper from the two mounting brackets.

Installation

1. Install the rear bumper on the two mounting brackets and secure with the eight washers and the bolts. Do not tighten the bolts (Figure 9-161).
2. Install the two tie down brackets on the rear bumper, two mounting brackets and the outer mounting brackets, with the four washers, bolts, washers and the locknuts. Do not tighten the locknuts.
3. Tighten the bolts installed in step 1 and the locknuts installed in steps 2, 3 and 4 to 90 lb-ft. (122 N•m).
4. Insert the trailer harness through the hole in the rear bumper and connect the trailer harness to the body harness.
5. Secure the trailer harness to the rear bumper with the two washers, bolts, washers and the locknuts.
6. Install the trailer hitch, if removed.
7. Install the rear license plate bracket.

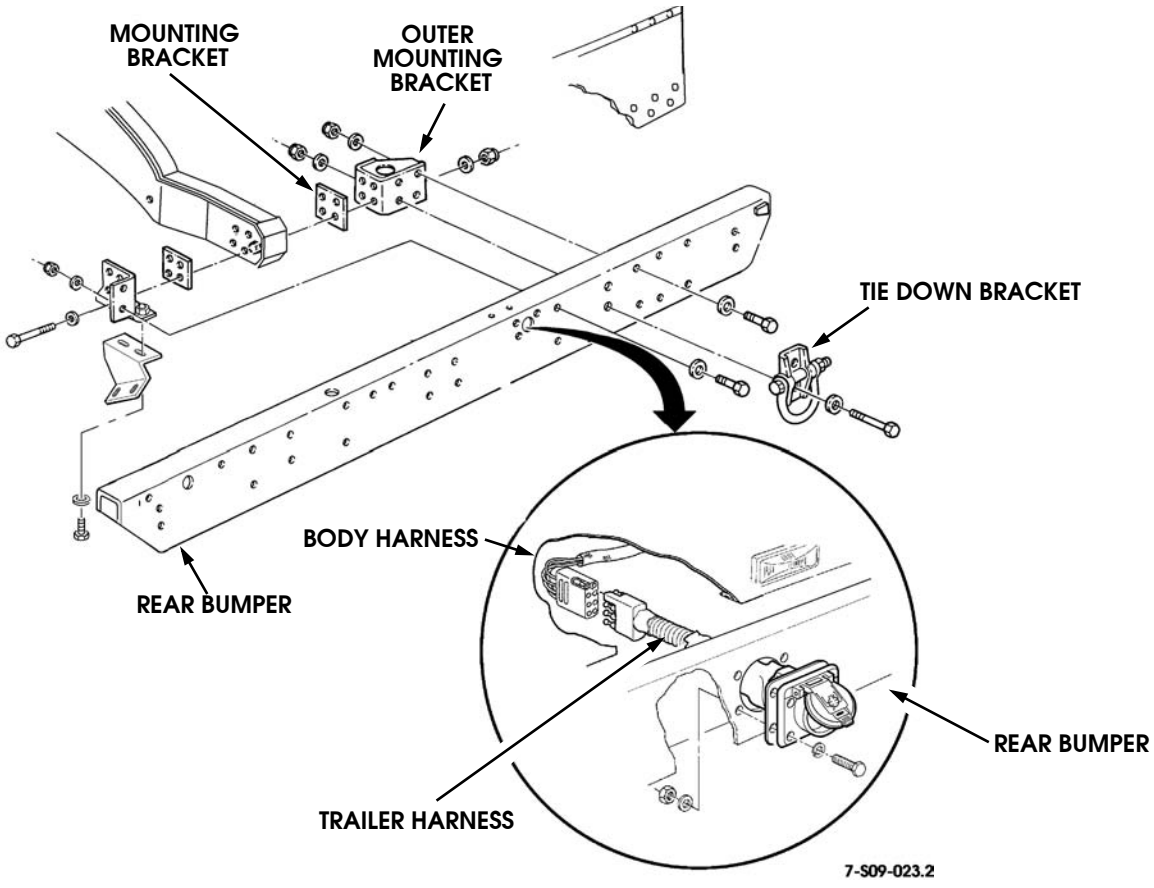


Figure 9-161: Rear Bumper Replacement

Rear Bumper Outer Mounting Bracket and Tie Down Bracket Replacement

Removal

1. Remove the rear body mount (Refer to section 10).
2. Remove the two locknuts, washers, bolts and the washers securing the tie down bracket and the outer mounting bracket to the mounting bracket and the rear bumper (Figure 9-162).
3. Remove the two bolts and the washers securing the outer mounting bracket to the mounting bracket.
4. Remove the four locknuts, washers, bolts, washers, outer mounting bracket and the spacer from the frame rail and the inner mounting bracket.

Installation

NOTE: Ensure the spacer on the inner side of the frame rail is in position before installing the spacer and the outer mounting bracket.

1. Install the spacer and the outer mounting bracket on the frame rail and the inner mounting bracket with the four washers, bolts, washers and the locknuts. Do not tighten the locknuts (Figure 9-162).
2. Secure the outer mounting bracket to the mounting bracket with the two washers and the bolts. Do not tighten the bolts.
3. Install the tie down bracket on the rear bumper and secure the tie down bracket and the outer mounting bracket to the mounting bracket and the rear bumper with the two washers, bolts, washers and the locknuts.
4. Tighten all the locknuts and the bolts to 90 lb-ft. (122 N•m).
5. Install the rear body mount (Refer to section 10).

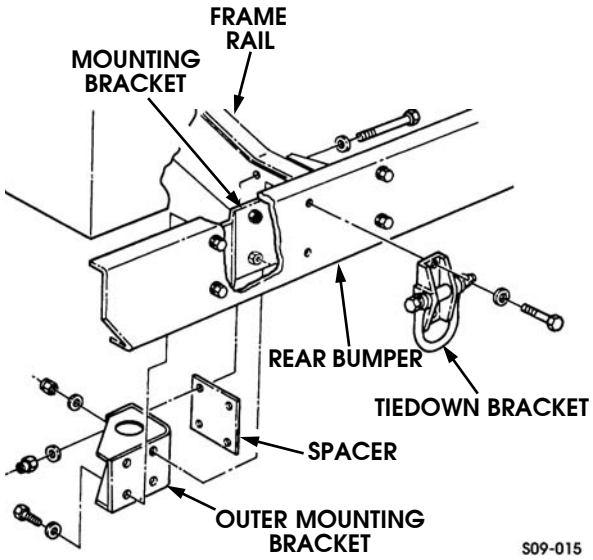


Figure 9-162: Rear Bumper Mounting Bracket Replacement

Lifting Shackle Replacement

Removal

Remove the cotter pin, slotted nut, bolt, spring washer and the shackle from the tie down bracket. Discard the cotter pin (Figure 9-163).

Installation

1. Install the shackle on the tie down bracket with spring washer, bolt and the slotted nut. Tighten the slotted nut enough to allow movement of the shackle (Figure 9-163).
2. Install the cotter pin in the slotted nut.

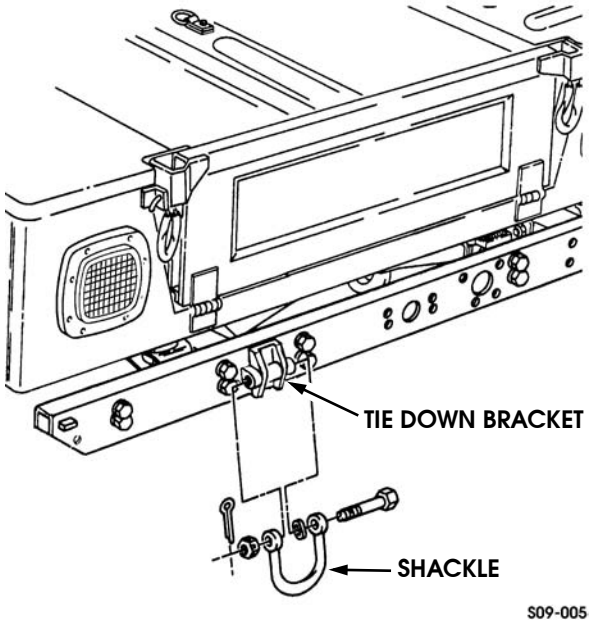
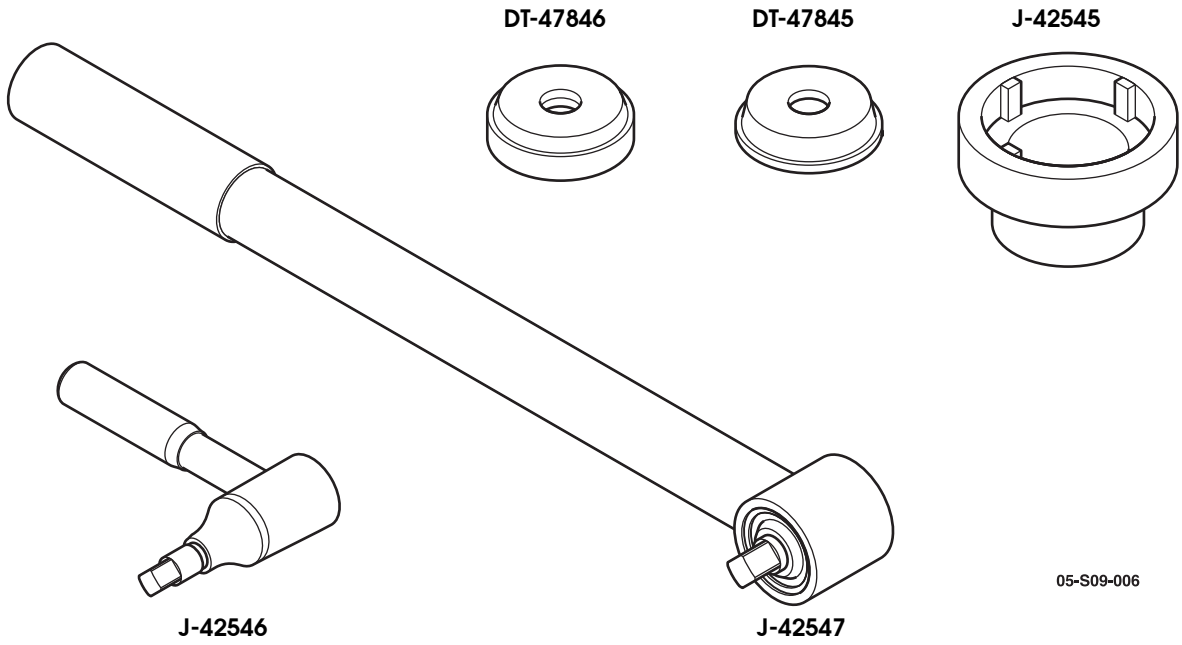


Figure 9-163: Lifting Shackle Replacement

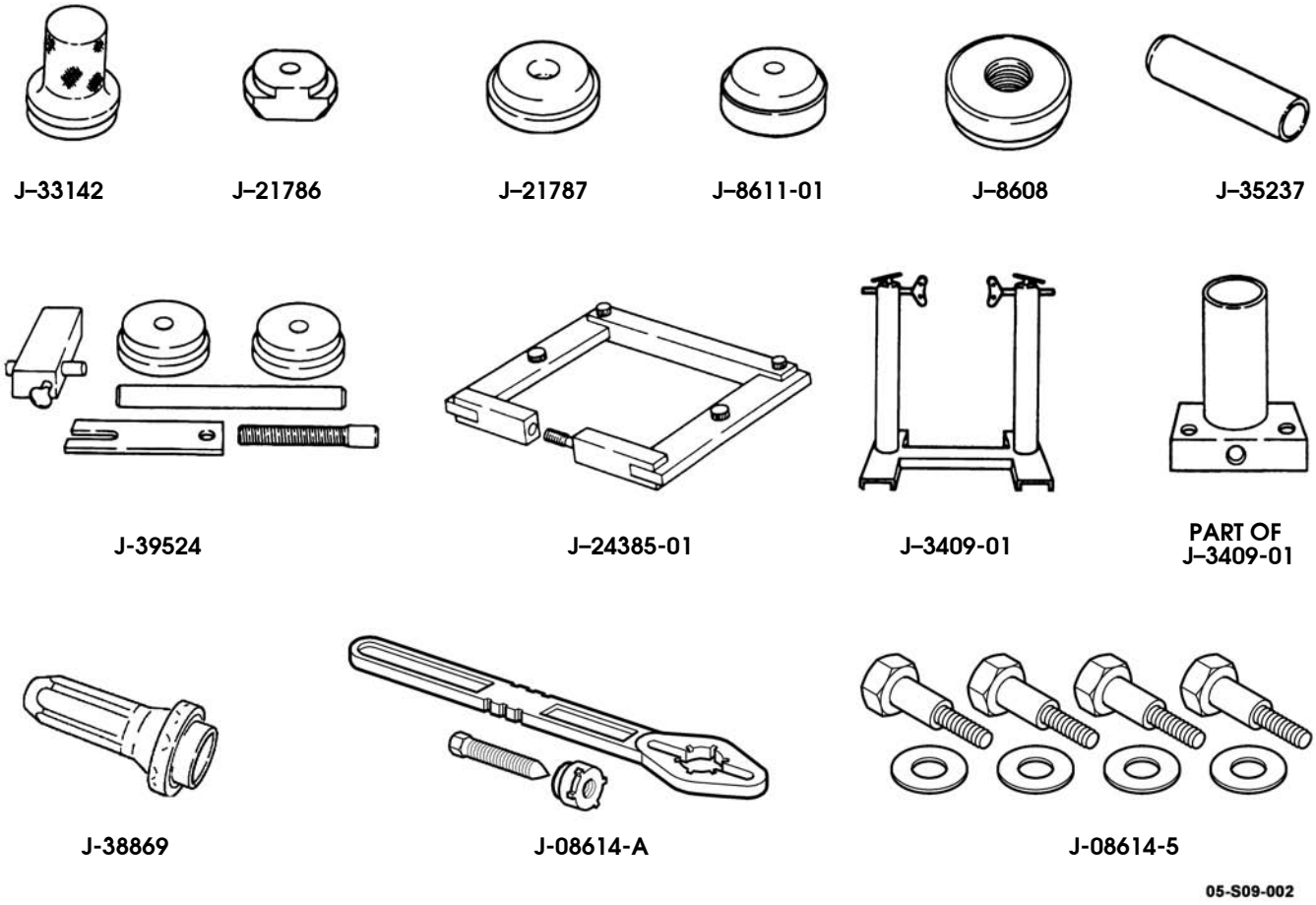
ESSENTIAL TOOLS



TOOL	DESCRIPTION
DT–47845	Installer, Input Seal
DT–47846	Installer, Spindle Seal
J–42546	1/4 in. Drive Torque Wrench (Preset)
J–42547	1/2 in. Drive Torque Wrench (Preset)
J-42545	Clamp Nut Socket

Procure from Kent-Moore.

SPECIAL TOOLS

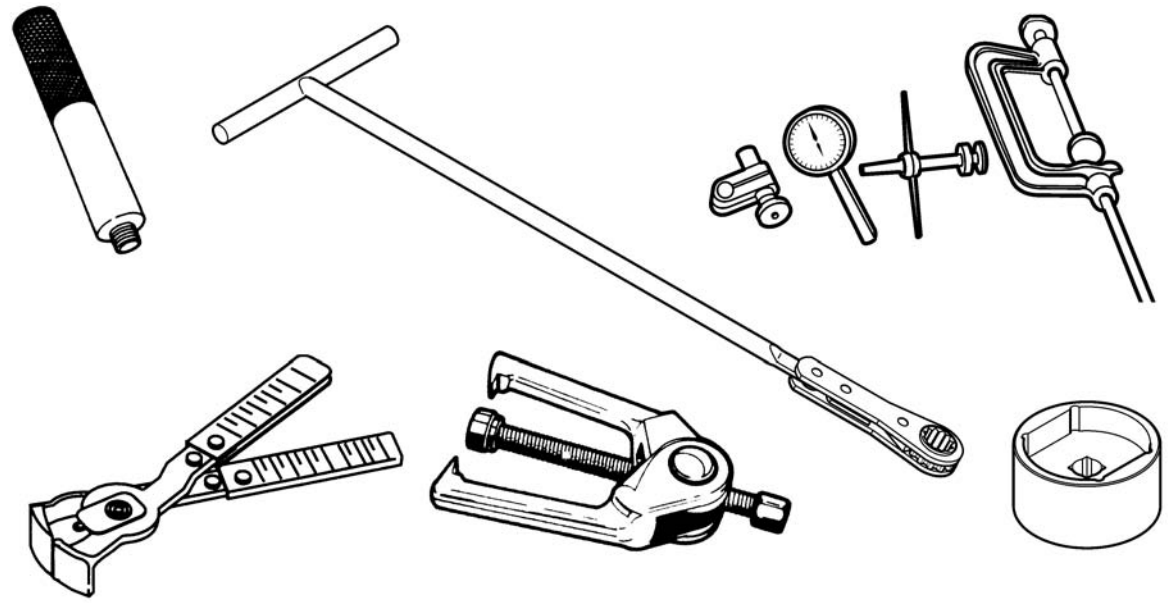


TOOL	DESCRIPTION
J-33142	Axle shaft and seal installer
J-21786	Bearing cup remover
J-21787	Bearing cup remover
J-8611-01	Bearing cup installer
J-8608	Bearing cup installer
J-35237	Bearing installer
J-39524	Pinion setting gauge set
J-24385-01	Spreader
J-3409-01	Axle holding fixture and adapter
J-38869	Installer, pinion seal
J-08614-A	Pinion flange holder
J-08614-5	Bolt kit yoke holding tool

Procure from Kent-Moore.

SPECIAL TOOLS

J-8092 J-45762 J-8001



J-22610 J-24319-B CH47505

05-S09-003

TOOL	DESCRIPTION
J-8092	Universal driver handle
J-24319-b	Puller
CH-47505	Shock mounting pin socket
J-22610	Axle boot pliers, eared clamp
J-8001	Dial indicator set

Procure from Kent-Moore.

THIS PAGE INTENTIONALLY BLANK.

Section 10 Body

TABLE OF CONTENTS

Armrest Replacement 10-29
Ashtray Replacement 10-23
Body Inspection and Repair 10-4
- Aluminum Repair 10-9
- Fiberglass Repair 10-14
- Lockbolt Failure 10-5
- Rivet Failure 10-5
- Rivet Replacement 10-6

Body Mount Replacement 10-92
Cargo Tiedown Replacement 10-107
Center Console Replacement 10-15
Cigarette Lighter Replacement 10-22
Dimmer Control Switch Replacement 10-20
Doors and Locks
- Door Stop Strap Assembly Replacement 10-62
- Door Glass 10-63
  - “Wind Noise” 10-66
  - Replacement 10-63
- Door Lock Actuator Replacement For Rear Cargo Door 10-49
- Door Seals Replacement 10-61
- Front Door Harness Replacement 10-53
- Power Door Lock Actuator Replacement 10-47
- Rear Cargo Door Lock Module Replacement 10-50
- Rear Door Harness Replacement 10-56
- Replacement 10-43
- Vertical Door Replacement 10-110
- Power Door Lock Rear Door and Jumper Harness Replacement 10-51

Engine Access Cover 10-23
- Hold-Down Striker Replacement 10-23
- Inner Flexible Latch Replacement 10-23
- Maintenance 10-24

Former Assembly Replacement, “A” Pillar 10-89
Front Striker Replacement 10-91
Fuel Filler Housing Replacement 10-95
General Body Information 10-4
Glovebox Replacement 10-22
Hood
- Center Hood Stop Replacement 10-75
- Front Hood Screen Replacement 10-76
- Grille and Screen Replacement 10-75
- Guide Bracket Assembly Replacement 10-76
- Hood and Hinge Replacement 10-71
- Hood Prop Rod and Bracket Replacement 10-70
- Hood Release Cable Replacement 10-67
- Hood Release Latch and Bracket Assembly Replacement 10-69
- Hood Retainer Bracket, L 10-78
- Hood Retainer Bracket, R 10-78
- Latch and Bracket Replacement 10-66
- Outer Hood Seal Replacement 10-74



Side Hood Stop Replacement 10-74
Instrument Panel
Center Dash Assembly Replacement 10-18
Gauge Replacement 10-19
Gauges and Switches 10-16
Indicator Lamp Replacement 10-19
Instrument Panel Replacement 10-16
Right Side Crash Pad Replacement 10-18
Switch Replacement 10-20
Upper Crash Pad Replacement 10-17
Interior Trim
B-Bar Replacement 10-31
Driver's Compartment Trim Replacement 10-35
Inner Kick Panels Replacement 10-38
Outer Kick Panel Replacement 10-40
Passenger's Compartment Trim 10-32
Replacement 10-31
Station Wagon Rear Compartment Trim 10-37
Tunnel Carpet, Padding and Hardboard Replacement 10-40
Interior Trim, Four-Passenger Soft Top 10-97
License Plate Bracket
Front Bracket Replacement 10-94
Rear Bracket Replacement 10-94
Lights
Front Courtesy Light 10-126
Interior and Exterior Lighting 10-116
Backup Light Switch 10-125
Cargo Light 10-122
Courtesy Light 10-125
Domelight Replacement 10-122
Front Turn Signal Light Replacement 10-119
Identification Light Replacement 10-118
Optional Trouble Light Replacement 10-125
Rear Turn Signal Light Replacement 10-121
Service Headlight Assembly 10-116
Service Headlight Electrical Connector and Grommet Replacement 10-127
Side Marker Light Assembly 10-118
Side Marker Light Lens and Lamp 10-117
Underhood Light Replacement 10-125
Load Barrier and Mounting Brackets 10-30
Mirrors
Lighted Visor Mirror Replacement 10-125
Power Mirrors 10-42
Rearview Mirror Replacement 10-43
Power Windows and Door Locks
Front Door Harness Replacement 10-53
Rear Door Harness Replacement 10-56
Rear Striker Assembly Replacement 10-91
Rear Support Bow Bracket, Station Wagon 10-90
Rear Vertical Door
Door Frame and Seal Replacement 10-115
Door Handle Replacement 10-111
Door Latch and Latch Rod Replacement 10-112

Door Replacement 10-111
Door Stop Replacement 10-114
Window Replacement 10-111
Removable Load Barrier and Mounting Brackets Replacement (Station Wagon) 10-30
Rocker Panel Protection Replacement 10-93
Seat Belts
Seat Belt Assembly Replacement 10-25
Seat Belt Retractor Assembly Replacement 10-26
Seats
Front Seats 10-27
Reclining Seat Replacement 10-28
Soft Top
Mounting Components and Accessories 10-98
Soft Top Support/Roll Cage Assembly 10-105
Speedometer/Odometer Replacement 10-20
Splash Shield (Engine) Replacement 10-78
Tailgate 10-106
Chain Brackets Replacement 10-106
Chain Replacement 10-109
Hinge Replacement 10-109
Tailgate and Seals Replacement 10-107
Tire Jack and Optional Triangle Warning Kit Hold-Down Replacement 10-96
Visor Replacement 10-41
Water Leak Detection and Repair 10-15
Windows
Power Window Regulator Replacement 10-60
Window Seal Replacement 10-64
Windshield
Assembly Maintenance 10-80
Glass and Weatherstrip Replacement 10-80
Heated Windshield 10-84
Reservoir and Pump Assembly 10-87
Washer Hoses Replacement 10-88
Washer Nozzle Replacement 10-87, 10-88
Washer System and Components 10-87
Windshield Assembly 10-80
Windshield Wipers
Wiper Jumper Harness Replacement 10-87
Wiper Linkage Replacement 10-85
Wiper Motor Assembly Replacement 10-85
Wiper Pivot Replacement 10-86
Wiper System and Components 10-85

GENERAL BODY INFORMATION

1. The HUMMER H1 body is constructed from high strength T6 aluminum. Welding should not be performed to make body repairs. Heat generated by welding will reverse the tempering process, causing a reduction in material strength.
2. The hood and engine access covers are made of fiberglass (sheet molding compound). Cracks, splits or holes may be repaired with a glass-reinforced plastic laminate.
3. Solid 0.1875 in. (4.8 mm) diameter aluminum rivets are the primary method of joining body components. Each rivet is inserted into a hole through two pieces of metal and a second head is formed by manual or pneumatic impacting or by squeezing the rivet. When making repairs, use blind rivets of the same size or oversize, with the appropriate grip length.
4. Blind structural aluminum rivets of 0.1875 in. (4.8 mm) diameter are used in applications where there is access from only one side of the part. Blind rivets are installed using a tool that pulls on the rivet stem causing a bulbed head to form on the back side of the part. Fastening is complete when stem breaks off. High strength is obtained in blind rivets by mechanically locking the remaining stem inside the rivet body.
5. Steel pull-type lock bolt fasteners of 0.1875 in. (4.8 mm) and 0.25 in. (6.4 mm) diameters are used where tension or high-shear loads exist. Lock bolts are two-piece unthreaded fasteners. One part is a high-strength, steel-headed, bolt-like part with serrations on its shank. The mating part is a collar which is swagged over the serrations causing the fastener to be locked in place.
6. To facilitate body repairs, it is acceptable to replace lock bolt fasteners and rivets with 0.25 in. (6.4 mm) series bolts. Do not replace lock bolt fasteners with rivets. Standard threaded fasteners should not be used, as these will quickly wear the aluminum structure. Bolt lengths should be chosen so that the cylinder portion of bolt is bearing on all members being joined. Bolts are designed as AN4-XX or AN4-C-XX, where XX defines grip length. Tighten all bolts to 71 lb in. (8 N•m).
7. Fatigue strength of riveted joints and seams is increased by epoxy adhesive application. Epoxy adhesive requires special material storage and metal preparation along with a low temperature heat cycle for curing. Where possible, extra rivets and thicker metal gauges should be used instead of adhesives when making repairs. Parts may be difficult to separate, even after rivets are removed.

BODY INSPECTION AND REPAIR

General Information

Damaged areas should be thoroughly cleaned and inspected to determine the cause and extent of damage. Body parts should be inspected for holes, cracks, dents, distortion or breaks. Fasteners should be inspected for breaks, stretching, looseness, cracked heads or hole elongation. Seams, flanges and joints should be inspected for straightness or local deformation as an indication that fasteners may have been stretched or holes elongated. It is possible for this to happen and fasteners will still appear to be tight in their holes. In addition, thoroughly inspect adjacent areas to determine if high loads have been transmitted from the damaged area to other areas. This can result in secondary damage in the form of distorted panels or seams, loosened or sheared fasteners, elongated fastener holes and/or cracks.

Classi cation

After the extent of damage has been determined, affected parts should be classified into one of the following categories:

- Negligible damage
- Damage repairable by patching
- Damage repairable by insertion
- Damage necessitating replacement of parts

1. Negligible damage.

Minor dents, nicks, scores, cracks and holes in a body panel which are within or are brought within, reasonable limits by a simple procedure without extensive rework are considered negligible damage. These defects should be considered more serious if located in main structural members such as frame rails, A-pillars or floor cross members rather than in body panels such as cowls or rear wheelhouses. Deep wrinkles of undetermined origin in body panels should not be classed as negligible until the source of the wrin-

kles has been investigated and positively identified. Damage other than small dents, holes, nicks and scratches will require repair or replacement of the part.

- Negligible Cracks. Isolated cracks less than 0.50 in. (1.27 cm) long may be classified as negligible cracks provided they are stop drilled at each end to stop propagation.
- Negligible Holes. Isolated holes no more than 0.50 in. (1.27 cm) in diameter (after they are made round with smooth edges) are classified as negligible holes, provided the distance from the edge of the holes to the nearest line of rivets exceeds the diameter of the hole.
- Negligible Dents and Distortion. Small dents and distorted areas may be classed as negligible if they can be repaired by hammering or bending without causing the material to crack. Heat will not be used for reforming.

2. Damage repairable by patching.

Non-negligible damage must be repaired or the section must be replaced. Patches can often be applied over damaged body panels, provided the damaged area is first trimmed to remove sharp edges or notches which could cause the start of new cracks. The patch must then be sized to overlap the area to allow for attaching rivets.

3. Damage Repairable by Insertion.

In certain cases, patch repairs may not be desirable because of impracticality or because a flush surface is desired. In this case, the damaged area must be cut away and replaced with equivalent material inserted flush with adjacent areas and backed up with a doubler.

4. Damage requiring replacement of parts.

Parts too badly damaged for repair or cases where replacement is easier than repair, fall into this category. Repair of welded assemblies such as body mounts are also included. Welded assemblies cannot be rewelded without destroying the strength of the part, and must be replaced.

Rivet Failure

Signs of rivet failure include tipped heads, looseness and sometimes chipped or cracked paint. If heads are tipped in the same direction and rivets are loose in consecutive groups, the joint has undergone excessive load. Rivet heads which are tipped in different directions and are not in groups may be improperly installed. With chipped or cracked paint, it may be necessary to remove paint to check the true condition of rivets. Rivets subjected to critical loads, but showing no distortion should be inspected if failure is suspected. The head should be drilled off and the shank should be carefully punched out. Failure is indicated by notched rivet shanks and misaligned holes. Flush rivets showing head slippage within the dimple or countersink indicate either sheet bearing or rivet shear failure and must be removed for replacement. If rivet failure cannot be detected by visual inspection, the joint can be checked by drilling and punching out several rivets. If rivet shanks are notched, rivets should be replaced with the next larger size rivets. If rivet holes show elongation due to local failure in tearing of the sheet, the next larger size rivet must be used in replacement. Any deformation of the sheet around the rivet, tear outs or cracks between rivets usually indicates partially failed or damaged rivets. Complete repair of the joint will require replacement by the next larger size rivets. Use the next 0.031 in. (0.79 mm) larger diameter rivet to obtain a tight joint when original hole has been enlarged. If original size rivet is installed, the rivet will not be able to carry its share of the shear load and the joint will not meet its strength requirements.

Lock bolt Fastener Failure

Lock bolts are used to withstand tension loads and high-shear loads. These fasteners are installed in their holes with an interference fit. No looseness can be permitted. Lock bolts showing evidence of being stretched, broken, loose in their holes, or having heads that do not set flat against the surface must be replaced. Guidelines used for detecting rivet failures also apply to lock bolts.

Lock bolt Removal

1. Working from the head side of the lock bolt, if accessible, file a small flat surface on the head, if it is rounded.
2. Center punch the head.
3. Using a hardened drill bit slightly smaller than the lock bolt, drill through the head. In cases where the lock bolts are too hard to be drilled with the available drills, grind the head down using a cutoff wheel or a carbide bit in a die grinder. When using the grinder method, cut the head down until it is very thin, but do not grind it off completely or touch the body part with grinding tool.
4. Use a pin punch to pry off the head or shear it off with a sharp chisel. Ensure the part is adequately supported while performing this step.
5. Drive the lock bolt out of its hole with a pin punch. Care must be taken so that the hole or the part is not distorted.

NOTE: In cases where the lock bolt head is inaccessible, the locking collar must be removed. Remove the collar by grinding or by splitting axially with a sharp chisel.

Rivet Replacement

NOTE: When removing rivets, care should be taken not to enlarge the rivet holes. Enlarged rivet holes require oversize replacement rivets.

Solid Rivet Removal

1. File a flat surface on the manufactured head, if accessible. It is always preferable to work on a manufactured head rather than one that is bucked over, since the former will always be more symmetrical around the shank.
2. Indent the center of the filed surface with a center punch.
3. Drill through the rivet head, using a drill bit slightly smaller than the diameter of the rivet shank to avoid over sizing the rivet hole.
4. Shear the weakened rivet head off with a sharp chisel. To prevent panel distortion, support the back side of the rivet and cut the rivet head along the direction of the rivet line or the panel edge.
5. Firmly support the panel from the opposite side and drive out the shank with a pin punch. If the rivet is unduly tight due to swelling between the sheets, drill the rivet shank out with an undersized drill bit.

Blind Rivet Removal

1. File a small, flat surface on the rivet head.
2. Center punch the flat surface. Support the back side of the rivet, if possible.
3. Using a small drill bit about the size of a rivet pin, drill off the tapered end of the pin which forms the lock.
4. Shear the lock, using a pin punch to drive out the pin.
5. Pry out the remainder of the locking collar.
6. Using a drill bit slightly smaller than the rivet shank, drill almost through the rivet head.
7. Pry off the rivet head with a pin punch.
8. Tap out the rivet shank with a pin punch.

Rivet Hole Drilling

1. Center punch all the new rivet locations. Center punch mark must be large enough to prevent the drill from slipping out of position, yet it must not dent the surface of the material. To prevent denting, place a bucking bar behind the material during punching.
2. Ensure the drill bit is the correct size and the points properly ground (Tables 1 and 2). A no. 10 drill bit is used to install standard 1.875 in. (48 mm) blind rivets.
3. Place a drill bit in the center mark for a new rivet locations or align the drill bit with the old hole when replacing the old rivets with oversize rivets (Table 3). When using a power drill, give the bit a few turns with fingers before starting the motor to ensure the drill does not jump out of position when the motor is started.

NOTE: Hold the drill at a 90 degree angle to the material surface. Avoid excessive pressure or letting the drill wobble. Do not push the drill through material.

4. Remove all the bumps with a metal countersink or a file.
5. Clean away all the drill chips. Ensure that no chips are trapped between the metal sheets.
6. Apply corrosion-resistant sealing compound to the hole and the surrounding area.

Table 1: Drill Bit Sizes for Solid Shank Rivets

Rivet Diameter	Drill Bit Size	Drill Bit Diameter
0.0625 in. (1.65 mm)	# 51	0.0670 in. (1.70 mm)
0.0938 in. (2.38 mm)	# 41	0.0960 in. (2.44 mm)
0.1250 in. (3.18 mm)	# 30	0.1295 in. (3.29 mm)
0.1563 in. (3.97 mm)	# 21	0.1590 in. (4.04 mm)
0.1875 in. (4.76 mm)	# 10	0.1910 in. (4.85 mm)
0.2500 in. (6.35 mm)	F	0.2570 in. (6.53 mm)
0.3125 in. (7.94 mm)	W	0.3230 in. (8.20 mm)
0.3750 in. (9.53 mm)	W	0.3869 in. (9.83 mm)

Table 2: Drill Bit Sizes for Blind Rivets

Rivet Diameter	Drill Bit Size	Minimum	Maximum
0.1250 in. (3.18 mm)	#30	0.129 in. (3.28 mm)	0.132 in. (3.35 mm)
0.1563 in. (3.97 mm)	#20	0.160 in. (4.06 mm)	0.164 in. (4.17 mm)
0.1875 in. (4.76 mm)	#10	0.192 in. (4.88 mm)	0.196 in. (4.98 mm)

Table 3: Oversize Diameter

Rivet Diameter	Drill Bit Size	Minimum	Maximum
0.1250 in. (3.18 mm)	#27	0.143 in. (3.63 mm)	0.146 in. (3.71 mm)
0.1563 in. (3.97 mm)	#16	0.177 in. (4.50 mm)	0.181 in. (4.60 mm)
0.1875 in. (4.76 mm)	#5	0.205 in. (5.21 mm)	0.209 in. (5.31 mm)

Hole Countersinking

NOTE: Some rivet installations in the body require the rivet to be flush with the rivet material surface. In these instances, countersunk or flush-head rivets are used.

1. When using countersunk rivets, the rivet holes must be countersunk with a tool having a 100 degree taper, so the rivet head will fit flush with the surface.
2. When using a hand-operated counter sinker, the hole must be tried with a rivet so the recess will not be too deep or too shallow. It is best to use a countersink with a stop on it so the depth of the countersink can be controlled. Typical countersinking dimensions for blind rivets are shown in Table 4. The minimum sheet thickness that can be machined for 100 degree countersunk rivets is given in Table 5.
3. Do not remove the edge of the hole on the blind side of the joint.

Blind Rivet Driving Practices and Precautions

1. Rivets should be inspected for proper installation. The grip length of each rivet is marked on the top of its head to provide positive identification. Use of proper grip length will produce a rivet installation where locking collar is flush with the top surface of the rivet head. Tolerance limit on the flushness is 0.020 in. (0.51 mm).
2. For proper rivet installation, it is imperative that the holes be properly prepared, tools be in good working order and the rivets properly installed. When problems occur, the source of trouble could be in any of these areas.

table 4: Countersinking Dimensions for 100 Degree Countersunk Blind Rivets

Countersinking Dimensions (100 Degree)		
Rivet Diameter	Minimum	Maximum
0.1250 in. (3.18 mm)	0.222 in. (5.64 mm)	0.228 in. (5.79 mm)
0.1563 in. (3.97 mm)	0.283 in. (7.19 mm)	0.289 in. (7.34 mm)
0.1875 in. (4.76 mm)	0.350 in. (8.89 mm)	0.356 in. (9.0 mm)

Table 5: Minimum Sheet Gauge for 100 Degree Machine Countersunk Rivets

Rivet Size	0.0938 in. (2.38 mm)	0.1250 in. (3.18 mm)	0.1563 in. (3.97 mm)	0.1875 in. (4.76 mm)	0.2500 in. (6.35 mm)
Gauge	0.040 in. (1.02 mm)	0.050 in. (1.27 mm)	0.064 in. (1.63 mm)	0.072 in. (1.83 mm)	0.072 in. (1.83 mm)

Blind Rivet Installation

NOTE: Ensure the proper rivet grip length is selected for each application (Table 6). Rivets can tolerate only 0.0468 in. (1.19 mm) variation in the material thickness for each particular rivet length. For double dimpled sheets, add countersink head height to the materials thickness.

1. Insert the rivet stem into the pulling head of the rivet gun or the adapter.
2. Hold the rivet gun in line with the axis of the rivet as accurately as possible.
3. Apply a steady, firm pressure against the rivet head.
4. Squeeze the handles of the manual gun. The rivet clamping action will pull the sheets together, seat the rivet head and the break stem flush with the head of the rivet.

Table 6: Rivet Grip

Material Thickness Range		**Rivet Grip No.**
MINIMUM	MAXIMUM	
Not Applicable	0.0625 in. (1.65 mm)	1
0.0625 in. (1.588 mm)	0.1250 in. (3.18 mm)	2
0.1250 in. (3.18 mm)	0.1875 in. (4.76 mm)	3
0.1875 in. (4.76 mm)	0.2500 in. (6.35 mm)	4
0.2500 in. (6.35 mm)	0.3125 in. (7.94 mm)	5
0.3125 in. (7.94 mm)	0.3750 in. (9.53 mm)	6
0.3750 in. (9.53 mm)	0.4375 in. (11.11 mm)	7
0.4375 in. (11.11 mm)	0.5000 in. (12.70 mm)	8
0.5000 in. (12.70 mm)	0.5625 in. (14.29 mm)	9
0.5625 in. (14.29 mm)	0.6250 in. (15.88 mm)	10
0.6250 in. (15.88 mm)	0.6875 in. (17.46 mm)	11
0.6875 in. (17.46 mm)	0.9750 in. (24.77 mm)	12

Aluminum Repair

CAUTION: *Body repairs should not be made using welding or heat for forming. Heat will only weaken the material and lead to further problems.*

Material

Aluminum material used for repairs should be of the same alloy and temper as the original if possible. In general, 6061-T6 aluminum alloy should be used. Material thickness must be the same or thicker. This alloy will work well for flat repairs, but is not well suited to bending because it is quite hard and cracks easily when bent sharply. When bends must be made, use softer 6061-T4 aluminum alloy and increase material thickness by at least 50 percent. As a general rule of thumb, 6061-T4 aluminum alloy should be bent with a minimum bend radius of one to two times material thickness, whereas 6061-T6 aluminum alloy requires at least three times material thickness radius for bends. In all cases, bends should be closely inspected for cracks. A suitable method for avoiding bending cracks is to obtain angles that are extruded from 6061-T6 aluminum alloy or use preformed angles for repairs.

Epoxy Adhesive

Where it is necessary to remove parts, note that epoxy adhesive is used in joints. Use care in parts removal to avoid unnecessary distortion. Parts should be separated by peeling action. Before parts are reassembled, it will be necessary to remove any remaining cured epoxy from joints so parts will fit together with good, even contact. Use of epoxy requires special storage and application procedures which do not lend themselves to repair. For this reason, epoxy will not be used for repair. To compensate for the lack of epoxy, additional rivets should be used when making repairs to existing joints.

Rivet Patterns

1. Rivet patterns are denoted by the rivet spacing and the rivet edge distance. The rivet edge distance is the distance from the center of the rivet to the nearest edge of the sheet. The rivet spacing is defined as the distance from the center of the rivet to the center of the adjacent rivet (Figure 10-1).
2. The required rivet spacing is determined by the strength needed in the joint. A general feel for strength required can be obtained by inspecting the rivet patterns in the surrounding areas. Body repairs made using single rows of rivets should be performed using rivet spacing not greater than 1.6 in. (4.1 cm) and not less than 0.625 in. (15.9 mm). Use 1 in. (25.4 mm) rivet spacing as a general practice for repairs. The rivet spacing used in the original construction may be greater due to the additional strength obtained by using epoxy adhesive. Do not use rivet edge distances less than 0.375 in. (9.5 mm).
3. High strength joints or large area patterns may require use of a double or a multiple rows of rivets to obtain sufficient strength.
4. Care must be taken to assure the rivet hole patterns are transferred accurately in cases where a part with no holes is mated to one which already has rivet holes. The hole patterns may be transferred using one of the following patterns:
    a. Lay a new part in place, and use the holes in the mating part as a drill template. This requires the new part to be underneath the mating part. Care must be taken not to distort the original holes.
    b. Use the removed part as a drill template by clamping the old and new parts together. This requires that the parts rest flat and the rivet flange be undistorted.

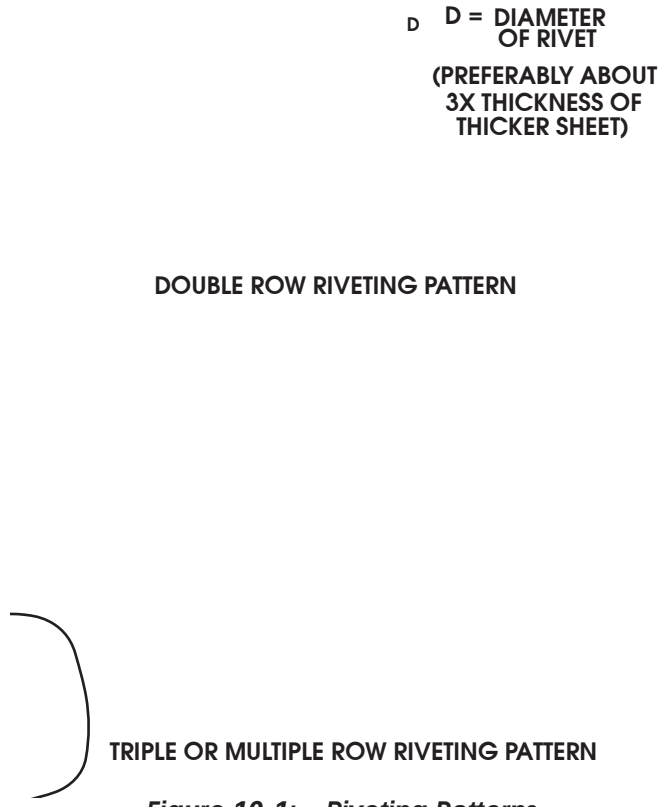


Figure 10-1: Riveting Patterns

Joint Design

1. Loads are applied through a joint to fasteners that hold it together. These loads are applied to fasteners in the form of shear loads or tension loads. If the load is perpendicular to the axis of the fasteners, the fasteners are loaded in the shear. The fasteners are loaded in the tension when the load is along the axis of the fastener, causing a pull on each end of the fastener.
2. Rivets are designed to be loaded in a shear. Do not create any new joints during the repairs which cause the rivets to be used in a tension application. The bolts should be used for tension applications or a substituted for rivets in very high shear load applications (Figures 10-2 and 10-3).

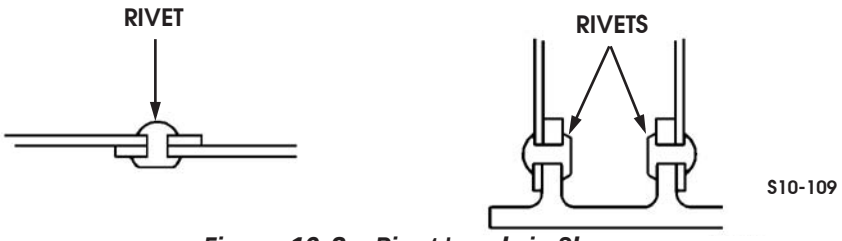


Figure 10-2: Rivet Loads in Shear

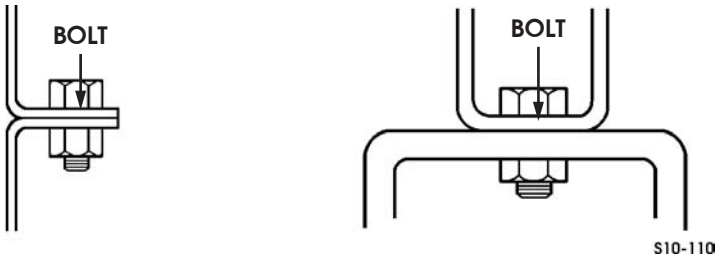


Figure 10-3: Bolts Replacing Rivets

Repair Parts

1. Paint the repair parts or the patches with epoxy primer before installation.
2. Apply a sealing compound to the mating surfaces to prevent corrosion.
3. Install the part or the patch.
4. Paint the repaired area with epoxy primer.
5. Paint the repaired area with the polyurethane as required.

Repair of Negligible Damage

1. Negligible cracks are repaired by drilling a small hole at each end of the crack to stop the crack propagation. This is called stop-drilling. Table 7 gives the proper drill sizes for the stop-drilling cracks.
2. Negligible holes are repaired by rounding and smoothing the edges of the holes to alleviate the stress risers caused by sharp notches.

CAUTION: *Never use heat to reform parts. The part strength is greatly reduced.*

3. Small dents and distorted areas may be repaired by bending or hammering as long as the operation does not cause the materials to crack or tear. Sharp bends should not be attempted.

Table 7: Stop-Drill Sizes for Negligible Cracks

SHEET THICKNESS	MINIMUM STOP DRILL BIT SIZE NO.
0-0.032 in. (0-081 mm) 0.033 in. (0.84 mm) and thicker	40 30

Repair by Patching

Most body panel damage that exceeds the limits of negligible damage may be repaired by patching. This procedure involves removal of damaged area and application of a patch to cover the area. The damaged area is prepared by rounding or smoothing all corners and edges to ensure cracks will not spread into undamaged areas (Figure 10-4). In case of a large crack, it may be desirable to stop-drill the crack rather than cut out a portion of the panel or structural member. Repair is completed by applying a large overlapping patch over the damaged area (Figure 10-5). The overlap must be sufficient to allow the observance of proper rivet edge distance (.25 in. or 6.4 mm). Large areas of damage are best repaired by attaching patch with multiple rows of rivets (Figure 10-6).

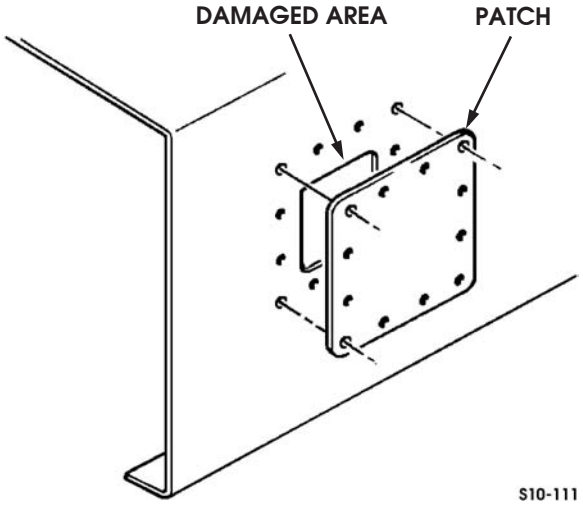


Figure 10-4: Patching

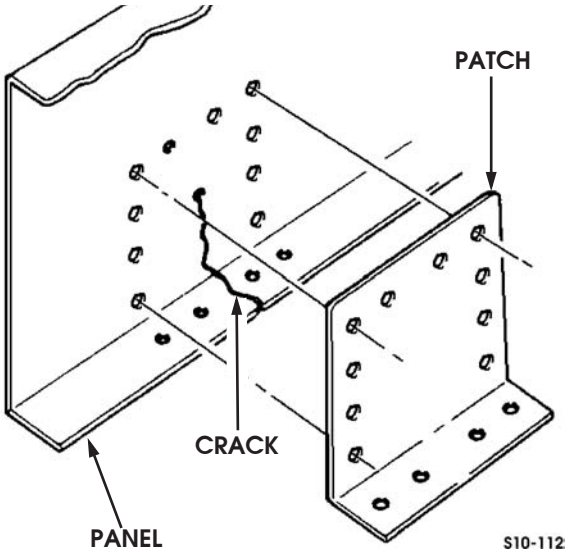


Figure 10-5: Patching Cracked Areas

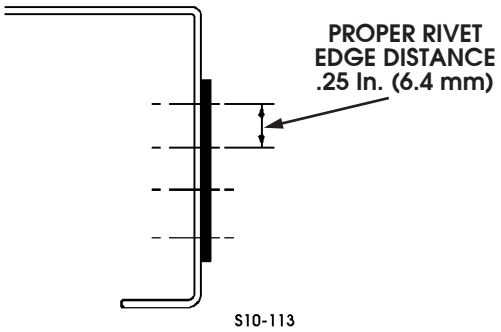


Figure 10-6: Proper Rivet Distance

Repair by Insertion

For damage that is large or more severe in nature than a crack or hole, it is often desirable to remove the damaged area, insert a piece of material into the removed area and reinforce with a doubler. This is a termed repair by insertion. This method of repair is typically stronger and stiffer than an added patch (Figures 10-7 10-8, 10-9, and 10-10).

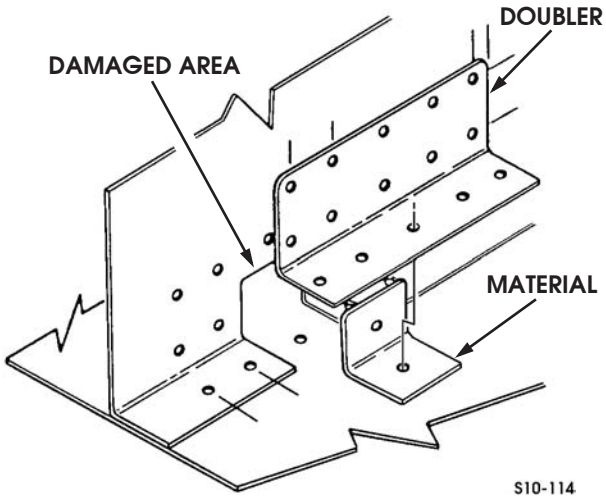


Figure 10-7: Reinforcing Damaged Area

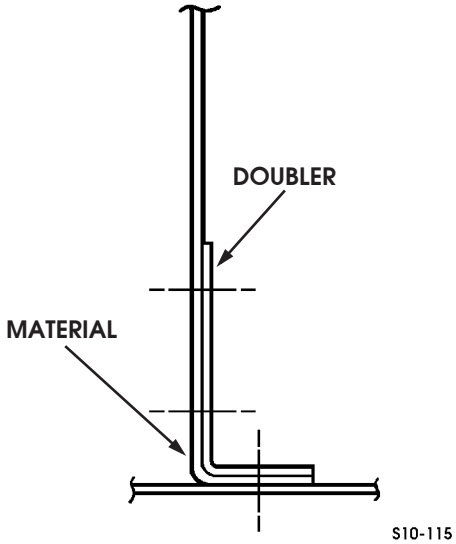


Figure 10-8: Doubler

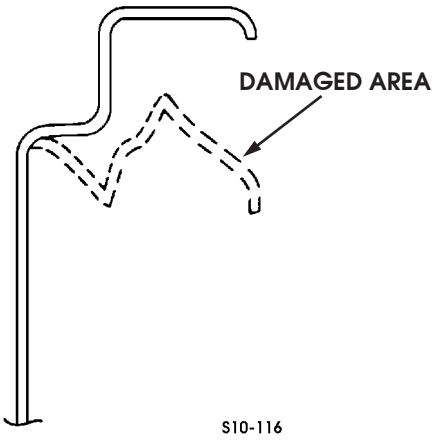


Figure 10-9: Damaged Body Area

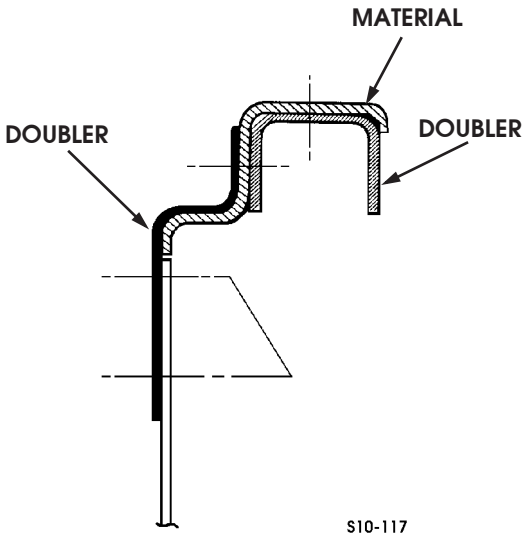


Figure 10-10: Side view of Doubler

Fiberglass Repair

General Information

The HUMMER H1 hood and the engine access cover are made of fiberglass (sheet molding compound). Crack, splits or holes may be repaired with a glass reinforced plastic laminate repair kit.

Inspection

NOTE: The hood surface has a thin layer of gel coat that may appear cracked in a spider web-like pattern due to the hood flexing. No repair is required.

1. Examine the cracks to determine if they are on the surface only or are deep breaks into the material thickness.
2. If the filler material chips off at the bonding flanges and appears as cracked but not broken through, the area need not be repaired.
3. If the total penetration crack is greater than 1 in. (25.4 mm) in a critical areas: hinges, latches or hood stop areas, repair it immediately (Figure 10-11).
4. If the total penetration cracks exist in noncritical areas, do not repair until the size is greater than 3 in. (76 mm).
5. If severe breaks develop in one area, remove the fragmented material and use the repair procedure for holes.

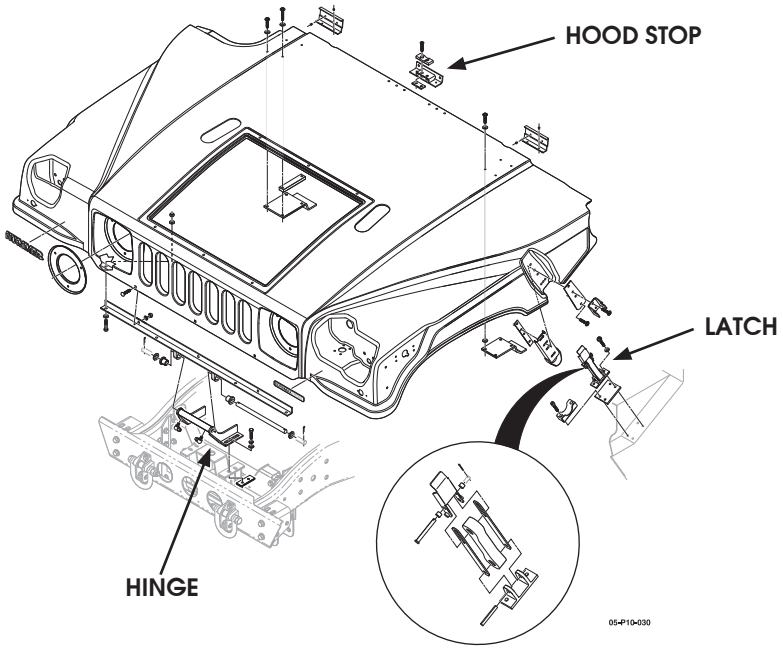


Figure 10-11: Hood Stop and Hinge

Repair

1. Repairing cracks or splits.

WARNING: When sanding fiberglass, personal protective equipment (respirator, goggles/shield, gloves, coveralls, etc.) must be used. Failure to do this may result in injury.

a. Using sandpaper, remove the dirt and the paint 3-4 in. (8-10 cm) around the area of the crack.
b. Rough-sand the surface to which the mat will be added and the underside of the surface, if possible. The surface must be dry.
c. Bevel the edges of the crack in a broad “V”.
d. Cut a piece of mat and apply to the underside of the surface with a resin mixture. Extend the patch beyond the break about 2 in. (5 cm). Press the patch firmly into place. Saturate the patch with additional layer of resin and then allow 1-3 hours to cure.
e. At the same time, cover the top exposed surface with resin, allowing 1 to 3 hours to cure.

f. For stressed areas, lightly sand the first patch and add another patch layer, repeating steps a through c.
g. Finish-sand the exposed surface.
h. Prime and paint.

2. Repairing the holes.
   a. Remove the damaged material.
   b. Using sandpaper, remove the dirt and the paint in the area of the hole extending away 3-4 in. (8-10 cm).
   c. Rough-sand the top and the underside of the surface to which the mats will be added.
   d. Cut two of the same size pieces of fiberglass mat that will extend about 2 in. (5 cm) past the edge of the hole.
   e. Coat both the top and the underside of the surface, and saturate both pieces of mat with the resin mixture.
   f. When tacky, apply one mat to the inner surface and one to the outer surface. Press the two patches together.
   g. Allow 1-3 hours to cure. Additional coats of resin may be added if necessary for appearance purposes. Sand lightly between coats.
   h. Finish-sand the exposed surface.
   i. Prime and paint.

WATER LEAK DETECTION AND REPAIR

If water has leaked into the vehicle, inspect for leakage points. Spray water, under pressure, against the vehicle in the general area where the leak is believed to be located. Have an assistant inside the vehicle locate and mark the point(s) where any water appears.

Water that appears at a certain place inside the vehicle may actually be entering the vehicle from another point. It may be necessary to remove the floor mat, interior trim panels, insulation, dash pad, instrument panel, etc. to gain access and diagnose the leak. Back track the path of water to the point of entry. If it is still not possible to locate the point of entry, try the following:

1. Close all the windows and doors.
2. Run a small stream of water over the suspected area(s) of leakage.
3. Using a leak detector-type solution (commercially available), spray a film over the suspect area on the exterior surface.
4. From inside the vehicle, use an air wand and force air onto the suspect leak area and check for pressure bubbles that indicate air is escaping from the vehicle.
5. Repair the leak.

If the leak is between body panels or around rivet heads, use Silaprene sealant (P/N 05593929) and wipe the sealant into and/or around the leak area. Be sure to remove any excess sealant while it is still pliable.

If the leak is around a door, it may be because the door is not properly aligned. Refer to Door Replacement in this section for instructions on door adjustment. If the door is contacting the weather seal correctly, make sure the weather seal is not damaged and is properly sealed on the door. If the weather seal is not properly sealed, rubber cement can be used to hold it in place. If the weather seal is damaged, replace it.

If the leak is around a window held by a weather seal (i.e., door glass), completely dry the area and apply a new window glass seal. If the new seal still does not close out against the glass, the window opening flange may need to be adjusted inward. If the weather seal is damaged, it should be replaced. Check the flange that holds the weather seal for any nicks or burrs that may have caused the damage.

Windshield leaks should be repaired by removing the glass and the weather seal that is leaking. Clean off any remaining sealer on the windshield frame and the weather seal, and lay a new bead of sealer evenly around the windshield frame and between the glass and the weather seal. Install the glass and weather seal as an assembly into the frame. Attach the retainers, and allow sealer to harden.

6. Retest the entire vehicle for leaks.

CENTER CONSOLE REPLACEMENT

Removal

1. Remove the five screws securing the glove box. Remove the glove box (Figure 10-13).
2. Remove the four screws securing the drivers side power window switch assembly and the assembly.
3. Remove the four screws securing the passenger side power window switch assembly and the assembly.
4. Remove the seven screws securing the rear passenger power window switch assembly and the assembly.

5. Remove the two screws securing the center console to the cargo floor (Figure 10-12).
6. Slide the center console toward the rear of the vehicle.
7. Remove the cigarette lighter heater from the console.

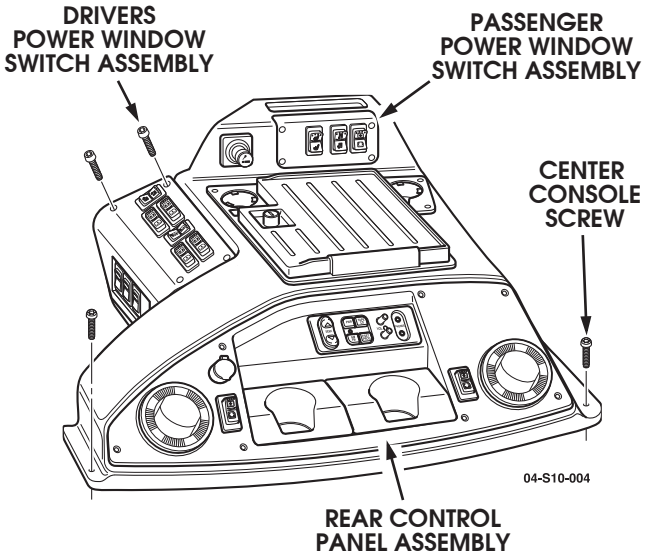


Figure 10-12: Center Console Replacement

Installation

1. Install the cigarette lighter heater in the center console.
2. Position the center console into place and install the drivers side power window switch assembly.
3. Install the two screws that secure the center console to the cargo floor.
4. Install the rear passenger power window switch assembly.
5. Install the passenger side power window switch assembly.
6. Install the glove box.

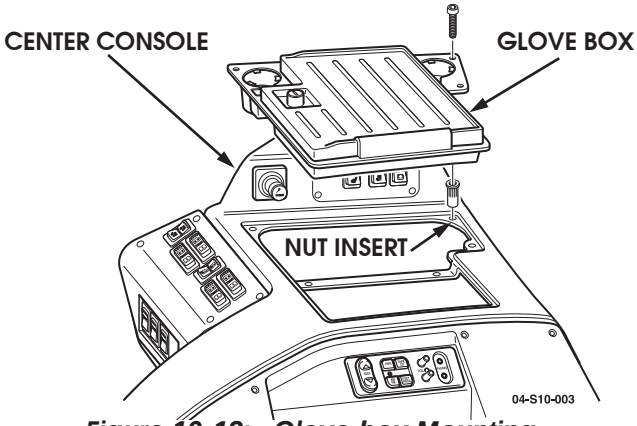


Figure 10-13: Glove box Mounting

INSTRUMENT PANEL/ GAUGES

Instrument Panel (I.P.) Replacement

Removal

1. Disconnect the negative battery cables (Refer to section 12).
2. Remove the upper crash pad.
3. Remove the left instrument panel closeout.

4. Unbolt the 56 way I.P. harness connector from the body harness.
5. Remove the ground strap from the I.P. wiring harness to the ground bar behind the I.P.
6. Remove the center dash assembly (Refer to section 10).
7. Remove the right side I.P. mounting bolt.
8. Remove the two left side I.P. mounting screws securing the I.P. to the A-pillar.
9. Remove the two screws on top of the I.P. and remove the I.P.

Installation

1. Maneuver the I.P. into position between the steering wheel and the A beam.
2. Loosely install the left side I.P. mounting bolts.
3. Loosely install the right side I.P. mounting bolts.
4. Install the two screws in the top of the I.P.
5. Tighten the previous loosely installed bolts.
6. Install the center dash assembly
7. Install the ground strap.
8. Install the 56 way I.P. harness connector.
9. Install the upper crash pad.
10. Install the left instrument panel closeout.
11. Connect the negative battery cables (Refer to section 12).

Crash Pad Replacement (Upper)

Removal

1. Remove the six screws securing the left and right defrost vents to the upper crash pad (Figure 10-14).
2. Remove the four screws securing the crash pad.
3. Slide the crash pad away from the windshield.
4. Disconnect the hoses from the left and right demisters and remove the pad.

Installation

1. Connect the hoses to the left and right demisters.
2. Engage the securing tabs and slide the crash pad forward to the windshield.
3. Secure the crash pad to the dashboard with the four screws.
4. Install the defroster vents and screws.

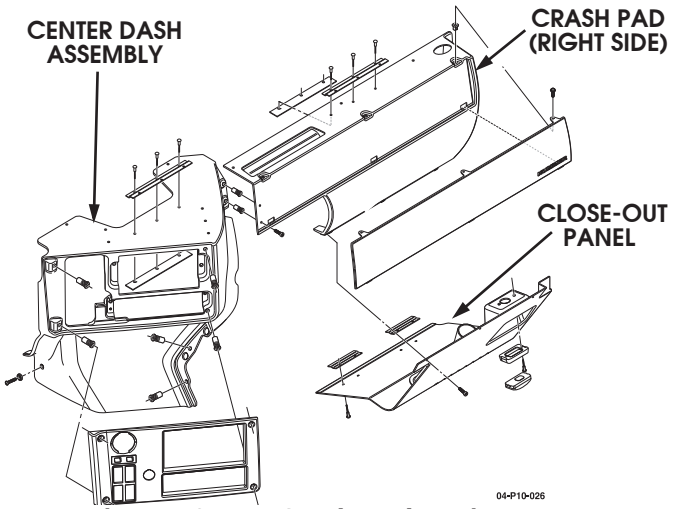


Figure 10-14: Crash pad Replacement

Crash pad Replacement (Right Side)

Removal

1. Remove the upper crash pad.
2. Remove the three screws securing the right side pad trim panel (Figure 10-14).
3. Remove the three screws securing the right side close-out panel.
4. Lower the panel, disconnect the floor vent hose and courtesy light.
5. Remove the four screws securing the right side crash pad and remove the pad.

Installation

1. Slide the demister hoses through the holes in the crash pad.
2. Attach the right side crash pad with the four screws.
3. Install the right side crash pad trim panel with the three screws.
4. Connect the floor vent hose, and courtesy light to the close-out panel.
5. Secure the lower close-out panel to the right side crash pad.
6. Install the upper crash pad.

Center Dash Assembly Replacement

Removal

1. Remove the upper crash pad.
2. Remove the four screws securing the radio bezel and the bezel.
3. Remove the CTIS air lines from the gauge.
4. Disconnect the CTIS switches at the sixteen way connector.
5. Remove the radio.
6. Remove the HVAC control head.
7. Remove the three screws securing the right side crash pad trim panel and trim panel.
8. Remove the drivers power window switch assembly.
9. Remove the screws securing the center console, so it can be moved toward the rear of the vehicle enough to get the center dash assembly out.
10. Remove the remaining five screws securing the center dash assembly and dash.

Installation

1. Install the center dash assembly and secure with the five screws.
2. Install the center console.
3. Install the drivers power window switch assembly and secure with the four screws.
4. Install the right side crash pad trim panel and secure with the three screws.
5. Install the radio.
6. Install the HVAC control head.
7. Install the CTIS air lines and the CTIS sixteen way connector.
8. Install the radio bezel.
9. Install the upper crash pad.

Gauge Module Replacement

NOTE: Gauge module replacement is basically the same for all instrument panel gauges.

Removal

1. Remove the eight allen screws and bezel around the gauge modules.
2. Remove the four retaining screws securing the gauge module.
3. Pull the gauge module out of the instrument panel far enough to expose the harness connector.
4. Disconnect the harness connector from the gauge module.

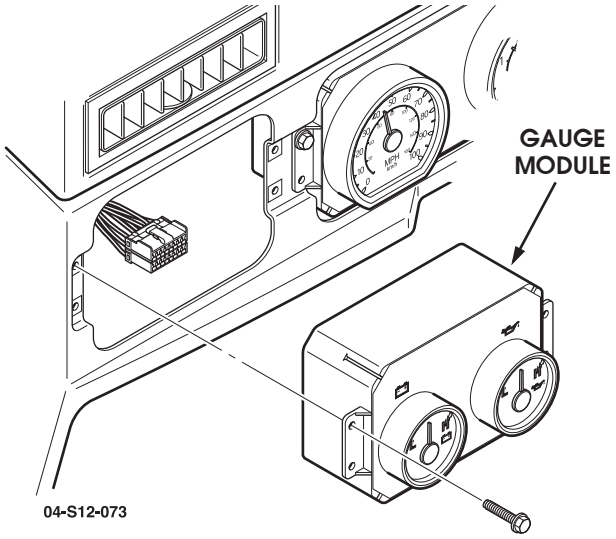


Figure 10-15: Module Replacement

Installation

1. Connect the harness connector to the gauge module.
2. Slide the module into the instrument panel and install the four retaining screws.
3. Install the bezel and eight allen screws.

Gauge Illumination

The only serviceable portion of the gauge modules are the back lighting bulbs. There are six bulbs in this module that are used for gauge illumination only. These bulbs are easily replaced by twisting them 1/4 turn out of the back of the circuit board on the module.

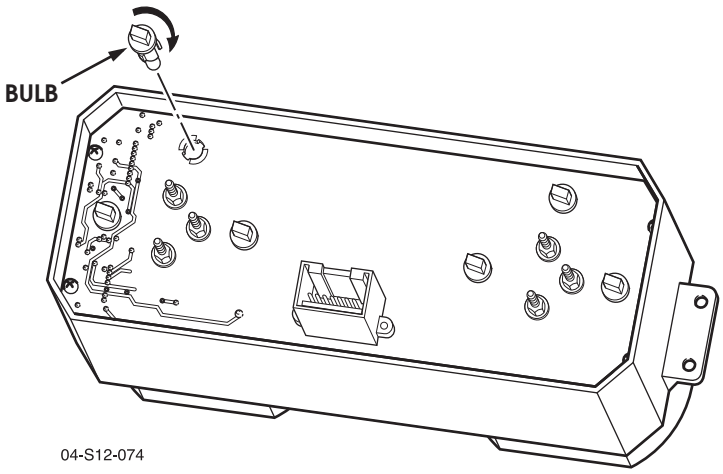


Figure 10-16: Illumination Bulb Replacement

Instrument Panel Switch Replacement

NOTE: All the instrument panel switches are replaced similarly, with the exception of the dimmer control switch. This procedure covers the main light switch.

CAUTION: *Some connectors can be installed incorrectly and cause damage to the electrical system. Make note of connector position prior to removal.*

Removal

1. Remove the closeout panel.
2. Reach up behind the instrument panel and remove the connector from the switch (Figure 10-17).
3. Push the switch from the switch housing.

Installation

1. Install the switch in the switch housing (Figure 10-17).
2. Install switch connector.
3. Install the closeout panel.

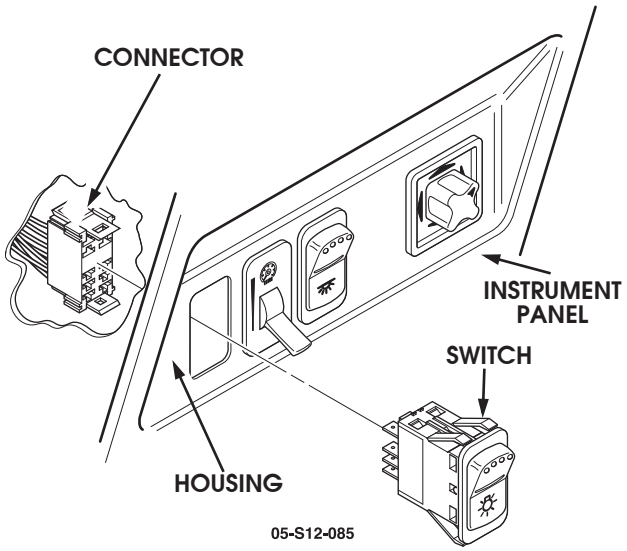


Figure 10-17: Instrument Panel Switch Replacement

Instrument Panel Dimmer Control Switch Replacement

Removal

1. Remove the closeout panel.
2. Reach up behind the instrument panel and disconnect the connector from the wiring harness (Figure 10-18).
3. Push the switch from the switch housing.

Installation

1. Install the switch in the switch housing (Figure 10-18).
2. Install the switch connector.
3. Install the closeout panel.

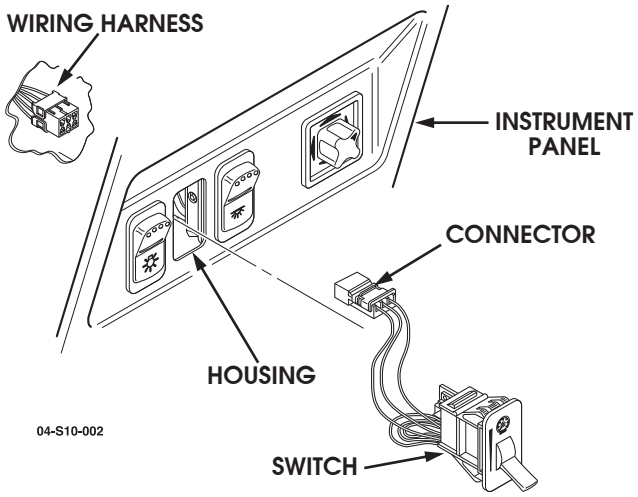


Figure 10-18: Instrument Panel Dimmer Control Switch Replacement.

Speedo/Tach Module

Removal

1. Remove the eight allen screws and bezel around the gauge modules.
2. Remove the four retaining screws from the speedo/tach module.
3. Pull the speedo/tach module out of the instrument panel far enough to expose the harness connector.
4. Disconnect the harness connector from the module and remove the module.

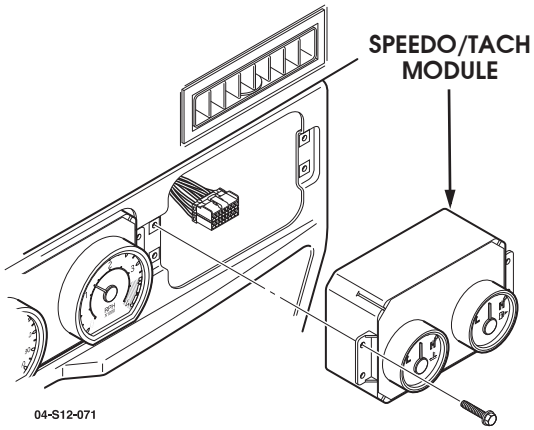


Figure 10-19: Speedo/Tach Module Removal

Installation

1. Connect the harness connector to the speedo/tach module.
2. Slide the module into the instrument panel and install the four retaining screws.
3. Install the bezel and eight allen screws.

CIGARETTE LIGHTER REPLACEMENT

Removal

1. Remove the element from the lighter assembly heater (Figure 10-20).
4. Remove the heater and the bezel from the console using the cigarette lighter socket tool (J-42059).
5. Remove the wiring harness connector from the lighter assembly

Installation

1. Install the wiring harness connector on the lighter assembly.
2. Install the heater in console (Figure 10-20).
3. Install the element in the lighter assembly.
4. Engage the cigarette lighter to ensure proper operation.

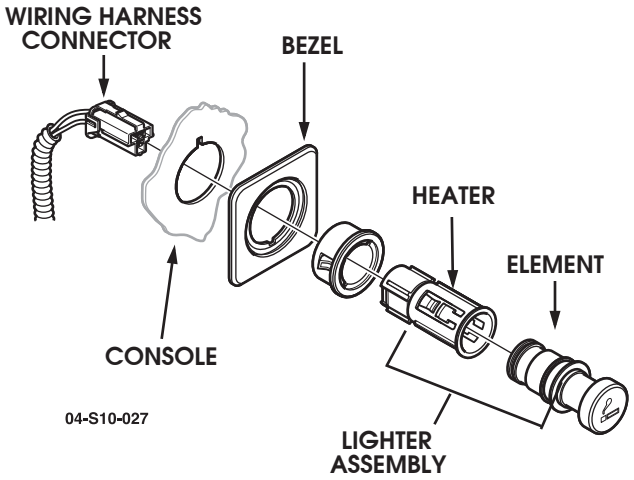


Figure 10-20: Cigarette Lighter Breakdown

GLOVE BOX REPLACEMENT

Removal

Remove the five screws securing the glove box to the center console and remove the box (Figure 10-21).

Installation

Secure the glove box to the center console with the five screws (Figure 10-21).

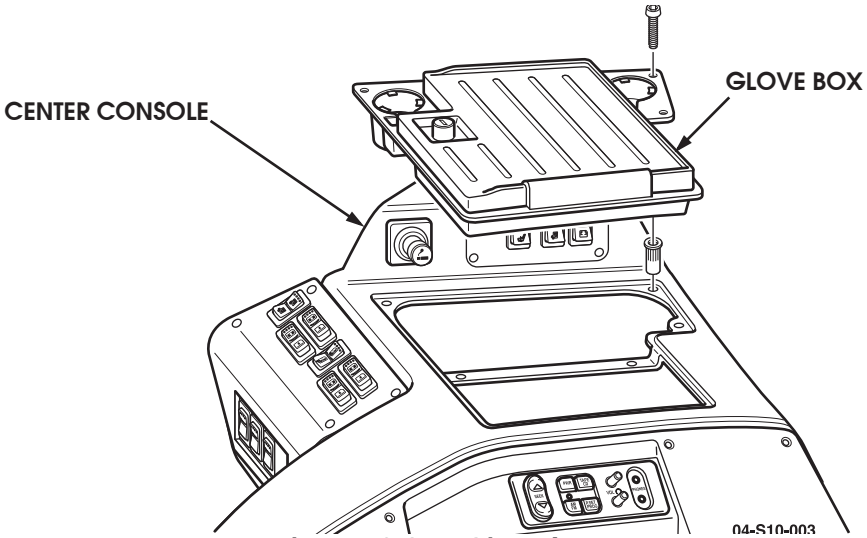


Figure 10-21: Glove box

ENGINE ACCESS COVER

Inner Engine Access Cover Flexible Latch and Hold-Down Striker Replacement

Removal

1. Remove the center dash assembly (Refer to secton 10).
2. Remove the center console (Refer to secton10).
3. Remove the right side crash pad (Refer to secton10).
4. Release the two engine cover flexible latches and the two hold down strikers (Figure 10-22).
5. Remove the rivets from the flexible latches to the cargo floor.
6. Remove the rivet from the hold down striker to the body (Figure 10-22).

Installation

1. Secure the flexible latch to the cargo floor with the rivets (Figure 10-22).
2. Secure the hold down striker to the body with the rivets (Figure 10-22).
3. Install the engine access cover and secure with the two flexible latches and the two striker latches.
4. Install the right side crash pad.
5. Install the center console.
6. Install the center dash assembly.

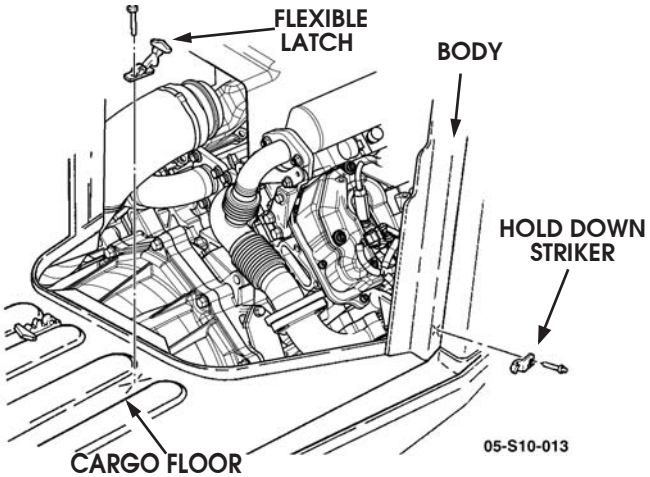


Figure 10-22: Inner Engine Access Cover Latch Location

Engine Access Cover Replacement

Removal

1. Remove the center dash assembly.
2. Remove the center console.
3. Remove the right side crash pad.
4. Unlatch the flexible latches from the keepers on the engine access cover hold-down brackets (Figure 10-23).
5. Unlatch the hold down latches from the engine access cover hold-down strikers.
6. Turn the ring studs and remove access cover.

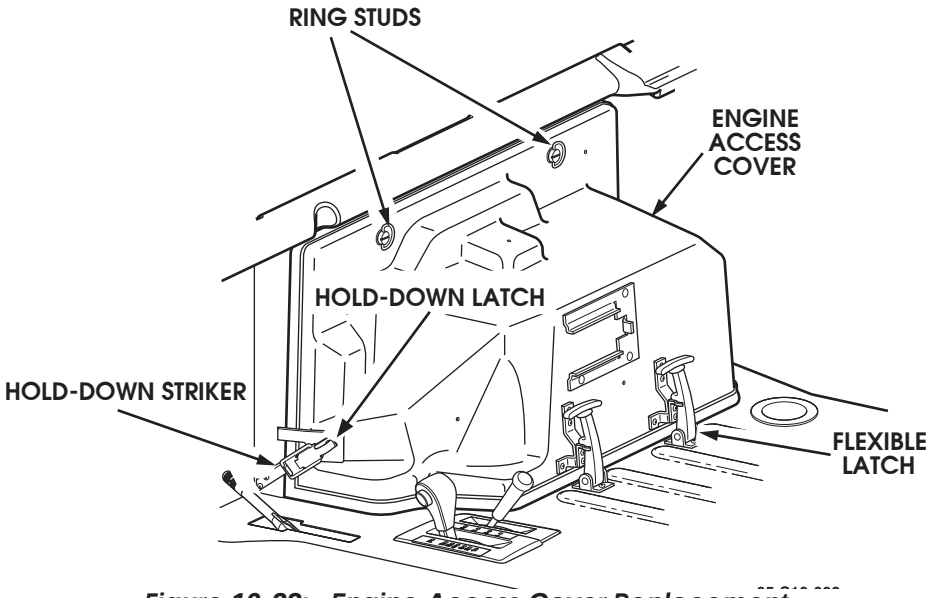


Figure 10-23: Engine Access Cover Replacement

Disassembly

1. Remove the rivets, retainers and the insulation from the engine access cover (Figure 10-24).
2. Remove the seal from the access cover.
3. Remove the retaining rings, washers and the ring studs from the access cover (Figure 10-25).
4. Remove the locknuts and the shoulder bolts securing the latch guide plates and the back plates to the access cover and remove the latches.
5. Remove the rivets, latch guide plates and the back plates from the access cover.
6. Remove the rivets and the keepers from the hold-down brackets.
7. Remove the rivets, nuts, washers, screws, hold-down brackets and the backing plates from the access cover.

Assembly

1. Secure the hold-down brackets and the backing plates to access the cover with rivets, screws, washers and the nuts (Figure 10-25).
2. Secure the keepers to the hold-down brackets with the rivets.
3. Secure the latch guide plates and the back plates to the access cover with the rivets.
4. Secure the latch guide plates to the back plates and the access cover with the shoulder bolts and the locknuts. Install latches.
5. Secure the washers and the ring studs to the access cover with the washers and the retaining rings.
6. Install the seal on the access cover (Figure 10-24).
7. Secure the insulation to the access cover with the rivets and the retainers.

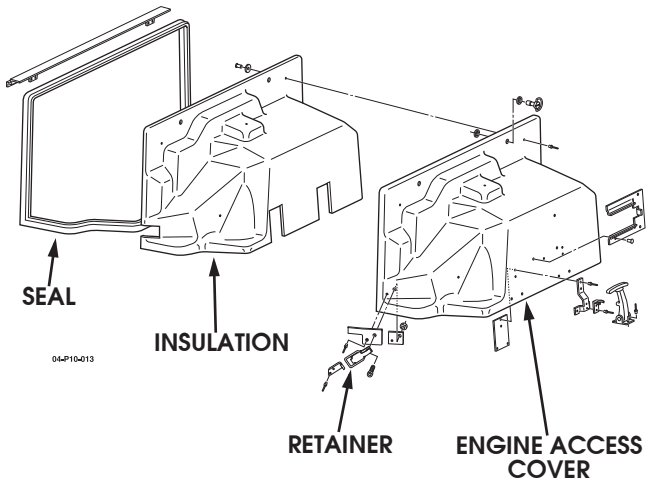


Figure 10-24: Engine Access Cover, Insulation and Seal Breakdown

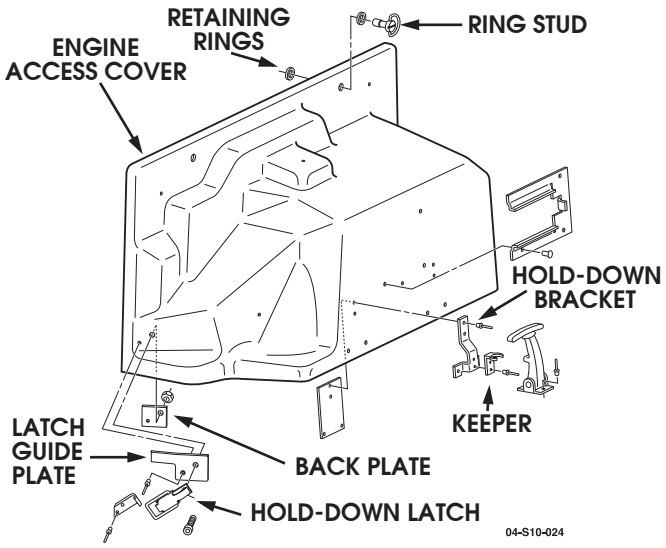


Figure 10-25: Engine Access Cover Fastener Positioning

Installation

1. Position the engine access cover and the fasten ring studs (Figure 10-25).
2. Secure the hold-down latches on the hold-down strikers.
3. Latch the flexible latches on the hold-down bracket keepers.
4. Install the center dash assembly.
5. Install the right side crash pad.
6. Install the center console.

Seat Belt Buckle Assembly Replacement

NOTE: Replacement of the seat belt assembly is basically the same for all seat locations on all the vehicle models. This procedure covers the left front seat belt buckle on the model 84 vehicle.

Removal

1. Move the seat to the forward position.
2. Remove the bolt/washer assembly and the seat belt buckle from the body (Figure 10-26).
3. Remove the four socket-head screws securing the shifter bezel and remove the bezel.

4. Remove the rear most left screw on the center console, the two screws to the rear of the seat belt buckle and the three screws that were under the lip of the shifter bezel.
5. Remove the inner kick panel enough to gain access to the seat belt buckle electrical connector.
6. Disconnect the seat buckle electrical connector from cross body harness connector and pull the seat belt buckle electrical connector through the opening in the inner kick panel.

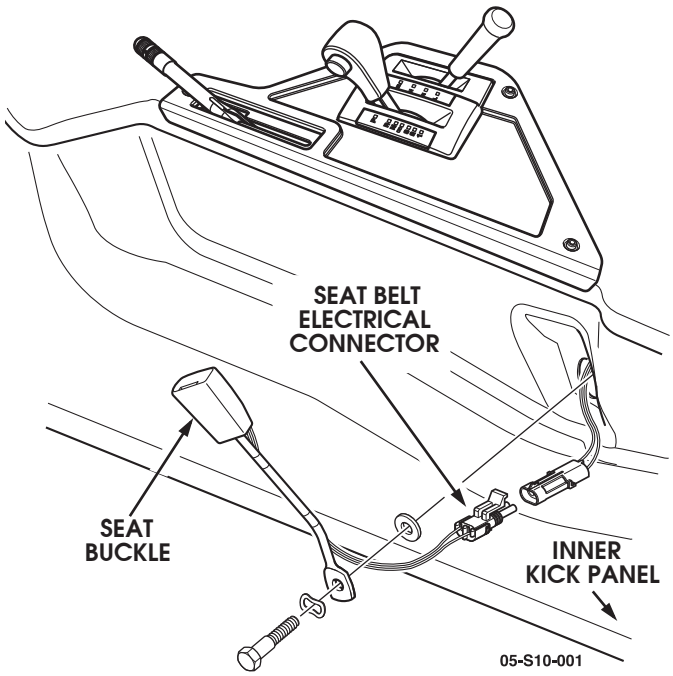


Figure 10-26: Seat Belt Electrical Connector Location

Installation

1. Route the seat belt buckle electrical connector through the opening in the inner kick panel and plug the seat buckle electrical connector into the cross body harness connector (Figure 10-26).
2. Install the inner kick panel.
3. Install the rear most left screw on the center console, the two screws to the rear of the seat belt buckle and the three screws that were under the lip of the shifter bezel.
4. Install the shifter bezel and secure with the four socket-head screws.
5. Secure the seat belt buckle to the body with the bolt/washer assembly. Tighten the bolt/washer assembly to 35-40 lb-ft (47-55 N•m).

Seat Belt Retractor Assembly Replacement

1. Remove the bolt/washer assembly, D-ring, webbing guide cover and the washer from the B-pillar (Figure 10-27).
2. Remove the screw/washer assembly, anchor bracket and washer from the bracket.
3. Remove the courtesy light lamp assembly, rivets, mounting bracket and washers from lower B-pillar trim (Figure 10-27).
4. Disconnect the body harness connector from the courtesy light lamp assembly.
5. Remove the screw/washer assemblies securing the lower B-pillar trim to B-pillar.
6. Remove the bolt, washer and retractor from the retractor mounting bracket. Remove seat belt assembly from lower B-pillar trim.
7. Remove the bolts, washers and the retractor mounting bracket from the B-pillar.
8. Remove the bolts, washers and the bracket from B-pillar and body.

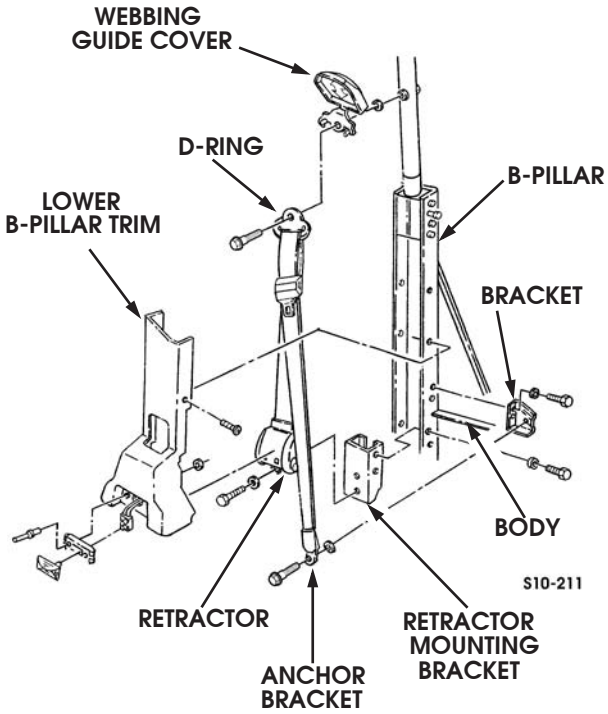


Figure 10-27: Seat Belt Assembly Breakdown

Installation

1. Secure the bracket to the B-pillar and the body with the washers and the bolts (Figure 10-27). Tighten the bolts to 12 lb-ft (16 N•m).
2. Secure the retractor mounting bracket to the B-pillar with the washers and the bolts. Tighten the bolts to 24 lb-ft (33 N•m).
3. Route the seat belt assembly through the opening in the lower B-pillar trim and secure the retractor to the retractor mounting bracket with the washer and the bolt. Tighten the bolts to 35-40 lb-ft (47-55 N•m).
4. Secure the lower B-pillar trim to the B-pillar with the screw/washer assemblies.
5. Secure the anchor bracket to the bracket with the washer and the screw/washer assembly. Tighten the screw/washer assembly to 35-40 lb-ft (47-55 N•m).
6. Secure the D-ring and the webbing guide cover to the B-pillar with the washer and the bolt/washer assembly.

DRIVER'S AND FRONT PASSENGER'S SEATS

Driver's and Passenger's Seat Pedestal disassembly

NOTE: The seat pedestal repair is similar for the driver's and the front passenger's seats. This procedure covers the driver's seat pedestal.

Removal

1. Remove the four bolts securing the pedestal to the floor and remove the seat pedestal assembly (Figure 10-28).
2. Remove the four nuts securing the seat base to the slide set and remove the base and seat as an assembly (Figure 10-28).
3. Remove the nuts, lock washers and the bolts securing the height adjuster to the slide set and remove the slide set.
4. Remove the cover and the bag from height adjuster (Figure 10-28).

Installation

1. Install the bag and the cover on the height adjuster.
2. Secure the height adjuster to the slide set with the bolts, lock washers and the nuts (Figure 10-28). Tighten the nuts to 24 lb-ft (33 N•m).

3. Secure the seat base to the slide set with the bolts, lock washers and the nuts. Tighten the nuts to 24 lb-ft (33 N•m).
4. Install the seat pedestal assembly and secure with the four bolts, lock washers and the washers to the floor. Tighten the bolts to 24 lb-ft (33 N•m).

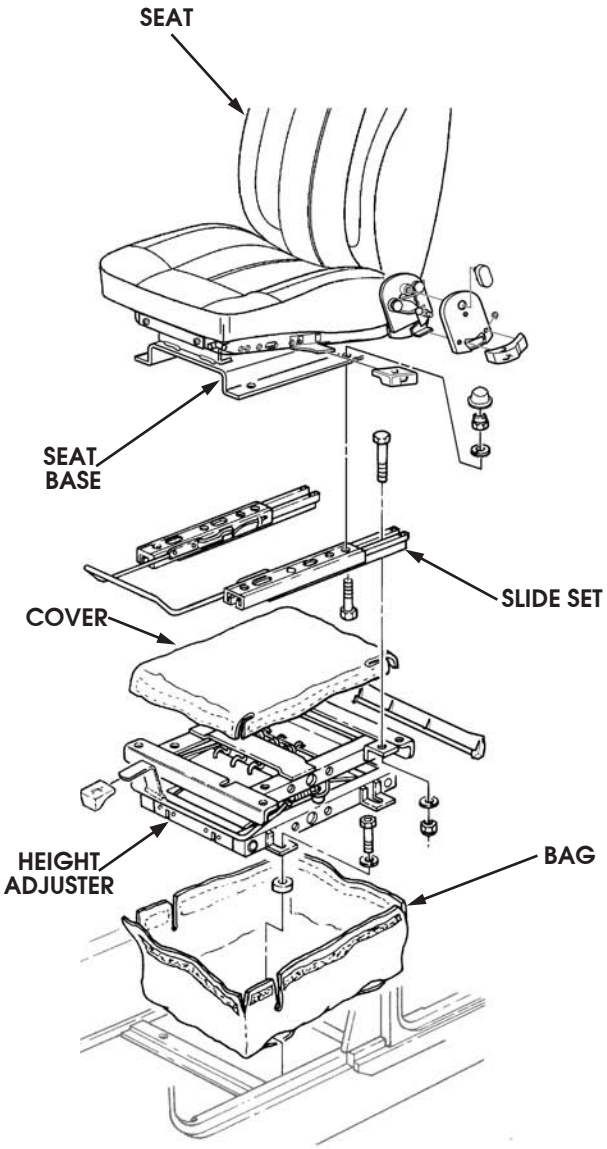


Figure 10-28: Seat Pedestal Assembly Breakdown

Reclining Driver's and Front Passenger's Seat Replacement

NOTE: The front driver's and the passenger's seats are replaced the same.

Removal

Remove the bolts, washers and the seat from the seat base (Figure 10-28).

Installation

Secure the seat to the seat base with the bolts and washers. Tighten the bolts to 15 lb-ft (20 N•m) (Figure 10-28).

Seat Armrest Replacement

Removal

1. Remove the plastic caps covering the exposed screws.
2. Remove the screws and the lock washers attaching the armrest to the seat support (Figure 10-29).

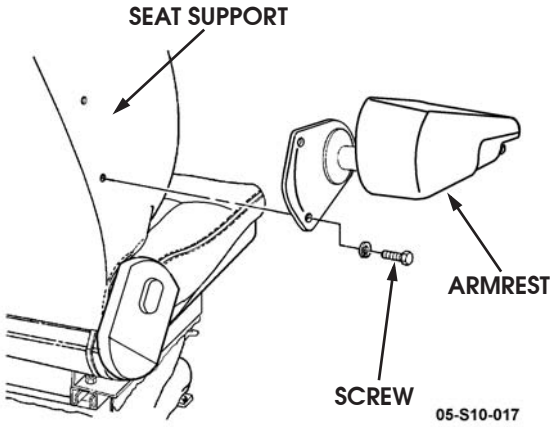


Figure 10-29: Seat Armrest Mounting

Installation

1. Secure the armrest to the seat support with the screws and the lock washers. Tighten the screws to 120 lb-in. (14 N•m).
2. Position the plastic caps over the exposed screw heads.

Headrest Replacement

Removal

1. Pull the headrest up to the top of it's travel.

NOTE: Care must be taken no to puncture or rip the seat leather.

2. Place a hose removing or similar type tool along the back side of the headrest ferrule and the leather material (Figure 10-30).
3. Holding the tool along side the ferrule from the rear push forward on the tool and pull up on the headrest at the same time. Perform this on both posts of the headrest (Figure 10-30).

Installation

1. Place the headrest post in the ferrules and push down (Figure 10-30).

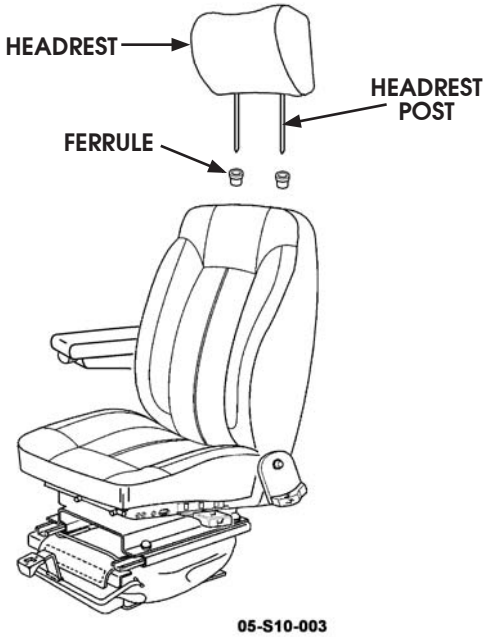


Figure 10-30: Seat Headrest

REMOVABLE LOAD BARRIER AND MOUNTING BRACKETS REPLACEMENT (STATION WAGON)

Removal

1. Remove the drive screws and the carpet assembly from the front and the back of the removable load barrier (Figure 10-31).
2. Remove the necessary interior trim to gain access to the mounting brackets.
3. Remove the removable load barrier by lifting the barrier up and out of the mounting brackets on the inner wheel house panels.
4. Remove the rivets and the mounting bracket from the left inner wheel house panel.
5. Remove the rivets and the mounting bracket from the right inner wheel house panel.

Inspection

Inspect the bumper strips. If they are damaged, replace them.

Installation

1. Secure the mounting bracket to the left inner wheel house panel with the rivets (Figure 10-31).
2. Secure the mounting bracket to the right inner wheel house panel with the rivets.
3. Install the removable load barrier in the mounting brackets.
4. Install the interior trim.
5. Secure the carpet assembly to the front and the back of the removable load barrier with the drive screws.

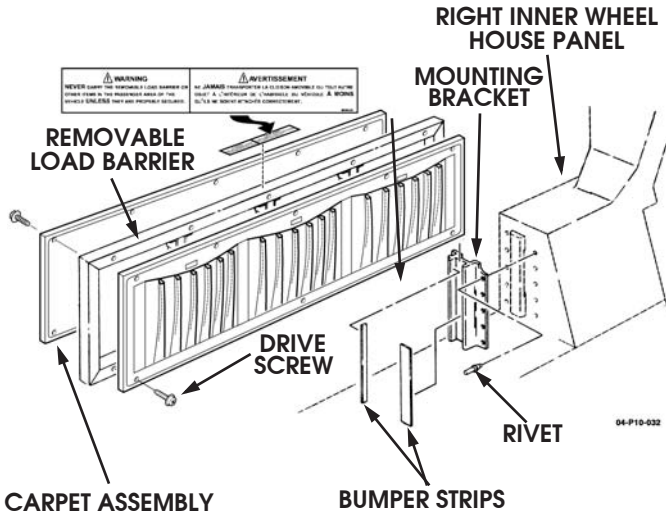


Figure 10-31: Removable Load Barrier Location

INTERIOR TRIM

B-Bar Replacement Model 84

Removal

1. Remove the passenger compartment trim.
2. Remove the trim from the B-bar.

NOTE: It may be necessary to remove any duct tape or tie straps securing the electrical wiring harnesses to the B-bar.

3. Remove the screws, washers and the headliner support from the B-bar (Figure 10-32).
4. Remove the screws, lock washers and the mounting brackets from the mounting blocks.
5. Remove the B-pillar seals and the rabbet seals from the B-pillar. Inspect and discard the seals if they are damaged.
6. Remove the locknuts, washers and the strikers from the B-pillar.
7. Remove the six locknuts, washers, bolts and the mounting blocks from the B-pillar.
8. Remove the B-bar.
9. Remove the screws, washers and the two trim mounting brackets from the B-bar.

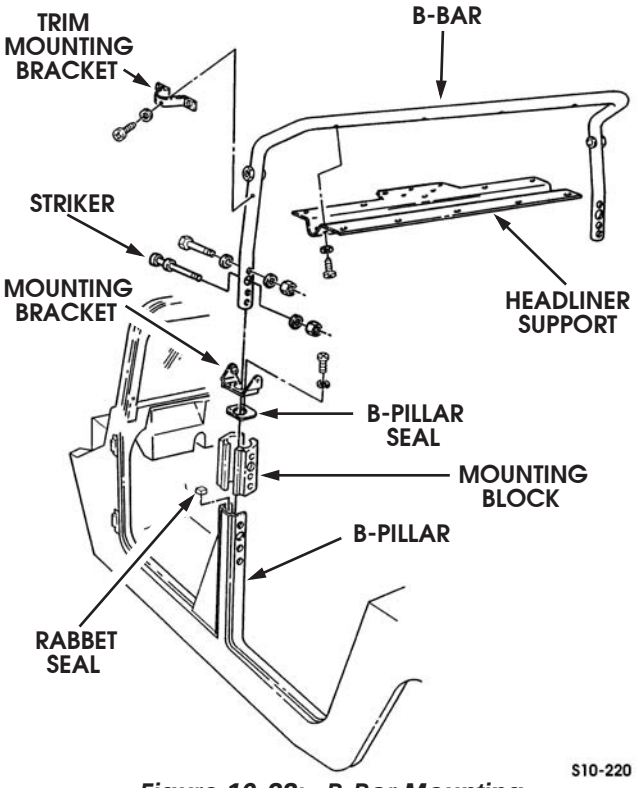


Figure 10-32: B-Bar Mounting

Installation

1. Secure the trim mounting brackets to the B-bar with the four washers and the screws (Figure 10-32).
2. Install the B-bar.
3. Secure the mounting blocks to the B-pillar with the washers, bolts and the locknuts. Tighten the locknuts to 24 lb-ft (33 N•m).
4. Secure the strikers to the B-pillar with the washers and the locknuts.
5. Install the B-pillar seals and the rabbet seals on the B-pillar.
6. Secure the mounting brackets to the mounting blocks with the lock washers and the screws.
7. Secure the headliner support to the B-bar with the washers and the screws.
8. Install the passenger compartment trim.

Passenger's Compartment Trim Replacement

Removal

1. Remove the drivers compartment trim.

NOTE: Perform step 2, 6, 8, 9,13, and 14 on model 84 only.

2. Remove the rear compartment trim.
3. Remove the seat belts.
4. Remove the rear seats.
5. Remove the speakers.

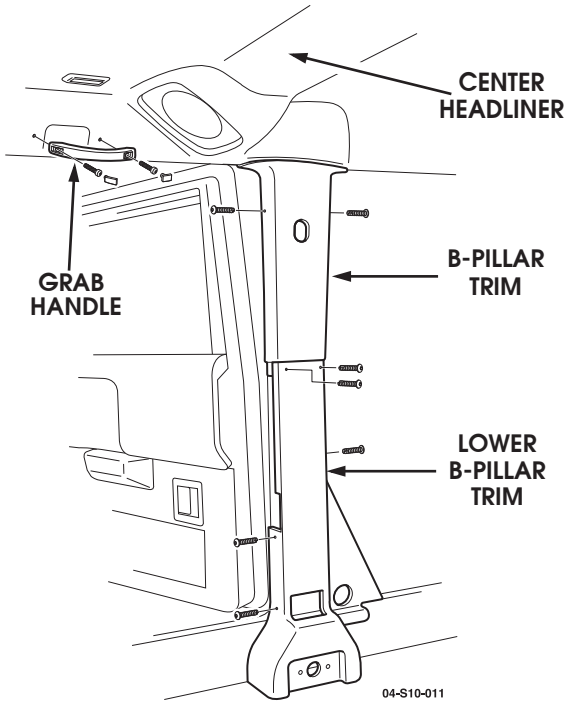


Figure 10-33: Driver Side Interior Trim Component Identification (Model 84)

6. Remove the grab handle covers, screws and the grab handle from the trim.
7. Remove the B-pillar screws and the B-pillar trim from the B-pillar.
8. Remove the B-pillar screws and the lower B-pillar trim from the B-pillar.
9. Remove the screw/washer assemblies and the upper C-pillar trim (Figure 10-34).
10. Remove the C-pillar screw/washer assemblies and the lower C-pillar trim from the lower C-pillar.

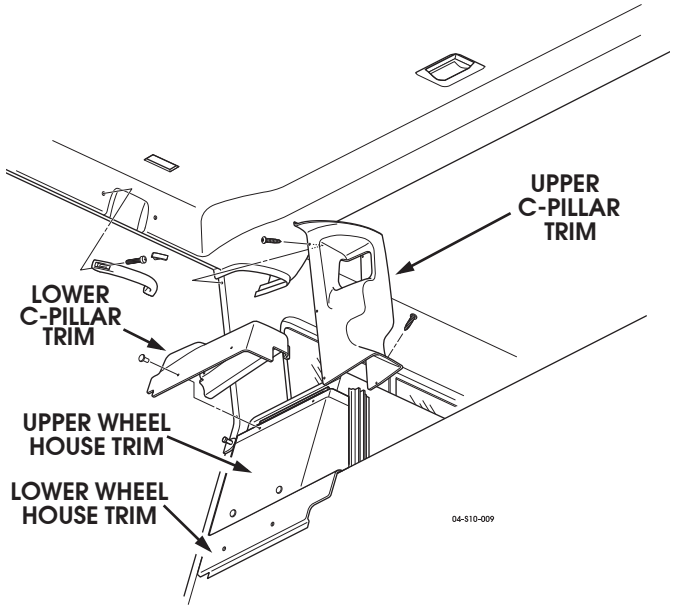


Figure 10-34: Interior Trim Component Identification (Model 84)

11. Remove the panel fasteners and the upper wheelhouse trim from the wheelhouse.
12. Remove the lower wheelhouse screw/washer assemblies and the lower wheelhouse trim from the wheelhouse.

NOTE: Perform step 12 on model 90 only.

13. Remove the lower center trim panel screw/washer assemblies and the lower center trim panel from the lower rear compartment wall.
14. Remove the dome light.
15. Remove the front and the rear j-channel, and the headliner from the roof.

Installation

1. Secure the headliner to roof with the j-channel.
2. Secure the dome light to the roof.

NOTE: Perform step 12 on model 90 only.

3. Secure the lower center trim panel to the lower rear compartment wall with screw/washer assemblies.
4. Secure the upper and the lower wheelhouse trim panels to the wheelhouse with the screw/washer assemblies and the panel fasteners.

NOTE: Perform steps 5 through 7 on model 84 only

5. Install the rear compartment trim.
6. Secure the lower C-pillar trim to the lower C-pillar with the four screw (Figure 10-34).
7. Secure the upper C-pillar trim to the C pillar with the screws.
8. Secure the B-pillar trim to the B-pillar with the screws (Figure 10-35).
9. Secure the lower B-pillar trim to the B-pillar.

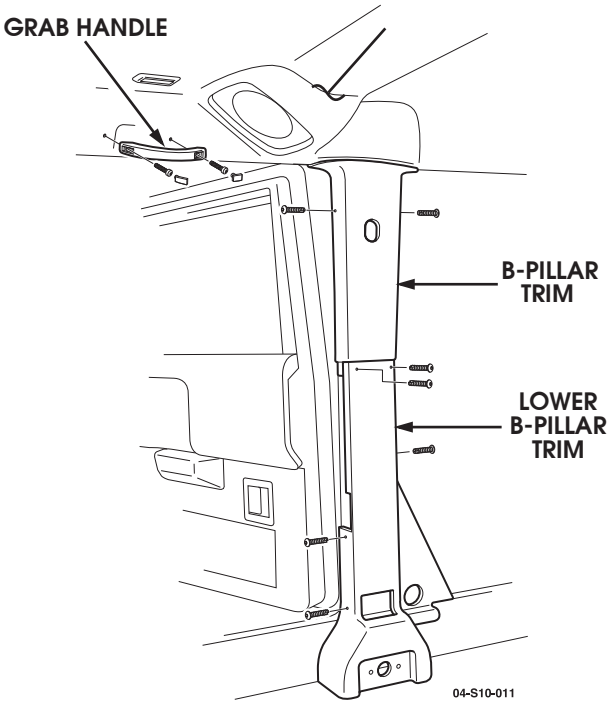


Figure 10-35: B-Pillar and Interior Trim Component Identification

10. Secure the grab handle to the trim with the screws and the covers.
11. Install the seat belt assemblies.
12. Install the overhead speakers (Refer to section 12).
13. Install the rear seats.
14. Install the drivers compartment trim.

Driver's Compartment Trim Replacement

Removal

1. Remove the overhead speakers from the driver's compartment.
2. Remove the visors.
3. Remove the rear view mirror.
4. Remove the covers, screws and the grab handle from the trim (Figure 10-37).
5. Remove the defrost vents (Figure 10-36).
6. Remove the upper crash pad (Figure 10-36).
7. Remove the screw and the windshield center trim from the windshield frame (Figure 10-37).
8. Remove the screws and the A-pillar trim from the A-pillar.
9. Remove the front seat belts.
10. Remove the screws and the B-pillar trim from the B-pillar.
11. Remove the screws and the lower B-pillar trim from the B-pillar (Figure 10-37).
12. Remove the dome light.
13. lower the head liner and slide forward out of the J-channel.
14. Remove the front seats.

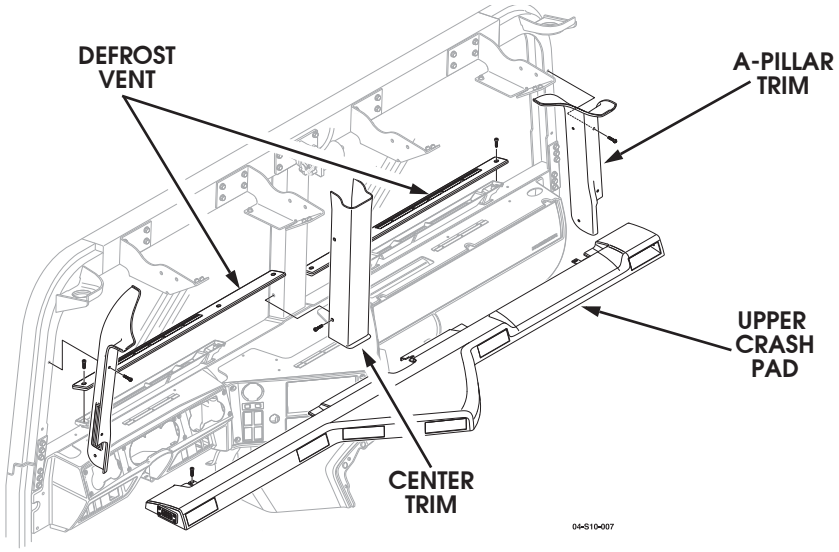


Figure 10-36: Driver's Compartment Trim Replacement

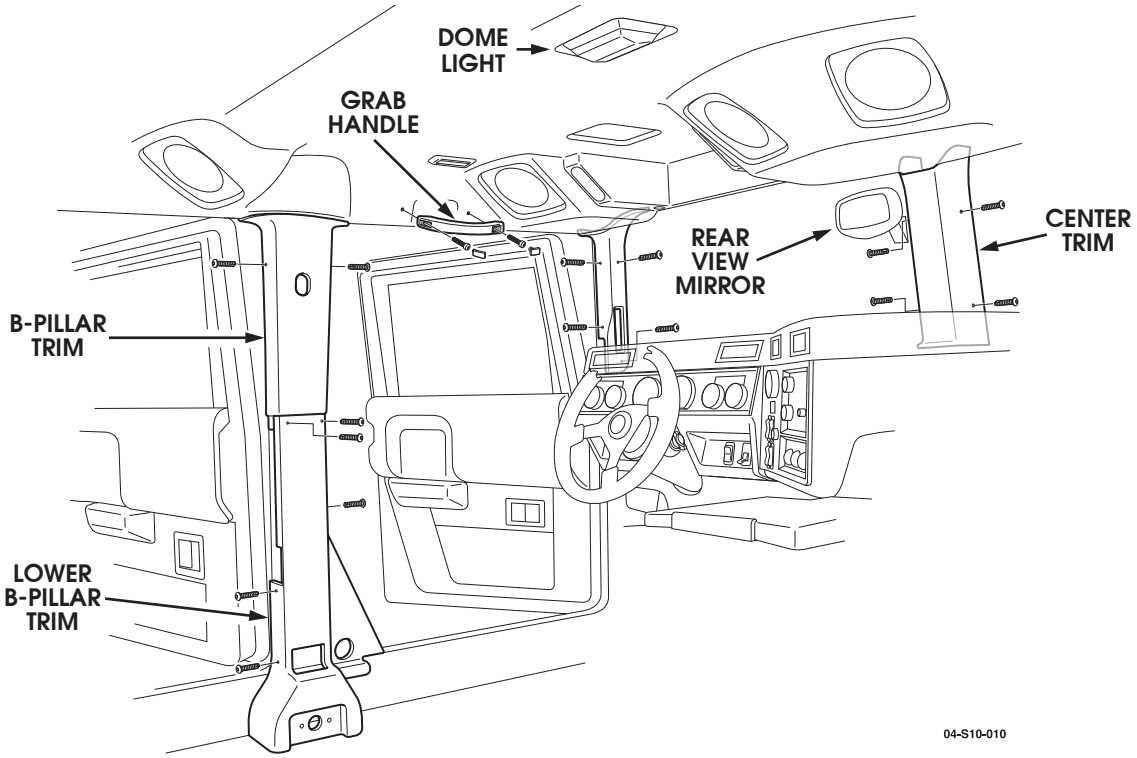


Figure 10-37: A-Pillar and B-Bar Interior Trim Identification

Installation

1. Position the headliner in the J-channel.
2. Secure the dome light to the roof with the screw.
3. Secure the grab handle to the trim with the screws and the covers.
4. Secure the B-pillar trim to the B-pillar with the screws (Figure 10-38).
5. Secure the lower B-pillar trim to the B-pillar with the screws.
6. Secure the front seat belt assemblies in place.
7. Secure the front seats to the floor with the bolts.
8. Secure the lower A-pillar trim to the A-pillar with the screws.
9. Secure the windshield center trim to the windshield frame with the screws (Figure 10-38).
10. Secure the visors to the brackets with the screws.
11. Install the upper crash pad (Refer to section 12).
12. Install the overhead speakers (Refer to section 12).

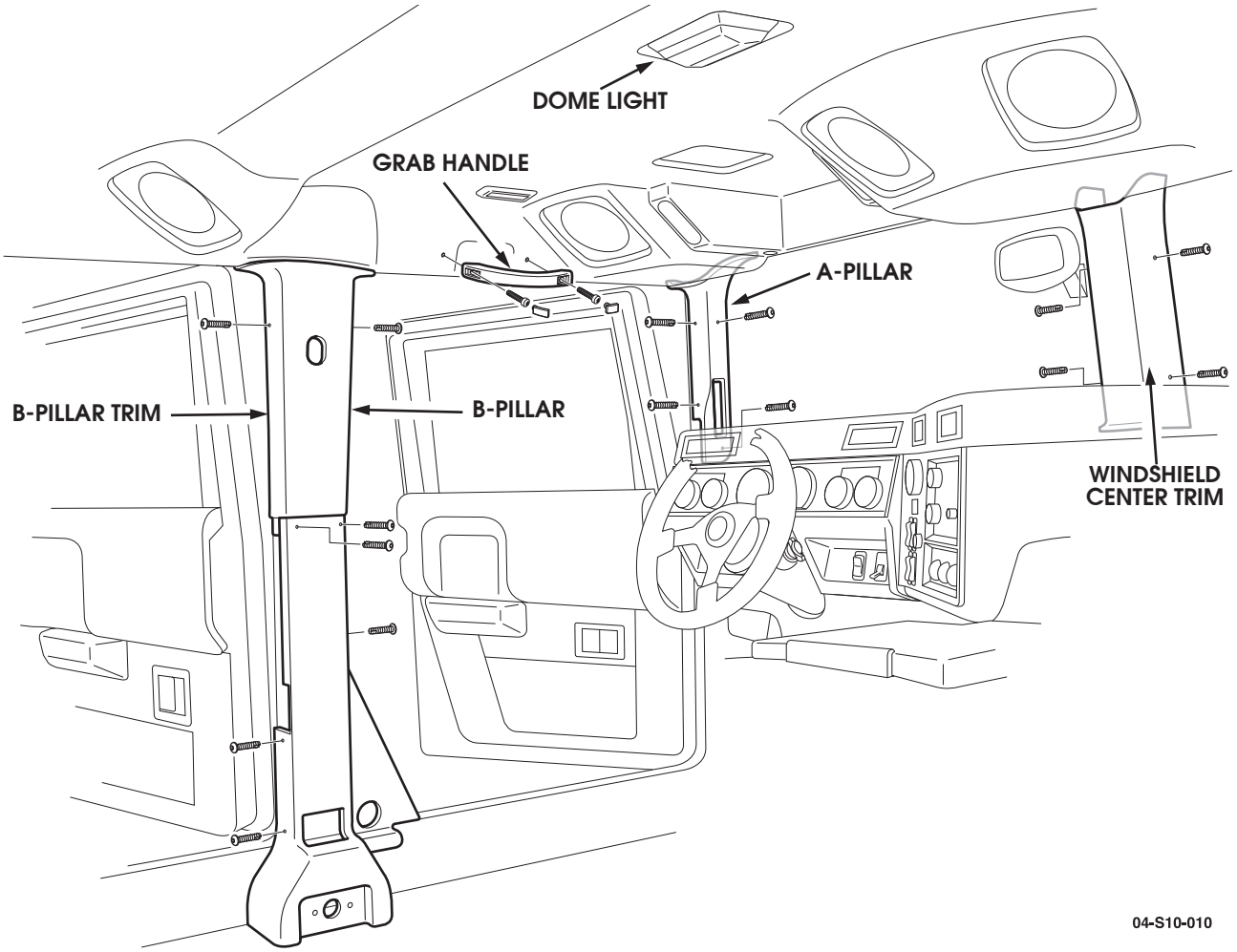


Figure 10-38: A-Pillar and B-Bar Interior Trim Components

Station Wagon Rear Compartment Trim Replacement

Removal

1. Remove the rear seats.
2. Remove the upper C-pillar trim.
3. Remove the bolts, washers, upper seat belt bracket and the seat belt assembly from the C-pillar (Figure 10-39).

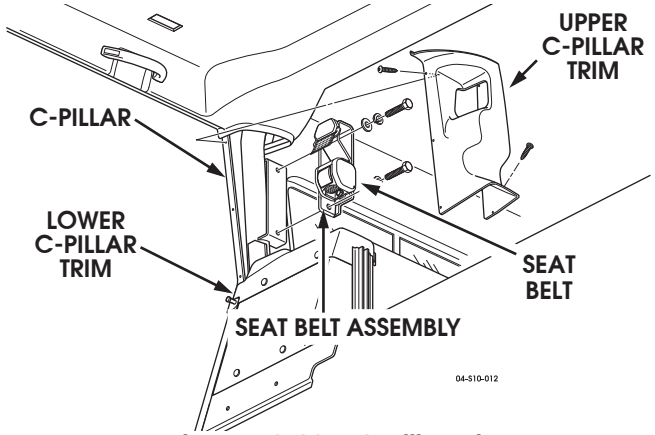


Figure 10-39: C-Pillar Trim

4. Remove the trim from the rear compartment side wall.

5. Remove the screws and the lower C-pillar trim from the C-pillar.
6. Remove the dome light.
7. Remove the panel fasteners and the rear headliner from the J-channel.

Installation

1. Secure the rear headliner to the J-channel and the roof with the panel fasteners.
2. Install the dome light.
3. Secure the trim panel to the compartment wall with the screw.
4. Secure the lower C-pillar trim to the lower side of the C-pillar with the screws.
5. Secure the seat belt assembly and bracket to the C-pillar with the washers and bolts. Tighten the bolts to 35-40 lb-ft (47-55 N•m).
6. Secure the upper C-pillar trim to the C-pillar with the screws.
7. Install the rear seats.

Inner Kick Panels Replacement

Removal

1. Remove the seats.
2. Remove bolts, washers and seat buckles from front and rear of tunnel (Figure 10-40).

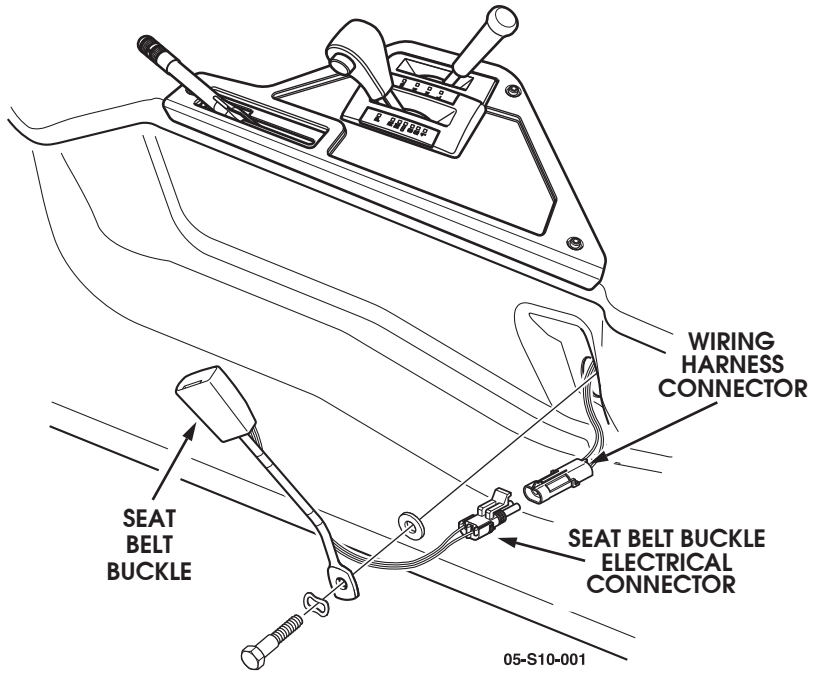


Figure 10-40: Seat Belt Buckle Electrical Connector Location

NOTE: Ensure the seat belt buckle electrical connector or wiring harness is pulled out and away from the kick panel for ease of installation.

3. Disconnect the seat belt buckle electrical connector from the wiring harness connector on the driver side.
4. Remove the panel fasteners, screw/washer assemblies and the rear wall trim from the rear compartment wall (Figure 10-41).
5. Remove the panel fasteners and the rear inner kick panel from the tunnel (Figure 10-42).

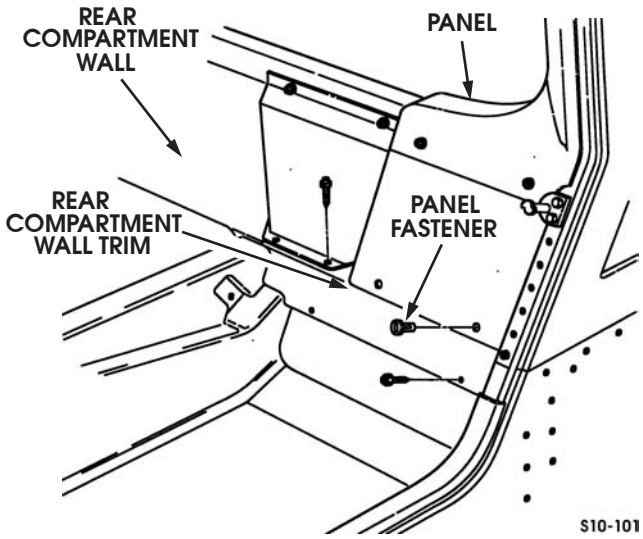


Figure 10-41: Rear Compartment Trim Removal

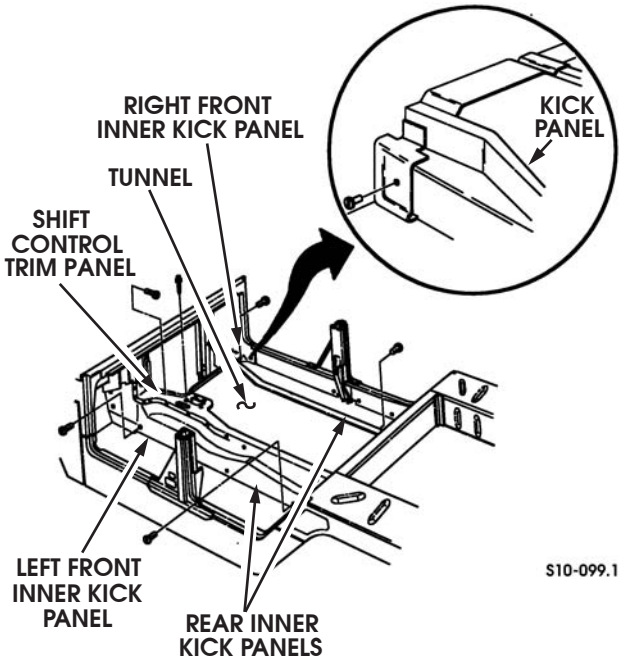


Figure 10-42: Inner Kick Panel Mounting

6. Remove the center consoles.
7. Remove the screws, panel fastener and the shift control panel from the tunnel (Figure 10-42).
8. Remove the panel fasteners and the left front inner kick panel from the tunnel.
9. Remove the panel fasteners and the right front inner kick panel.
10. Remove the panel fastener and the inner kick panel from the rear of tunnel.

Installation

1. Secure the rear inner kick panel to the right rear of the tunnel with the panel fastener (Figure 10-42).
2. Secure the right front inner kick panel to the tunnel with the panel fasteners.
3. Secure the left front inner kick panel to the tunnel with the panel fasteners.
4. Secure the shift control trim panel to the tunnel with the screw/washer assemblies and the panel fastener.
5. Install the center consoles.

6. Secure the rear inner kick panels with the panel fasteners (Figure 10-41).
7. Secure the rear wall trim to the rear compartment wall with the panel fasteners and the screw/washer assemblies.
8. Connect the driver side seat belt buckle electrical connector (Figure 10-40).
9. Secure the seat buckles to the tunnel with the washers and the bolts. Tighten the bolts to 35-40 lb-ft (47-55 N•m).
10. Install the seats.

Outer Kick Panel Replacement

Removal

1. Remove the door stop straps.
2. Remove the panel fasteners and the right front outer kick panel from the body (Figure 10-43).
3. Remove the panel fasteners and the left front outer kick panel from the body.
4. Remove the panel fasteners and the left center outer kick panel from the body.
5. Remove the panel fastener and the right center outer kick panel from the body.
6. Remove the screws, washers and the rear lower seat belt brackets from the body.
7. Remove the panel fasteners and the left and right rear outer kick panels from the body.

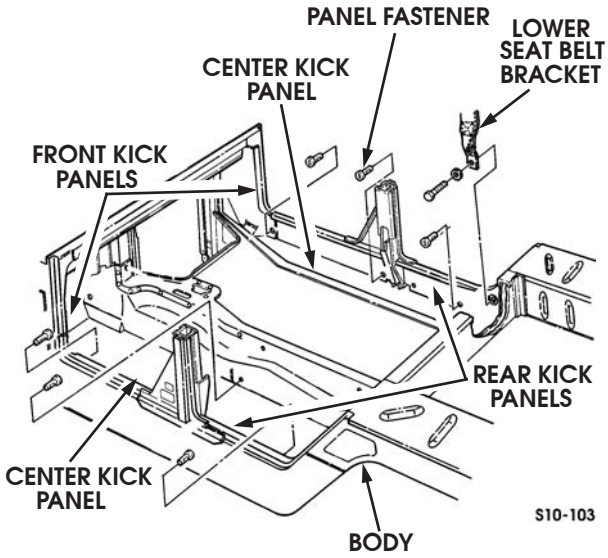


Figure 10-43: Outer Kick Panel Identification

Installation

1. Secure the left and the right rear outer kick panels to the body with the panel fasteners (Figure 10-43).
2. Secure the rear lower seat belt brackets to the body with the washers and the screws.
3. Secure the right center outer kick panel to the body with the panel fastener.
4. Secure the left center outer kick panel to the body with the panel fasteners.
5. Secure the left front outer kick panel to the body with the panel fasteners.
6. Secure the right front outer kick panel to the body with the panel fasteners.
7. Install the door stop straps.

Tunnel Carpet, Padding and Hardboard Replacement

Removal

1. Remove the inner kick panels.
2. Remove the carpet from the tunnel (Figure 10-44).
3. Remove the padding from the tunnel.

4. Remove the panel fasteners and the hardboard from the tunnel.

Installation

1. Secure the hardboard to the tunnel with the panel fasteners (Figure 10-44).
2. Install the padding on the tunnel.
3. Install the carpet on the tunnel.
4. Install the inner kick panels.

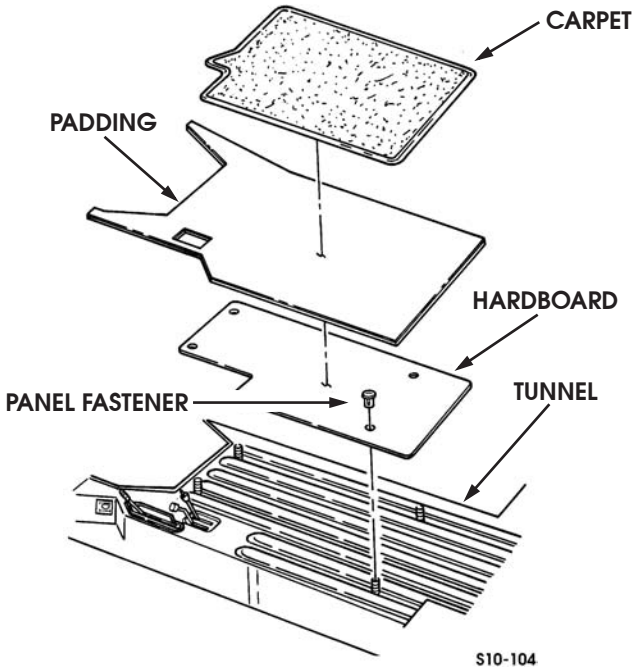


Figure 10-44: Carpet and Padding Installation

VISOR REPLACEMENT

Removal

NOTE: The visor replacement is the same for each side of the vehicle. This procedure covers the driver's side.

1. Remove the six screws, lock washers and the visor from the body (Figure 10-45).

Installation

1. Secure the visor mounting brackets to the body with the six screws, lock washers and washers.

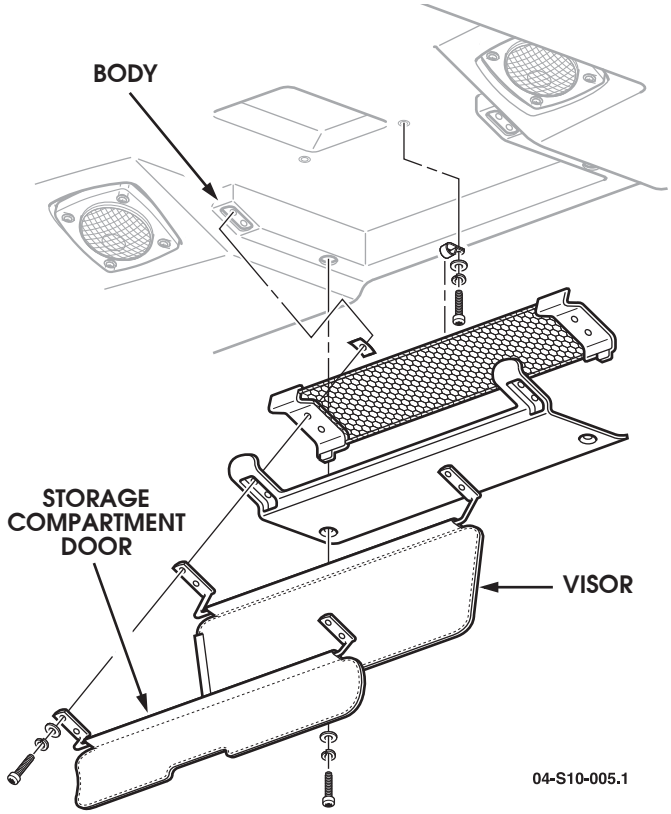


Figure 10-45: Visor Mounting

POWER MIRRORS

Power Mirror Assembly Replacement

Removal

1. Remove the three screws securing the power mirror assembly and the gasket to the mounting plate (Figure 10-46).
2. Disconnect the power mirror assembly connector from the door jumper harness.
3. Inspect the gasket and replace if damaged.

Installation

NOTE: Ensure the door jumper harness is routed through the gasket before connecting to the power mirror assembly.

1. Connect the power mirror assembly connector to the door jumper harness (Figure 10-46).

NOTE: The wires from the power mirror assembly must be coiled in the mirror housing to ensure clearance of the attachments.

2. Install the gasket and the power mirror assembly on the mounting plate with the three screws.

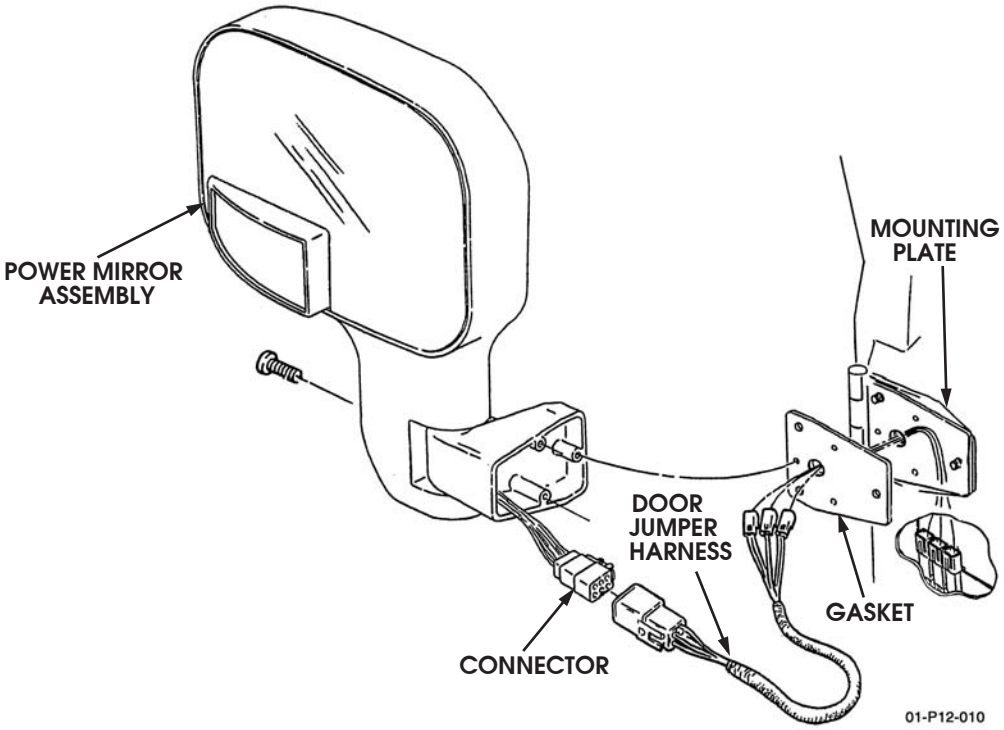


Figure 10-46: Power Mirror Assembly

Rearview Mirror Replacement

Removal

1. Remove the screw and the rear view mirror from the mirror bracket.

NOTE: Perform step 2 only if the bracket requires replacement. Mark the location of the bracket prior to removal.

2. Remove the bracket from the windshield.

Cleaning and Inspection

Clean the epoxy remains from the windshield.

Installation

NOTE: Perform step 1 only if bracket was removed.

1. Secure the mirror bracket to the windshield with quick-drying epoxy. Allow to dry.
2. Secure the rear view mirror to the mirror bracket the with screw.

DOOR REPLACEMENT

Door replacement varies in complexity depending on the type and number of components that must be removed from the old door and installed on the new door. Removal and installation of these components are detailed in the previous pages of this section. Any reference to wiring harness removal and installation is covered in Section 12.

NOTE: Door replacement is basically the same for all doors.

Removal

CAUTION: *To avoid damage, support door during removal.*

1. Remove the side view mirror (front doors only).

2. Remove the door harness from the pillar (Refer to section 12).
3. Remove the door stop strap assembly.
4. Remove the twelve-point bolts and washers securing the upper door hinge to the pillar (Figure 10-47).

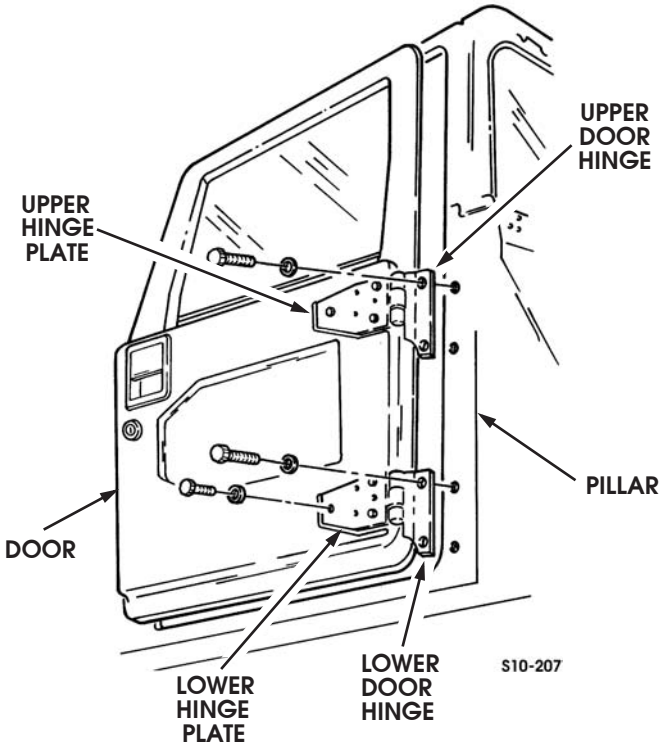


Figure 10-47: Door Mounting

5. Close the door.
6. Remove the twelve-point bolts and washers securing the lower door hinge to the pillar and remove the door.

Disassembly

1. Remove the twelve-point bolts, washers and the upper and lower hinge plates from the door (Figure 10-47).
2. Remove the power windows and/or the door locks switches from the door (Refer to section 10).
3. Remove the screws and door pull handle or armrest from door trim panel.
4. Remove the screws securing the inside door handle to the door trim panel. Pull the handle away from the trim panel and disconnect the inside operating rod from the handle.
5. Remove the screw/washer assemblies and the door trim panel from the door.
6. Remove the vapor barrier and the moisture barrier flap from the door (Figure 10-48).
7. Disconnect the inside operating rod from the door latch assembly and remove the rod (Figure 10-49).
8. Remove the lock cylinder clip from the lock cylinder.
9. Push the lock cylinder through the outside of the door. Remove the clip securing the lever and the lock operating rod to the cylinder and remove the cylinder from the door (Figure 10-51).
10. Remove the nuts and the lock washers securing the gasket and the outside door handle to the door. Disconnect the outside operating rod from the handle and remove the handle.

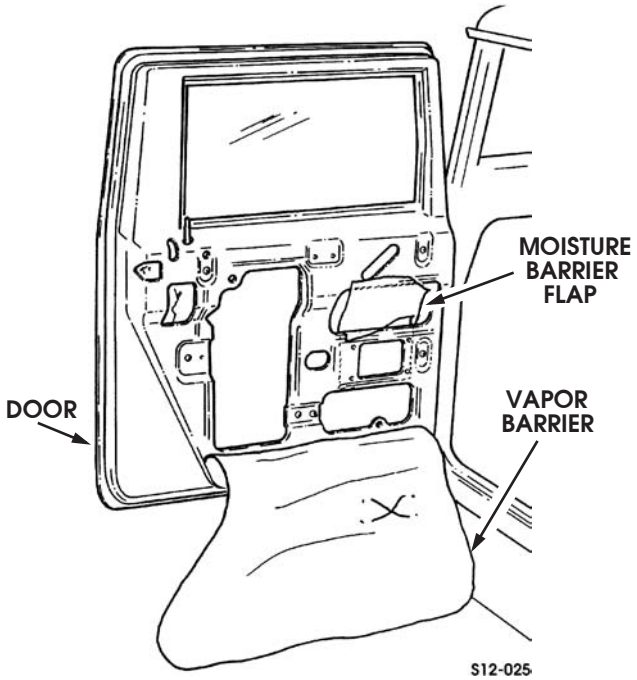


Figure 10-48: Vapor Barrier and Moisture Barrier Flap

11. Remove the screws, lock washers and the latch assembly from the door (Figure 10-50).
12. Remove all the rods from the door latch assembly.

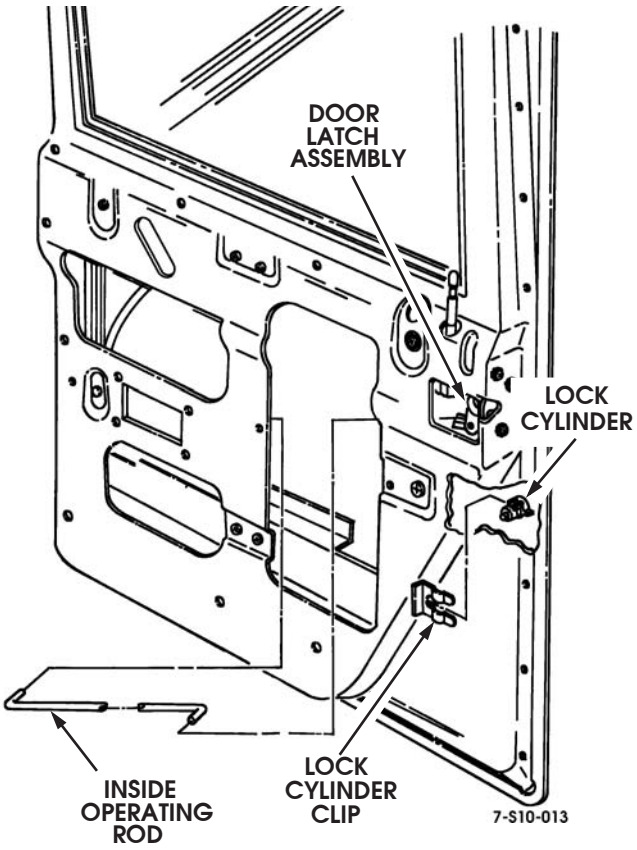


Figure 10-49: Inside Operating Rod Location

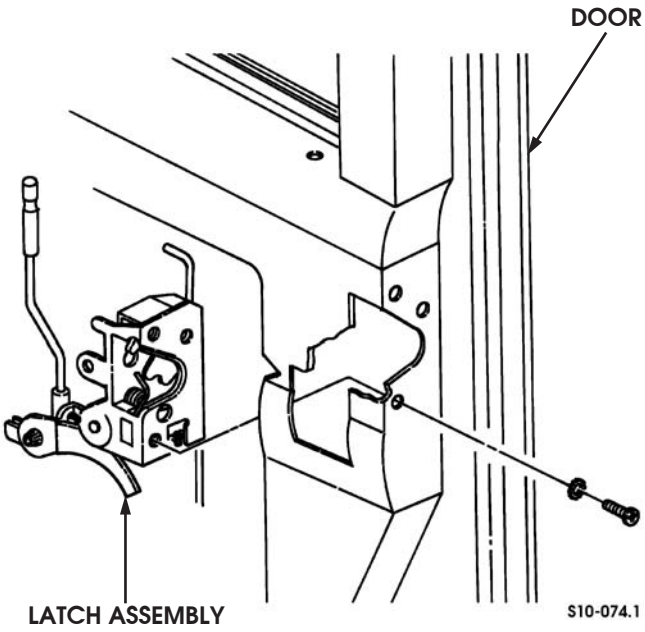


Figure 10-50: Latch Assembly

CAUTION: *Firmly support the glass during regulator removal to avoid damage.*

Remove the power window regulator (Refer to section 10).

Cleaning and Inspection

NOTE: Clean all the components and examine for wear or damage. Replace if necessary.

Assembly

1. Install the power windows regulator (Refer to section 10).
2. Install all the rods on the door latch assembly (Figure 10-50).

WARNING: Screws securing the latch assembly have metric threads. Substituting non-metric threaded screws can result in door opening during vehicle operation. Do not substitute screws.

3. Secure the latch assembly to the door with the lock washers and the screws.
4. Connect the outside operating rod to the outside door handle and secure the gasket and the outside door handle to the door with the nuts and the lock washers (Figure 10-51).
5. (Front doors only) Install the lock cylinder in the door and secure the lock operating rod and the lever to the lock cylinder with the clip.
6. (Front doors only) Secure the lock cylinder in the door with the lock cylinder clip (Figure 10-49).
7. Install the inside operating rod on the door latch assembly.

NOTE: The vapor barrier must be completely sealed at all edges to prevent water entry into the interior of the vehicle.

8. Install the moisture barrier flap and the vapor barrier on the door (Figure 10-48).
9. Secure the door trim panel to the door with the screws (Figure 10-48).
10. Connect the inside operating rod to the inside door handle and install the inside door handle on the door trim panel with the screws.

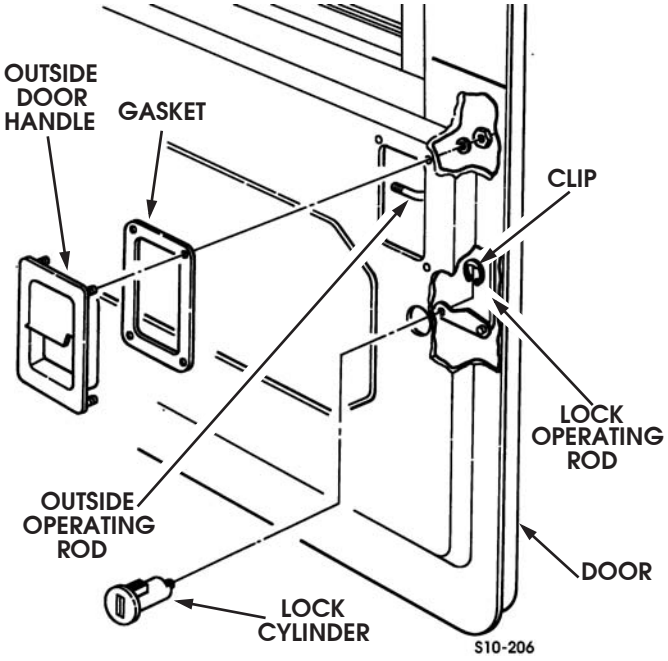


Figure 10-51: Lock Cylinder and Outside Door Handle

11. Install the door pull handle or the armrest on the door trim panel with the screws.
12. Secure the upper and the lower hinge plates to the door with the washers and the twelve-point screws.

CAUTION: *To avoid damage, support the door during installation.*

13. Secure the lower door hinge to the pillar with the washers and the twelve-point screws. Do not tighten the screws.
14. Secure the upper door hinge to the pillar with the washers and the twelve-point screws. Do not tighten the screws.
15. Install the door stop strap assembly.
16. Install the power windows and door locks harness on the pillar (Refer to section 12).
17. Install the side view mirror after adjustment (front doors only).

Adjustment

1. Loosen the twelve-point screws securing the upper and lower door hinges to pillar.
2. Raise the door as high as possible. Push the hinges toward the front of the vehicle as far as they will go and tighten the twelve-point screws to 10 lb-ft (13 N•m).
3. Loosen the twelve-point screws securing the upper and the lower hinge plates to the door.
4. Close the door and tighten the twelve-point screws to 10 lb-ft (13 N•m).

Power Door Lock Actuator Replacement

Removal

NOTE: Actuator replacement is the same for all doors.

1. Raise the window.
2. Remove the door trim panel.
3. Remove the vapor barrier (Figure 10-52).

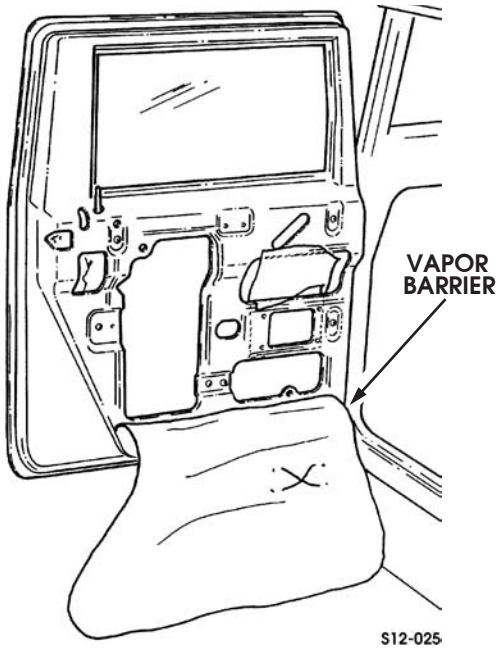


Figure 10-52: Vapor Barrier Removal/Installation

4. Detach the door harness connector from the door actuator (Figure 10-53).

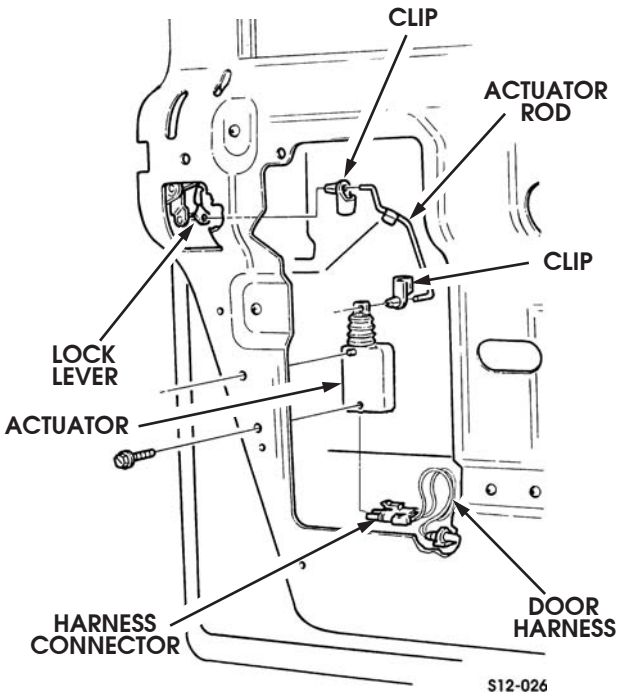


Figure 10-53: Door Lock Actuator Removal/Installation

5. Remove the actuator attaching screws.
6. Remove the actuator from the door and disconnect the actuator rod from the clips and actuator.

Installation

NOTE: The color coding on the actuator rod is positioned away from the actuator during installation. The actuator rods are color coded as follows: left front, red; right front, green; left rear, yellow; and right rear, blue.

1. Connect the clip and actuator rod to the lock lever (Figure 10-53).

2. Install the opposite clip on the actuator and connect the rod to the actuator.
3. Secure the actuator with the mounting screws.

CAUTION: *The actuator threads will strip if overtightened.*

4. Connect the harness wires to the actuator.

NOTE: The vapor barrier must be completely sealed at all edges to prevent water entry into the interior of the vehicle.

5. Install the vapor barrier (Figure 10-52).
6. Install the door trim panel.

Door Lock Actuator Replacement For Rear Cargo Door (HMCS Only)

Removal

1. Remove the window from the primary rear door.
2. Remove the four screws and the interior door handle.
3. Remove the twelve screws securing the inner door panel to the door.
4. Remove the inner door panel.
5. Disconnect the link rod from the lock actuator by rotating the plastic lock clip clockwise.
6. Remove the link rod from the plastic clip and the plastic clip from the actuator.
7. Remove the screw securing the door lock actuator to bracket.
8. Disconnect the door lock harness from the actuator.
9. Remove the actuator from the bracket (Figure 10-54).

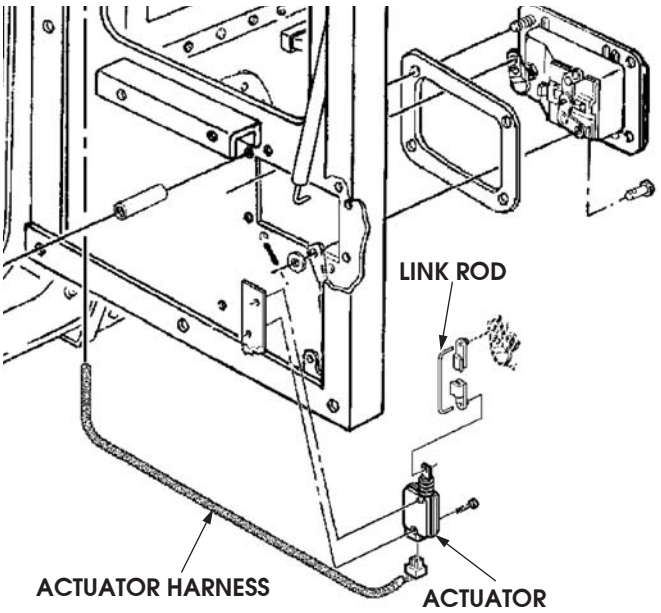


Figure 10-54: Cargo Door Lock Actuator

Installation

1. Connect the door lock harness to the new door lock actuator.
2. Place the actuator on the bracket so the actuator plunger is on the left side of the actuator.
3. Install the screw securing door lock actuator to bracket.
4. Install the plastic clip into hole in the lock actuator plunger.
5. Install the link rod into the plastic clip and rotate counter clockwise to the lock in place (Figure 10-54).
6. Install the inner door pane with twelve screws.

7. Install the inner door handle with four screws.
8. Verify the operation of the door handle and the door locks.

Rear Cargo Door Lock Module Replacement (HMCS Only).

Removal

1. Remove the right rear seat.
2. Remove the right rear seat belt retractor assembly (Refer to section 10).
3. Remove the right rear corner trim assembly (Figure 10-55).

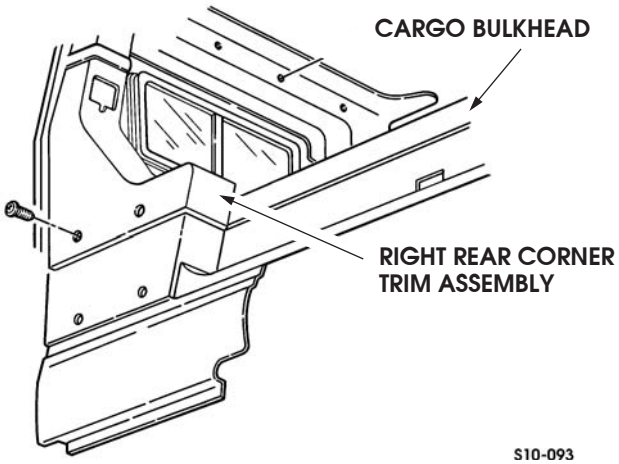


Figure 10-55: Removing Right Rear Trim Piece

4. Disconnect the rear door lock harness jumper assembly from the rear door lock module.
5. Pull the module loose from the hook and loop attaching it to the body.

Installation

1. Apply new a hook and loop strip to new rear door lock module.
2. Affix the new module to the body and connect the rear door lock harness jumper.
3. Verify the operation of the rear door locks.
4. Install the right rear trim piece (Figure 10-55).
5. Apply loctite 242 to the seat belt retractor bolt.
6. Install the seat belt retractor bolt and torque to 35-40 lb-ft (47-55 Nm).
7. Install the right rear seat.

Rear Cargo Door Lock Harness Jumper Replacement

Removal

1. Remove the right rear seat.
2. Remove the right rear seat belt retractor assembly (Refer to section 10).
3. Remove the right rear corner trim assembly (Figure 10-55).
4. Disconnect the harness from the rear door lock module.
5. Remove the slide out bulkhead.
6. Remove the closeout panel from the passenger side of the rear cargo door frame.
7. Disconnect the harness from the door hinge contacts.
8. Pull the padding and carpet on the cargo area wall upward to expose the harness.
9. Remove the remaining trim pieces behind the right rear passenger seat.

10. Remove the lower passenger side B-pillar trim.
11. Remove the passenger side right-hand kick panel.
12. Disconnect the rear cargo door lock jumper.
13. Remove the harness from the vehicle.

Installation

1. Connect the rear cargo door lock jumper harness to the connector at the B-Pillar.
2. Route the harness along the same locations to the rear cargo door lock module.
3. Connect the harness to the door lock module.
4. Route the harness to the door hinge contacts and connect it.
5. Install the passenger side cargo door frame closeout panel.
6. Reposition the cargo area padding.
7. Install the trim pieces behind the right rear passenger seat.
8. Install the rear passenger right hand side kick panel.
9. Install the passenger side lower B-pillar trim.
10. Install the removable cargo area bulkhead.
11. Install the right rear seat belt retractor assembly (Refer to section 10).
12. Install the passenger right rear seat.

POWER DOOR LOCK REAR DOOR AND JUMPER HARNESS REPLACEMENT

Removal

NOTE: Left and right rear power door locks harness replacement procedures are identical.

1. Remove the front seat.
2. Remove the trim from the B-pillar (Refer to section 10).
3. Remove the side trim and the outer kick panel (Refer to section 10).
4. Remove the rear door trim (Refer to section 10).

NOTE: The vapor barrier may be positioned under velcro strip If so, cut around velcro strip to remove vapor barrier.

5. Remove the vapor barrier and the moisture barrier flap.
6. Remove the cap screw and the clamp securing the rear door harness to the door reinforcement.
7. Disconnect the rear door harness from the jumper harness.
8. Remove the convoluted tubing from the rear door harness.
9. Remove the two-lead connector from the rear door harness with a pin extraction tool.
10. Remove the cap screw, washer, nut and the lock washer assembly and the P-clamp from the rear door harness and the B-pillar.
11. Pull the harness through the rubber grommet in the B-pillar.
12. Remove and inspect the grommet. Discard if damaged.
13. Remove the two cap screws and the support bracket from the rear door.
14. Pull the harness through the door bushing and remove the support bracket from the harness. Inspect the support bracket bushing. Replace if damaged.
15. Inspect the bushing in the rear door. Replace if damaged.
16. Disconnect the door harness connector from the actuator lead.
17. Disconnect the clip from the door reinforcement and remove from the rear door harness.
18. Remove the rear harness from the door.
19. Disconnect the jumper harness from the dash harness at the A-pillar. Remove the tie straps and the jumper harness (Figure 10-56).

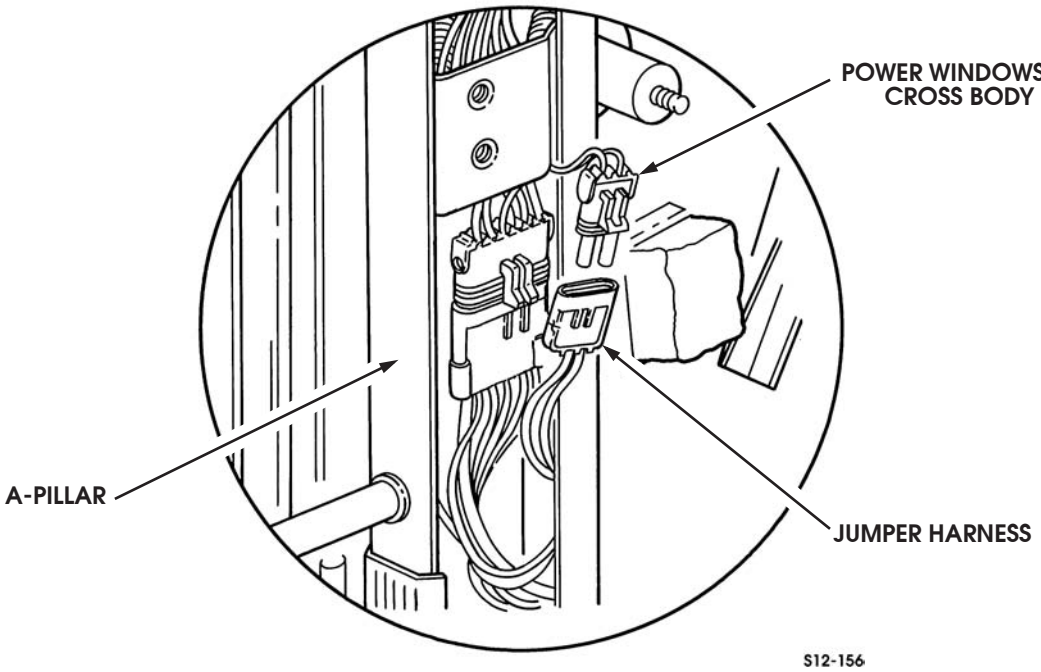


Figure 10-56: Door Harness Connection

Installation

NOTE: Lubricate the bushings, rubber grommet and the door harness teflon cover with silicone spray.Install the clip and support bracket on the rear door harness (Figure 10-57).

1. Install the harness in the door bushing.
2. Install the support bracket in the rear door with the two cap screws.
3. Install the rubber grommet in the B-pillar.
4. Install the harness through the grommet until the yellow tape touches the back of the B-pillar.
5. Install the P-clamp on the harness at the yellow tape and the B-pillar with the cap screw, washer and the lock washer and the nut assembly.
6. Install the two-lead connector on the rear door harness, matching the wire colors to the jumper harness. Connect the harness to the jumper harness.
7. Route the rear door harness along the bottom of the rear door. Secure the harness to the door reinforcement with the clip.
8. Attach the door harness connector to the actuator. Tighten the power window motor mounting screws, if loose.
9. Install the convoluted tubing on the rear door harness wires and secure with black electrical tape.
10. Install the P-clamp on the rear door harness at the yellow tape area and secure to the door reinforcement with one cap screw.
11. Install the vapor barrier and the moisture barrier flap.
12. Install the rear door trim (Refer to section 10).
13. Install the side trim and the outer kick panel (Refer to section 10).
14. Install the trim on the B-pillar and the B-beam (Refer to section 10).
15. Install the front seat (Refer to section 10).

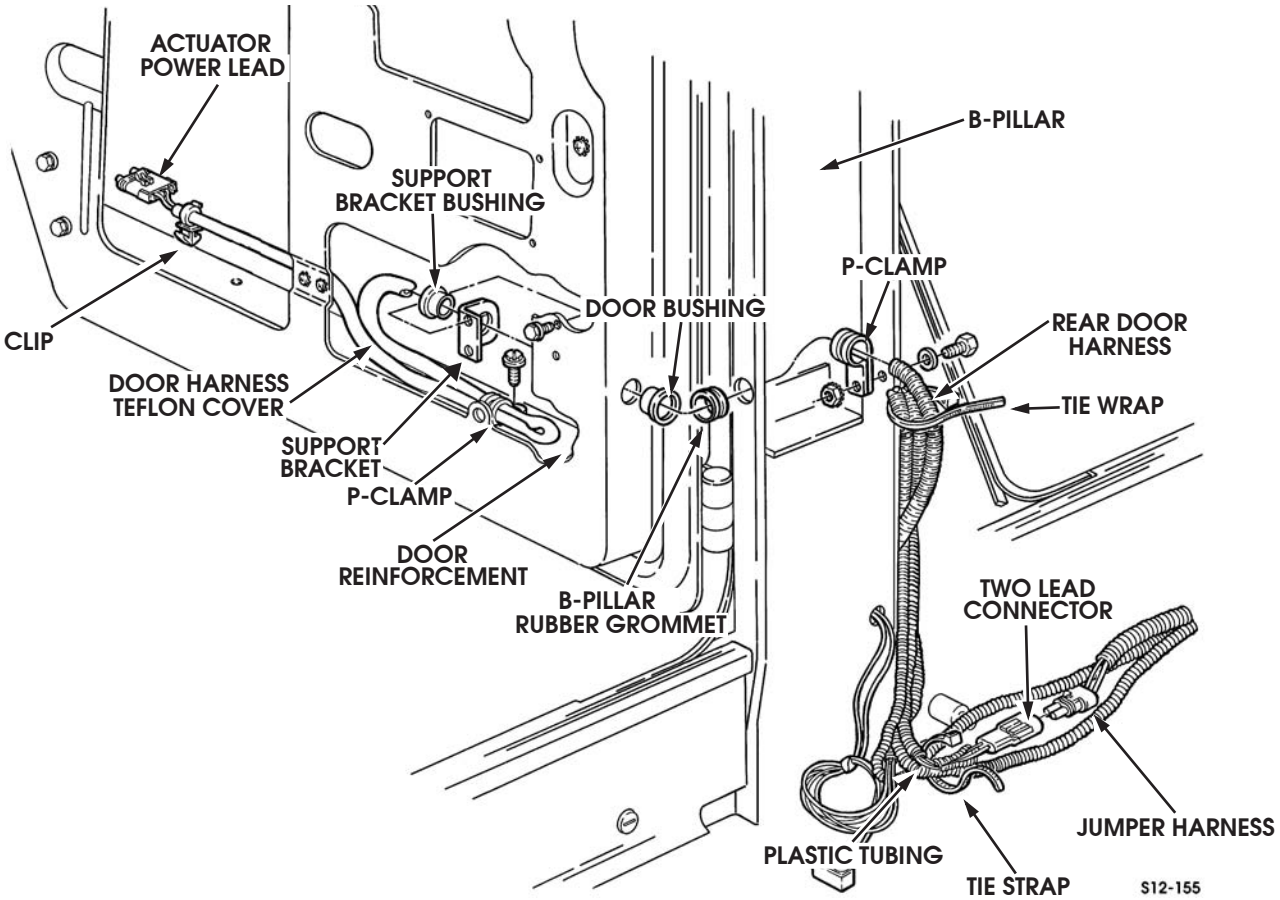


Figure 10-57: Door Harness Routing

POWER WINDOW AND DOOR LOCKS FRONT DOOR HARNESS REPLACEMENT

Removal

1. Remove the front outer kick panels (Refer to section 10).
2. Remove the front door trim, vapor barrier and the moisture barrier flap from the door (Refer to section 10).
3. Disconnect the two harness connectors from the power mirrors body harness connectors.
4. Remove the screw, nut, lock washer and the clamp securing the harness to the A-pillar. Discard the nut and the lock washer assembly
5. Remove the harness wires from the 4-way and the 6-way connectors.

NOTE: Lubricate the bushings, grommet and the harness teflon cover with silicone spray.

6. Pull the harness through the A-pillar rubber grommet.
7. Remove and inspect the A-pillar rubber grommet. Replace if damaged.
8. Disconnect the two harness connectors from the power mirrors door jumper harness connectors (Figure 10-58).
9. Remove the self-tapping screw and the clamp securing the harness to the door reinforcement (Figure 10-60).
10. Remove the two self-tapping screws and the harness mounting bracket from the door assembly.
11. Pull the harness through the door bushing.
12. Inspect the door bushing and replace if damaged.
13. Remove the harness mounting bracket and the mounting bracket bushing from the harness. Inspect the bushing and replace if damaged.
14. Disconnect the harness connector from the power window regulator (push the locking tab up on the bottom of the connector).
15. Disconnect the harness connector from the power door locks actuator.

16. Remove the retainer and the harness from the door assembly.

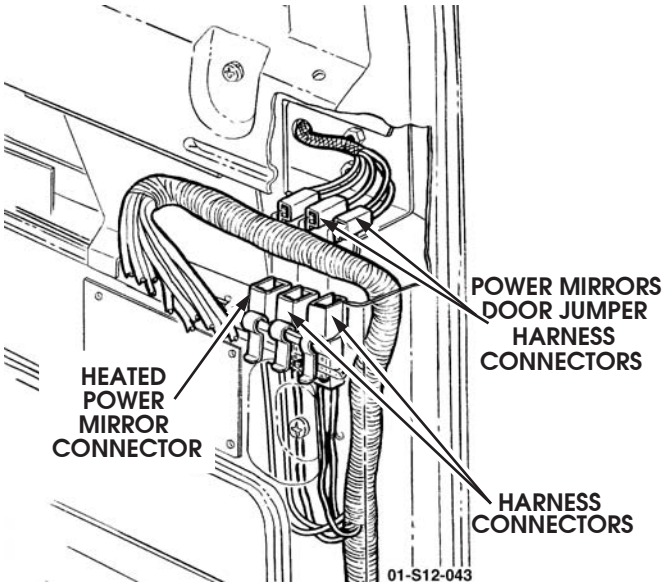


Figure 10-58: Heated Power Mirrors Door Harness

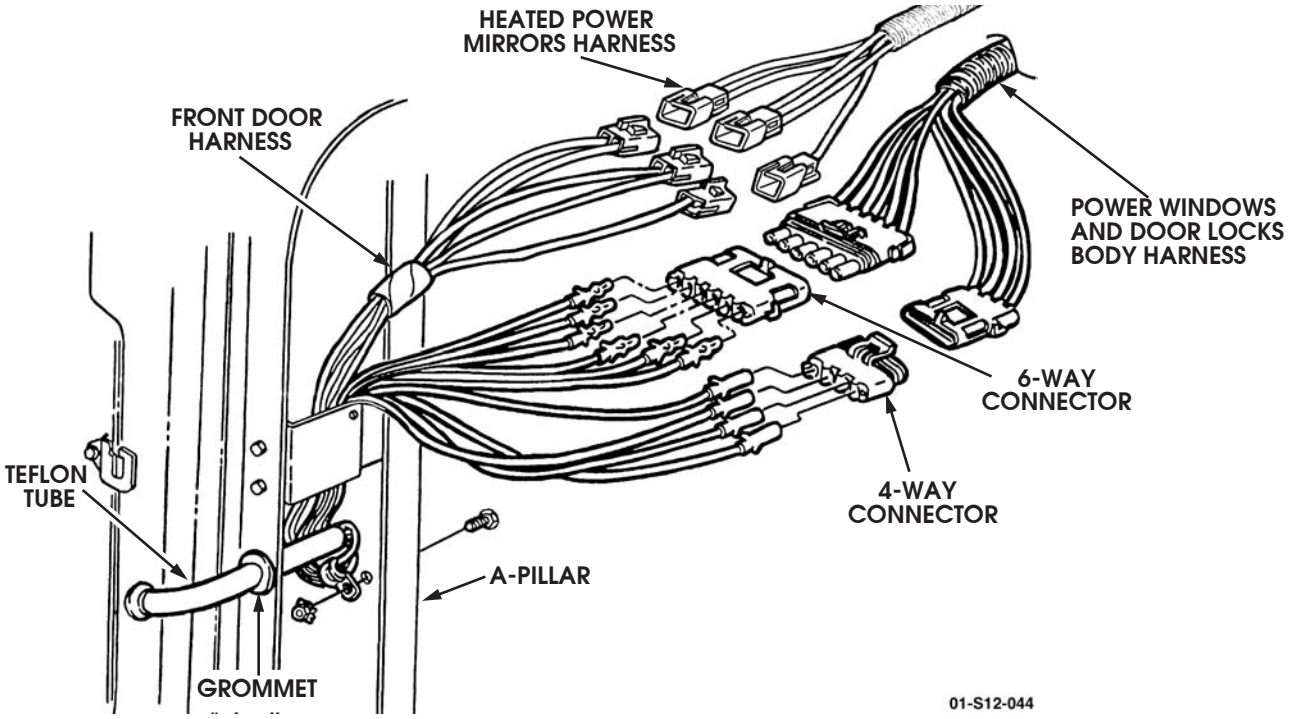


Figure 10-59: Power Windows and Door Locks Connections

Installation

NOTE: Lubricate the bushing, grommet and harness teflon cover with silicone spray.

1. Route the harness through the harness mounting bracket, mounting bracket bushing and the door bushing (Figure 10-60).
2. Install the harness mounting bracket on the door assembly with the two self-tapping screws (Figure 10-61).
3. Route the harness through the A-pillar rubber grommet (Figure 10-59).

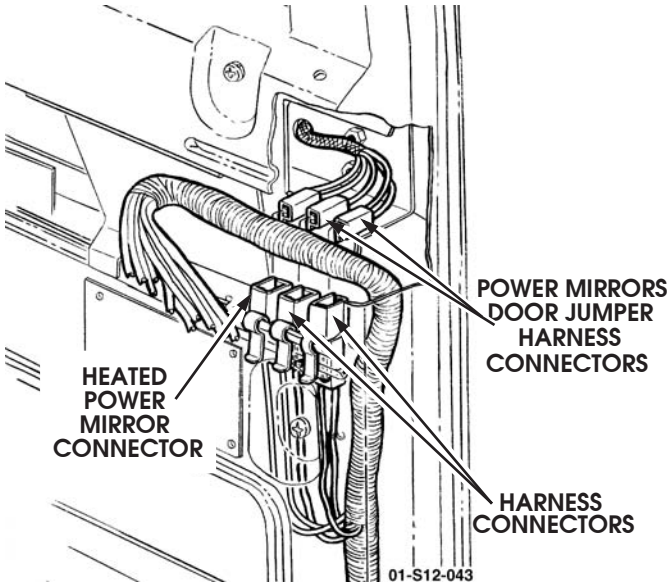


Figure 10-60: Heated Power Mirrors Door Harness

NOTE: When connecting the harness wires to the 4-way and 6-way connectors, ensure the wire colors align with the mating connector wires.

4. Connect the harness wires to the 4-way and the 6-way connectors.
5. Connect the 4-way and the 6-way harness connectors to the power windows and the door locks body harness connectors.
6. Connect the two harness connectors to the power mirrors body harness connectors.
7. Secure the harness to the A-pillar with the clamp, self-tapping screw, nut and the lock washer assembly.

NOTE: Be careful to match the wire colors, since the harness connectors can be interchanged.

8. Connect the two harness connectors to the power mirrors door jumper harness connectors (Figure 10-59).
9. Connect the harness connector to the power window regulator (Figure 10-61).
10. Connect the harness connector to the power door lock actuator.
11. Secure the harness to the door reinforcement with the clamp and the self-tapping screw.
12. Secure the harness to the door assembly with the retainer.
13. Install the moisture barrier flap, vapor barrier and the door trim panel on the door (Refer to section 10).
14. Install the front outer kick panels (Refer to section 10).
15. Connect the battery ground cable (Refer to section 12).
16. Check the power windows and the door locks for proper operation.

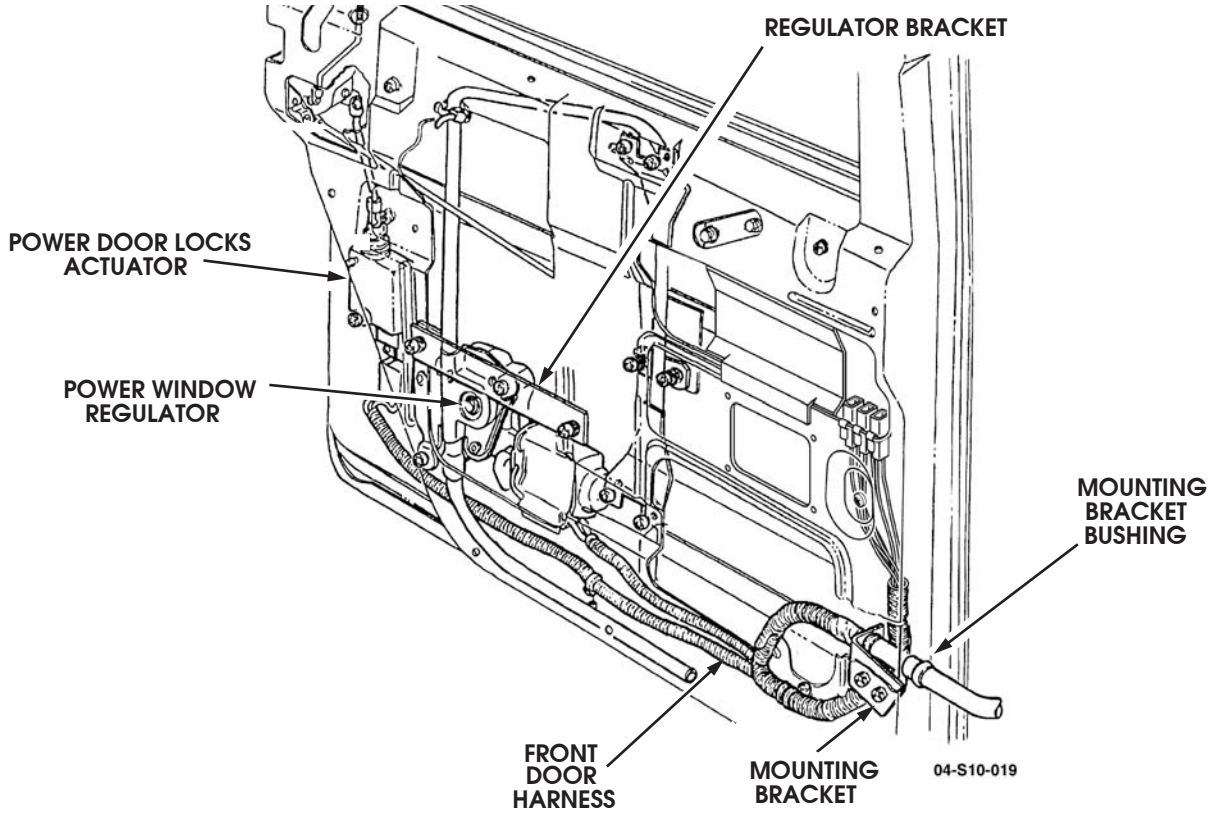


Figure 10-61: Power Windows and Door Locks Door Harness

POWER WINDOWS AND DOOR LOCKS REAR DOOR HARNESS REPLACEMENT

Removal

1. Remove the center outer kick panel and the lower B-pillar trim (Refer to section 10).
2. Remove the rear door trim, vapor barrier and the moisture barrier flap from the door (Refer to section 10).

NOTE: Tag the leads for installation.

3. Disconnect the 6-way harness connector from the power windows and the door locks rear door jumper harness connector (Figure 10-62).

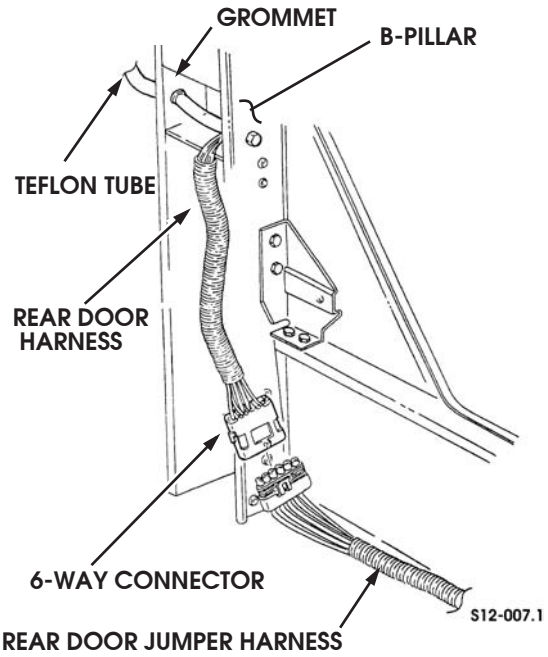


Figure 10-62: Rear Door Harness and Rear Door Jumper Harness

4. Remove the harness wires from the 6-way connector.
5. Remove the screw, nut, lock washer and the clamp securing the harness to the B-pillar. Discard the nut and the lock washer assembly.

NOTE: Lubricate the bushings, grommet and the harness teflon cover with silicone spray.

6. Pull the harness through the B-pillar rubber grommet.
7. Remove and inspect the B-pillar rubber grommet. Replace it if damaged.
8. Remove the two self-tapping screws and the harness mounting bracket from the door assembly (Figure 10-63).
9. Pull the harness through the door bushing.
10. Inspect the door bushing and replace it if damaged.
11. Remove the harness mounting bracket and the mounting bracket bushing from the harness. Inspect the bushing and replace it if damaged.
12. Remove the self-tapping screw and the clamp securing the harness to the door reinforcement.
13. Disconnect the harness connector from the power window regulator (push the locking tab up on the bottom of the connector).
14. Disconnect the harness connector from the power door lock actuator.
15. Remove the retainer securing the harness to the door assembly.
16. Remove the tie strap and the harness from the door assembly. Discard the tie strap.

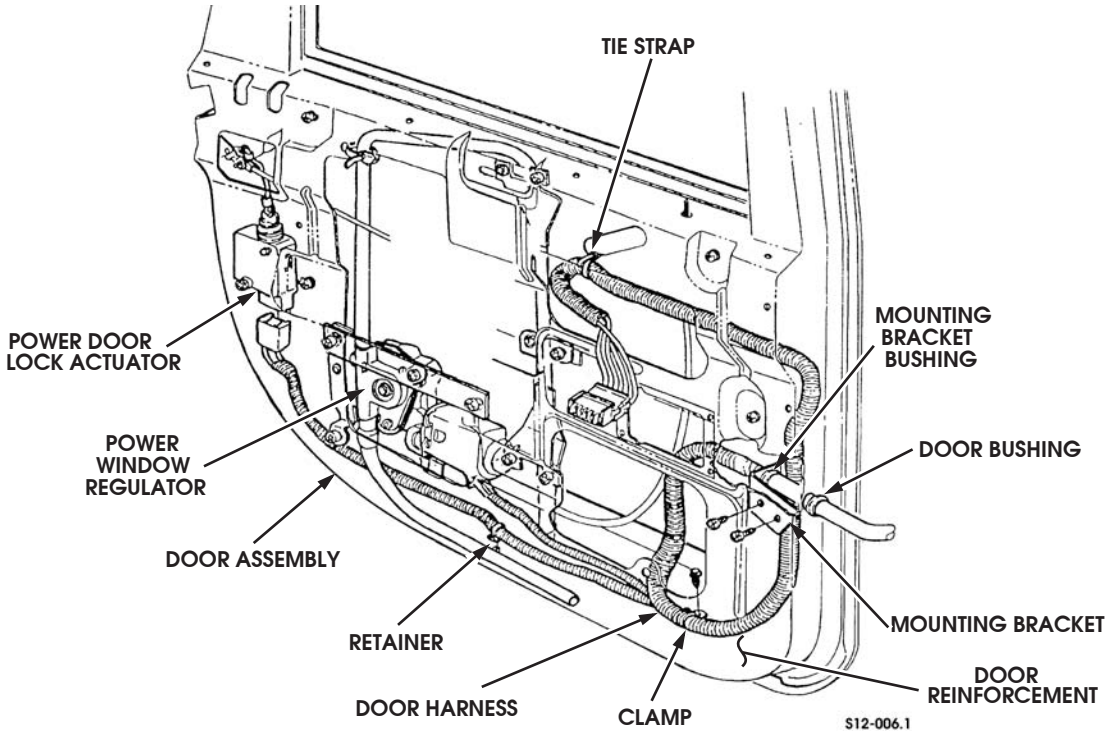


Figure 10-63: Rear Door Harness

Installation

NOTE: Lubricate the bushings, grommet and the harness teflon cover with silicone spray.

1. Route the harness through the harness mounting bracket, mounting bracket bushing and the door bushing (Figure 10-63).
2. Install the harness mounting bracket on the door assembly with the two self-tapping screws
3. Route the harness through the B-pillar rubber grommet (Figure 10-64).

NOTE: When connecting the harness wires to the 6-way connector, ensure the wire colors align with the mating connector wires.

4. Connect the harness wires to the 6-way connector.
5. Connect the 6-way harness connector to the power windows and the door locks rear door jumper harness connector (Figure 10-65).
6. Secure the harness to the B-pillar with the clamp, screw, nut and the lock washer assembly.

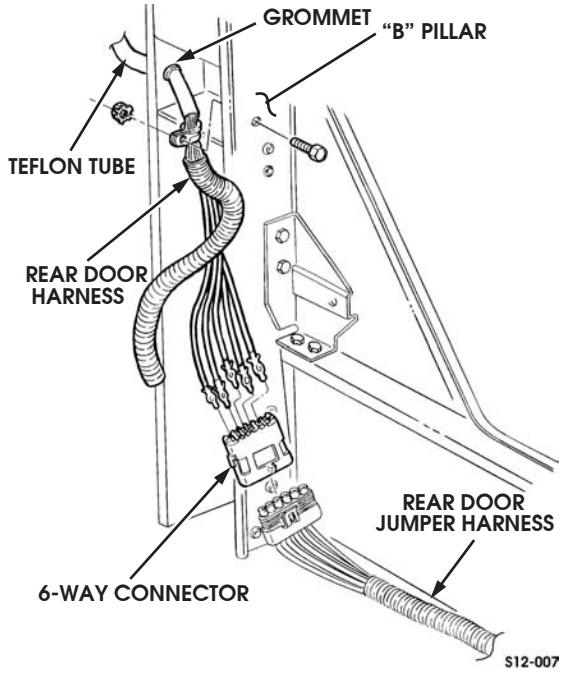


Figure 10-64: Rear Door Harness and Rear Door Jumper Harness

7. Connect the harness connector to the power window regulator (Figure 10-63).
8. Connect the harness connector to the power door lock actuator.
9. Secure the harness to the door reinforcement with the clamp and the self-tapping screw.
10. Secure the harness to the door assembly with the retainer.
11. Secure the harness to the door assembly with a tie strap.
12. Install the moisture barrier flap, vapor barrier and the door trim panel on the door (Refer to section 10).
13. Install the lower B-pillar trim and the center kick panel (Refer to section 10).
14. Connect the battery ground cable (Refer to section 12).
15. Check the power windows and the door locks for proper operation.

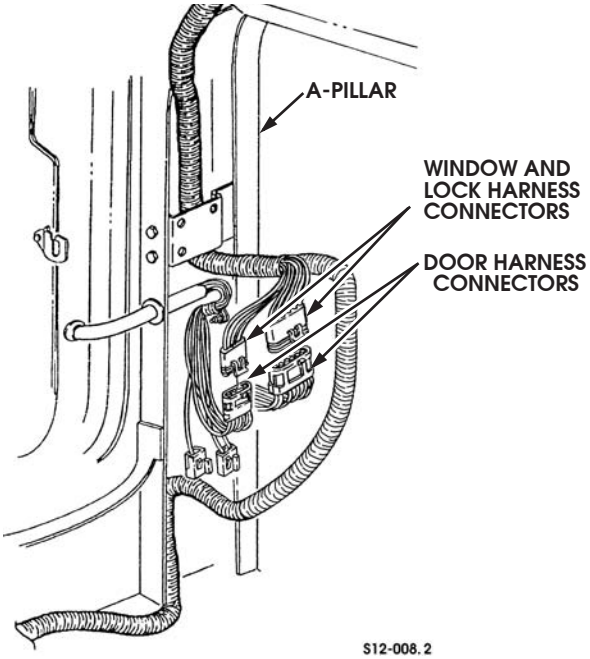


Figure 10-65: Door Harness Connectors

POWER WINDOWS

Power Window Regulator Replacement

Removal

NOTE: Operate the motor to position the glass in the opening to provide access to the two screws securing the glass and its bracket to the regulator. If the motor is inoperative, other means to remove these screws will be necessary such as drilling access holes in the door inner panel.

1. Remove the door trim and the vapor barrier.

CAUTION: *Support the window in the full up position during regulator removal to avoid damage.*

NOTE: Prior to removal, mark the location of the screws for installation.

2. Disconnect the power window and the door lock harness connector from the regulator motor (Figure 10-66) (push the locking tab up on the bottom of the connector).
3. Remove the two screws and the lock washers securing the regulator bracket to the door. Discard the lock washers.
4. Remove the screw, lock washer and the regulator bracket from the regulator. Discard the lock washers.
5. Remove the screw securing the regulator motor to the door.
6. Remove the four screws, lock washers, cable and the bracket assembly from the door. Discard the lock washers.
7. Remove the two screws, lock washers and the washers securing the regulator cable and the bracket assembly to the window bracket. Discard the lock washers.
8. Remove the tie strap and the regulator from the door. Discard the tie strap.

Installation

1. Install the regulator in the door and secure with a tie strap (Figure 10-66).
2. Secure the regulator cable and the bracket assembly to the window bracket with the two washers, lock washers and the screws.
3. Secure the regulator cable and the bracket assembly to the door with the four lock washers and the screws.
4. Secure the regulator motor to the door with the screw.
5. Install the regulator bracket on the door with the two lock washers and the screws.
6. Secure the regulator bracket to the regulator with the lock washer and the screw.
7. Connect the power window and the door lock harness connector to the regulator motor.
8. Check the operation of the regulator.
9. Install the door trim and the vapor barrier

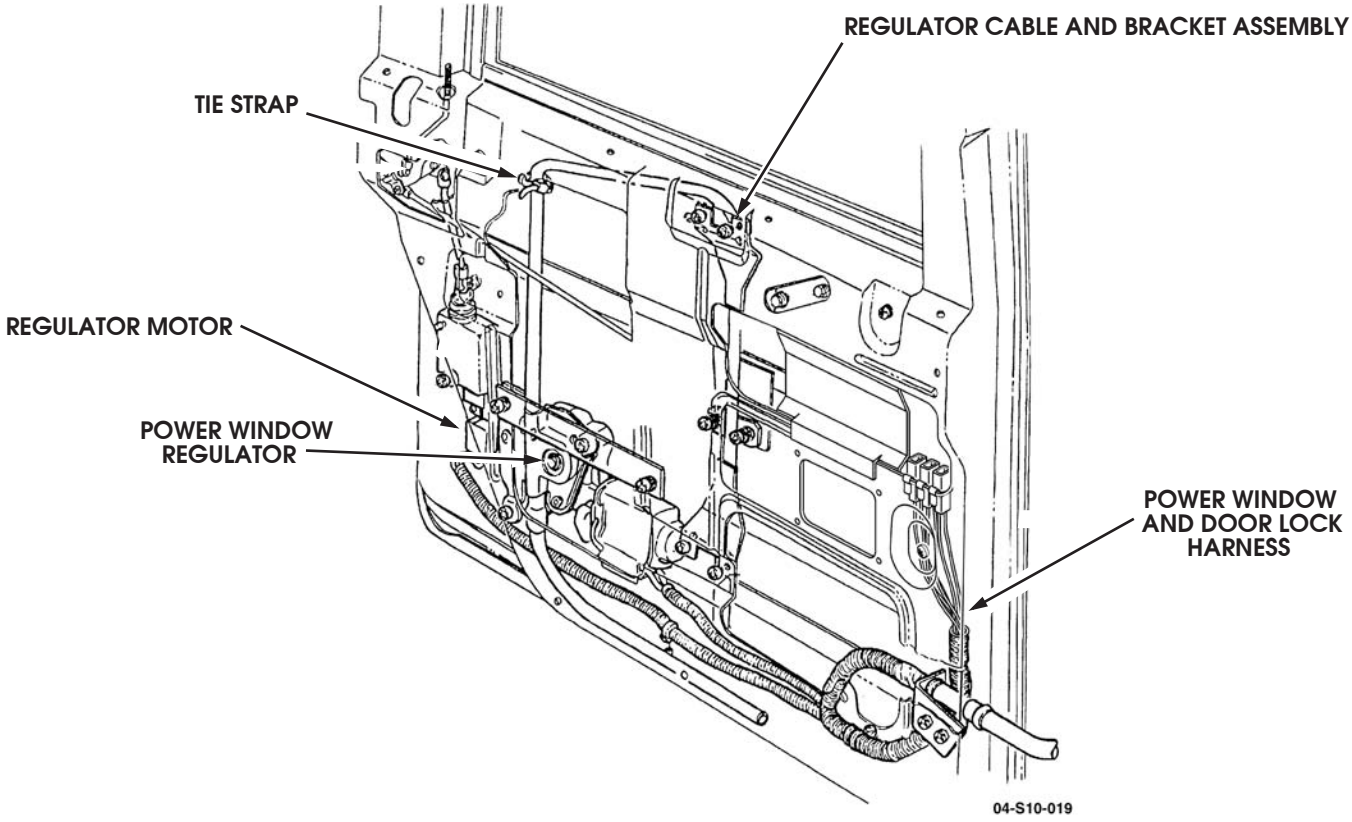


Figure 10-66: Power Window Regulator

DOOR SEALS REPLACEMENT

NOTE: The door seals come in bulk and must be cut to the appropriate lengths. For hard top vehicles, cut 12 feet for the doors and 10 feet for the body opening. For soft-top vehicles, cut 6 feet for the doors and 5 feet for the body opening.

Removal

NOTE: Note the position of the old seals before removal.

1. Remove the door strap so that the door will swing open far enough to access the seals (Figure 10-67).

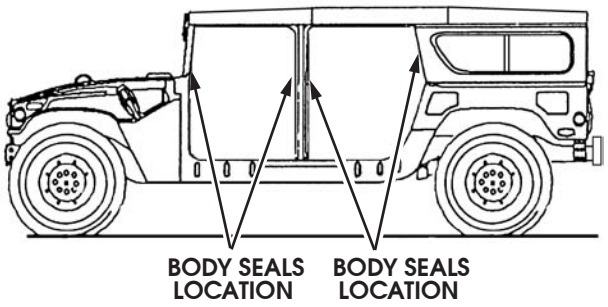


Figure 10-67: Body Seals Location

2. Remove the old seal from the door frame and the body area. Clean any remaining adhesive residue from the door surface.

Installation

1. Cut the door and the body seals to the proper lengths (see note above).
2. Beginning at the bottom of the door, press the door seal around the outside of the door frame (Figure 10-68).

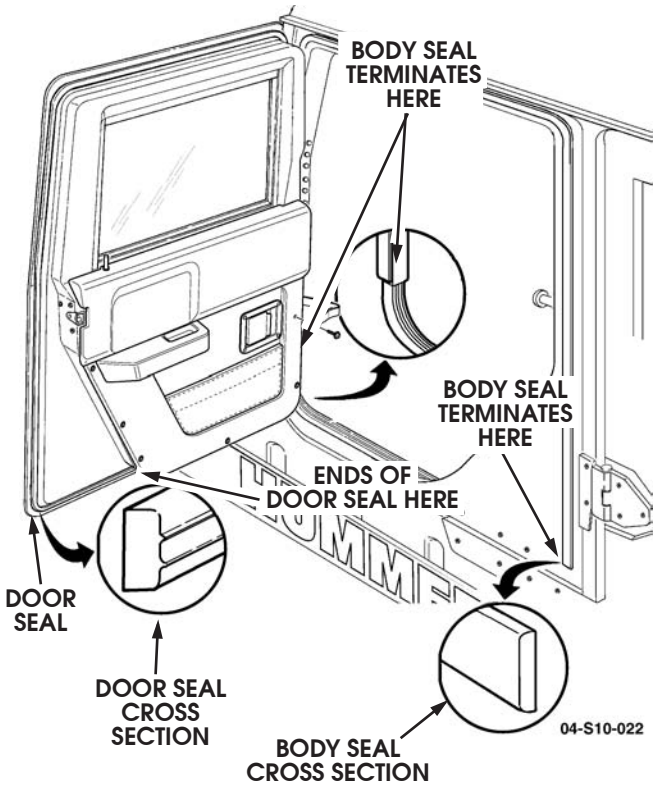


Figure 10-68: Door and Body Seal Replacement

3. Apply the body seal in the same location as the seal that was removed.
4. Install the door strap.

DOOR STOP STRAP ASSEMBLY REPLACEMENT

Removal

1. Remove the bolt, washer and the door stop strap assembly from the door (Figure 10-69).
2. Remove the two bolts, washers, door stop strap assembly and the courtesy light from the A-pillar (**front door only**).
3. Remove the bolt, washer and the door stop strap assembly from the B-pillar (**rear door only**).

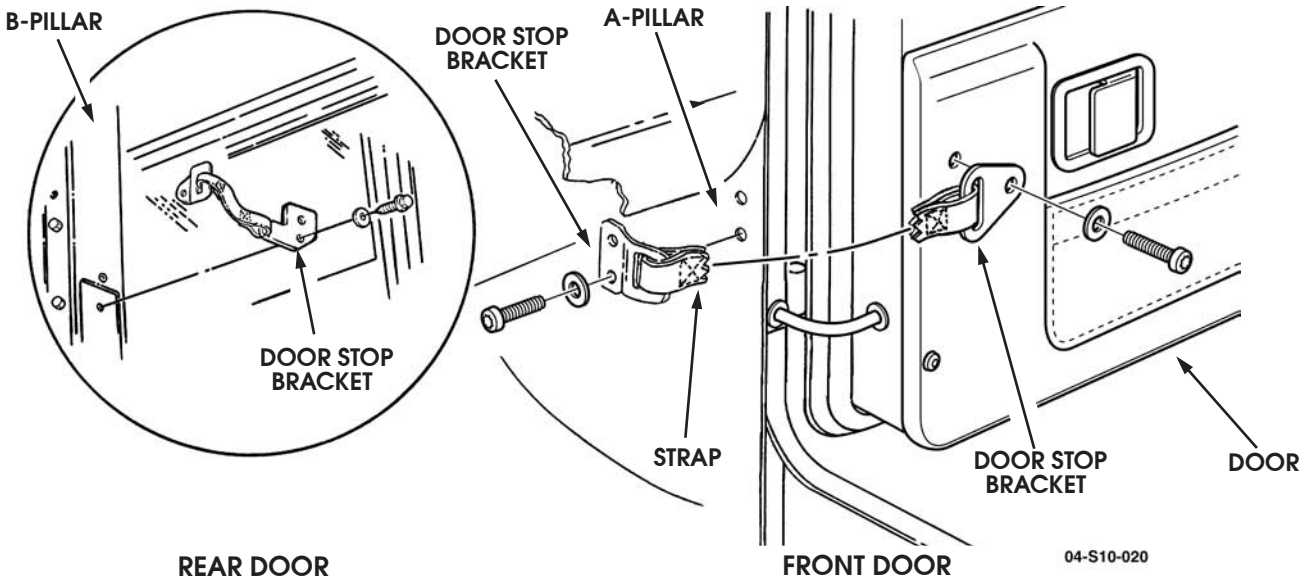


Figure 10-69: Door Stop Strap Assembly

Installation

1. Secure the door stop strap assembly to the door with the washer and the bolt. Tighten the bolt to 12 lb-ft (16 N•m) (Figure 10-69).
2. Secure courtesy light and door stop strap assembly to A-pillar with two washers and bolts. Tighten bolts to 12 lb-ft (16 N•m) (**front door only**).
3. Secure the door stop strap assembly to the B-pillar with the two washers and the bolts. Tighten the bolts to 78 lb-ft (106 N•m) (**rear door only**).

DOOR GLASS REPLACEMENT

NOTE: Door glass replacement is the same for all of the doors. This procedure covers the right front door.

Removal

1. Remove the window regulator.
2. Remove the beltline seal (Figure 10-70).

NOTE: Mark the location of the screws prior to removal for installation.

3. Remove the four screws, lock washers, front and rear channels and the door window seals from the door.
4. Rotate the glass/lift channel bracket assembly 90 degrees and remove through the window opening.

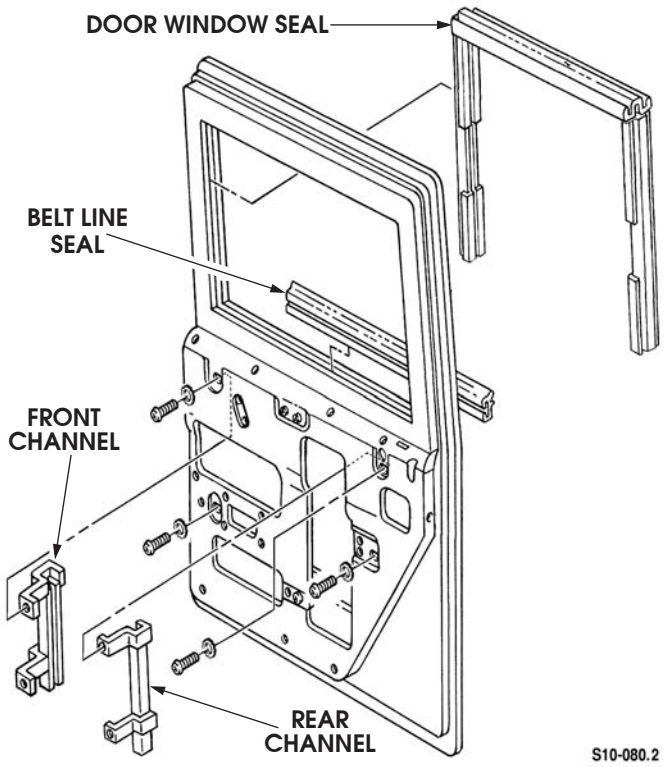


Figure 10-70: Window Channel Locations

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage and replace if necessary.

Remove all the glass remains from the channels and the bottom of the door (Figures 10-70 and 10-71).

Installation

1. Insert the glass/lower channel bracket assembly into the door through the window opening at 90° from the installed position.
2. Rotate the glass/lower channel bracket assembly so that it is aligned with the appropriate channels (Figure 10-71)

3. Install the glass in the front and rear channels and the channel brackets and secure the channels and the channel brackets to the door with the four lock washers and the screws (Figure 10-70).
4. Install the upper and the lower window channels.
5. Install the window regulator.
6. Operate the window several times to ensure the glass is properly aligned.

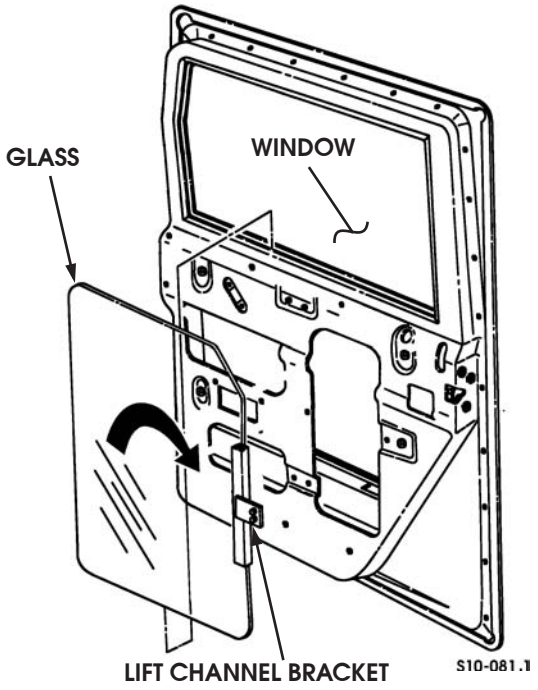


Figure 10-71: Glass/Lift Channel Bracket

WINDOW SEAL REPLACEMENT

Removal

1. Lower the window fully, remove and set aside for later use, both the inner and outer beltline seals (Figure 10-72).
2. Pull the top of the door window seal down and out of the seal channel, cut the front and rear legs at the beltline and remove the door window seal.
3. Remove the armrest, door strap, door trim panel and pull the vapor barrier down far enough to gain access to the mounting screws for the removable seal channels.
4. Raise the glass, remove the armrest mount plate and the removable seal channels containing the remainder of the original door window seal legs. Discard the seal pieces and lower the glass.

Installation

NOTE: The long leg of the door window seal is installed toward the front of the vehicle on the front doors and toward the rear of the vehicle on the rear doors. Do not lubricate the upper seal area, lubricant will affect the pressure-sensitive adhesive.

1. Sparingly lubricate the door window seal legs with dish soap (or equivalent) and insert in the door while maintaining alignment with the glass and the seal channel (Figure 10-72).
2. Install one of the upper corners of the seal in the door channel before removing the protective backing strip on the pressure-sensitive adhesive. This procedure will allow the corner to be fully seated before the pressure-sensitive adhesive contacts the upper channel. Premature adhesive contact could make it difficult to move the seal into place. Remove the protective backing strip and place the remainder of the seal in the channels.
3. Install the removable seal channels, lightly snug the channels to the glass and tighten the mounting screws.

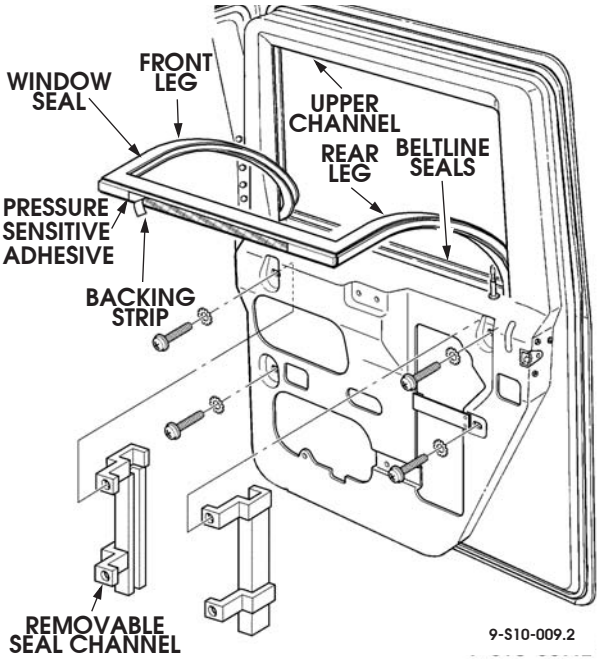


Figure 10-72: Window Seal Installation

4. Install both beltline seals.
5. Check the window for free operation and close the window completely to ensure proper adhesion of the pressure-sensitive adhesive to the upper seal channel. Also check the glass for proper, even alignment just before the window is closed. Adjust as necessary to ensure even pressure and a good seal.
6. With the window in the closed position, use a piece of notebook paper to check the seal-to-glass interface at the front and rear legs (Figure 10-73). This check and subsequent adjustment will preclude the possibility of wind noise caused by gaps at the interface. If the paper cannot be inserted between the seal and the glass, or if it can be inserted but resistance is felt, adjustment of the fixed seal channel is probably not necessary. If the paper slides between the seal and the glass loosely, the following adjustment procedure should be performed. Most wind noise can be eliminated by adjusting (tightening) the seal-to-glass interface. Excessive interface tightening could cause the window to have excess drag and open or close too slowly.

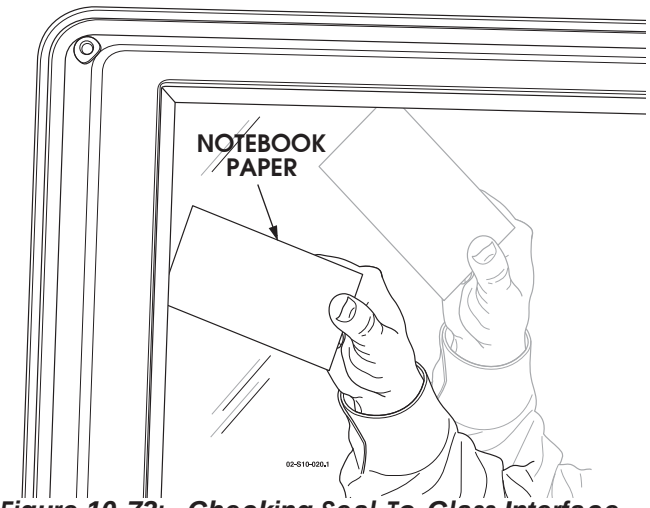


Figure 10-73: Checking Seal-To-Glass Interface

CAUTION: *Apply masking tape to the jaws of the locking pliers to ensure that the pliers do not mar the surface of the seal during channel adjustment.*

7. The fixed seal channels can be adjusted to obtain the proper seal-to-glass interface using 3″ wide jaw locking pliers (commonly used for sheet metal work) with masking tape applied to the jaws (Figure 10-74). Adjust the locking pliers so they can be clamped on the window seal with just enough force to grip without falling off the seal. Adjust the pliers tighter by one

full turn on the adjusting screw as a start point and squeeze the seal in the areas that measured loose with the paper check. Recheck the interface with the paper (Figure 10-73) and continue to squeeze, if necessary, until the desired interface is obtained.

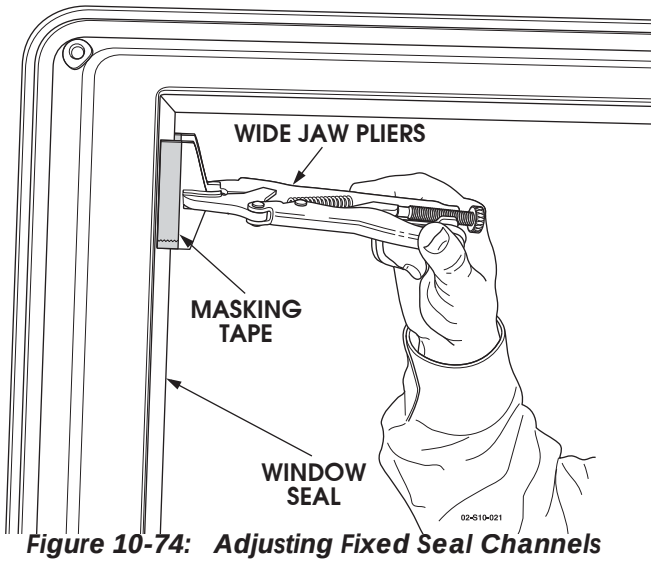


Figure 10-74: Adjusting Fixed Seal Channels

8. Install the armrest mount plate, the vapor barrier, the door trim panel, the door strap and the armrest.

Door Glass "Wind Noise" Diagnosis and Repair/Side Window Alignment

Wind noise or whistle generating from the side windows at highway speeds is the result of inadequate sealing of the glass at the upper seal. The glass must be properly aligned in the window opening, adjust door glass as follows:.

1. Loosen, but do not remove, the lift channel bracket mounting bolts.
2. Place a block of wood (or equivalent symmetrical object) across the upper seal of the window opening.
3. Roll the window up so that the glass contacts the block of wood and squares itself on the window opening.
4. Tighten the lift channel bracket mounting bolts.
5. Verify proper window operation

HOOD, HOOD LATCH AND PROP ROD

Hood Latch and Bracket Replacement

Removal

NOTE: If only the rubber latch is to be replaced, the spring pin does not have to be completely out of the base.

1. Remove the spring pin, limiter straps and the rubber isolator from the base (Figure 10-75).
2. Remove the two bolts and the base from the body.
3. Remove the four bolts, latch bracket, latch plate, hood latch stop bracket and the bolt tapping plate from the hood. (Figure 10-75).

Disassembly

Remove the cotter pin, latch pin, spring pin, two rollers, two limiter straps and the hood latch from the rubber isolator (Figure 10-75).

Assembly

Secure the hood latch and the limiter straps to the rubber isolator with the two rollers, latch pin and the cotter pin (Figure 10-75).

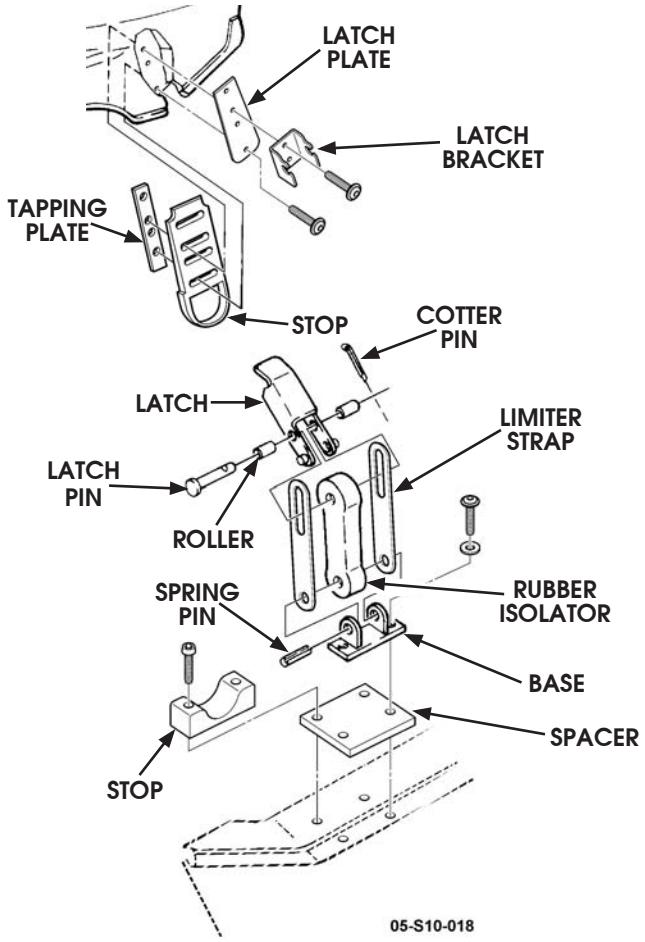


Figure 10-75: Hood Latch Replacement

Installation

1. Secure the latch bracket, latch plate and the hood latch stop bracket to the hood with the four bolts and the bolt tapping plate. Tighten the bolts to 10 lb-ft (14 N•m) (Figure 10-75).

NOTE: If base plate or stop plate on passenger side or spacer on drivers side were removed a sealer must be applied to prevent water intrusion into the cabin compartment.

2. Apply a sealing compound to the bottom of the base before securing the base to the body with the two bolts. Tighten the bolts to 6 lb-ft (8 N•m) (Figure 10-75).
3. Secure the rubber isolator and limiter straps to the base with the spring pin.

HOOD RELEASE CABLE ASSEMBLY REPLACEMENT

Removal

1. Raise and secure the hood.
2. Remove the cable handle, two nuts, lockwasher, nut and the cable assembly from the cable mounting bracket.
3. Remove the cable assembly from the cable clamp bracket (Figure 10-77).
4. Remove the cable assembly and the grommet from the body.
5. Remove the lock pin from the cable assembly.

Installation

1. Install the lock pin on the cable assembly (Figure 10-77).
2. Secure the cable assembly to the cable clamp bracket.

3. Secure the cable assembly to the cable mounting bracket with the nut, lockwasher, two nuts and the cable handle (Figure 10-76).
4. Install the grommet and the cable assembly on the body and apply sealer around the cable and the grommet.
5. Lower the hood.

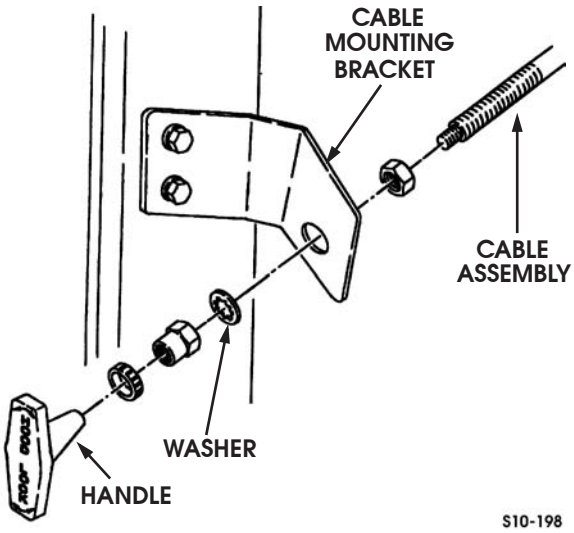


Figure 10-76: Hood Release Handle Assembly Mounting

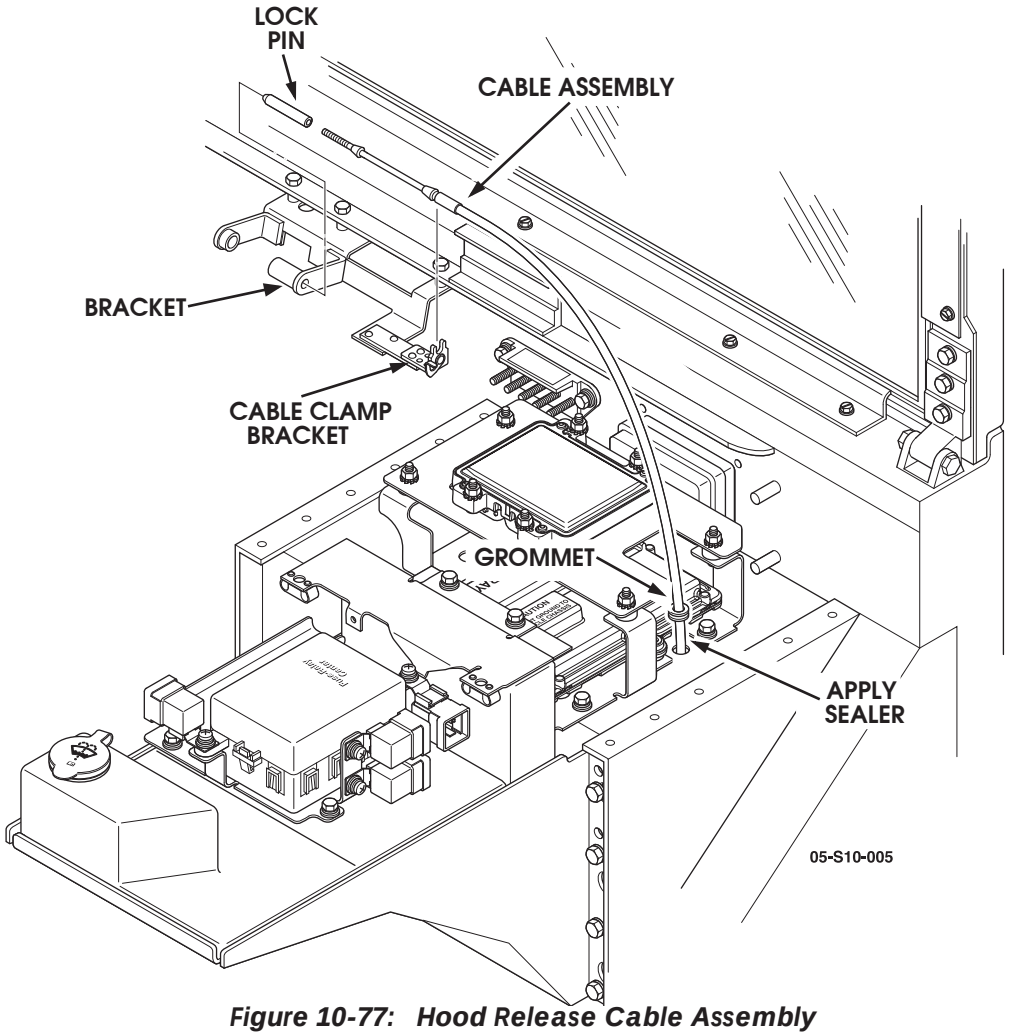


Figure 10-77: Hood Release Cable Assembly

Hood Release Latch and Bracket Assembly Replacement

Removal

1. Raise and secure the hood.
2. Remove the two bolts, lockwashers and the latch assembly from the hood (Figure 10-78).
3. Remove the pin, spring and the lock arm from the latch assembly (Figure 10-79).
4. Remove the cable assembly from the cable clamp bracket (Figure 10-77).
5. Remove the three nuts, lockwashers, bolts and the bracket assembly from the body.
6. Remove the two nuts and the lockwasher assemblies, screws and the cable clamp bracket from the bracket assembly.

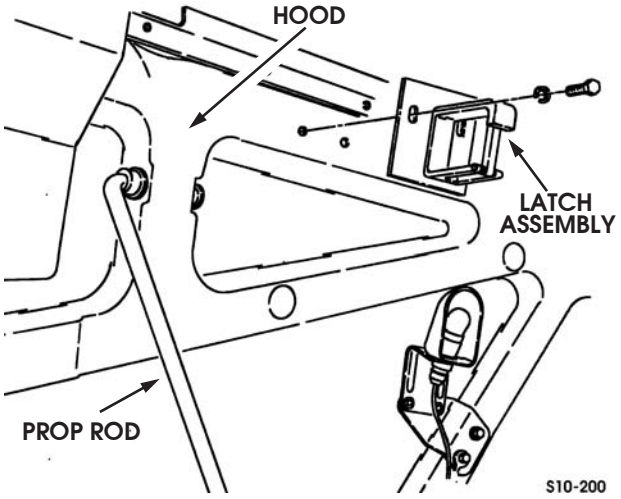


Figure 10-78: Hood Release Latch and Bracket Assembly Mounting

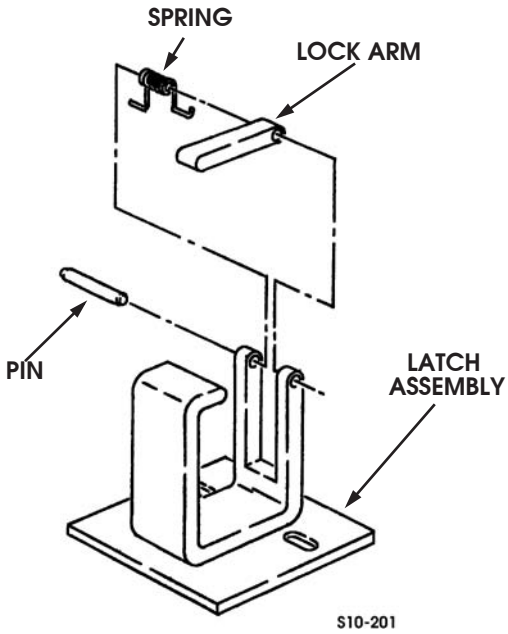


Figure 10-79: Latch Assembly Breakdown

Installation

1. Secure the cable clamp bracket to the bracket assembly with the two screws, nut and the lockwasher assemblies.
2. Secure the bracket assembly to the body with the three bolts, lockwashers and the nuts.
3. Secure the cable assembly to the cable clamp bracket. Seal the grommet with a silicone sealer (Figure 10-77).

4. Secure the spring and the lock arm to the latch assembly with the pin (Figure 10-79).
5. Secure the latch assembly to the hood with the two lockwashers and the bolts (Figure 10-78).
6. Lower the hood.

Hood Prop Rod and Bracket Replacement

Removal

WARNING: To avoid injury or damage to equipment, support the hood during the hood prop rod and the bracket replacement.

1. Raise and support the hood.
2. Remove the cotter pin, two washers and the hood prop rod from the hood (Figure 10-80).
3. Remove the four screws, lockwashers, bracket and the hood prop rod from the airlift bracket (Figure 10-81).

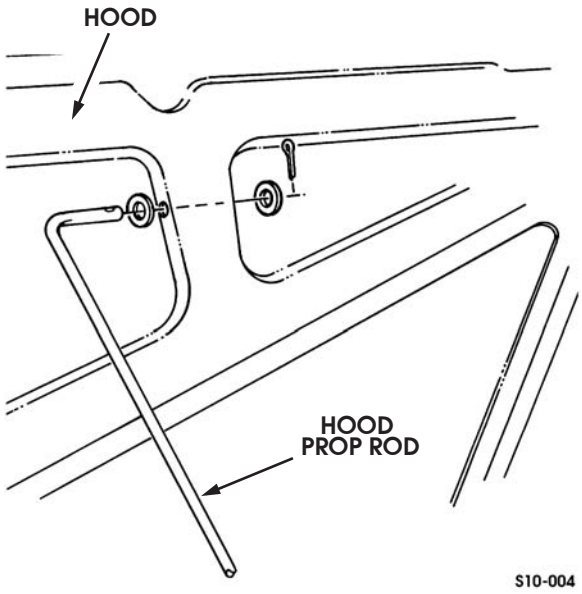


Figure 10-80: Hood Prop Rod Replacement

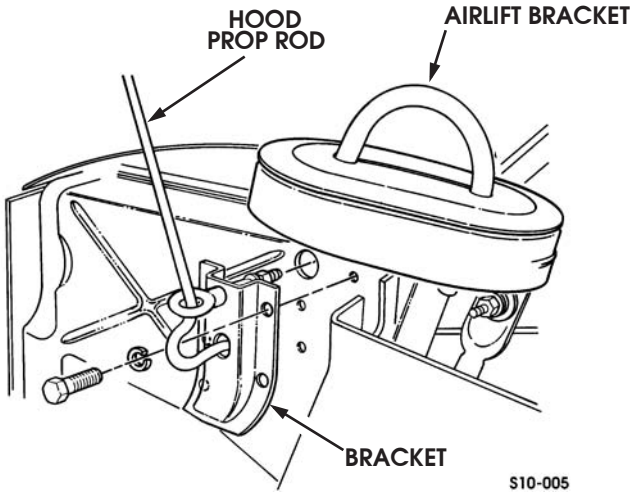


Figure 10-81: Hood Prop Rod and Bracket Replacement

Disassembly

1. Remove the hood prop rod from the eyebolt (Figure 10-82).
2. Remove the locknut, washer, bushing, spring, snapring, bushing, washer and the eyebolt from the bracket.

Cleaning and Inspection

NOTE: Clean all the components, and examine for wear or damage. Replace if necessary.

Inspect the two bushings and the spring for cracks, wear or distortion (Figure 10-82).

Assembly

1. Secure the bushing to the bracket with the snapring (Figure 10-82).

NOTE: The length of the spring with the bracket assembled is 2-1/4 in. (5.7 cm).

2. Secure the washer, eyebolt, spring, bushing, washer and the locknut to the bracket.
3. Install the hood prop rod into the eyebolt.

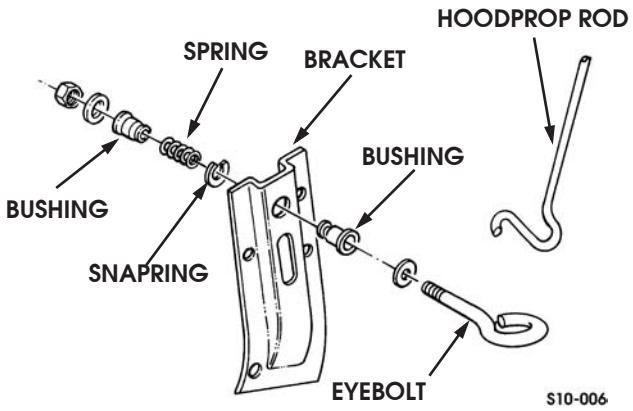


Figure 10-82: Hood Prop Rod and Bracket Assembly Breakdown

Installation

1. Secure the hood prop rod and the bracket to the airlift bracket with the four lockwashers and the screws. Tighten the screws to 6 lb-ft (8 N•m) (Figure 10-81).
2. Secure the hood prop rod to the hood with the two washers and the cotter pin (Figure 10-80).
3. Lower the hood.

Hood and Hinge Replacement

Removal

1. Raise and secure the hood.

WARNING: To avoid injury, or damage to equipment, support the hood during removal and installation.

2. Remove the P-clamp securing the hood harness to the splash shield bracket and disconnect the two electrical connectors.
3. Remove the two cotter pins, two washers and the hinge pin securing the upper hinge half to the lower hinge half.
4. Remove the cotter pin, two washers and the prop rod from the hood (Figure 10-83).
5. Remove the hood.

NOTE: Perform steps 6 and 7 if replacing hinges.

6. Remove the six bolts, washers, locknuts and the two upper hinge halves, from the hood (Figure 10-83).
7. Remove the four locknuts, washers, bolts, washers and the lower hinge.

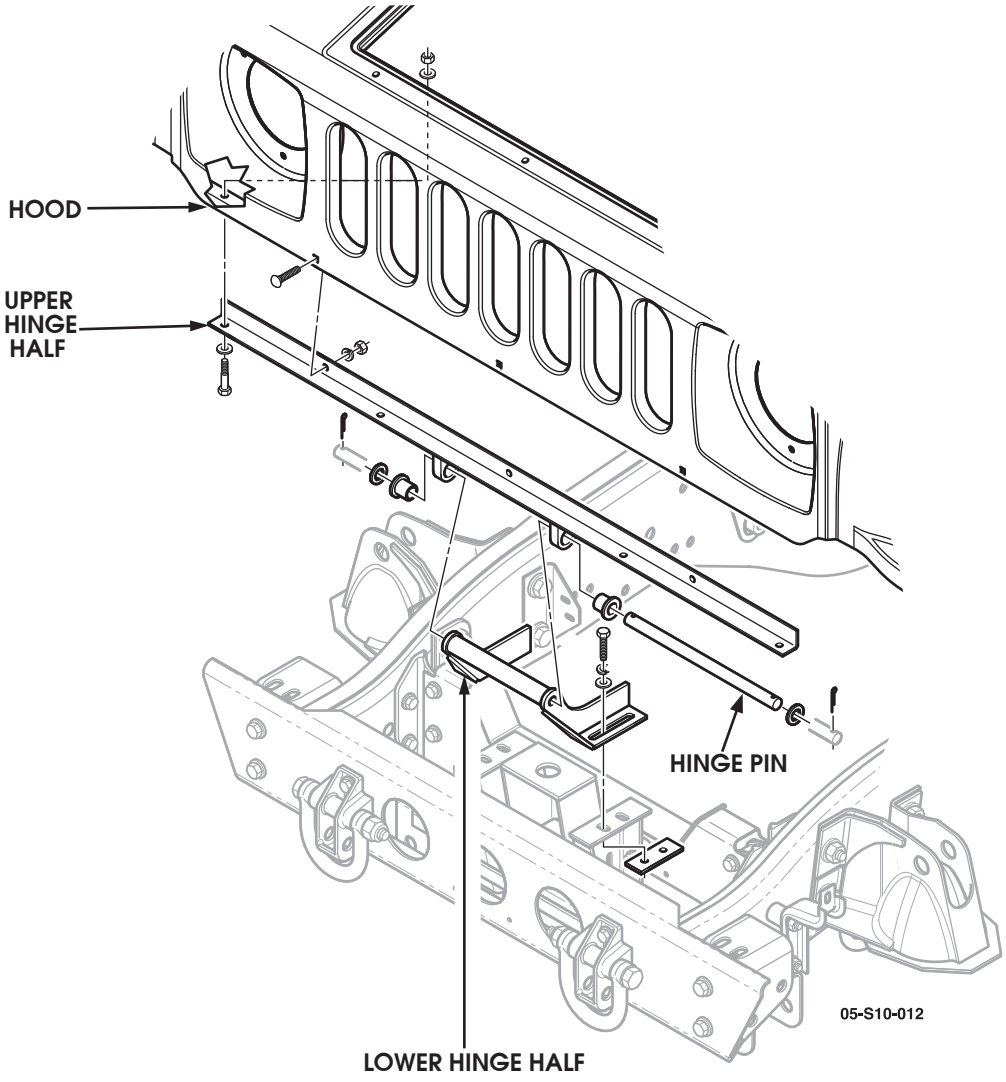


Figure 10-83: Hood and Hinge Assembly Breakdown

Inspection and Repair

NOTE: Refer to Fiberglass Repair for inspection and repair of the hood.

Installation

NOTE: Perform steps 1 and 2 if the hinges were removed.

1. Secure the lower hinge half to the support bracket with the four washers, bolts, washers and the locknuts. Do not tighten the bolts (Figure 10-83).
2. Secure the upper hinge half to the hood with the six bolts, washers and the locknuts. Tighten the bolts to 28 lb-ft (38 N•m).
3. Install the hood by mating the upper hinge half to the lower hinge half and securing with the washers, hinge pins, washers and the two cotter pins.
4. Connect the two electrical connectors and install the P-clamp securing the hood harness to the splash shield.
5. Secure the hood prop rod to the hood with the two washers and the cotter pin (Figure 10-83).
6. Align the hood and tighten the lower hinge half bolts to 28 lb-ft (38 N•m).
7. Check the headlight aim and adjust if necessary.

Hood Alignment

Alignment should be checked whenever replacing the hood stops, hinges or latches. Surfaces that adjoin hood seals should be checked for signs of wear from hood movement.

1. Inspect the hood prior to adjustment to determine the condition of the seals, hinges and the stops. Replace or repair any worn parts.

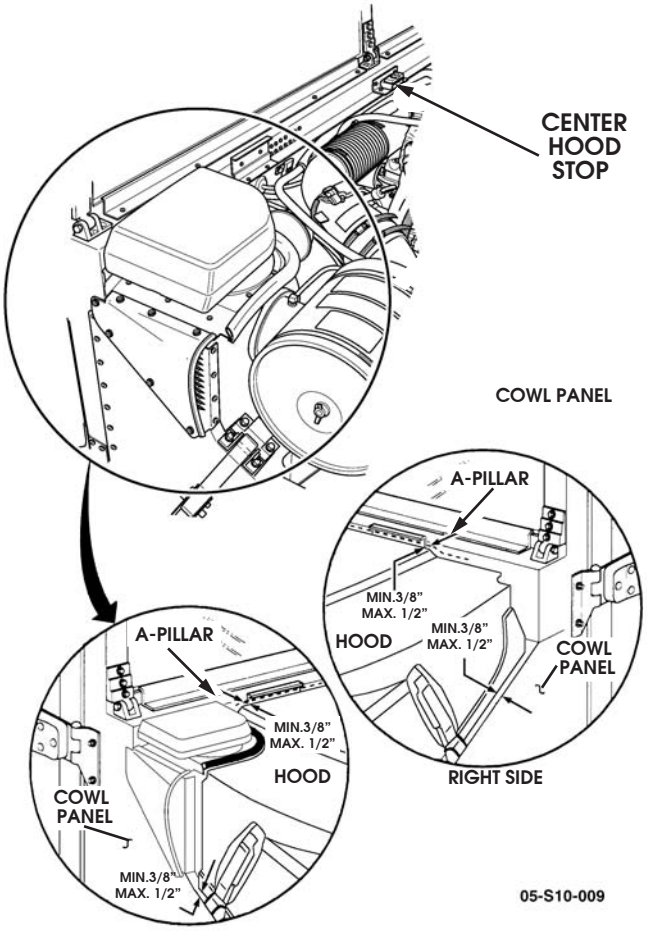


Figure 10-84: Hood Alignment Specifications

2. Open the hood and loosen the center hood stop (Figure 10-84).
3. Gently close the hood and loosen the lower hinge half locknuts.
4. Gently position the hood to obtain the proper and an even clearance with the A-pillar and both of the front cowl panels (minimum 3/8" / maximum 1/2") (Figure 10-84).
5. Tighten the lower hinge half locknuts to the lock adjustment. Open the hood gently and position the guide bracket assembly to contact the center hood stop. Gently close the hood to check the guide bracket assembly position (Figures 10-84 and 10-85).
6. Tighten and recheck the guide bracket assembly position. When properly positioned, tighten to 10 lb-ft (14 N•m) (Figure 10-85).
7. Tighten the front lower hinge half locknuts to 28 lb-ft (38 N•m) and recheck the hood position.

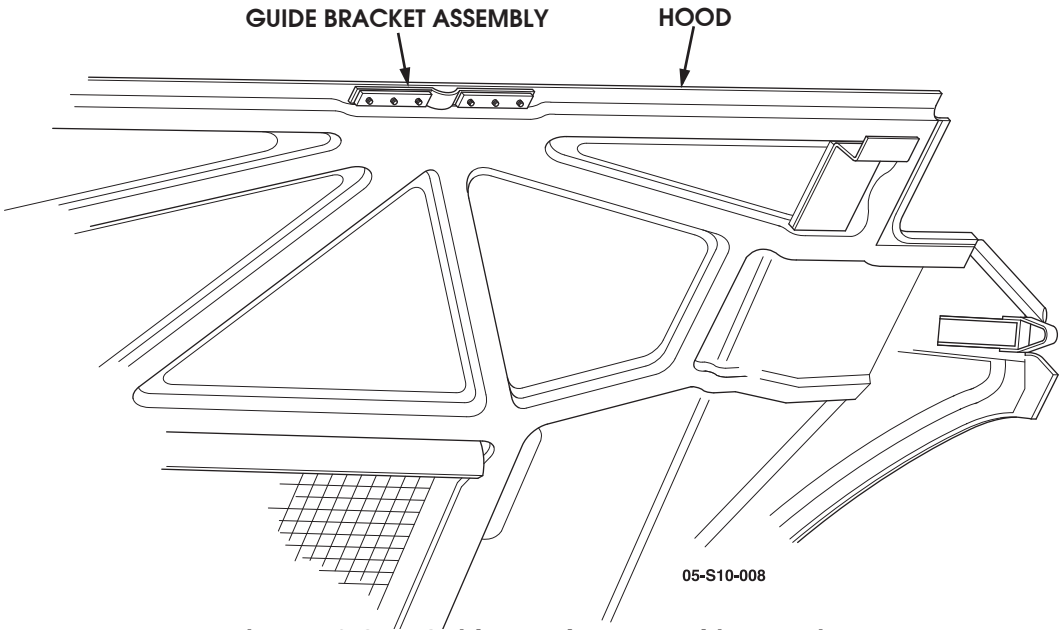


Figure 10-85: Guide Bracket Assembly Location

8. Lubricate all the hood stops, hinges and the guide brackets. Latch the hood.
9. Test drive to ensure proper alignment (no squeaks).
10. Check the headlight aim and adjust it if necessary.

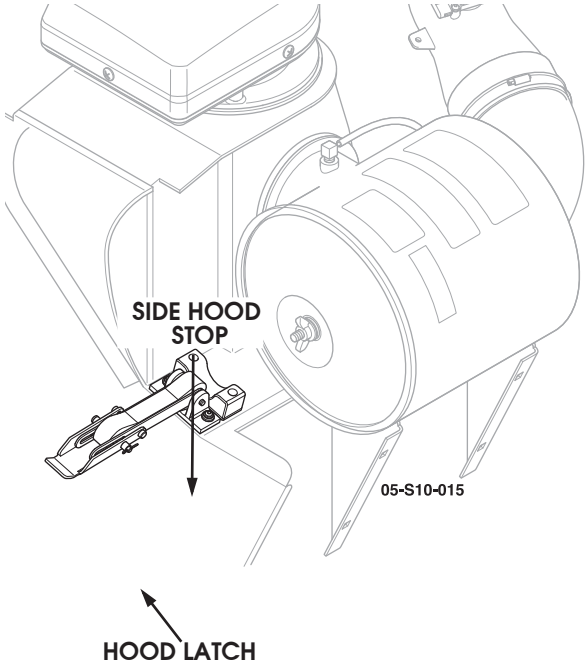


Figure 10-86: Hood Latch and Stop Location

Side Hood Stop Replacement

Removal

Remove the two bolts, washers and the side hood stop from the body (Figure 10-86).

Installation

Apply a silicone sealer to the bottom and secure the side hood stop to the body with the two washers and bolts. Tighten the bolts to 6 lb-ft (8 N•m) (Figure 10-86).

Grille and Screen Replacement

Removal

1. Remove the six locknuts, washers, bolts, washers and the grille from the hood (Figure 10-87).
2. Remove the six locknuts, washers, screws, washers and the screen from grille.

Installation

1. Secure the screen to the grille with the six washers, screws, washers and the locknuts. Tighten the locknuts to 6 lb-ft (8 N•m) (Figure 10-87).
2. Secure the grille to the hood with the six washers, screws, washers and the locknuts. Tighten the locknuts to 7 lb-ft (9 N•m).

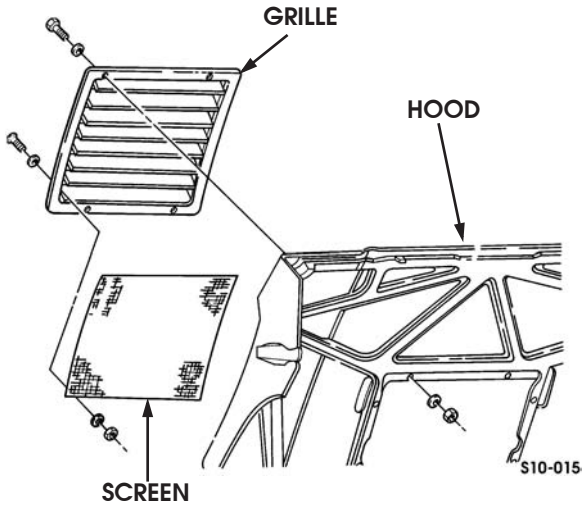


Figure 10-87: Grille and Screen Replacement

Center Hood Stop Replacement

Removal

Remove the two bolts, washers, center hood stop and the plate from the A-beam (Figure 10-88).

Installation

Secure the center hood stop and the plate to the A-beam with the two washers and the bolts. Tighten the bolts to 12 lb-ft (16 N•m) (Figure 10-88).

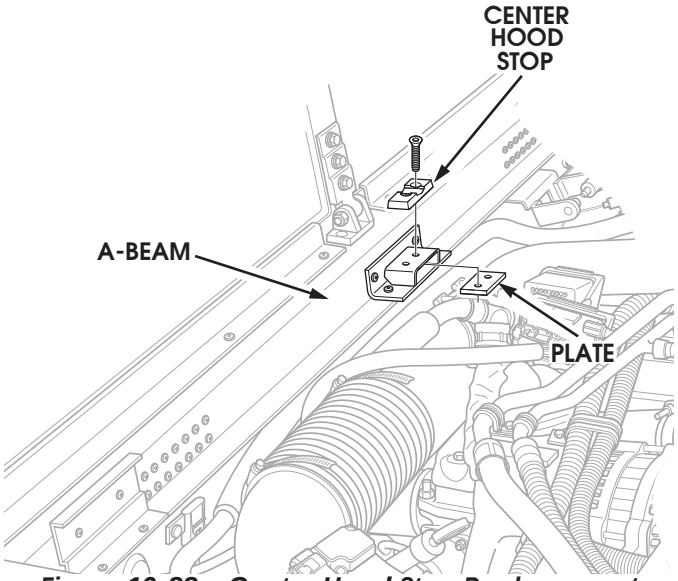


Figure 10-88: Center Hood Stop Replacement

Guide Bracket Assembly Replacement

Removal

Remove the six locknuts, twelve washers, guide bracket assembly, two guide plates and the six bolts from the hood (Figure 10-89).

Installation

1. Loosely attach the guide plate and the guide bracket assembly to the hood with the six bolts, twelve washers and the six locknuts. Tighten the locknuts to 10 lb-ft (14 N•m) (Figure 10-89).
2. Lower the hood and align the guide bracket assembly with the center hood stop on the A-beam (Figure 10-88).
3. Mark the guide bracket assembly position, raise the hood and tighten the locknuts to 10 lb-ft (14 N•m) (Figure 10-89).

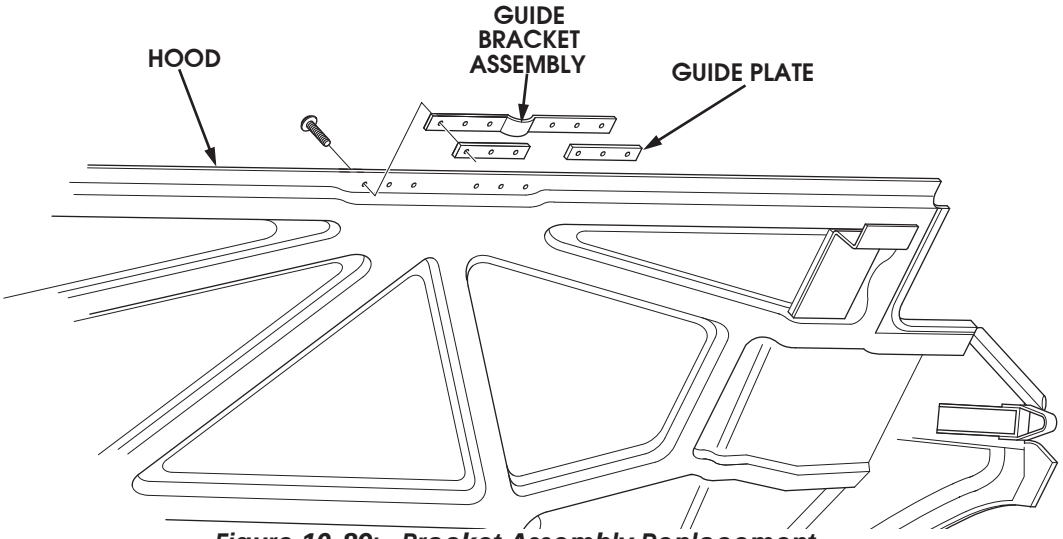


Figure 10-89: Bracket Assembly Replacement

Front Hood Screen Replacement

Removal

1. Remove the three locknuts, washers and the carriage bolts securing the front hood screen to the hood (Figure 10-90).
2. Remove the three bolts, harness clamps, washers and the front hood screen from the hood.

Installation

1. Secure the front hood screen to the hood with the three washers, harness clamps and the bolts. Tighten the bolts to 20-30 lb in. (2-3 N•m) (Figure 10-90).
2. Secure the front hood screen to the hood with the three carriage bolts, washers and the locknuts. Tighten the locknuts to 21 lb-ft (29 N•m).

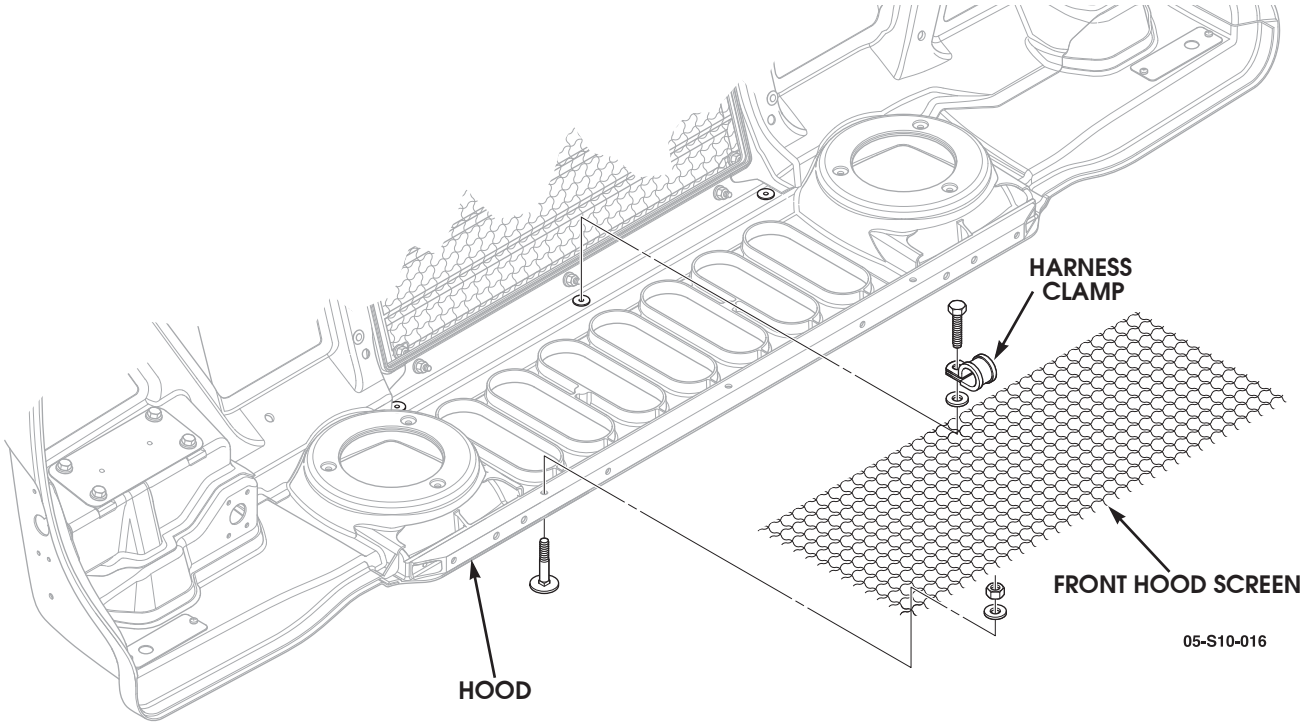


Figure 10-90: Front Hood Screen Replacement

Right Hood Retainer Bracket Replacement

Removal

Remove the four bolts, lockwashers, washers, right hood retainer bracket and the spacer from the hood (Figure 10-91).

Installation

Secure the right hood retainer bracket and the spacer to the hood with the four washers, lockwashers and the bolts (Figure 10-91).

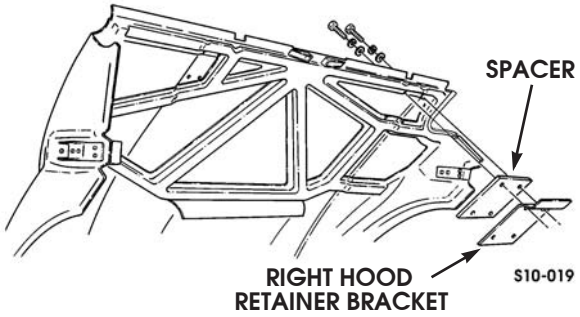


Figure 10-91: Right Hood Retainer Bracket Replacement

Left Hood Retainer Bracket Replacement

Removal

Remove the four bolts, lockwashers, washers, left hood retainer bracket and the four washers from the hood (Figure 10-92).

Installation

Install the left hood retainer bracket on the hood with the eight washers, four lockwashers and the bolts (Figure 10-92).

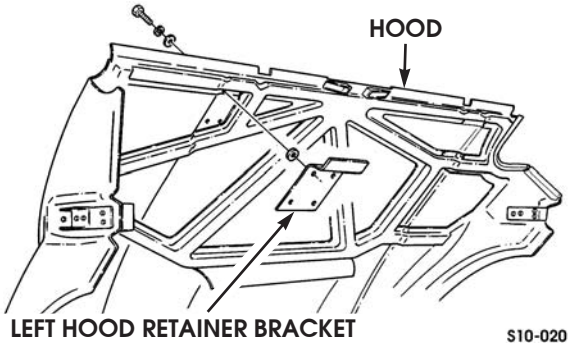


Figure 10-92: Left Hood Retainer Bracket

ENGINE SPLASH SHIELD REPLACEMENT

Removal

WARNING: To avoid injury or damage to equipment, raise and support hood during removal and installation.

NOTE: This section covers the left engine splash shield, the right splash shield is part of the battery box and is detailed in section twelve.

1. Disconnect the fluid level sensor connector on the brake master cylinder.
2. Remove the hood prop rod and the bracket (Refer to section 10).
3. Remove the three locknuts, washers, bolts and the washer securing the splash shield to the support brackets and remove splash shield.

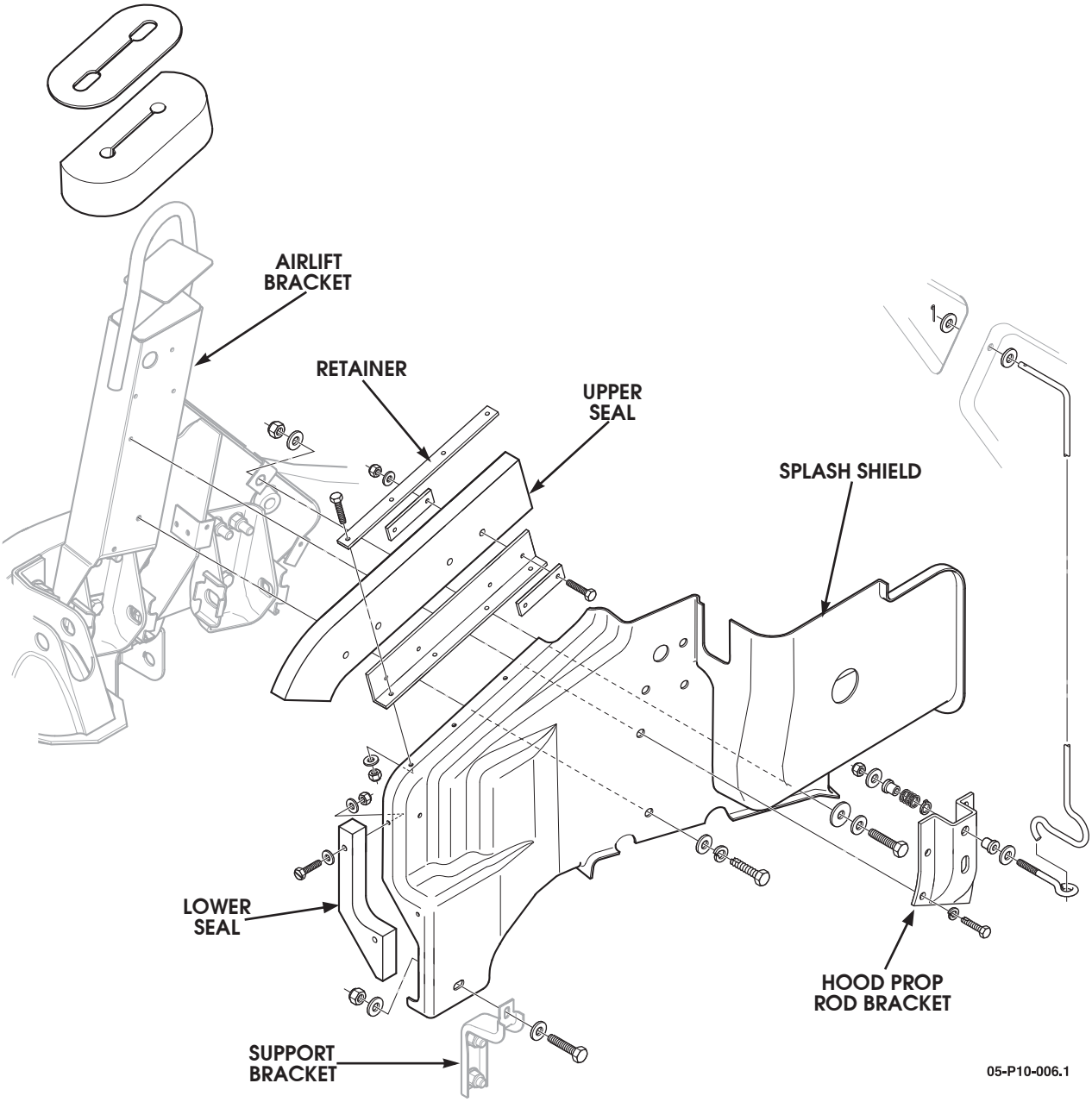


Figure 10-93: Engine (Left) Splash Shield Assembly Replacement

Disassembly

1. Remove the four locknuts, washers, bolts, upper seal and the retainer from the splash shield (Figure 10-93).
2. Remove the two locknuts, washers, bolts and the lower seal from the splash shield (Figure 10-93).

Assembly

1. Secure the upper seal and the retainer to the splash shield with the four locknuts, washers and the bolts.
2. Secure the lower seal to the splash shield with the two locknuts, washers and the bolts.

Installation

1. Secure the splash shield to the support bracket with the three locknuts, washers, bolts and the washer (Figure 10-93). Tighten the bolts to 10 lb-ft (14 N•m).
2. Install the hood prop rod and the bracket.
3. Connect the fluid level sensor connector to the brake master cylinder.

WINDSHIELD ASSEMBLY

Windshield Glass and Weatherstrip Replacement

Removal

1. Remove the windshield wiper arm and the blade.
2. Remove the six bolts and the upper retainer from the windshield frame (Figure 10-94).
3. Remove the four bolts and the center retainer from the windshield frame.
4. Remove the four bolts and the lower retainer.
5. Remove the weatherstrip and the glass from the windshield frame.
6. Clean the sealing compound from the windshield frame.

Installation

1. Apply a 1/8 in. (3 mm) bead of sealing compound to the edge of the glass and the windshield frame (Figure 10-94).
2. Position the weatherstrip on the glass.
3. Position the glass and the weatherstrip to the windshield frame with the center retainer and the four bolts.
4. Secure the upper retainer to the windshield frame with the six bolts.
5. Secure the lower retainer to the windshield frame with the four bolts
6. Apply a thin bead of sealing compound to the top edge of the outside weatherstrip.
7. Install the windshield wiper arm and the blade.

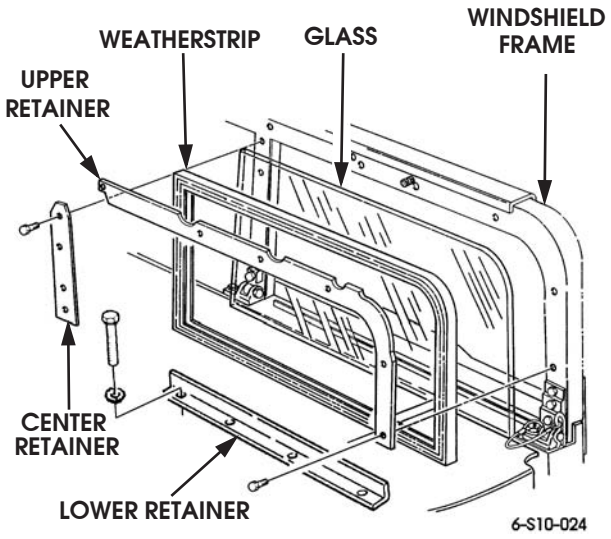


Figure 10-94: Windshield Glass Replacement

Windshield Assembly Replacement

WARNING: To avoid injury or damage to equipment, support windshield during removal and installation.

Removal

1. Remove the soft top or loosen the roof assembly, as applicable.
2. Remove the windshield wiper blade and the arm.
3. Remove the windshield wiper linkage.
4. Remove the windshield wiper arm pivots.
5. Remove the two locknuts and the bolts securing the windshield assembly to the A-pillar (Figure 10-95).

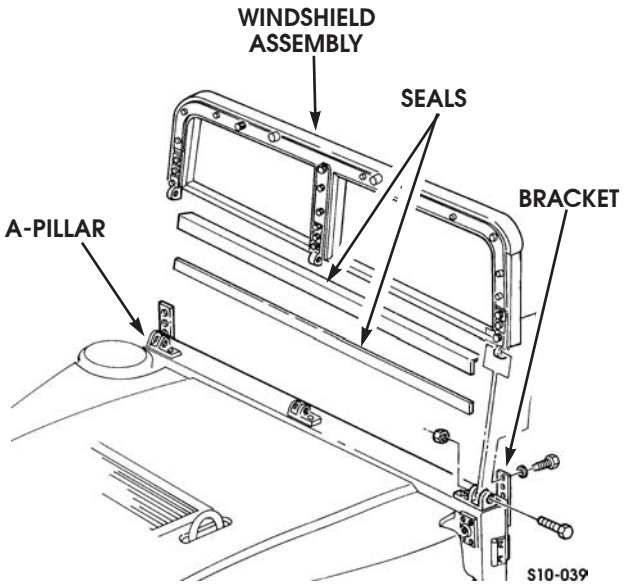


Figure 10-95: Windshield Assembly Mounting

6. Disconnect the roof harness, wiper motor, heated windshield, clearance light and the compass mirror connections at the center pillar and pull the harness loose from the windshield center pillar (Figure 10-96).
7. Remove the six bolts and the washers securing the windshield assembly to the two brackets (Figure 10-95).
8. Remove the windshield assembly from the A-pillar.
9. Remove the two seals from the windshield assembly.
10. Clean the remains of the seals from the windshield.

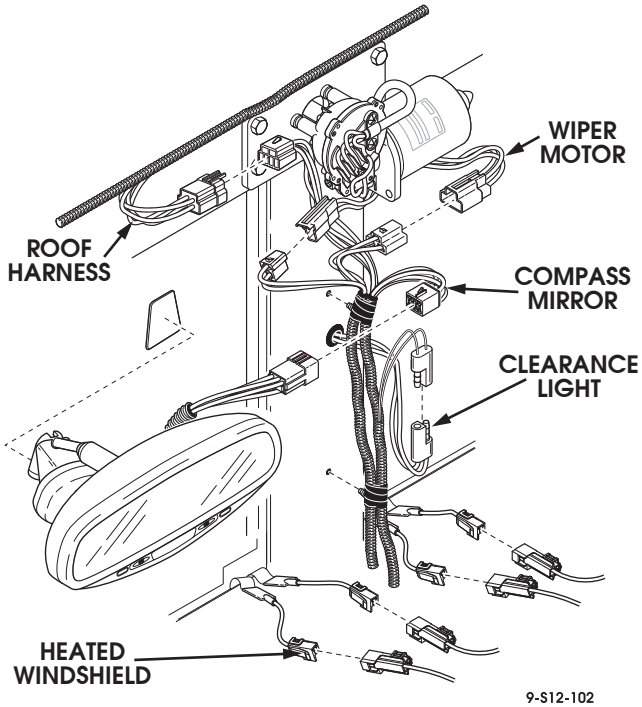


Figure 10-96: Wiring Harness Lead Location

Disassembly

NOTE: Perform steps 1 and 2 for model 90. Perform step 3 for all other models.

1. Remove the eleven rivets, former and the seal from the windshield assembly (Figure 10-97).
2. Remove the eight rivets and the two corner caps from the windshield assembly and replace it if damaged.
3. Remove the thirteen rivets, former and the seal from the windshield assembly (Figure 10-97).
4. Clean the remains of the seal from the windshield assembly.

Assembly

NOTE: Perform steps 1 and 2 for model 90. Perform step 3 for all other models.

1. Secure the seal and the former to the windshield assembly with the eleven rivets (Figure 10-97).
2. Secure the two corner caps to the windshield assembly with the eight rivets.
3. Secure the seal and the former to the windshield assembly and secure with the thirteen rivets (Figure 10-97).

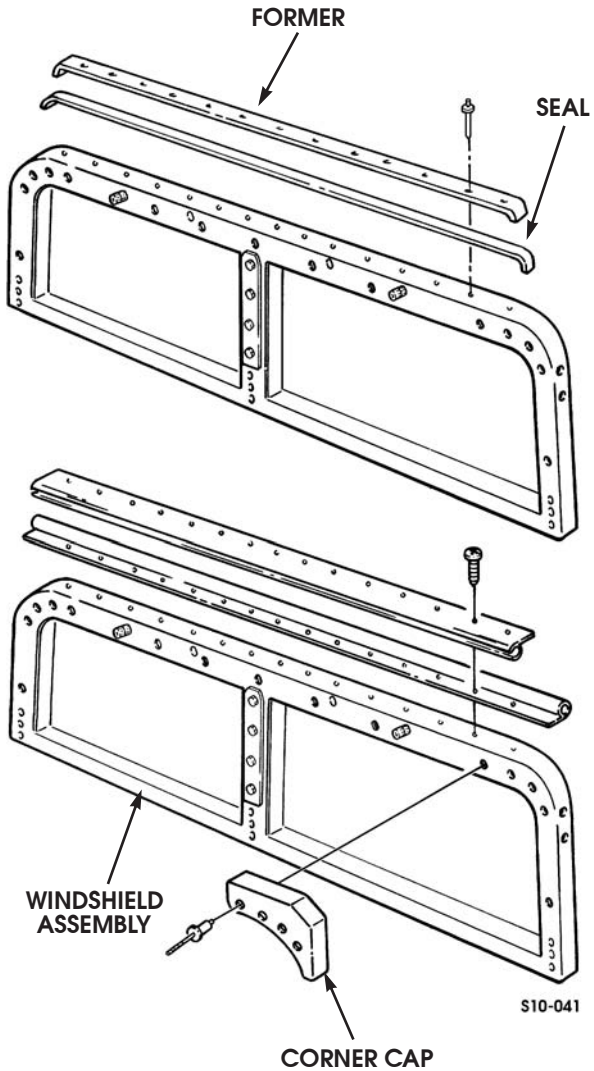


Figure 10-97: Windshield Assembly Seal Replacement

Installation

1. Position the two seals on the windshield assembly (Figure 10-95).
2. Position the windshield assembly over the A-pillar.

3. Secure the windshield assembly to the two brackets with the six bolts and the washers.
4. Connect the two jumper harness leads to the body harness leads and insert the grommet into the windshield center pillar (Figure 10-96).
5. Secure the windshield assembly to the A-pillar with the two bolts and the locknuts (Figure 10-95).
6. Install the windshield wiper arm pivots.
7. Install the windshield wiper linkage.
8. Install the windshield wiper arm and the blade.
9. Install the soft top.

HEATED WINDSHIELD

The optional heated windshield is capable of defrosting the windshield glass in less than 10 minutes at 0° F. The system is comprised of a rocker switch with an integrated time delay module (Figure 10-98), two relays and two fuses and in-glass heating elements.

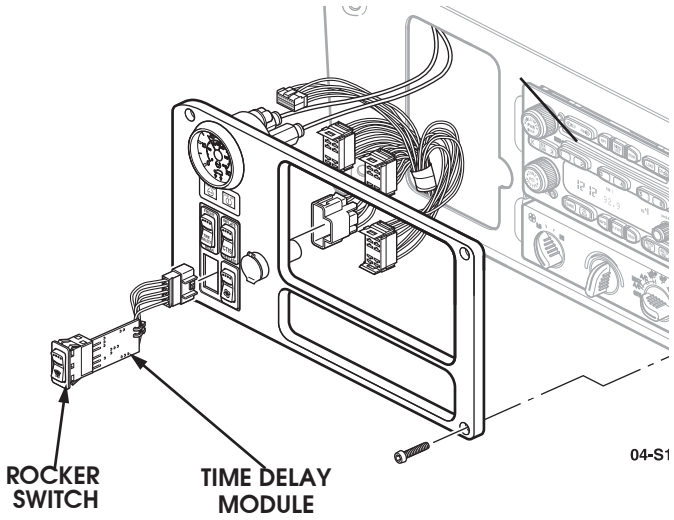


Figure 10-98: Rocker Switch/Time Delay Module Location

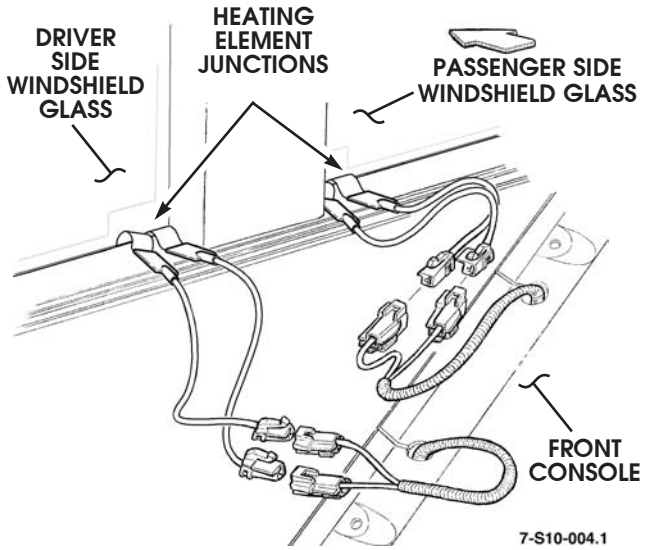


Figure 10-99: Heating Element Junction Location

The rocker switch/time delay module is mounted on the power window master switch on the driver side of the front console (Figure 10-98).

Removal

1. Remove the screws and pull the power window master switch from the radio bezel (Figure 10-98).
2. Lift the connector clip and pull connector from the rocker switch/time delay module.
3. Squeeze the clips on the rocker switch/time delay module and remove switch/module from the bezel.

Installation

1. Push the rocker switch/time delay module into the bezel opening and snap it into bezel.
2. Attach the electrical connector to the rocker switch/time delay module (Figure 10-99).
3. Install the radio bezel.

WINDSHIELD WIPER SYSTEM AND COMPONENTS

Windshield Wiper Motor Assembly Replacement

Removal

1. Remove the windshield center trim from the windshield assembly.
2. Remove the drivers compartment headliner.
3. Disconnect the windshield wiper motor assembly harness from the crossbody harness (Figure 10-100).
4. Remove the three bolts, washers and the lockwashers securing the windshield wiper motor assembly to the windshield assembly.
5. Remove the retainer securing the windshield wiper linkage to the windshield wiper motor cranking pin and remove the windshield wiper motor assembly.

Installation

1. Lubricate the windshield wiper motor cranking pin and secure the windshield wiper linkage to the windshield wiper motor cranking pin with the retainer (Figure 10-100).
2. Secure the windshield wiper motor assembly to the windshield assembly with the three lockwashers, washers and the bolts. Tighten the bolts to 12 lb-ft (16 N•m).
3. Connect the windshield wiper motor assembly harness to the crossbody harness.
4. Install the drivers compartment headliner.
5. Secure the windshield center trim to the windshield assembly.

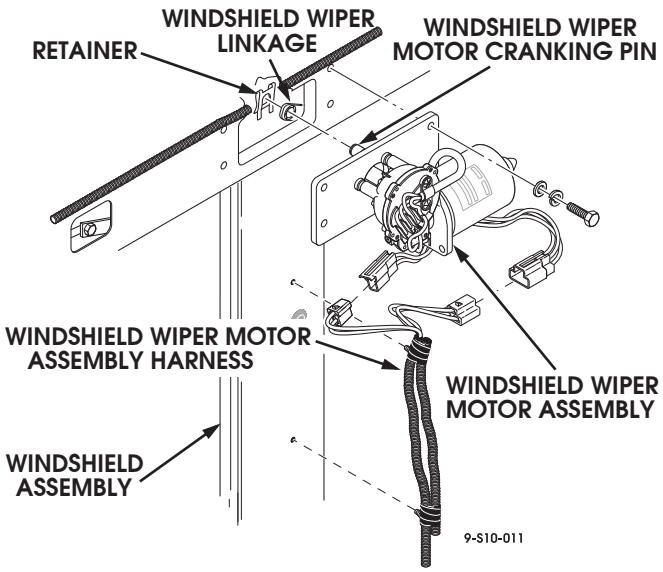


Figure 10-100: Windshield Wiper Motor Assembly Replacement

Windshield Wiper Linkage Replacement

Removal

NOTE: Left and right side windshield wiper linkage replacement procedure is the same. This procedure covers the left side.

1. Remove the windshield wiper motor assembly.
2. Disconnect the windshield wiper linkage from the windshield wiper pivot cranking lever pin and remove the windshield wiper linkage (Figure 10-101).

Installation

1. Secure windshield wiper linkage to the windshield wiper pivot cranking lever pin (Figure 10-101).

2. Install the windshield wiper motor assembly on the windshield assembly.

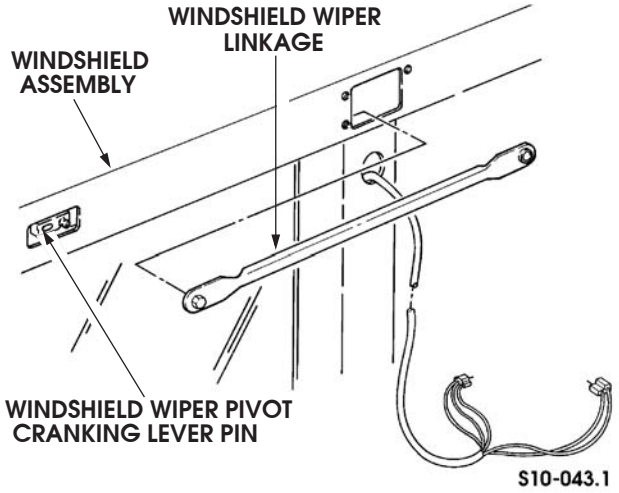


Figure 10-101: Windshield Wiper Linkage Replacement

Windshield Wiper Pivot Replacement

Removal

NOTE: Left and right side windshield wiper pivot replacement procedure is the same. This procedure covers the left side.

1. Remove the windshield wiper arm assembly.
2. Remove the drivers compartment headliner.
3. Remove the windshield wiper linkage from the windshield wiper pivot cranking lever pin (Figure 10-102).
4. Remove the nut, washer and the rubber washer securing the windshield wiper pivot to the windshield assembly and remove the windshield wiper pivot.

Installation

1. Secure the windshield wiper pivot to the windshield assembly with the rubber washer, washer and the nut (Figure 10-102).
2. Secure the windshield wiper linkage to the windshield wiper pivot cranking lever pin.
3. Install the drivers compartment headliner.
4. Install the windshield wiper arm assembly.

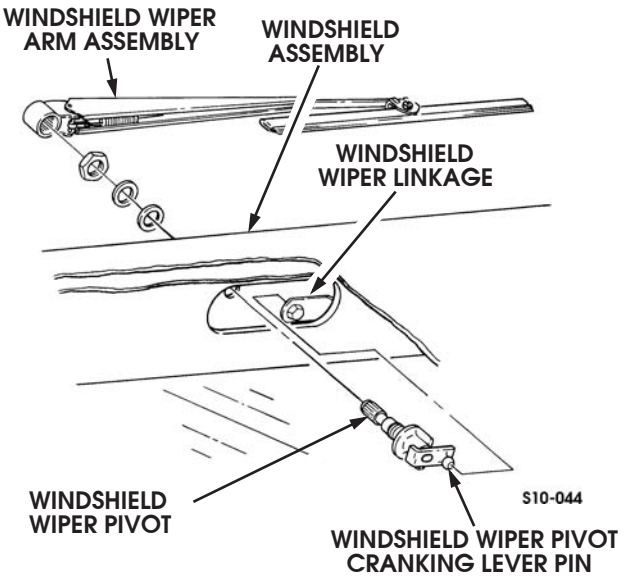


Figure 10-102: Windshield Wiper Pivot Replacement

WINDSHIELD WASHER SYSTEM AND COMPONENTS

Reservoir and Pump Assembly Replacement

Removal

1. Drain the reservoir.
2. Remove the three screws, washers and lock washers retaining the external fuse box to the washer reservoir and set it aside.
3. Remove the two screws and the retaining bracket securing the ABS ECU enclosure. Set aside the ECU with the enclosure.
4. Disconnect the pump connector from the reservoir and the pump assembly (Figure 10-103).
5. Disconnect the fluid level connector from the fluid level sensor assembly.
6. Remove the four bolts, lock washers and the reservoir assembly from the reservoir support assembly.
7. Disconnect the windshield washer hose from the reservoir and the pump assembly.
8. Inspect the wellnuts for damage. Replace if damaged.

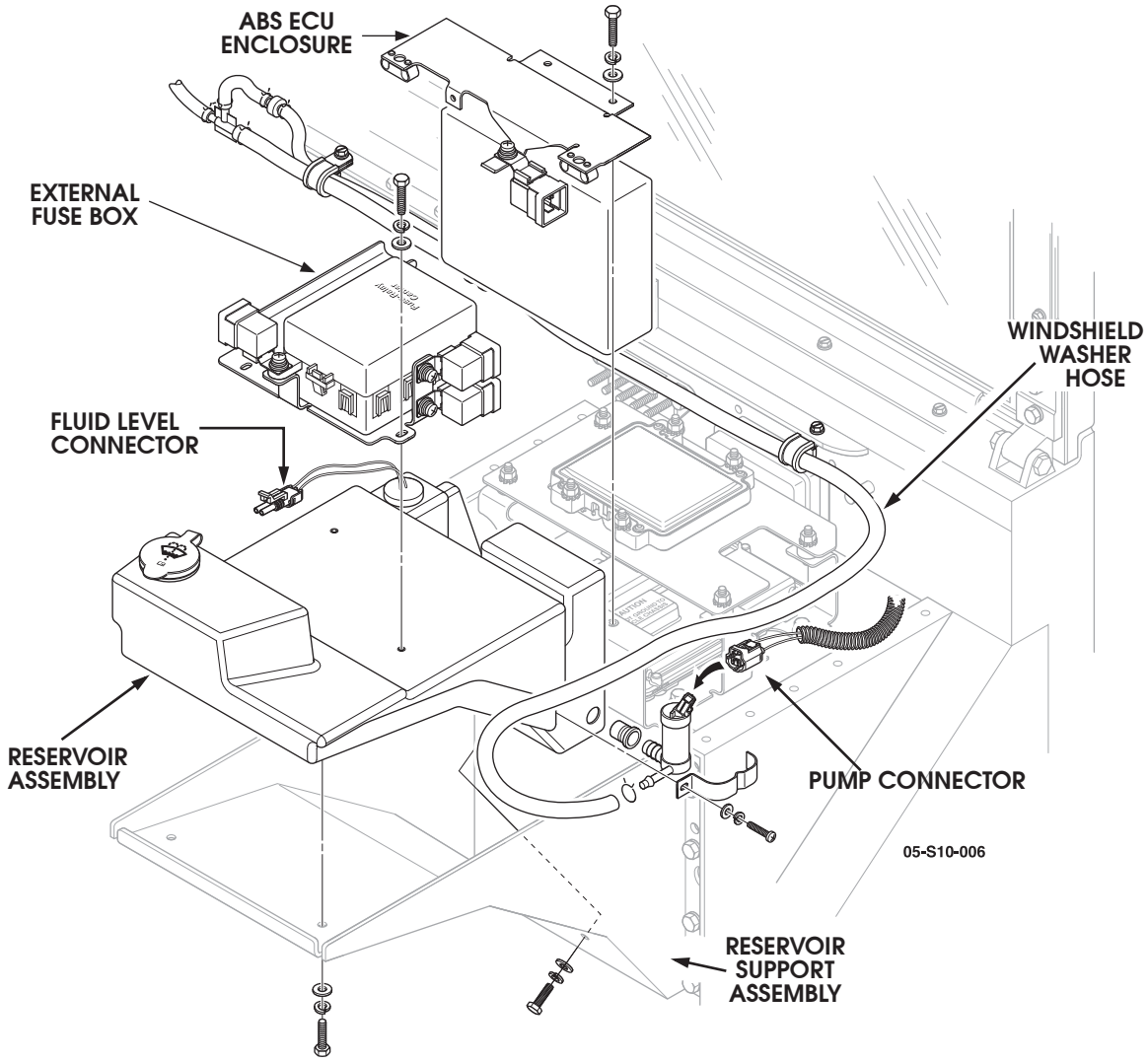


Figure 10-103: Windshield Washer Fluid Reservoir and Pump Replacement

Installation

1. Connect the windshield washer hose to the reservoir and the pump assembly.
2. Secure the reservoir assembly to the reservoir support assembly with the four lockwashers and the bolts. Tighten the bolts to 8 lb-ft (11 N•m) (Figure 10-103).

3. Connect the fluid level connector to the fluid level sensor assembly.
4. Connect the pump connector to the pump assembly.
5. Secure the ABS ECU enclosure with the retaining bracket and the two screws.
6. Secure the external fuse box to the washer reservoir with the three screws, washers and lock washers.
7. Fill the reservoir.

Windshield Washer Nozzle Replacement

Removal

1. Compress the spring clamp and disconnect the hose from the nozzle (Figure 10-104).
2. Remove the screw and the nozzle from the body.

Installation

1. Secure the nozzle to the body with the screw.
2. Connect the hose to the nozzle and reposition the spring clamp.

Windshield Washer Hose Replacement

Removal

1. Remove the three nuts, washers, screws, washers and the p-clamps securing the hose to the body.
2. Remove the washer reservoir (Refer to section 10).
3. Compress the spring clamps and disconnect the washer hose from the pump and the tee.
4. Compress the spring clamps and disconnect the three hoses from the tee, check valve and the nozzles.

Installation

1. Connect the three hoses to the tee, check valve and the nozzles.
2. Connect the hose to the tee and the pump.
3. Secure the hoses to the body with the three clamps, washers, screws, washers and the nuts.
4. Install the washer reservoir (Refer to section 10).

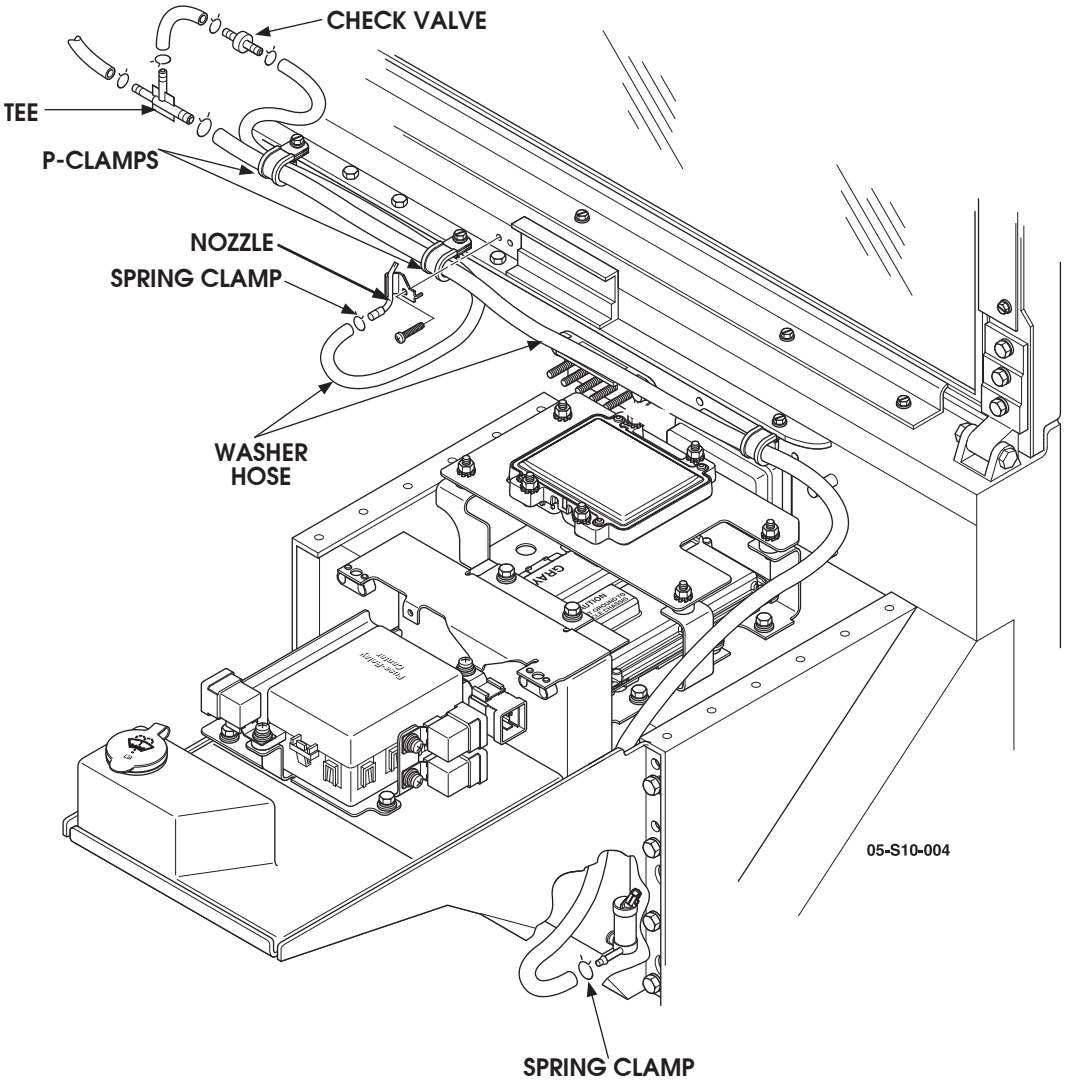


Figure 10-104: Windshield Washer Nozzle Replacement

A-PILLAR FORMER ASSEMBLY REPLACEMENT (SOFT TOP ONLY)

Removal

1. Remove the soft top.
2. Remove the 12 screws and the A-pillar former from the A-pillar (Figure 10-105).
3. Clean the mounting surface on the A-pillar.

Cleaning and Inspection

NOTE: Clean all the components, examine for wear or damage and replace if necessary.

Inspect the wellnuts. Replace if defective or damaged.

Installation

1. Peel the paper backing from the A-pillar former and secure the former to the A-pillar with the 12 screws (Figure 10-105).
2. Install the soft top.

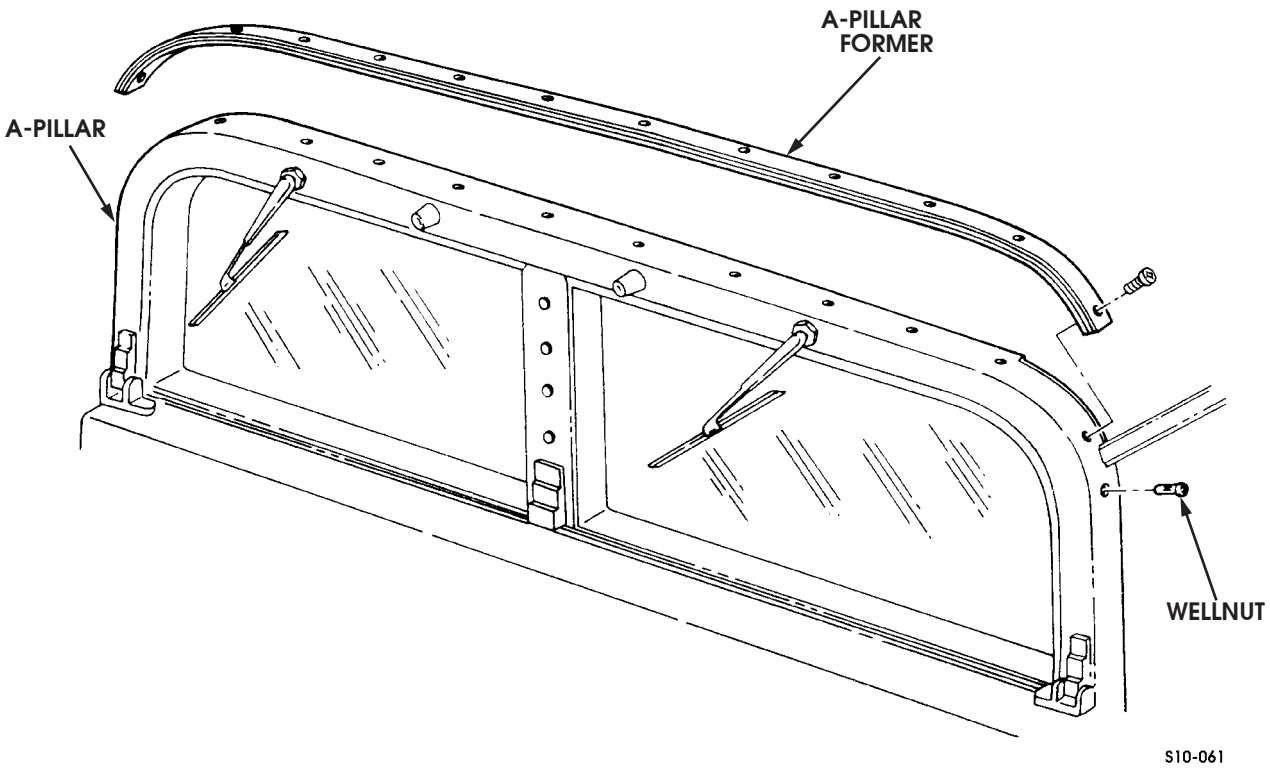


Figure 10-105: A-Pillar Former Assembly Replacement

REAR SUPPORT BOW BRACKET REPLACEMENT

Removal

1. Remove the rear support bow assembly.
2. Remove the two screws and the support bow bracket from the body (Figure 10-106).

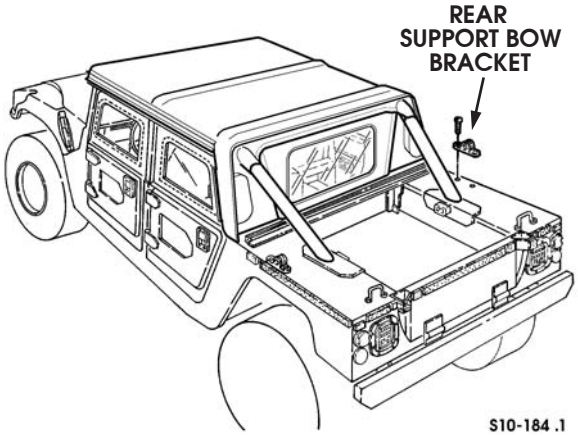


Figure 10-106: Rear Support Bow Bracket Replacement

Installation

1. Secure the bracket to the body with the two screws (Figure 10-106).
2. Install the rear support bow assembly.

FRONT STRIKER REPLACEMENT

Removal

Remove the locknut, washer, striker guard and the striker from the front door pillar (Figure 10-107).

Installation

Secure the striker and the striker guard to the front door pillar with the washer and the locknut (Figure 10-107). Tighten the locknut to 41 lb-ft (56 N•m).

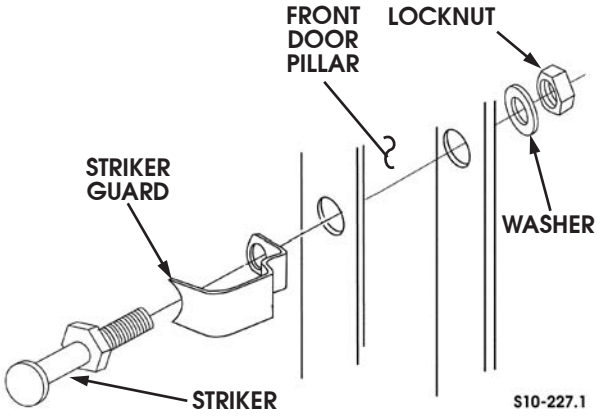


Figure 10-107: Front Striker Assembly Replacement

REAR STRIKER ASSEMBLY REPLACEMENT

Removal

Remove the two screws, washers, backing plate and the rear striker assembly from the rear door pillar (Figure 10-108).

Installation

Secure the rear striker assembly to the rear door pillar with the backing plate, two washers and the screws (Figure 10-108). Tighten the screws to 12 lb-ft (16 N•m).

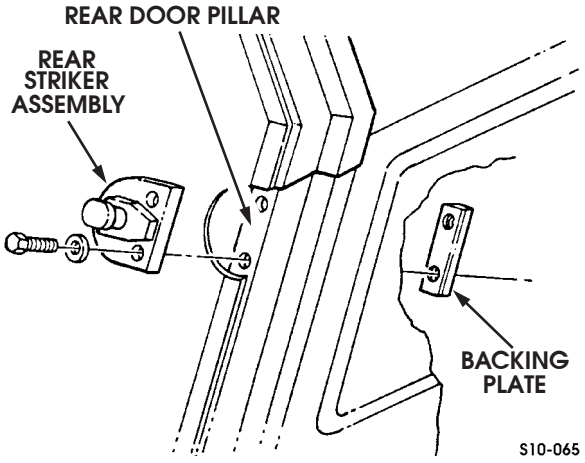


Figure 10-108: Rear Striker Assembly Replacement

BODY MOUNT REPLACEMENT

Removal

NOTE: Removal and installation procedures for intermediate and rear body mounts are the same. This procedure covers the left intermediate body mount.

1. Remove the locknut, washer, bolt, washer and the spacer securing the sleeve, upper cushion and the lower cushion to the body bracket and the frame bracket (Figure 10-110).
2. Raise the vehicle at the body reinforcement adjacent to the body mount to be removed (Figure 10-109).
3. Raise the body far enough to separate the upper cushion from lower cushion and remove the sleeve, upper cushion and the lower cushion (Figure 10-110).

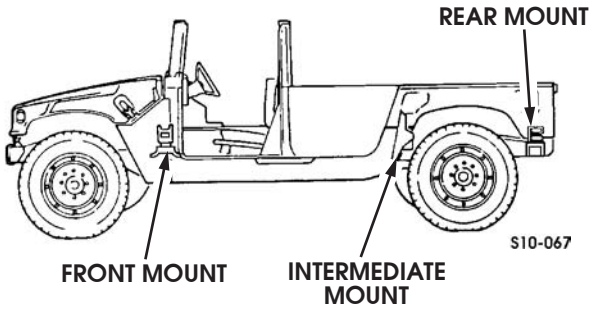


Figure 10-109: Left Side Body Mount Locations

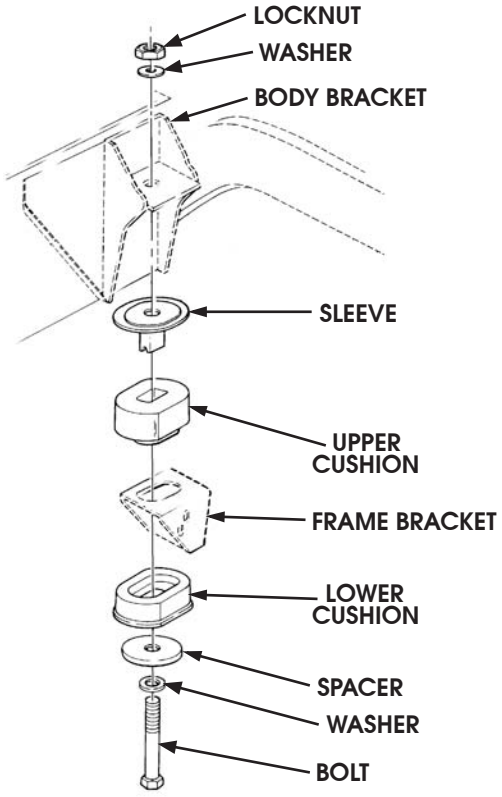


Figure 10-110: Body Mount Cushions Replacement

Installation

1. Position the lower cushion, upper cushion and the sleeve between the body bracket and the frame bracket (Figure 10-110).

2. Lower the body and ensure the lower cushion, sleeve, upper cushion and the body bracket align. Secure with the spacer, washer, bolt, washer and the locknut. Tighten the locknut to 90 lb-ft (122 N•m).

ROCKER PANEL PROTECTION REPLACEMENT

Removal

NOTE: Removal of the rocker panel protection is similar for both sides. This procedure covers one side only.

NOTE: Socket head screws are secured in place with Loctite 242 and may require considerable effort to break loose.

1. Remove the nine socket head screws securing the rocker panel protection to the body. Support the rocker panel protection with a floor jack (Figure 10-111).

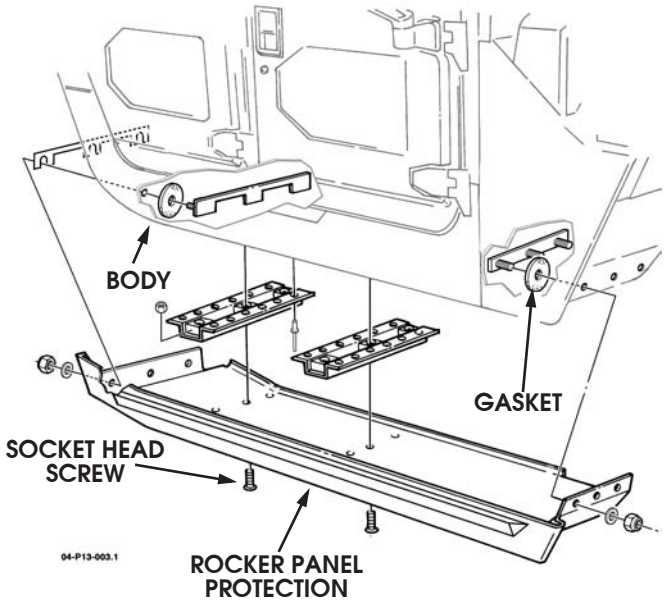


Figure 10-111: Rocker Panel Protection

3. Remove the three nuts and washers securing rocker panel protection to front footwell.
4. Remove the three nuts and washers securing the rocker panel protection to the rear footwell.

CAUTION: *Rocker panel protection is heavy. Remove with a floor jack.*

5. Remove the rocker panel protection from the body.
6. Inspect the three retainer nuts on the body. Discard if damaged.

Installation

CAUTION: *Rocker panel protection is heavy. Raise into place with a floor jack.*

1. Raise the rocker panel protection to the body.
2. Secure the rocker panel protection to the rear footwell with the three washers and the nuts. Do not tighten the nuts.
3. Secure the rocker panel protection to the front footwell with the three washers and the nuts. Tighten the nuts at the front and rear footwells to 37 lb-ft (50 N•m).

NOTE: Apply Loctite 242 to threads of socket head screws.

4. Remove the floor jack and secure the rocker panel protection to the body with the nine socket head screws. Tighten the socket head screws to 37 lb-ft (50 N•m).

Rear License Plate Bracket Replacement

Removal

1. Remove the four screws securing the lamp guard to the license plate bracket/lamp assembly and the bumper.
2. Remove the two screws and the lockwashers securing the bracket/lamp assembly to the bumper (Figure 10-112).
3. Disconnect the two leads from the light bracket and remove the bracket.

Installation

1. Connect the two leads to the light bracket.
2. Secure the bracket/lamp assembly to the bumper with the two lock washers and screws.
3. Install the lamp guard with the four screws and the washers.

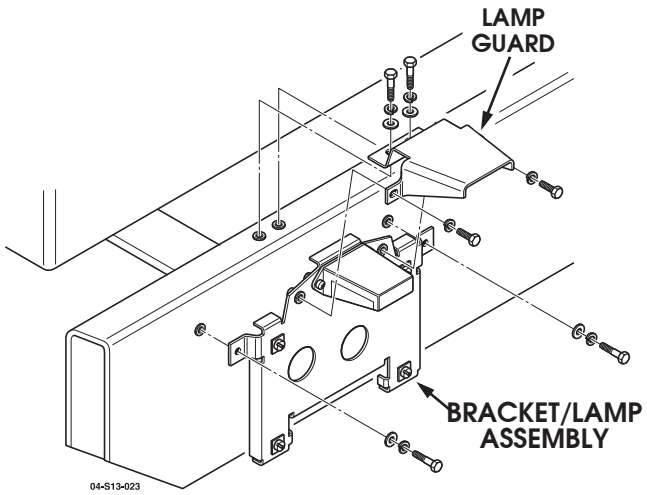


Figure 10-112: Rear License Plate Bracket

Front License Plate Bracket Replacement

Removal

1. Remove the two capscrews, lockwashers, license plate and the two grommets from the bracket. Discard the lockwashers (Figure 10-113).
2. Remove the two screws, lockwashers and the bracket from the bumper. Discard the lockwashers.

Installation

1. Install the bracket on the bumper with the two lockwashers and the screws (Figure 10-113).
2. Install the license plate on the bracket with the two grommets, lockwashers and the capscrews.

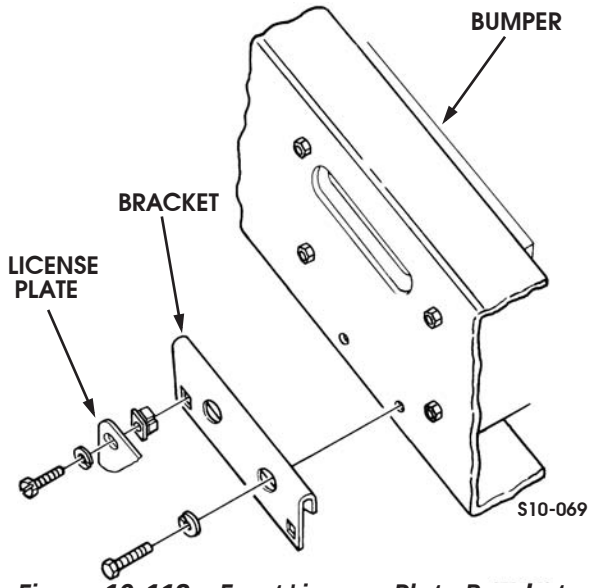


Figure 10-113: Front License Plate Bracket

FUEL FILLER HOUSING REPLACEMENT

Main Fuel Tank

Removal

1. Remove the filler cap from the filler spout (Figure 10-114).
2. Remove the screw securing the cap tether to the fuel filler housing, mark the location for reassembly
3. Remove the three socket head capscrews, washers and the reinforcement ring securing the fuel filler housing to the filler spout.
4. Remove the five screws securing the fuel filler housing and the warning label to the right outer wheelhouse panel.
5. Push the filler cap through the filler housing and remove the fuel filler housing.
6. Inspect the six speednuts for damage. Replace if defective or missing.

Installation

1. Pull the filler spout through the fuel filler housing and install the housing on the right outer wheelhouse panel with the five screws and the warning label. Tighten the screws to 18 lb in. (2 N•m) (Figure 10-114).
2. Using the sixth screw, install the fuel cap tether (not shown) to the fuel filler housing at the sixth screw position.
3. Secure the fuel filler housing to the filler spout with the three socket head capscrews, washers and the reinforcement ring.
4. Install the filler cap on the filler spout.

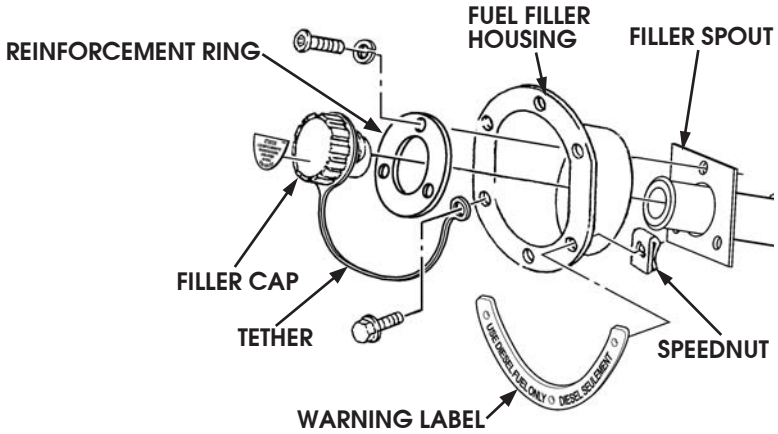


Figure 10-114: Fuel Filler Housing - Main Tank

Auxiliary Fuel Tank

Removal

1. Remove the filler cap from the filler spout (Figure 10-115).
2. Remove the screw securing the cap tether to the fuel filler housing, mark the location for reassembly
3. Remove the three socket head capscrews, washers and the reinforcement ring securing the fuel filler tube to the housing.
4. Remove the three screws, warning label and the fuel filler housing from the body.

Installation

1. Secure the fuel filler housing and the warning label to the body with the three screws.
2. Using the forth screw, install the cap tether to the fuel filler housing at the forth screw position.
3. Secure the fuel filler tube to the housing with the reinforcement ring, three socket head capscrews and the washers.
4. Screw the filler cap into the filler spout.

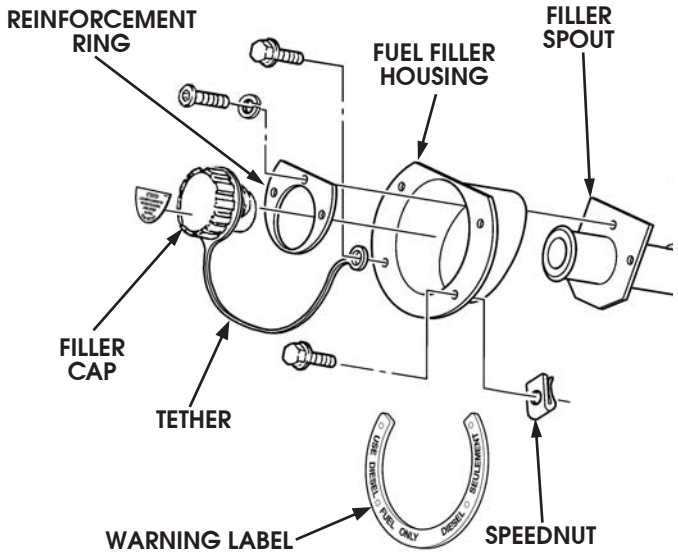


Figure 10-115: Fuel Filler Housing Auxiliary Fuel Tank

Tire Jack and Optional Triangle Warning Kit Hold-Down Replacement Station Wagon and Open Top

Removal

1. Remove the triangle warning kit and the tire jack from the under the right rear seat.
2. Remove the two wing nuts, washers, screws, clamp bracket and the hold-down bracket from the seat support (Figure 10-116).
3. Remove the nut, washer, screw, washer and the strap bracket from the seat support.
4. Remove the nut, washer, screw, washer and the strap from the strap bracket.

Installation

1. Secure the strap to the strap bracket with the screw, two washers and the nut (Figure 10-116).
2. Secure the strap bracket to the seat support with the screw, two washers and the nut.
3. Secure the hold-down bracket and the clamp bracket to the seat support with the two screws, washers and the wing nuts.
4. Position the tire jack and the triangle warning kit in place and secure with the strap.

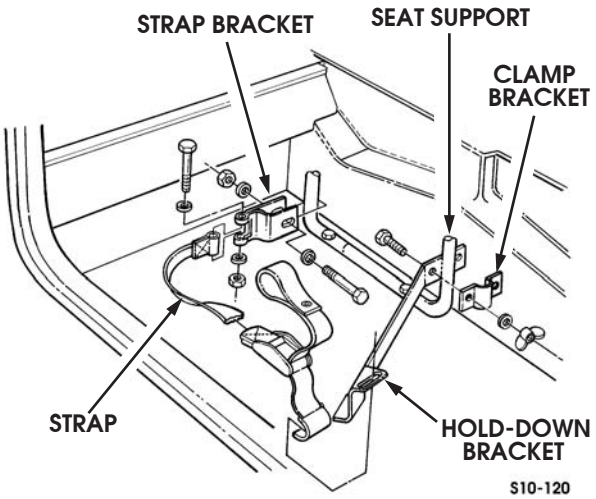


Figure 10-116: Emergency Equipment Hold-Down Bracket Replacement

FOUR-PASSENGER SOFT TOP

Interior Trim Replacement

Removal

1. Remove the center console.
2. Remove the speakers from the rear wall (Refer to section 12).
3. Remove the screws from the windshield frame center trim.
4. Remove the four screw and washer assemblies and the trim from the side of the rear compartment wall (Figure 10-117).
5. Remove the three screws and the lower B-pillar trim from the B-pillar (Figure 10-117).
6. Disconnect the courtesy light electrical connector and remove the courtesy light lens, two rivets, washers and the courtesy light from the trim.
7. Remove the four screws, two panel fasteners, lower trim and the trim from rear compartment wall (Figure 10-117).
8. Remove the screw and the washer assembly and the center trim from the rear compartment.

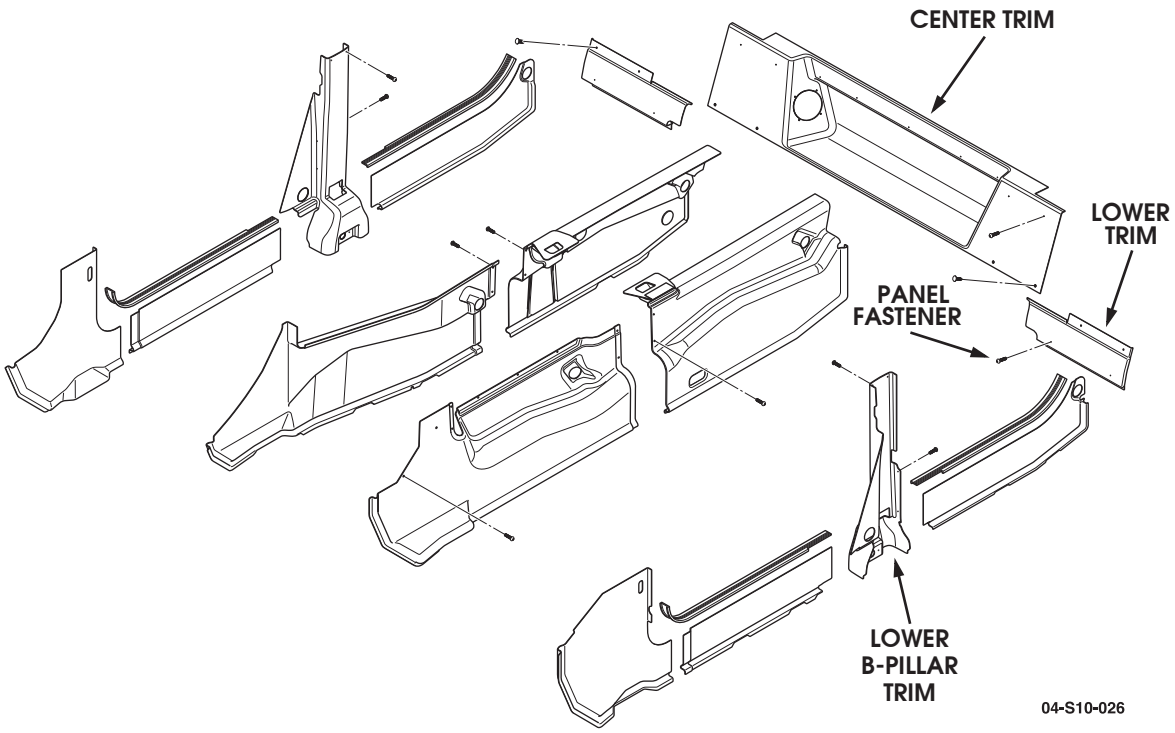


Figure 10-117: Rear Wall Compartment Location

Installation

1. Secure the center trim to the rear compartment wall with the screw and the washer assembly (Figure 10-117).
2. Secure the lower trim and the trim to the rear compartment wall with the two panel fasteners and the four screw and the washer assemblies.
3. Secure the trim to the rear compartment wall with the four screw and the washer assemblies.
4. Connect the courtesy light electrical connector, and secure the courtesy light to the trim with the two washers and the rivets (Figure 10-117).
5. Secure the courtesy light lens to the courtesy light bracket.
6. Fasten the lower B-pillar trim with the three screws.
7. Secure the windshield center trim to the windshield frame with the two screw.
8. Install the speakers on the rear wall (Section 12).
9. Install the center console.
10. Install the front and the rear seats.

Soft Top Mounting Components Replacement

NOTE: The following removal and installation instructions include replacement of all soft top mounting components and accessories. Use only the applicable steps for replacing specific components.

Removal

1. Remove the four-passenger soft top, tonneau cover or station wagon soft top, if applicable. Refer to the owner's manual for proper procedure.
2. Remove the tonneau cover wood bow from the two retainer brackets (Figure 10-118).
3. Remove the four screws and the two bow retainer brackets from the wheelhouses.

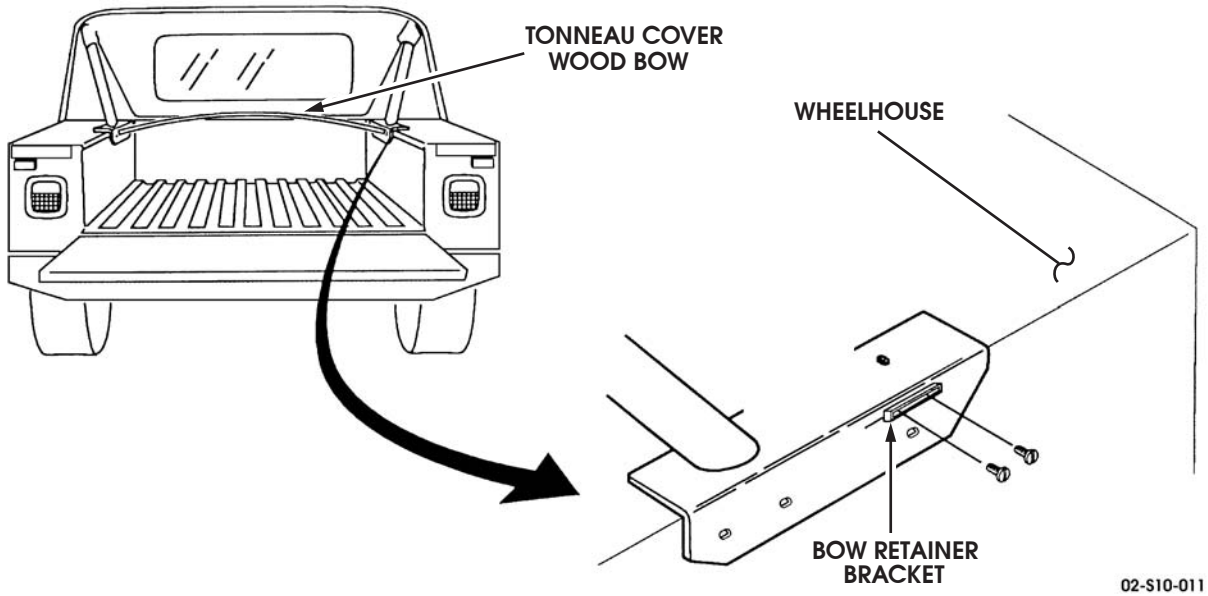


Figure 10-118: Tonneau Cover Wood Bow Removal

4. Remove the velcro strips and the patches from the tonneau area (Figure 10-119).

NOTE: Perform steps five and six for both sides of the vehicle. The left side is shown.

5. Remove the 41 in. (104 cm) tonneau extrusion from the side of the wheelhouse.
6. Remove the 9 in. (23 cm) tonneau extrusion from the rear of the wheelhouse.
7. Remove the 43 in. (109 cm) tonneau extrusion from the tailgate.

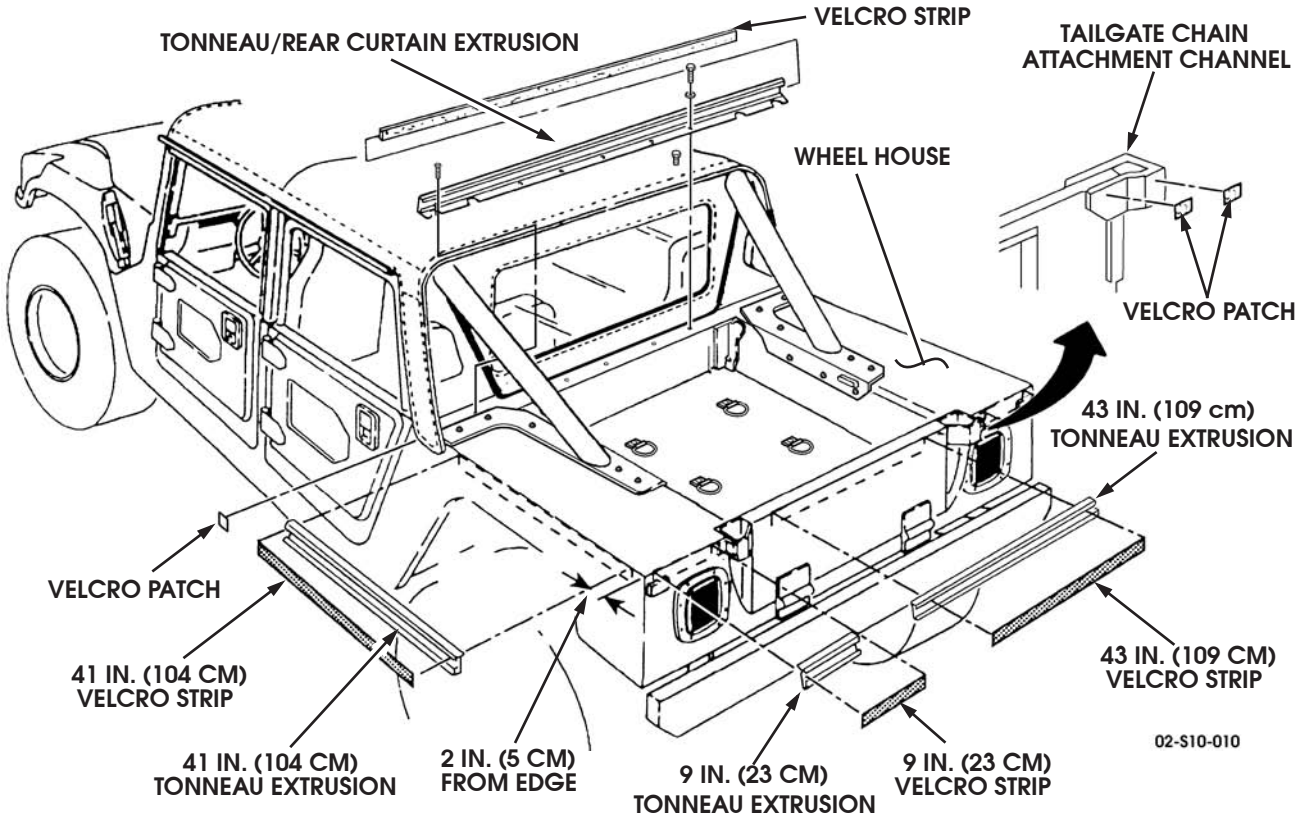


Figure 10-119: Velcro Strip and Patch Removal

8. Remove the five screws, lockwashers, four self-tapping screws and the tonneau/rear curtain extrusion from the body.

9. Remove the front and the rear inner door seals (Figure 10-120).

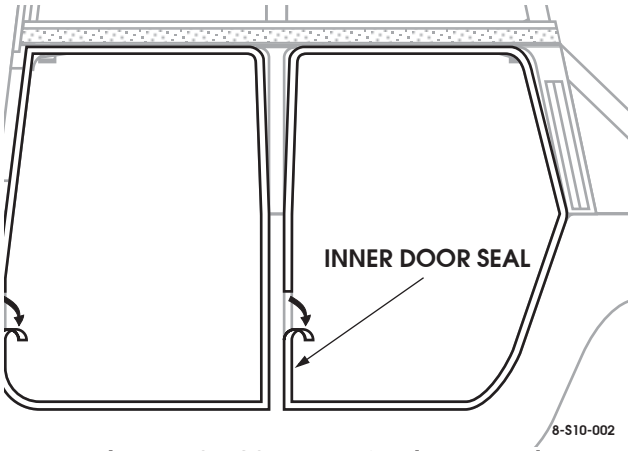


Figure 10-120: Door Seal Removal

NOTE: This procedure is written for the left side of the vehicle only. Duplicate steps are necessary to service the right hand side.

10. Remove the soft top from the vehicle.
11. Remove the D-strip seal from the windshield frame. Do not remove the P-strip seal (Figure 10-121).

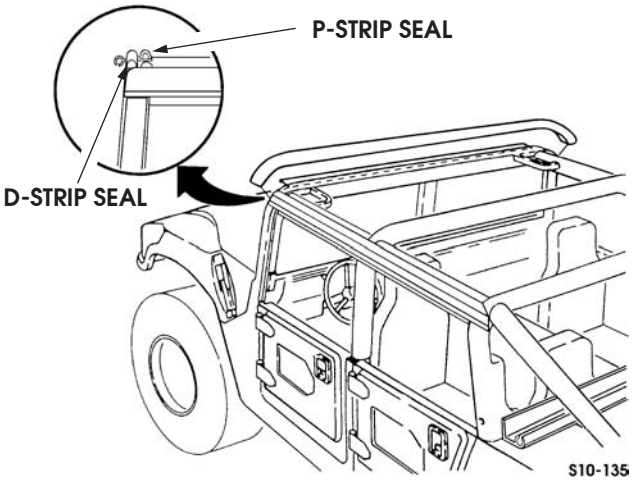


Figure 10-121: D-Strip Seal Removal

12. Remove the 12 screws securing the front attachment rail to the top of the windshield frame and remove the rail.
13. Slide the velcro strips in the two side rails, rearward to remove and set aside.
14. Remove the four screws securing the B-pillar cover to the bottom of the H-rail.

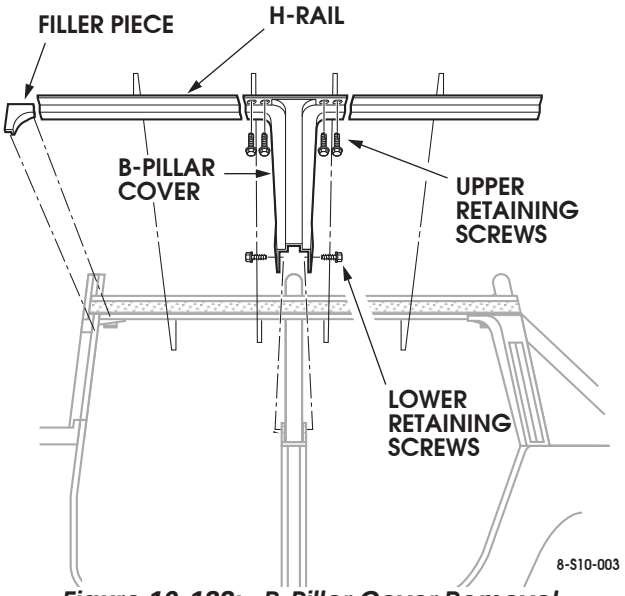


Figure 10-122: B-Pillar Cover Removal

15. Remove the two bolts securing the B-pillar cover to the B-pillar. Remove the B-pillar cover (Figure 10-122).
16. Remove the three screws securing the C-pillar cover to the H-rail (Figure 10-123).
17. Remove the four bolts securing the lower inner and outer bracket on the C-pillar cover. Remove the cover.

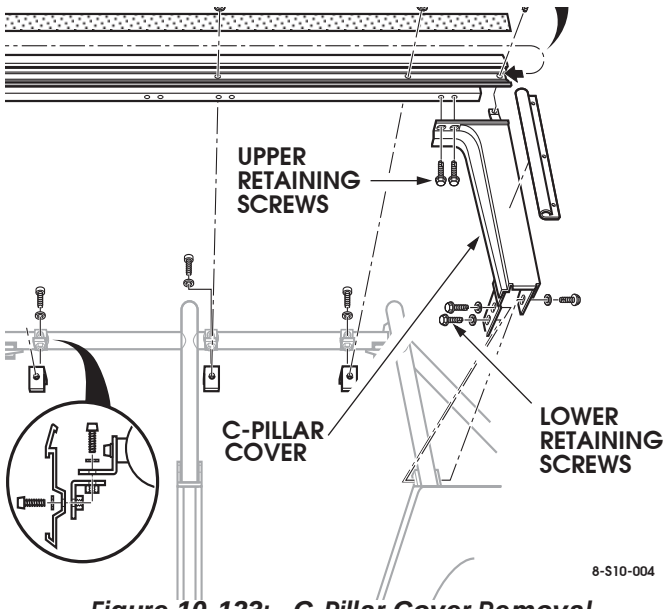


Figure 10-123: C-Pillar Cover Removal

18. Remove the three screws securing the H-Rail to the vehicle safety cage. Leave the L-brackets on the safety cage unless the cage is going to be replaced, remove the H-rail (Figure 10-124).

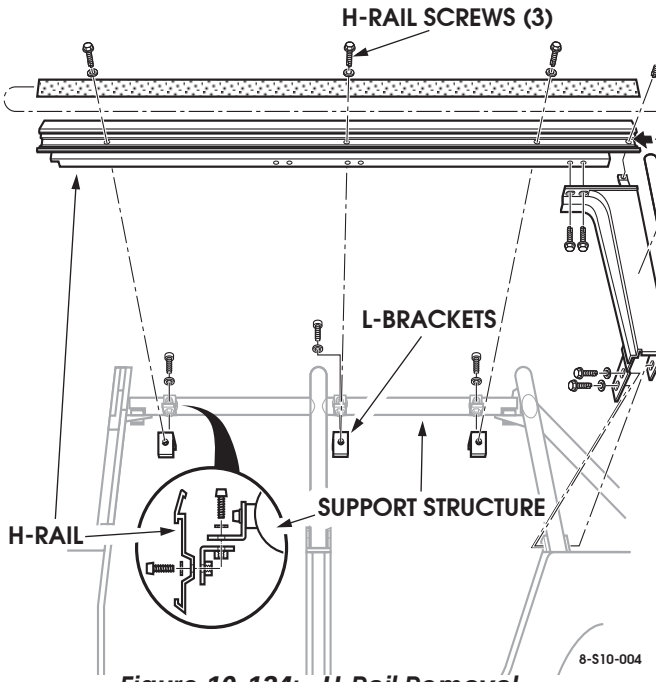


Figure 10-124: H-Rail Removal

NOTE: While removing the H-rail, note where sealer is placed so during installation, the sealer can be duplicated

Installation

1. Install the L brackets to support the structure so the bend is to the bottom and the brackets are adjusted upward as far as they could go. Leave the brackets finger tight to ease installation of other components and adjustment later in the procedure.
2. Using the bolt and the washer, install the threaded L-brackets onto the H-rail so the bend is upwards. Tighten the bolt.
3. Put foam tape on the top mating surface of the C-pillar cover and place the rear extrusion against the bottom surface of the H-rail. Install the three screws (Figure 10-125).
4. Put foam tape on the top edge of the B-pillar cover. Place the cover against the bottom edge of the H-rail and tighten the four upper screws (Figure 10-125).
5. Apply sealer to the bottom of the B- and the C-pillar covers.
6. Install the H-rail onto the support structure. Place the L-brackets installed on the H-rail under the L-brackets on the support structure. Tighten the screws when installed.
7. Install the lower fasteners in the B-pillar cover. Do not tighten (Figure 10-125).
8. Install the lower fasteners in the C-pillar cover. Do not tighten (Figure 10-125).
9. Adjust the H-rail and the extrusions so the seams are flush, tighten the fasteners.
10. Install the front upper corner filler piece with the two rivets and the sealer (Figure 10-125).
11. Clean the excess sealer from the mating surfaces.
12. Install the new inner door seals. Check the door to frame fit and adjust the structure if necessary.
13. Install the rail and the P-seal on the top of the windshield with the (12) screws.
14. Install the new rubber D-seal between the P-seal and the rail.
15. Install the soft top and secure.

NOTE: Clean all the surface residue with a tape adhesion promoter before installing the extrusions with 2 sided tape.

16. Secure the tonneau/rear curtain extrusion to the body with the five lockwashers, capscrews and the four self-tapping screws. Use windshield sealer between the extrusion and the body (Figure 10-119).
17. Install the 43 in. (109 cm) tonneau extrusion on the tailgate.
18. Secure the 9 in. (23 cm) tonneau extrusion to the rear of the wheelhouse.

19. Secure the 41 in. (104 cm) tonneau extrusion to the side of the wheelhouse, 2 in. (5 cm) from the rear corner edge of the wheelhouse.
20. Install the velcro strips in the extrusions.
21. Install one velcro patch on each wheelhouse side and two velcro patches on each tailgate chain attachment channel.
22. Secure the two bow retainer brackets to the wheelhouses with the four screws (Figure 10-126).
23. Leak check the vehicle and add sealer where necessary.
24. Test drive the vehicle and check for wind noise.

CAUTION: *The ideal crown height of the bow is shown. If there is excessive crowning of the bow, cut the end of the wood bow with a saw to reduce the crown. Do not cut more than 0.25 in. (6 mm) at a time or the bow may become too short.*

25. Measure and record the distance across the cargo bed, between each rear support bar brace. Add 0.25 to 0.50 in. (6 to 13 mm) to this dimension and mark and cut the wood bow to this dimension.
26. Position the wood bow in the two retainer brackets. Lay a straight edge across the wheel houses as shown (Figure 10-126). The ideal bow height is 1.5 in. from the straight edge to the bow crown.
27. Install the four-passenger soft top, tonneau cover and the slant-back soft top or station wagon soft top, if applicable. Refer to the owner's manual.

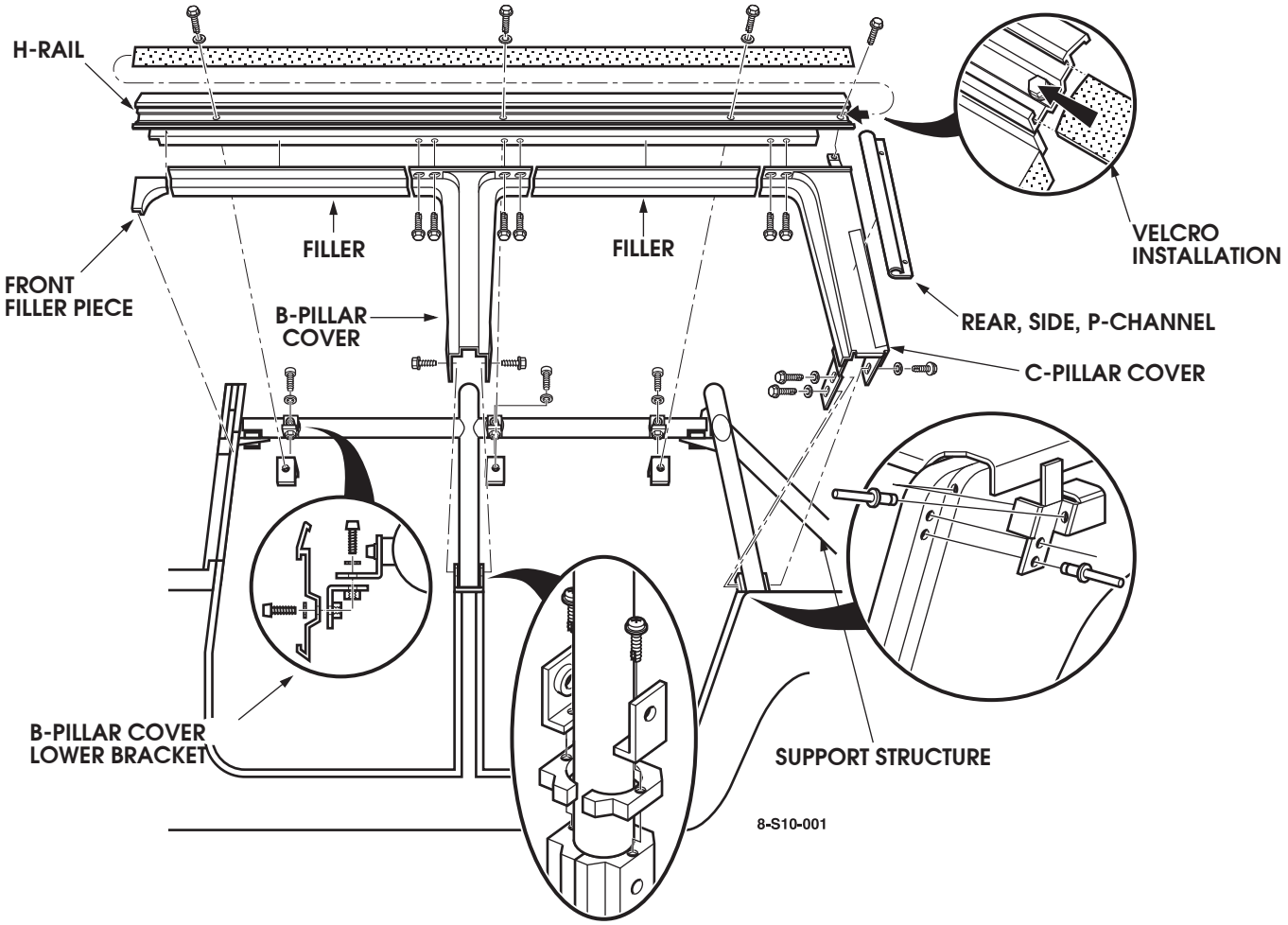


Figure 10-125: Rail and Support Structure Locations

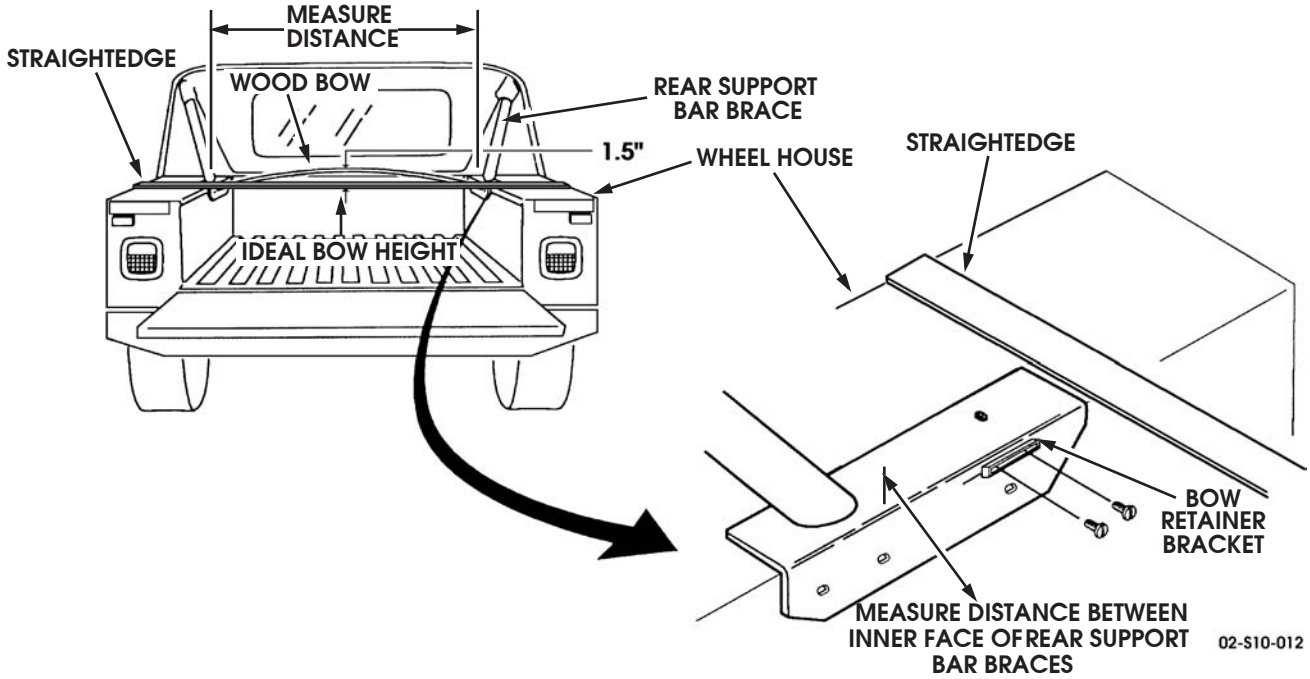


Figure 10-126: Bow Retainer Bracket Installation

SOFT TOP SUPPORT ASSEMBLY

Removal

1. Remove the soft top.
2. Remove the interior grab handles.
3. Remove the vinyl wrap and padding from the roll cage assembly.
4. Remove the inner door seals.
5. Drill the rivets on the front corner filler plates located at the top front of the front door openings.
6. Remove the H rails, B- and the C-pillar covers (Figure 10-127).
7. Remove the hardware and the door striker from the B-pillar.
8. Remove the fasteners securing the windshield frame to the support structure and the rear supports to the body.
9. Using an overhead hoist, remove the support structure as a complete assembly.
10. Repair or replace the individual pieces as necessary, leaving the hardware loose, so the new pieces can be adjusted to the structure once the unit is installed.

Installation

1. Apply sealer to the rear support where the body contact is made.
2. Lower the structure assembly onto the vehicle.
3. Install the hardware and strikers in the B-pillar and the front and the rear supports (Figure 10-127).
4. Install the H rail, B- and the C-pillar covers. Use the body sealer where removed.
5. Apply sealer to the filler plates and the rivet to the body using the existing holes.
6. Tighten the hardware on the assembly.
7. Install the new inner door seals.
8. Install the padding and the vinyl wrap on the soft top support bar assembly.
9. Install the interior grab handles.
10. Install the soft top and leak check.

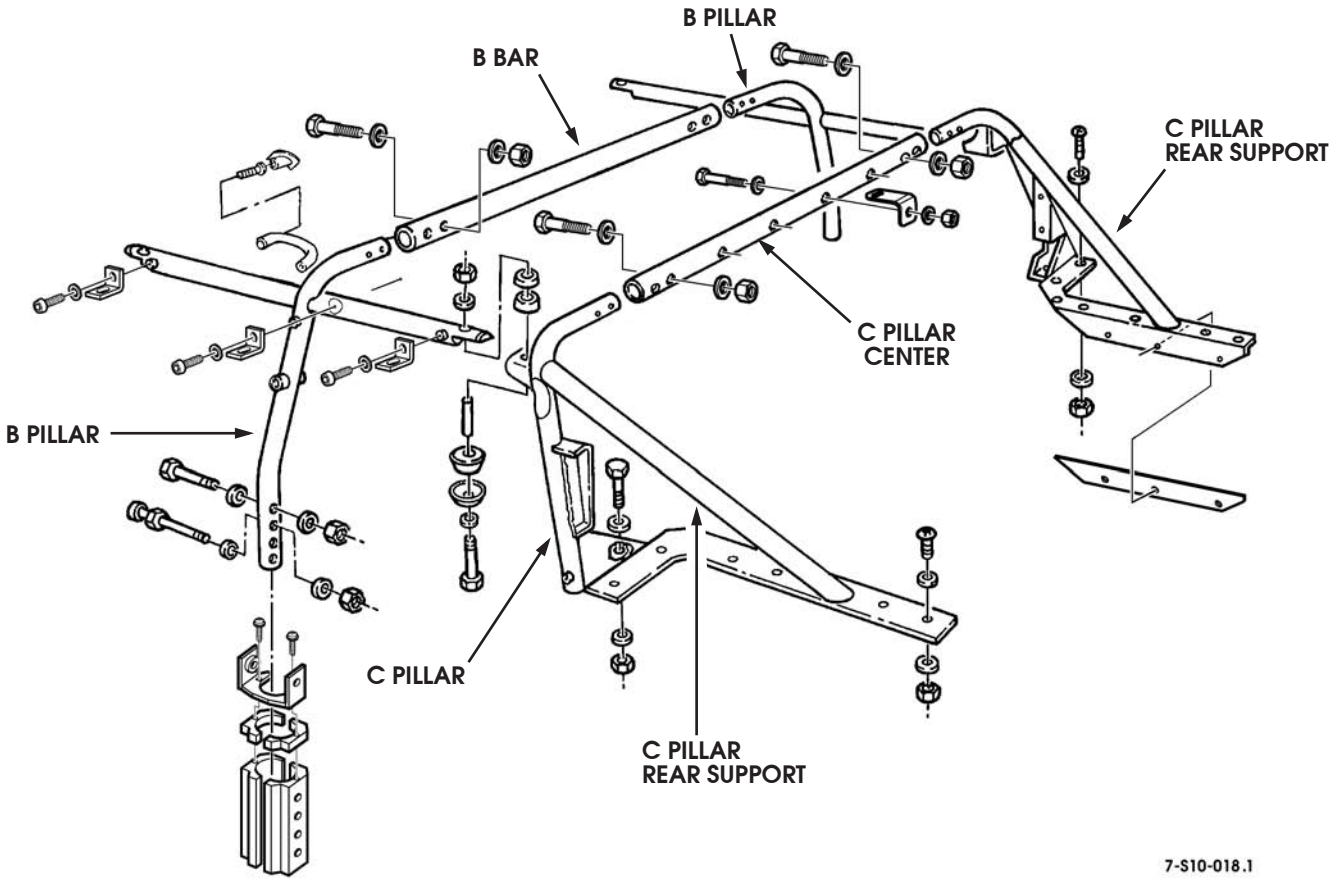


Figure 10-127: Support Structure Assembly

TAILGATE

Tailgate Chain and Latch Brackets Replacement

Removal

Remove the four locknuts, eight washers, four bolts, chain bracket and the latch bracket from the body (Figure 10-128).

Installation

Secure the chain bracket and the latch bracket to the body with the four bolts, eight washers and the four locknuts. Tighten the bolts to 15 lb-ft (20 N•m) (Figure 10-128).

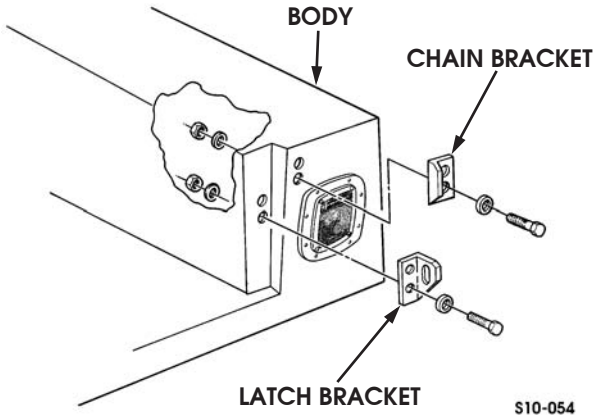


Figure 10-128: Tailgate Bracket Installation

Cargo Tiedown Replacement

NOTE: Cargo tiedown replacement shown represents the three tie downs across the rear at the D-beam. All other tie downs are secured into nut inserts in the body and do not require the nut and washer.

Removal

Remove the locknut, washer, screw and the cargo tiedown from the cargo floor (Figure 10-129).

Installation

Install the cargo tiedown on the cargo floor with the screw, washer and the locknut. Tighten the fasteners to 65 lb-ft (88 N•m) (Figure 10-129).

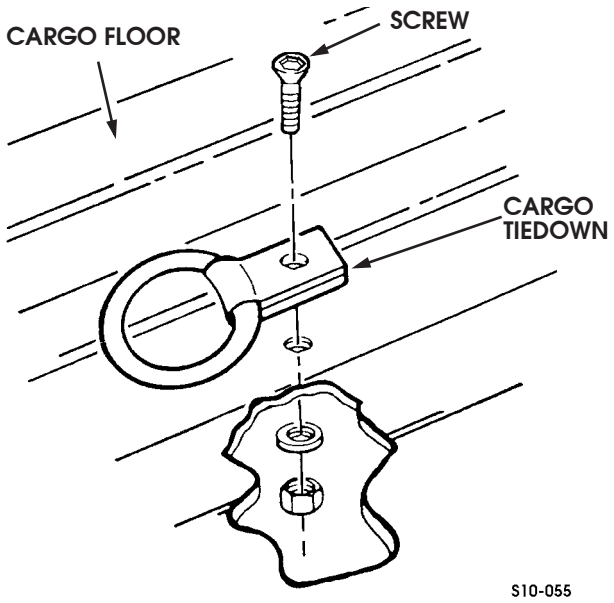


Figure 10-129: Cargo Tiedown Replacement (rear at D-beam shown)

Tailgate and Seals Replacement

Removal

1. Remove the six locknuts, washers and the bolts securing the tailgate to the body (Figure 10-130).
2. Disconnect the two chains from the tailgate and remove the tailgate and shims from the body.

NOTE: Perform step 3 for open top models. Perform step 4 and 5 for station wagon models.

3. Remove the two vertical seals from the tailgate. Discard the seals.
4. Remove the two vertical and the horizontal seals from the body and the four vertical seals and the one horizontal seal from the tailgate. Remove the two corner seals (station wagon model only). Discard the seals (Figure 10-131).
5. Remove the two corner seals from the tailgate (station wagon model only).
6. Remove the two grommets from the tailgate.
7. Clean the adhesive from the tailgate and the body.

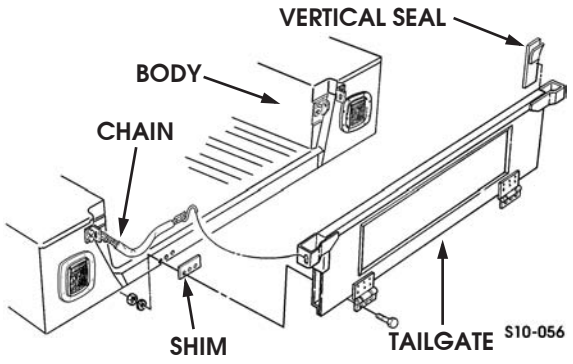


Figure 10-130: Tailgate and Seals Replacement

Installation

1. Install the two grommets on the tailgate (Figure 10-131).

NOTE: Perform steps 2 through 4 for station wagon and open body models. Perform step 5 for two- and four-door models.

2. Remove the paper backing and install the four vertical seals and the one horizontal seal on the tailgate. Ensure the upper vertical seals overlap the lower seals.
3. Remove the paper backing from the two horizontal and the vertical seals and install on the body.
4. Remove the paper backing from the two corner seals and install on the tailgate (station wagon model only).
5. Remove the paper backing from the two vertical seals and install the seals on the tailgate (Figure 10-130).
6. Secure the tailgate to the body with the six bolts, washers and the locknuts. Shim the hinges as needed to align the tailgate with the body. When aligned, tighten the bolts to 26 lb-ft (35 N•m).
7. Attach the two tailgate chains bracketed to the body and to the tailgate.

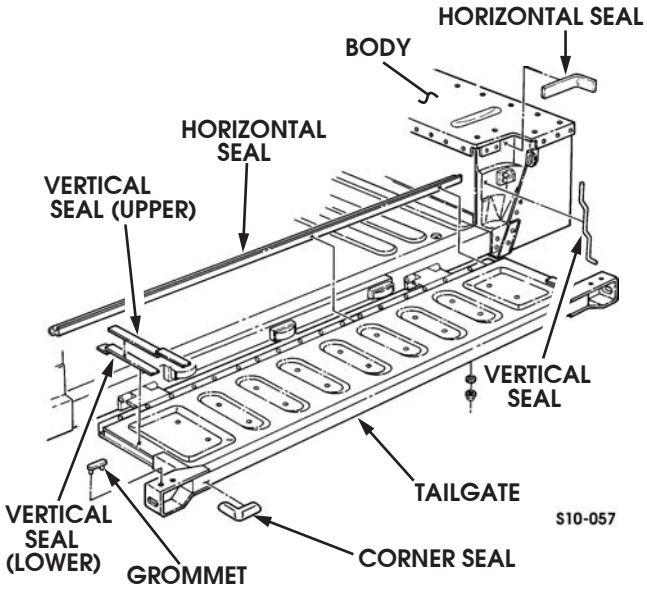


Figure 10-131: Tailgate Mounting Bracketry and Seal Location

Tailgate Chain Replacement

Removal

1. Lower the tailgate.
2. Open the chain cap link and disconnect the chain from the bracket (Figure 10-132).
3. Unhook the chain from the chain bracket.

Installation

1. Hook the chain to the chain bracket (Figure 10-132).
2. Connect the chain to the bracket.
3. Raise the tailgate.

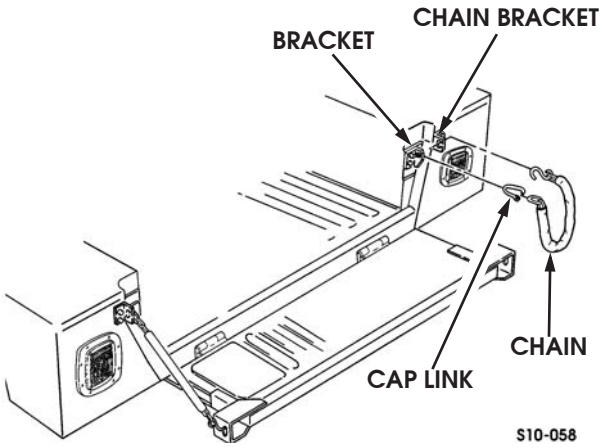


Figure 10-132: Tailgate Chain Replacement

TAILGATE HINGE REPLACEMENT

NOTE: To facilitate alignment when replacing hinges, place a small strip of masking tape along each side and bottom of hinge before removal.

Removal

Remove the tailgate by removing the six locknuts, washers and the bolts from the tailgate while still closed. Note the number of shims under each hinge and set them aside. Remove the tailgate by releasing the tailgate chains (Figure 10-133).

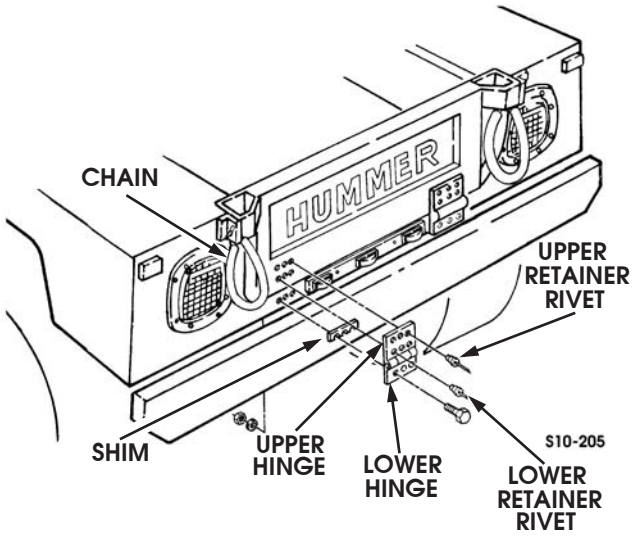


Figure 10-133: Tailgate Hinge Replacement

Disassembly

1. Place the tailgate on a padded work surface and remove the hinge retainer rivets. Remove the hinge and clean any debris from the rivet holes.
2. Clean the tailgate and apply a light coat of seam sealant to the hinge mounting area.

Assembly

1. Transfer hole position with long scribe or use a paper template to mark hole location on new hinge. Drill holes with 3/16” drill and deburr.
2. Using three 0.187 in. x 0.626 in. rivets, fasten the hinge to the lower set of holes on the tailgate.
3. Fasten the hinge to the upper set of holes on the tailgate with the three 0.187 in. x 0.563 in. rivets.

Installation

1. Position the tailgate on the bed and secure with the tailgate chains. Loosely install the bolts, washers and the locknuts into the hinges. Insert the proper amount of shims under each hinge.
2. Slightly tighten the bolts, but not tight them enough to restrict movement into alignment with tape marks.
3. Align the hinges and the tailgate into proper position and torque the bolts to 26 lb-ft (35 N•m). Remove any excess sealant from the hinges and the body.
4. Refinish the hinges and the fasteners as required.

VERTICAL DOOR REPLACEMENT

Removal

1. Remove the seven screws securing the hinge to the door.
2. Slowly pull the door away from the hinge to expose the interior lock harness connections.
3. Disconnect the interior door lock harness from the contacts on the hinge and tape to the door to prevent loss.

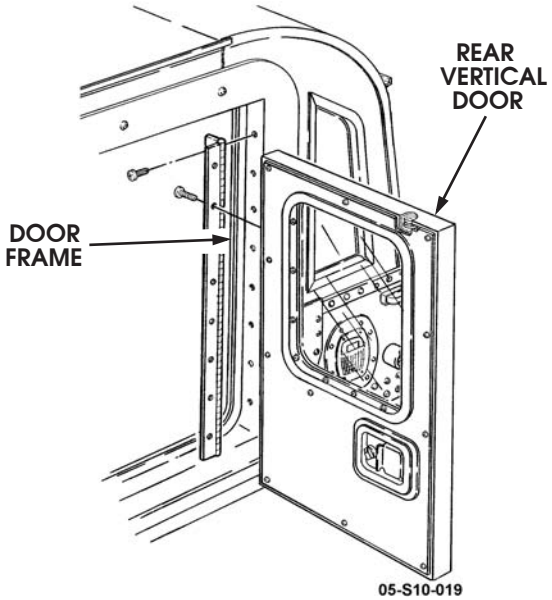


Figure 10-134: Rear Vertical Door Replacement

Installation

1. Position the door close to the hinge to allow the interior door lock harness to be connected to the contacts on the hinge.
2. Secure the hinge to the door frame with the seven screws (Figure 10-134).
3. Verify the operation of the door locks and the door latch.
4. If alignment is necessary, loosen the seven screws on the interior side of the door hinge. The slots in the hinge will allow up and down adjustment.

5. Tighten the seven screws in the hinge.

Window Replacement

Removal

Remove the eleven screws, window retainer bracket and the window from the rear vertical door (Figure 10-135).

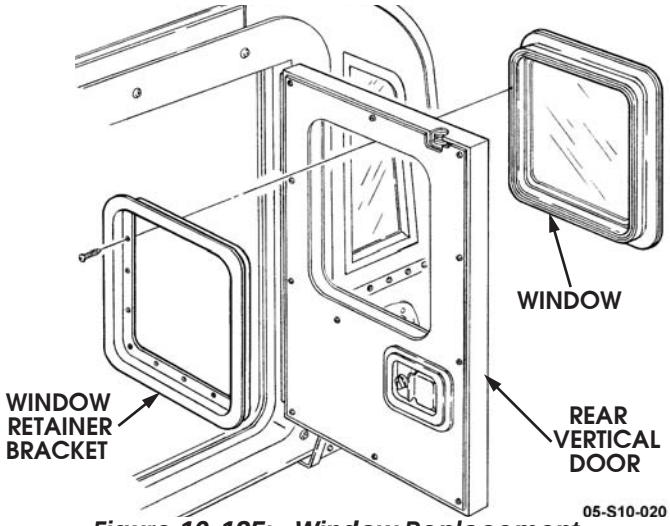


Figure 10-135: Window Replacement

Installation

Secure the window to the rear vertical door with the window retainer bracket and the eleven screws (Figure 10-135).

Door Handle Replacement

Removal

1. Remove the rear door window.
2. Remove the four screws and the interior door handle from the door (Figure 10-136).
3. Remove the twelve screws and the close-out panel from the door.
4. Remove the two cotter pins, washers and the latch rods from the exterior door handle.
5. Remove the lock motor rod from the door handle (Figure 10-138).
6. Remove the four spacers and the exterior door handle from the door.

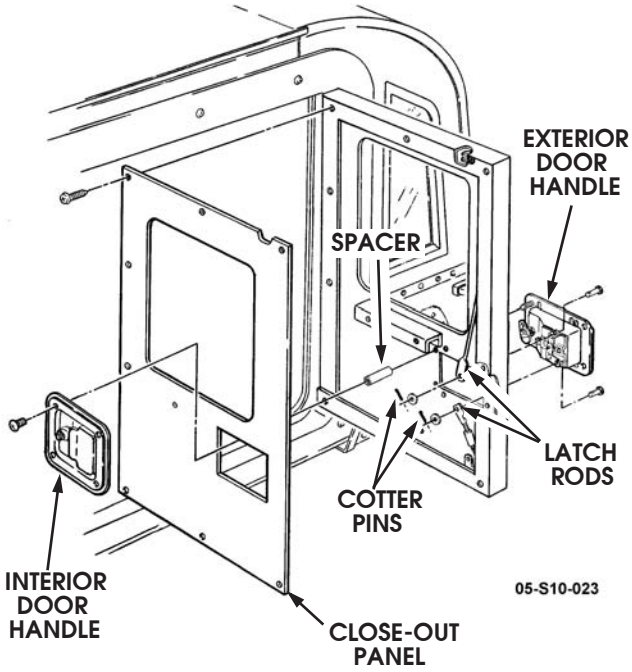


Figure 10-136: Door Handle Replacement

Installation

1. Secure the exterior door handle to the door with the four spacers (Figure 10-136).
2. Install the lock motor rod to the door handle lock latch with the plastic clip (Figure 10-138).
3. Secure the latch rods to the exterior door handle with the two washers and the cotter pins.
4. Secure the close-out panel to the door with the twelve screws.
5. Secure the interior door handle to the door with the four screws.
6. Install the rear door window.

Door Latch and Latch Rod Replacement

Removal

1. Remove the rear door window.
2. Remove the four screws and the interior door handle from the door (Figure 10-137).
3. Remove the twelve screws and the close-out panel from the door.
4. Remove the pin connector, cotter pin, washer and the latch rod from the exterior door handle.
5. Remove the lock motor rod from the door handle (Figure 10-138).
6. Remove the four screws and the lower door latch bracket from the door.
7. Remove the cotter pin and the latch rod from the lower door latch.
8. Remove the four screws and the locknuts holding the lower door latch to the lower door latch bracket (Figure 10-137).

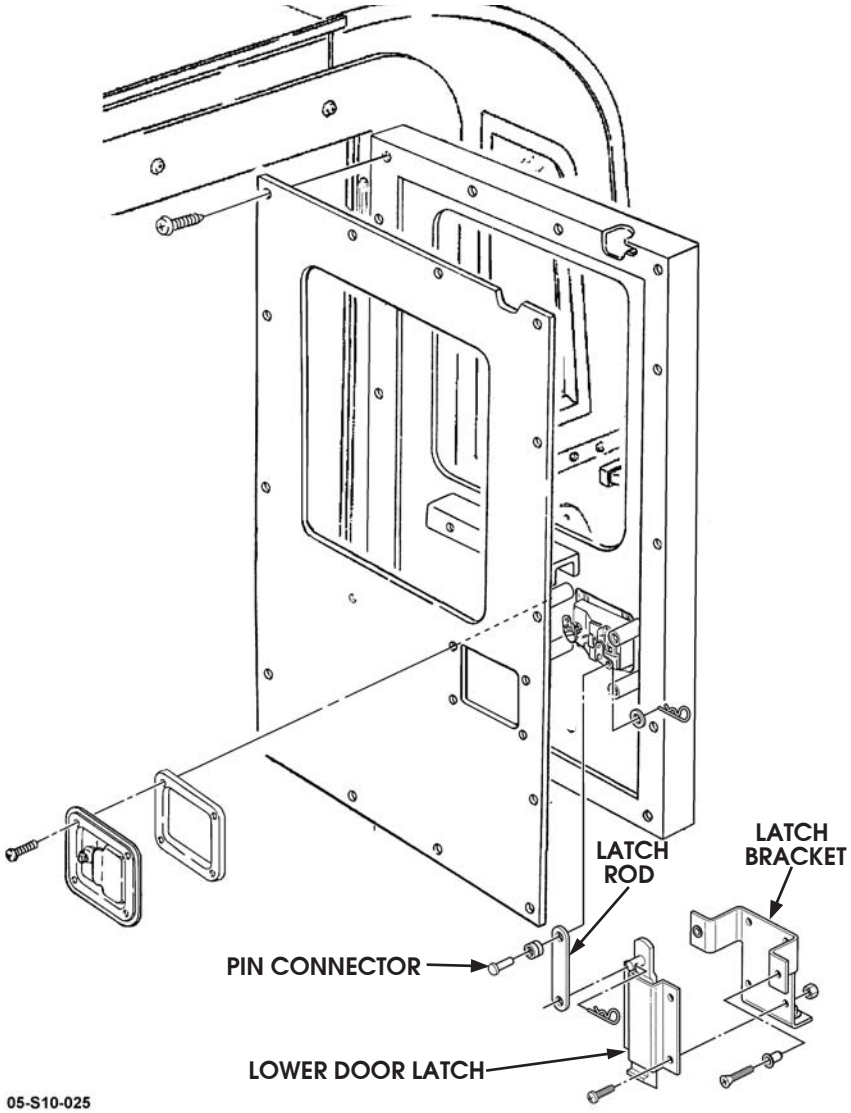


Figure 10-137: Door Latch and Latch Rod Replacement

Installation

1. Secure the lower door latch to the lower door latch bracket with the four screws and the locknuts (Figure 10-137).
2. Secure the latch rod to the lower door latch with the cotter pin.
3. Secure the lower door latch bracket to the door with the four screws.
4. Secure the latch rod to the exterior door handle with the pin connector, washer and the cotter pin (Figure 10-137).
5. Install the lock motor rod to the door handle lock latch with the plastic clip (Figure 10-138).
6. Secure the close-out panel to the door with the twelve screws.
7. Install the rear door window. Secure the interior door handle to the door with the four screws.

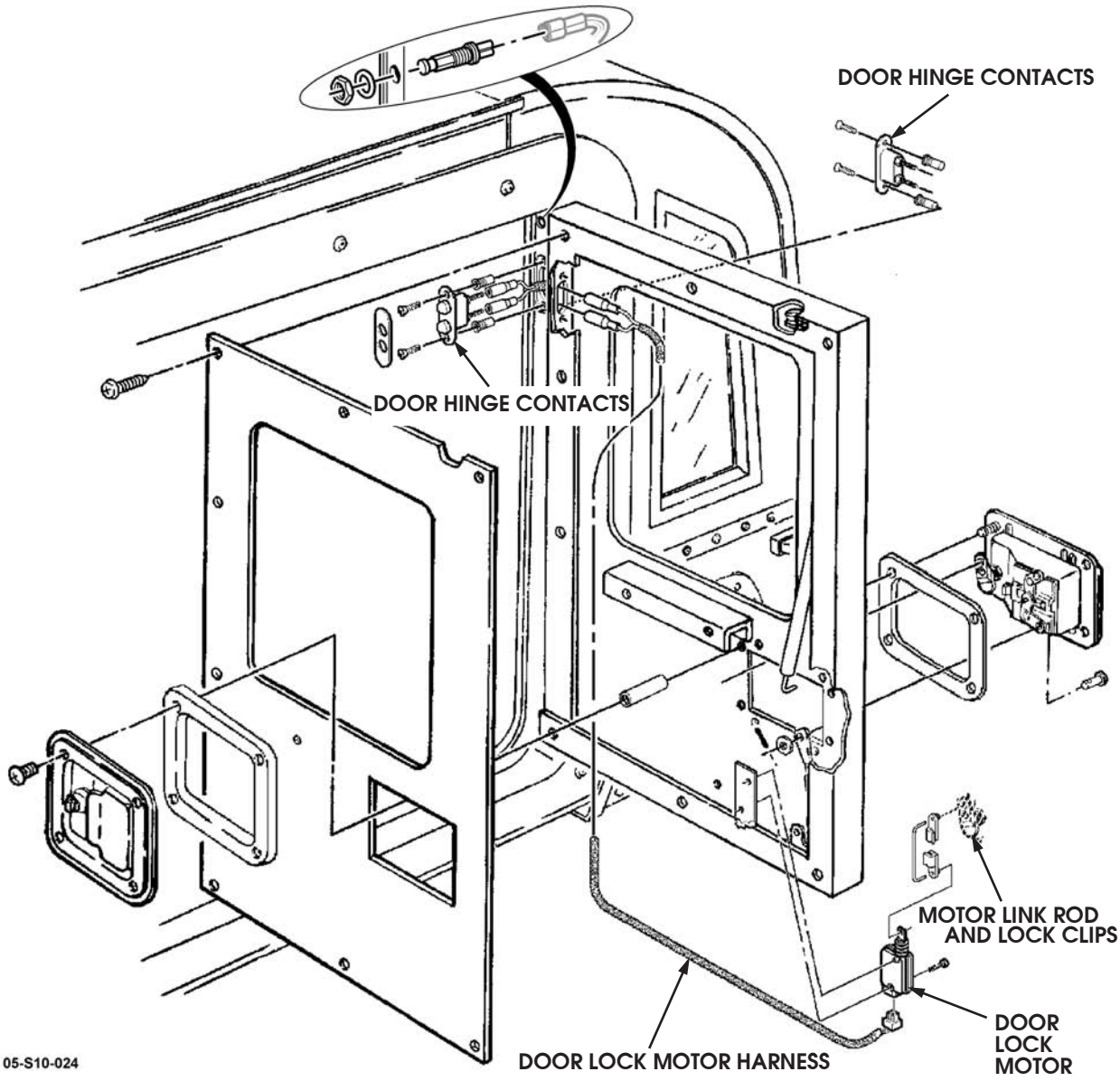


Figure 10-138: Cargo Door Electric Locks

Door Stop Replacement

Removal

1. Remove the rear door window.
2. Remove the four screws and the interior door handle from the door (Figure 10-137).
3. Remove the twelve screws and the close-out panel from the door.
4. Remove the bolt, door stop ball and the retainer from the door (Figure 10-139).
5. Remove the bolt, washer, door stop socket and the retainer from the right rear wheelhouse.

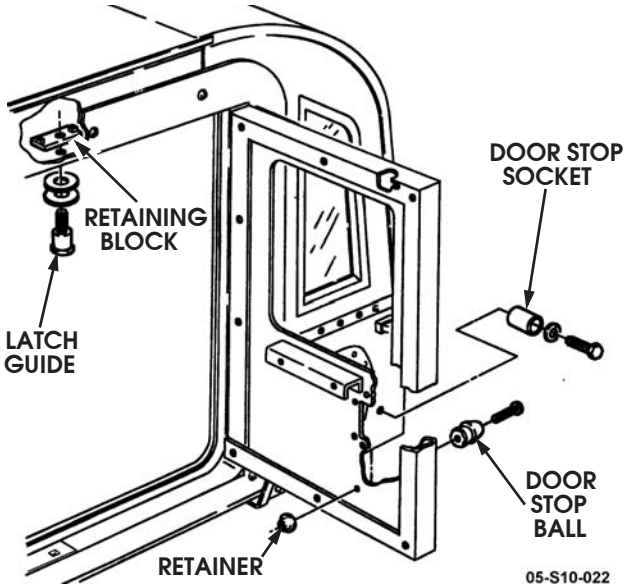


Figure 10-139: Door Stop and Latch Guide Replacement

Installation

1. Secure the door stop socket to the right rear wheelhouse with the washer, bolt and the retainer (Figure 10-139).
2. Secure the door stop ball to the door with the bolt and the retainer.
3. Secure the close-out panel to the door with the twelve screws (Figure 10-137).
4. Secure the interior door handle to the close-out panel with the four screws.
5. Install the rear door window.

Latch Guide Replacement

Removal

Remove the latch guide, two washers and the retaining block from the door frame (Figure 10-139).

Installation

Secure the latch guide to the door frame with the two washers and the retaining block (Figure 10-139).

Adjustment

Close the door and check the alignment, then adjust the latch guide as necessary.

Door Frame and Seal Replacement

Removal

1. Remove the dome lamp fuse.
2. Remove the seven screws securing the inner portion of the door hinge to the door frame.
3. When the hinge is loose, carefully pull away to access the connectors for the door lock contacts in the hinge.
4. Disconnect the door lock harness connectors and label them for reassembly.
5. Remove the vertical doors from the door frame.
6. Remove the upper and the lower latch guides.
7. Remove the inner passenger side closeout panel on the inside of the door frame.
8. Disconnect the dome lamp switch harness from the door jamb switch.
9. Remove the fourteen screws from the door frame (Figure 10-140).
10. Remove the door frame completely

11. Remove the seal from the door frame.

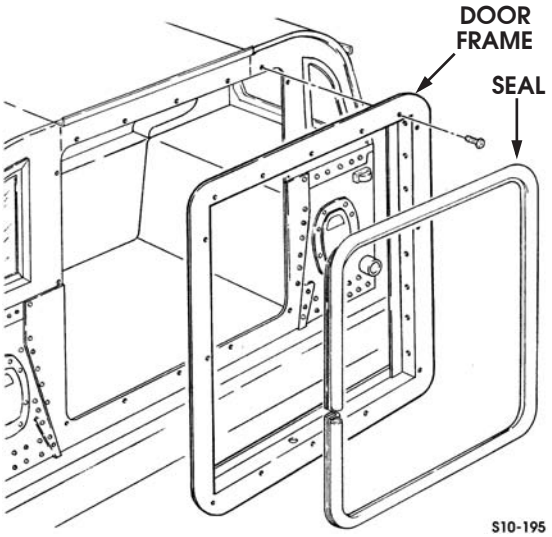


Figure 10-140: Door Frame and Seal Replacement

Installation

1. Position the seal on the door frame (Figure 10-140).
2. Secure the door frame to the vehicle with the fourteen screws.
3. Install a new door jamb switch and connect it to the dome lamp harness.
4. Install the upper and the lower latch guides.
5. Install the vertical doors on the door frame.
6. Connect the door lock harness connections to the back of the door hinge contacts.
7. Install the interior closeout panel.
8. Close the door to adjust the new door jamb switch.
9. Install the dome lamp fuse.
10. Verify the operation of the door lamps and the cargo switch.

INTERIOR AND EXTERIOR LIGHTING REPLACEMENT

Service Headlight Assembly Replacement

Removal

NOTE: To remove the headlight only, perform steps 1 and 2. To remove the entire assembly, continue with steps 3 through 6.

1. Loosen the three screws and remove the retaining ring from the headlight mount (Figure 10-141).
2. Disconnect the headlight jumper harness from the headlight and the remove headlight.
3. Loosen the two screws securing the headlight mount to the headlight housing and remove the mount from the housing and the spring.
4. Disconnect the headlight jumper harness from the headlight housing and remove the harness.
5. Disconnect the three leads from the back of the housing.
6. Remove the three nuts, lockwashers, washers and the housing from the hood.

Installation

NOTE: To install the headlight only, perform steps 5 and 6. To install the entire assembly, perform all the steps.

1. Connect the three leads to the back of the housing (Figure 10-141).

2. Secure the headlight housing to the hood with the three washers, lockwashers and the nuts.
3. Secure the headlight mount to the housing, with the spring and the two screws.
4. Connect the headlight jumper harness to the headlight housing.
5. Connect the headlight to the jumper harness and secure the headlight to the headlight mount with the retaining ring and the three screws.
6. Check the headlight for proper operation.

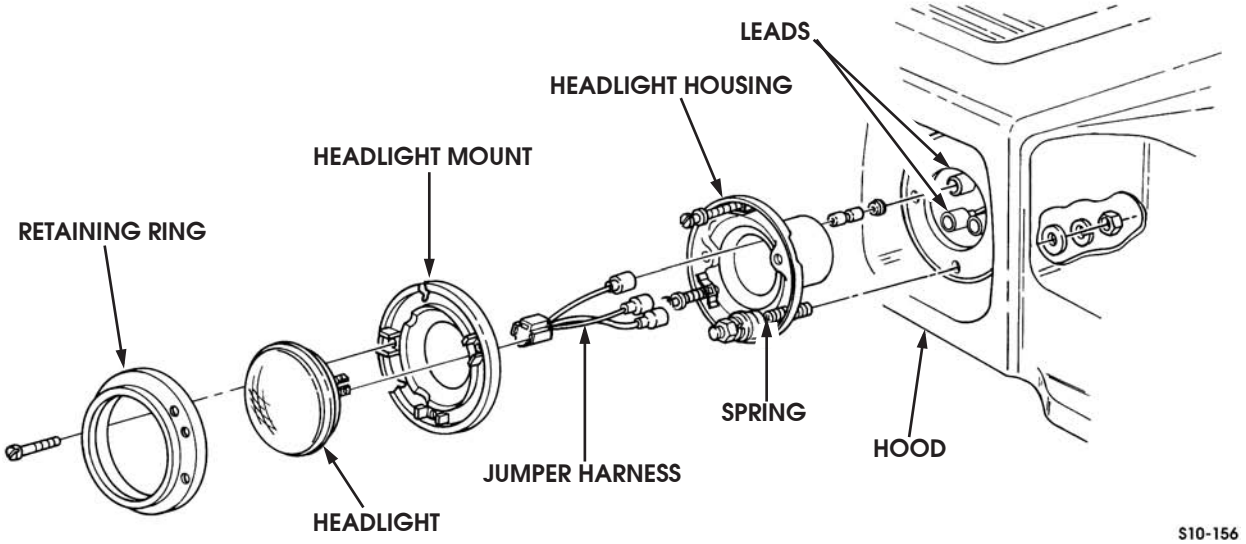


Figure 10-141: Headlight Assembly Replacement

Side Marker Light Lens and Lamp Replacement

Removal

1. Remove the two retaining screws and pull the side marker light away from the body until the harness is exposed. (Figure 10-142).
2. Disconnect the harness and remove the side marker light.
3. Remove the bezel and the gasket.

Installation

1. Feed the side marker light through the gasket and the bezel.(Figure 10-142).
2. Connect the side marker light harness to the underbody harness.
3. Align the side marker light, gasket and the bezel with the mounting holes on the body and secure with the retaining screws.
4. Ensure the side marker light operates properly.

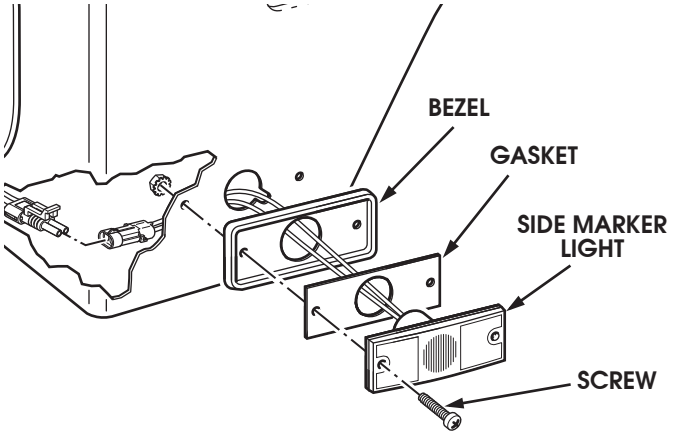


Figure 10-142: Side Marker Light Lens and Lamp Replacement

Identi cation Light Replacement

NOTE: All identification lights are replaced the same. The bulb is not removable from the lens. The light is replaced as an assembly.

Removal

1. Carefully pry the tabbed sides of the identification light from the light bracket (Figure 10-143).
2. Disconnect the light from the wiring harness.

Installation

1. Connect the identification light to the wiring harness (Figure 10-143).
2. Snap the light into the light bracket.

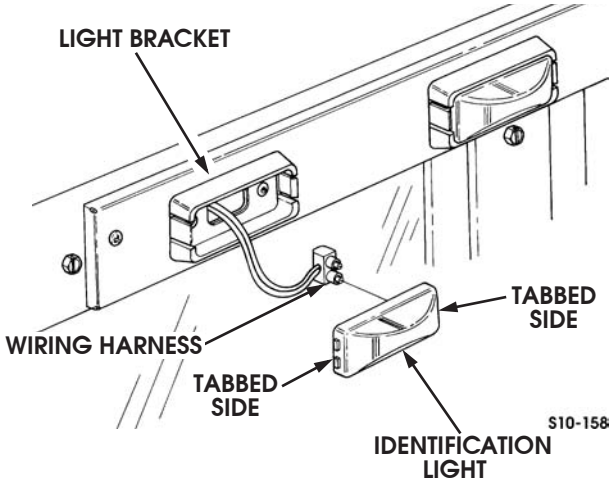


Figure 10-143: Identification Light Replacement

Side Marker Light Assembly Replacement

NOTE: Replacement of the front and the rear light assemblies is basically the same. This procedure covers the front left side marker.

Removal

1. Remove the four screws, washers and the close-off cover from the hood (Figure 10-144).
2. Disconnect the harness lead from the marker light harness (Figure 10-145).
3. Remove the two screws, the side marker light, gasket and the bezel.

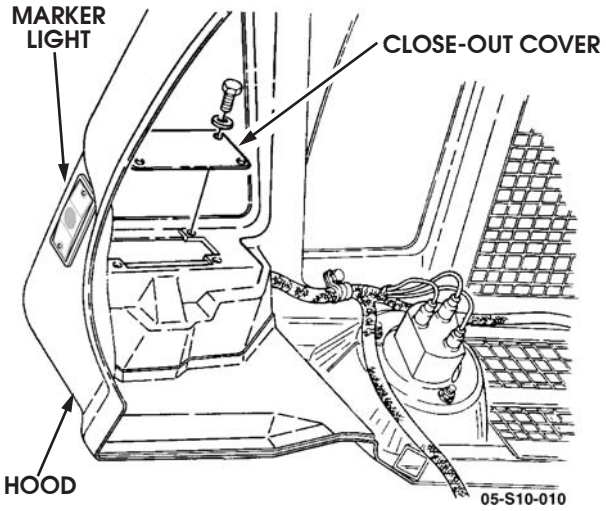


Figure 10-144: Close-Out Cover Location

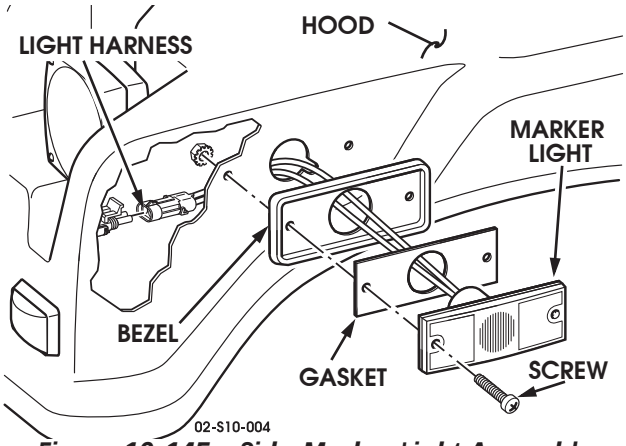


Figure 10-145: Side Marker Light Assembly

Installation

1. Feed the side marker light through the gasket and the bezel (Figure 10-144).
2. Connect the side marker light harness to the underbody harness.
3. Align the side marker light, gasket and the bezel with the mounting holes on the body and secure with the retaining screws.
4. Secure the close-out cover to the hood with the four washers and the screws (Figure 10-145)
5. Ensure the side marker light operates properly.

Front Turn Signal Light Replacement

Removal

NOTE: To remove the lamp only, perform steps 1 and 2.

1. Remove the four screws, lens and the gasket from the turn signal light (Figure 10-146).
2. Remove the lamp from the socket.

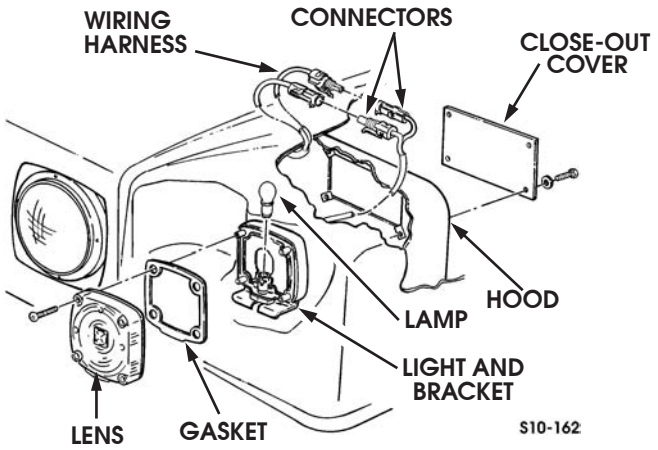


Figure 10-146: Front Turn Signal Assembly Breakdown

3. Remove the four screws, washers and the close-out cover from the hood.
4. Disconnect the two connectors from the wiring harness.
5. Remove the two nuts and the lockwasher assemblies, washers, bracket and the light from the hood (Figure 10-147).
6. Remove the two screws, lockwashers and the light from the bracket.

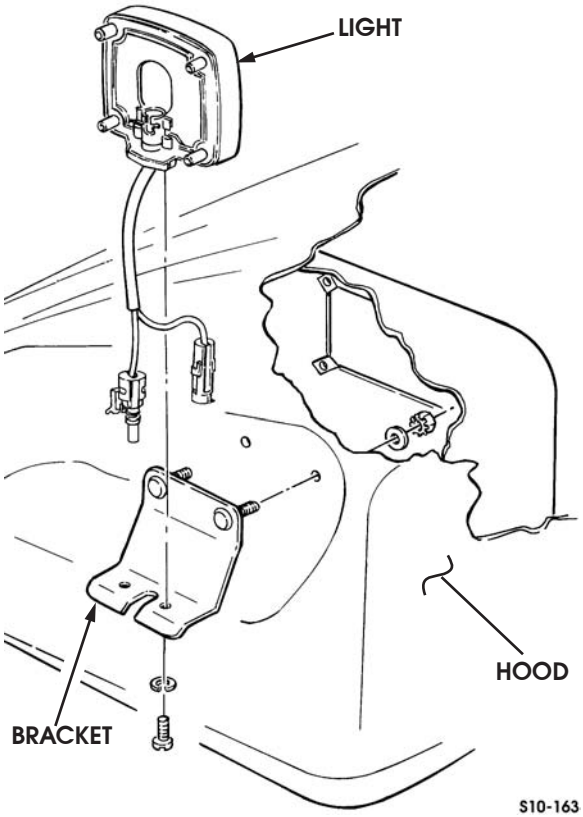


Figure 10-147: Front Turn Signal Bracket

Installation

NOTE: To install the lamp only, perform steps 5 and 6.

1. Secure the light to the bracket with the two lockwashers and the screws (Figure 10-147).
2. Secure the bracket and the light to the hood with the two washers and the nuts and the lockwasher assemblies.
3. Connect the two connectors to the wiring harness (Figure 10-146).

4. Secure the close-out cover to the hood with the four screws and the washers.
5. Install the lamp in the socket.
6. Secure the gasket and the lens to the light with the four screws.
7. Ensure the turn signal works properly.

Rear Turn Signal Light Replacement

Removal

NOTE: To remove the lamps only, perform steps 1 and 2.

1. Remove the four screws, lens and the gasket from the turn signal light (Figure 10-148).

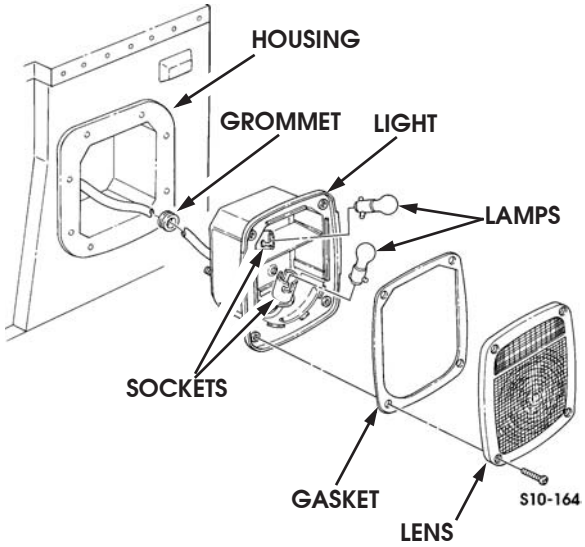


Figure 10-148: Rear Turn Signal Light Assembly

2. Remove the two lamps from the sockets.
3. From behind the light, remove the three nuts, lockwashers, four leads and the three washers securing the light to the light housing (Figures 10-148 and 10-149).
4. Remove the two nuts, clamps and the screws securing the harness to the shield (Figure 10-149).
5. Remove the two screws, lockwashers and the shield from the beam.
6. Disconnect the two connectors from the wiring harness.
7. Remove the light and the grommet from the housing (Figure 10-148).

Installation

NOTE: To install the lamps only, perform steps 6 and 7.

1. Install the light and the grommet in the housing (Figure 10-148).
2. Connect the two connectors to the wiring harness (Figure 10-149).
3. Secure the harness to the shield with the two screws, clamps and the nuts.
4. Secure the shield to the beam with the two lockwashers and the screws.
5. Secure the light to the light housing with the three washers, four leads, three lockwashers and the nuts (Figures 10-148 and 10-149).
6. Install the two lamps in the sockets (Figure 10-148).
7. Secure the gasket and the lens to the light with the four screws.
8. Ensure the turn signal and the backup lights work properly.

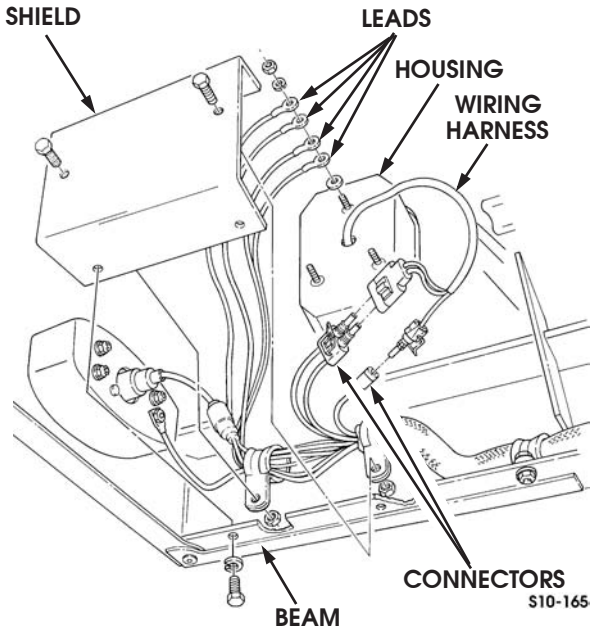


Figure 10-149: Shield and Wiring Location

Domelight/Cargo Light Replacement Removal

1. Remove the domelight lens (Figures 10-150, 10-151, and 10-152).
2. Remove the lamp from the domelight.
3. Remove the screws securing the domelight to the ground lead and the connector.
4. Remove the screw and the domelight from the roof bracket.

Installation

1. Secure the domelight, connector and the ground lead to the roof bracket with the screws (Figures 10-150, 10-151, and 10-152).
2. Install the lamp in the domelight.
3. Install the domelight lens.

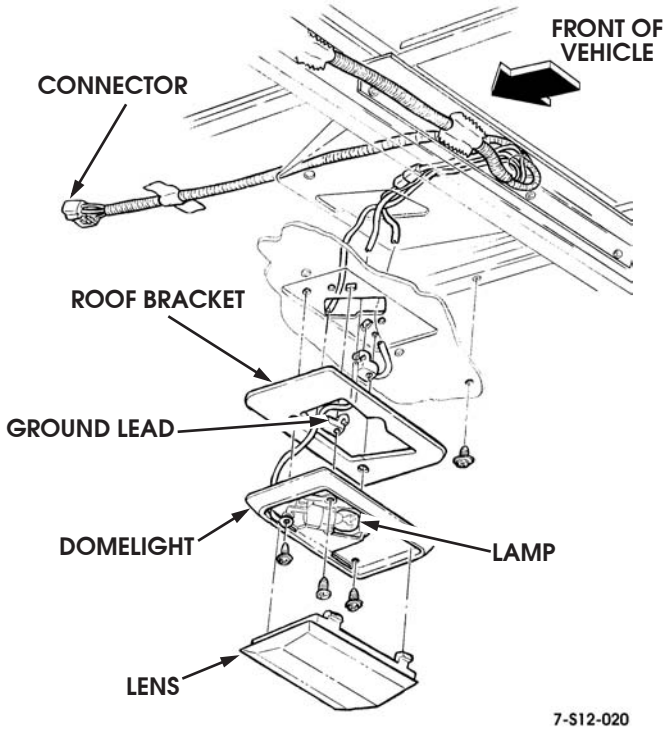


Figure 10-150: Standard Domelight Replacement

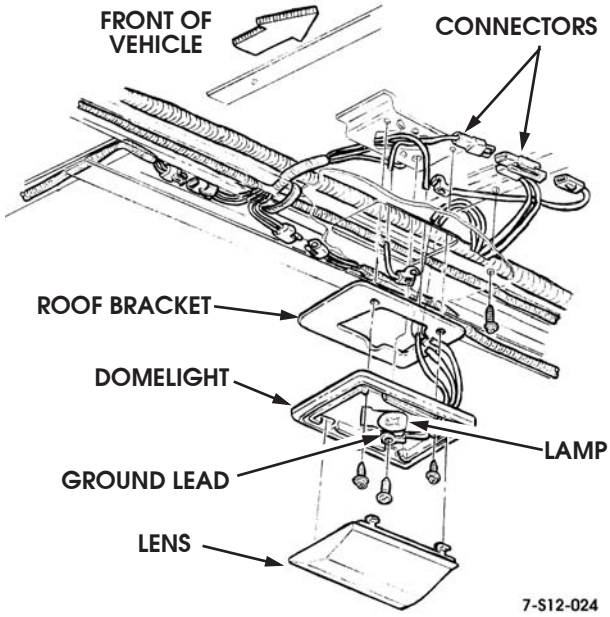


Figure 10-151: Rear Domelight (HMCS)

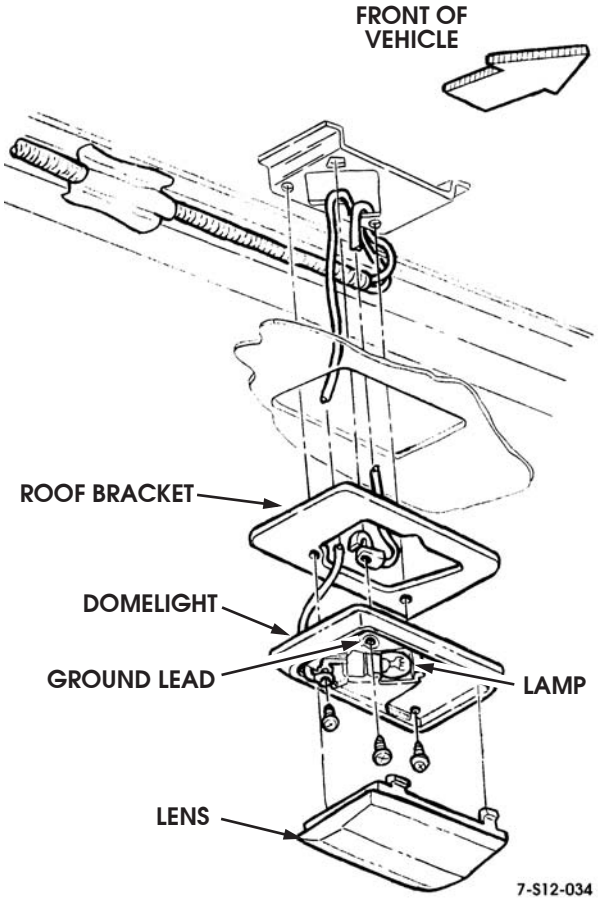


Figure 10-152: Cargo Light (HMCS)

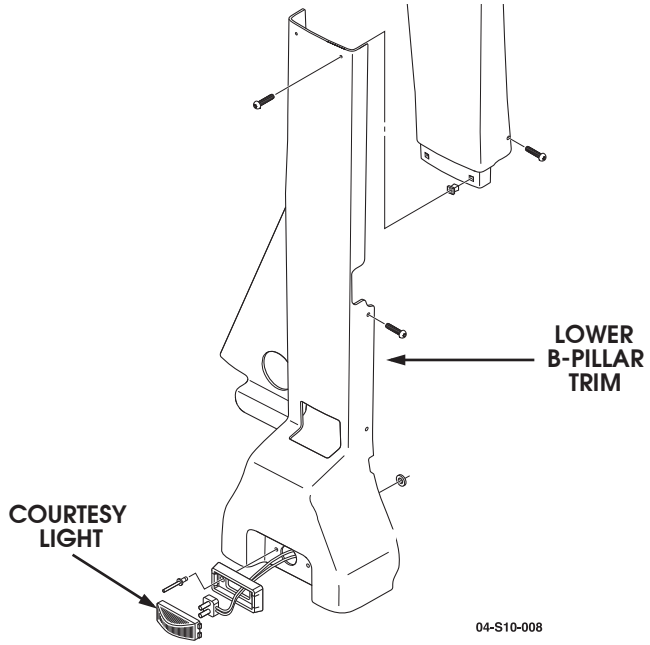


Figure 10-153: Rear Seat Courtesy Light Replacement

Underhood Light Replacement

Removal

1. Disconnect the two connectors from the wiring harness (Figure 10-154).
2. Remove the two screws, washers, ground lead, bracket and the light from the hood.
3. Remove the lamp from the light.

Installation

1. Install the lamp in the light (Figure 10-154).
2. Secure the light, bracket and the ground lead to the hood with the two washers and the capscrews.
3. Connect the two connectors to the wiring harness.

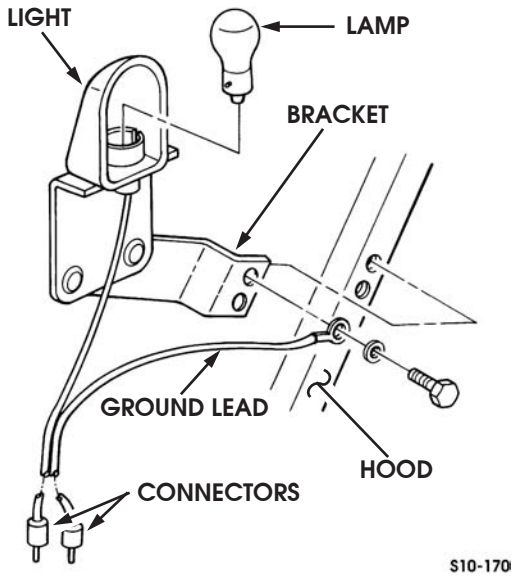


Figure 10-154: Underhood Light Replacement

Daytime Running Lights (DRL) Module Replacement (Canada Only)

Removal

1. Disconnect the Daytime Running Lights (DRL) connector from the harness assembly (Figure 10-155).
2. Remove the two screws, washers, nuts and the DRL module from the kick panel.

Installation

1. Secure the DRL module to the kick panel with the two screws, washers and the nuts (Figure 10-155).
2. Connect the DRL connector to the harness assembly.

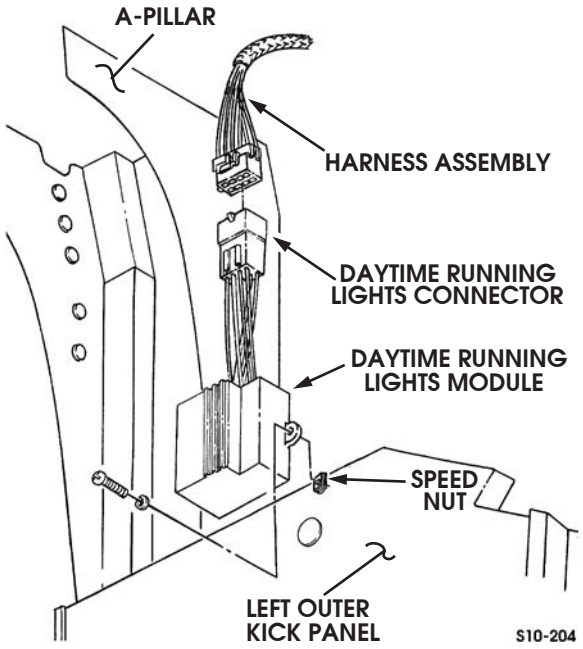


Figure 10-155: Daytime Running LIghts Module

Front Driver and Passenger Courtesy Light Replacement

Removal

1. Carefully pry the courtesy light from the mounting bracket (Figures 10-156 and 10-157).
2. Disconnect the light from the wiring harness.

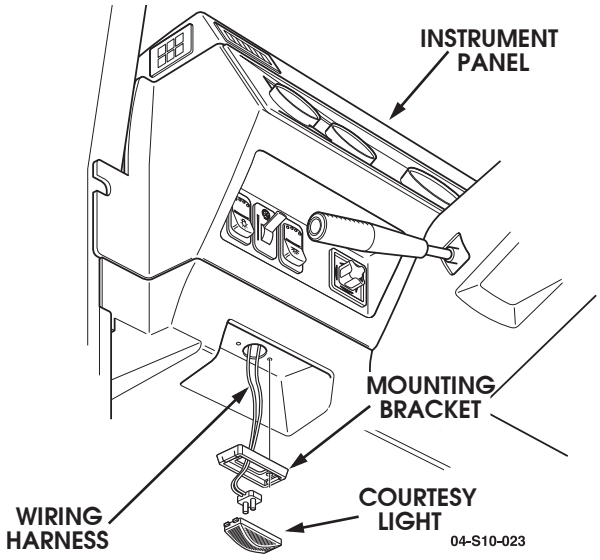


Figure 10-156: Front Driver Side Courtesy Light Replacement

Installation

1. Connect the courtesy light to the wiring harness (Figures 10-156 and 10-157).
2. Snap the light into the mounting bracket.

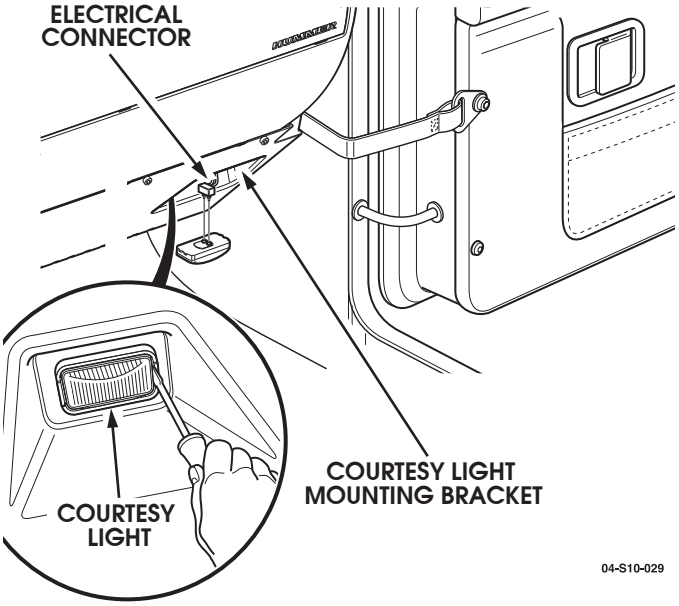


Figure 10-157: Front Passenger Side Courtesy Light Replacement

Headlight Electrical Connector and Grommet Replacement

Removal

1. Remove the headlight and the jumper harness.
2. Remove the connector from the grommet (Figure 10-158).
3. Remove the grommet from the headlight housing.

Installation

1. Install the grommet in the headlight housing (Figure 10-158).
2. Install the connector in the grommet.
3. Install the jumper harness and the headlight.

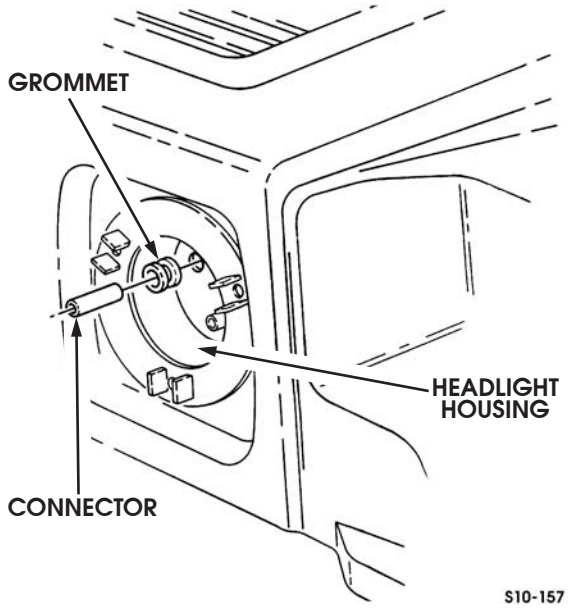


Figure 10-158: Headlight Electrical Connector and Grommet Replacement

THIS PAGE INTENTIONALLY BLANK.

Section 11 Heating/Ventilation/Air Conditioning (HVAC)

TABLE OF CONTENTS

A/C System Refrigerant and Capacity 11-6
Blower Motor Resistor Replacement 11-30
Climate Control System
- A/C Pressure Hose Replacement 11-19
- Condenser Replacement 11-22
- Control Head Replacement 11-17
- Heater Hose Replacement 11-25
- Heater/A/C Diagnosis 11-2
- System Performance Checks 11-2

Compressor
- Replacement 11-28

Evaporator 11-43
- Air Intake Assembly Replacement 11-47
- Cycling Switch Replacement 11-47

HVAC
- Ambient Temperature Switch 11-29
- Auxiliary HVAC Unit
  - A/C Drain Tube(s) Replacement 11-50
  - Blower Motor Replacement 11-53
  - Blower Switch Replacement 11-49
  - Evaporator/Heater Core Replacement 11-52
  - Expansion Valve Replacement 11-54
  - Heater Hose Replacement 11-49
  - High-Pressure Hose Replacement 11-51
  - Low-Pressure Hose Replacement 11-52
  - Replacement 11-47
- Blend Door Motor 11-41
- Compressor
  - Description 11-2
- Condenser 11-29
- Controls 11-31
- Drain Tube Replacement 11-27
- Essential Tools 11-56
- Heater Hose Replacement 11-25
- High Pressure Cutoff Switch 11-30
- Low Pressure Cutoff Switch 11-24
- Main HVAC Unit 11-33
  - Blower Motor 11-37
  - Diverter Doors 11-33
  - Evaporator 11-36
  - Expansion Valve 11-36
  - Heater Core 11-35
  - Replacement 11-37
  - Thermostatic Cycling Switch 11-36
- Receiver Dryer Replacement 11-23
- Receiver/Dryer 11-29
- Receiver/Dryer Pressure Switch Replacement 11-25
- Special Tools 11-57
- Specifications 11-15

System Description 11-2
System Diagnosis 11-9
System Performance Checks 11-2
Unit Service 11-32
Vacuum Door Motor 11-40
Vacuum Pump 11-55
Water Control Valve 11-26
Water Control Valve Replacement 11-26
Pressure Hose Torque Specifications 11-18

HVAC SYSTEM DESCRIPTION

The heating, ventilating, and air conditioning system consists of the main unit, auxiliary unit, ducting for air, hoses to transport refrigerant, coolant hoses, a water valve, A/C compressor, condenser, receiver dryer, expansion valve, safety switches and vacuum pump. Function of the system is controlled by the vehicle operator using the control panel on the console.

Auxiliary Unit

A secondary HVAC unit is used on all 4-passenger vehicles as standard equipment. The auxiliary unit includes a secondary heater core, evaporator, expansion valve, blower motor and controls. Both the heater and A/C work in parallel with the main unit, requiring that the main system be in operation to activate the auxiliary unit. The blower in the auxiliary unit is operated using a 3-position switch on the console and provides 2 speeds and an off position.

A/C COMPRESSOR DESCRIPTION

All 2006 vehicles use a common Denso compressor. The compressor is belt driven off the engine accessory drive and utilizes an electric clutch to engage and disengage the compressor drive. The compressor is lubricated with required GM PAG oil. The compressor is specifically designed to operate with R134a refrigerant.

SYSTEM PERFORMANCE CHECKS

Before performing any air conditioning repair, perform the following:

1. Check the drive belt for wear, damage or loss of tension. Replace drive belt as necessary.
1. Check the compressor for secure mounting and proper alignment. Tighten loose hardware and align as necessary.
2. Visually inspect the compressor, hoses and other accessible parts of the system for damage or leaks. Look for patches of dirt, dust, and oil build-up. Refrigerant leaks usually involve compressor oil loss. This is especially applicable to the clutch end of the compressor.
3. Verify operation of the climate control system by performing the following:
   a. With the mode (air flow) control knob set to OFF, run the engine to operating temperature (180°-240°F (82°-116°C)).
   b. Rotate the temperature control knob clockwise until it stops at the warmest setting.
   c. Rotate the mode control knob counterclockwise until it stops at the face setting.
   d. Turn the fan control knob to any setting above LO and note the direction and temperature of the air flow.
   e. Verify that heated air is coming from the instrument panel vents.
   f. Rotate the mode control knob clockwise to the next setting, floor vents, and verify that heated air comes from the appropriate vents.
   g. Continue checking the air flow positions, floor/defrost blend, and defrost.

NOTE: Any time the air flow control knob is placed in defrost or a defrost blend position (with an ambient temperature above 40°F), the compressor clutch engages to dehumidify the incoming air.

   h. Rotate the temperature control knob counterclockwise to its coldest extreme. Verify that cold air comes from the defrost vents. If the outside air temperature is 40°F or warmer, the refrigeration system will be responsible for cooling the air. If it is cooler than 40°F, the compressor will not cycle and the incoming air will simply be the outside air directed into the passenger compartment.

i. Rotate the mode control knob counterclockwise until it stops at the Max A/C panel setting and verify that the compressor clutch engages and the air becomes colder. Turn the mode dial to the A/C setting. Verify that the air recirculation door closes and the system brings in outside air.

j. Check that the blower motor delivers air at four different speeds. If not, perform the electrical troubleshooting. Repair or replace the blower motor, switch, relay or blower motor resistor card.

k. Check the water control valve operation, heater shutoff valve should open completely when the temperature control knob is rotated clockwise.

Heating System Tests

In most cases, a low heat condition means an insufficient quantity of heated engine coolant is flowing through the heater core. Check as follows:

1. Check the engine coolant level. If the level is low, add coolant and inspect for leaks. If the coolant level is correct, continue with the tests.
2. Check the pressure cap on surge tank for improper sealing with tester J–24460-01 or equivalent. If the cap is OK, continue with the tests. Replace the cap if it fails to seal and recheck the heater operation.
3. Set the heater controls to the highest heat setting.
4. Operate the engine until the coolant is at normal operating temperature (180-220° F or 82-113° C).
5. Check the temperature of the coolant flowing through the heater core inlet and outlet hoses.
   - If both hoses feel hot and are about the same temperature, the water control valve is OK and the core is not restricted. Continue with the test.
   - If both hoses are only warm (or even cool), the engine is either not at operating temperature, or a water pump or thermostat problem has occurred.
   - If the inlet hose is cool, or only slightly warm, a water control valve or vacuum solenoid problem has occurred. Test as described in this section.
6. If heat output is still unsatisfactory but all else checks correctly, the problem is with the heat door in the main unit or in the outlet ducts.

A/C System Leak Testing

There are two methods of detecting refrigerant leaks. One method is with the use of an electronic leak detector and the other uses a fluorescent tracer dye in the refrigerant which is viewed at the leak site with an ultra violet (black) light.

Dye leak testing

R134a florescent dye will remain in the lubricant for the life of the vehicle as long as the vehicle's AC system has not been flushed. To perform a dye leak test, do the following:

1. Recover the existing R134a refrigerant and record the refrigerant weight.
2. Add R134a florescent dye J–41447 using the dye injector J–41459.
3. Recharge the AC system following the procedures outlined in chapter 11.
4. Check for leaks using the high intensity black light J-42220. If no leaks can be found, advise the customer of the dye in the system and that it may need to be checked at a later date.

Electronic leak testing

Recommended electronic leak detector is the D-Tek, pocket portable model (Figure 11-1). It is self powered by NiCad batteries, extremely compact, and will locate leaks as small as 1/4 ounce. The Kent-Moore Tool number is J–41995.

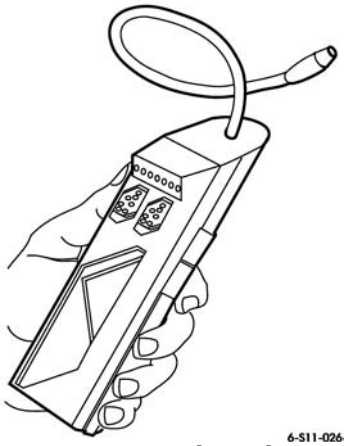


Figure 11-1: D-Tek Leak Detector

The D-Tek probe is flexible and can be used to make a 360° check of each hose connector and fitting. The correct method of leak testing fittings is shown in (Figure 11-2)

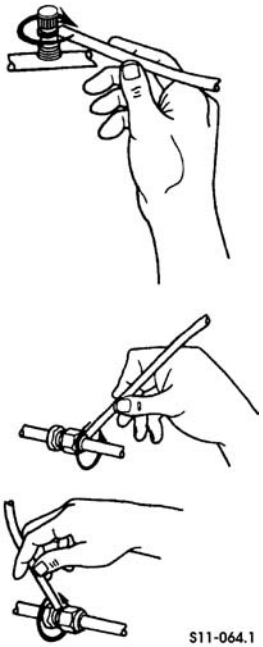


Figure 11-2: Leak Testing Technique at Connections

A/C system potential leak points are outlined in (Figure 11-3). Be sure to check each fitting and connector carefully with the D-Tek tool.

CONNECTOR IDENTIFICATION

1. COMPRESSOR-OUT
2. CONDENSER - IN
3. CONDENSER - OUT
4. DRYER - IN
5. DRYER - OUT
6. H/P AUX TEE - IN
7. H/P AUX TEE - OUT
8. AUX EVAP - IN
9. AUX EVAP - OUT
10. MAIN EVAP - IN
11. MAIN EVAP - OUT
12. L/P AUX TEE - IN
13. L/P AUX TEE - OUT
13. L/P AUX TEE - OUT
13. L/P AUX TEE - OUT
15. COMPRESSOR - FRONT SEAL
16. SCHRADER VALVES

NOTE: Move the detector wand at a slow, consistent rate above and below and around fittings/connections. Carefully inspect all hose connections to metal ferrules on crimp shells. Also test the small inspection holes on the shells.

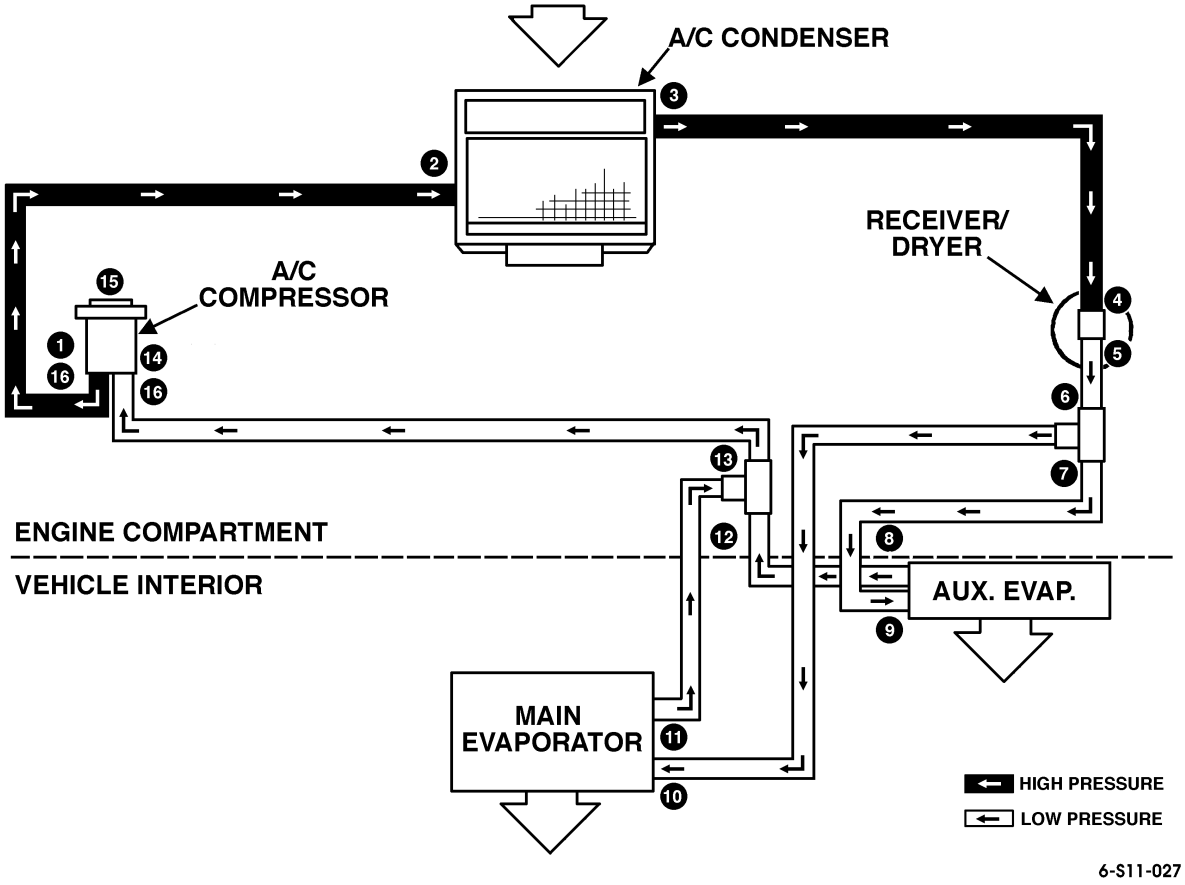


Figure 11-3: A/C System Leak Check Points

A/C SYSTEM REFRIGERANT AND CAPACITY

The required refrigerant for HUMMER H1 A/C systems is R-134a. This is a colorless, odorless non-flammable, liquefied gas. System refrigerant capacity is: 2 lbs 4 oz.

A special refrigerant oil is required for use with R-134a which is polyalkaline glycol (PAG). This is the only oil that can be used with R-134a refrigerant. More specifically, General Motors® PAG oil must be used with the A/C compressor on the HUMMER H1.

CAUTION: *R12 and R-134a refrigerants are* ***not*** *compatible. They must never be intermixed. Unsatisfactory cooling, rapid sludge buildup, and compressor failure will result.*

CAPACITIES:

- Main unit with Aux 2 lbs 4oz

R-134a Refrigerant Precautions

To avoid product damage and personal injury, the following precautions should be followed when working with R-134a refrigerant.

- Wear safety goggles when servicing the A/C system as the refrigerant is under pressure.
- Never mix R-134a and R-12 refrigerants. They are incompatible and will cause severe damage to system components if mixed.
- Use an approved A/C service cart such as the Kent Moore J–39500-A to service the system. Recommended service carts are those capable of evacuation, recovery, recycling and recharging of systems with R-134a.
- The only compressor lubricant oil that can used with this system is General Motors PAG oil. Use of substitutes will result in compressor failure.
- Lubricate system fittings and o-rings with PAG oil for leak proof connections.
- Do not heat containers of R-134a above 125° F (52° C).
- Never puncture or incinerate containers of R-134a.
- Avoid breathing R-134a. The gas will irritate the nose, throat, and lungs. In addition, because R-134a is heavier than air, it can displace oxygen in a confined and a poorly ventilated area. Be sure the work area is properly ventilated in case of accidental release into the nearby atmosphere.

A/C System Pressure Test

System pressure testing involves measuring suction and discharge pressures with manifold gauge set J–39183-C or with the gauges contained in A/C service cart J–39500-A. One gauge is for high side (discharge) pressures and one for low side (suction) pressures. The gauges allow pressures to be checked while the system is in operation.

On models where access to the service ports is limited, coupler adapters J–39500-20A and J–39500-24A, will make gauge hose connection easier.

Pressure Test Procedure

1. Connect the gauge hoses on the service cart J–39500-A to the service ports on the suction and the discharge lines. The red hose goes to the high side (discharge) port and the blue hose to the low side (suction) port.
2. Note the pressure with the engine NOT running and the A/C system inoperative. There should be approximately 50 psi to 70 psi in the system. If pressure is lower or zero, a system leak exists. Add a small charge to the system. Then leak test and repair as necessary before proceeding.
3. Start and run the engine at 1200 rpm.
4. Set the A/C controls to the maximum cooling and set the blower to the highest speed.
5. Verify that the compressor clutch engages. If the clutch fails to engage, diagnose and repair before proceeding.
6. Record the low and the high side pressures. Depending on the engine speed and the shop ambient temperature, the low side pressure will range from 36-55 psi (250-382 kPa) and the high side pressure from 164-238 psi (1130-1640 kPa). Ambient temperatures will affect the refrigerant pressures in the system. On cool days, the pressures are lower, on hot days the pressures are higher. Refer to system pressure comparison chart at the end of this section.

NOTE: The relative humidity can effect outlet temperature, over 50% relative humidity will reduce outlet duct temperature.

7. If the low and the high side pressures are OK, check the air temperature at the outlet duct closest to the evaporator with a thermometer J–6742-03. The temperature should range from 59°F to 64°F with the inlet temperature between 76-85°F. Be sure the thermometer tip is inserted into the duct to a depth of at least one inch (25 mm).
8. If the low and the high side pressures are incorrect and the air duct outlet temperatures are greater than the specified, refer to the pressure test diagnosis charts for potential causes.

A/C Servicing Precautions

There are precautions that should be followed when servicing the A/C system. The precautions are necessary to avoid component damage and personal injury.

- Wear eye protection when servicing the system. The refrigerant is under pressure and will cause injury if it contacts the eyes.
- Never perform system repairs until after the system has been fully discharged.
- Do not use refrigerant recovery, recycling, charging, and evacuation/discharge servicing equipment that does not meet SAE J–2210 standards.
- Never attempt to replace system components while the engine is running.
- Avoid having R-134a contact the skin. The refrigerant can cause an injury similar to frostbite. Exercise care when handling R-134a.
- Do not allow any type of open flame near R-134a.
- Avoid breathing R-134a fumes. The refrigerant will cause eye, nose, throat and lung irritation.
- Never mix R-12 and R-134a in the same system. The two refrigerants are **not** compatible. Mixing the two will result in failure of the compressor and other system components.
- Never use PAG oil from an unsealed container. The oil will quickly absorb moisture from the air if not sealed.

Recovering (Discharging) A/C System Refrigerant

1. Shut the engine off.
2. Connect the hoses from the service cart J–39500-A to the suction and the discharge service ports. The red hose goes to the discharge side and the blue hose to the suction side. Use adapter fittings J–39500-20 and 24A if necessary. If the manifold gauge set J–39183-C is being used, connect the center hose to a recovery tank or system.

NOTE: If both gauges indicate a zero reading, the system does not contain any refrigerant. Add a small charge, leak test and make the necessary repairs before proceeding.

3. Begin the recovery/discharge cycle as described in the service cart instructions.
4. Recovery is complete when the service cart gauges read slightly below zero.
5. Secure the service cart as described in the manufacturer's instructions.

Recycling System Refrigerant

The J–39500-A service cart (from Kent Moore), will recycle R-134a refrigerant when necessary. The original recovered refrigerant is moved through a combination filtration/dryer unit built into the cart. This unit removes impurities allowing refrigerant reuse. Follow the manufacturer's instructions carefully for the recycle process because incorrect use could result in moisture in the refrigerant. The recycle process is accomplished automatically when the service cart is in evacuation mode.

Evacuating the A/C System

CAUTION: *Do not evacuate an A/C system that is not completely discharged. Check system pressures with a gauge set if unsure about charge level.*

The A/C system evacuation process involves applying 26-28 inches Hg to the A/C system for a minimum of 20 minutes. The applied vacuum removes moisture. A vacuum pump built into the service cart generates the necessary vacuum.

1. Connect the service cart J–39500-A to the service ports.

2. Discharge the system.
3. Connect the vacuum pump to the center hose on the manifold if the gauge set J–39183-C is being used.
4. Turn the vacuum pump on and open the gauge valves.

NOTE: The high side gauge should drop to zero or below. If not, a blockage in the A/C system is indicated. Deduct 1 in. vacuum from the maximum attainable reading for each 1000 ft. elevation above sea level.

5. Evacuate the unit until the low pressure gauge reads 26-28 in. Hg.
6. Turn the vacuum pump off and allow the system to sit undisturbed for 15 min to check for vacuum leaks. If the pressure rises, diagnose the system leak.
7. Continue the evacuation for thirty minutes after the correct gauge reading of 26-28 in. Hg vacuum has been achieved.
8. Turn the gauge valves to the closed position after evacuation is complete.
9. Turn off the vacuum pump and disconnect the center hose from the vacuum pump.

Checking/Adding Refrigerant Oil

It is not necessary to check or add oil as routine maintenance. It is necessary to add oil when the evaporator, condenser, compressor or receiver/dryer has been replaced or there was a large leak. When a system is discharged, it is also necessary to replace any oil carried out with the refrigerant.

CAUTION: *All replacement compressors are shipped with 8 oz. (237 ml) of oil in the crankcase. This oil must be drained completely and replaced in like amount to the failed compressor. Add 2 oz. above what is found in the failed compressor. Failure to do so will cause an overcharge of oil in the system and will lower cooling efficiency. An extreme overcharge condition may cause early compressor failure.*

1. If a major component was replaced, add clean GM PAG oil as follows.
   a. Condenser – 1 oz. (30 ml).
   b. Evaporator – 3 oz. (84 ml).
   c. Receiver/Dryer – 2 oz. (60 ml).
   d. Auxiliary Unit - 2 oz. (60 ml).
   e. Compressor – see step 3.
   f. Any other known quantity of oil.
2. Add oil to the system. Add directly into the component. Oil can also be added directly from the service cart after the system evacuation.
3. Check the oil in the compressor:
   a. Recover/discharge A/C system refrigerant.
   b. Remove the compressor.
   c. Tip the compressor on the hose connection end and drain into a clean container. Allow it to drain for ten minutes. Measure and discard the oil.
   d. When the new compressor is received, drain the oil that was shipped inside. Replace the oil in an equal amount to that which was drained from the old compressor. If less than one ounce (30 ml) is drained from the old compressor, add two ounces (60 ml) to the new compressor. If more than one ounce (30 ml) is drained, replace the same amount in the new one.
   e. Plug or block the ports and turn compressor over slowly several times.
4. Perform the evacuation, recharging and the leak testing of system.

Charging The A/C System

NOTE: If the A/C system requires replacement of a major component, refrigerant oil must be added to the system to compensate for the loss.

1. Evacuate the A/C system. Follow the manufacturer's recommended service procedures for the equipment being used.
2. Connect the refrigerant source to the center hose if the manifold gauge set J–39183-C is being used.
3. Open the refrigerant R-134a source to allow the refrigerant to flow into the system.

4. Purge the center hose, low-pressure hose and the high-pressure hose as follows:
   a. Slightly loosen the center hose at the manifold gauge set the center port until the refrigerant escapes, then tighten the hose.
   b. Open the high-pressure and the low-pressure gauge valves to allow refrigerant to flow into the high-pressure and the low-pressure hoses.
   c. Turn the high-pressure and the low-pressure gauge valves clockwise to the OFF position.
   d. Purge the high-pressure and the low-pressure hoses at the service ports of the compressor.

WARNING: Make sure high-pressure gauge valve is in closed position on manifold gauge set during charging. Failure to do so will cause compressor to build pressure in refrigerant container. This could result in injury to personnel or damage to equipment if the container cracks.

5. Start the engine and set the engine speed at 1500 rpm.
6. Turn the A/C system to max cold and the blower fan on high speed.

NOTE: Keep the refrigerant container upright at all times so the refrigerant enters the system as a gas.

7. Open the low-pressure gauge valve until the system is fully charged.
8. Close the low-pressure gauge valve.
9. Return the engine to normal idle.
10. Check the A/C system performance.
11. Disconnect and remove the service cart.

SYSTEM DIAGNOSIS

System diagnosis should begin with the system performance checks described in this section. The checks will help verify that a problem actually exists as opposed to an incorrect setting by the vehicle operator.

In addition to the performance checks, problem verification will also involve pressure testing, leak testing, individual component testing, air flow and temperature testing and refrigerant recovery, evacuation or recharge. The tools and equipment required for this purpose are described in each procedure.

The diagnosis charts outline common heater and A/C problems. The potential causes are listed in order of probability (most-to-least probable). However, the charts are guides only and will not outline all of the possible system faults that might occur. System testing is still required for verification.

The primary diagnostic method of checking A/C system performance is the pressure test. The test is performed with manifold gauge set J–39183-C. The gauges allow suction and discharge pressures to be checked while the system is operating. The pressure test diagnosis charts describe common faults that cause incorrect system pressures.

Water Valve Does Not Operate

Step	Action	Value(s)	Yes	No
1	Actuate the water valve lever by hand, does it move freely, and does spring pressure re-open the valve when you release it.?		go to step 3.	go to step 2.
2	Replace the tie strap securing the water valve to the body. Does the valve move freely now?		Problem is corrected.	Replace the water valve.
3	Using a hand vacuum pump J–35555, apply 18” Hg to the water valve vacuum motor. Does the valve close and hold vacuum for at least 1 minute.	18” Hg	go to step 4.	Replace the water valve.
4	Release the vacuum on the water valve, does the valve return to the open position?		go to step 5.	Replace the water valve.
5	Attach J–35555 to the vacuum supply line for the water valve. Turn the ignition key to the on position. Rotate the temperature control dial to the cold position. Is sufficient vacuum present?	18” Hg	go to step 6.	go to step7.
6	With J–35555 still attached to water valve vacuum supply line, rotate the temperature control dial to the hot position. Does atmosphere vent in?	0” Hg	System is working correctly.	go to step 8.
7	Check for kinks, breaks and blockages in the vacuum harness between the water valve and the HVAC control head. Are any found?		Repair or replace the vacuum harness as necessary.	go to step 9.
8	With J–35555 still attached to the water valve vacuum supply line, disconnect the HVAC control head 2 hose blk/wht connector. Does atmosphere vent in?	0” Hg	Replace the control head.	Remove the blockage in the white vacuum line to the water valve.
9	Disconnect the 2 hose blk/wht connector at the HVAC control head. Install J–35555 onto the blk hose. Turn the ignition key to the on position. Is sufficient vacuum present?	18” Hg	Replace the control head.	go to step 10.
10	Locate vacuum connection on rear of vacuum pump. Install J–35555 onto connection and start and idle engine. Is sufficient vacuum present?	18” Hg	Locate and repair the blockage/ breakage in vacuum harness between the vacuum pump and the HVAC control head.	Replace the vacuum pump.

Heater Diagnosis

Condition	Possible Cause	Correction
Inadequate or No Heat	1. Heat control knob not set in heat mode or engine not warmed up.	1. Advise owner/driver.
	2. Low engine coolant level.	2. Add coolant as needed and check for leaks.
	3. Air the in coolant system. Usually occurs after coolant drain and refill.	3. Bleed air from the cooling system.
	4. Thermostat faulty.	4. Replace thermostat(s) if stuck closed or remains open continuously.
	5. Kinked or collapsed radiator hose or heater hose.	5. Replace the hose.
	6. Water pump failure.	6. Replace the pump.
	7. Heater core plugged or leaking.	8. Replace the core.
	9. Blower motor fault.	10. Check circuit fuse and wiring. Replace the motor if at fault.
	11. Outside air leaking into the heater core section of the plenum.	12. Seal the plenum or realign as needed.
	13. Water control valve or vacuum motor fault.	14. Replace the valve if stuck closed or partially open. Replace motor if open or shorted.
	15. Blend air door stuck or misadjusted.	16. Repair as needed.
Inadequate Defrost	1. Duct restricted or connecting hose is loose.	1. Repair as needed.
	2. Defroster nozzle misaligned or damaged (bent, cracked, partially closed).	2. Repair as needed.
	3. Insufficient heat.	3. Check for low coolant level, coolant leaks, air in the system, faulty thermostat or water valve, collapsed hose, plugged heater core, binding air door in main unit.
	4. Blower motor fault.	4. Check circuit fuse and wiring. Replace the motor if open or shorted.
NOTE: Improperly adjusted or binding mode door linkage can also cause low, poor or no airflow to any location.		

Air Flow Diagnosis

Condition	Possible Cause	Correction
No Air Flow from Outlets	1. Blower motor fuse blown.	1. Replace the fuse.
	2. Blower motor harness damage (short, open, loose connection).	2. Check the harness continuity with an ohmmeter and repair as needed.
	3. Blower motor fault.	3. Run a 12V jumper directly to the motor. The motor should run at high speed. If the motor fails to run, replace it. If the motor runs, check the resistor.
	4. Blower motor resistor fault.	4. Replace the resistor if the motor runs when the resistor is bypassed or if the blower runs at high speed setting but will not run at one or all of the lower settings.
Air Flows from Incorrect Outlets	1. Actuator motor or linkage fault.	1. Remove the passenger side trim to expose both the actuator motors and observe the linkage operation. Adjust the linkage if required. Replace the motor and/or linkage if inoperative.
Low-Weak Air Flow from Outlets	1. Restriction in air ducts.	1. Repair as needed.
	2. Restriction in intake hose into main unit.	2. Repair as needed.
	3. Blower motor fault.	3. Replace the motor or the resistor if either is inoperative.
	4. Misadjusted or binding mode door linkage.	4. Adjust as necessary.

A/C System Diagnosis

Condition	Possible Cause	Correction
Water on the Passenger Side Floor	1. Evaporator drain hose plugged or installed incorrectly.	1. Open the hose with utility knife or trim end off hose. Make sure routing of the hose is to the outside of the passenger compartment.
	2. Coolant leak from the heater core.	2. Replace the core if leaking. Replace clamps or hoses if leaking at the heater core connections.
	3. Road splash entering the compartment through the evaporator/heater core opening, or through the intake air inlet area.	3. Water test and seal off as needed.
	4. Water leaking into the passenger compartment.	4. Water test and correct the leaks.
Musty Smell	1. Water leaking into the passenger compartment.	1. Water test and correct the leaks.
	2. Evaporator drain partially or fully plugged.	2. Open or trim off the drain hose with a utility knife. Correct the routing if necessary.
	3. Mold-Mildew development on the evaporator surface, coils, fins.	3. Clean the evaporator with a mild disinfectant soap or replace the evaporator as necessary.

A/C Pressure Test Diagnosis

Condition	Possible Cause	Correction
Low Side High High Side High (Discharge Air Warm - Discharge Line Warm to Hot)	1. Condenser fins obstructed or distorted.	1. Clear the obstruction with water spray and compressed air. Straighten distorted fins with tool J–36847 or equivalent.
	2. System overcharged.	2. Recover excess charge with A/C service cart J–39500-A.
	3. Air in the system.	3. Evacuate and recharge the system.
	4. Expansion valve failed.	4. Replace the valve.
	5. Condenser restricted.	5. Replace the condenser. Evacuate and recharge the system.
	6. Compressor drive belt slipping.	6. Replace the belt or belt tensioner as needed.
Low Side High High Side High (Discharge Air Slightly Cool - Discharge Line Cool)	1. Air and moisture in the system.	1. Discharge the system. Replace the receiver/dryer and evacuate - recharge the system.
	2. Leak at A/C line of 1/2 ounce or less.	2. Locate with J–41995 leak detector. Recharge the system and verify proper operation.
Low Side Low High Side Low	1. System low on refrigerant.	1. Add refrigerant and leak test the system. Correct the leak source and recharge as needed. **NOTE:** If leak was large, check the compressor oil level also and correct as needed.
	2. Expansion valve failed.	3. Replace the valve, then evacuate and recharge the system.
Low Side High High Side Low	1. Internal leak in compressor	1. Replace the compressor and evacuate - recharge the system.
	2. Expansion valve failure.	2. Discharge the system. Replace the valve and recharge the system.
	3. Drive belt slip.	3. Replace the belt.
Low Side Low High Side High	1. Expansion valve failed.	1. Discharge the system. Replace the valve and recharge.
	2. A/C hose constricted, plugged.	2. Check the hose for kinks. Replace the hose if plugged and evacuate - recharge the system.
	3. Receiver/Dryer restricted or has failed.	3. Evacuate the system. Replace the receiver/dryer and recharge the system.
	4. Condenser problem (blocked, damaged).	4. Evacuate the system. Replace the condenser and recharge the system.

A/C Pressure Test Diagnosis (Continued)

Condition	Possible Cause	Correction
Low Side and High Side Normal But Cooling is Inadequate	1. Air and/or moisture in the system.	1. Leak test the system. Repair leaks if necessary. If leaks are not evident, evacuate and recharge the system.
	2. Receiver/Dryer fault.	2. Evacuate the system, replace the receiver/dryer and recharge the system.

Compressor Diagnosis

Condition	Possible Cause	Correction
Compressor Noise	1. System overcharge.	1. Recover all R-134a with J–39500-A service cart and recharge with the proper charge.
	2. Drive belt problem.	2. Replace the belt if worn, frayed, cut or torn.
	3. Compressor clutch fault.	3. Replace the core or pulley bearing as needed.
	4. Compressor internal fault.	4. Replace the compressor if pressure test indicates worn, inoperative condition.
Compressor Does Not Engage	1. System fuse blown.	1. Replace the fuse. Check the circuit for shorts, ground.
	2. Clutch wires damaged.	2. Repair the wires.
	3. Pressure cycling clutch or A/C cutout switch fault.	3. Replace the switch(s) as needed.
	4. Compressor clutch failure.	4. Replace the clutch core and/or pulley as needed.
	5. Compressor seized.	5. Replace compressor.
	6. High engine coolant temperature triggering A/C cutout switch.	6. Let the engine cool down and fix the engine cooling system problem first.
Compressor Engages but Cooling is Inadequate	1. A/C duct restrictions, loose connections.	1. Repair as needed.
	2. System leaks (high side pressure below 50 psi (345 kPa)).	2. Check for leaks with J-41995 leak detection tool and repair as needed.
	3. Expansion valve inoperative.	3. Replace the valve.
	4. Receiver/Dryer fault.	4. Replace the receiver/dryer
	5. Condenser fault.	5. Replace the condenser.
	6. Compressor internal wear.	6. Replace the compressor if pressure indicates internal wear or damage.

SPECIFICATIONS

System refrigerant — R-134a
Compressor oil — PAG (polyalkaline glycol)
Refrigerant capacity — 2 lbs. 4oz.
Compressor type — Denso

A/C System Test Pressures

Ambient Temperature		Low Side Pressure Range*		High Side Pressure Range*	
F°	C°	Psi	kPa	Psi	kPa
70	21	10-32	69-221	112-270	772-1861
75	24	12-33	83-228	120-280	827-1930
80	27	17-34	117-234	131-310	903-2137
85	29	18-35	124-241	185-325	1276-2172
90	32	19-47	131-324	210-330	1448-2275
95	35	21-47	145-324	225-350	1551-2413
100	38	28-51	193-352	240-370	1655-2551
110	43	30-55	207-379	255-390	1758-2689

*Low and high side pressures are affected by temperature. Higher temperature will cause higher pressures.

R-134a Pressure-to-Temperature Relationship Chart (with Engine OFF)

Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a
0	-14.7	25	29.3	70	69.6	200	130.1
1	-12.1	26	30.5	75	72.9	210	133.5
2	-9.6	27	31.7	80	76.1	220	136.7
3	-7.2	28	32.9	85	79.2	230	139.8
4	-4.9	29	34.0	90	82.2	240	142.9
5	-2.7	30	35.1	95	85.0	250	145.9
6	-0.6	32	37.4	100	87.8	260	148.8
7	1.4	34	39.5	105	90.5	270	151.6
8	3.4	36	41.6	110	93.1	280	154.3
9	5.3	38	43.6	115	95.6	290	157.0
10	7.1	40	45.6	120	98.0	300	159.6
11	8.9	42	47.4	125	100.4	310	162.2
12	10.6	44	49.2	130	102.7	320	164.7

R-134a Pressure-to-Temperature Relationship Chart (with Engine OFF)

Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a	Psi	Temp (°F) R-134a
13	12.3	46	51.0	135	104.9	330	167.2
14	13.9	48	52.8	140	107.1	340	169.6
15	15.4	50	54.5	145	109.3	350	171.9
16	17.0	52	56.4	150	111.4	360	174.2
17	18.5	54	57.8	155	113.3	370	176.5
18	19.9	56	59.3	160	115.4	380	178.7
19	21.4	58	60.8	165	117.4	390	180.7
20	22.8	60	62.4	170	119.3	400	183.1
21	24.1	62	63.9	175	121.2	-	-
22	25.5	64	65.4	180	123.0	-	-
23	26.8	66	66.8	185	124.8	-	-
24	28.0	68	68.2	190	126.6	-	-

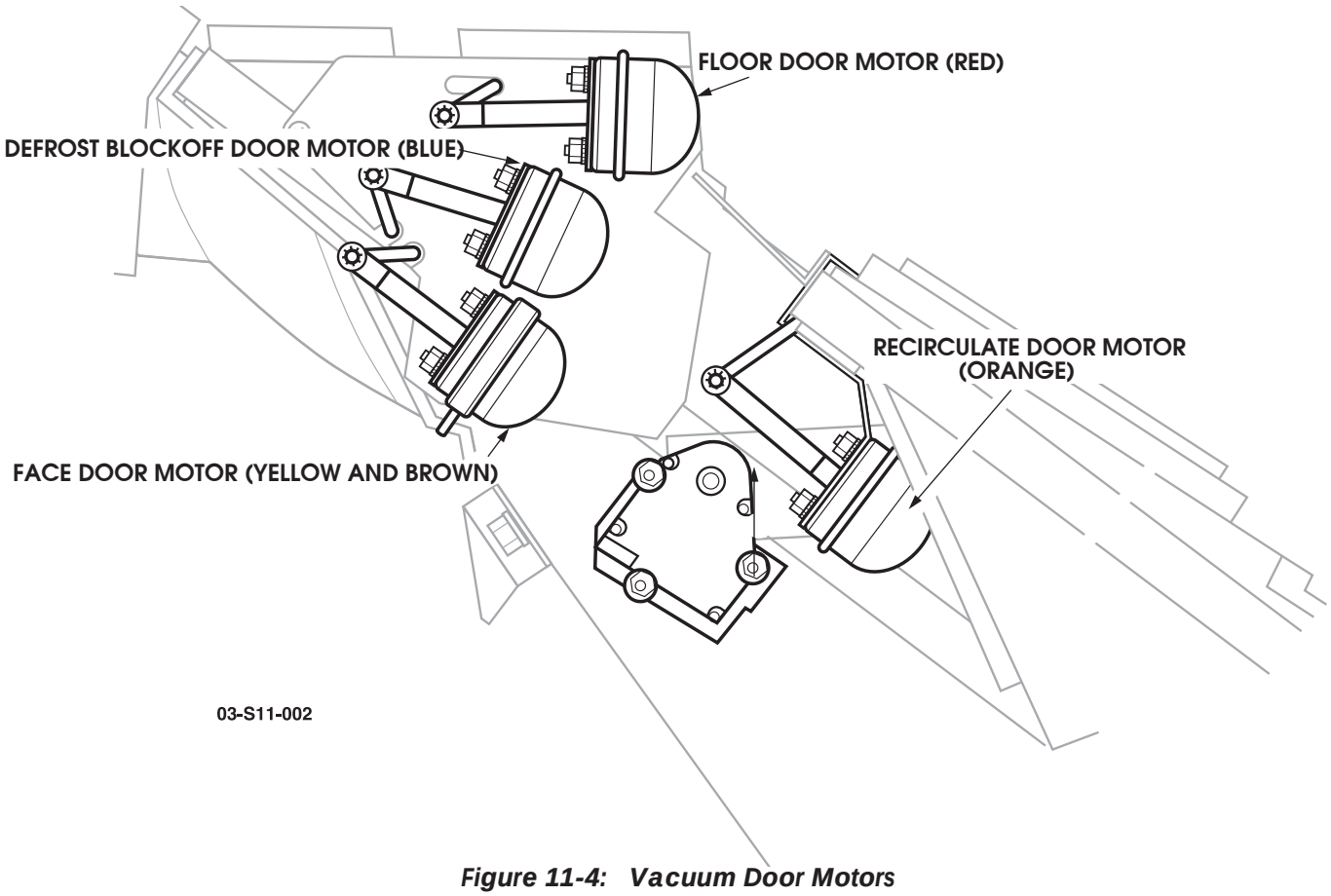


Figure 11-4: Vacuum Door Motors

Vacuum Door Motor Arm Positioning (Figure 11-4)

	OFF	MAX	A/C	A/C Blend	Face	Floor	Defrost/ Floor	Defrost
Floor	out	out	out	in	out	in	out	out
Defrost blockoff	out	out	out	out	out	out	out	in
Face	out	in	in	half	in	out	out	out
Recirculate	out	in	out	out	out	out	out	out

CLIMATE CONTROL HEAD REPLACEMENT

Removal

1. Remove the radio bezel.
2. Remove the screw attaching the climate control head to the center dash assembly (Figure 11-5).
3. Pull the climate control head out far enough to disconnect the electrical connectors and the vacuum hoses.

Installation

1. Connect the electrical connectors and the vacuum hoses to the climate control head.
2. Push the climate control head toward the longer side bracket until flush, then secure it with the screws.
3. Install the radio bezel.

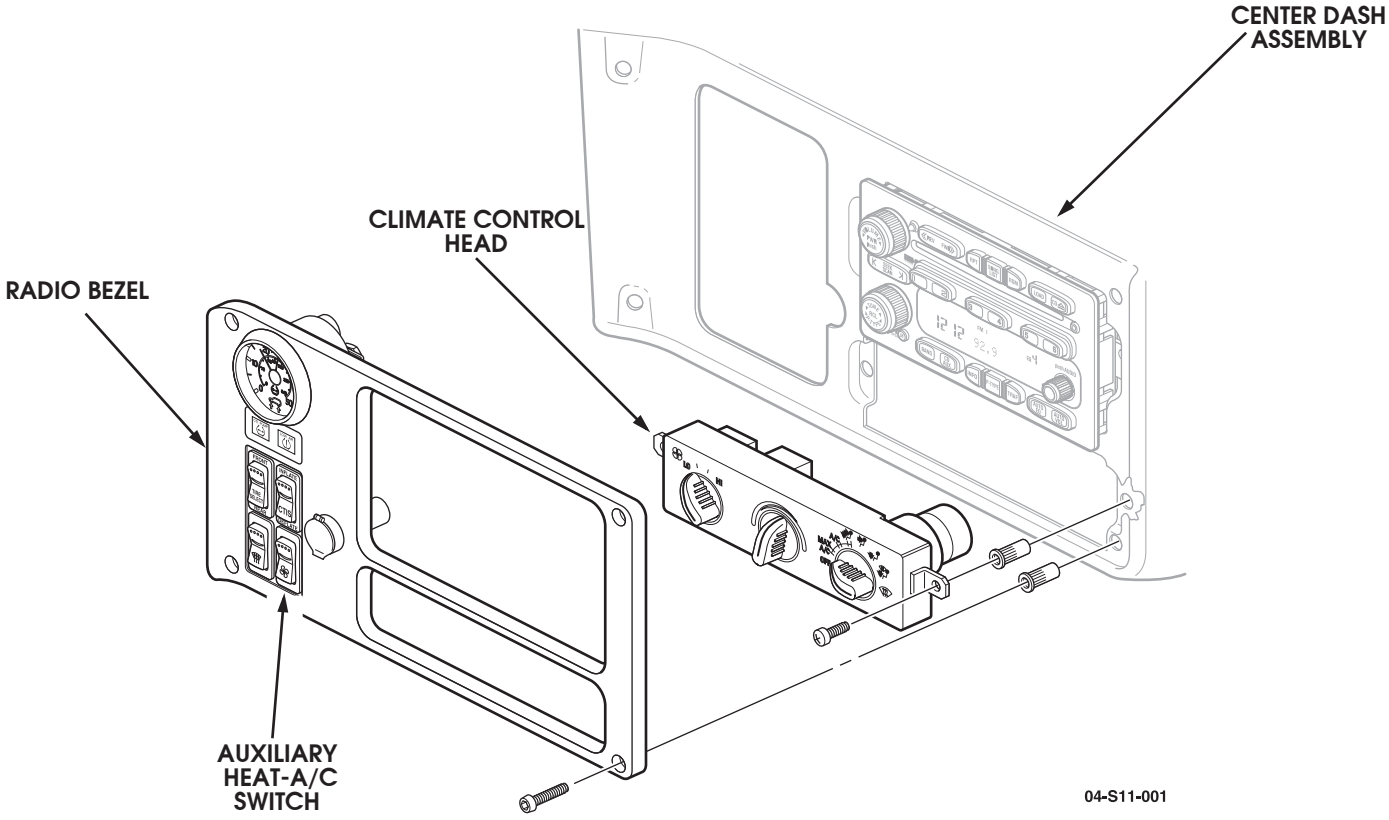


Figure 11-5: Climate Control Head Replacement

PRESSURE HOSE TORQUE SPECIFICATIONS

CAUTION: *To avoid potential thread or fitting damage, hand start connections before using wrenches.*

Air conditioning system fittings are a common source of refrigerant leaks. When service requires disconnecting and connecting fittings, observe the following:

- When tightening or loosening hose and tube fittings, use two wrenches for equalized support (Figure 11-6).

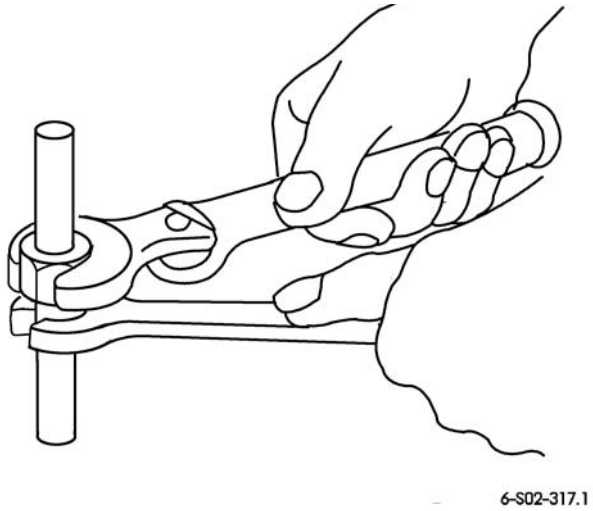


Figure 11-6: Hose and Tube Fittings

- Plug the open ends of hoses after disassembly. Do not remove the plugs from hose fittings until each component is ready for connection. This will prevent moisture and dirt contamination which can cause compressor wear and system blockage.
- Make sure that O-rings are properly seated before assembly (Figure 11-7).
- Carefully interlock male and female ends of hoses (Figure 11-8).
- Before making any hose and tube connection, apply a few drops of refrigerant oil to the O-rings and threaded portions of the connector. Make connections quickly.
- Tighten fittings to proper torque specification based on hose size.

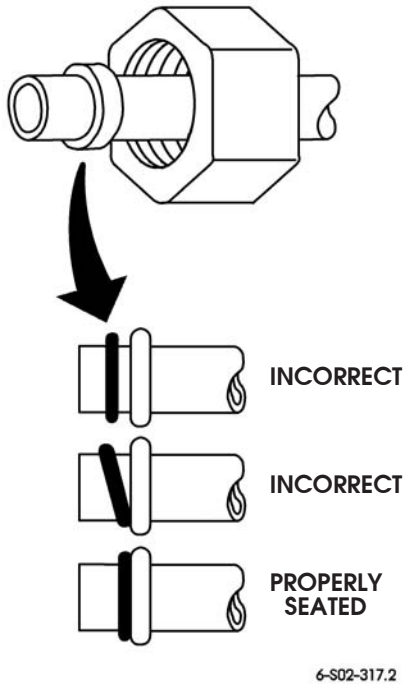


Figure 11-7: Correct Seating O-Rings

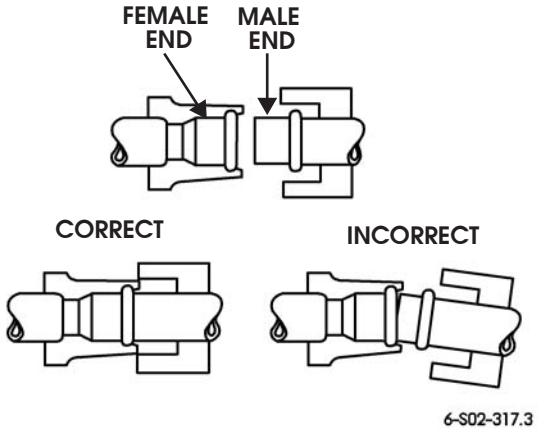


Figure 11-8: Proper Connection of Hose End

Pressure Hose Torque Values				
Hose Size	**Torque (Ft. Lb.)**		**Torque (Newton Meters)**	
	Minimum	**Maximum**	**Minimum**	**Maximum**
#6 Liquid Hose	11	13	15	17
#8 Discharge Hose	15	20	20	27
#10 Suction Hose	21	27	28	36
#12 Suction Hose	24	28	33	38

AIR CONDITIONING PRESSURE HOSE REPLACEMENT

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

CAUTION: *Cover all open lines to prevent contamination.*

Suction Manifold Hose Replacement

Removal

1. Discharge the air conditioning system.
2. Remove the air cleaner and the splash shield.
3. Disconnect the auxiliary hose connection.
4. Disconnect the suction hose from the expansion valve manifold, discard the O-ring (Figure 11-9).
5. Disconnect the suction hose at the compressor discard the O-ring (Figure 11-10).
6. Remove the hose assembly from the vehicle.

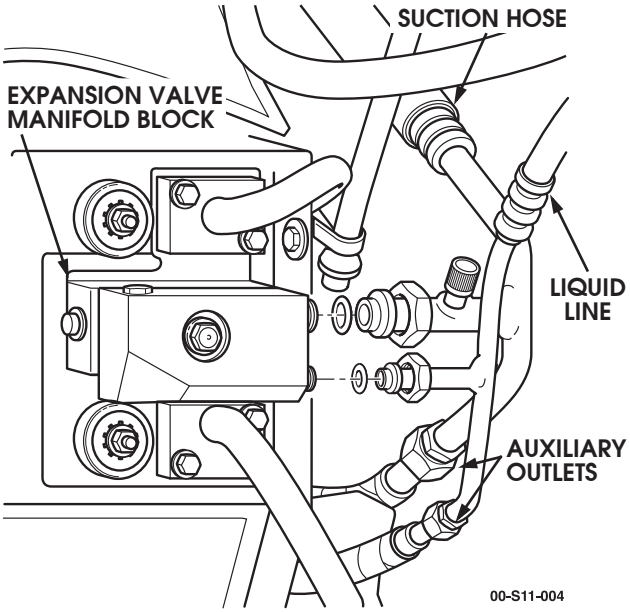


Figure 11-9: Suction Manifold Hose Removal

Installation

1. Install the suction hose onto the expansion valve manifold block with a new O-ring.
2. Torque the fitting to 21-27 lb-ft. (28-36 N•m).
3. Install the auxiliary unit refrigerant line using a new O-ring.
4. Torque the auxiliary unit line to 21-27 lb-ft. (28-36 N•m).
5. Install the suction hose onto the compressor with a new O-ring and torque the bolt to 12 lb-ft. (16 N·m).
6. Evacuate the system for 30 min.
7. Recharge the system with 2lbs. 4oz. R134a.
8. Performance test the A/C system.
9. Install the air cleaner and the splash shield.

Discharge Hose Replacement

Removal

1. Disconnect the discharge hose from the condenser. Remove and discard the O-ring (Figure 11-11).

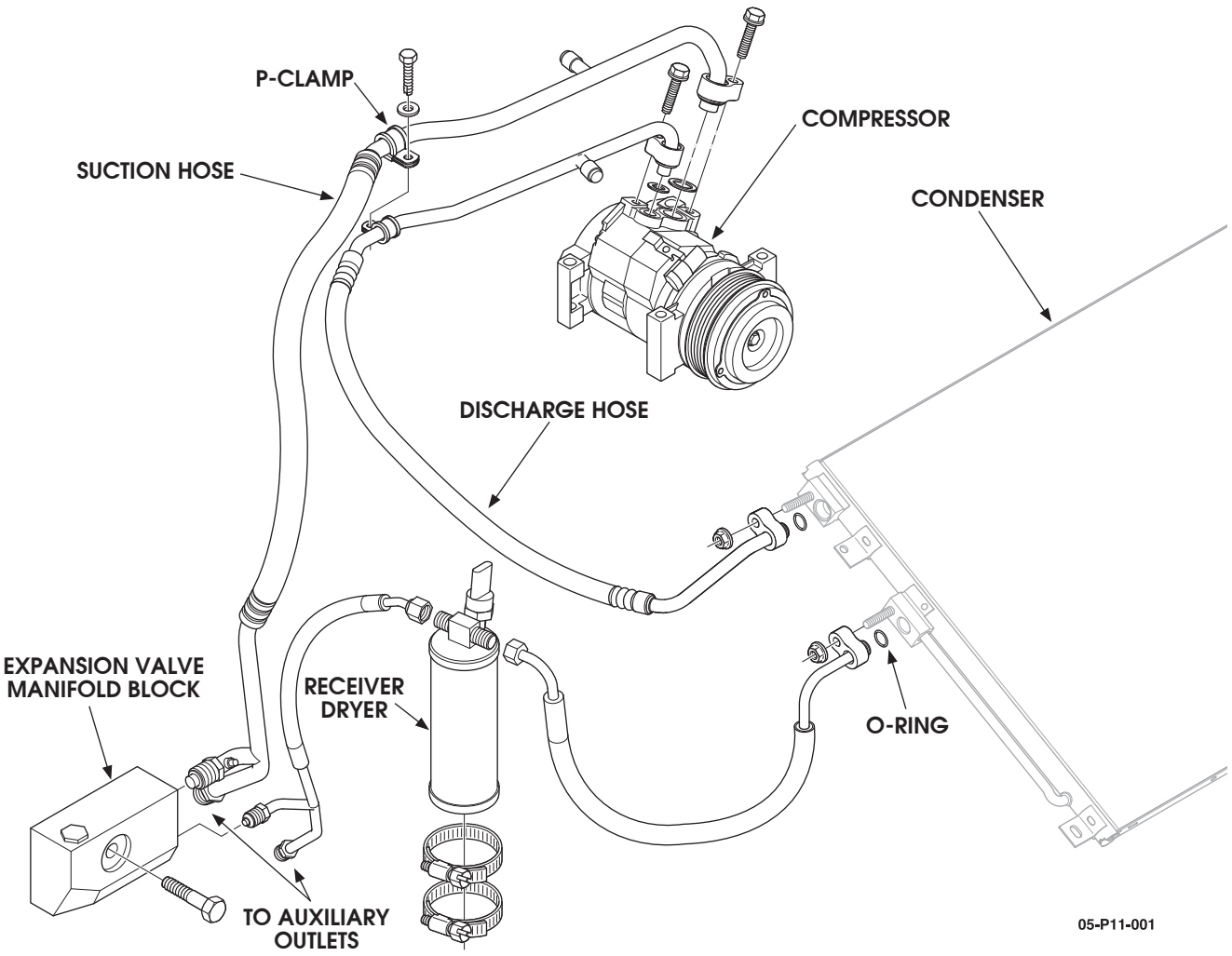


Figure 11-10: A/C System

2. Remove the P-clamp holding the line to the support bracket.
3. Remove the discharge hose from the compressor and discard the O-ring (Figure 11-9).

Installation

CAUTION: *To avoid potential thread or fitting damage, hand start connections before using wrenches.*

1. Position the O-ring on the discharge hose (Figure 11-9).
2. Secure the discharge hose to the compressor with the bolt and torque to 12 lb-ft. (16 N·m).
3. Lubricate the O-ring and install the discharge hose to the condenser and torque the nut to 12 lb-ft. (16 N·m).
4. Install the driver side engine splash shield.
5. Evacuate and charge the air conditioning system.
6. Check for system leaks.
7. Check the A/C operation.

Condenser-to-Receiver/Dryer Hose

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

CAUTION: *To avoid potential thread or fitting damage, hand start connections before using wrenches.*

1. Discharge the air conditioning system.
2. Disconnect the hose from the condenser and remove the O-ring. Discard the O-ring (Figure 11-11).
3. Remove the hose and the O-ring from the receiver/dryer. Discard the O-ring.

Installation

1. Lubricate the O-ring with PAG oil and secure the hose to the condenser with the nut torque to 12 lb-ft. (16 N·m).
2. Lubricate the O-ring with PAG oil, position on the hose, and secure the hose to the receiver/dryer. Using two wrenches for equalized support, tighten to 11-13 lb-ft. (15-18 N•m).
3. Evacuate and charge the air conditioning system.
4. Check the system for leaks.
5. Check the air conditioning system operation.

Receiver/Dryer-To-Evaporator Core Hose

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

1. Discharge the air conditioning system.
2. Disconnect the hose from the receiver/dryer and remove the O-ring. Discard the O-ring (Figure 11-11).
3. Disconnect the auxiliary hose connection (if equipped).
4. Remove the hose and the O-ring from the expansion valve manifold block. Discard the O-ring (Figures 11-9 and 11-11)

Installation

1. Lubricate the two O-rings with PAG oil and position on the hose.
2. Secure the hose to the expansion valve manifold block. Using two wrenches for equalized support, tighten to 11-13 lb-ft. (15-18 N•m).
3. Torque the auxiliary unit line to 11-13 lb-ft. (15-18 N•m).
4. Secure the hose to the receiver/dryer. Using two wrenches for equalized support, tighten to 11-13 lb-ft. (15-18 N•m) (Figure 11-12).
5. Leak test the system.

CONDENSER REPLACEMENT

Removal

WARNING: Air conditioning system components are subject to high pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

1. Discharge the air conditioning system.

NOTE: Cover all the open lines to prevent contamination.

2. Disconnect the two pressure hoses from the condenser and remove the O-rings. Discard the O-rings.

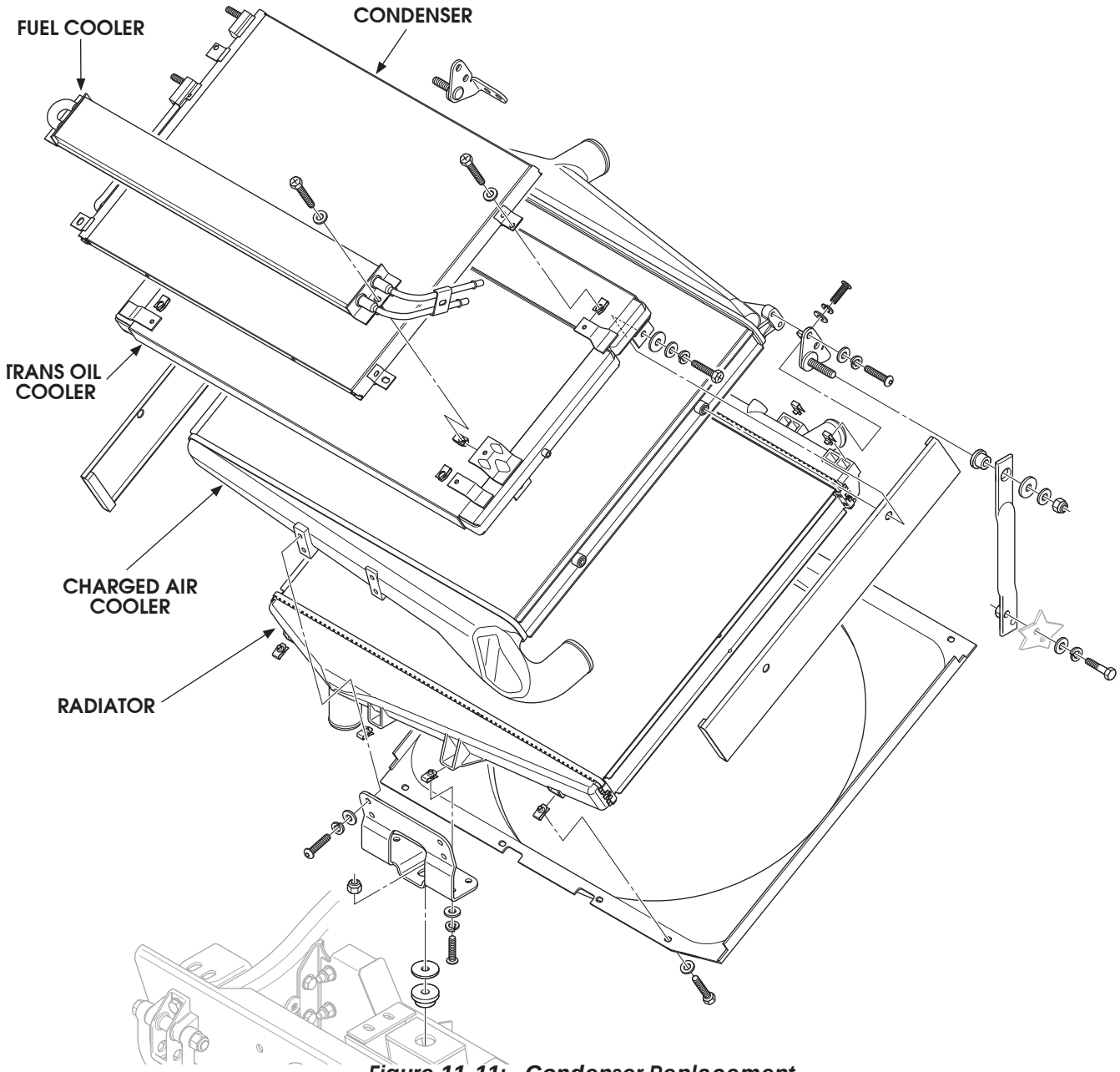


Figure 11-11: Condenser Replacement

3. Remove the two screws holding the fuel cooler to the condenser (Figure 11-11).
4. Remove the four screws holding the A/C condenser to the trans oil cooler.
5. Remove the condenser carefully from between the fuel cooler and the trans oil cooler.

Installation

1. Secure the condenser to the trans oil cooler with the four screws (Figure 11-11).
2. Secure the fuel cooler to the condenser with the two screws.
3. Lubricate the two O-rings with PAG oil and install the pressure lines to the condenser torque to 12 lb-ft. (16 N·m).
4. Evacuate and charge the air conditioning system.

RECEIVER/DRYER REPLACEMENT

Removal

WARNING: Air conditioning system components are subject to high-pressure R-134a gas. Always discharge pressure and contain refrigerant using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

NOTE: The receiver/dryer will quickly absorb water from the atmosphere when not sealed. Do not leave the system open during service. The receiver/dryer should be replaced any time major components are replaced. If in doubt, replace the unit.

1. Discharge the air conditioning system.
2. Disconnect the electrical connector from the low pressure switch (Figure 11-12).

NOTE: Cover all the open lines to prevent contamination.

3. Disconnect the two hoses from the receiver/dryer and remove the O-rings. Discard the O-rings.
4. Remove the two clamps and the receiver/dryer from the bracket.

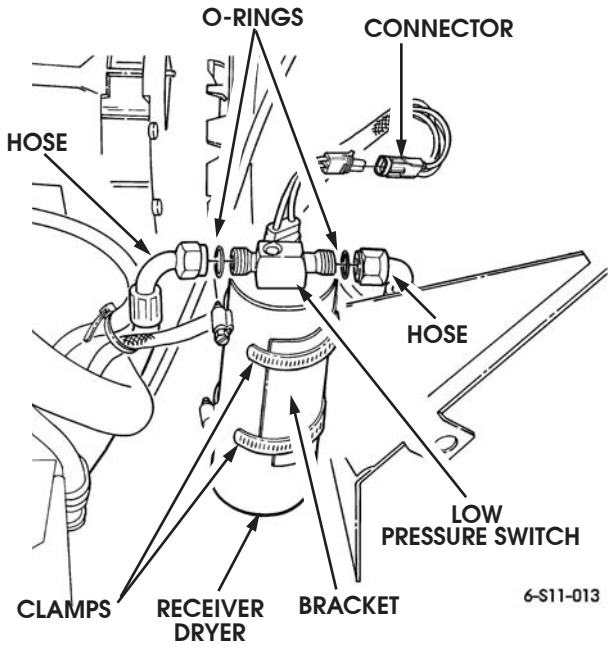


Figure 11-12: Receiver/Dryer

Installation

1. Secure the receiver/dryer to the bracket with the two clamps. Position the hose attachment ports to the front and the rear of the vehicle (Figure 11-12).
2. Lubricate the two O-rings with PAG oil and position on the hose fittings.
3. Connect the two hoses to the receiver/dryer.
4. Connect the electrical connector to the low pressure switch.
5. Test the system for leaks.

LOW PRESSURE CUTOFF SWITCH

The low pressure cutoff switch is mounted on the receiver/dryer. The switch is wired in series with the compressor activation circuit. Should pressure drop below the switch setting, the switch will open and interrupt current flow to the compressor clutch. The switch will prevent damage to the system from lack of oil flow due to inadequate charge or very low ambient temperatures. The switch will close when the system pressure rises to safe levels (Figure 11-16).

LOW PRESSURE CUTOFF SWITCH REPLACEMENT

Removal

1. Disconnect the pressure switch jumper connector from the receiver/dryer low pressure switch (Figure 11-13).

NOTE: The receiver/dryer is equipped with a schrader valve to prevent refrigerant loss with the pressure switch removed. Unscrew the pressure switch as quickly as possible to avoid excessive loss of refrigerant.

2. Using a wrench, remove the pressure switch from the receiver/dryer.

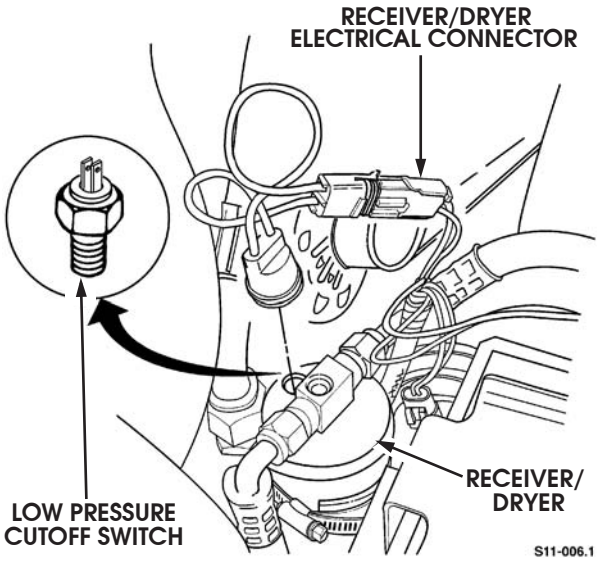


Figure 11-13: Low Pressure Cutoff Switch Mounting

Installation

1. Thread the new pressure switch on the receiver/dryer fitting by hand and use a wrench to finish securing the pressure switch (Figure 11-13).

NOTE: Install the pressure switch as quickly as possible to avoid excessive loss of refrigerant.

2. Connect the pressure switch jumper electrical connector to the pressure switch.
3. Check the pressure switch fitting for leaks using suitable leak-testing equipment.

HEATER HOSE REPLACEMENT

Engine coolant is routed through 5/8 inch diameter heater hose from the auxiliary coolant pump to the bottom fitting of the heater shutoff valve. When the valve is open, coolant flows through another length of hose from the valve's rearward lower fitting to the front and rear heater core inlet ports, the heater core outlet hoses are routed to the rearward upper fitting on the heater shutoff valve. The coolant return hose is routed from the forward upper heater shutoff valve fitting to the lower heater hose nipple (Figure 11-15).

Removal

1. Drain the cooling system (Refer to section 4).
2. Move the constant tension clamps either end of the hose to be removed.

NOTE: Damage to the heater core can result if too much force is applied to the ports. If the hose is not easily removed by moderate twisting and pulling, cut the hose just beyond the port. Then cut the hose remaining on the port lengthwise and remove it.

3. Remove the hose ends from the fittings by twisting and pulling.

Installation

1. With the clamps loosely in place, connect the hose ends to the respective fittings.

2. Tighten the clamps.
3. Refill the cooling system and check for leaks (Section 4).

WATER CONTROL VALVE

The water control valve determines when coolant will flow through the heater cores. The design of the valve allows the engine coolant to flow around (bypass) the HVAC system when the temperature dial on the control head is moved to the cold position. The valve is operated by vacuum directed by the control head. When vacuum is applied, the valve bypasses. When atmospheric pressure is vented in, engine coolant flows through the heater cores (Figure 11-14).

WATER CONTROL VALVE REPLACEMENT

Removal

1. Place a drain container under the vehicle directly below the control valve (Figure 11-14).

NOTE: Use extreme caution when working on a hot engine. Let the engine cool down before proceeding.

2. Relieve the pressure from the cooling system by loosening the coolant pressure cap.
3. Remove the air intake hoses.
4. Disconnect the vacuum hose from the control valve diaphragm.
5. Clamp the control valve hoses with heater hose clamp pliers or equivalent tool.
6. Remove the hoses from the valve.
7. Remove the tie wrap and the valve from the mounting bracket.

Installation

CAUTION: *Do not overtighten the tie wrap that secures the control valve to the mounting bracket. Overtightening can deform the valve housing and cause binding. After tightening, push the plunger in and out of the vacuum diaphragm to ensure the valve is moving freely.*

1. Gently secure the control valve to the mounting bracket with the tie wrap (Figure 11-14).
2. Secure the hoses to the valve with the clamps.
3. Release and remove the hose clamp pliers or equivalent tools from the valve hoses.
4. Connect the valve vacuum hose (Figure 11-14).
5. Check the coolant level and add coolant if necessary.
6. Tighten the coolant pressure cap.
7. Check the valve for proper operation and leaks.

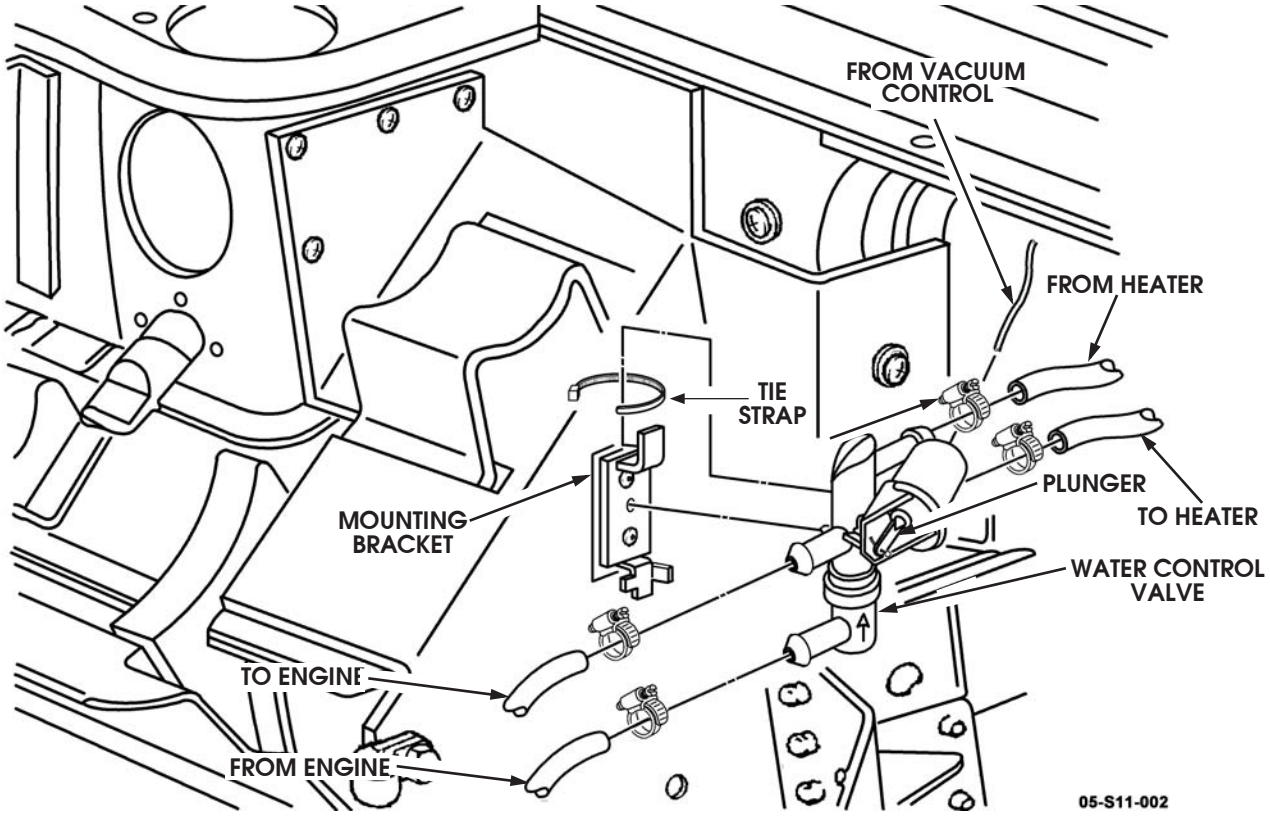


Figure 11-14: Water Control Valve

DRAIN TUBE REPLACEMENT

Removal

1. Remove the drain tube from the main HVAC unit inner cowl area by pulling straight out. If the drain tube grommet pulled out with the drain tube, it will need to be reinstalled. It may be necessary to loosen the drain tube from the main HVAC unit drain outlet.

Installation

1. Install the drain tube and the grommet, if removed, to the drain tube outlet on the main HVAC unit (Figure 11-15). Ensure the drain tube is attached to the main HVAC unit drain outlet.

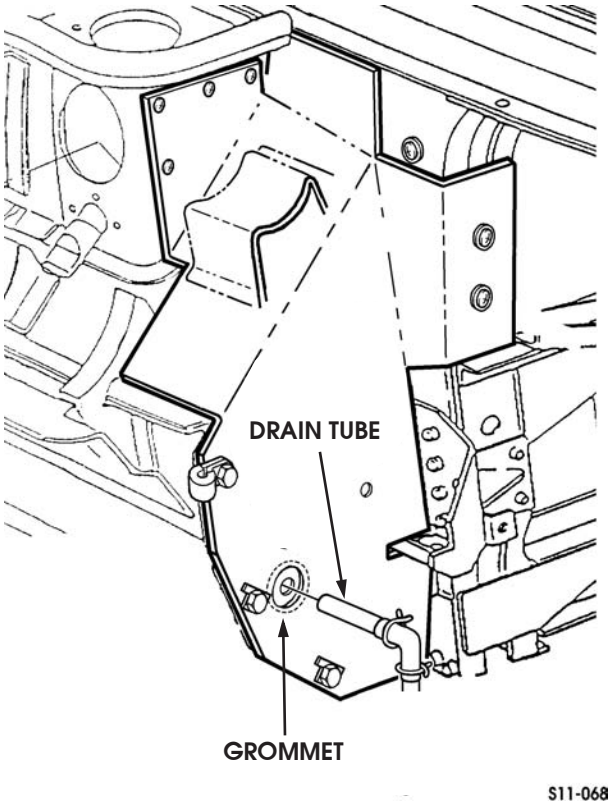


Figure 11-15: Drain Tube Replacement

COMPRESSOR REPLACEMENT

WARNING: Air conditioning system components are subject to high-pressure refrigerant R-134a gas. Always discharge pressure and contain R-134a using approved service equipment. Use extreme care when handling R-134a. Direct contact with skin may cause frostbite. Do not smoke in areas where R-134a is stored or used. Failure to follow these warnings may result in serious injury.

Removal

1. Discharge the air conditioning system.
2. Remove the belt from the A/C compressor.
3. Remove the bolt and the discharge hose the from the A/C compressor (Figure 11-16).
4. Remove the bolt and the suction hose from the A/C compressor (Figure 11-16).
5. Discard the sealing washers and cap all of the openings.
6. Disconnect the electrical connectors from the compressor.
7. Remove the A/C compressor mounting bolt and remove the compressor.

Installation

1. Install the A/C compressor and torque the mounting bolts to 37 lb-ft. (50 N·m).
2. Connect the electrical connections.
3. Remove the caps or tape from the hose and line ends.
4. Install the A/C suction hose to the compressor using a new sealing washer. Torque the bolt to 12 lb-ft. (16 N·m).
5. Install the A/C discharge hose to the compressor using a new sealing washer. Torque the bolt to 12 lb-ft. (16 N·m).
6. Install the drive belt.
7. Evacuate and recharge the A/C system.
8. Leak test the fittings of the component using the J-39400-A leak detector.

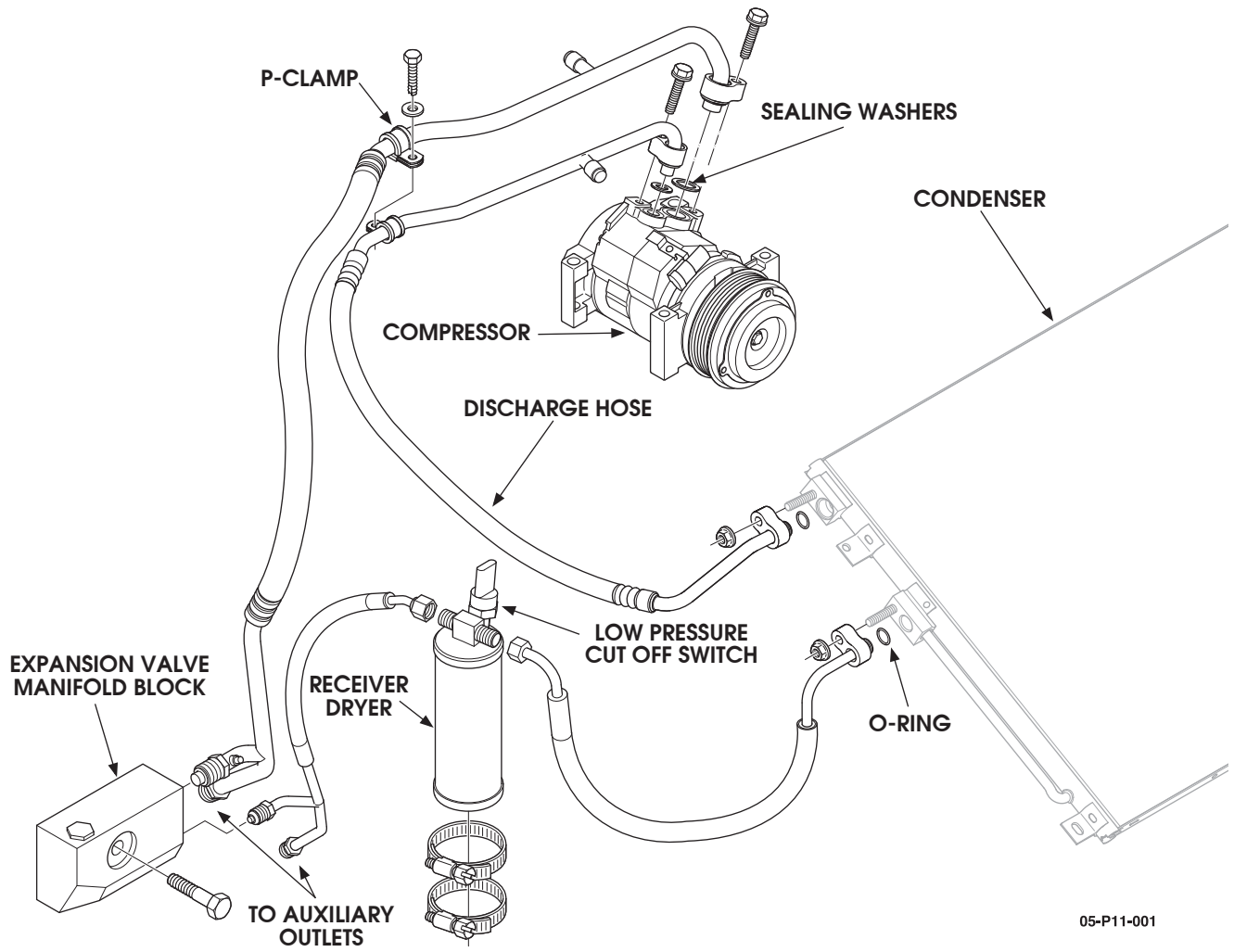


Figure 11-16: Receiver/Dryer

RECEIVER/DRYER

The receiver/dryer provides storage for high pressure liquid refrigerant. Desiccant inside of the receiver/dryer assists in removing moisture from the refrigerant. The receiver/dryer also acts as a filter, filtering out particles of debris and preventing bubbles of vapor form entering the expansion valve (Figure 11-16).

AMBIENT TEMPERATURE SWITCH

The ambient temperature switch is mounted on the passenger side near the condenser. The switch, which monitors ambient air temperature, is wired in series with the compressor activation circuit. The switch interrupts current flow to the compressor clutch when outside temperature drops below 45°F (10°C).

CONDENSER

The condenser provides heat exchange for the A/C system. The condenser is located on the front of the radiator and cooler assemblies. Air from forward movement, and the engine cooling fan is forced through the fins of the condenser, removing heat from the highly pressurized refrigerant. Refrigerant enters the condenser as a vapor and exits as a liquid.

BLOWER MOTOR RESISTOR REPLACEMENT

Removal

1. Remove the right side crash pad.
2. Unplug the blower motor resister connector.
3. Remove the two screws securing the resister to the HVAC unit and remove the resister (Figure 11-17).

Installation

1. Secure the resistor to the HVAC unit with the screws.
2. Plug the HVAC harness connector into the resistor.
3. Check the blower motor operation.
4. Install the right side crash pad.

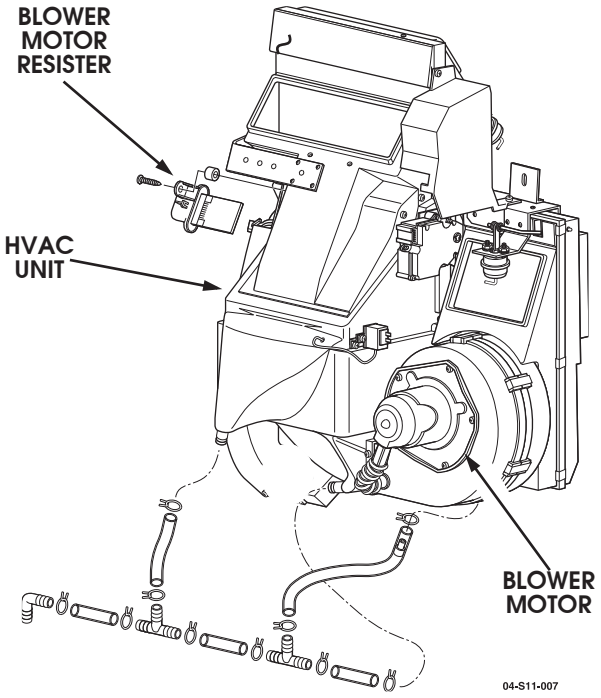


Figure 11-17: Blower Motor Resistor Replacement

HIGH PRESSURE CUTOFF SWITCH

The high pressure cutoff switch is located in the rear of the compressor. The switch is wired in series with the compressor clutch and exposed to high side pressure in the compressor. Should pressure exceed the switch setting, current will be interrupted to the compressor clutch until the pressure drops to safe levels, then the switch will close allowing the clutch to engage.

Service

The high pressure cutoff switch is serviced as an assembly with the A/C compressor.

HVAC CONTROLS

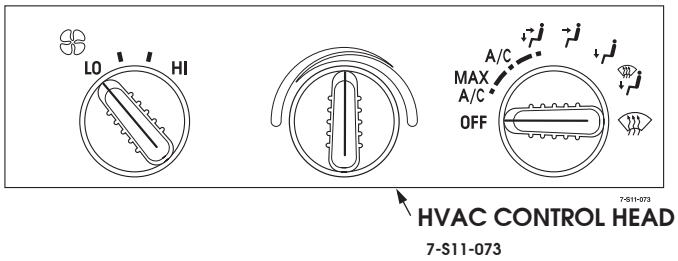


Figure 11-18: HVAC Control Panel

The HVAC system is operated using a control panel. The panel has controls for:

- Blower speed
- Air temperature
- Mode
- Air conditioning

Status for all of the controls is shown using painted marks on the faceplate of the control panel. Operation is based on driver input, no automatic function is incorporated. Controls for the HVAC system are based on (vacuum) door motors and water valve controls and (electric) blower motor and temperature door motor controls (Figure 11-18).

Blower Speed Dial

The blower speed dial has 4 positions.

- Low
- Med 1
- Med 2
- High

The operator selects the fan speed by rotating the dial clockwise (Figure 11-19).

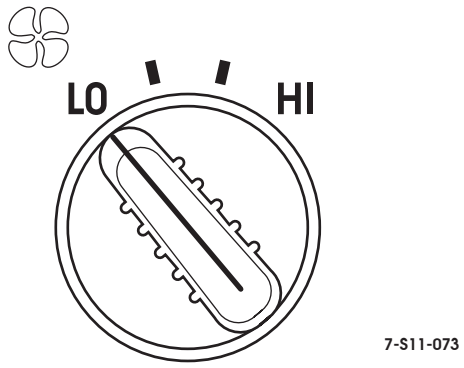


Figure 11-19: Blower Speed Dial

Temperature Dial

The temperature dial controls the temperature of the air exiting the HVAC unit. When the dial is rotated to the cold position, the water valve is shut off and the temperature door isolates the heater core. When the dial is rotated to the HOT position, the water valve opens and the temperature blend door directs air through the heater core. Between COLD and HOT, temperature is regulated by changing the amount of air that passes through the heater core (Figure 11-20).

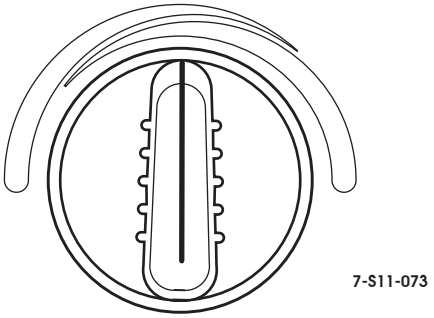


Figure 11-20: Temperature Control Dial

Mode Dial

The mode dial allows the operator to direct air to a selected area. When the driver rotates the dial clockwise and chooses a mode, vacuum is sent to the vacuum motors that must close (Figure 11-21).

NOTE: When the main HVAC unit is without vacuum, air will be directed to the defrost and floor vents and fresh air will be used. The blower motor on the HVAC unit will not function if the mode dial is set to the OFF position. When the dial is positioned in an A/C mode, the compressor clutch will be activated.

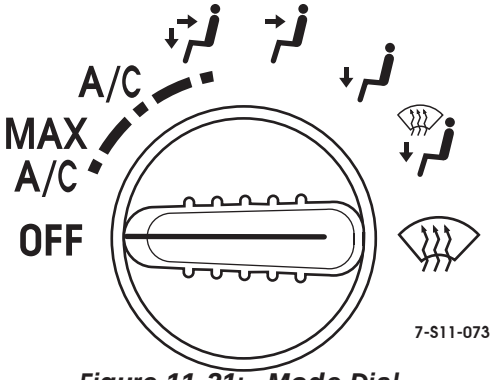


Figure 11-21: Mode Dial

HVAC UNIT SERVICE

WARNING: When working with refrigerant, always use protective equipment to prevent injury. Refrigerant handling should be done only by technicians trained and certified in the use of refrigerant and refrigerant service equipment.

CAUTION: *Use only equipment and materials designed to operate with R134a refrigerant. Never substitute parts or materials designed for R12.*

CAUTION: *Never use sealers in or on the HVAC unit that are not designed for ventilation systems. Some sealers release noxious or irritating odors that will be offensive to operators of the vehicle. Neutral cure sealers should be used when sealing any area of the HVAC unit that could potentially expose the operator of the vehicle or the passengers to the released chemicals.*

MAIN HVAC UNIT

The main HVAC unit is comprised of a heater core for heating air, an evaporator for cooling air, mode doors to direct airflow and an electric blower motor/ fan to force air through the case to be heated or cooled (Figure 11-22).

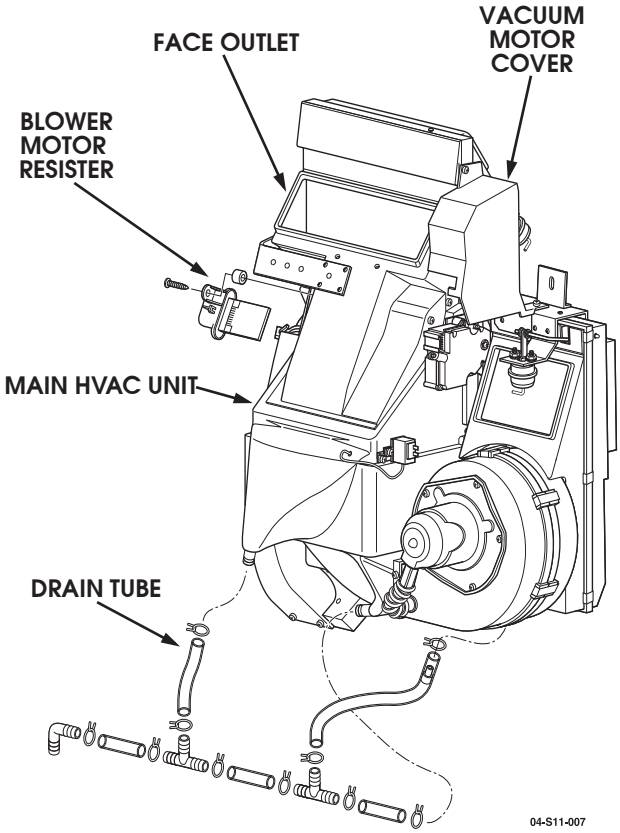


Figure 11-22: Main HVAC Unit

Diverter Doors

Three diverter doors occupy the outlet area of the main unit. Various positions and combinations of three doors provide the system with the following mode selections:

- Off
- Maximum A/C - Recirculate
- A/C
- A/C Face/Floor blend
- Face
- Floor
- Defrost

All four of the mode doors are operated using vacuum motors mounted externally to the case (Figure 11-23). The motors are as follows:

- Floor door motor
- Defrost block-off motor
- Face door motor
- Recirculate door motor

The vacuum motors are capable of two positions: fully extended (spring pressure) or fully retracted (vacuum). The face door motor is an exception, having a third position in the center of travel. A second vacuum inlet is added to the face door motor for this purpose (Figure 11-23).

The temperature blend door motor operates the temperature blend door. This door is responsible for regulating outlet air temperature by directing air through the heater core or by blocking air to the core. The temperature blend door motor is electric and can be positioned at multiple points.

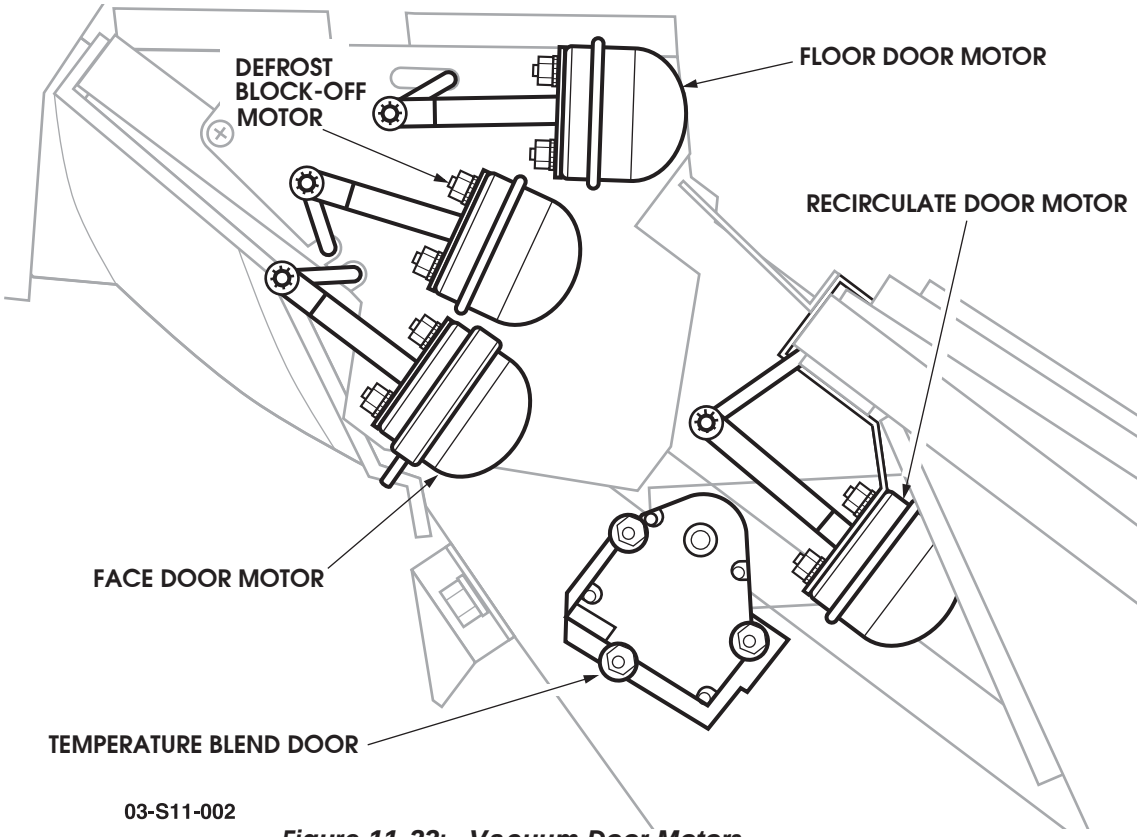


Figure 11-23: Vacuum Door Motors

Heater Core

The heater core is composed of aluminum with numerous passages allowing heated engine coolant to pass through, transferring heat into the passing air from the blower motor. Coolant flow through the heater core is controlled by the water control valve in the engine compartment (Figure 11-24).

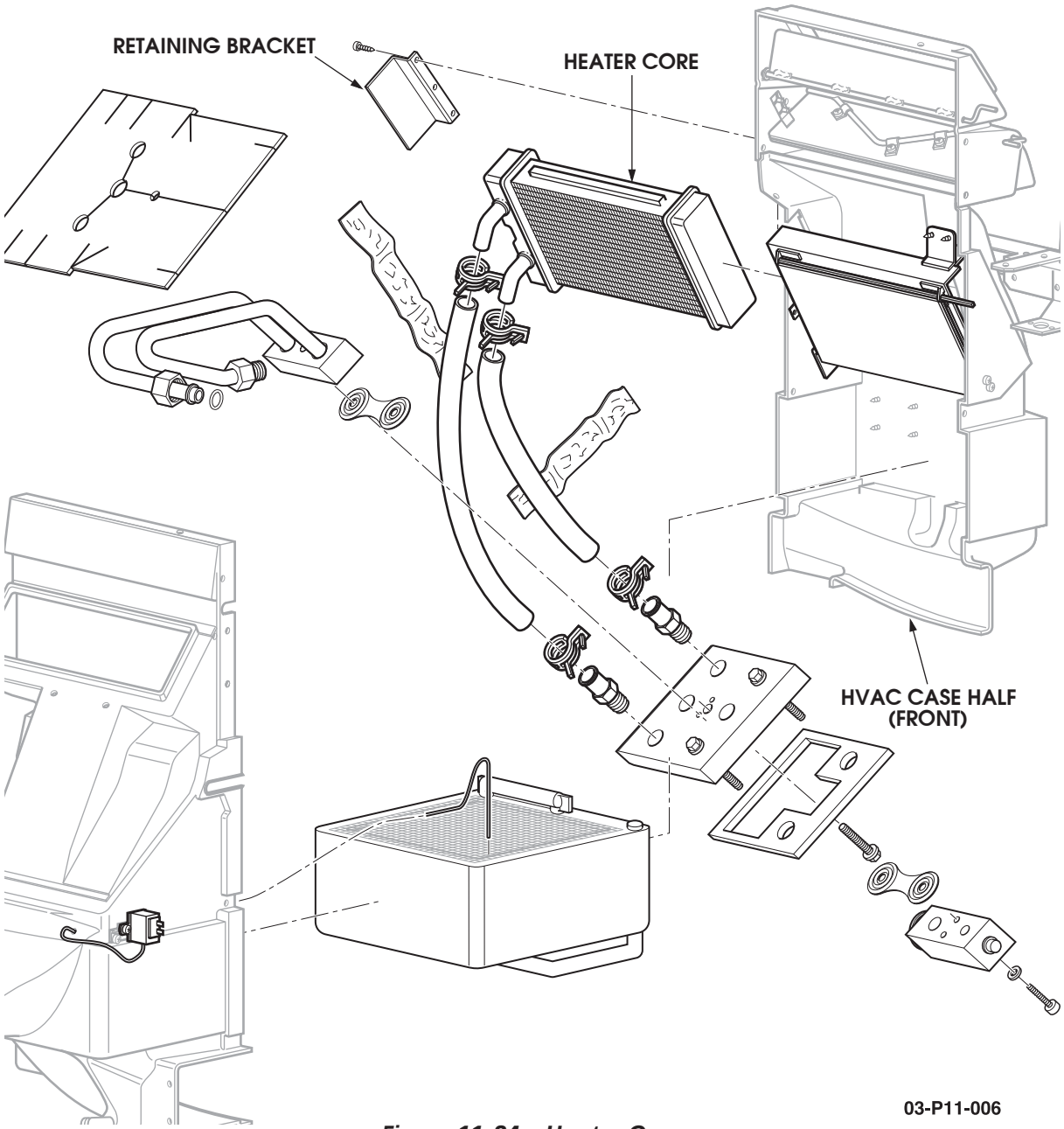


Figure 11-24: Heater Core

Evaporator

The evaporator is composed of a wide flat aluminum tube bent in a serpentine pattern. Fins extending out from the tube assist in transferring heat from the passing air into the refrigerant which is evaporating inside of the tubes (Figure 11-25).

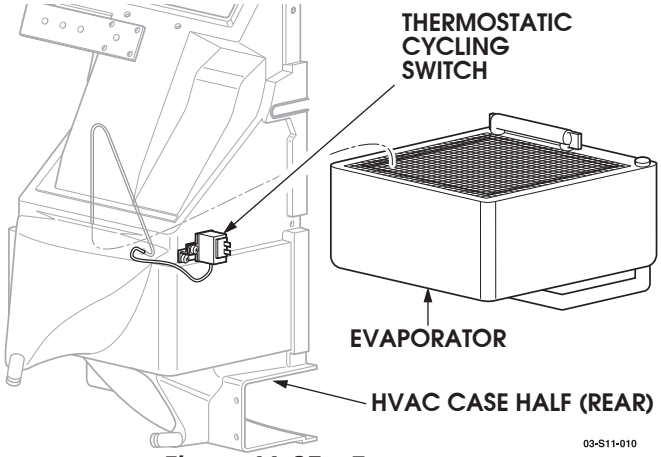


Figure 11-25: Evaporator

Thermostatic Cycling Switch

The thermostatic cycling switch is mounted on the side of the main HVAC unit (Figure 11-25). The thermostatic cycling switch is responsible for turning off the compressor clutch when evaporator temperature approaches freezing. Temperature is sensed by a capillary tube inserted in the fins of the evaporator. Should the evaporator reach freezing temperatures, moisture condensing on the fins of the evaporator will freeze and hinder air flow. The thermostatic cycling switch will interrupt current to the compressor clutch until the temperature rises to about 40° F.

Expansion Valve

The expansion valve controls the flow of refrigerant through the evaporator. Refrigerant must be metered to prevent the liquid refrigerant from flooding the evaporator. The expansion valve is exposed to both low and high pressures and bases refrigerant flow on the pressure which is exiting the evaporator (Figure 11-26).

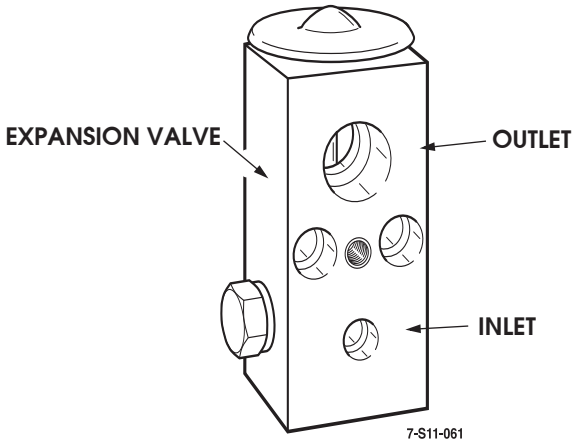


Figure 11-26: Expansion Valve

Blower Motor

The blower motor is a permanent magnet electric motor that drives a wheel type fan (Figure 11-27). The air enters the unit from the outside air intake or from a door on the interior of the vehicle. The air is then forced through the evaporator and heater core.

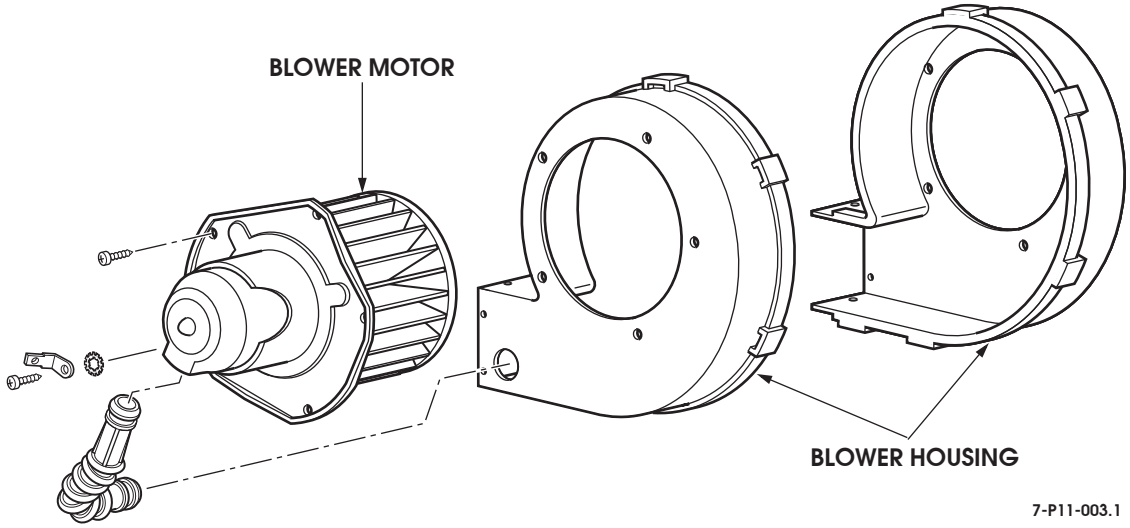


Figure 11-27: Blower Motor and Housing

MAIN UNIT REPLACEMENT

Removal

1. Drain the Coolant into an approved container.
2. Recover the refrigerant.
3. Remove the rain cap and the adapter.
4. Remove the air intake elbow, air cleaner and the splash shield.
5. Remove the four bolts securing the heater core extension tubes to the passthrough plate. Plug all open holes and discard all the sealing washers (Figure 11-28).

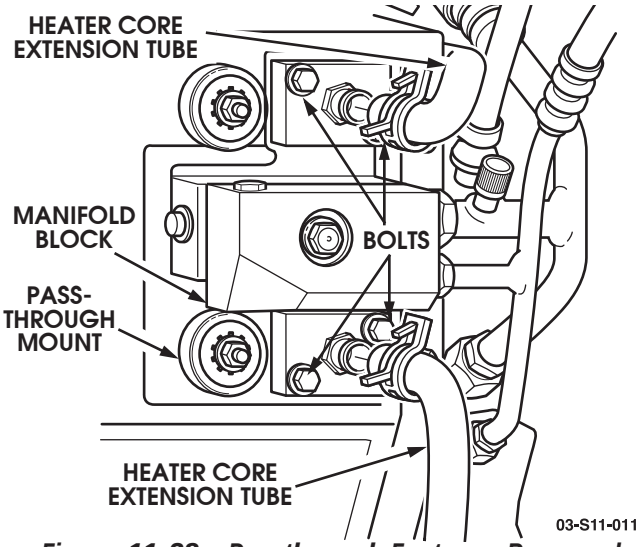


Figure 11-28: Passthrough Fastener Removal

6. Remove any pliable sealer from the exterior of the passthrough plate.
7. Remove the center console.
8. Remove the right side crash pad.

9. Remove the fastener from the passenger side closeout panel.
10. Lower the panel down to gain access to the floor outlet hose, remove the screw securing the hose and remove the closeout panel.
11. Remove the two screws securing the passenger side of the auxiliary heat/cool unit. Raise the cover up approximately 2" and support with a block of wood.
12. Remove the passenger side door strap bracket and the seat belt buckle assembly.
13. Remove the front passenger seat and the right front inner and outer kick panels.

NOTE: Panels are removed to prevent damage that would occur during HVAC unit removal.

14. Note the HVAC harness positioning prior to removal/disconnect.
15. Disconnect the vacuum motor harness, engine HVAC harness, water valve harness, temperature blend door connector, cycling switch connections, power mirror harness, resistor harness, power door lock harness, power window harness and the blower motor connections (Figure 11-29).

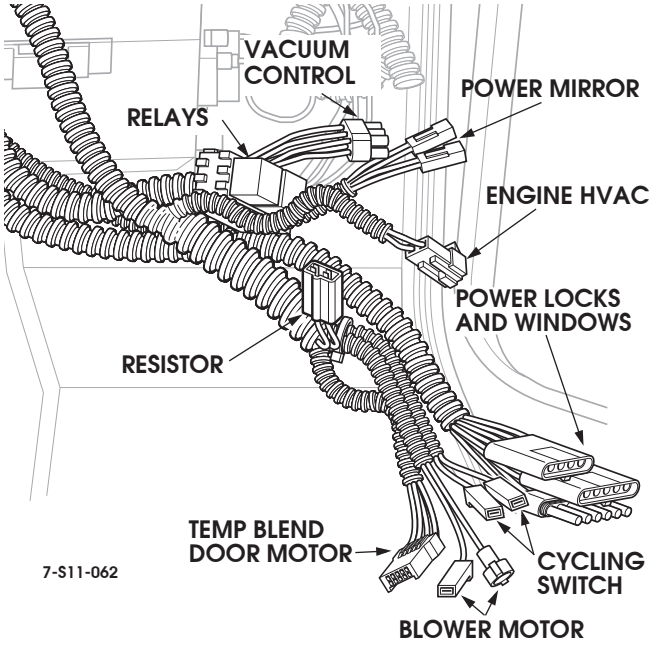


Figure 11-29: Harness/Connector Identification

16. Pull the harnesses clear of the HVAC unit and secure.
17. Remove the screw(s) securing the floor duct to the top of the HVAC unit. Disconnect the hose going to the passenger floor area and remove the hose.
18. Remove the two screws, the Christmas tree fastener and remove the transition assembly.
19. Remove the bolt securing the HVAC manifold block to the expansion valve and discard the sealing gasket. Cap all the openings.
20. Remove the two interior bolts securing the left and the right side of the HVAC unit to the body. Support the unit prior to removing the second fastener to prevent the unit from falling down and causing possible damage or injury (Figure 11-30).
21. Removal of the unit can be accomplished by lowering and pulling straight rearward.

Installation

Lift the HVAC unit into the vehicle.

1. Set the lower bracket on the HVAC unit on top of the lower body bracket. Ensure that the studs on the pass through plate align with the holes in the body. Harnesses must be positioned to exit to the right side of the HVAC unit.
2. Pivot the unit upwards until it rests against the defrost and floor ducts. Install the right side fastener, two nuts, washers and grommets on the passthrough plate. Slowly tighten the front pass through mounts first. This action will pull the unit forward. Ensure that the defrost and heating ducts align properly with the outlets on the HVAC unit before tightening inside mounts.

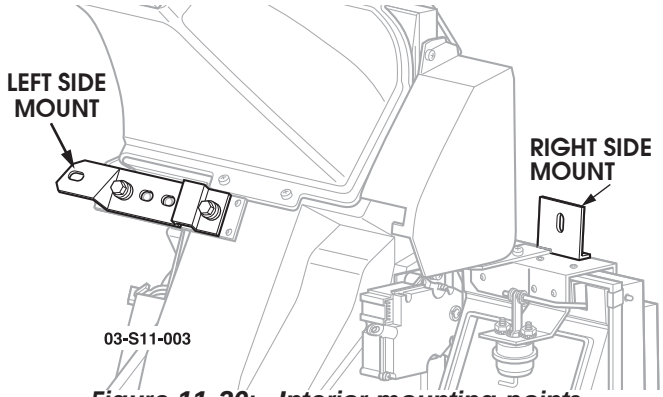


Figure 11-30: Interior mounting points

NOTE: The HVAC unit should have a 1/2" inch spacer between the left side bracket and the body. If the spacer was not present when the unit was removed, it should be installed when the unit is taken out of the vehicle for service.

3. Install the left hand interior fastener with the 1/2"spacer, it may be necessary to loosen the bracket and slide it left or right to align the hole. Tighten the fastener (Figure 11-31).

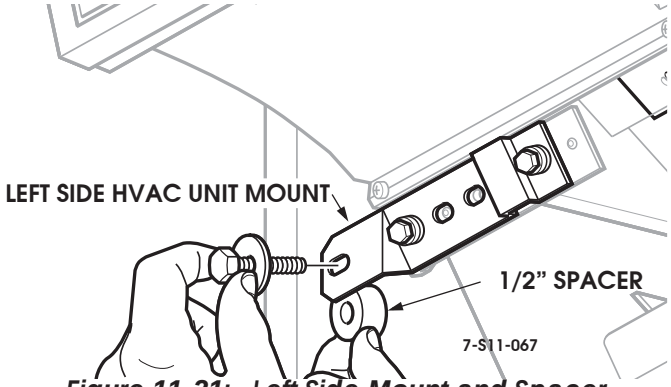


Figure 11-31: Left Side Mount and Spacer

4. Install the screw(s) securing the drivers floor duct to the main HVAC unit.
5. Install the passenger side floor duct and route to the right as previously removed.
6. Install the transition assembly with the two screws and a new christmas tree fastener.

CAUTION: *Be sure to remove all of the devices used to plug the openings in the heater lines and the A/C lines.*

7. Install the manifold block to the expansion valve using a new sealing gasket, torque the fastener to 25 lb-ft.
8. Install the heater core extension tubes onto the passthrough plate using the new sealing washers. Torque the fasteners to 32 in lbs.
9. Evacuate the A/C system for 45 minutes, with a 10 minute hold time for a leak check.
10. Refill the cooling system.

NOTE: When refilling, use bleeder screws on the engine and the radiator to purge as much air as possible from the system. The bleeder screws also allow easier filling of the cooling system.

11. Charge the A/C system to 2lbs 4oz. Add 2oz. oil if the unit is new or the evaporator was replaced.
12. Leak check the passthrough plate for body leaks using a water hose. If leakage is noted inside the vehicle, seal the leaks from the outside using body sealer in small amounts.
13. Leak check the A/C lines using a R134-A leak detector.
14. If no leaks are found, install the air cleaner housing, elbow, adapter, rain cap and the air cleaner splash shield.
15. Connect the vacuum control harness, cycling switch connections, power mirror harness, door lock harness, power window harness, blower motor connections, resistor harness, engine HVAC harness, temperature blend door connector and the water valve harness.

16. Install the center console and check the operation of the A/C and the heat.
17. If the A/C and the heat are functioning properly, install the left front and the right front passenger side kick panels, door strap and the seat belt buckle assembly.
18. Install the right front seat and the crash pad.
19. Install the right side closeout panel.

VACUUM DOOR MOTOR

Removal

1. Remove the right front crash pad.
2. Locate and remove the two screws securing the vacuum motor cover to the main HVAC unit.
3. Locate the faulty vacuum motor and remove the vacuum line. If multiple motors are to be replaced, tag the vacuum lines as they are removed.
4. Note the position of the mounting studs on the motor to be replaced. Mark the holes that the studs pass through (Figure 11-32).

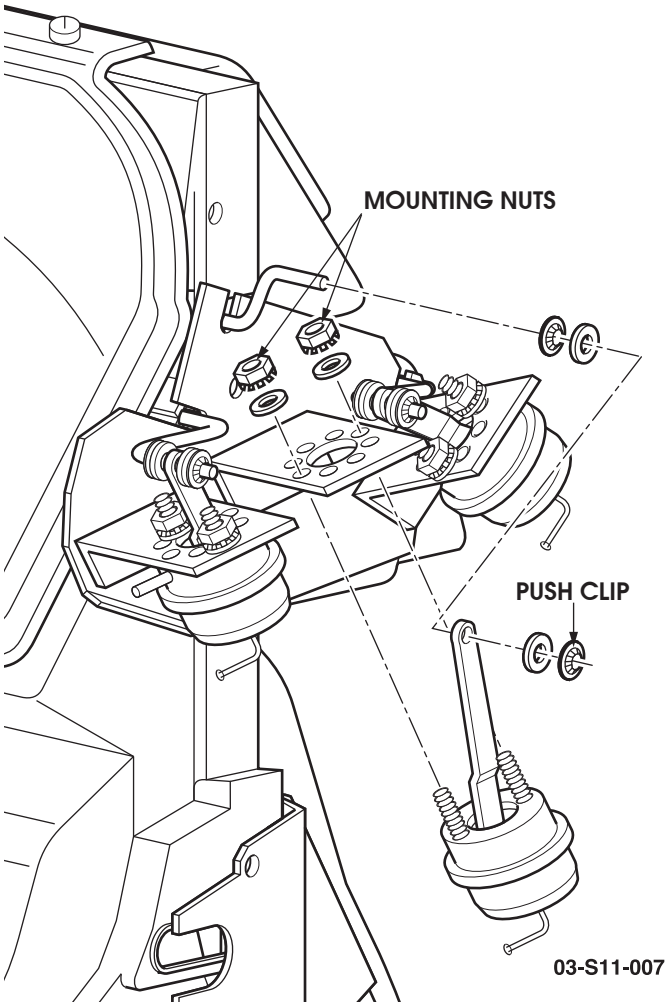


Figure 11-32: Vacuum Door Motor Replacement

5. Note the position of the motor arm relative to the door lever. Mark the side facing away from the HVAC unit.
6. Remove the outer push clip with side cutting pliers and discard.
7. Remove the washer under the push clip, do not discard.
8. Remove the two mounting nuts and the vacuum motor (Figure 11-32).

Installation

1. Secure the vacuum motor with the two mounting nuts.
2. Slide the motor arm on the door lever and secure with the washer and a new push clip.
3. Install the vacuum lines.
4. Secure the motor cover with the two screws.
5. Install the right front crash pad.

BLEND DOOR MOTOR

Removal

1. Disconnect the motor electrical connection.
2. Remove the three nuts securing the motor to the bracket (Figure 11-33).

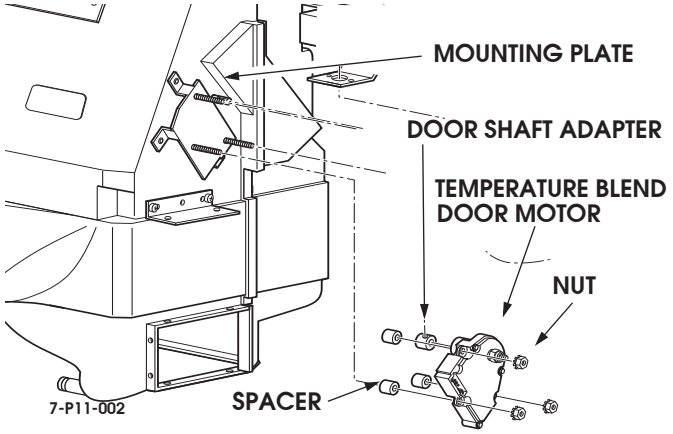


Figure 11-33: Temperature Blend Door Motor Removal

NOTE: Do not loosen the set screw on the door shaft adapter!

3. Remove the motor by pulling it straight off. Do not discard the spacers behind the motor.

Installation

1. Install the blend door motor spacers and door shaft adapter.
2. Install the blend door motor and secure with the three nuts.
3. Connect the motor electrical connection.

Heater Core Removal

NOTE: Screws should be noted for length as they are removed to aid in correct reassembly. Some screw lengths are critical to prevent interference with interior parts.

NOTE: Most of the screws used are threaded into the plastic housing of the HVAC unit. Care should be used to prevent over-tightening of the hardware and stripping the holes out.

1. Remove the HVAC unit from the vehicle (Refer to section 11).
2. Set the HVAC unit on a bench so the rubber heater hoses are visible and facing upwards.
3. Remove the protective cover and fully expose the rubber heater hoses .

NOTE: Foam tape and permagum tape should always be replaced with new material where it was removed from during disassembly. The tapes are used to insulate hot and cold parts and prevent condensation from dripping on the passenger floor.

4. Remove the constant tension clamps from the heater hoses at the heater core (Figure 11-34).

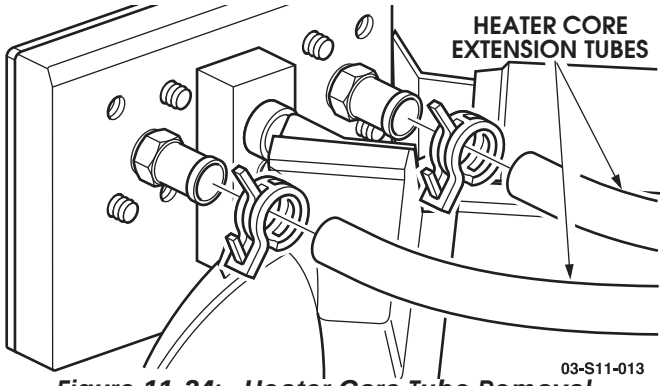


Figure 11-34: Heater Core Tube Removal

5. Carefully remove the hoses from the heater core.
6. Remove the retaining plate (Figure 11-35).

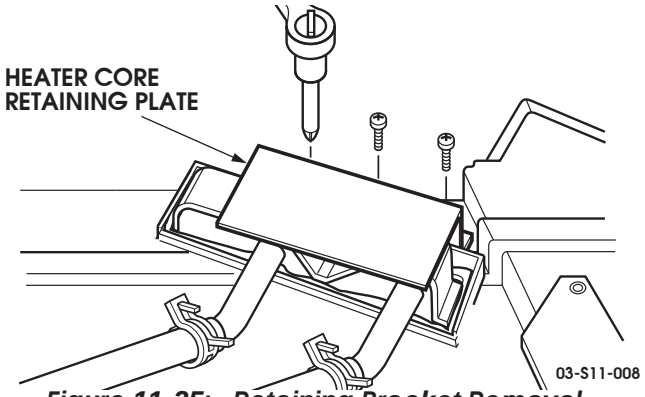


Figure 11-35: Retaining Bracket Removal

7. Remove the heater core from the HVAC unit. Note positioning of any foam tape on the heater core and duplicate on the new part (Figure 11-36).

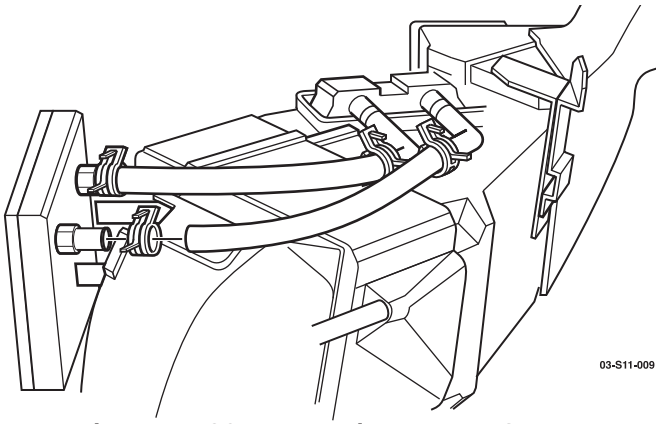


Figure 11-36: Removing Heater Core

Installation

1. Apply new foam tape in same position as on the old heater core.
2. Install heater core into the HVAC unit.
3. Install the retaining plate.
4. Install the heater hoses and secure with the constant tension clamps.
5. Install the protective cover.
6. Install the HVAC unit in the vehicle.

EVAPORATOR

Removal

NOTE: Observe the screws as they are removed to ensure correct screws are used in the correct location on the assembly.

1. Remove the HVAC unit from the vehicle (Refer to “Main Unit Replacement” on page 11-37).
2. Remove the heater core from the main unit (Refer to “Heater Core Removal” on page 11-41).
3. Disconnect the vacuum harness from the vacuum motors. The motors are color coded to the vacuum tubing (Figure 11-37).

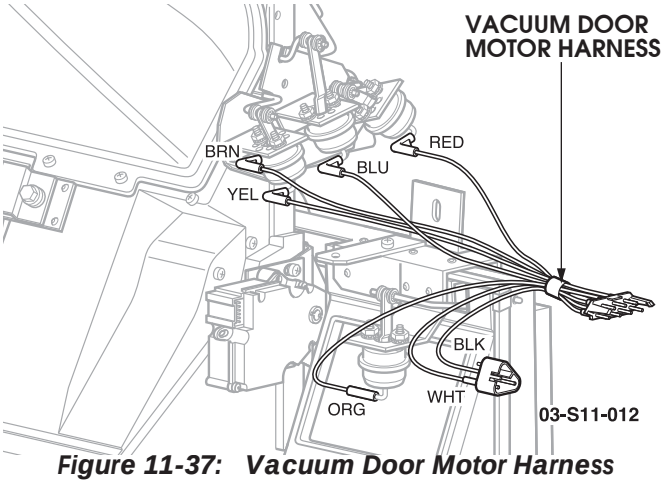


Figure 11-37: Vacuum Door Motor Harness

4. Remove the air intake housing from the main unit by removing the attaching screws at the blower housing (Figure 11-39) and the bracket at the front of the unit (Figure 11-38).

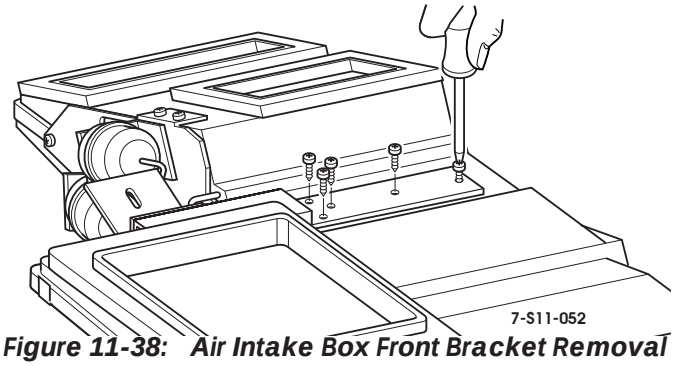


Figure 11-38: Air Intake Box Front Bracket Removal

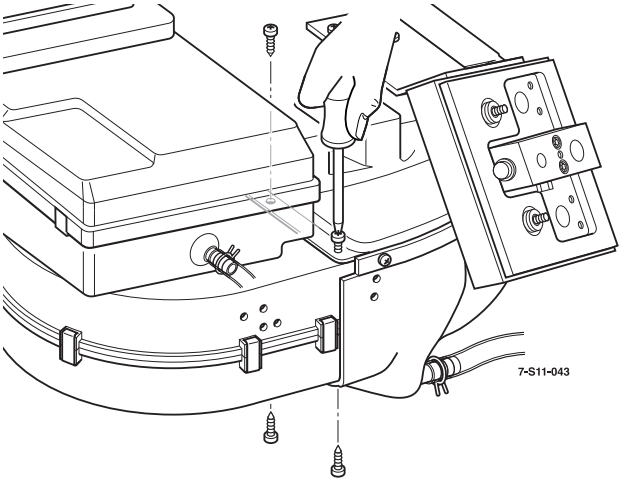


Figure 11-39: Lower Blower Housing Hardware Removal

5. Remove the floor door arm retaining push clip, arm and the two washers from the floor door (Figure 11-40).

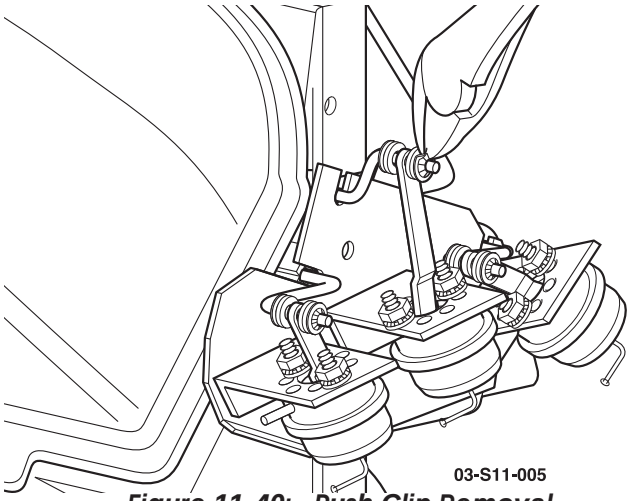


Figure 11-40: Push Clip Removal

6. Remove the screws securing the vacuum motor mounting plate to the main HVAC unit and remove the mounting plate (Figure 11-41).
7. Remove the screws securing the case halves together. Do not attempt to separate the case at this time (Figure 11-41).

CAUTION: *Do not attempt to pull the switch out of the case, the capillary tube is secured to the evaporator.*

8. Using a utility knife, carefully cut through the sealer between the two case halves. Use caution to prevent cutting the case.

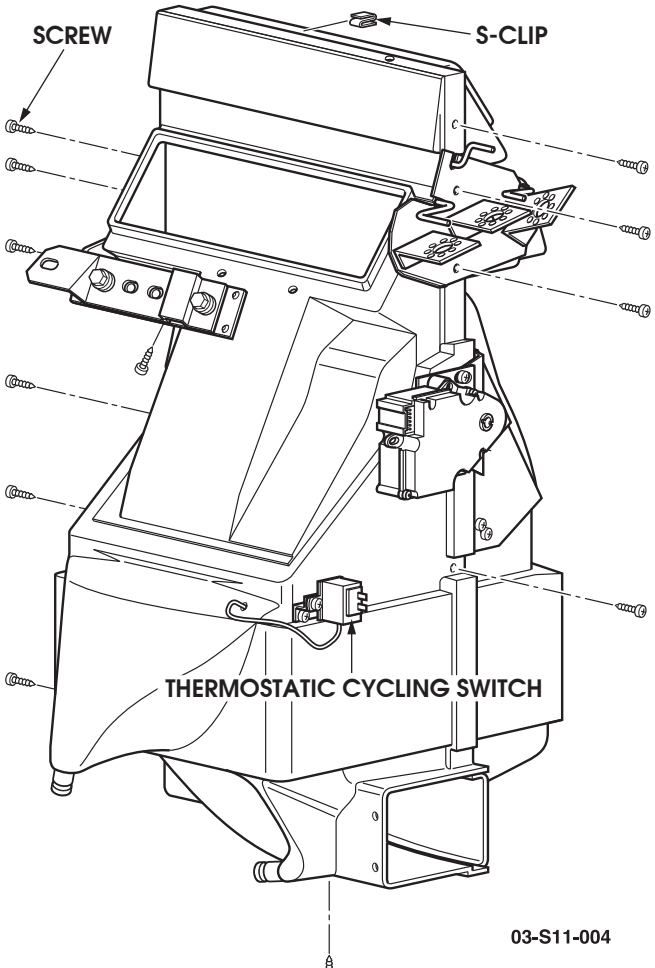


Figure 11-41: Case Half Hardware Removal

9. Using a putty knife or scraper, carefully spread apart the entire case seam.
10. Separate the case halves. Note that the thermostatic cycling switch must be separated from the evaporator.
11. Remove the permagum tape from around the liquid and the vapor tubes and discard.
12. Remove the expansion valve block from the passthrough plate, discard the gasket (Figure 11-42).

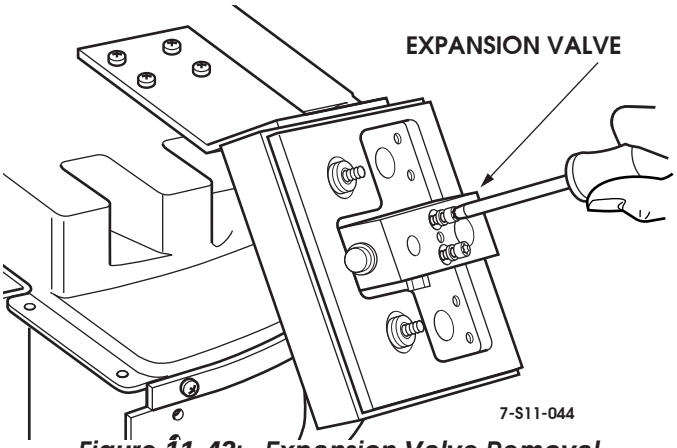


Figure 11-42: Expansion Valve Removal

13. Remove the screws securing the passthrough plate support bracket to the main unit (Figure 11-43).

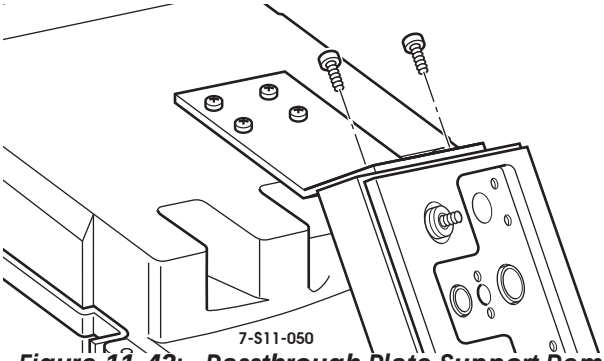


Figure 11-43: Passthrough Plate Support Removal

14. Remove the bolt securing the passthrough plate to the evaporator manifold connection, remove the plate and the support bracket.
15. Remove the evaporator from the unit (Figure 11-44).
16. Carefully remove the capillary tube from the evaporator, noting the positioning in the evaporator fins (Figure 11-44).

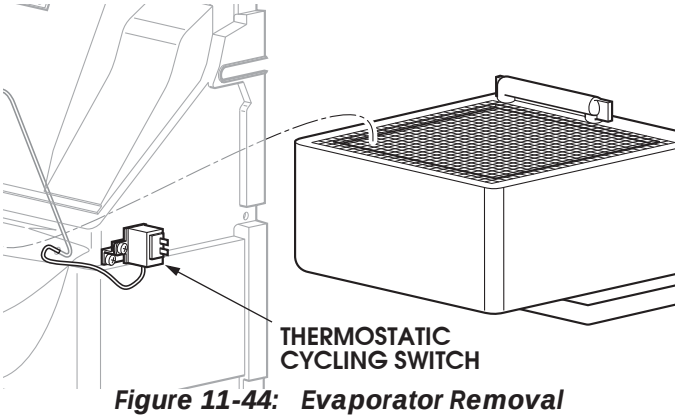


Figure 11-44: Evaporator Removal

17. Disconnect the evaporator extension tubes at the O-ring fittings (Figure 11-45). Discard the O-rings.

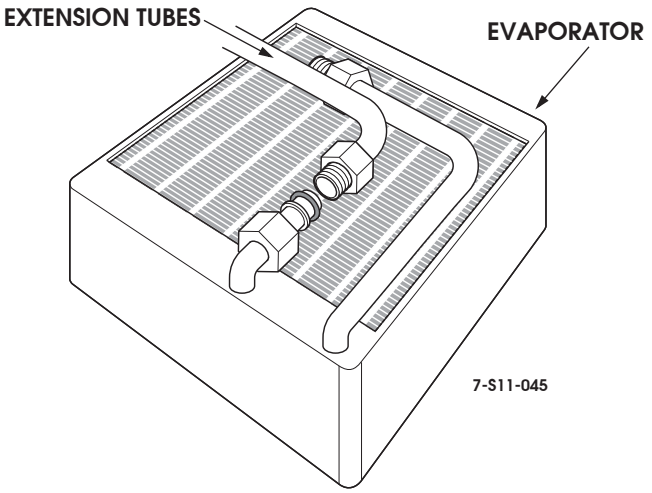


Figure 11-45: Evaporator Extension Tubes Removal

Installation

1. Obtain a new evaporator. Ensure that any foam tape found on the previously removed unit is duplicated on the replacement.
2. Install the extension tubes onto the new evaporator using new o-rings lubricated with refrigerant oil.
3. Install the evaporator into the original case half.
4. Position the thermostat capillary tube in the same location it was removed from on the original evaporator. It will be necessary to hot glue the tube near the exit hole (Figure 11-44).
5. Install the second half of the HVAC unit, ensuring that the edges of the case halves engage the S clips around the seam.
6. Install the screws securing the two halves together.
7. Using a neutral cure silicone sealer, seal the entire perimeter of the seam.
8. Install the passthrough plate onto the main unit and the evaporator. Install the bolt securing the evaporator extension tubes to the passthrough plate. Use a new sealing washer between the passthrough plate and the evaporator extension tubes.

NOTE: It may be necessary to trim the center from the gasket as received. The normal span of the gasket will not fit the evaporator extension tube span.

9. Install the expansion valve with a new sealing washer and torque to 100 in lbs.
10. Install the Vacuum motor bracket onto the main unit
11. Install the defrost door motor onto the mounting plate.
12. Connect all the vacuum motors to their perspective door arms using the washers and a new push clips.
13. Install a new door travel limiting rivet into the case, placing the door on the side of the rivet it was originally resting on.
14. Install the air intake assembly onto the main case.
15. Install the lower support bracket.
16. Install the heater core and the retaining brackets, using a new sealing washers on the heater core tubes. Torque the heater manifold to 32 in-lbs.
17. Install the vacuum harness onto the vacuum motors.
18. Install the unit into the vehicle (Refer to section11).
19. Fill the cooling system.
20. Evacuate the A/C system for a minimum of 45 minutes, with a 10 minute hold time for a leak check. Charge with 2 lbs 4 oz. of R-134A refrigerant, adding the same amount of oil that was drained from the original evaporator.

Thermostatic Cycling Switch Replacement

Removal

1. Remove the evaporator (Refer to section 11).
2. Carefully remove the capillary tube from the evaporator, noting the positioning in the evaporator fins (Figure 11-44).
3. Remove the two screws and remove the thermostatic cycling switch from the HVAC unit.

Installation

1. Secure the thermostatic cycling switch to the HVAC unit with the two screws.
2. Install the evaporator into the original case half.
3. Position the thermostat capillary tube in the same location it was removed from on the original evaporator. It will be necessary to hot glue the tube near the exit hole (Figure 11-44).
4. Install the evaporator and the main HVAC unit into vehicle (Refer to section 11).

Air Intake Assembly Replacement

Removal

1. Remove the main HVAC unit (Refer to section 11).
2. Remove the air intake housing from the main unit by removing the attaching screws at the blower housing (Figure 11-39) and the bracket at the front of the unit (Figure 11-38).

Installation

1. Install the air intake housing on the main HVAC unit and secure with the screws.
2. Install the main HVAC unit into the vehicle (Refer to section 11).

AUXILIARY AIR CONDITIONING/HEATING UNIT

The auxiliary HVAC unit is utilized to enhance the heating and cooling of the Hummer. The unit is located under the center console. A secondary evaporator in parallel with the front evaporator and a heater core in parallel with the front heater core and a second blower motor are included. The auxiliary unit requires that the front heater or A/C system be operating for heating or cooling. The auxiliary blower motor operates with a switch on the engine console, with two available speeds, high and low. There is a refrigerant cut-off solenoid for the auxiliary unit to stop refrigerant flow when the temperature control knob is in the heat position and the A/C compressor is running in the defrost mode.

AUXILIARY AIR CONDITIONING/HEATING UNIT REPLACEMENT

Removal

1. Discharge the air conditioning system.
2. Remove the center console (Refer to section 10).
3. Install hose pinch pliers on heater hoses to minimize coolant loss.
4. Remove the heater hoses from the auxiliary unit heater core ports (Figure 11-47).
5. Remove the A/C hoses from the auxiliary unit.
6. Remove the drain tubes from the auxiliary unit (Figure 11-47).

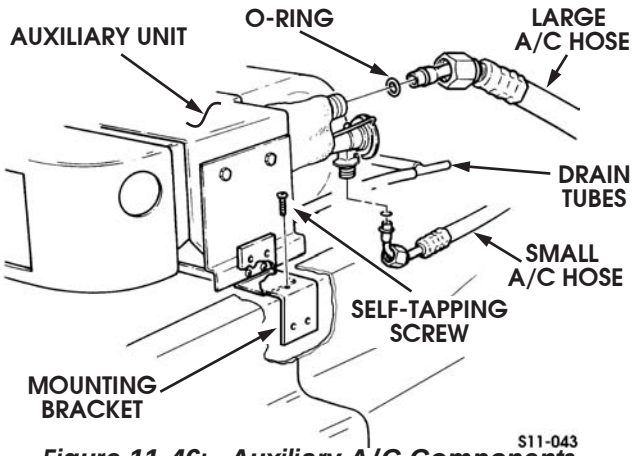


Figure 11-46: Auxiliary A/C Components

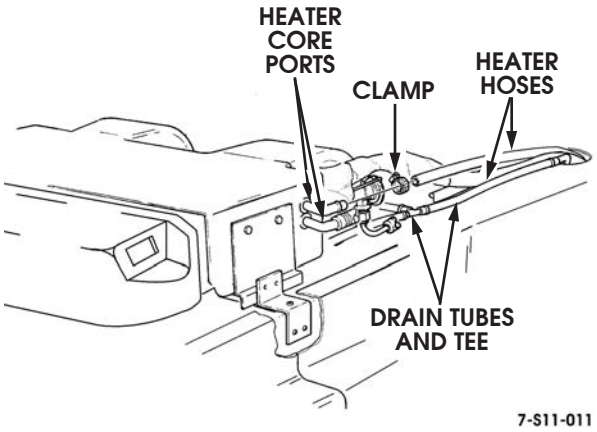


Figure 11-47: Auxiliary Heater Hose Routing

7. Remove the screws securing the side brackets to the tunnel mounting bracket.
8. Remove the auxiliary unit from the vehicle.

Installation

1. Install the auxiliary unit in the vehicle and secure the side brackets to the tunnel mounting bracket with the screws (Figure 11-46).
2. Install the drain tubes on the auxiliary unit (Figure 11-47).
3. Install the A/C hoses on the auxiliary unit.
4. Wrap the low pressure fitting with prestite tape.
5. Secure the heater hoses to the heater core ports on the auxiliary unit with the constant tension clamps. Remove the hose pinch pliers.
6. Evacuate, charge, and leak test the air conditioning system.
7. Check the engine coolant level and add coolant as necessary.
8. Start the engine and operate the auxiliary and the front air conditioning system to check for proper operation.
9. Check the coolant connections for leakage, repair if necessary.
10. Stop the engine, recheck the coolant level and add coolant if necessary.
11. Install the center console (Refer to section 10).

AUXILIARY BLOWER SWITCH REPLACEMENT

Removal

1. Remove the four screws securing the center dash bezel and the bezel.
2. Remove the connector from the back of the blower switch (Figure 11-48)
3. Depress the tabs on the blower switch and push the switch through the faceplate.

Installation

1. Push the blower switch into the opening in the bezel.
2. Secure the connector to the blower switch and check the operation (Figure 11-48).
3. Install the center dash bezel and secure with the four screws.

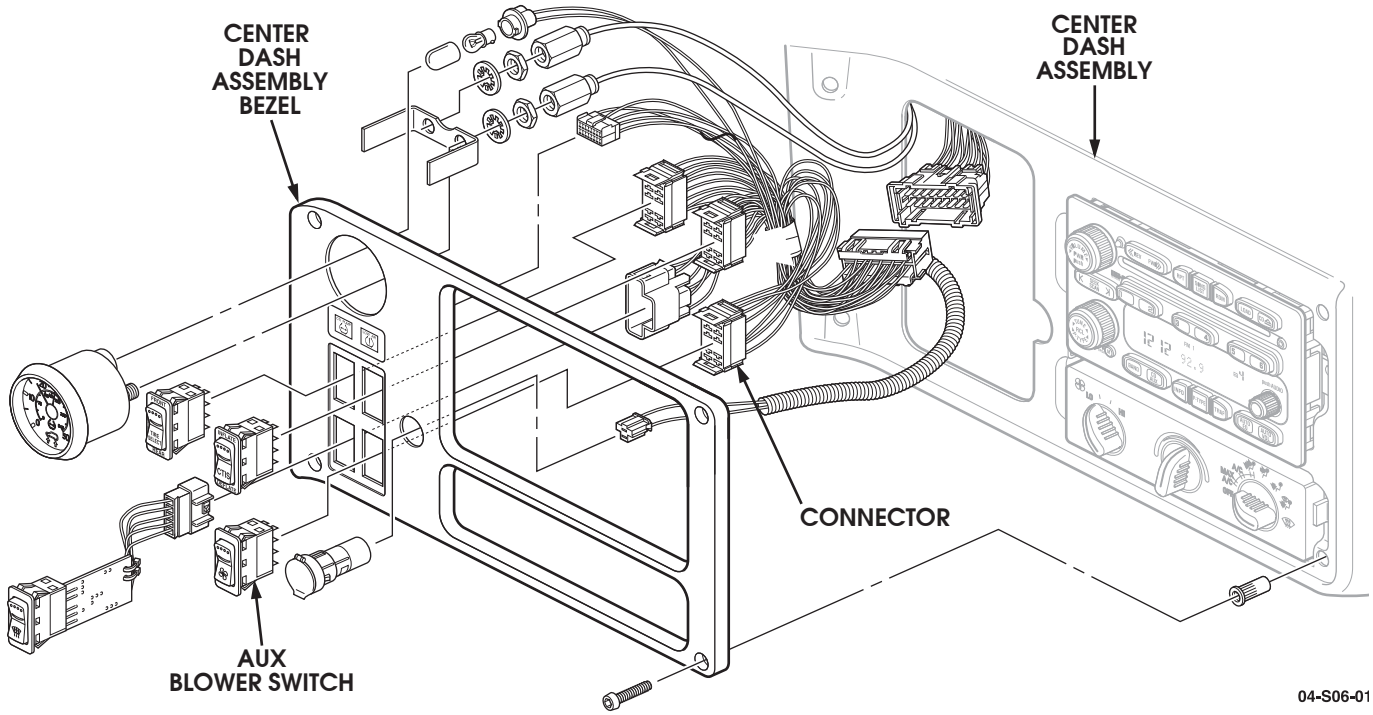


Figure 11-48: Blower Switch Replacement

AUXILIARY HEATER HOSE REPLACEMENT

NOTE: Heater hose replacement is the same for both heater hoses.

NOTE: Production heater hose will have full underbody length of foil back insulation sleeve. Make sure the replacement hose also has this protection.

Removal

1. Drain the cooling system (Refer to section 4).
2. Remove the air cleaner induction tube (Refer to section 3).
3. Select the heater hose to replace, loosen the hose clamps and remove the heater hose from the hose splice.
4. Remove the two P-clamps from the underbody securing the auxiliary hoses.
5. Remove the center console.
6. Remove the constant tension clamps securing the heater hose to the heater and to the core port on the auxiliary unit (Figure 11-47).
7. Pull the heater hose through the tunnel grommet.
8. Remove the heater hose.

Installation

1. Attach one hose end to the auxiliary unit heater core port and secure with the clamp (Figure 11-47).
2. Route the hose through the grommet to the engine area.
3. Connect the hose to the hose splice and secure with the clamp.
4. Install the two P-clamps to the underbody securing the installed hose to the existing hoses.
5. Fill the cooling system (Refer to section 4).
6. Install the air cleaner induction tube (Refer to section 3).
7. Pressure test the cooling system and check for leaks.
8. Install the center console.
9. Start the engine and run until the engine warms up.
10. Check the heating units for proper operation.

AUXILIARY A/C DRAIN TUBE(S) REPLACEMENT

Removal

1. Remove the center console.
2. Remove the clamps from the drain tube section being replaced (Figure 11-49).
3. Remove the drain tube.

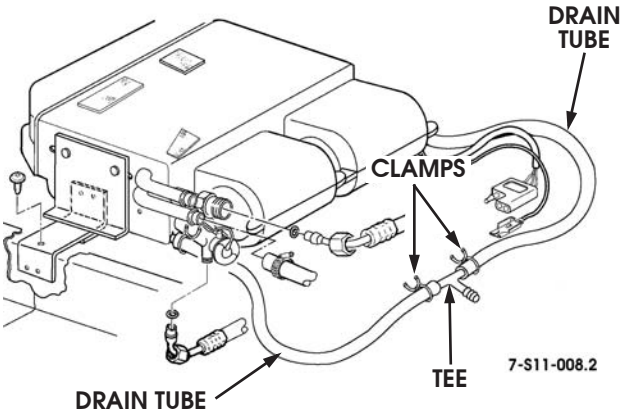


Figure 11-49: Auxiliary A/C Drain Tube Replacement

Installation

1. Install the drain tube section and secure with the clamps (Figure 11-49).
2. Install the center console.

REFRIGERANT SOLENOID REPLACEMENT

Removal

1. Discharge the air conditioning system.
2. Remove the center console.
3. Using two wrenches for equalized support, remove the auxiliary high pressure hose from the refrigerant solenoid. Remove and discard the O-ring.
4. Using two wrenches for equalized support, remove the refrigerant solenoid from the high pressure line to the auxiliary expansion valve. Remove and discard the O-ring.

Installation

1. Using two wrenches for equalized support, install the refrigerant solenoid to the high pressure line from the auxiliary expansion valve, tighten to 11-13 lb-ft. (15-18 N•m).

2. Install the auxiliary high pressure hose to the refrigerant solenoid. Using two wrenches for equalized support, tighten to 11-13 lb-ft. (15-18 N•m).
3. Install the center console.
4. Evacuate, charge and leak test the system.
5. Start the engine and check the A/C system operation.

AUXILIARY HIGH-PRESSURE HOSE REPLACEMENT

NOTE: Production hoses have a full underbody length of foil backed heat resistant sleeving. Replacement hoses should have the same level of thermal protection.

Removal

1. Discharge the air conditioning system.
2. Remove the air cleaner assembly and the air induction tube (Section 3).
3. Remove the center console.
4. Using two wrenches to equalize support, remove the auxiliary high pressure hose from the expansion valve manifold. Remove and discard the O-ring (Figure 11-50).
5. Using two wrenches for equalized support, remove the auxiliary high pressure hose from the auxiliary expansion valve. Remove and discard O-ring (Figure 11-51).
6. Remove the two P-clamps securing the hose to the underbody.
7. From under the vehicle, pull the high-pressure hose through the grommet.

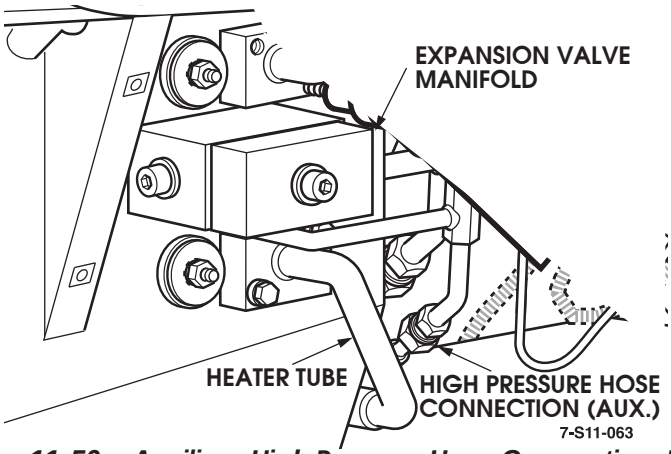


Figure 11-50: Auxiliary High Pressure Hose Connection, Front

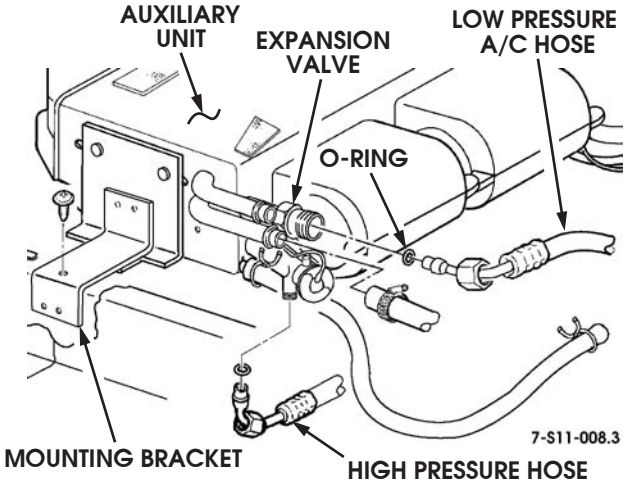


Figure 11-51: Auxiliary High-Pressure Hose Connection, Rear

Installation

1. Route the expansion valve end of the hose through the grommet to the auxiliary unit.
2. Lubricate and position the O-ring on the high pressure hose and hand thread the hose fitting onto the expansion valve. Using two wrenches for equalized support, tighten to 11-13 lb-ft. (15-18 N•m) (Figure 11-51).
3. Route the other end of the hose to the expansion valve manifold (Figure 11-50).
4. Lubricate and position the O-ring on the hose and secure to the high expansion valve manifold. Using two wrenches for equalized support, tighten to 11-13 lb-ft. (15-18 N•m).
5. Install the two P-clamps to secure the hoses to the underbody.
6. Install the center console.
7. Evacuate, charge and leak test the system.
8. Start the engine and check the A/C operation.

AUXILIARY LOW-PRESSURE HOSE REPLACEMENT

Removal

1. Discharge the air conditioning system.
2. Remove the air cleaner assembly and the air induction tube (Refer to section 3).
3. Using two wrenches for equalized support, remove auxiliary low-pressure hose from the low-pressure hose fitting. Remove and discard the O-ring (Figure 11-50).
4. Remove the two P-clamps securing the hoses to the underbody.
5. Remove the center console.
6. Remove the prestite tape from the low-pressure hose. Using two wrenches for equalized support, remove the hose from the auxiliary unit. Remove and discard the O-ring (Figure 11-51).
7. From under the vehicle, pull the low pressure hose through the grommet.

CAUTION: *To avoid potential thread or fitting damage, hand start connections before using wrenches.*

Installation

1. Route the evaporator end of the hose through the grommet to the auxiliary unit.
2. Lubricate and position the O-ring on the hose and secure to the auxiliary unit. Using two wrenches for equalized support, tighten to 21-27 lb-ft. (29-37 N•m) (Figure 11-51).
3. Route the other end of the low-pressure hose under the hood to the low pressure fittings.
4. Lubricate and position the O-ring and secure the auxiliary low pressure hose to the existing low pressure hose fitting. Using two wrenches for equalized support, tighten to 24-28 lb-ft. (33-38 N•m) (Figure 11-50).
5. Install the two P-clamps to secure the hoses to the underbody.
6. Install the center console.
7. Evacuate, charge and leak test the system.
8. Start the engine and check the A/C operation.

AUXILIARY EVAPORATOR/HEATER CORE REPLACEMENT

Removal

1. Remove the auxiliary unit from the vehicle.
2. Remove the four screws and the plenum from the housing.
3. With the auxiliary unit on a bench, remove the six plastic locking pins securing the unit housing halves together (Figure 1).
4. Remove the four screws from the blower motor support.
5. Remove the four screws securing the side brackets to the upper housing half.
6. Separate the housing halves.
7. Remove the blower motor assembly from the bottom housing.

8. Remove the evaporator/heater core assembly from the lower housing.
9. Remove the plastic stick pins and the mesh filter from the evaporator/heater core assembly.

NOTE: If the expansion valve is to be reused, remove the valve from the evaporator/heater core assembly and install on the replacement unit.

Installation

1. Install the mesh filter on the evaporator/heater core assembly with the plastic stick pins (Figure 11-52).
2. Install the evaporator/heater core assembly in the lower housing.
3. Install the blower motor assembly in the lower housing.
4. Install the upper housing to the lower housing with the six plastic locking pins, the four blower motor support screws and the four screws securing the side brackets to the upper housing.
5. Install the plenum on the housing with the four screws.
6. Install the auxiliary unit into the vehicle.
7. Evacuate, charge and leak test the A/C and the heating system.

AUXILIARY BLOWER MOTOR REPLACEMENT

Removal

1. Disconnect the auxiliary unit mounting hardware and tilt the unit up to gain access to the blower motor support screws.
2. Remove the support screws and the screws securing the side brackets to the upper housing half.
3. Separate the housing halves and remove the blower motor assembly from the lower housing.

Installation

1. Install the blower motor assembly in the lower housing and the housing halves back together.
2. Install the side brackets to the upper housing half with the screws and the support screws.
3. Position the auxiliary unit and secure with the mounting hardware.

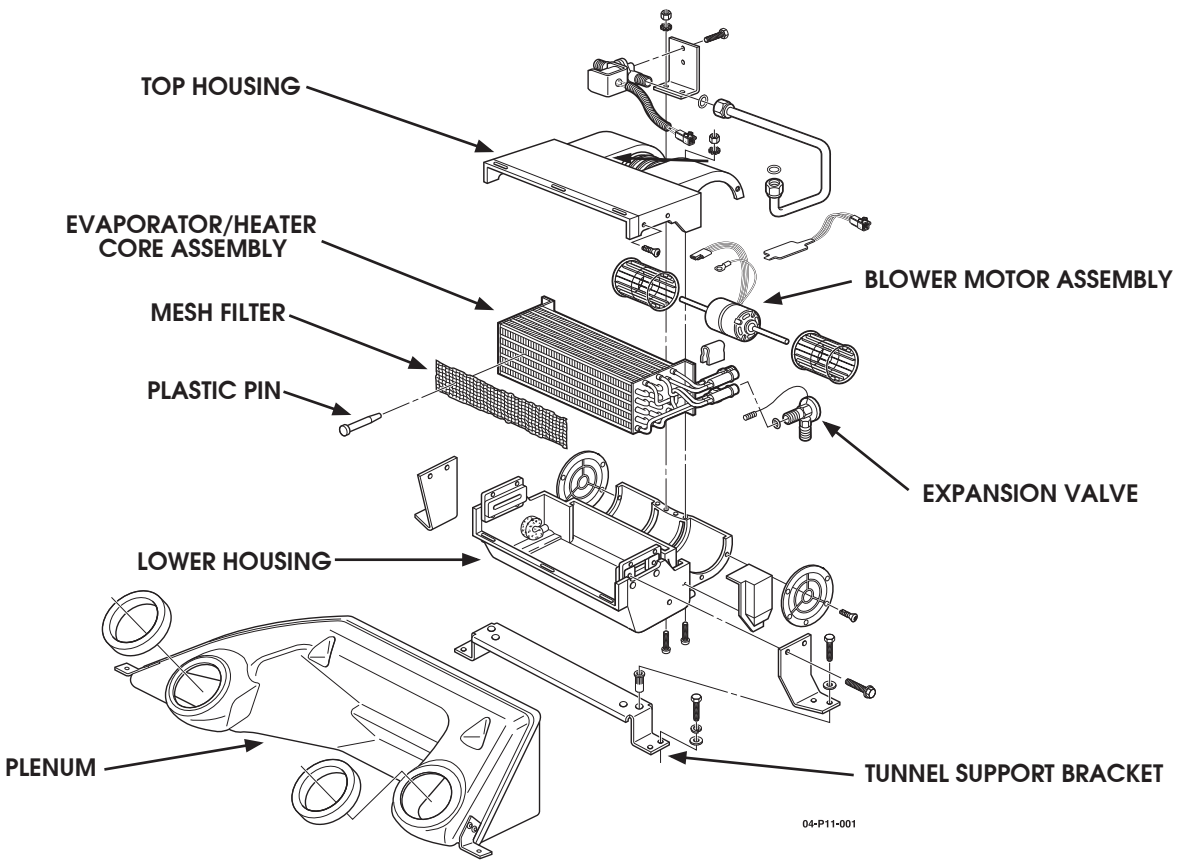


Figure 11-52: Auxiliary Air Conditioning Components

AUXILIARY EXPANSION VALVE REPLACEMENT

Removal

1. Discharge the air conditioning system.
2. Remove the center console.
3. Remove the prestite tape and the bulb clamp.
4. Using two wrenches for equalized support, remove the high-pressure hose from the expansion valve. Remove the O-ring from the hose and discard the O-ring (Figure 11-53).
5. Using two wrenches for equalized support, remove the expansion valve from the auxiliary unit. Remove and discard the O-ring (Figure 11-46).

Installation

1. Install the O-ring and the expansion valve on the auxiliary unit. Using two wrenches for equalized support, tighten to 15-20 lb-ft. (20-27 N•m) (Figure 11-46).
2. Position the O-ring onto the high pressure hose and hand-thread the hose fitting onto the expansion valve. Using two wrenches for equalized support, tighten to 11-13 lb-ft. (15-17 N•m) (Figure 11-53).
3. Install the prestite tape and the bulb clamp.
4. Evacuate, charge, and leak test the system.
5. Install the center console.
6. Start the engine and check the operation of the auxiliary unit.

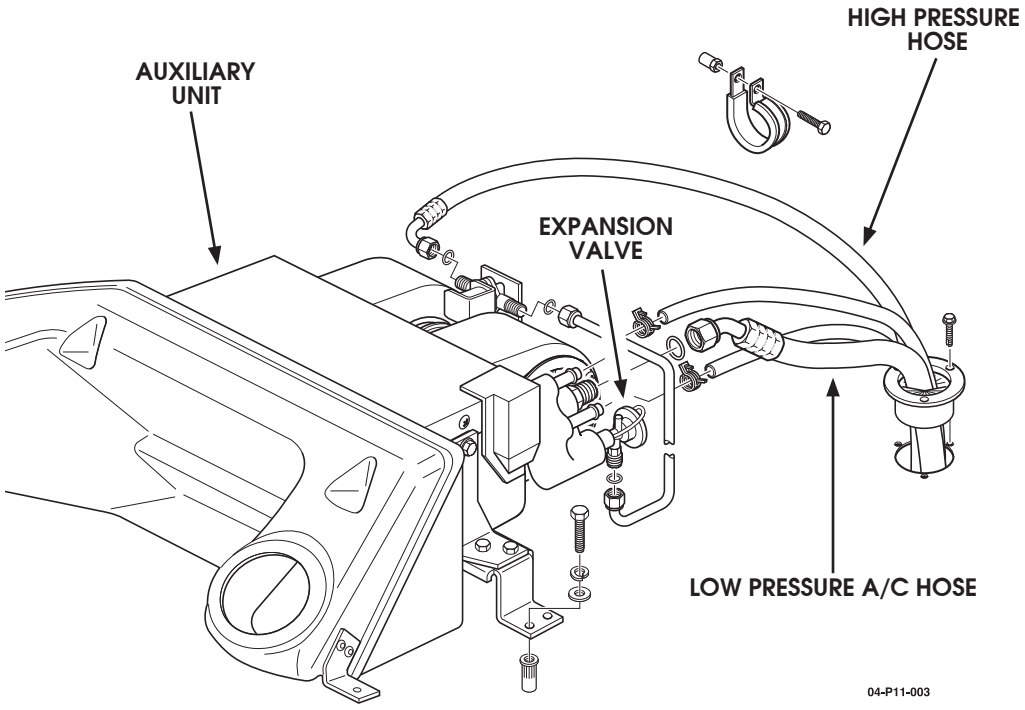


Figure 11-53: Expansion Valve Removal/Installation

VACUUM PUMP

The vacuum pump is located under the hood near the air cleaner assembly. It is an electrically operated motor with a built in pressure sensor switch, when the ignition is turned on and the vacuum drops below 11” Hg the motor is activated until 15” Hg vacuum is achieved.

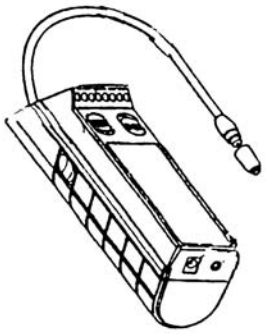
Removal

1. Disconnect the vacuum hose.
2. Disconnect the electrical connector.
3. Remove the three retaining screws with a long shank number two Phillips screw driver and remove the pump.

Installation

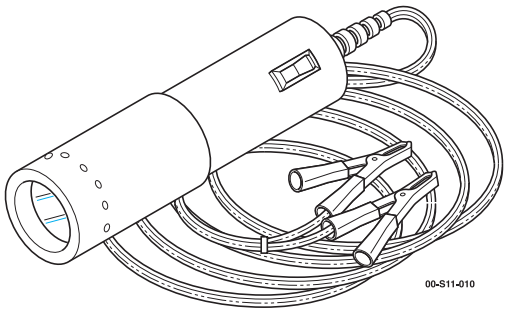
1. Install the vacuum pump with the three retaining screws.
2. Connect the electrical connector.
3. Connect the vacuum hose.
4. Check the vacuum pump for proper operation.

ESSENTIAL TOOLS



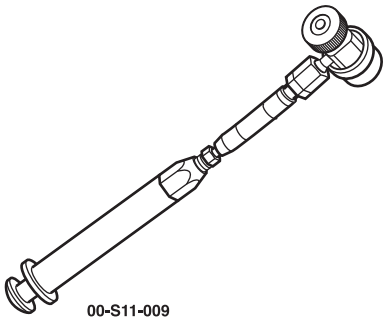
7-S11-015

J–41995



00-S11-010

J–42220



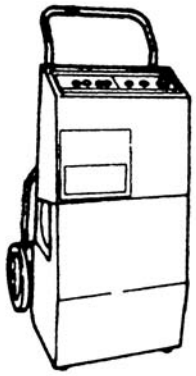
00-S11-009

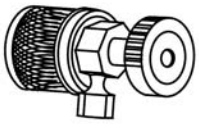
J–41459

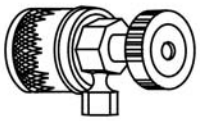
Tool No.	Description
J–41995	Leak Detector, A/C R134a
J–41459	Leak Detection Dye Injector
J–42220	High Intensity Ultra Violet (Black) Light

Procure from Kent-Moore.

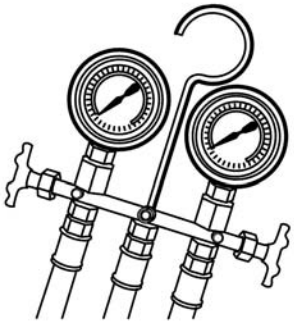
SPECIAL TOOLS


J–39500-A


J–39500-24A

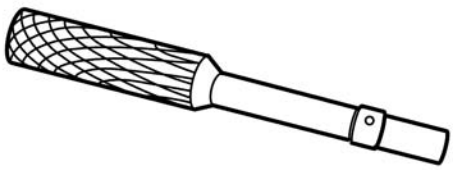

J–39500-20A


J–6742-03


J–39183-C



J–36847


J–24182-2A


J–35555

05-S11-001

Tool No.	Description
J–39500-A	A/C Recovery, Recycle, Evacuate and Discharge Service Cart (from Robinaire)
J–39500-20A	High Side Coupler Adapter (Compact Profile)
J–39500-24A	Low Side Coupler Adapter (Compact Profile)
J–39183-C	Manifold Gauge Set
J–6742-03	Thermometer
J–36847	Condenser Fin Straightener Tool
J–24182-2A	Schrader Valve Core Tool
J-35555	Hand Vacuum Pump

Procure from Kent-Moore.

THIS PAGE INTENTIONALLY BLANK.

Section 12 Electrical System

TABLE OF CONTENTS

ABS 12-128
Alternator 12-29
Audio
- Antenna System Test 12-123
- CD Changer (Delco) Replacement 12-111
- Diagnosis-Delco Audio System 12-116
  - Corrective Action 12-117
  - Identifying Concerns 12-116
- Electrical Harness Replacement, Delco Monsoon (Models 83, 84 & 91) 12-114
- Electrical Harness Replacement, Delco Standard (Model 90) 12-116
- Generator Whine Concerns 12-118
- Overhead Console, Speaker and Amplifier Replacement (Delco Monsoon) 12-111
- Radio (Delco) Replacement 12-111
- Rear Seat Audio (RSA) Unit Replacement 12-114
- Symptom Table 12-119
- System Description 12-110
- Test Antenna 12-118

Battery
- Battery Charging 12-22
- Cable Maintenance 12-24
- Power Distribution 12-29
- Replacement 12-26
- Splash Shield and Seal Service 12-28
- Tray Replacement 12-28

Brake Shift Interlock System 12-46
- Brake Shift Interlock Cable Inoperative 12-46
- Ignition Switch Replacement 12-44

Charging System
- Alternator 12-29
- Diagnostics 12-31

Cigarette Lighter Replacement 12-57
Circuits
- Basic Electrical 12-7
- Faults 12-8
- Maintenance and Repair 12-11

Connectors
- C1/ 102 Way 12-204
- C100/ 3 Way 12-271
- C101/ 3 Way 12-272
- C102/ 3 Way 12-272
- C103/ 10 Way 12-273
- C104/ 6 Way 12-273
- C105/ 4 Way 12-274
- C107/ 2 Way 12-274
- C108/ 3 Way 12-274
- C10-A/ 4 Way 12-216
- C10-B/ 4 Way 12-216
- C11/ 13 Way 12-217
- C110/ 10 Way 12-275

C111/ 10 Way 12-275
C112/ 10 Way 12-276
C113/ 10 Way 12-276
C114/ 10 Way 12-277
C115/ 10 Way 12-277
C116/ 10 Way 12-278
C117/ 10 Way 12-279
C118/ 10 Way 12-280
C119/ 10 Way 12-281
C12/10 Way 12-217
C120/ 10 Way 12-282
C121/ 10 Way 12-283
C122/ 10 Way 12-284
C123/ 10 Way 12-285
C124/ 10 Way 12-285
C125/ 10 Way 12-286
C126/ 10 Way 12-286
C127/ 10 Way 12-287
C128/ 10 Way 12-287
C129/ 10 Way 12-288
C13/ 8 Way 12-218
C130/ 10 Way 12-288
C131/ 16 Way 12-289
C132/ 5 Way 12-289
C133/ 6 Way 12-289
C134/ 2 Way 12-290
C135/ 4 Way 12-290
C136/ 3 Way 12-290
C138/ 8 Way 12-290
C139/ 4 Way 12-291
C14/ 4 Way 12-218
C140/ 3 Way 12-291
C15/4 Way 12-219
C16/3 Way 12-219
C17/ 4 Way 12-219
C18/8 Way 12-220
C2/42 Way 12-207
C20/ 3 Way 12-221
C21/4 Way 12-221
C22/4 Way 12-221
C23/ 10 Way 12-222
C24/ 4 Way 12-222
C25/ 4 Way 12-223
C26/ 6 Way 12-223
C28/3 Way 12-224
C3/ 56 Way 12-209
C30/ 8 Way 12-224
C31/ 8 Way 12-225
C33/ 16 Way 12-225
C34/ 20 Way 12-226
C35/ 3 Way 12-227
C36/ 2 Way 12-227
C37 /4 Way 12-228

C38 /3 Way 12-228
C39/ 7 Way 12-229
C40/6 Way 12-229
C41/ 8 Way 12-230
C42/ 6 Way 12-230
C43/3 Way 12-230
C44/2 Way 12-231
C46/ 5 Way 12-231
C47/ 10 Way 12-231
C48/10 Way 12-232
C49/10 Way 12-232
C50/ 6 Way 12-233
C51/ 6 Way 12-234
C52/ 2 Way 12-234
C53/ 16 Way 12-235
C54/ 16 Way 12-236
C55/ 16 Way 12-237
C56/ 24 Way 12-238
C57/ 4 Way 12-239
C58/ 12 Way 12-239
C59/ 16 Way 12-240
C6/56 Way 12-211
C60/8 Way 12-241
C62/ 32 Way 12-241
C63/ 4 Way 12-243
C64/ 3 Way 12-243
C65/ 3 Way 12-244
C66/ 11 Way 12-244
C67/ 6 Way 12-245
C68-A/ 4 Way 12-245
C68-B/ 4 Way 12-245
C69/ 4 Way 12-246
C7/35 Way 12-213
C70-A/ 4 Way 12-246
C70-B/ 4 Way 12-246
C71-A/ 4 Way 12-247
C71-B/ 4 Way 12-247
C72/16 Way 12-248
C73/ 6 Way 12-249
C74/ 6 Way 12-249
C75/56 Way 12-250
C76/ 72 Way 12-252
C77/ 56 Way 12-254
C78/ 32 Way 12-256
C79/ 32 Way 12-258
C8/ 6 Way 12-215
C80/ 14 Way 12-259
C81/ 24 Way 12-260
C82/ 40 Way 12-261
C83/ 40 Way 12-263
C84/ 6 Way 12-264
C85/ 12 Way 12-264
C86/ 80 Way 12-265

C87/ 40 Way 12-266
C88/ 12 Way 12-267
C90/ 4 Way 12-268
C91/ 5 Way 12-268
C92/ 2 Way 12-268
C93/ 2 Way 12-268
C94/ 2 Way 12-269
C95/ 2 Way 12-269
C96/ 3 Way 12-269
C97/ 3 Way 12-270
C98/ 7 Way 12-270
C99/ 3 Way 12-271
C9-A/ 2 Way 12-215
C9-B/ 2 Way 12-216
Cruise Control
Cruise Control Inoperative VIN Z 12-108
CTIS
CTIS Compressor Inoperative 12-48
CTIS Exhaust Valve Inoperative 12-49
CTIS Front Inflate Valve Inoperative 12-49
CTIS Rear Inflate Valve Inoperative 12-50
Diagnostics 12-7
Tools 12-10
Fuel System
Fuel Tank Selector System Inoperative 12-42
Fuse/Relay Location and Identification 12-16
Fusible Link Maintenance 12-13
General Information
Auxiliary Power Point, Interior Fuse Box 12-16
Auxiliary Power Studs, Exterior Fuse Box 12-21
Diagnostic Tests 12-10
Fuse/Relay Location and Identification 12-16
Ground Points 12-22
Preliminary Checks 12-7
Glow Plugs
Diagnostics 12-38
Heated Glass
Both Heated Windshields Inoperative 12-84
Right Heated Windshield Inoperative 12-83
Heated Leather Seats 12-124
Horn 12-56
Horn Replacement 12-56
Horns Inoperative 12-57
HVAC Systems
HVAC Compressor Inoperative 12-74
HVAC Main Blower Inoperative ALL BUT High 12-73
HVAC Temperature Door Inoperative 12-76
Ignition
Ignition Switch InterLock System 12-45
Ignition System 12-43
Instrument Panel 12-58
Coolant/Fuel Module 12-67
CTIS Gauge and Control Module 12-71

Self Tests and Bulb Checks 12-61
Diagnostics 12-62
Speedo/Tach Module 12-60
Transmission Temperature/Engine Oil Module 12-64
Lighting
System Description 12-52
Turn/Hazard Switch 12-54
Power Locks
Cargo Door Lock Inoperative 12-98
General Replacement 12-91
Keyless Entry & Theft Detterent System Operating Instructions 12-93
Keyless Entry Programming 12-94
Remote Entry System Inoperative 12-99
Power Mirrors
Ambient Temperature Sensor 12-103
Auto-Dimming Compass Mirror Calibration and Zone Adjustments 12-102
Auto-Dimming Rear View Mirror 12-101
Compass Mirror Display Inoperative 12-104
Power Side Mirror With Heater Mirror 12-105
Power Windows
Express Down Window Module 12-86
Power Windows Inoperative, All Windows 12-88
Starter 12-33
Overhaul 12-34
Tools, Essential 12-301
Transmission
Neutral Start Back Up (NSBU) Switch 12-126
Windshield 12-78, 12-79
Heated Windshield 12-82
Wipers
Windshield Wiper Motor Inoperative All Speeds 12-78
Windshield Wipers Intermittent Speeds Inoperative 12-79
Wiper Motor Assembly Replacement 12-77
Wiring Schematics
ABS/ TT4 Main System Diagram 12-128
ABS/TT4 Power, Ground and Warning Lamp Circuit 12-127
Accelerator Pedal Position (APP) Circuit 12-129
Alternator 12-130
Audio 12-131
Barometric Pressure (BAR0) Sensor 12-132
Blower Motor (Auxiliary) 12-133
Blower Motor (Main) 12-134
Boost Sensor 12-135
Brake Lights 12-137
Buck Up Lights 12-136
Cam Sensor/ Crank Sensor 12-138
Chime Module 12-139
Compass Mirror 12-140
Coolant Gauge 12-141
Coolant Pump Auxiliary 12-142
Coolant Temp Sensor/ Low Coolant Switch/ Coolant Module Warning Lights 12-143
Coolant Temperature Sensor 12-144
Cruise Control 12-145

CTIS System 12-146
Diagnostic Link Connector 12-147
E Locker 12-149
EGR Solenoid 12-148
Express Down Module/ Power Windows 12-150
Fuel Gauge 12-151
Fuel Injectors/ Fuel Injection Control Module (FICM) 12-152
Fuel Module Warning Lights 12-153
Fuel Pressure Regulator/ Fuel Rail Pressure Sensor 12-154
Fuel Selector/ Sending Unit 12-155
Fuel Temperature Sensor 12-156
Gauge Modules Power And Grounds 12-157
Glow Plug Control Module 12-158
Head Lamp/ Dimmer Switch 12-159
Head Lights 12-160
Horn 12-161
HVAC 12-162
HVAC (Auxiliary) 12-163
HVAC Compressor 12-164
Ignition Switch 12-165
Intake Air Temperature Sensor 12-166
Lighting Buss/ Fuses 12-167
Locks Power HMCO W/ Incandescent Bulbs Through Vin 226860 12-170
Locks Power HMCO W/ Led Bulbs From Vin 226861 12-171
Locks power hmcs W/ Incandescent bulbs through vin 226860 12-168
Locks Power HMCS W/ Led Bulbs From Vin 226861 12-169
Mass Air Flow Sensor (MAF) 12-172
Mirror Power Heated 12-173
Neutral Safety Back Up (NSBU) Switch 12-174
Oil Pressure Module 12-175
Oil Pressure Sending Unit/ Oil Pressure Module Warning Lights 12-176
Oil Pressure Sensor 12-177
Over Drive Switch 12-178
Remote Entry 12-179
Seat Drivers Heated 12-180
Seat Passenger Heated Wiring Schematics 12-181
Shifter/ Shift Interlock 12-182
Speed Sensors 12-183
Speedo Module 12-185
Speedo Module Indicator Lights 12-184
Starter System 12-186
Tachometer Module 12-187
Tachometer Module Indicator Lights 12-188
Tow Haul Switch 12-190
Transmission Solenoids 12-193, 12-194
Transmission Temperature Module 12-191
Transmission Temperature/ Oil Module Warning Lights 12-192
Turbo Vane Position Sensor/ Turbo Vane Solenoid 12-195
Turn Signal Switch 12-189
Windows Power W/ Incandescent Bulbs Through VIN 226860 12-197
Windows Switches W/Incandescent Bulbs (Drivers Console) Through Vin 226860 12-196
Windshield (Heated) 12-198
Wiper/ Washer 12-199

DIAGNOSTICS

The following section of the service manual deals with electrical diagnostics. The section consists of three main tools:

1. Diagnostic charts
2. Wiring diagrams
3. Connector legend

Diagnostic Charts

Diagnostic charts are designed to take you through individual steps to locate a problem. The steps start at a point in the electrical system and progress to find the problem without overlooking items that may be contributing to the problem. In most cases the chart will refer to a wiring diagram, and connector callouts, both of which are provided for reference. The charts are designed to find problems which are current, not intermittent. These charts do not include preliminary visual checks. The preliminary checks must be done prior to using the charts for diagnosis. If the checks are not done, a simple problem such as a blown fuse may be overlooked.

Wiring Diagrams

Wiring diagrams give a visual representation of the vehicle wiring the diagnostic charts refer to. The wiring diagrams in this section are broken down into systems. The diagrams will include any part of the electrical system which pertains to the system being diagnosed. Refer to the connector legend for connector identification of system connectors.

Connector Legend

The connector legend is a reference library of all the vehicle connectors that are called out in the wiring diagrams. Included are drawings of both male and female connector halves called out with pin/cavity arrangement, and a listing of all included circuits.

Preliminary Checks

The diagnostics in this section are designed to find problems that are not obvious. Before starting any formal diagnostic chart, preliminary checks must be performed. Preliminary checks should include:

- Visual inspection of all components
- Inspection of any fuses related to the system
- Connector inspection
- Inspection of electrical harnesses
- Charging system and batteries

These types of checks are not included in the diagnostic chart. In fact, most of the charts rely on the fact that you, the technician, has performed these initial inspections.

Diagnostic Strategy

Whenever a vehicle is being diagnosed for a problem, a strategy should be used. The following charts are strategy based, meaning they all follow the principle of starting simple and working step by step to more complex tests. This allows problems which may be small in nature to be found quickly, and not overlooked. NEVER skip steps in a diagnostic chart. Each step relies on a previous step for correct diagnosis. Avoid random diagnostics and parts replacement which can lead to long, expensive diagnostic times and may not reveal the problem.

Intermittent Failures

ALL of the charts in this section are for use on current failures. Do not attempt to use these charts to diagnose a problem unless you are sure the problem currently exists. If the problem is intermittent, parts will be unnecessarily replaced, or no problem will be found.

BASIC ELECTRICAL CIRCUITS

WARNING: When removing battery cables, disconnect ground cable first. Ensure all switches are off before disconnecting battery ground cable

General

An electrical circuit is a number of electrical devices which are connected in a loop from a positive voltage source (battery positive) to a negative ground source.

Parallel Circuits

The HUMMER H1 electrical system is a parallel circuit. In a parallel circuit, the electrical devices form more than one current path to and from the power supply. The supply voltage is the same in each path.

Circuit Components

A normal circuit path starts at the power supply (battery system or alternator). Next in line is the circuit protection: fusible link, fuse, or circuit breaker. The circuit load, such as lights, motors, or solenoids completes the circuit to the ground system.

Circuit protection devices

Fusible Links

A fusible link is a section of wire, usually two gauge sizes smaller than the circuit it protects. If the current rating of a fusible link is compromised, the fusible link will melt open.A special insulation prevents wire fires, and swells when heated to indicate the position of the open in the wire.

Circuit Breakers

Circuit breakers are electrical mechanical devices that will act as a fuse to prevent excess current flow in a circuit. Unlike fuses, the mechanical opening of contacts stops current flow. The contacts will reset in a short period of time. This process will repeat until the current excess is stopped.

Fuses

The most common protector in the vehicle electrical circuit is a fuse. A fuse is a metallic connector within a circuit that is made of a low melting point metal that acts as a “weak link”. If current rises above the fuses’ rating, the metal will melt and separate, leaving an open. The fuse is surrounded by a non flammable plastic covering, and will limit current to a specific amperage. Fuses can be found in range from 1A to 30A, and be mini or maxi types. All fuses used on the HUMMER H1 are blade type.

Circuit Controllers

Circuit controllers are used to turn the current off and on in a circuit. Controllers can be mechanical or solid state.

Solid state controllers combine the use of semi conductors along with electromechanical devices to control current in a circuit. Solid state controllers are typically associated with computers, and engine control systems. Most solid state controllers are specific to a purpose.

Mechanical controllers are the most common type, and can be seen as switches or relays. Switches are a primary controller while relays are typically secondary controllers.

Primary mechanical controllers are very simple contacts that are either open or closed, and can be changed state. Primary controllers are usually limited in their ability to handle large current flows due to the restriction of size.

Secondary mechanical controllers are used in conjunction with the primary controllers to handle larger current draws in a circuit. Primary controllers are used to operate the secondary controllers from a remote location, placing less or no restriction on the size of a secondary controller. The secondary controller is usually a relay.

Circuit Faults

The following are the four electrical fault conditions that cause a malfunction in a circuit: open, short, short to ground, and high resistance connection

Open

An open circuit occurs whenever there is a break in the circuit continuity. The break can be caused by a connector disconnect, a broken wire, or a defective component (Figure 12-1).

Short

A short circuit happens when the current bypasses part of the normal circuit. This bypassing is usually caused by wire pinching or chaffing. Usual symptoms are inappropriate activation or deactivation of a load device (Figure 12-2).

Short To Ground

A grounded circuit is also a short circuit, except the current flows directly to ground with very little restriction. This is usually caused by wire pinching or chaffing against the frame or body (Figure 12-3).

High Resistance Connection

A high resistance connection is an electrical connection that is corroded or loose. High resistance connections cause a decrease in current flow that can affect the proper operation of an electrical load.

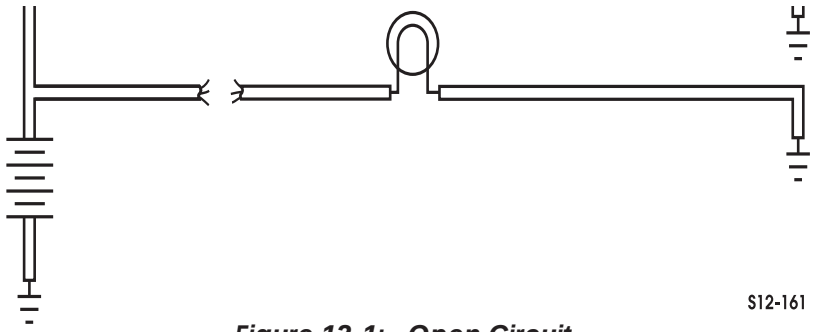


Figure 12-1: Open Circuit

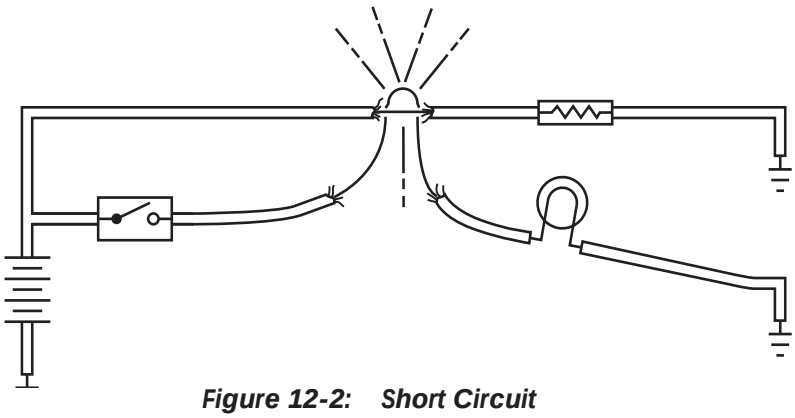


Figure 12-2: Short Circuit

Figure 12-3: Grounded Circuit

DIAGNOSTIC TOOLS

Digital Multimeter

A digital multimeter (J–39200) is required to safely test for electrical malfunctions on the HUMMER H1. Due to the complexity of the electrical system, a test light should not be used to test electrical circuits.

- Test lights do not have current limiting capabilities. The use of a test light may actually cause an electronic component to fail.
- Sharp test light probes may break wire strands, causing circuit failure.
- Breaks in the insulation allow moisture and contaminants to enter connectors and components, increasing the chances for corrosion. Even a small increase in resistance can give false readings from a sensor to an electronic component.

A digital multimeter performs all the tests a test light can perform with a greater degree of accuracy. In addition, a multimeter can be used to test for current in a circuit.

DIAGNOSTIC TESTS

NOTE: Follow all manufacturer's recommendations when testing for current. All multi-meters have a maximum current rating. Not all multimeters contain a fuse that protects the multimeter from excess current draw.

Amperage Test

Use caution when testing for current. Always check multimeter owner's manual for maximum current to be tested. Most multimeters are fuse-protected when measuring current. However, some meters are not protected and therefore can be damaged by excessive current. Position multimeter leads after closed switch and before load (Figure 12-4).

Voltage Test

Multimeters have a number of different voltage scales to choose from. Always use the lowest scale possible to test the circuit. For example, if you select the 200 volt scale and you are testing for battery voltage, most multimeters will display 12 volts. By selecting the next smallest scale, 20 volts, the display will read 12.8 volts, a more accurate measurement. Position multimeter leads on each side of the load (Figure 12-5).

OHM Test

CAUTION: *Before using a multimeter, ensure the circuit is not energized. Even a small voltage applied to an multimeter will damage it.*

Continuity - Testing for continuity in a circuit requires the use of the lowest ohm scale available. Position the multimeter leads on each side of the circuit or component being tested. A reading of less than one ohm is acceptable continuity (Figure 12-6).

Resistance - To test for resistance, first touch the meter leads together to ensure that the meter zeros out, then position the leads of the multimeter on each side of the circuit or component. Adjust the multimeter ohm setting until an acceptable reading is observed. Verify the reading with the specification.

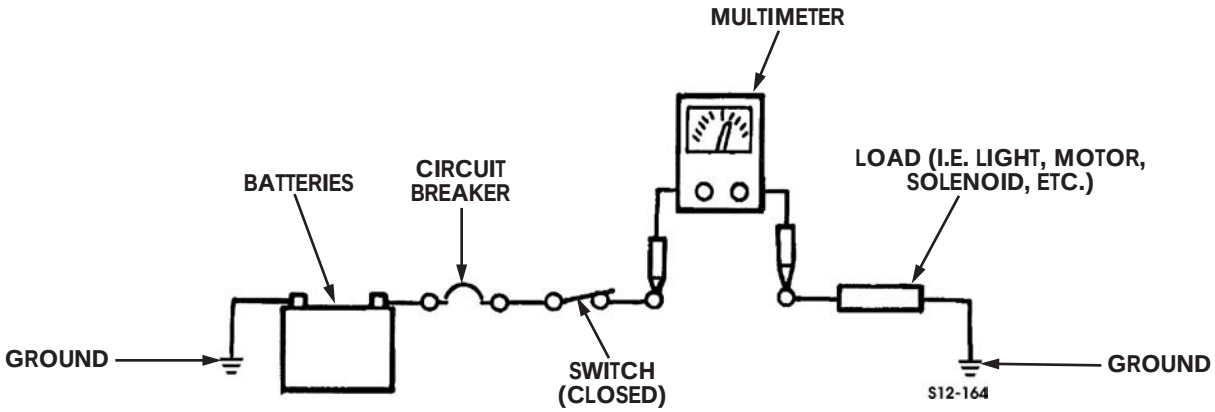


Figure 12-4: Amperage Test

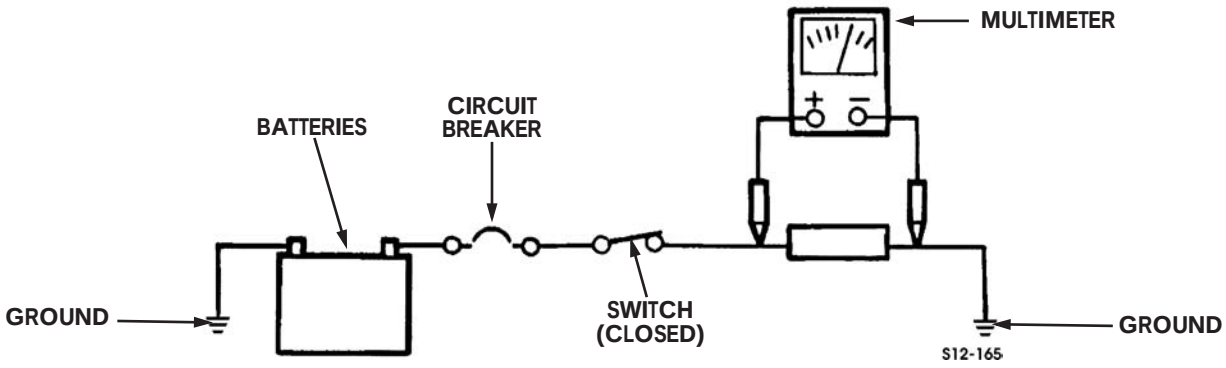


Figure 12-5: Voltage Drop Test

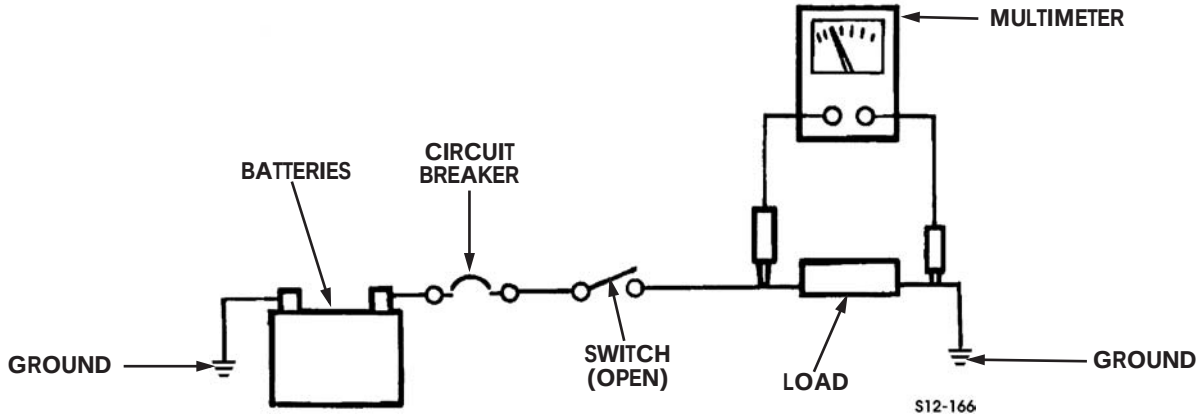


Figure 12-6: Ohm Test

CIRCUIT MAINTENANCE AND REPAIR

All electrical connections must be kept clean and tight. Loose or corroded connections may cause a discharged battery, weak starting, dim lights, or possible electrical system damage.

Wires must be replaced or repaired if insulation becomes burned, cracked, or deteriorated. When replacing a wire, it is important that the same gauge size wire be used. Refer to wiring diagram for proper wire gauge sizes. Never replace a wire with one of a smaller size or replace a fusible link wire with a wire of a larger size. It should also be noted that fusible link wire utilizes a special insulation covering. When replacing a fusible link wire, the replacement wire should be the type in accordance with SAE J156. Further, fusible link wire should never be shortened or spliced. If a repair is necessary, entire fusible link wire must be replaced with one of the proper gauge size, length and insulation type.

Any wire repair must maintain the waterproof integrity of the vehicle. Any splice located below the 30 in. (76 cm.) fording level or in a high splash area must be waterproof and heavy duty adhesive wall shrink tubing should be used as a minimum in these areas.

Each harness or wire must be held securely in position to prevent damage to insulation caused by vibrating and chafing.

NOTE: Before performing any wire repair, disconnect battery ground cable.

Ground Point legend

G1 - Engine ground-Intake Manifold

G2 - Ground Buss Exterior Fuse Box

G3 - Body Ground

G4 - Instrument Panel Ground Buss Interior

G5 - Frame Ground

Wiring Repair

Wiring harness and wires - All wires are of a specific insulation color indicated on the wiring diagrams. Insulation color helps to identify circuits and make correct connections. Insulation colors and their abbreviations are as follows:

BK - Black	PK - Pink
BR - Brown	PP - Purple
DB - Dark Blue	RD - Red
DG - Dark Green	GY - Gray
TN - Tan	LB - Light Blue
WH - White	LG - Light Green
YL - Yellow	OR - Orange

Wire repair is very important for the continued, reliable operation of the vehicle. This repair must be done as described in the following procedure:

Single Wire Repair (Exposed)

1. Remove the damaged area, removing as little wire as possible (Figure 12-8).

NOTE: Care should be exercised in stripping the wire insulation to avoid cutting wire conductor strands.

2. Strip the wire ends to the appropriate length required by the splice clip (Figure 12-9).

NOTE: Heat shrink tubing is available in various diameters. Typically the heat shrink tubing will shrink to approximately one-half of its original diameter, therefore the tubing diameter selected for the repair should not be greater than twice the wire insulation diameter to ensure a proper seal.

3. Slide heat shrink the tubing over one of the wire ends (Figure 12-10).

NOTE: Splice clips are available for different wire gauge sizes. Therefore, it is important to select the appropriate size for the wire gauge being repaired.

4. Slide both ends of the wire into the splice clip and crimp the splice clip to the wire ends (Figure 12-11).
5. Pull the wires, by hand, in the opposite directions to test the crimp of the splice clip.
6. Center heat shrink the tubing over the splice clip (Figure 12-12).
7. Using a heat gun or equivalent heat source, apply heat to the heat shrink tubing until the tubing conforms to the splice clip and the wire insulation (Figure 12-13).
8. After the splice cools, apply two layers of vinyl adhesive electrical tape to complete the repair (Figure 12-14).

Single Wire Repair (In a Harness)

1. Remove the harness covering in the affected area (Figure 12-15).
2. Repair the damaged wire using the exposed single wire repair procedures. (Go to Step 1.)
3. After completing the wire repair, apply two layers of vinyl adhesive electrical tape over the affected area to complete the repair (Figure 12-16).

Multiple Wire Repair (In a Harness)

NOTE: Since more than one splice is required in this case, stagger the wire splices such that they are no closer than 3 in. (7.6 cm) from each other.

Repair the affected wires using the single wire repair (in a harness) procedures.

FUSIBLE LINK MAINTENANCE

The following procedure covers the replacement of fusible links encountered through circuit diagnosis.

1. Disconnect the battery ground cable.
2. Carefully remove the old fusible link from the termination (alternator, power stud, starter).
3. Locate the original wiring harness splice between the fusible link and the wiring harness (Figure 12-7).
4. Cut the fusible link splice on the harness side. Do not splice into the original fusible link; this may be weakened and cause a premature failure and repeat problem.
5. Identify the original fuse link size and length of the fuse link and cut away from the vehicle.
6. Matching the wire size, cut a length of the fusible link wire to the total length cut from the vehicle in Step 4. Be sure to compensate for any harness wire removed with the original wire. This will avoid overtight wiring that may become separated with normal operation.

NOTE: Fusible link is a wire with special insulation. It is important that replacement material be fusible link wire and it should be labeled as such. The replacement fusible link should be between six and nine inches long.

7. Install a new crimp on the connector of the same type and size as the original lug or connector. Seal the connection with low temperature heat shrink tubing.
8. Place a piece of heat shrink tubing onto the wire and install a butt connector onto the fusible link.
9. Install the fusible link by connecting it to the wiring harness with the butt connector and the heat shrink tubing.
10. Connect the terminal end to the original location, alternator, power stud, or the starter. Reconnect the battery ground cable and check the circuit(s) affected for proper operation.

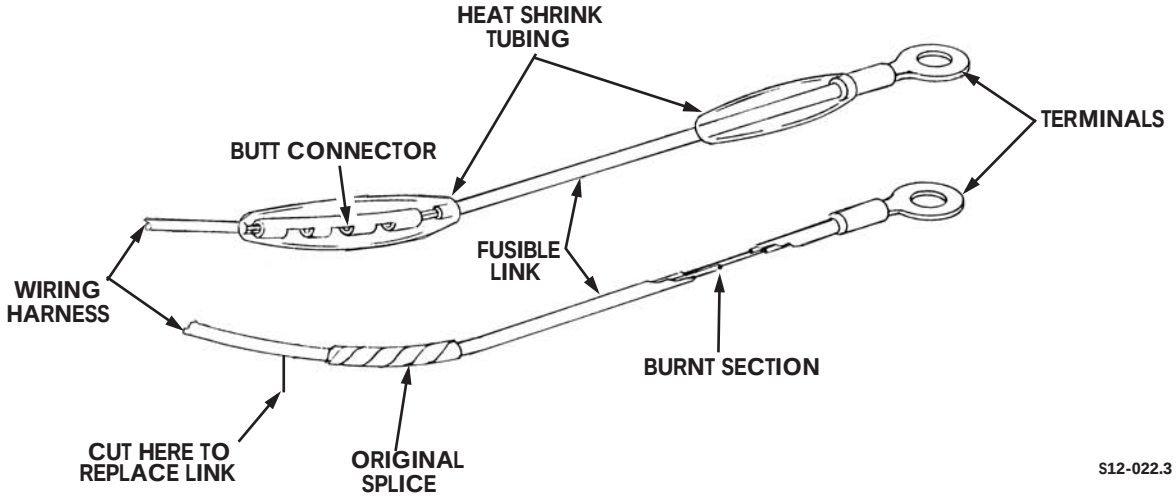


Figure 12-7: Fusible Link



Figure 12-8: Damaged Wire

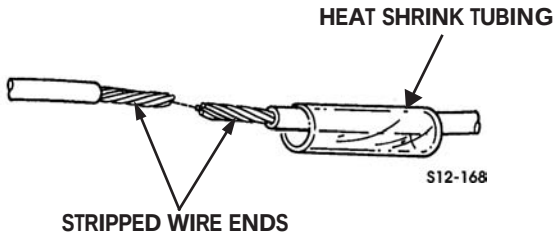


Figure 12-9: Heat Shrink Tubing

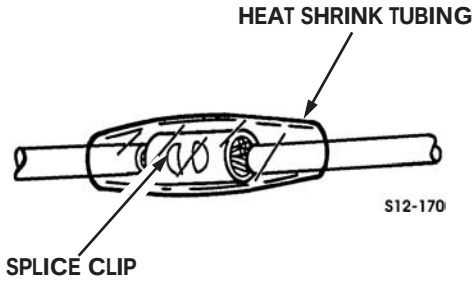


Figure 12-10: Splice Clip

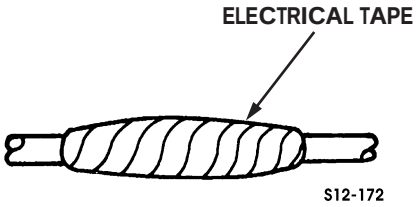


Figure 12-11: Electrical Tape

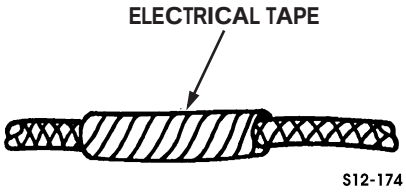


Figure 12-12: Electrical Tape

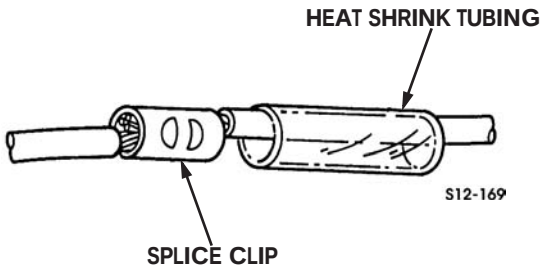


Figure 12-13: Splice Clip

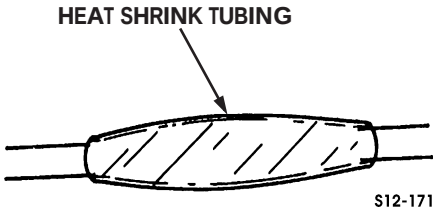


Figure 12-14: Heat Shrink Tubing



Figure 12-15: Damaged Wire

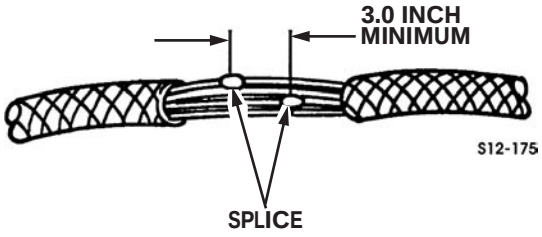


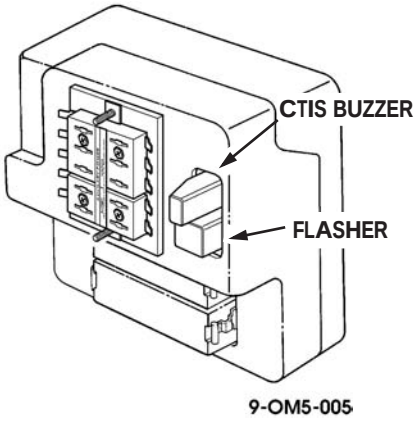
Figure 12-16: Multiple Wire Splice

FUSE/RELAY LOCATION AND IDENTIFICATION

Interior Fuse Box

The interior fuse box, is located under the instrument panel to the left of the steering column. The fuse box is divided into two mini-fuse junction blocks, relays, and a auxiliary power point.The mini-fuse blocks may be accessed without removing the main fuse box cover (Figure 12-17).

To access relays, the main fuse box cover must be removed. Before removing any of the fuse box access covers, refer to the illustrations and charts in this section for the location of specific fuses, relays, and circuit breakers. Doing this will enable you to go directly to the fuse or circuit breaker you want to inspect.



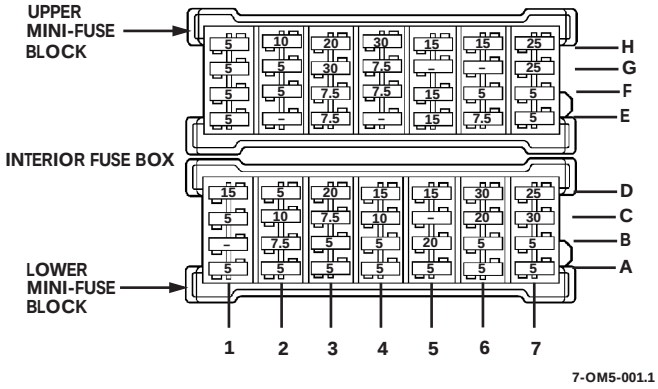


Figure 12-17: Interior Fuse Box and Mini Fuse Layout

Fuses and circuit breakers protect the vehicle's electrical system from damage caused by overloading. An overloaded circuit breaker will switch the circuit on again, causing intermittent operation. A blown fuse will permanently disable the circuit until the fuse is replaced.

Whenever a fuse blows or a circuit breaker opens a circuit, all electrical components using that circuit will not operate. Therefore, during diagnosis of any of these electrical components, check the appropriate fuses and circuit breakers for damage (Figure 12-20).

In Line Fuses

Some fuses are placed in-line with the components they are protecting, meaning they are not located in the fuse box but in the actual wire suppling current to the device. The only inline fuse used on the HUMMER H1 is in the power feed to the HVAC high blower relay. This fuse is located on the passenger side of the engine compartment inside a black plastic cover.

Auxiliary Power Point

An auxiliary power point is provided to ease installation of aftermarket electrical accessories. The power point is divided into 2 sections: Ignition and Battery. When a power supply is needed, a fuse must be installed into one of the empty slots, and a connec-

tion made to the adjacent terminal. The main supply circuits to both sections of the aux. power point are fused to 30 amps. Total amperage draw on either section should not exceed 30 amps.

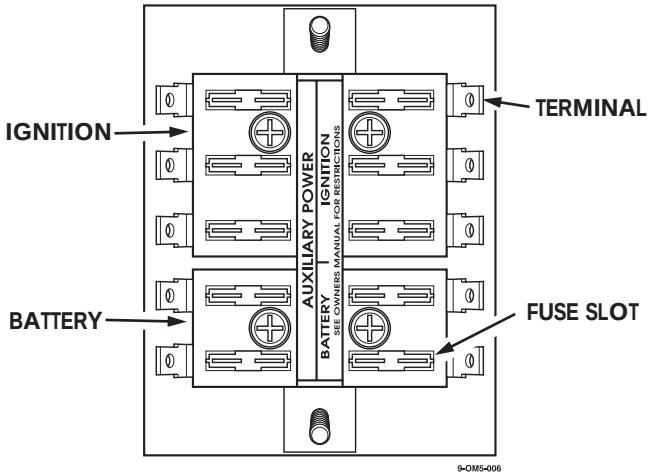


Figure 12-18: Auxiliary Power Point

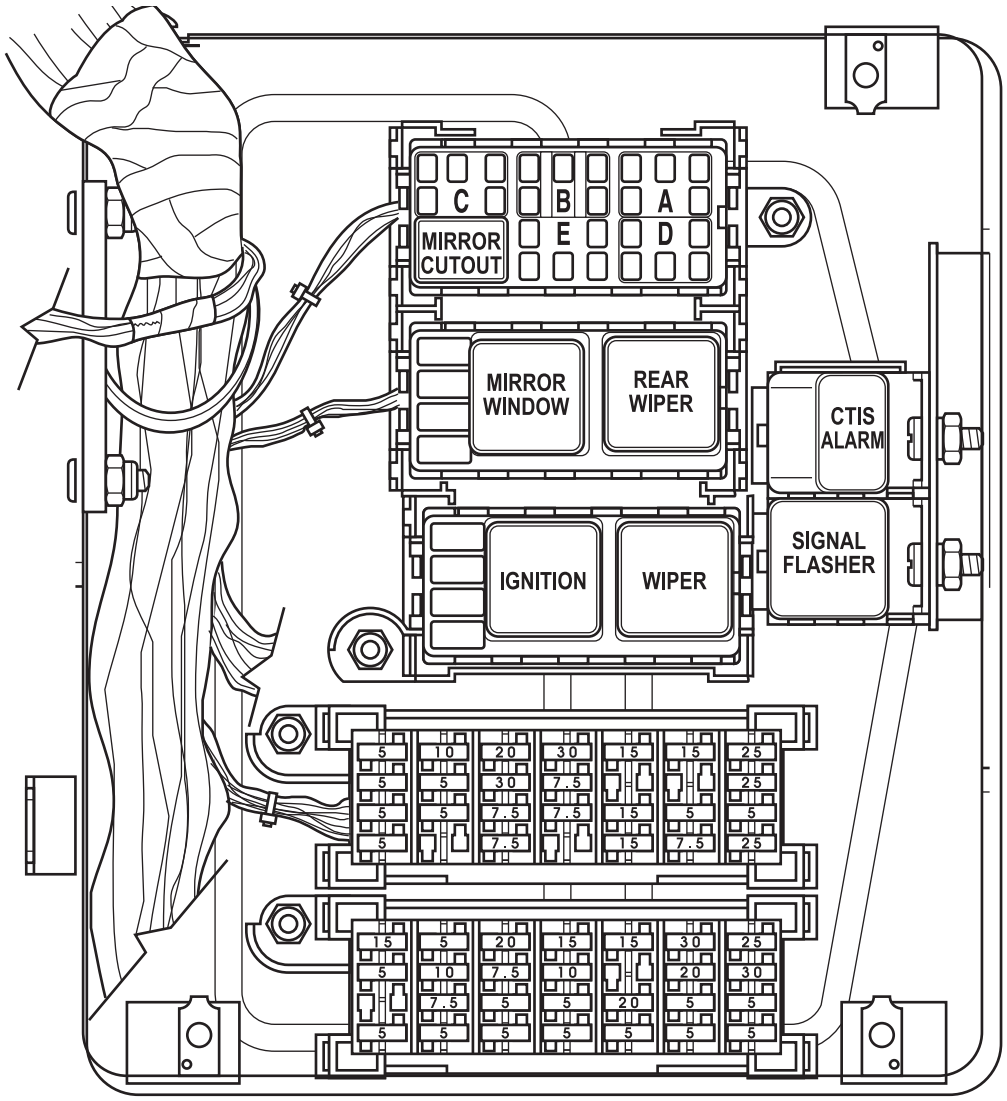


Figure 12-19: Relay Location (Interior Fuse Box)

UPPER MINI-FUSE LOCATION

FUSE	AMPERAGE	CIRCUIT PROTECTED
1E	5	Spare Fuse
2E	–	Blank
3E	7.5	Spare Fuse
4E	–	Blank
5E	15	Spare Fuse
6E	7.5	IGN Interlock Solenoid
7E	5	Aux Water Pump
1F	5	Running Lights
2F	5	Panel Lights Dimmer
3F	7.5	Front Parking/Running Lights
4F	7.5	Rear Parking/Running Lights
5F	15	Trailer Park Lights
6F	5	Underhood and Trouble Lights
7F	5	Warning Chimes
1G	5	CTIS/Key Chime
2G	5	Power Windows
3G	30	Auxiliary Power Point (Ignition)
4G	7.5	Radio Ignition
5G	–	Blank
6G	–	Blank
7G	25	Windshield Wiper/Washer
1H	5	ALDL RKE
2H	10	Radio Memory/Clock
3H	20	Power Door Locks/Power Mirror
4H	30	Auxiliary Power Point (Battery)
5H	15	Dome/Courtesy Lights
6H	15	Auxiliary Power Outlet (console)
7H	25*	Trailer Brake Controller

*May not be provided.

LOWER MINI-FUSE LOCATION

FUSE	AMPERAGE	CIRCUIT PROTECTED
1A	5	Spare Fuse
2A	5	Brake Switch
3A	5	Cruise Control
4A	5	Trans Switches
5A	5	HVAC Pump
6A	5	Aux Water Pump
7A	5	ECM Relay
1B	–	Blank
2B	7.5	Brake Interlock
3B	5	Fuel Tank Selector Switch
4B	5	Gauges/Indicator Lights/MIL
5B	20	Heated Seats
6B	5	E Locker
7B	5	Remote Entry Ignition Feed
1C	5	Transmission Shifter Lock/Heated Windshield
2C	10	A/C Clutch Relay And Compass
3C	7.5	Backup Lights
4C	10	Turn Signals
5C	–	Blank
6C	20	HVAC Control
7C	30	HVAC Blower
1D	15	Radio Amplifier-Monsoon only
2D	5	Compass Mirror
3D	20	Cigar Lighters
4D	15	Stoplights
5D	15	Hazard Flasher
6D	30	E Locker
7D	25	Anti-lock Brakes

Exterior Fuse Box

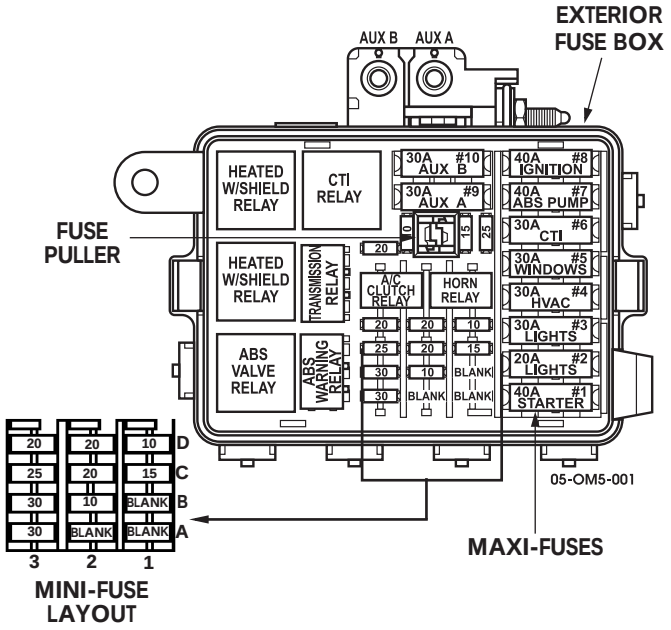


Figure 12-20: Exterior Fuse Box

The exterior fuse box is located under the hood on the driver's side of the engine compartment. The exterior fuse box houses mini and maxi fuses, circuit breakers, and relays which supply power to many of the electrical components in the engine compartment. The exterior fuse box can be accessed by first removing the left side cowl cover then removing the fuse box cover itself. Fuse and relay locations are labeled on the inside of the cover. Spare mini fuses are located in the exterior fuse box for convient replacement. A fuse puller is also provided to ease fuse removal.

Mini-Fuse Identification (Exterior Fuse Box)

Fuse	Amperage	Circuit Protected
1A	–	Blank
2A	–	Blank
3A	30	Heated Windshield
1B	–	Blank
2B	10	ECM Battery Feed
3B	30	Heated Windshield
1C	15	Engine Ignition Feed
2C	20	Alternator
3C	25	IGN/ Fuel Injector Control module
1D	10	ECM Ignition Feed
2D	20	Fuel Heater
3D	20	Maf / Glow Plug Control Module

Maxi-Fuse Identification (Exterior Fuse Box)

Fuse/ CB	Amperage	Circuit Protected
1	40A	Starter Circuit
2	20A CB	Parking Lights
3	30A CB	Headlights
4	30A CB	HVAC
5	30A CB	Power Windows
6	30A	CTIS Compressor
7	40A	ABS/TT4 Hyd. Pump
8	40A	Ignition Switch Batt Feed
9	30A	Auxiliary power stud A
10	30A	Auxiliary power stud B

Auxiliary Power Studs

The external fuse box provides 2 threaded studs for use as auxiliary power connections. Each stud is fused for up to 30 amps with maxi-fuses located in the external fuse box. Both studs provide battery power.

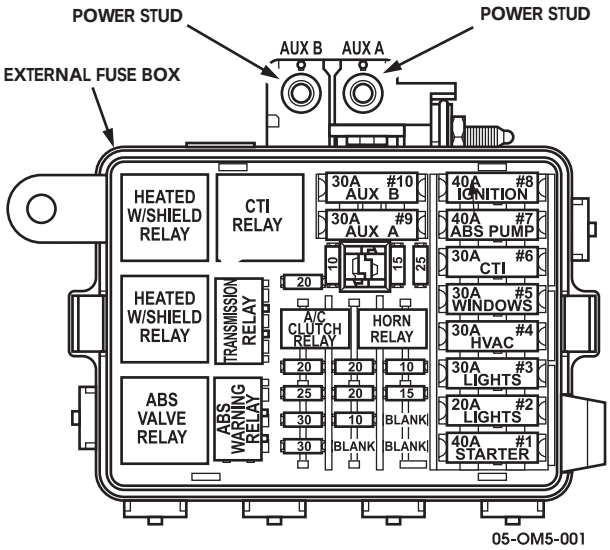


Figure 12-21: Auxiliary Power Studs

Ground Points

Two main grounding points are provided to ground vehicle systems and add-on items. The main grounding stud is located on the driver's side of the engine compartment next to the exterior fuse box. The second grounding point is located to the left of the instrument panel on the interior of the vehicle.

NOTE: Never drill holes in the body to ground electrical items, the corrosion resistance is compromised, and bad grounding could result.

BATTERY CHARGING

General Information

A low charge or discharged battery can be recharged as long as the cells are not shorted, sulfated, or damaged. Batteries can be recharged quickly at 20 amp charge levels, or for longer periods at 10, 5, or 2 amps. A 5 amp charge is preferable.

The battery charger should be equipped with a polarity sensor to avoid damage through incorrect hookup. Charger capacity should range from 5 to 20 amps for slow and fast charge rates.

The time and amp rate of charge required will vary depending on battery condition and temperature. Generally, it takes longer to recharge a cold battery. State of charge will also affect charging time as a partially discharged battery may only require one third the charge time of a fully discharged battery. There are a number of safety precautions that must be observed before charging a battery. The following precautions are necessary to avoid personal injury:

Battery Charging Precautions

- Battery electrolyte contains sulfuric acid which can cause severe burns. Avoid contact with electrolyte by wearing protective gloves and a face shield. Flush skin or eyes with water if contact occurs and seek medical assistance immediately.
- Always wear eye and facial protection when connecting charging equipment.
- Never attempt to charge a frozen battery. The case could fracture at the first surge of current.
- Never charge a battery with a low electrolyte level. Internal arcing and battery explosion could occur.
- Never exceed a 20 amp charge with a cold battery. Use a lower (5-10 amp) rate until the battery warms up.
- Never use excessive charge rates. Reduce charge rate if the battery becomes overly warm, or if a steady stream of gas starts to exit the vents.
- Do not use high charge rates on a completely discharged battery. Use low rates or a trickle charge only.
- Never allow sparks, or an open flame near a charging battery. The charging process generates hydrogen gas which is highly inflammable.
- Charge batteries in properly ventilated areas only. Do not allow hydrogen gas to accumulate and concentrate in poorly ventilated areas.

Charge Rate and Time

Charge rate will depend on battery temperature and degree of discharge. Ideally, charging should not proceed until battery temperature has reached 60°F (16°C). However, in cases where a cold battery must be charged, start with a 5 amp rate and increase it as battery temperature rises.

In the case of a fully discharged battery, a 24 hour trickle charge of 1-2 amps is recommended. A 20 amp charge rate should be used when a battery is only partially discharged.

Suggested charge times are outlined in the charge rate chart (Figure 12-22). Note that the chart suggested times and rates are for a battery at 70°F (21°C). Charge times will be greater if battery temperature is below 55°F (13°C).

	CHARGE RATE		
	5 Amps	10 Amps	20 Amps
No-Load Test Voltage	Charge Time at 70°F (21°C)		
12.25 to 12.39	6 Hrs.	3 Hrs.	1.5 Hrs.
12.00 to 12.24	8 Hrs.	4 Hrs.	2 Hrs.
11.95 to 12.09	12 Hrs.	6 Hrs.	3 Hrs.
9.80 to 11.95	14 Hrs.	7 Hrs.	3.5 Hrs.

6-S12-105

Figure 12-22: Charge Rate Chart

Battery Checking Procedures

Visual Inspection

Check for obvious damage, such as a cracked or broken case or cover or overcharging of the electrical system that could permit loss of electrolyte. If obvious damage is noted, replace the battery.

Load Test

Before proper testing, the battery must be in a fully charged state to obtain an accurate test. Load testing requires the use of battery side terminal adapters to ensure good connections. Do not attempt to load test a side post battery by screwing bolts into the terminals as connections.

NOTE: When load testing, batteries must be disconnected from each other.

1. Using a battery load tester, measure voltage across the battery terminals. Normal battery voltage should be 12v or higher. Recent cranking or load testing will lower the normal voltage. If no cranking or load testing has been performed, and battery voltage is below 12v, replace the battery.
2. Connect battery load tester to the battery to be tested. If battery has been recently charged, apply a 300 amp load for 15 seconds to remove the surface charge. Skip this step if the battery has not been charged.
3. Wait 15 seconds for the battery to recover. Apply the necessary load test for the battery being tested. The load required should be listed on the battery label, if it is not, use the cold crank amperage divided by 2. (300 cca/2=150 cca)This load should be applied for 30 seconds
4. If the voltage does not drop below the minimum value, the battery is good and should be returned to service. The battery temperature must be estimated by feel and by the temperature the battery has been exposed to for the proceeding few hours. If the battery has been exposed to temperatures below ambient, use the chart below to adjust the minimum test voltage (Figure 12-23).

Estimated Temperature	Minimum Voltage
70°F(21°C)	9.6
50°F(10°C)	9.4
30°F(0°C)	9.1
15°F(-10°C)	8.8
0°F(-18°C)	8.5
0°F(Below -18°C)	8.0

Figure 12-23: Load Test Values vs.Temperature

5. If the voltage drops below the minimum value listed, replace the battery.

Parasitic Draw Test

Tools Required:

- J–38758 Parasitic Draw Test Switch
- J–39200 Digital Multimeter

1. Remove the negative battery cable from the rear battery.
2. Install the male end of the parasitic draw test switch over the crossover negative battery cable using the long battery bolt from the battery cable removed in step 1.
3. Open the parasitic draw test switch
4. Connect the negative battery cable to female end of the parsitic draw test switch using a short battery bolt.
5. Close the parsitic draw test switch.
6. Road test the vehicle while activating all accessories, such as the radio and air conditioning.
7. Turn the ignition switch to the off position and remove the key.

NOTE: It is important that from this point on, electrical continuity must be maintained in the ground circuit to the battery, either through J–38758 in the on position, or through J–39200.

8. Some components, such as the ECM or TCM, have timers that draw several amps of current while they cycle down. This can give a false parasitic drain reading. Wait 15 minutes for these components to power down before continuing this test.

NOTE: If another DVOM, is being used other than J–39200, ensure that the ammeter will handle 10 amps of current without damage.

9. Install a jumper wire with a 10 amp fuse between the two terminals on the parasitic draw test switch. Open the switch and wait 10 seconds. If the fuse does not blow, the parasitic load is less than 10 amps and the J–39200 can be used. Close the switch on the tester and remove the jumper wire and fuse.
10. Set J–39200 to the 10 amp scale and place leads in the correct ports in the meter for amperage testing on the 10 amp scale.
11. Connect the meter leads to the two terminals on the parasitic load test switch and open the switch.
12. Wait 60 seconds then take a reading from the meter. If the current reading is at or below 2 amps, turn the test switch to the on position. Reset the meter to read milliamps.
13. Open the switch and take the reading in milliamps.
14. Find the reserve capacity of the batteries on the vehicle. Since there are 2 batteries, add the reserve capacities together. (100 minutes + 100 minutes = 200 minutes reserve capacity). Divide the number by 4 and the answer, given in milliamps, is the maximum allowable parasitic drain the batteries will support.

NOTE: Always turn the switch knob to the “on” position before removing each fuse to maintain continuity in the electrical system and to avoid damaging the meter due to accidental overloading, such as opening a door to change a fuse.

15. If current draw is too high, remove system fuses one at a time until the draw returns to a value less than or equal to the maximum allowable for the batteries. Repeat the test for parasitic drain after any repair has been performed.
16. When the cause of excessive current draw has been located and repaired, remove the meter, test switch and terminal adapters and connect the negative battery cable to the battery.

BATTERY CABLE REPLACEMENT

Battery Negative Cables - Removal

1. Remove the caps from the battery negative cable (Figure 12-24).
2. Remove the battery cable bolts.
3. Disconnect the winch negative cable, if equipped.

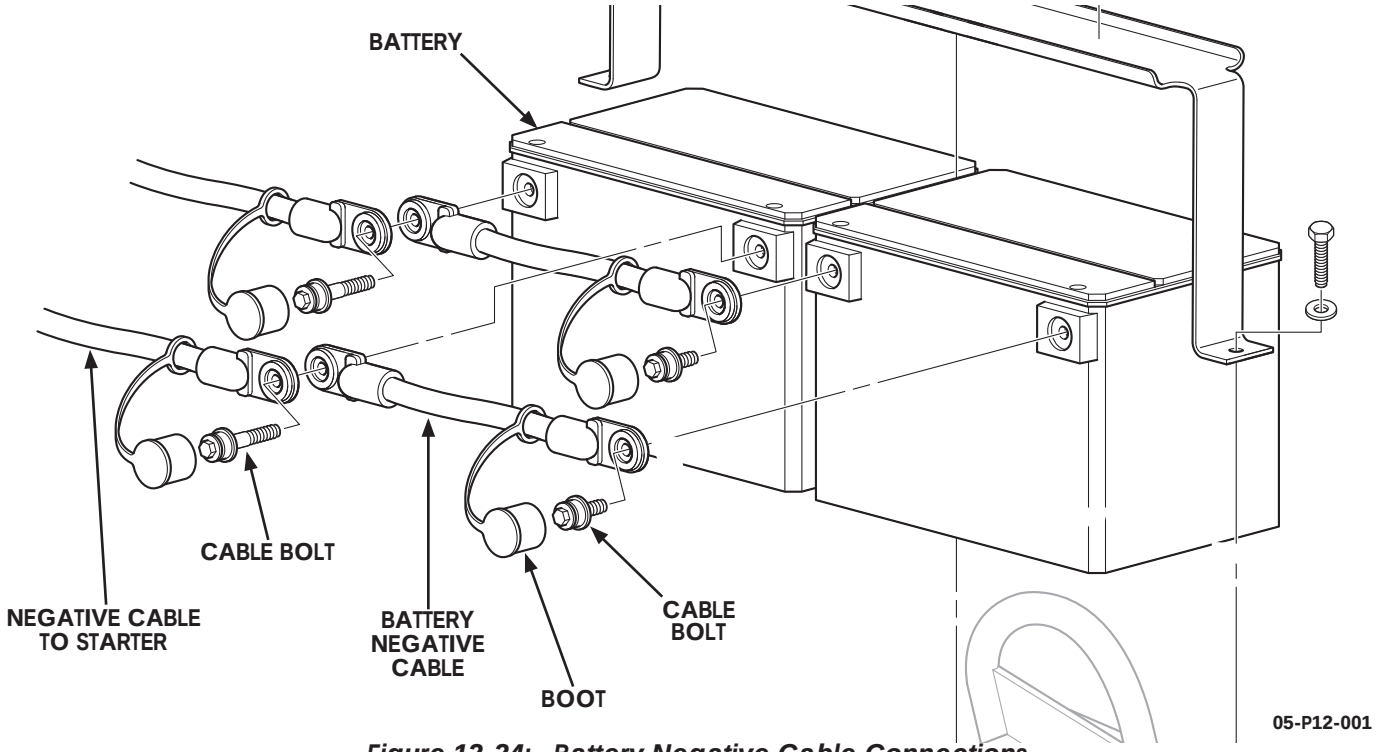


Figure 12-24: Battery Negative Cable Connections

4. Remove the starter bolt securing the negative cable to the starter and remove the negative cable (Figure 12-25).

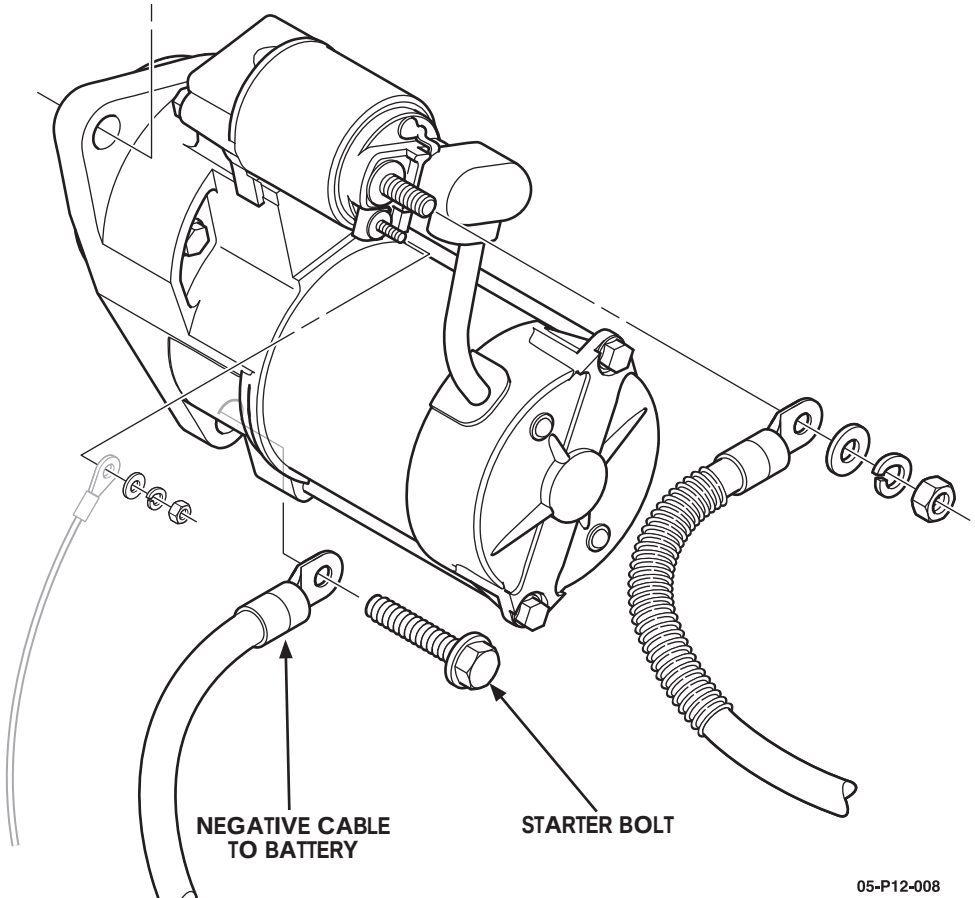


Figure 12-25: Negative Cable to Cylinder Block Attachment

Battery Negative Cables - Installation

1. Connect the negative cables to the starter, and the batteries.
2. Tighten the battery cable bolts to 8-12 lb-ft. (11-16 N•m).
3. Install the caps on the battery cable bolts.

Battery Positive Cable - Removal

1. Disconnect the battery negative cables.
2. Remove the caps from the battery positive cable(s) (Figure 12-26).
3. Disconnect the starter cable at the battery.
4. Disconnect the battery positive cable, and the winch cable, if equipped, at the battery.
5. Remove the locknut, washer, capscrew, and the clamp securing the starter cable to the bracket.
6. Disconnect the starter cable at the starter.

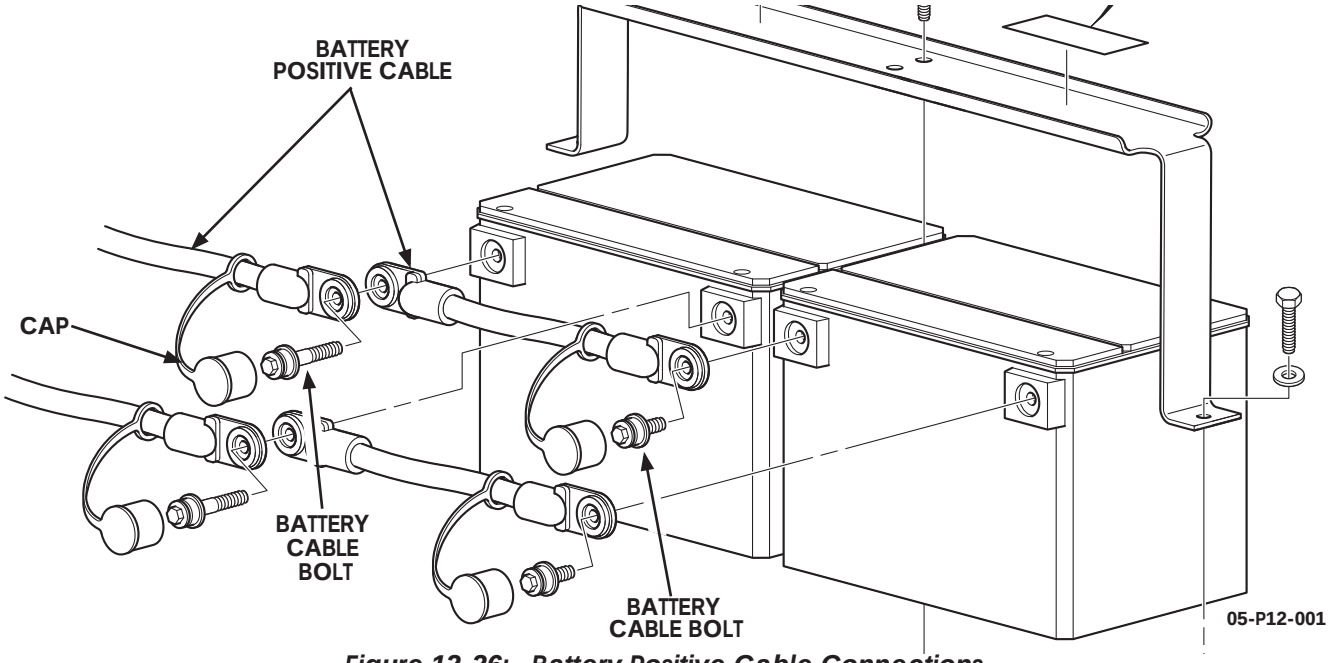


Figure 12-26: Battery Positive Cable Connections

Battery Positive Cables - Installation

1. Connect the starter cable to the starter with the lockers and the nut. Tighten the nut to 12-16 lb-ft (16-22 N•m).
2. Secure the starter cable to the bracket with the clamp, capscrew, washer, and the locknut.
3. Connect the battery positive cable to the battery.
4. Connect the winch cable to the battery positive post (Figure 12-26).
5. Connect the battery negative cables.
6. Tighten the cable-to-battery bolts to 8-12 lb-ft. (11-16 N•m).

BATTERY REPLACEMENT

WARNING: Battery electrolyte contains sulfuric acid which can cause severe burns. If acid contacts eyes or skin, flush affected areas liberally with water and obtain medical assistance immediately. If acid contacts clothing, flush with water and replace affected clothing. Always wear eye protection, and remove all jewelry before working on batteries.

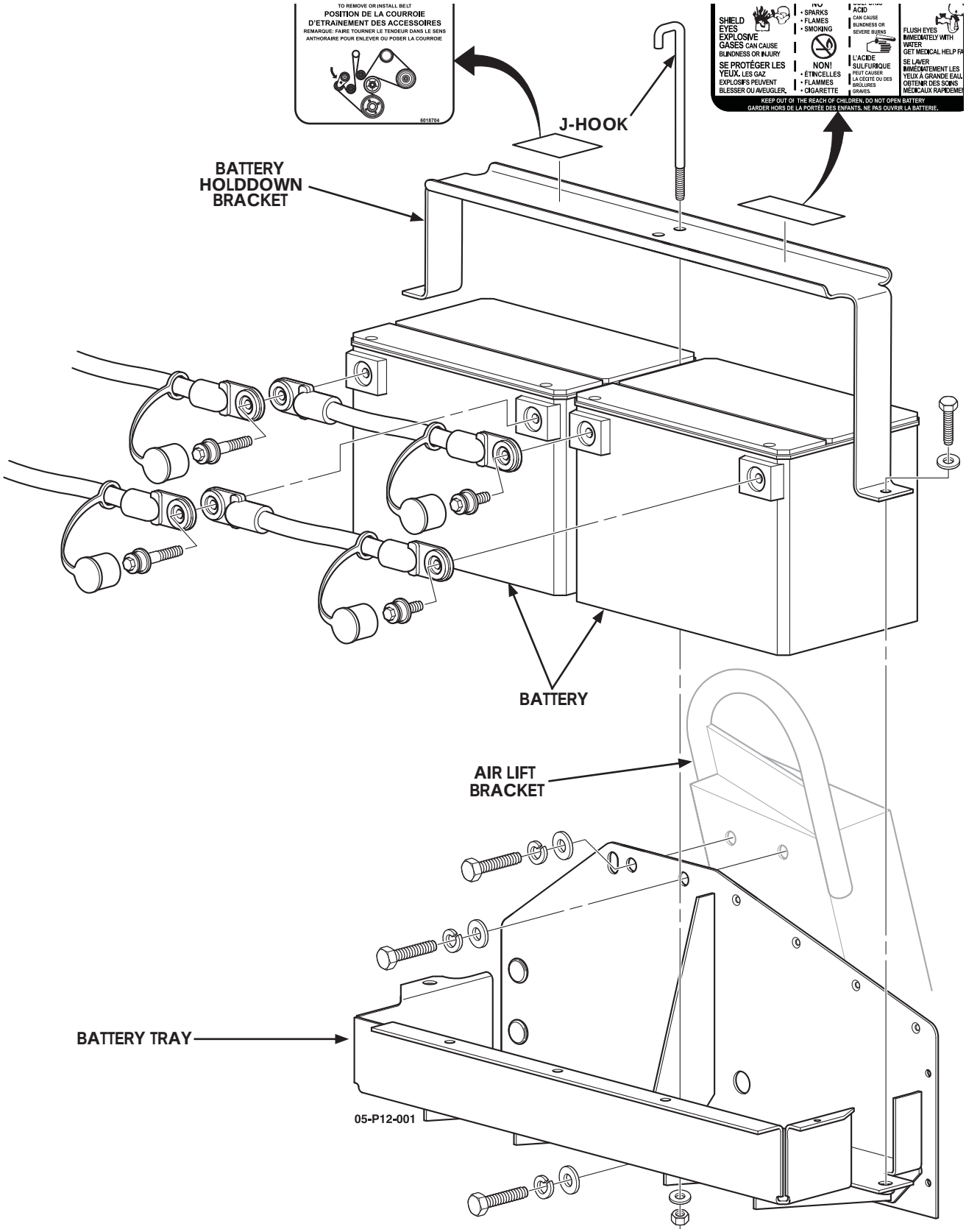


Figure 12-27: Battery Removal/Installation

1. Disconnect the battery cables.
2. Remove the J-hook, and the holddown bracket bolts (Figure 12-27).

3. Remove the holddown bracket.
4. Remove the one or both the batteries as required.
5. Clean the battery tray.
6. Install one or both the batteries in the tray (Figure 12-27).
7. Install the holddown bracket and the J-hook.
8. Connect the battery cables.

BATTERY TRAY REPLACEMENT/INSTALLATION

1. Disconnect and remove the batteries.
2. Remove the splash shield and the battery tray shield.
3. Remove the battery tray from the airlift bracket (Figure 12-27).
4. Install the battery tray on the airlift bracket.
5. Install the battery tray shield and the splash shields.
6. Install and connect the batteries.

BATTERY SPLASH SHIELD

Splash Shield Removal/ Installation

1. Remove the bolts securing the splash shield to the battery tray (Figure 12-28).
2. Install the splash shield to the battery tray and secure with the bolts.

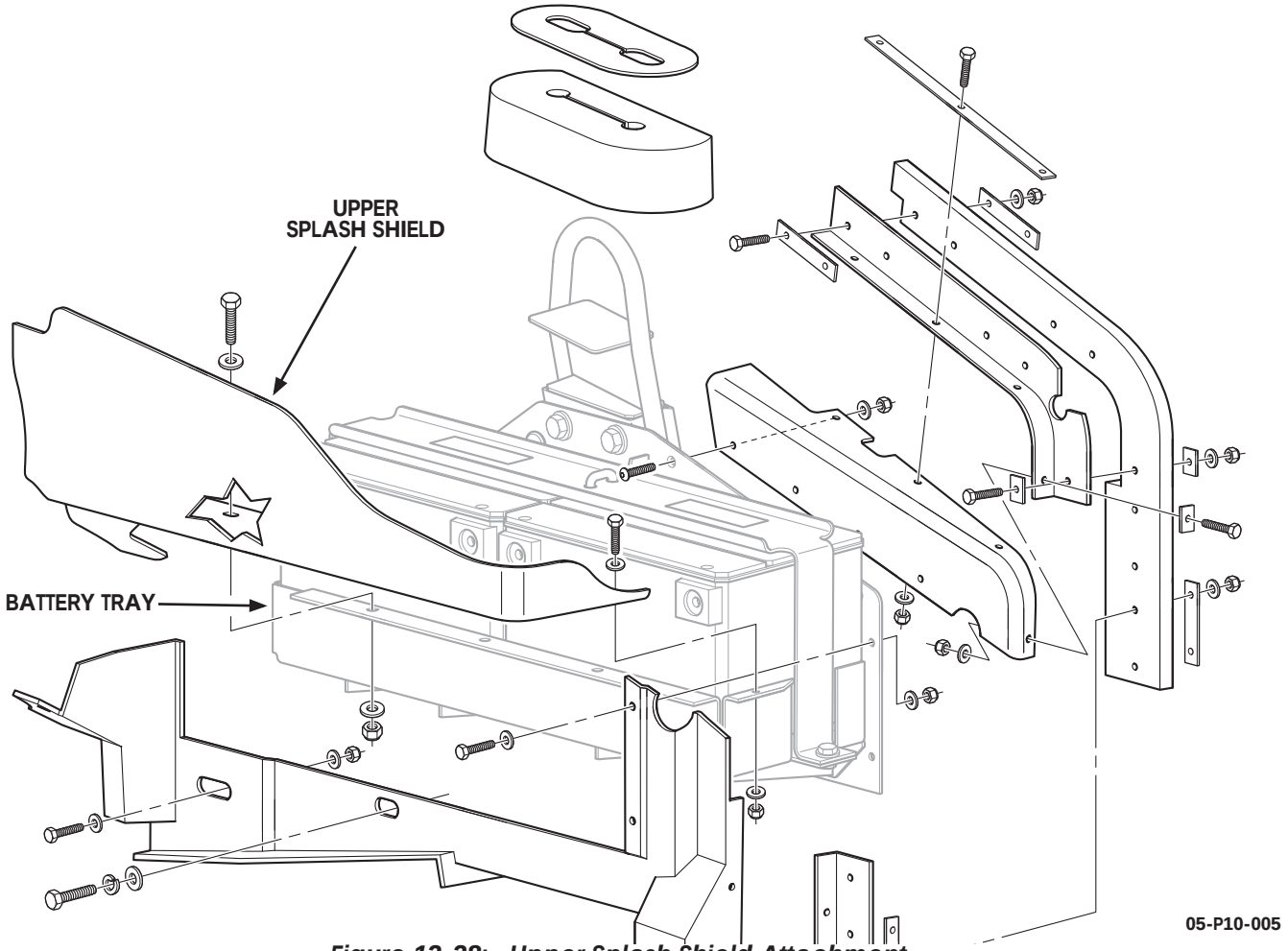


Figure 12-28: Upper Splash Shield Attachment

MAJOR POWER DISTRIBUTION

The following charts and illustrations convey how power is distributed from the vehicle batteries to the fuse/relay centers.

Power is supplied to the fuse boxes from the batteries through fusible links. Each fuse box has internal power busses that direct the power to the fuses (Figure 12-29). The busses are indicated on the fuse charts as follows: I = Ignition, B = Battery, A = Accessory, L = Lamps.

The fuse charts contain a listing of the **cavities** in the fuse box, the corresponding **circuits**, wire **colors** and **gauges (ga.)**. Power is supplied to an individual fuse by the **buss** indicated in the left **buss** column. The **circuit number (CKT No.)** contains two entries for a fuse: the power supply **buss** and the outgoing **circuit number**. The numbers in the **cavity** column relate to the cavities indicated on the fuse/relay cavity I.D. illustrations.

Using this information, you can determine which cavity of a fuse is the power supply cavity and which other fuses are supplied by the same buss.

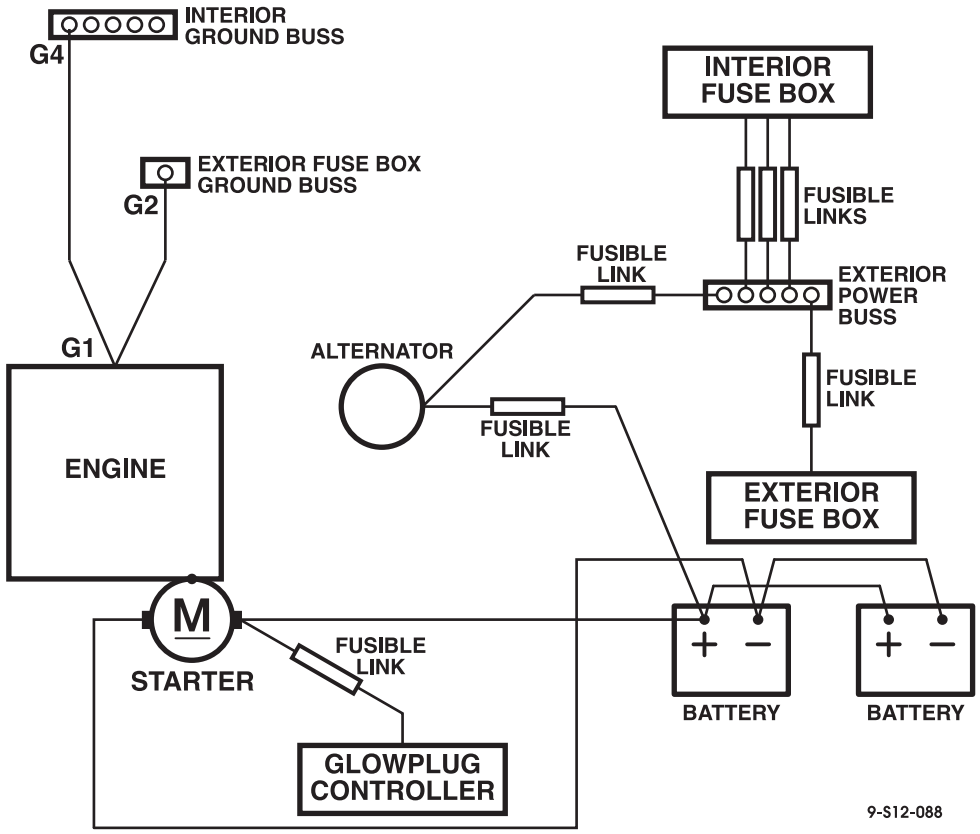


Figure 12-29: Major Power And Ground Schematic

ALTERNATOR

Removal

1. Disconnect the battery negative cable.
2. Drain the coolant and remove the coolant over flow tank.
3. Remove the serpentine drivebelt from the alternator pulley.
4. Remove the P clamp securing the alternator wires.
5. Loosen the two bolts securing the alternator to the alternator bracket (Figure 12-30).
6. Pull the alternator away from the engine. Remove the nut and the lockwasher and disconnect the battery wires from the battery alternator terminal (Figure 12-31).
7. Unlock and disconnect the field wire (Figure 12-31).
8. Remove the alternator from the engine.

Installation

1. Connect the battery wires to the alternator. Secure with the lockwasher and the nut. Tighten the nut to 62-80 lb-in (7-9 N•m).
2. Connect the field wire connector to the alternator.
3. Move the alternator into alignment with the bracket and install the mounting bolts. Tighten the bolts 18 lb-ft (25 N•m).
4. Install the serpentine drivebelt on the pulley and adjust the belt.
5. Connect the battery negative cable.

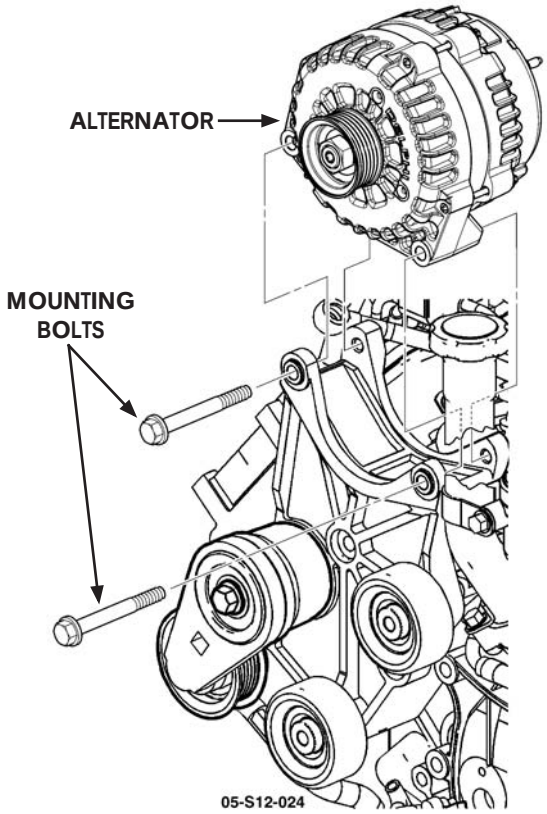


Figure 12-30: Alternator Mounting

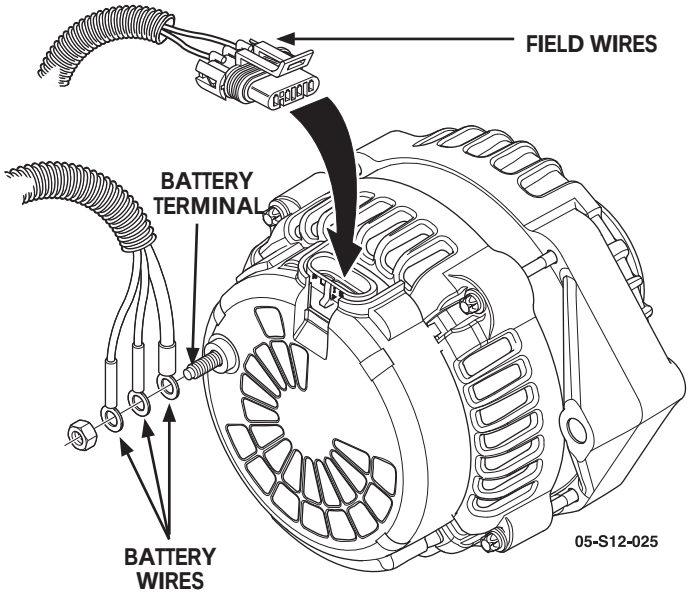


Figure 12-31: Alternator Connections

Alternator Inoperative (No Charge) (Figure 12-86)

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Go to Diagnostic System Check - Vehicle in Vehicle DTC Information
2	Start the engine. Does the charge indicator illuminate.		Go to Step 3	Go to Symptoms - Engine Electrical
3	**NOTE:** The green POWER lamp of the tester should remain illuminated while the tester is being used. 1. Turn OFF the ignition. 2. Connect the red lead of the J 41450-B Universal CS alternator test harness to the alternator output terminal. 3. Connect the black lead of the J 41450-B to the metal alternator housing. Does the green POWER lamp on the tester illuminate?		Go to Step 6	Go to Step 4
4	Measure the voltage from the output terminal of the alternator to the alternator metal housing. Does the voltage measure equal to the specified value?	12 Volts	Go to Step 14	Go to Step 5
5	Measure the voltage from the output terminal of the alternator to the battery negative terminal. Does the voltage measure equal to the specified value?	12 Volts	Go to Step 12	Go to Step 11
6	1. Turn OFF completely the load tool before connecting or disconnecting a carbon pile load tester to the battery. Otherwise, sparking at the terminals could cause battery gasses to explode. 2. Connect a carbon pile tester to the vehicle. **NOTE:** Ensure that all alternator output circuit wires pass through the inductive probe. 3. Connect an inductive ammeter to the output circuit of the alternator. 4. Disconnect the alternator harness connector. 5. Locate the matching harness connector on the J 41450-B , and connect the connector to the alternator. Does the red DIAGNOSTIC lamp on the tester illuminate?		Go to Step 7	Go to Step 13
7	1. Start the engine and allow it to idle for 30 seconds. 2. Increase the engine speed to 2500 RPM. Does the red DIAGNOSTIC lamp on the tester illuminate?		Go to Step 15	Go to Step 8

Alternator Inoperative (No Charge) (Figure 12-86)

Step	Action	Value(s)	Yes	No
8	1. Maintain the engine speed at 2500 RPM. **NOTE:** If the generator is not capable of producing the Load Test amps, operate the alternator at it's maximum possible output. 2. Turn ON the load of the carbon pile tester and increase the load until the generator output is equal to the Load Test value given in alternator usage. Does the red DIAGNOSTIC lamp on the tester illuminate?		Go to Step 15	Go to Step 9
9	1. Maintain the engine speed at 2500 RPM and continue to operate the alternator at the load test value. 2. Measure the voltage drop from the output terminal of the alternator to the positive terminal on the battery. Does the voltage measure greater than the specified value?	0.5 Volts	Go to Step 11	Go to Step 10
10	1. Maintain the engine speed at 2500 RPM and continue to operate the alternator at the load test value. 2. Measure the voltage drop from the battery negative terminal to the metal housing of the alternator. Does the voltage measure greater than the specified value?	0.5 Volts	Go to Step 12	Go to Step 16
11	Repair the high resistance or an open in the output circuit of the alternator. Did you complete the repair?		Go to Step 16	
12	Repair the high resistance or open in the ground circuit of the alternator. Did you complete the repair?		Go to Step 16	
13	1. Disconnect the J 41450-B tester harness connector from the alternator, but leave the alligator clips connected so that the green POWER lamp remains illuminated. 2. Connect a jumper lead, with an in-line 100-ohm resistor between the J 41450-B tester harness connector terminal B of the alternator and a good ground. Does the red DIAGNOSTIC lamp illuminate?		Go to Step 15	Go to Step 14
14	There is a problem with the J 41450-B . Refer to the manufacturers instructions, how to test the J 41450-B for proper operation. Has the J 41450-B tester been replaced?		Go to Step 3	

Alternator Inoperative (No Charge) (Figure 12-86)

Step	Action	Value(s)	Yes	No
15	Replace the alternator. Did you complete the replacement?		Go to Step 16	
16	Operate the vehicle in order to verify the repair. Did you correct the condition?		System OK	Go to Step 2

STARTER

Removal

1. Disconnect the battery negative cable(s) and the winch negative cable, if equipped.
2. Loosen the bolts securing the starter to the transmission.
3. Then lower the starter to gain access to the terminals.
4. Remove the cap and/or adhesive sealant from the starter terminal (Figure 12-32).
5. Disconnect the starter cable or the cables from the starter terminals (See Figure 12-32).
6. Disconnect the solenoid wire from the solenoid.
7. Remove the starter from the vehicle.

Installation

1. Connect the solenoid wire to the solenoid terminal with the clip and the screw. Tighten the screw to 22 lb-in. (2 N•m).
2. Connect the starter cable to the starter terminal. Tighten the nut to 25-31 lb-ft (34-42 N•m).
3. Position the starter in the converter housing.
4. Install and tighten the starter bolts to 58 lb-ft (78 N•m).
5. Connect the battery negative cable.

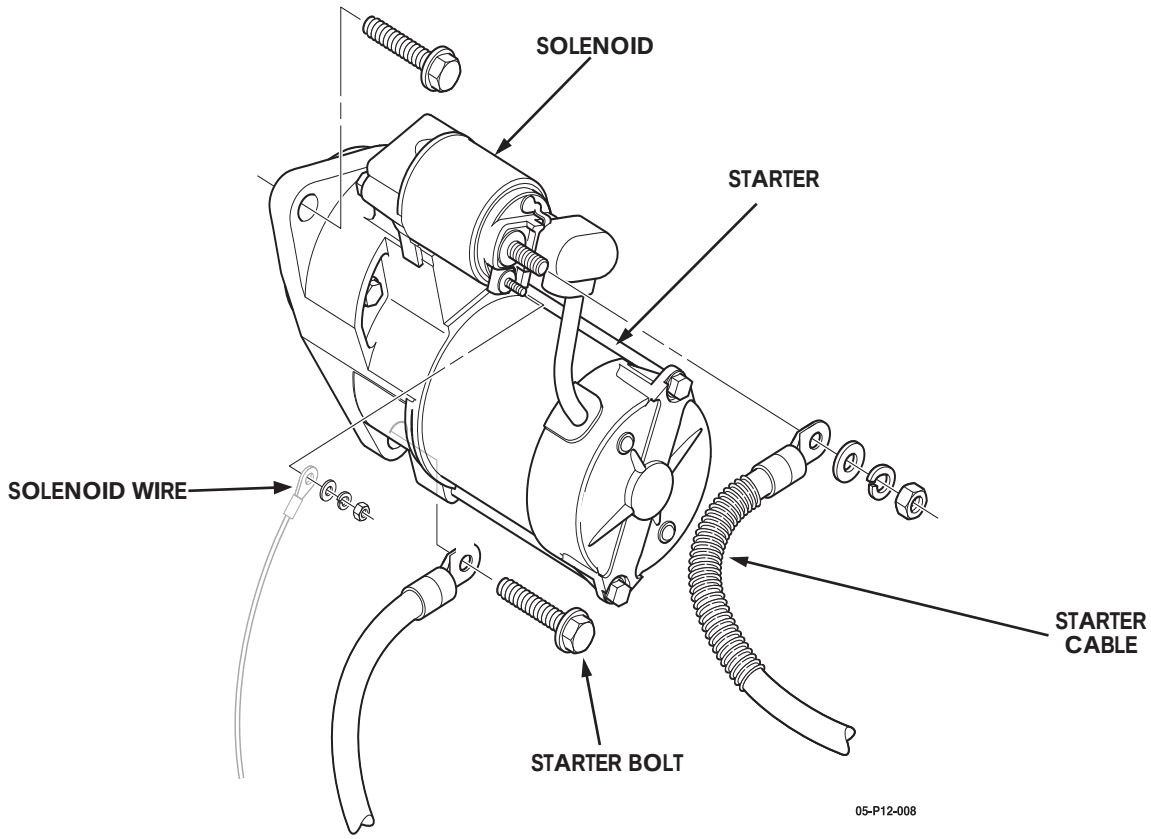


Figure 12-32: Starter Mounting

Starter Test

1. Connect the voltmeter, ammeter, switch and the battery to the starter as shown (Figure 12-33).

CAUTION: *Do not operate the starter motor for more than 10 seconds at a time. Allow the starter motor to cool at least 2 minutes between tests to avoid overheat damage.*

WARNING: Starter must be secured to prevent movement from start up torque. Test cables must be of a sufficient gauge size to conduct starter current.

2. Close the switch, and adjust the voltage to 9.5 volts on the voltmeter using a carbon pile. Check the rotating speed of the armature with a tachometer. Read the current draw on the ammeter.
3. Maximum current draw should be 65 amps with a minimum armature speed of 5000 rpm. If a low speed, high current condition exists, check the armature for shorts or grounds. If a low speed, low current draw exists, inspect the starter motor for a bad connections or a poor brush contact.

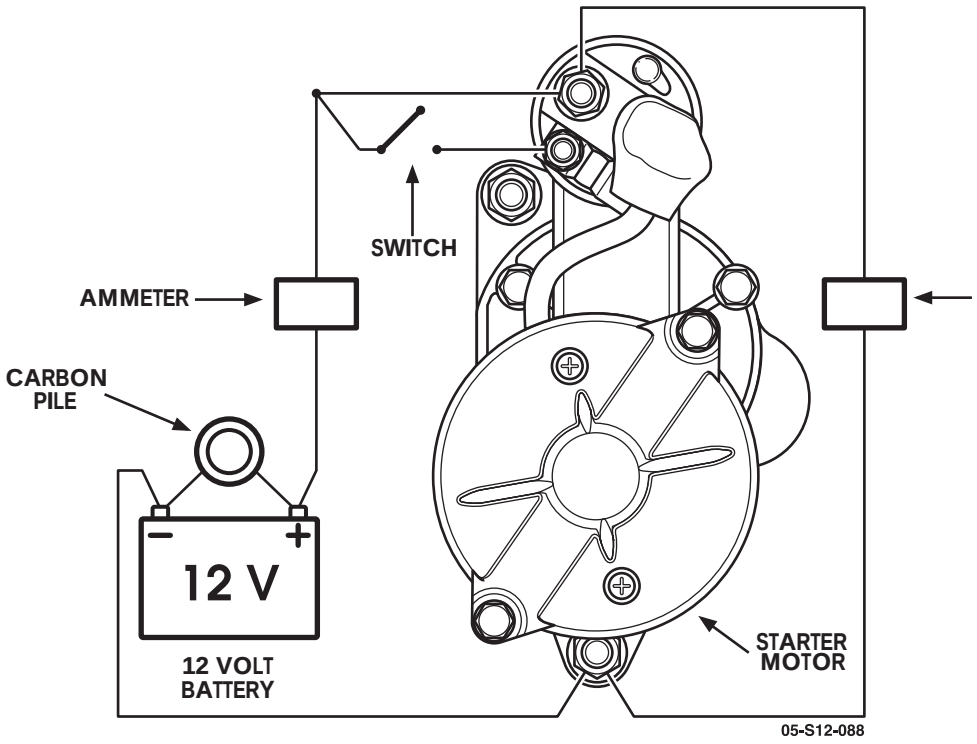


Figure 12-33: Starter Test Connections

Starter Solenoid Click, Engine Does Not Crank

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?		Go to Step 2	Diagnostic System Check - Vehicle in Vehicle DTC Information
2	Turn the ignition to the START position. Did the starter solenoid click?		Go to Step 3	Go to Starter Solenoid Does Not Click
3	Inspect the engine and belt drive system for mechanical binding seized engine, seized alternator. Does the engine move freely?		Go to Step 4	Go to Engine Will Not Crank - Crankshaft Will Not Rotate
4	Test the battery positive cable between the battery and the starter solenoid for high resistance. Did you find and correct the condition?		Go to Step 8	Go to Step 5
5	Test the ground circuit between the battery and the starter motor for a high resistance. Did you find and correct the condition?		Go to Step 8	Go to Step 6

Starter Solenoid Click, Engine Does Not Crank

Step	Action	Value(s)	Yes	No
6	Inspect for poor connections at the starter. Did you find and correct the condition?		Go to Step 8.	Go to Step 7.
7	Replace the fulty Starter. Did you complete the replacement?		Go to Step 8.	
8	Operate the system for which the symptom occurred. Did you correct the condition?		System OK.	Go to Step 2.

Starter Solenoid Does Not Click (Figure 12-145)

Step	Action	Value(s)	Yes	No
1	Did you preform the Diagnostic System Check?		Go to step 2.	Go to diagnostic system check.
2	Turn the ignition switch to the START position. Does the engine crank?		Intermittent condition, poor connections in wiring.	Go to step 3.
3	Turn the ignition switch to the START position. Does the starter motor relay click?		Go to step 11.	Go to step 4.
4	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector C-77. 3. Connect a test lamp between pin 18 (CKT 331 WH) of the ECM harness and a good ground. 4. With the transmission in park, turn the ignition switch to the START position. Does the test light illuminate?		Go to step 7.	Go to step 5.
5	Inspect for poor connections at the ECM connector pins 18 and 35, exterior fuse box #1 40 amp maxi fuse, or ignition switch connector pin ST (CKT 33 WH). Did you find and correct the condition ?		Go to step 29.	Go to step 6.
6	Test circuit 37 and crank fuse # 1 in exterior fuse box for an open or high resistance. Did you find and correct the condition ?		Go to step 29.	Go to step 27.
7	1. Turn OFF the ignition. 2. Disconnect the ECM harness connector C-77. 3. Connect A test lamp between the pin 35 (CKT 332 BK) and a good ground. 4. Turn the ignition to the START position. Does the test light illuminate?		Go to step 19.	Go to step 8.

Starter Solenoid Does Not Click (Cont'd) (Figure 12-145)

Step	Action	Value(s)	Yes	No
8	1. Remove the starter motor relay. 2. Connect a test lamp from pin 87 (CKT 37 YL) and a good ground. Turn the ignition to the START position. Does the test light illuminate?		Go to step 9.	Go to step 10.
9	1. Connect a test lamp from pin 85 (CKT 332 BK) to a good ground. 2. Turn the ignition to the START position. Does the test light illuminate?		Go to step 17.	Go to step 14.
10	1. Turn OFF the ignition. 2. Disconnect the neutral start back up switch (NSBU). 3. Turn ON the ignition, with the engine OFF. 4. Connect a 10-amp fused jumper to pin 1 (CKT 331 WH). 5. Turn the ignition switch to the START position. Does the test light illuminate?		Go to step 18.	Go to step 15.
11	1. Turn OFF the ignition. 2. Disconnect the starter motor relay. 3. Connect a test lamp to pin 87 (CKT 37 YL) and a good ground. Does the test light illuminate?		Go to step 12.	Go to step 23.
12	Connect a 30-amp fused jumper to pin 30 (CKT 34 LB). Does the engine crank?		Go to step 17.	Go to step 13.
13	Does the fuse in the jumper open?		Go to step 24.	Go to step 16.
14	Test circuit 332 BK for an open or high resistance. Did you find and correct the condition ?		Go to step 29.	Go to step 25.
15	Test circuit 33 WH for an open or high resistance. Did you find and correct the condition ?		Go to step 29.	Go to step 21.
16	Test circuit 37 YL for an open or high resistance. Did you find and correct the condition ?		Go to step 29.	Go to step 22.
17	Inspect for poor connections at the starter motor relay. Did you find and correct the condition ?		Go to step 29.	Go to step 25.
18	Inspect for poor connection at the NSBU switch harness connector. If OK perform NSBU adjustment procedure in SECTION 5 of the service manual. Did you find and correct the condition ?		Go to step 29.	Go to step 26.

Starter Solenoid Does Not Click (Cont'd) (Figure 12-145)

Step	Action	Value(s)	Yes	No
19	Inspect for poor connection at the ECM harness connector C-77. Did you find and correct the condition ?		Go to step 29.	Go to step 20.
20	Replace the ECM. Did you complete the replacement?		Go to step 29.	–
21	Inspect for a poor connection at the ignition switch harness connector pin ST(CKT 33 WH). Did you find and correct the condition ?		Go to step 29.	Go to step 27.
22	Inspect for poor connections at the starter solenoid. Did you find and correct the condition ?		Go to step 29.	Go to step 28.
23	Repair the open or high resistance in circuit 37 YL. Did you find and correct the condition ?		Go to step 29.	–
24	Repair the short to ground in circuit 34 LB. Did you find and correct the condition ?		Go to step 29.	–
25	Replace the starter relay. Did you complete the replacement?		Go to step 29.	–
26	Replace the NSBU switch. Did you complete the replacement?		Go to step 29.	–
27	Replace the ignition switch. Did you complete the replacement?		Go to step 29.	–
28	Replace the starter. Did you complete the replacement?		Go to Step 29.	–
29	Operate the system for which the symptom occurred. Did you correct the condition?		system OK.	Go to Step 2.

Glow Plugs Inoperative (Figure 12-117)

Step	Action	Value	Yes	No
1.	Before clearing any DTC's, use the scan tool Capture Info to save the Freeze Frame and Failure Records for reference. The ECM's data is deleted once the Clear Info function is used. Did you perform the On-Board Diagnostic (OBD) System Check?		Go to step 2.	
2.	If DTC P0380 is set after a ECM reflash. Connect a scan tool. Turn the ignition ON leaving the engine OFF. Observe the Glow Plug System Type parameter on the scan tool. Does the scan tool display the Glow Plug System Type as California?		Go to step 3.	Go to (LINK-GO TO-REPAIR-609502) Glow Plug System Type Relearn

Glow Plugs Inoperative (Cont'd) (Figure 12-117)

Step	Action	Value	Yes	No
3.	Connect a scan tool. Turn the ignition ON leaving the engine OFF. Use the scan tool to command the glow plugs ON and OFF. Observe the Glow Plug System Type parameter on the scan tool. Does the scan tool display a voltage near the first specified value with the glow plug commanded ON and near the second specified value with the glow plug commanded OFF?	5.0-5.6 Volts 0.9-1.5 Volts	Go to step 7.	Go to step 4.
4.	Does the scan tool display a glow plug voltage greater than the specified value?	5.6 Volts	Go to step 21.	Go to step 5.
5.	Does the scan tool display a glow plug voltage greater than the specified value?	0.3 Volts	Go to step 10.	Go to step 6.
6.	Turn the ignition ON leaving the engine OFF. Touch the battery feed stud on the glow plug controller with an unpowered test lamp connected to ground. Is the test light ON?		Go to step 8.	Go to step 25.
7.	The DTC is intermittent. If any additional DTC's were stored, refer to those table(s). Were there any additional DTC's stored?		Go to the applicable DTC table.	Go to Diagnostic Aids.
8.	Disconnect the glow plug relay control connector. Turn the ignition ON with the engine OFF. With an unpowered test lamp connected to ground, probe the glow plug relay harness ignition feed circuit (CKT 239 RD). Is the test light ON?		Go to step 9.	Go to step 16.
9.	Turn the ignition ON with the engine OFF. Connect an unpowered test lamp to B+, probe the glow plug relay ground circuit (BK). Is the test light ON?		Go to step 10.	Go to step 17.
10.	Turn the ignition ON with the engine OFF. Verify that the glow plug relay control harness is disconnected. With a DMM connected to ground, probe the glow plug relay control circuit (466 YL) at the glow plug relay harness connector. Use a scan tool to command the glow plugs ON and OFF. Does the DMM display a voltage near the first specified value with the glow plugs commanded ON and near the second specified voltage with glow plugs commanded OFF?	9-12 Volts 0 volts	Go to step 12.	Go to step 11.
11.	Is the voltage equal to or more than the specified value all the time?	1.0 Volt	Go to step 23.	Go to step 18.

Glow Plugs Inoperative (Cont'd) (Figure 12-117)

Step	Action	Value	Yes	No
12.	Turn the ignition ON leaving the engine OFF. Reconnect the glow plug relay control harness. With a DMM connected to ground, back probe the glow plug relay signal circuit (506 LB) at the ECM harness connector. Use a scan tool to command the glow plugs ON. Observe the DMM while the glow plugs are commanded ON. Is the voltage at the specified value?	5.0-5.6 Volts	Go to step 21.	Go to step 13.
13.	Turn the ignition OFF. Disconnect the right and left bank glow plug output circuit connectors at the glow plug relay. With an unpowered test lamp connected to B+, probe each circuit. Does each circuit turn ON the test lamp?		Go to step 26.	Go to step 14.
14.	Turn the ignition OFF. Disconnect each glow plug connector at the glow plug that did not illuminate the test lamp. With an unpowered test lamp connected to B+, probe the terminal on the glow plug. Does each glow plug illuminate the test lamp?		Go to step 26.	Go to step 25.
15.	Turn the ignition OFF. Disconnect each glow plug connector at the glow plug. With an unpowered test lamp connected to B+, probe each circuit at the glow plug output connectors. Is the test lamp OFF at each of the circuits?		Go to step 20.	Go to step 27.
16.	Repair an open or a short to ground in the glow plug relay ignition feed circuit (CKT 239 RD). Did you complete the repair?		Go to step 30.	
17.	Repair any opens or poor connections in the glow plug relay ground circuit (BK). Did you complete the repair?		Go to step 30.	
18.	Inspect the glow plug relay control circuit (466 YL) for an open or short to ground. If the glow plug relay control circuit is open or shorted to ground, repair as necessary. Did you find and correct the condition?		Go to step 30.	Go to step 19.
19.	Inspect the glow plug relay control circuit (CKT 466 YL) for a proper connection at the ECM and replace the terminal if necessary. Did you find an improper connection and make the necessary repair?		Go to step 30.	Go to step 29.
20.	Inspect the glow plug relay signal circuit (CKT 506 LB) for an open or short to ground. If the glow plug relay signal circuit is open or shorted to ground, repair as necessary. Did you find and correct the condition?		Go to step 30.	Go to step 28.

Glow Plugs Inoperative (Cont'd) (Figure 12-117)

Step	Action	Value	Yes	No
21.	Inspect the glow plug relay signal circuit (CKT 506 LB) for a proper connection at the ECM and replace the terminal if necessary. Did you find an improper connection and make the necessary repair?		Go to step30.	Go to step 22.
22.	Test for a short to voltage in the glow plug relay signal circuit (CKT 506 LB). Did you find the improper condition?		Go to step 30.	Go to step 28.
23.	Test for a short to voltage in the glow plug relay control circuit (CKT 466 YL). Did you find and correct the condition?		Go to step 30.	Go to step 29.
24.	Repair the open or poor connection on the battery feed circuit. Did you complete the repair?		Go to step 30.	
25.	Replace any glow plug that did not illuminate the test lamp. Did you complete the repair?		Go to step 30.	
26.	Repair the open or poor connections in the glow plug harness. Did you complete the repair?		Go to step 30.	
27.	Repair the short to ground in the glow plug harness. Did you complete the repair?		Go to step 30.	
28.	Replace the glow plug relay. Did you complete the repair?		Go to step 30.	
29.	THE NEW ECM MUST BE PROGRAMMED.Replace the ECM. Did you complete the repair?		Go to step 30.	
30.	Use a scan tool to clear the DTC's. Start the engine. Allow the engine to idle until the engine reaches normal operating temperature. Select the DTC and the specific DTC function. Enter the DTC number which was set. Operate the vehicle, with the Conditions for Setting this DTC, until the scan tool indicates the diagnostic Ran. Does the scan tool indicate the diagnostic Passed?		Go to step 31.	Go to step 2.
31.	Does the scan tool display any addition undiagnosed DTC's?		Go to the applicable DTC table.	System OK.

Fuel Tank Selector System Inoperative (No Tank Switch) (Figure 12-114)

Step	Action	Value(s)	Yes	No
1.	Remove fuel tank selector switch from dash, and disconnect switch from harness. Using a DVOM, set to measure resistance, probe the black wire of the fuel selector switch connector (CKT 59) with the black lead, and the positive lead on the ground studs at left of dash.Is resistance below specification?	<.2 Ω	Go to step 4	Repair open or bad connection in CKT 59 between fuel selector switch and IP ground studs.
2.	Using a DVOM set to measure voltage, place the positive lead on the grey wire (CKT 787) at the fuel tank selector switch. Turn the ignition ON. Does the meter read voltage?	+12 v	Go to step 3	Repair open or short to ground in CKT 787.
3.	Re-connect fuel tank selector switch. Using a DVOM, set to measure voltage, back probe the red wire (CKT 786) with the negative lead and brown wire (CKT 789) with the positive lead. Turn the ignition ON. With the switch in the AUX position voltage should be present, when the switch is moved to the MAIN position, reverse polarity voltage should be present. Does meter show opposite voltages when moved between AUX and MAIN?	+12 v= AUX -12 v=MAIN	Go to step 4.	Replace fuel tank selector switch and recheck system.
4.	Disconnect fuel selector valve electrical connection. Using a DVOM, set to measure voltage, probe the brown wire with the positive lead, and the red lead with the negative lead. Turn the ignition ON. With the switch in the AUX position voltage should be present, when the switch is moved to the MAIN position, reverse polarity voltage should be present. Does meter show opposite voltages when moved between AUX and MAIN	12 v+=AUX 12 v-=MAIN	Replace fuel selector valve	Go to step 5.
5.	Relocate the ground lead of the DVOM, set to measure voltage to a known good ground. Turn the ignition ON, and the tank selector switch in the AUX position, probe the brown wire (CKT 789) with the positive meter lead. Is voltage present?	+12 v	Go to step 8.	Repair open, bad connection or short to ground in CKT 789.
6.	Turn the ignition ON, and the tank selector switch in the MAIN position, probe the red wire (CKT 786) with the positive meter lead, the ground lead should be on a know good ground. Is voltage present?	+12 v	No electrical problems found, problem may be intermittent or mechanical.	Repair open, bad connection or short to ground in CKT 786.

IGNITION SYSTEM

System Description

The ignition switch is located on the steering column just below the ignition lock cylinder (Figure 12-34). The ignition switch bolts to the lock cylinder housing and is controlled by the column lock actuator. When the ignition lock cylinder is rotated forward it pushes the lock actuator down. The downward action of the actuator is transferred to the ignition switch causing the switch to select a different status (“Off”, “Run”, “Start”). When the lock cylinder is released after a full forward motion it will default to the “Run” position. When the ignition lock cylinder is rotated backwards it pulls the lock actuator up. The upward action of the actuator is again transferred to the ignition switch causing the switch to select a different status (“Start”, “Run”, “Off” “Lock” “Accessory”).

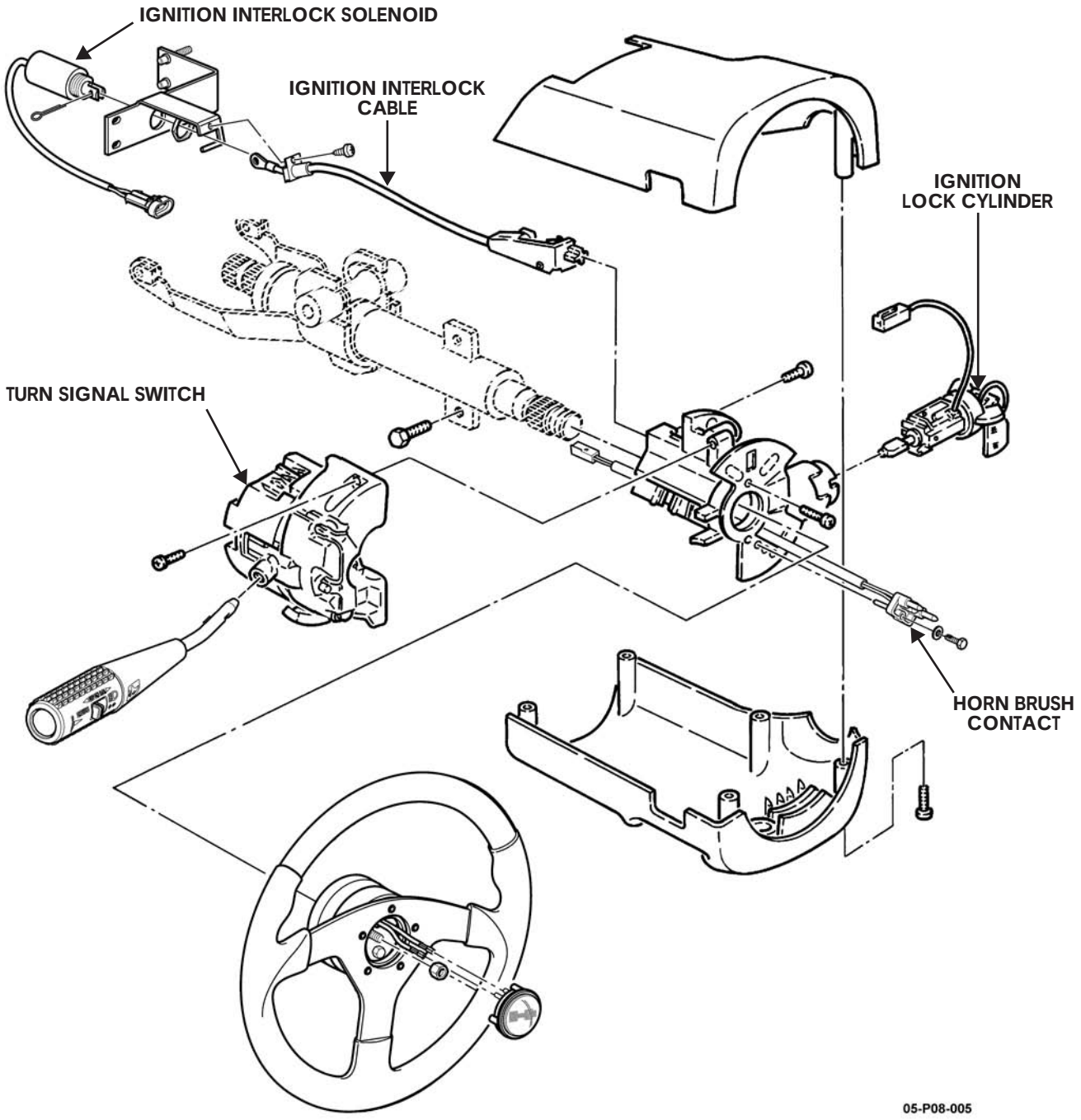


Figure 12-34: Ignition Switch Exploded View

Ignition Switch Replacement (Figure 12-35)

Removal

1. Remove the steering column covers.
2. Remove the multi-function switch.
3. Remove the screw and the interlock cable from the ignition switch (Figure 12-35).
4. Remove the two cap screws and the ignition switch from the steering column.

Installation

1. Apply thread-locking compound to the cap screw threads and install the ignition switch on the steering column with the two capscrews.
2. Install the interlock cable on the ignition switch with screw.
3. Install the multi-function switch.
4. Install the steering column covers.
5. Ensure the ignition switch operates properly.

Ignition Switch Quick Test (Figure 12-124)

Connect DVOM	Key Position	Values
Check between the two BATT terminals.	Accessory, Lock, Off, Run, and Start.	Closed circuit in all 5 positions.
Between the BATT terminal and ST.	Accessory, Lock, Off, Run, and Start.	Closed in the **Start** position only.
Between the BATT terminal and A2.	Accessory, Lock, Off, Run, and Start.	Closed in the **Run** position only.
Between the BATT terminal and I1.	Accessory, Lock, Off, Run, and Start.	Closed in the **Run** position only.
Between the BATT terminal and I2.	Accessory, Lock, Off, Run, and Start.	Closed in the **Start** position only.
Between the BATT terminal and A1,	Accessory, Lock, Off, Run, and Start.	Closed in the **Run** and the **Accessory** position only.
Between terminal P1 and the Ignition switch case.	Accessory, Lock, Off, Run, and Start.	Closed in the **Start** position only.

When testing the ignition switch with the “Quick Test” make sure the test is performed with the harness disconnected. The terminals to be checked will be on the ignition switch.

IGNITION SWITCH INTERLOCK SYSTEM DESCRIPTION

The purpose of the ignition interlock is to prevent the driver from turning the ignition to the lock position while the vehicle is in any gear other than park. When the shifter is removed from the park position, voltage from the interlock switch energizes the ignition interlock solenoid and pulls the cable, stoping the ignition from being turned to the lock position. If electrical power is lost due to a dead battery or system failure, the solenoid defaults to the open position. With the ignition interlock solenoid in the open position the ignition can be turned to the lock position.

Ignition Switch Interlock inoperative (Figure 12-141)

STEP	ACTION	VALUES	YES	NO
1.	Does the brake shift interlock work properly?		Go to step 2.	Go to brake shift interlock inoperative
2.	With the ignition switch in the “run” position using a DVOM check for voltage at fuse 6 E. Is the specified voltage present?	B+	Go to step 3.	Go to step 6
3.	With the ignition switch in the “run” position activate the park brake and place the shifter in the neutral position. Using a DVOM check for voltage at the WH wire (CKT 1071) between pin A of the ignition interlock solenoid connector and a good ground. Is the specified voltage present?	B+	Go to step 4.	Replace the 6 E fuse or repair the wire to the B3 as necessary. Did you make the necessary repairs?
4.	Using a DVOM check for voltage at the WH wire (CKT 1071) between pin A and the BK wire (CKT 1072) pin B of the ignition interlock solenoid connector. Is the specified voltage present?	B+	Replace the ignition interlock solenoid	Go to step 5.
5.	Using a DVOM measure the resistance of the BK wire (CKT 1072) between pin B of the ignition interlock solenoid connector and pin D of the sifter assembly. Is the resistance greater than the specified value?	.2 Ohms	Repair the high resistance in the (CKT 1072) between pin B of the ignition interlock solenoid connector and pin D of the sifter assembly	Replace the shifter assembly.

BRAKE SHIFT INTERLOCK SYSTEM DESCRIPTION

The purpose of the brake shift interlock solenoid is to prevent a driver from engaging a transmission gear before the brakes are applied (Figure 12-35). When the brake pedal is depressed, voltage from the brake switch de-energizes the interlock solenoid. The transmission shift lever can then be pulled out of the park position. If electrical power is lost due to a dead battery or system failure, the solenoid defaults to the open position. With the brake/shift interlock solenoid in the open position the shifter may not be moved out of the park position.

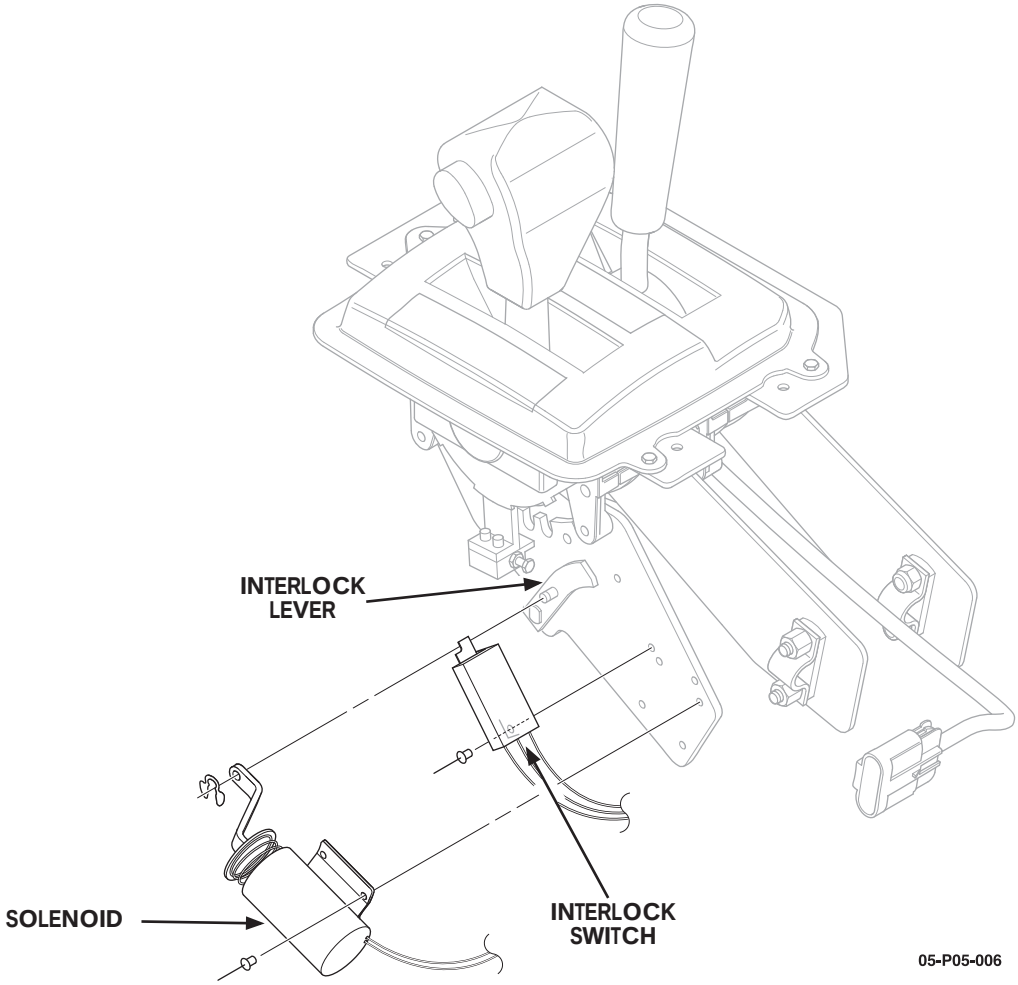


Figure 12-35: Brake Shift Interlock Solenoid

Brake Shift Interlock Inoperative (Figure 12-141)

STEP	ACTION	VALUES	YES	NO
1	Gain access to the shifter assembly connector. Using a DVOM, check for the resistance on the LB wire (CKT 32) between pin B and a good ground. Is the resistance greater than the specified value?	.2 Ω	Repair the open or bad connection in CKT 32 between the interlock solenoid and G1.	Go to step 2.
2	With the ignition switch in the “run” position and the brake pedal depressed. Check the voltage between the WH wire (CKT 520) pin A of the shifter assembly connector and a good ground. Is the specified voltage present?	B+	Replace the shifter assembly.	Go to step 3.

Brake Shift Interlock Inoperative (Figure 12-141)

STEP	ACTION	VALUES	YES	NO
3	With the ignition switch in the “run” position and the brake pedal depressed. Check the voltage between M8 cavity of the shift inter lock relay and a good ground. Is the specified voltage present?	B+	Repair the open or high resistance in the WH wire (CKT) 520 between the shifter assembly connector and cavity M8 of the shift inter lock relay	Go to step 4.
4	With the ignition switch in the “run” position and the brake pedal depressed. Check the voltage between L9/L7 cavity of the shift inter lock relay and a good ground. Is the specified voltage present?	B+	Go to step 5.	Repair the open or high resistance in the RD wire (CKT 1073) between the shift inter lock relay and buss 1 A
5	With the ignition switch in the “run” position and the brake pedal depressed. Check the voltage between M9 cavity of the shift inter lock relay and a good ground. Is the specified voltage present?	B+	Replace the shift inter lock relay.	Go to step 6.
6	With the ignition switch in the “run” position and the brake pedal depressed. Check the voltage between pin A of the brake switch and a good ground. Is the specified voltage present?	B+	Repair the open or bad connection on CKT 1070 between the shift inter lock relay brake switch.	Replace the brake switch.

CTIS Compressor Inoperative (Figure 12-102)

Step	Action	Value(s)	Yes	No
1	Using a DVOM, set to measure voltage, probe the terminals on the CTIS compressor. With the CTIS compressor switch set to inflate, and the ignition on, is voltage present?	+12v	Replace the compressor	Go to step 2.
2	Move the ground lead to a known good ground and the positive lead still on the compressor, ignition on, compressor switch on inflate. Is voltage present?	+12v	Repair open or bad connection in CKT57 between compressor and G2.	Go to step 3.
3	Remove compressor relay from the exterior fuse box. Using a DVOM, set to measure voltage, Probe cavity 1(CKT46) of the CTIS compressor relay socket with the positive lead, and cavity 2(CKT59) with the negative lead. Ignition on, CTIS compressor switch to on, is voltage present?	+12v	Go to step 7.	Go to step 4.
4	Using a DVOM, set to measure resistance, check continuity to ground at cavity 2 of the compressor relay socket. Is resistance below specification?	<.2Ω	Go to step 5.	Repair open or bad connection in CKT59 between compressor relay and G2.
5	Remove compressor switch from the dash. Using a DVOM, set to measure voltage. Ignition on, compressor switch set to inflate. Check for voltage on white wire(CKT46). Is voltage present?	+12v	Repair open or bad connection in CKT46 between compressor switch and relay.	Go to step 6.
6	Using a DVOM, set to measure voltage, turn the ignition on. Check for voltage at both orange wires(CKT640) at the rear of the compressor switch. Is voltage present?	+12v	Replace the compressor switch.	Repair open, bad connection or short in CKT640 between compressor switch and fuse 1G.
7	Using a DVOM, set to measure continuity measure continuity between cavity 5(CKT437) of the compressor relay socket and the green wire(CKT437) at the compressor. Is resistance below specifications?	<.2Ω	Go to step 8.	Repair open, bad connection, or short in CKT437 between relay and compressor.
8	Using a DVOM, set to measure voltage, place the positive lead in cavity 3 (CKT436) of the compressor relay. Place the ground lead in cavity 2(CKT59). Is voltage present?	<.2Ω	Replace the compressor relay.	Repair open, bad connection or short in CKT436 between compressor relay and Maxi fuse#6.

CTIS Exhaust Valve Inoperative (Figure 12-102)

Step	Action	Value(s)	Yes	No
1	Disconnect exhaust solenoid. Using a DVOM, set to measure voltage, probe the light green wire(CKT47) with the positive lead, and the black wire(CKT57) with the negative lead. Ignition on, move the compressor switch to deflate. Is voltage present?	+12v	Replace exhaust solenoid.	Go to step 2.
2	Check continuity to ground on the black wire(CKT57) at the exhaust solenoid. Is resistance below specification?	<.2Ω	Go to step 3.	Repair open or bad connection in CKT57 between exhaust solenoid and G2.
3	Remove compressor switch. Using a DVOM, set to measure voltage, check for voltage at both orange wires (CKT640). With ignition on is voltage present?	+12v	Go to step 4.	Repair open, bad connection or short in CKT640 between compressor switch and fuse 1G.
4	Using a DVOM, set to measure voltage, check for voltage at the light green wire(CKT47) with the ignition on and compressor switch to deflate. Is voltage present?	+12v	Repair open bad connection or short in CKT 47 between compressor switch and exhaust solenoid.	Replace compressor switch.

CTIS Front Inflate Valve Inoperative (Figure 12-102)

Step	Action	Value(s)	Yes	No
1	Disconnect front inflate solenoid. Using a DVOM, set to measure voltage connect the positive lead to the tan wire(CKT91), and the negative lead to the black wire(CKT57). With the ignition on, selector switch set to both, and the compressor switch to inflate, is voltage present?	+12v	Replace front inflate solenoid.	Go to step 2.
2	Check continuity to ground on the black wire(CKT57) at the front inflate solenoid. Is resistance below specification?	<.2Ω	Go to step 3.	Repair open or bad connection in CKT57 between front inflate valve and G2.
3	Remove selector switch and compressor switch from the I/P. Using a DVOM, set to measure voltage, ignition on, and compressor switch set to inflate. Check for voltage on both yellow wires(CKT144) at rear of selector switch. Is voltage present.	+12v	Go to step 6.	Go to step 4.

CTIS Front Inflate Valve Inoperative (Figure 12-102)

Step	Action	Value(s)	Yes	No
4	Ignition on, compressor switch on inflate, check for voltage on yellow wires(CKT144)at rear of compressor switch. Is voltage present?	+12v	Repair open, bad connection or short in CKT144 between compressor switch and selector switch.	Go to step 5.
5	Ignition on, check for voltage at both orange wires(CKT640) at back of compressor switch. Is voltage present?	+12v	Replace compressor switch.	Repair open, bad connection or short in CKT640 between compressor switch and fuse 1G.
6	Ignition on, compressor switch set to inflate, selector switch set to both. Check for voltage at the tan wire(CKT91) at the back of the selector switch. Is voltage present?	+12v	Repair open, bad connection, or short in CKT91 between selector switch and front inflate valve.	Replace the selector switch.

CTIS Rear Inflate Valve Inoperative (Figure 12-102)

Step	Action	Value(s)	Yes	No
1	Disconnect front inflate solenoid. Using a DVOM, set to measure voltage connect the positive lead to the grey wire(CKT92), and the negative lead to the black wire(CKT57). With the ignition on, selector switch set to both, and the compressor switch to inflate, is voltage present?	+12v	Replace rear inflate solenoid.	Go to step 2.
2	Check continuity to ground on the black wire(CKT57) at the rear inflate solenoid. Is resistance below specification?	<.2Ω	Go to step 3.	Repair open or bad connection in CKT57 between rear inflate solenoid and G2.
3	Remove selector switch and compressor switch from the I/P. Using a DVOM, set to measure voltage, ignition on, and compressor switch set to inflate. Check for voltage on both yellow wires(CKT144) at rear of selector switch. Is voltage present.	+12v	Go to step 6.	Go to step 4.

CTIS Rear Inflate Valve Inoperative (Figure 12-102)

Step	Action	Value(s)	Yes	No
4	Ignition on, compressor switch on inflate, check for voltage on yellow wires(CKT144)at rear of compressor switch. Is voltage present?	+12v	Repair open, bad connection or short in CKT144 between compressor switch and selector switch.	Go to step 5.
5	Ignition on, check for voltage at both orange wires(CKT640) at back of compressor switch. Is voltage present?	+12v	Replace compressor switch.	Repair open, bad connection or short in CKT640 between compressor switch and fuse 1G.
6	Ignition on, compressor switch set to inflate, selector switch set to both. Check for voltage at the grey wire(CKT92) at the back of the selector switch. Is voltage present?	+12v	Repair open, bad connection, or short in CKT92 between selector switch and front inflate valve.	Replace the selector switch.

LIGHTING SYSTEM DESCRIPTION

Lighting Schematics

See the following Figures for Lighting Schematics on:

Headlight Schematic (Figure 12-39)

Lighting Buss Schematic (Figure 12-39)

Back Up Light Schematic (Figure 12-40)

Brake Light Schematic (Figure 12-43)

Indicator Light Schematic (Figure 12-44)

Key/Headlight Chime Schematic (Figure 12-44)

Switches (Figure 12-36)

The light switches on the instrument panel control the interior and exterior lights of the vehicle.



Figure 12-36: Lighting Switches

Master Lighting Switch

The master lighting switch activates the headlights and the parking lights. It also sends a +12 volt signal to the dimmer switch to power the interior panel lighting.

Panel Light Dimmer Switch

The panel light dimmer switch brightens or dims the lights in the instrument panel and accessories. The voltage for the dimmer switch comes from the master lighting switch when the master lighting switch is in the “Park” or “Lights” Positions.

Dome Light Switch

The dome light switch activates the dome light(s), as well as the courtesy lights located at each seat position. The dome light(s) and courtesy lights will also come on automatically whenever any door is opened. The activation of the dome lights with the door however does not run through the dome light switch that is controlled by the door switches.

Multifunction Switch

The multifunction switch is located in the steering column. It is two switches housed in one unit. These switches are as follows:

a. The main switching unit is the turn/hazard switch. This is were the brakes connect to the hazards to override the flasher.

b. The high beam selector which allows the driver to change the headlights from low beams to high beams.

Instrument Panel Switch Replacement

NOTE: All instrument panel switches are replaced similarly, with the exception of the dimmer control switch. This procedure covers the main light switch.

Removal

1. Remove the drivers side closeout panel.
2. Reach up behind the instrument panel, and disconnect the connector from the switch (Figure 12-37).
3. Push the switch from the switch housing.

Installation

1. Install the switch in the switch housing (Figure 12-37).
2. Plug the connector into the switch.
3. Install the drivers side closeout panel.

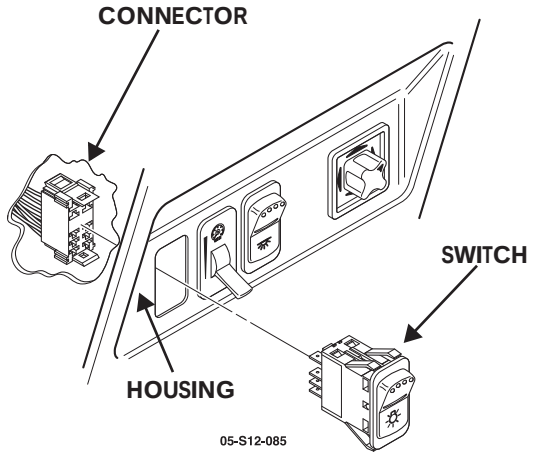


Figure 12-37: Master Lighting Switch Removal

Instrument Panel Dimmer Control Switch Replacement

Removal

1. Remove the drivers side closeout panel.
2. Reach up behind the instrument panel and un plug the connector from the switch.
3. Push the switch from the switch housing.

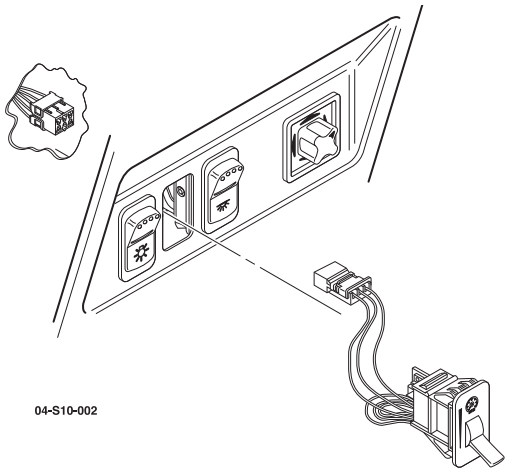


Figure 12-38: Dimmer Control Switch Replacement

Installation

1. Install the switch in the switch housing (Figure 12-38).
2. Plug the connector into the switch.
3. Install the drivers side closeout panel.

Turn/Hazard Switch

The turn/hazard switch is located in the multifunction switch on the steering column (Figure 12-39).

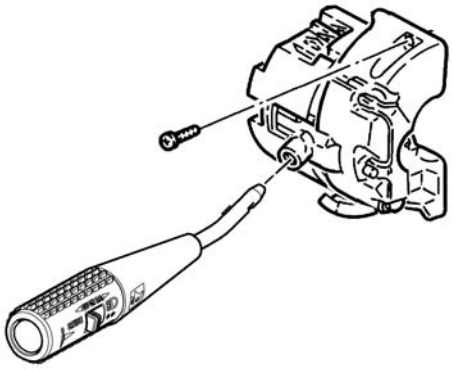


Figure 12-39: Multifunction Switch & Control Lever

The turn/hazard switch can be diagnosed with an ohm meter. If a problem is suspected in the turn/hazard switch, disconnect the harness from the switch and visually inspect the terminals on the back of the switch. If the terminals appear satisfactory, use the quick test charts to check the continuity between the specified terminals on the switch. If any of the following circuit checks disagrees with the specified results, the switch is defective and will require replacement.

NOTE: *Values of 0-0.2Ω is recommended for a closed circuit. Any values of ≥0.3Ω may cause irregular operation of the circuit.*

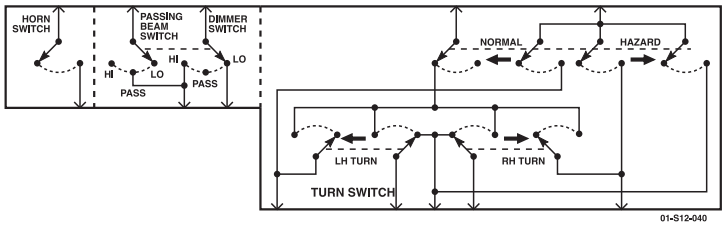
Component Quick Test

Hazard Switch Circuit

Terminals	Switch Position	Values
C40-A (385 TN) and C40-D (44 LB)	Hazard Applied Turn Signals Off	Open Circuit
C40-A (385 TN) and C39-A (3 LB), C39-B (9 YL)	Hazard Applied Turn Signals Off	Closed Circuit
C40-A (385 TN) and C40-E (2 LG), C40-F (5 DG)	Hazard Applied Turn Signals Off	Closed Circuit

Turn Switch Circuit (Figure 12-40)

Terminals	Switch Position	Values
C40-D (44 LB) and C39-B (9 YL)	Left Turn Hazards Off	Closed Circuit
C40-D (44LB) and C39-A (3 LB)	Left Turn Hazards Off	Closed Circuit
C40-D (44 LB) and C40-F (5 DG)	Right Turn Hazards Off	Closed Circuit
C40-D (44 LB) and C40-E (2 LG)	Right Turn Hazards Off	Closed Circuit



MULTIFUNCTION SWITCH

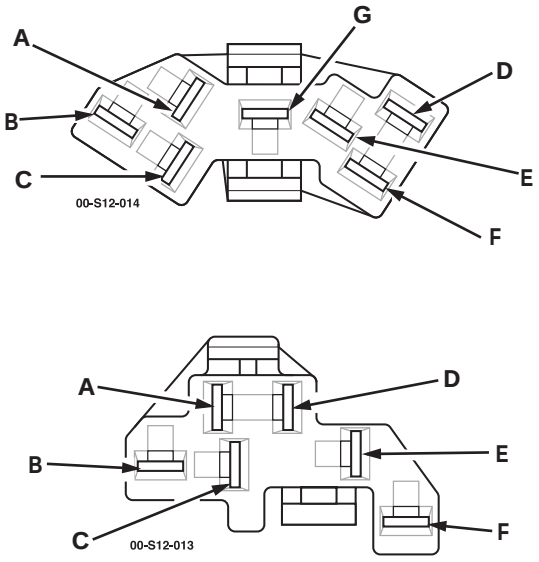


Figure 12-40: Turn Switch Circuit

HORN

Horn Replacement

Removal

1. Remove the harness connectors and adapters from the horn.
2. Remove the nut and the horn from the mounting bracket (Figure 12-41).

NOTE: Overtightening horn mounting nut will distort the horn bellows and result in an “off-key” horn tone.

Installation

1. Secure the horns to the mounting bracket with the nuts.
2. Plug the harness connectors and the adapters into the horns.

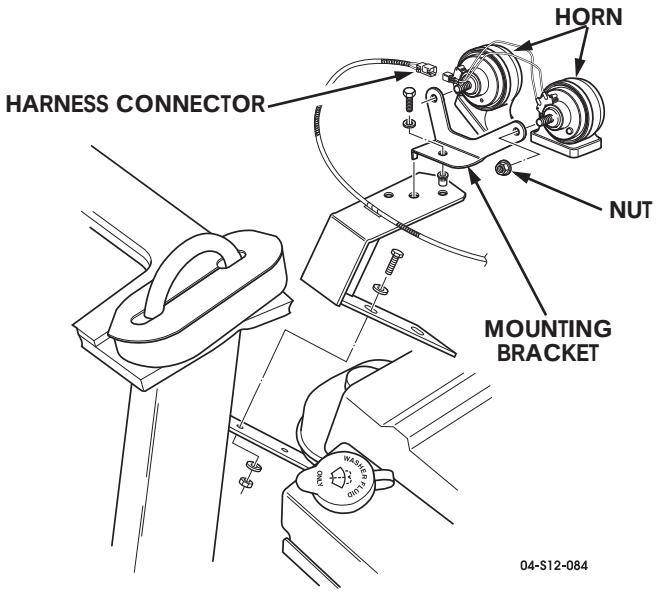


Figure 12-41: Horn and Horn Mounting Bracket Replacement

Horn Mounting Bracket Replacement

Removal

1. Remove the two horns.
2. Remove the bolts, washers, lock washers, nuts, and the horn mounting bracket from the airlift bracket (Figure 12-41).

Installation

1. Secure the horn mounting bracket to the airlift bracket with the bolts, washers, lock washers, and the nuts (Figure 12-41).
2. Install the two horns.

Horns Inoperative (Figure 12-120)

Step	Action	Value	Yes	No
1.	Locate the horn assemblies under the hood. Disconnect the harness from the horn assemblies. With a DVOM, check the ground circuit 58 (BK) between pin B harness side and a good ground. Is the ground circuit within specifications?	<.2 Ω	Go to step 2.	Repair the open or bad connection on CKT 58 between the horn assemblies and G2.
2.	With a DVOM, back probe the horn circuit 6 (WH) pin A on the horn assemblies and check for voltage when the horn button is pushed. Is the specified voltage present?	+12v	Replace the horn assemblies.	Go to step 3.
3.	Remove the horn relay from the exterior fuse box. With a DVOM, check resistance between the relay cavity 1F and the horn circuit 6 (WH) pin A on the horn assemblies. Does the resistance meet the specifications?	<.2 Ω	Go to step 4.	Repair the open or bad connection in CKT 6 between the horn relay and the horn assembly.

Horns Inoperative (Figure 12-120)

Step	Action	Value	Yes	No
4.	With a DVOM, check for voltage in cavities 3E and 1E of the exterior fuse box. Is the specified voltage present?	+12v	Go to step 5.	Repair the open or bad connection in CKT 7 between the horn relay and the exterior fuse box.
5.	With a DVOM, check the resistance to ground on cavity 3F, of the exterior fuse box, when the horn switch is pressed. Does the resistance meet the specifications?	<.2 Ω	Replace the horn relay.	Go to step 6.
6.	With a DVOM, back probe C1 circuit 1 (DB) pin 12 Activate the horn switch and watch the resistance on the meter. Does the resistance meet the specifications?	<.2 Ω	Repair the open or bad connection on CKT 1 between the horn switch and the horn relay.	Replace the horn bottom.

CIGARETTE LIGHTER REPLACEMENT

Removal

1. Remove the element from the lighter assembly heater (Figure 12-42).
3. Remove the heater and the bezel from the console using the cigarette lighter socket tool (J–42059).
4. Remove the wiring harness connector from the lighter assembly

Installation

1. Install the wiring harness connector on the lighter assembly.
2. Install the heater in console (Figure 12-42).
3. Install the element in the lighter assembly.
4. Engage the cigarette lighter to ensure proper operation.

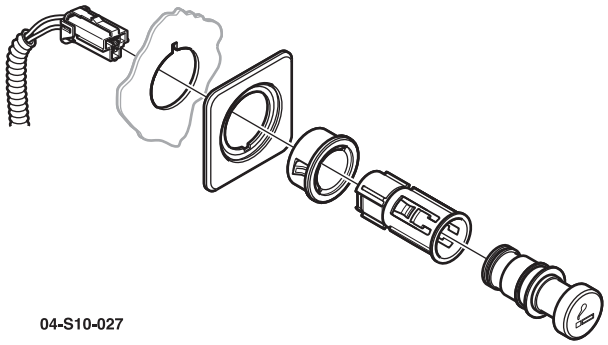


Figure 12-42: Cigarette Lighter Breakdown

INSTRUMENT PANEL SYSTEM DESCRIPTION

The instrument panel system includes three gauge modules, a CTIS control module and assorted control switches (Figure 12-43).

The three gauge modules are self contained allowing minimal repair. They are equipped with an anti-fog coating on the inboard side of the lens and an anti-scratch coating on the out board side of the lens. The warning light bulbs have been replaced with light

emitting diodes (LED) for clearer viewing. The CTIS module has also been improved with a domed lens to reduce glare and contains LEDs for clearer viewing.

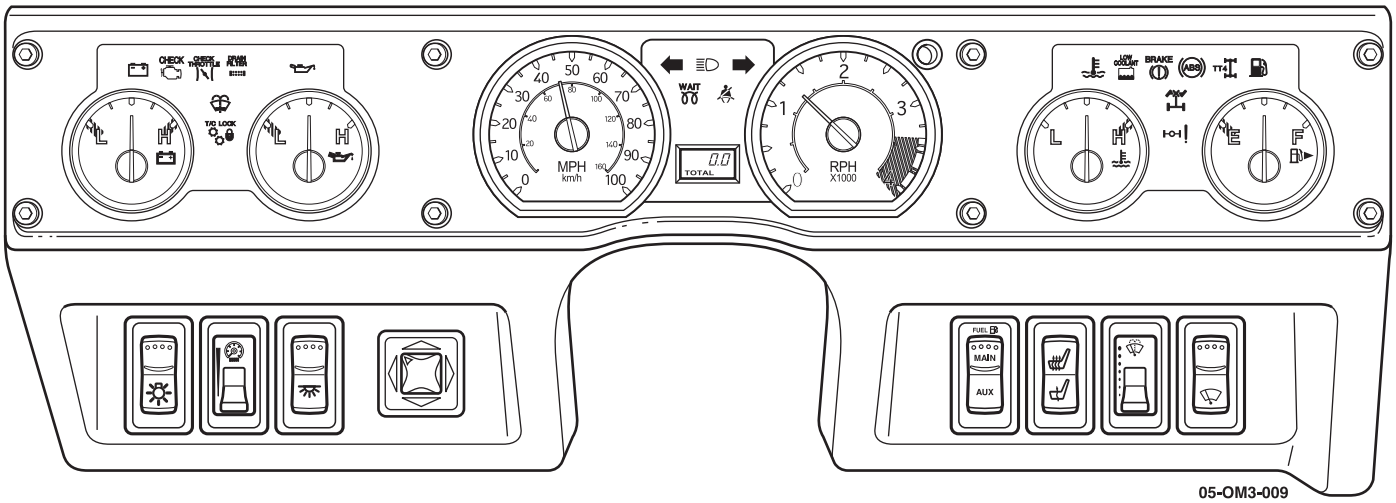


Figure 12-43: Instrument Panel

NOTE: When working on or around the back of the instrument panel clusters always wear a static strap. The gauge modules are extremely sensitive to voltage and may be damaged if shocked.

Instrument Panel Switch Replacement

NOTE: All instrument panel switches are replaced similarly, with the exception of the dimmer control switch. This procedure covers the main light switch.

CAUTION: *Some connectors can be installed incorrectly and cause damage to the electrical system. Make note of connector position prior to removal.*

Removal

1. Remove the drivers side closeout panel.
2. Reach up behind the instrument panel and push Remove the connector from the switch (Figure 12-44).
3. Push the switch from the switch housing.

Installation

1. Install the switch in the switch housing.
2. Plug the connector into the switch (fig 12-97).
3. Install the drivers side closeout panel.

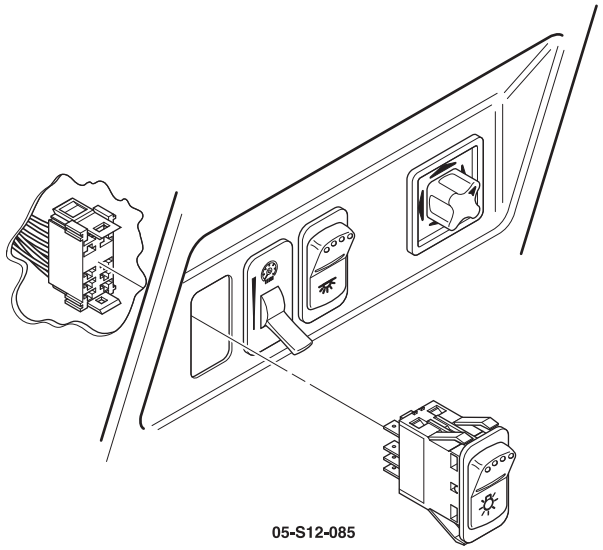


Figure 12-44: Switch Replacement

Instrument Panel Dimmer Control Switch Replacement

Removal

1. Remove the drivers side closeout panel.
2. Reach up behind the instrument panel, and unplug the connector from the wiring harness (Figure 12-45).
3. Push the switch from the switch housing.

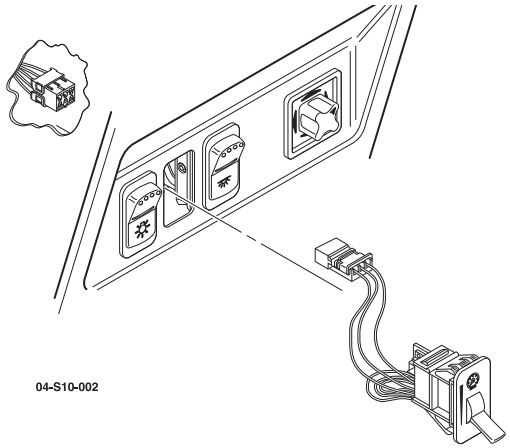


Figure 12-45: Instrument Panel Dimmer Control Switch Replacement

Installation

1. Install the switch in the switch housing (Figure 12-45).
2. Plug the connector into the switch.
3. Install the drivers side closeout panel.

SPEEDO/TACH MODULE

The speedo/tach module is the primary control of the three gauge modules (Figure 12-46). It controls the start up bulb test and the operating voltage that the other modules use. Main power is supplied to the speedo/tach module on circuit 30 (GY). It then sends operating voltage to the volt/oil module through circuit 913 (WH) and to the coolant/fuel module through circuit 916 (TN) (Figure 12-116).

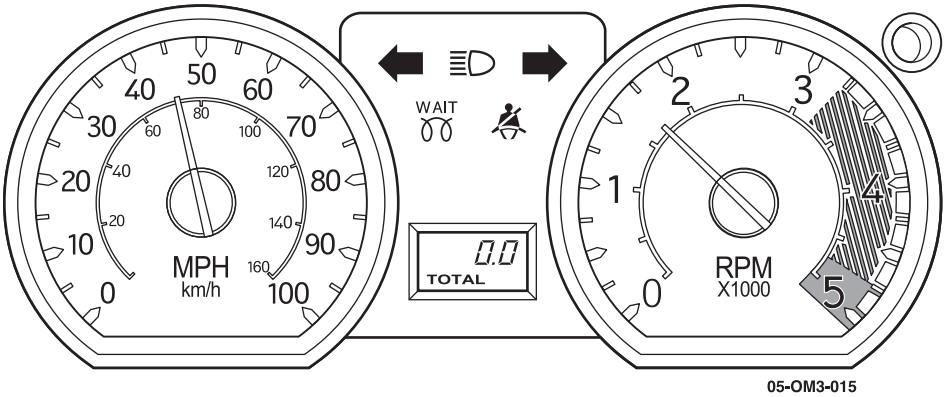


Figure 12-46: Speedo/Tach Module

Speedo/Tach Module

Removal

1. Remove the eight allen screws, and the bezel from around the gauges.
2. Remove the four retaining screws from the speedo/tach module (Figure 12-47).
3. Pull the speedo/tach module out of the instrument panel far enough to expose the harness connector.
4. Disconnect the harness connector from the speedo/tach module and remove the module.

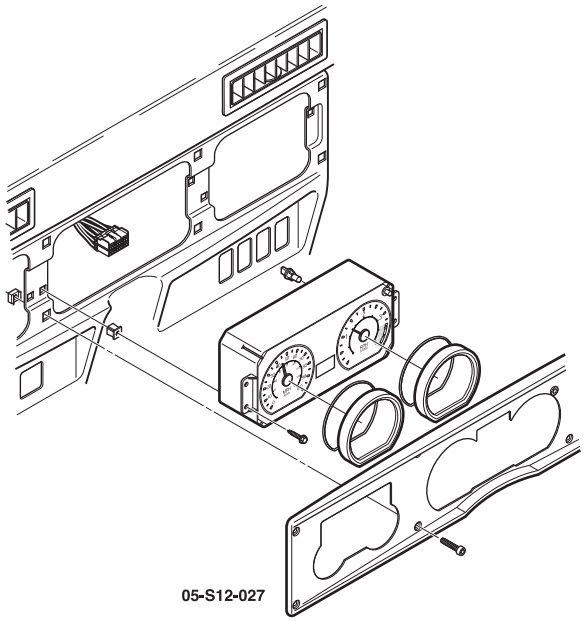


Figure 12-47: Speedo/Tach Module Removal

Installation

1. Connect the harness connector to the speedo/tach module.
2. Slide the module into the instrument panel and install the four retaining screws.
3. Install the bezel, and eight allen screws.

Gauge Illumination

The only serviceable portion of the speedo/tach module is the back lighting bulbs. There are six bulbs in this module that are used for gauge illumination only. These bulbs are easily replaced by twisting them 1/4 turn out of the back of the circuit board on the module (Figure 12-48). The other modules are similar in repair to the speedo/tach module.

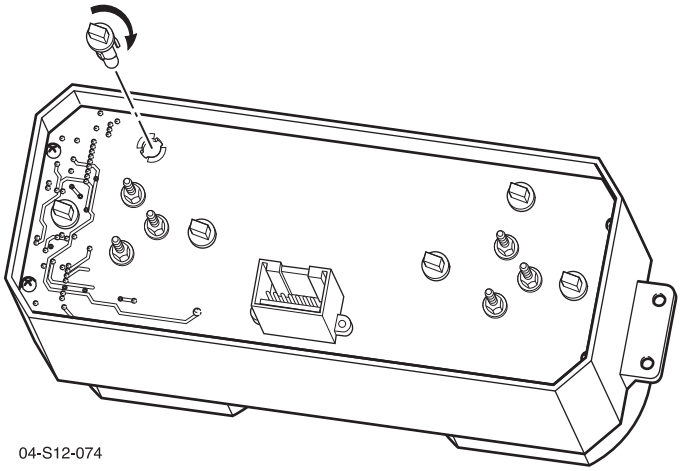


Figure 12-48: Illumination Bulb Replacement

Circuit Description

The speed sensor circuit consists of a magnetic induction type sensor, TCM, ECM and wiring. Geared teeth pressed on the output shaft induce an alternating current in the sensor. This A/C signal is transmitted to the TCM. The TCM relays the signal to the ECM. When the ECM receives the signal it compensates for various axle ratios and converts the signal into a digital signal for use by the speedometer, cruise control, and the ELocker module. The speed signal is also used to control shift points, line pressure, TCC and diagnostic codes. Circuit 353 sends a signal of 128K pulses per mile to the speedometer and the ELocker module (Figure 12-142).

Speedometer Calibration Check

To check accuracy of the speedometer use the calibration chart above. The gauge panel must be connected to the harness to verify speed. Back probe the signal wire with a DVOM, and check the hertz reading while accelerating to 30 MPH then to 60 MPH then decelerate to 30 MPH and check the reading. The readings should approximate the specifications above.

Speedometer Calibration Check

Approximate Reading	Input	Ascending	Descending
30 MPH	33.33 Hz	X	
60 MPH	66.67 Hz	X	
30 MPH	33.33 Hz		X

Odometer Illumination

The odometer illumination is *not* serviceable. Back lighting is on at all times on the odometer. The circuit that feeds power to the odometer back lighting changes when the head lamp switch is in the “On” position. With the headlight switch in the “On” position the odometer back lighting switches to illumination circuit 17 (PP). This allows the odometer back lighting to be dimmed.

Self Tests and Bulb Checks

Speedo/Tach Self test

The speedo/tack module is equipped with a self test function to indicate proper functionality.

To preform the self test hold the “trip odometer reset button” down and turn the ignition switch to the “Run” position. A normally operating module will have the speedo gauge reading between 45-55 MPH and the tachometer between 1500-2500 RPM. The gauges should stay in this position until the “trip odometer reset button” is released.

NOTE: The odometer will advance at a rate of 0.8 miles a minute as long as the self test is running. This is a test to see if the odometer is functioning properly.

Warning/Indicator “Bulb Check”

The “Bulb Check” signal is a battery voltage signal sent out from the speedo/tach module for 4.1 seconds (+ 1.0 second). The purpose of this test is to verify that all warning lights are functioning properly. The speedo/tack module sends this voltage to the volt/oil module though circuit 910 (RD). From the volt/oil module voltage travels to the coolant/fuel module on circuit 911 (GY/BK) and then to the CTIS module on circuit 912 (DB) (Figure 12-143).

If any of the test circuits between the modules were to have excessive resistance or an open, the module(s) after the problem may not function properly on the “bulb check”.

For example: If circuit 911 (GY/BK) were to become open the coolant/fuel module and the CTIS module may not function properly.

Tachometer Calibration Check

Approximate Reading	Input	Ascending	Descending
600 RPM	43.33 Hz	X	
2000 RPM	133.33 Hz	X	
600 RPM	43.33 Hz		X

Tachometer Calibration Check

To check the accuracy of the tachometer use the calibration chart above. The gauge panel must be connected to the harness to verify RPM. Back probe the signal wire with a DVOM, and check the hertz reading while accelerating to 600 RPM then to 2000 RPM then decelerating back to 600 RPM and checking the readings. The readings should approximate the specifications above.

NOTE: The “Bulb Check” only lasts for 4.1 seconds requiring cycling of the ignition to check the signal voltage.

“Bulb Check” Inoperative (Figure 12-147)

Step	Action	Value(s)	Yes	No
1	Do any of the modules perform the “Bulb Check”?		Go to step 5.	Go to step 2.
2	Remove the speedo/tach module and disconnect the harness. Turn the ignition switch to the “Run” position. With a DVOM, check for voltage on terminal 7 (CKT 30 GY) on the harness connector. Is battery voltage present?	>12.6v	Go to step 3	Repair the open or bad connection on circuit 30 (GY), between the speedo/tach module and fuse 4B of the interior fuse box.
3	With a DVOM, check the resistance to ground on terminal 14 (CKT 59 BK) on the harness connector. Does the resistance meet the specification?	< 0.2 Ω	Go to step 4.	Repair the open or bad connection on circuit 59 BK between the speedo/tach module and G4
4	With a DVOM, check the voltage on terminal 10 (CKT 910 RD). Is the specified voltage present?	> 12.6v	Go to step 5.	Replace the speedo/tach module.
5	Does the volt/oil module perform the “Bulb Check” when the ignition switch is cycled?		Go to step 10.	Go to step 6.

"Bulb Check" Inoperative (Figure 12-147)

Step	Action	Value(s)	Yes	No
6	Remove the volt/oil module and check for system voltage on terminal 13 (CKT 913 WH). Is system voltage present?	>12.6v	Go to step 8.	Go to step 7.
7	With a DVOM, check the continuity on circuit 913 (WH) between the volt/oil module and the speedo/tach module. Does the continuity meet the specification?	< 0.2 Ω	Replace the speedo/tach module.	Repair circuit 913 (WH) between the speedo/tach module and the volt/oil module.
8	Check for the "Bulb Check" signal voltage on terminal 9 (CKT 910 RD). Is the specified voltage present?	> 12.6v	Go to step 9.	Repair the open or bad connection on circuit 910 RD between the speedo/tach module and the volt/oil module.
9	With a DVOM, check the resistance on terminal 14 (CKT 59 BK) of the volt/oil module connector on the instrument harness. Is the specified resistance present?	< 0.2 Ω	Replace the volt/oil module.	Repair ground circuit (CKT 59 BK) between the volt/oil module and ground G4.
10	Does the coolant/fuel module perform the "Bulb Check" when the ignition switch is cycled?		Go to step16	Go to step 11.
11	Remove the coolant/fuel module and check for system voltage on terminal 13 (CKT 916 TN). Is system voltage present?	>12.6v	Go to step 13.	Go to step 12.
12	With a DVOM,DVOM, check the continuity on circuit 916 (TN) between the coolant/fuel module and the speedo/tach module. Does the continuity meet the specification?	< 0.2 Ω	Replace the speedo/tach module.	Repair circuit 916 (TN) between the speedo/tach module and the coolant/fuel module.
13	Check for the "Bulb Check" signal voltage on terminal 7 (CKT 911 GY/BK). Is the specified voltage present?	> 12.6v	Go to step 15.	Go to step 14.
14	With a DVOM, check the continuity on circuit 911 (GY/BK) between the coolant/fuel module and the speedo/tach module. Does the continuity meet the specification?	< 0.2 Ω	Replace the speedo/tach module.	Repair circuit 911 (GY/BK) between the coolant/fuel module and the speedo/tach module.
15	With a DVOM, check the resistance on terminal 14 (CKT 59 BK) of the coolant/fuel module connector on the instrument harness. Is the specified resistance present?	< 0.2 Ω	Replace the coolant/fuel module.	Repair the ground circuit (CKT 59 BK) between the coolant/fuel module and ground G4.
16	Remove the CTIS module and check for specified voltage on terminal 2 (CKT 915 LB). Is system voltage present?	10v	Go to step 18.	Go to step 17.

"Bulb Check" Inoperative (Figure 12-147)

Step	Action	Value(s)	Yes	No
17	With a DVOM, check the continuity on circuit 915 (LB) between the coolant/fuel module and the CTIS module. Does the continuity meet the specifications?	< 0.2 Ω	Replace the coolant/fuel module.	Repair circuit 915 (LB) between the coolant/fuel module and the CTIS module.
18	Check for the "Bulb Check" signal voltage on terminal 4 (CKT 912 DB). Is the specified voltage present?	> 12.6v	Go to step 20.	Go to step 19.
19	With a DVOM, check the continuity on circuit 912 (DB) between the coolant/fuel module and the CTIS module. Does the continuity meet the specifications?	< 0.2 Ω	Replace the coolant/fuel module.	Repair circuit 912 (DB) between the coolant/fuel module and the CTIS module.
20	With a DVOM, check the resistance on terminal 3 (CKT 59 BK) of the CTIS module connector on the harness. Is the specified resistance present?	< 0.2 Ω	Replace the CTIS module.	Repair ground circuit (CKT 59 BK) between the CTIS module and ground G4.

TRANSMISSION TEMPERATURE/ENGINE OIL MODULE

The transmission temperature/engine oil module is located on the left hand side of the instrument panel (Figure 12-49). It contains two gauges (trans temperature and oil pressure), six warning lights (low voltage, check engine, check throttle, drain filter, transmission temperature, low washer fluid and low oil pressure), and two indicator lights (T/C lock and check transmission).

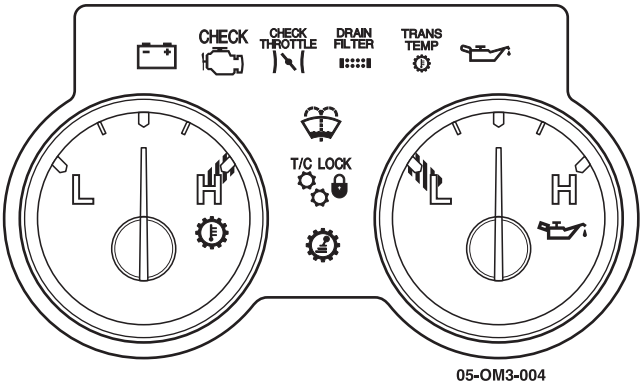


Figure 12-49: Transmission Temperature/Engine Oil Module

Like the speedo/tach module, the only serviceable item on this module is the gauge illumination bulbs. These bulbs are removed by turning a quarter turn counter clockwise out of the back of the module.

Warning/Indicator "Bulb Check"

When the ignition is turned to the "Run" position the "Bulb Check" should operate. The "Bulb Check" is a 4.1 second

(± 1.0) test to see that all indicator and warning lights are functioning. If the "Bulb Check" fails to operate correctly, refer to the bulb check diagnostic chart in this section.

Transmission Temperature/Engine Oil Module Replacement

Removal

1. Remove the eight allen screws, and bezel around the gauge modules.

2. Remove the four retaining screws securing the trans temperature/engine oil module (Figure 12-50).
3. Pull the trans temperature/engine oil module out of the instrument panel far enough to expose the harness connector.
4. Disconnect the harness connector from the trans temperature/engine oil module.

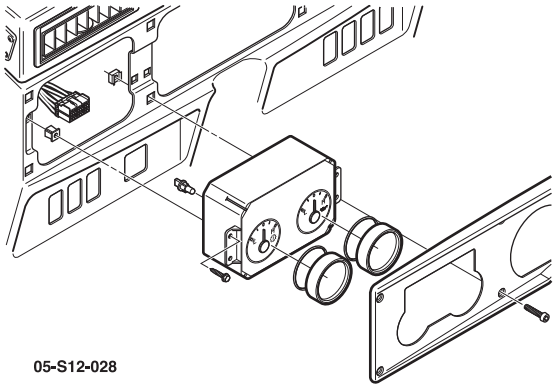


Figure 12-50: Trans Temp/Oil Module Removal

Installation

1. Connect the harness connector to the trans temperature/engine oil module.
2. Slide the module into the instrument panel and install the four retaining screws.
3. Install the bezel, and eight allen screws.

Oil Pressure Gauge Calibration Check

Reading	Input	Ascending	Descending
Low	0 Ω		X
Mid. Point	50 Ω	X	
High	99 Ω	X	

Oil Pressure Gauge Calibration Check

To check accuracy of the oil pressure gauge use the calibration chart above. The gauge panel must be connected to the harness to verify oil pressure. Back probe the signal wire with a DVOM and check the resistance verses the gauge readings. The readings should approximate the specifications.

Oil Pressure Warning Light Check

Reading	Input	Status	Asc./Des.	Input Tol.
Red Band	20 Ω	ON	Des.	±8Ω
Gray Band	>22 Ω	OFF	Asc	±8Ω

The oil pressure warning light and gauge reference the same tan wire (CKT 620). If the light activation point is questionable, refer to the chart to verify accuracy.

Warning lights for the Trans Temp/Oil Module

All the LEDs on the volt/oil module receive voltage from a control circuit built in to the module. This controller is powered up with system voltage on the white wire (CKT 913) (Figure 12-150).

The warning lights are also connected to a 4.1 second bulb check. This is achieved by a voltage signal being supplied to the module through the red wire (CKT 910). When the module receives the voltage signal it activates an internal timer which supplies a ground to all the LEDs on the board.

Low Battery Light

The low battery light is a red LED. It is controlled by a ground signal supplied by the alternator on the orange wire with a black tracer (CKT 904).

Check Engine Light

The check engine light is a red LED. It is controlled by a ground signal supplied by the PCM on the brown wire (CKT 658).

Low Washer Fluid Light

The washer fluid light is an amber LED. It is controlled by a ground signal supplied by the low washer fluid level switch on the yellow wire (CKT 793). This light has been dampened with a 1.5 second delay. The purpose of this delay is to prevent the washer fluid light from flashing when the fluid is sloshing around. When testing this circuit supply ground for a minimum of 3 seconds.

TC Lock Light

The TC lock indicator is a green LED. It is controlled by a ground signal supplied by the transfer case lock switch on the dark green wire (CKT 210).

Check Throttle Light

The check throttle light is an amber LED. It is controlled by a ground signal supplied by the PCM on the dark blue wire (714).

Drain Filter Light

The drain filter light is an amber LED. It is controlled by a ground signal supplied by the water in filter sensor on the yellow wire (CKT 327).

Low Oil Pressure Light

The low oil pressure light is a red LED. It is controlled by a ground signal supplied by an internal driver. This internal driver watches the oil pressure signal on the tan wire (CKT 31). If the signal drops below 20 Ω then the driver sends a ground signal to illuminate the LED. The light will reset if the signal on the wire rises above 22 Ω.

COOLANT/FUEL MODULE

The coolant/fuel module is located on the right side of the instrument panel. In contains two gauges (coolant temperature and fuel level), seven warning lights (high coolant temp., low coolant, brake, ABS, low fuel and ELocker) and two indictor lights (TT4) and front ELocker (Figure 12-51).

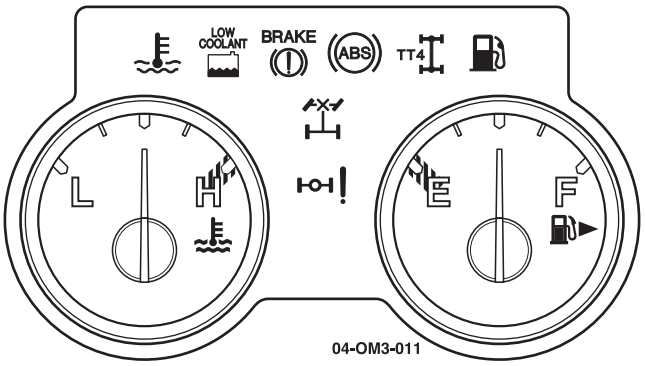


Figure 12-51: Coolant/Fuel Module

Like the speedo/tach module the only serviceable items on this module are the gauge illumination bulbs. These bulbs are removed by turning a quarter turn counterclockwise out of the back of the module.

Coolant/Fuel Module Replacement

Removal

1. Remove the eight allen screws, and the bezel around the gauge modules.
2. Remove the four retaining screws from the coolant/fuel module (Figure 12-52).
3. Pull the coolant/fuel module out of the instrument panel far enough to expose the harness connector.
4. Disconnect the harness connector from the coolant/fuel module and remove the module.

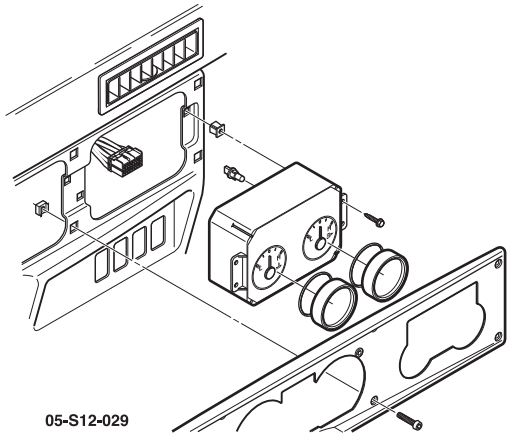


Figure 12-52: Coolant/Fuel Module Replacement

Installation

1. Connect the harness connector to the coolant/fuel module.
2. Slide the module into the instrument panel and install the four retaining screws.
3. Install the bezel, and eight allen screws.

Coolant Temperature Gauge and Warning Light Calibration Check

To check accuracy of the coolant temp gauge or light use the calibration chart. The gauge panel must be connected to the harness to verify coolant temperature. Back probe the signal wire with a DVOM, and check the resistance verses the gauge readings. The

readings should approximate the specifications. The coolant temperature warning light and gauge reference the same dark green wire (CKT 39). If the light is activating at a questionable point, reference the chart to verify accuracy (Figure 12-110).

Coolant Temperature Gauge Calibration Check

Approximate Reading	Input	Input Tol.	Ascending	Descending
Cold	1500 Ω	± 5 Ω		X
Mid. Point	260 Ω	± 5 Ω	X	
Hot	56 Ω	± 3 Ω	X	

Coolant Temperature Light Calibration Check

Approximate Reading	Inputs	Input Tol.	Ascending	Descending	Status
Red Band	75 Ω	±5	X		On
Gray Band	>80 Ω	±5		X	Off

Fuel Gauge and Warning Light Calibration.

To check accuracy of the fuel gauge or warning light use the calibration chart. The gauge panel must be connected to the harness to verify the fuel level. Back probe the signal wire with a DVOM, and check the resistance verses the gauge readings. The readings should approximate the specifications. The fuel level warning light and gauge reference the same pink wire (CKT 29). If the light is activating at a questionable point, reference the chart to verify accuracy.

Fuel Gauge Calibration Checks

Approximate Readings	Inputs	Input Tol	Ascending	Descending
Empty	272 Ω	±5 Ω		X
1/2	113 Ω	±5 Ω		X
Full	20 Ω	±3 Ω	X	

Low Fuel Warning Light

Approximate Readings	Inputs	Input Tol	Ascending	Descending	Status
1/8	210 Ω	±10 Ω		X	ON
1/4	145 Ω	±10 Ω	X		OFF

Warning Lights for the Coolant/Fuel Module

All the LEDs on the coolant/fuel module receive voltage from a control circuit that is built in to the module. This controller is powered up with system voltage on the tan wire (CKT 916) (Figure 12-112).

The warning and indicator lights are also connected to a 4.1 second timed bulb check circuit. This is activated by a voltage signal being supplied to the module through the grey wire with a black tracer (CKT 911). When the module receives the voltage signal it activates an internal timer which supplies a ground to all the LEDs on the board.

ABS Warning Light

The ABS warning Light is an amber LED. It is controlled by a ground signal supplied by the ABS ECU on the red wire (CKT 603).

Brake Warning Light

The brake warning light is a red LED. It is controlled by a ground signal supplied by either the parking brake switch or the low brake fluid switch. The signal is supplied on the brown wire (CKT 42).

Low Coolant Warning Light.

The low coolant warning light is an amber LED. It is controlled by a ground signal supplied by the low coolant switch on the red wire (CKT 794).

TT4 Indicator Light

The TT4 indicator light is an amber LED. It is controlled by a ground signal supplied by the ABS ECU on the purple wire (CKT 961).

Coolant Temperature Warning Light

The coolant temperature warning light is a red LED. It is controlled by an internal driver in the gauge module circuit board. This driver watches the coolant temperature signal that is supplied on the dark green wire (CKT 39). When the driver sees resistance on the dark green wire (CKT 39) fall to < 75 Ω it activates the LED. It will not turn the LED off until it sees resistance > 80 Ω.

Low Fuel Warning Light

The low fuel warning light is an amber LED. It is controlled by an internal driver in the gauge module. This driver watches the signal on the pink wire (CKT 29). When resistance on the pink wire (CKT 29) increases to 210 Ω the driver will activate the LED. The LED will remain on until the driver sees that the resistance on the signal has fallen below 145 Ω.

NOTE: The fuel gauge is heavily dampened to prevent erratic readings. As a result fuel light activation may occur before the gauge reads low.

ELocker Warning Light

The Elector warning light is an amber LED. It is controlled by a ground signal supplied by the ELocker control module on the white wire with a black tracer (CKT 879).

Warning/Indicator "Bulb Check"

When the ignition is turned to the "Run" position the "Bulb Check" should operate. The "Bulb Check" is a 4.1 second (± 1.0) test to see that all indicator and warning lights are functioning. If the "Bulb Check" fails to operate correctly, refer to the diagnostic chart.

AUXILLARY COOLANT PUMP

The auxiliary coolant pump is located at the right front of the engine compartment. One hose attaches to the EGR cooler and the other to the transfer case by-pass valve. It has two purposes:

- To give a little extra boost to the flow of coolant through the EGR cooler at low water pump speeds.
- To provide protection against heat soaking of the engine.

The auxiliary coolant pump will stay on after engine shut down to circulate coolant and reduce hot spots. A temperature switch located on the top of the radiator will close and then open when the coolant temperatures is back to acceptable level.

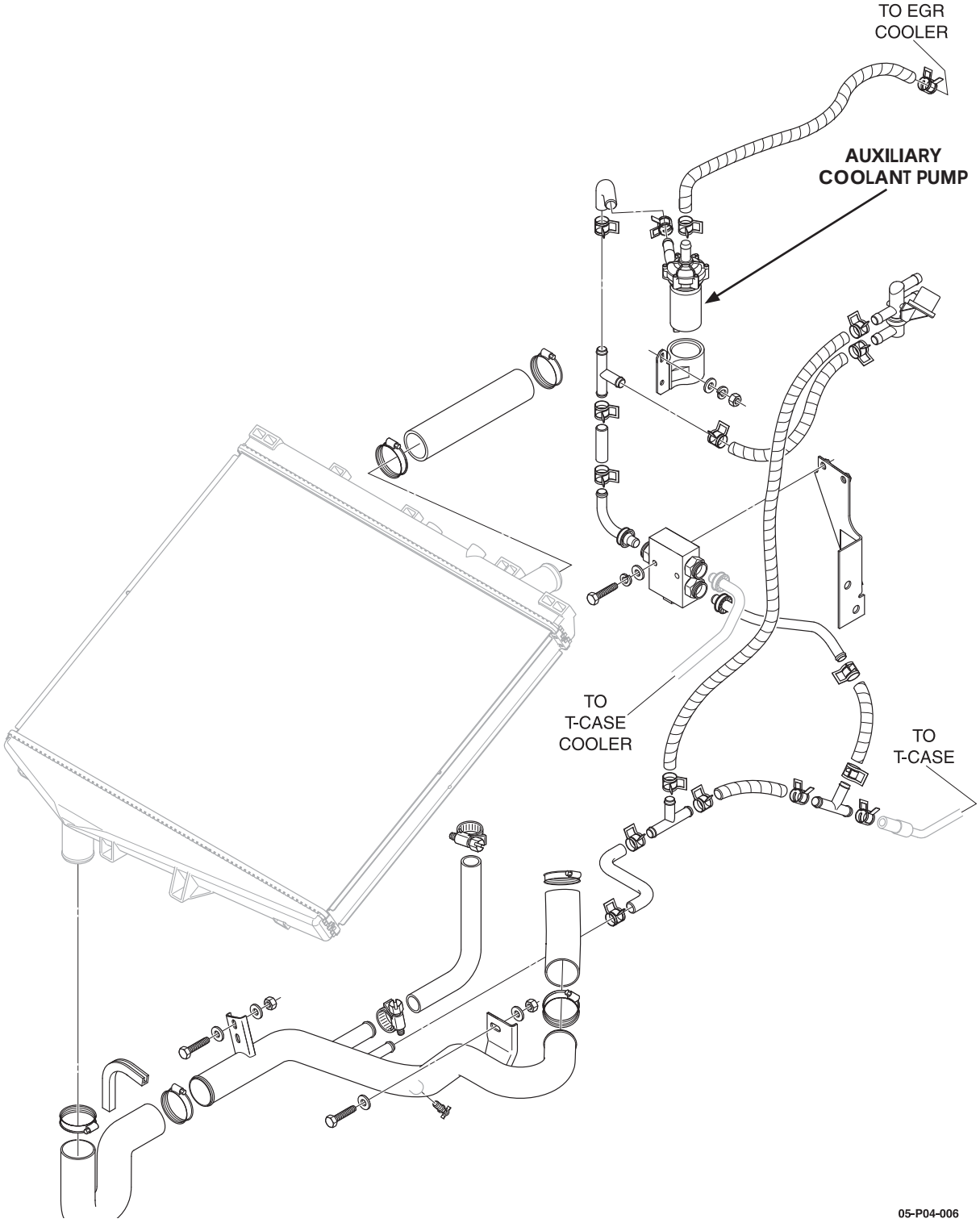


Figure 12-53: Cooling Plumbing W/ T-case Valve and Auxiliary Coolant Pump

AUXILIARY COOLANT PUMP SWITCH

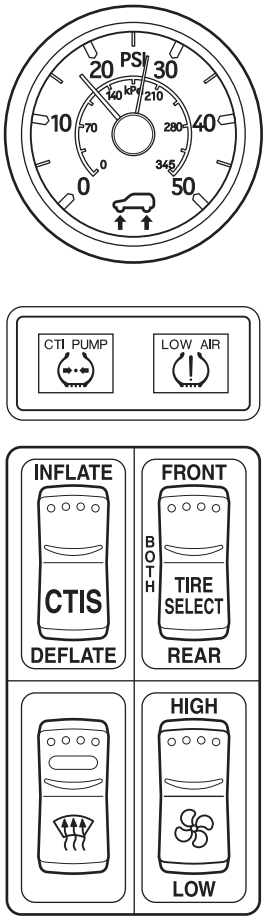
The operation of the pump once the key is off is via the temperature switch in the top of the radiator. The switch circuit closes when the coolant temperature exceeds 215°F (+/-5°F) and turns on the pump. There is a little hysteresis designed in so the pump switches off at a slightly lower temperature as the coolant temperature decreases.

CTIS GAUGE AND CONTROL MODULE

The CTIS module is located on the right side of the coolant/fuel module. It contains a tire pressure gauge, a low air pressure warning light, a CTIS air compressor indicator, a tire selector switch and an inflate/deflate switch (Figure 12-54).

The air pressure gauge has a domed lens to reduce glare. The low air pressure warning light and the CTIS air compressor indicator light are LEDs to improve visibility.

Serviceable items on the CTIS module include the air pressure gauge, the selector switch, the inflate/deflate switch and all the back lighting bulbs. The LED warning and indicator lights are *not* serviceable.



05-OM3-007

Figure 12-54: CTIS Module

CTIS Module Replacement

WARNING: The CTIS system components are subject to high air pressure. Always relieve the air pressure prior to servicing the CTIS system. Failure to follow this warning may result in serious injury.

Removal

1. Relieve the CTIS system air pressure (Refer to section 6).
2. Remove the four allen screws from the bezel around the CTIS/RADIO/.

3. Pull the CTIS module out enough to gain access to the wiring harness and air lines that attach to the back of the module.
4. Note the position of the two air lines on the back of the air pressure gauge and disconnect them. Tagging the lines prior to removal to assure proper installation is recommended.
5. Disconnect connector C12 from the instrument panel harness and remove the CTIS module.

Installation

1. Connect connector C12 to the instrument panel harness.
2. Install the air pressure lines to the back of the air pressure gauge. Make sure to install lines in the same position as they were removed.
3. Install the CTIS module in the instrument panel and secure with four allen screws.

CTIS Air Pressure Gauge Replacement

WARNING: The CTIS system components are subject to high air pressure. Always relieve the air pressure prior to servicing the CTIS system. Failure to follow this warning may result in serious injury.

Removal

1. Remove the center dash assembly bezel.
2. Remove the two air lines at the quick disconnects.
3. Remove the air pressure gauge back lighting bulb.
4. Remove the two retainer nuts that secure the air pressure gauge retainer bracket (Figure 12-55).
5. Remove the air pressure gauge retainer bracket and the air pressure gauge from the bezel.

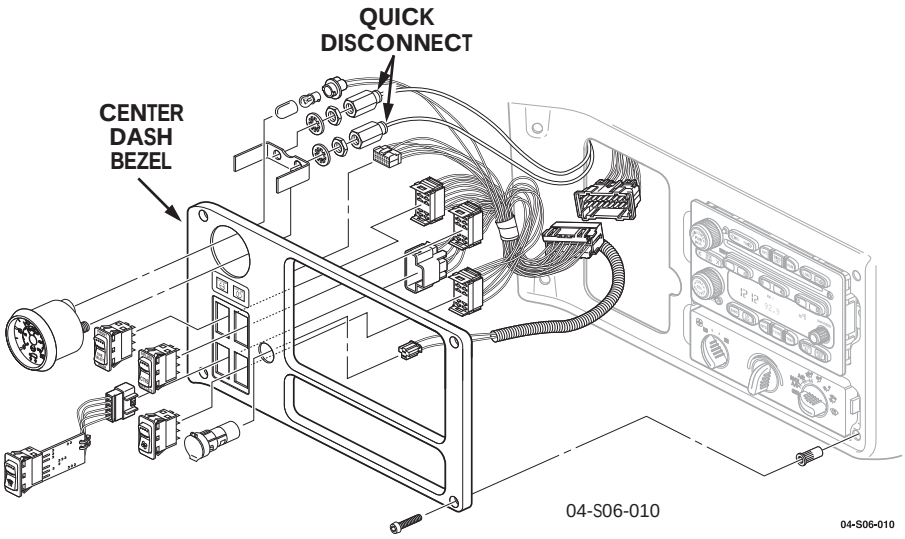


Figure 12-55: CTIS Module Break Down

Installation

1. Install the air pressure gauge, retainer bracket and the nuts.
2. Install the air pressure gauge back lighting bulb.
3. Install the air lines and the bezel.

Inflate/Deflate and Tire Selector Switch Replacement.

WARNING: The CTIS system components are subject to high air pressure. Always relieve the air pressure prior to servicing to the CTIS system. Failure to follow this warning may result in serious injury.

Removal

1. Remove the CTIS module.
2. Disconnect the harness from the back of the inflate/deflate switch and the tire selector switches.
3. Remove the inflate/deflate and tire selector switches from the CTIS module.

Installation

1. Install the inflate/deflate and tire selector switches from the CTIS module.
2. Install the harness connector to the back of the inflate/deflate switch and the tire selector switches.
3. Install the CTIS module.

Air Pressure Gauge Back Lighting

The air pressure gauge back lighting is the only lighting component that is serviceable on the CTIS control unit. To service the bulb in the air pressure gauge, pull the harness and bulb socket out of the back of the air pressure gauge. With the harness and bulb socket removed from the air pressure gauge, twist the bulb a quarter of a turn from the harness receiver and remove the bulb.

Warning/Indicator "Bulb Check"

When the ignition is turned to the "Run" position the "Bulb Check" should operate. The "Bulb Check" is a 4.1 second test to see that all indicator and warning lights are functioning. The test signal is a battery voltage signal supplied on circuit 915 (LB). If the "Bulb Check" fails to operate refer to the diagnostic chart.

Warning/Indicator Lights for the CTIS module.

The LEDs on the CTIS module receive a ground on circuit 59 (BK). The control side of these LEDs is a voltage signal.

The warning/indicator lights are also connected to a 4.1 second "Bulb Check". This is achieved by a voltage signal being supplied to the module through circuit 912 (DB). When the module receives the voltage signal it activates an internal timer which activates the LEDs (Figure 12-99).

CTIS Air Compressor Indicator Light

The CTIS air compressor indicator light is a green LED. It is controlled by a voltage signal supplied on circuit 46 (WH). When the signal is present on this circuit the CTIS module makes the LED blink.

Low Air Warning Light

The low air warning light is a red LED. It is controlled by a voltage signal supplied by either the front pressure switch or the rear pressure switch on circuit 46 (WH).

HVAC ELECTRICAL SYSTEM

HVAC Main Blower Inoperative ALL Except High (Figure 12-90)

Step	Action	Value(s)	Yes	No
1	Ignition on, blower switch set to Med 2, mode dial set to face. Measure voltage on the yellow wire (CKT 754) at the blower relay. Is voltage present?	8 -10v	Replace the blower relay.	Go to step 2.
2	Ignition on, blower switch set to Med 2, mode dial set to face. Measure voltage on the grey wire (CKT 752) at the blower resistor. Is voltage present?	+12v	Replace the blower resistor.	Go to step 3.

HVAC Main Blower Inoperative ALL Except High (Figure 12-90)

Step	Action	Value(s)	Yes	No
3	Ignition on, blower switch set to Med2, mode dial set to face. Measure voltage on the grey wire (CKT 752) at the back of the HVAC control head. Is voltage present?	+12v	Repair open, bad connection or short to ground in CKTs 751, 752, and 755 between HVAC control head and resistor block.	Replace control head.

HVAC Compressor Inoperative (Figure 12-123)

Step	Action	Value(s)	Yes	No
1	Perform On-board diagnostic system check. Is system functioning properly?		Go to step 2.	Diagnose problem in on-board diagnostic system first.
2	Does A/C system have an adequate charge?		Go to step 3.	Diagnose leak and recharge.
3	Is engine in an overheated condition?		Cool down and recheck.	Go to step 4.
4	Connect scan tool to vehicle. Ignition on, find misc. tests and command compressor clutch on. Does clutch come on?		Go to step 10.	Go to step 5.
5	Disconnect the compressor clutch. Connect a test lamp to ground, and probe the brown wire at the clutch connector. Using the scan tool, command the clutch on. Does the test light come on?		Replace the compressor clutch.	Go to step 6.
6	Remove A/C relay from the exterior fuse box. Using a DVOM, set to measure voltage, ignition on, check for voltage on the green wire (CKT 400) at the relay in the exterior fuse box. Is voltage present?	+12v	Go to step 7.	Repair open, bad connection or short in CKT400 between exterior fuse box and ignition switch.
7	Using a DVOM, set to measure voltage, place the positive lead on a battery power source. Place the ground lead on the dark green wire (CKT 440) at the relay. Using the scan tool, command the compressor clutch on. Does meter display battery voltage?	+12v	Go to step 8.	Go to step 9.
8	Using a DVOM, set to measure resistance. Check resistance on the brown wire (CKT 348) at the relay, and the brown wire (CKT 348) at the compressor clutch connector. Is resistance below specification?	<.2Ω	Replace compressor relay.	Repair open or bad connection in CKT 348 between clutch relay and compressor clutch.
9	Ignition on, using a DVOM, set to measure voltage, backprobe the dark green wire in C27 at the ECM (CKT 440) with the negative lead. Place the positive lead on a battery voltage source. Using the scan tool, command the compressor clutch on. Does the meter display battery voltage?	+12v	Repair open, or bad connection in CKT 440 between ECM and A/C clutch relay.	Replace the ECM.

HVAC Compressor Inoperative (Cont'd) (Figure 12-123)

Step	Action	Value(s)	Yes	No
10	Ignition on, locate engine data list, and "A/C Request". Turn mode dial on HVAC control head to MAX A/C. Does scan tool display indicate A/C request?		Replace ECM.	Go to step 11.
11	Ignition on, mode dial set to MAX A/C. Using a DVOM, set to measure voltage, backprobe the tan wire (CKT 198) at the temperature cutout switch on the HVAC unit with the positive probe. Place the negative lead on a known good ground. Is voltage present?	+12v	Go to step 14.	Go to step 1.
12	Ignition on, mode dial set to MAX A/C. Using a DVOM, set to measure voltage, backprobe the yellow wire (CKT 347) at the temperature cutout switch on the HVAC unit with the positive probe. Place the negative lead on a known good ground. Is voltage present?	+12v	Replace the temperature cutout switch.	Go to step 13.
13	Using a DVOM, set to measure voltage, ignition on, mode dial set to MAX A/C, backprobe for voltage on the yellow wire (CKT 347) in the 8 wire connector at the rear of the HVAC control head. Is voltage present?	+12v	Repair open, bad connection or short in CKT 347 between HVAC control head and temperature cutout switch.	Replace control head.
14	Ignition on, mode dial set to MAX A/C. Disconnect the high pressure cutout switch on the compressor. Using a DVOM, set to measure voltage, check for voltage on the tan wire (CKT 198). Is voltage present?	+12v	Go to step 15.	Repair open, bad connection, or short in CKT 198 between temperature cutout switch and high pressure cutout switch.
15	Using a DVOM, set to measure resistance, check continuity across the two pins on the high pressure cutout switch. Is resistance below specification?	<.2Ω	Go to step 16.	Replace the high pressure cutout switch.
16	Ambient temperature above 45°. Disconnect the ambient temperature switch. Using a DVOM, set to measure resistance, measure continuity across the ambient temperature switch terminals. Is resistance below specification?	<.2Ω	Go to step 17.	Replace ambient temperature switch.
17	Disconnect low pressure cutout switch. Using a DVOM, set to measure resistance, measure continuity across the low pressure cutout switch. Is resistance below specification?	<.2Ω	Repair open, bad connection or short in CKT 439 between high pressure cutoff switch and ECM.	Replace the low pressure cutout switch.

HVAC Temperature Door Inoperative (Figure 12-121)

Step	Action	Value(s)	Yes	No
1	With the ignition switch in the run position, operate temperature control dial and observe the motor. Does door move?		Condition is intermittent.	Go to step 2.
2	Remove the temperature blend door motor from the side of the HVAC case. With the ignition switch in the run position, operate the temperature control dial and observe the motor. Is the motor turning?		Mechanical problem in the HVAC case.	Go to step 4.
3	Disconnect electrical connector from the temperature blend door motor. Using a DVOM, set to measure voltage, and using J–35616-92 test adapters, probe the dark green wire (CKT 399) with the positive lead and the black wire (CKT 58) with the negative lead. Turn the ignition switch to the run position. Is voltage present?	+12v	Go to step 6.	Go to step 4.
4	With ignition on, using a DVOM, set to measure voltage and using J–35616-92 test adapters probe the dark green wire (CKT 399) with the positive lead. Place the negative lead on a known good ground. Is voltage present?	+12v	Go to step 5.	Repair open or short to ground between temperature blend door motor and fuse 7C.
5	With the ignition off, and using a DVOM, set to measure ohms, check for resistance between the black wire (CKT 58) of the temperature blend door, and a good ground. Does resistance exceed specifications?	<.2Ω	Locate open or bad connection between temperature blend door motor and G4.	Go to step 6.
6	Using a DVOM, set to read volts, the ignition switch on the run position, and using J–35616-92 test adapters, probe the light blue wire (CKT 402) with the positive lead, and the black wire (CKT 58) with the negative lead. Rotate temperature control dial on the HVAC control head from cold to hot and back. Is voltage present at the cold setting and 0v on the hot setting?	Cold = +12v Hot = 0v Cold = +12v	Replace the temperature blend door motor.	Go to step 7.
7	Disconnect the 8 wire connector at the HVAC control head. Using a DVOM, set to measure ohms, check resistance between the light blue (CKT 402) of the 8 wire connector, and the light-blue wire (CKT 402) of the temperature blend door connector. Does resistance exceed specifications?	62KΩ	Go to step 9.	Go to step 8.
8	Check for open or bad connection between the HVAC control head 8 wire connection and the temperature blend door motor connection. Check for loose terminals at the control head. Was a bad connection found?		Repair or replace harness as necessary.	Go to step 9.

HVAC Temperature Door Inoperative (Cont'd) (Figure 12-121)

Step	Action	Value(s)	Yes	No
9	Using a DVOM, set to measure voltage, probe the dark green wire (CKT 399) of the 8 wire connector on the HVAC control head with the positive lead, and the black wire (CKT 58) of the three wire HVAC control head connector with the negative lead. With ignition on, is voltage present?	+12v	Replace faulty HVAC control head.	Go to step 10.
10	Using a DVOM, set to measure voltage, probe the dark green wire (CKT 399) of the HVAC control head eight wire connector with the positive lead. Attach the negative lead to a known good ground. With the ignition switch in the run position, is voltage present?	+12v	Go to step 11.	Locate short or open between the HVAC control head and fuse 7C.
11	Using a DVOM, set to measure ohms, check resistance between the black wire (CKT 58) of the HVAC control head connector and a good ground. Does resistance exceed specifications?	<.2Ω	Replace faulty HVAC control head.	Locate and repair open or poor connection in the ground circuit between CKT 58 and G4.

WINDSHIELD WIPER SYSTEM AND COMPONENTS

Windshield Wiper Motor Assembly Replacement

Removal

1. Remove the headliner.
2. Remove the center trim from the windshield assembly.
3. Disconnect the windshield wiper motor assembly harness from the crossbody harness (Figure 12-56).
4. Remove the three bolts, washers, and lock washers securing the windshield wiper motor assembly to the windshield assembly.
5. Remove the retainer securing the windshield wiper linkage to the windshield wiper motor cranking pin and remove the windshield wiper motor assembly.

Installation

1. Lubricate the windshield wiper motor cranking pin and secure the windshield wiper linkage to the windshield wiper motor cranking pin using the retainer (Figure 12-56).
2. Secure the windshield wiper motor assembly to the windshield assembly with the three lock washers and bolts. Tighten the bolts to 12 lb-ft (16 N•m).
3. Connect the windshield wiper motor assembly harness to the crossbody harness.
4. Secure the windshield center trim to windshield.
5. Install the headliner.

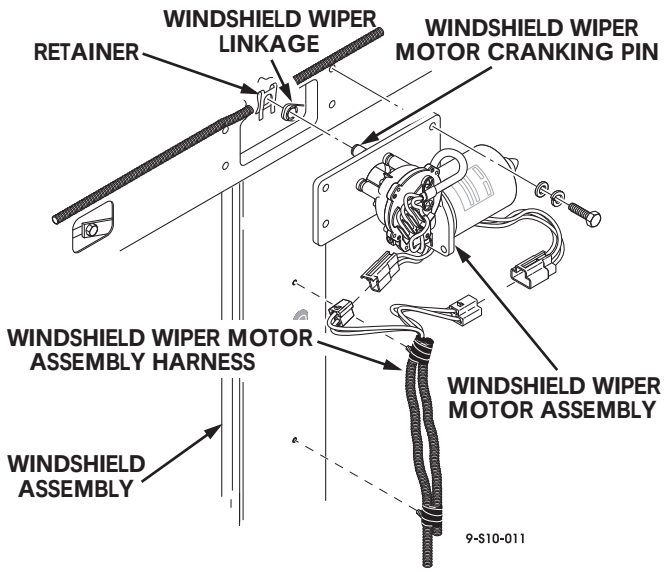


Figure 12-56: Windshield Wiper Motor Assembly Replacement

Windshield Wiper Motor Inoperative All Speeds (Figure 12-158)

Step	Action	Value(s)	Yes	No
1	Gain access to the wiper motor connector under the windshield trim. Using a DVOM, set to measure resistance, check resistance to ground on the brown wire (CKT 59). Is the resistance below the specified value?	<.2 Ω	Go to step 2.	Repair open or bad connection in CKT 59 between the wiper motor and G4.
2	Turn the ignition switch to the “RUN” position and the wiper switch to “LOW”. Using a DVOM, set to measure voltage, check for voltage at the dark green wire (CKT 63). Is the specified voltage present?	+12v	Replace the wiper motor.	Go to step 3.
3	Remove the wiper switch from the instrument panel and turn the ignition to the “RUN” position. Using a DVOM, set to measure voltage, back probe the yellow wire (CKT 65) at the wiper switch. Is the specified voltage present?	+12v	Replace the wiper switch.	Repair the open or bad connection in CKT 65 between the wiper switch and fuse 13G.

Windshield Wiper Motor Inoperative on LOW (Figure 12-158)

Step	Action	Value(s)	Yes	No
1	Remove the wiper switch from the instrument panel. Turn the ignition to the “RUN” position and the wiper switch to “LOW”. Using a DVOM, back probe the dark green wire (CKT 63) at the switch. Is the specified voltage present?	+12v	Go to step 3.	Go to step 2.

Windshield Wiper Motor Inoperative on LOW (Figure 12-158)

Step	Action	Value(s)	Yes	No
2	Using a DVOM, set to measure voltage, back probe the yellow wire (CKT 65) at the wiper switch. Place the ground lead on a known good ground. With the ignition on, is the specified voltage present?	+12v	Replace the wiper switch.	Repair open or bad connection in CKT 65 between the wiper switch and fuse 13G.
3	Gain access to the wiper motor connector behind the windshield trim. Using a DVOM, back probe the dark green wire (CKT 63) at the wiper motor. Turn the ignition switch to the “RUN” position, and set the wiper switch to “LOW”. Is the specified voltage present?	+12v	Replace the wiper motor.	Repair the open or bad connection in CKT 63 between the wiper motor and the wiper switch.

Windshield Wiper Motor Inoperative on High (Figure 12-158)

Step	Action	Value(s)	Yes	No
1	Remove the wiper switch from the instrument panel. Turn the ignition to the “RUN” position and the wiper switch to “HIGH”. Using a DVOM, set to measure voltage, back probe the red wire (CKT 61). Is the specified voltage present?	+12v	Go to step 3.	Go to step 2.
2	With the ignition switch in the RUN” position, check the voltage at the yellow wire (CKT 65). Is the specified voltage present?	+12v	Replace the wiper switch.	Repair the open or bad connection on CKT 65 between the wiper switch and fuse 13G.
3	Gain access to the wiper motor connector under the windshield trim. Turn the ignition switch to the “RUN” position and the wiper switch to the “HIGH” position. Using a DVOM, check the voltage at the red wire (CKT 61). Is the specified voltage present?	+12v	Replace the wiper motor.	Repair the open or bad connection on CKT 61 Between the wiper motor and the wiper switch.

Windshield Wipers Intermittent Speeds Inoperative (Figure 12-158)

Step	Action	Value(s)	Yes	No
1	Do the windshield wipers work normally on the low and high speeds?		Go to step 2.	Refer to the diagnostic chart for the specific problem on the standard wiper diagnosis.

Windshield Wipers Intermittent Speeds Inoperative (Cont'd) (Figure 12-158)

Step	Action	Value(s)	Yes	No
2	Remove the wiper switch from the instrument panel. Disconnect the wiper switch from the harness.Using a DVOM, measure resistance between terminals 2 and 3 of the switch. Is the resistance below the specified value?	<.2 Ω	Connect the intermittent wiper switch to the harness. Go to step 3.	Replace the wiper switch.
3	Turn the ignition switch to the "RUN" position and the intermittent wiper switch to "MEDIUM DELAY". Using a DVOM, set to measure voltage, back probe the brown wire (CKT 945) at the intermittent switch. Voltage should pulse from 12 volts to 0 volts every 2-7 seconds depending on the switch position. Is the voltage in the specified range.	+12v pulse 2-7 seconds	Go to step 5.	Go to step 4.
4	Ignition should be in the "RUN" position. Using a DVOM, set to measure the voltage, back probe the yellow wire (CKT 65) at the intermittent wiper switch. Is the specified voltage present?	+12v	Replace the intermittent wiper switch.	Repair the open or bad connection in CKT 65 between the intermittent wiper switch and fuse 13G.
5	Remove the intermittent wiper relay from the fuse box. Turn the ignition switch to the "RUN" position. Using a DVOM, measure voltage drop between the brown wire (CKT 945) and the black wire (CKT 59). The voltage should pulse from 12 volts to 0 volts every 2 to 7 seconds. Is the voltage in the specified ranges?	+12v pulse 2-7 seconds	Go to step 7.	Go to step 6.
6	Using a DVOM, set to measure resistance, measure resistance to ground at the black wire (CKT 59) of the fuse box. Is resistance below specification?	<.2 Ω	Repair the open or bad connection, in CKT 945 between the intermittent wiper switch and the intermittent wiper relay.	Repair open or bad connection in CKT 59 between the intermittent wiper relay and G4.
7	Turn the ignition to the "RUN" position. Use a DVOM, to measure voltage drop between the yellow wire (CKT 65) and the black wire (CKT 59). Is the specified voltage present?	+12v	Go to step 8.	Repair the open or bad connection in CKT 65 between fuse 13G and the intermittent wiper relay.
8	With the ignition switch in the "RUN" position and the wipers on "LOW", check the voltage drop between the dark blue wire (CKT 28) at the motor and the black wire (CKT 59) at the relay. Does the voltage switch from 12 volts to 0 volts as the wiper completes its cycle?	0v – +12v – 0v	Replace the intermittent wiper relay.	Go to step 9.

Windshield Wipers Intermittent Speeds Inoperative (Cont'd) (Figure 12-158)

Step	Action	Value(s)	Yes	No
9	Gain access to the wiper motor connection. Back probe the black wire (CKT 65) with the positive lead, and the brown wire (CKT 59) with the negative lead. With the ignition on is the voltage drop in the specified range?	+12v	Replace the wiper motor.	Repair the open or bad connection in CKT 65 between the wiper motor and fuse 13G

HEATED WINDSHIELD

The optional heated windshield is capable of defrosting the windshield glass in less than 10 minutes at 0° F. The system is comprised of a rocker switch with an integrated time delay module (Figure 12-57), two relays, and two fuses, and two in-glass heating elements.

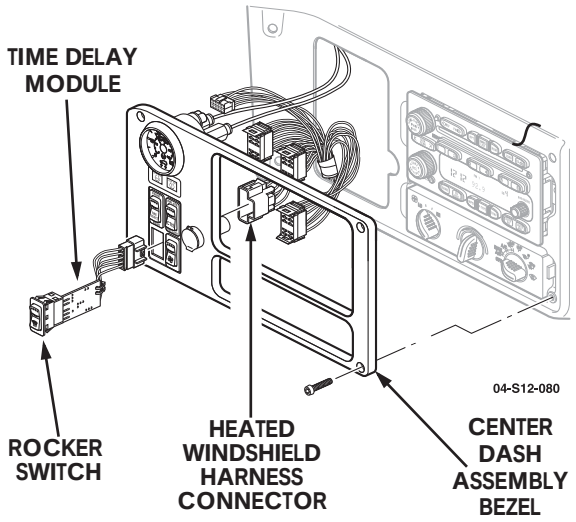


Figure 12-57: Rocker Switch/Time Delay Module Location

The rocker switch/time delay module is mounted in the center dash assembly bezel (Figure 12-57).

Removal

1. Remove the screws and the center dash assembly bezel (Figure 12-57).
2. Lift the connector clip and pull the connector from the rocker switch/time delay module.
3. Squeeze the clips on the rocker switch/time delay module and remove the switch/module from the bezel.

Installation

1. Push the rocker switch/time delay module into the bezel opening and snap into the bezel.
2. Attach the electrical connector to the rocker switch/time delay module.
3. Install the center dash assembly bezel.

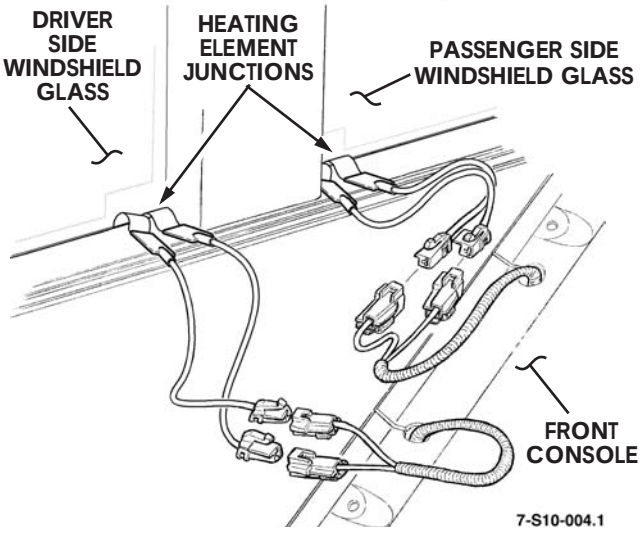


Figure 12-58: Heating Element Connection Location

Heated Windshield Element Connection

The heated windshield element connection is located under the windshield center trim at the bottom of the windshield (Figure 12-58).

Left Heated Windshield Inoperative (Figure 12-157)

Step	Action	Value(s)	Yes	No
1	Gain access to the heated windshield connections. With the ignition in the "RUN" position, preform a voltage drop test between the yellow wire (CKT 740) and the black wire (CKT 59) going to the left hand windshield. Turn the heated windshield "ON". Is the specified voltage present?	+12v	Replace the heated windshield.	Go to step 2.
2	Using a DVOM,, check the resistance to ground at the black wire (CKT 59) going to the left side windshield. Does the resistance to ground meet the specified range?	<.2 Ω	Go to step 3.	Repair the open or bad connection in CKT 59 between the windshield and G4.
3	Remove the left hand heated windshield relay from the exterior fuse box. Check the voltage drop between the brown (CKT 580) and the black wire (CKT 59). With the ignition in the run position, turn the heated windshield switch to "ON". Is the specified voltage present?	+12v	Go to step 4.	Repair the open or bad connection in CKT 580 between the heated windshield switch and Heated windshield relay (R-4).
4	With the ignition still in the run position and the relay still removed. Preform a voltage drop test between the black wire (CKT 59) and the red wire (CKT 738). Is the specified voltage present?	+12v	Go to step 5.	Repair the open or bad connection in CKT 738 between fuse 2C and R-4.
5	With a DVOM,, check the resistance between the yellow wire (CKT 740) at the relay and the yellow wire (CKT 740) at the windshield. Does the resistance meet the specified value?	<.2 Ω	Replace relay R-4.	Repair the open or bad connection in CKT 740 between the left side heated windshield and R-4.

Right Heated Windshield Inoperative (Figure 12-157)

Step	Action	Value(s)	Yes	No
1	Gain access to the heated windshield connections. With the ignition in the "RUN" position and the heated windshield switch on, preform a voltage drop test between the purple wire (CKT 739) and the black wire (CKT 59) going to the right hand windshield. Turn the heated windshield "ON". Is the specified voltage present?	+12v	Replace the heated windshield.	Go to step 2.

Right Heated Windshield Inoperative (Figure 12-157)

Step	Action	Value(s)	Yes	No
2	Using a DVOM,, check the resistance to ground at the black wire (CKT 59) going to the right side windshield. Does the resistance to ground meet the specified range?	<.2 Ω	Go to step 3.	Repair the open or bad connection in CKT 59 between the windshield and G4.
3	Remove the right hand heated windshield relay from the exterior fuse box. Check the voltage drop between the brown wire (CKT 580) and the black wire (CKT 59). With the ignition in the "RUN" position, turn the heated windshield switch to "ON". Is the specified voltage present?	+12v	Go to step 4.	Repair the open or bad connection in CKT 580 between the heated windshield switch and the heated windshield relay (R-2).
4	With the ignition still in the "RUN" position. Preform a voltage drop test between the black wire (CKT 59) and the purple wire (CKT 739). Is the specified voltage present?	+12v	Go to step 5.	Repair the open or bad connection in CKT 739 between fuse 2C and R-2.
5	With a DVOM,, check the resistance between the purple wire (CKT 739) at the relay and the purple wire (CKT 739) at the windshield. Does the resistance meet the specified value?	<.2 Ω	Replace relay R-2.	Repair the open or bad connection in CKT 739 between the left side heated windshield and R-2.

Both Heated Windshields Inoperative (Figure 12-157)

Step	Action	Value(s)	Yes	No
1	Gain access to the heated windshield connections. Using a DVOM,, check the resistance to ground on the black wires at both windshields. Does the resistance meet the specified value?	<.2 Ω	Go to step 2.	Repair the open or bad connection in CKT 59 between the windshields and G4.
2	Remove the heated windshield switch from the bezel. Turn the ignition switch to the "RUN" position and turn the heated windshield switch to the "ON" position. Using a DVOM, check the voltage drop between the brown wire (CKT 580) and the black wire (CKT 58). Is the specified voltage present?	+12v	Repair the open or bad connection in CKT 580 between the heated windshield switch and the relays.	Go to step 3.

Both Heated Windshields Inoperative (Figure 12-157)

Step	Action	Value(s)	Yes	No
3	Using a DVOM,, measure the resistance to ground on the black wire (CKT 59) at the heated windshield switch. Does the resistance meet the specification?	<.2 Ω	Go to step 4.	Repair the open or bad connection in CKT 59 between the heated windshield switch and G4.
4	With the ignition in the “RUN” position and the heated windshield switch in the “ON” position. Use a DVOM, to check for voltage at both tan wires (CKT 83) at the heated windshield switch. Is the specified voltage present?	+12v	Replace the heated windshield switch.	Repair the open or bad connection in CKT 83 between the windshield switch and fuse 1C interior.

POWER WINDOW SYSTEM

System Description

The power window system is the same for all models except model 89 which does not have the rear windows. All models with power windows have the following components: a driver side window motor and switch, driver side controls for all windows including the window lock out switch (Figure 12-59), a front side window motor and switch, a circuit breaker, the power window relay and an express down window module. All models except the model 89 have a set of rear window motors and switches.

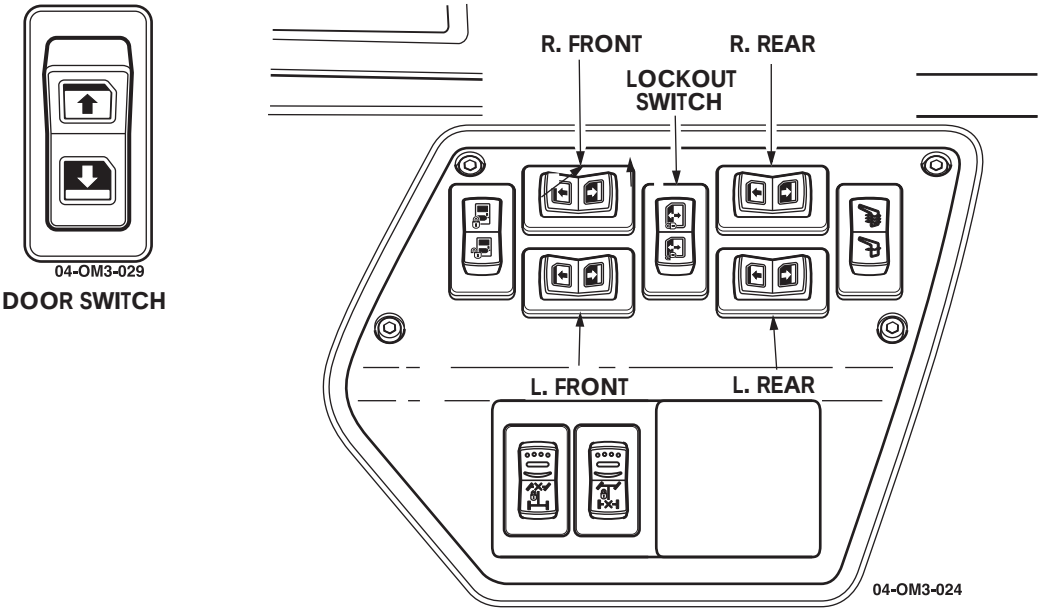


Figure 12-59: Power Window Switches

Window Lock Out Switch

The window lock out switch allows the driver to over ride the passengers window controls (Figure 12-60). When activated the window lock out switch will open the circuit for the passenger activated window controls, thereby giving the driver complete control of the window switches.

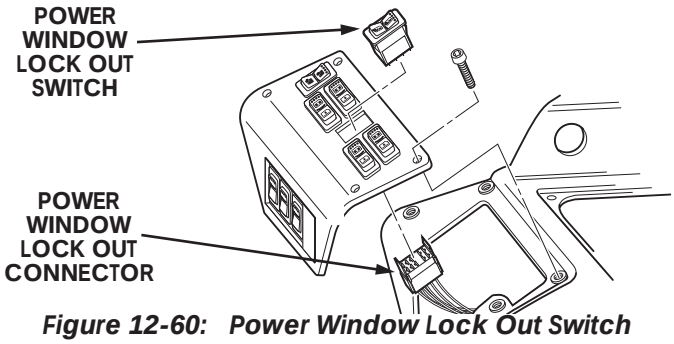


Figure 12-60: Power Window Lock Out Switch

Express Down Window Module

This module provides automatic full-open of a front power window from a single actuation of the window switch. Once the power window down switch has been activated for 300ms, the module enters auto mode and the switch can be released. The window will continue moving downward until one of the following conditions occurs:

1. The power window “DOWN” switch is activated.
2. The power window “UP” switch is activated.
3. The module senses that the power window motor is stalled.
4. The module has been in auto mode for 8 seconds.

Drivers Window Inoperative

Step	Action	Value(s)	Yes	No
1.	Do all the other windows operate as designed?	——	Go to step 2.	Refer to proper chart.
2.	Remove the drivers window switch and harness from the bezel. With a DVOM, check the resistance to ground on one black wire (CKT 56) and the other black wire (CKT 56) at the switch. Does the resistance on each wire meet the specifications?	<.2 Ω	Go to step 3.	Repair the open or bad connection in CKT 56 between the power window switch and G4.
3.	Turn the ignition switch to the"Run" position and check the voltage on the red wire (CKT 171). Is the specified voltage present?	+12v	Go to step 4.	Repair the open or bad connection on CKT 171 between the window switch and relay R4.
4.	Connect the window switch to the harness. With the ignition in the "Run" position, back probe the purple wire (CKT 222) and the yellow wire (CKT 226) with a DVOM, set to measure voltage. Operate the window switch and observe the voltage polarity. The voltage should switch from +12v to -12v with the operation of the switch. Does the polarity switch?	+12v to -12v	Go to step 5.	Replace the drivers door power window switch.
5.	Gain access to the express down window module. With the power window switch in the down position, check for voltage at the yellow wire (CKT 226). Is the specified voltage present?	+12v	Go to step 6.	Repair the open or bad connection on CKT 226 between the express down module and the window switch.
6.	With the power window switch in the down position, check for voltage at the white wire (CKT 228) of the express down module. Is the specified voltage present?	+12v	Go to step 7.	Replace the express down module.
7.	Gain access to the window motor. Disconnect the harness and with a DVOM, check the wires for polarity change when the power window switch is operated. Does the polarity change?	+12v to -12v	Replace the power window motor.	Repair the open or bad connection on CKTs 226 and 227 between the window switch and the window motor.

Express Down Feature Inoperative (Figure 12-109)

Step	Action	Value(s)	Yes	No
1	Does the drivers window function correctly other than the express down feature?	__	Go to step 2.	Refer to proper chart.
2	Gain access to the express down module. with the ignition in the "RUN" position, check the red wire (CKT 171) for voltage. Is the specified voltage present?	+12v	Replace the express down module.	Repair the open or bad connection on CKT 171 between the express down module and relay R4.

Power Windows Inoperative, All Windows (Figure 12-156)

Step	Action	Value(s)	Yes	No
1.	Remove relay R4 from the interior fuse box. With a DVOM, check the black wire (CKT 59) for resistance to ground. Does the resistance meet the specified value?	<.2 Ω	Go to step 2.	Repair the open or bad connection in CKT 59 between relay R4 and Ground G4.
2.	With a DVOM, check the voltage on the blue wire (CKT 175) at R4. Is the specified voltage present?	+12v	Go to step 3.	Repair the open or bad connection in CKT 175 between R4 and fuse 5M in the exterior fuse box.
3.	Turn the ignition switch to the "Run" position. With a DVOM, check the voltage on the dark green wire (CKT 296) at R4. Is the specified voltage present?	+12v	Go to step 4.	Repair the open or bad connection in CKT 296 between R4 and fuse 2G in the interior fuse box.
4.	Remove the drivers door window switch and harness from the bezel. Disconnect the power window switch from the harness. With a DVOM, check the resistance between the red wire (CKT 171) on the drivers power window switch harness and the red wire (CKT 171) at R4 of the interior fuse box. Does the resistance meet the specification?	<.2 Ω	Replace relay R4 in the interior fuse box.	Repair the open or bad connection in CKT 171 between the drivers window switch and R4.

Power Windows Only Operate Using The Console Switches

Step	Action	Value(s)	Yes	No
1.	Does the drivers door window operate as designed?	—	Go to step 2.	Refer to the proper chart.
2.	If the window lock out switch is in the "Lock" position move it to the "Unlock" position. Are the power windows operating as designed?	—	No further repair is needed at this time.	Go to step 3.
3.	Gain access to the power window switches on the console. With a DVOM, check for a ground at each of the black wires (CKT 56) on all three power window switches. Do all six wires meet with the specified value for resistance to ground?	<.2 Ω	Go to step 4.	Repair the open or bad connection between the power window switches and ground G4.
4.	Turn the ignition switch to the "Run" position. With a DVOM, back probe the purple wire (CKT 222) on the power window lock out switch. Make sure the switch is in the "Unlock" position. Is the specified voltage present?	+12v	Refer to the individual window charts.	Go to step 5.
5.	With the ignition still in the "Run" position check the voltage on the red wire (CKT 171) of the power window lockout switch harness. Is the specified voltage present?	+12v	Replace the power window lock out switch.	Repair the open or bad connection between the power lock out switch and relay R4.

Passenger Front Door Power Window Inoperative

Step	Action	Value(s)	Yes	No
1.	Do all the other windows operate as designed?	—-	Go to step 2.	Refer to the proper chart.
2.	Gain access to the passenger front power window switch harness. Turn the ignition switch to the run position. With a DVOM, check the voltage at the purple wire (CKT 170). Is the specified voltage present?	+12v	Go to step 3.	Repair the open or bad connection in CKT 170 between the power window switch and the power window lock out switch.
3.	Disconnect the power window switch from the harness. Using a DVOM, check for resistance to ground on the orange wire (CKT 314) and the dark blue wire (CKT 313). Does the resistance meet the specifications?	<.2 Ω	Go to step 4.	Repair the open or bad connection on CKT 313 or 314 between the passenger door window switch and the console window switch.
4.	Connect the power window switch to the harness and make sure that the ignition switch is in the run position. With a DVOM, back probe the red wire (CKT 227) and the yellow wire (CKT 226) at the same time. Check the voltage while operating the switch from “Up” to “Down”. Is the specified voltage present and does the polarity change from positive to negative with the action of the switch?	+12v to -12v	Go to step 5.	Replace the passenger front power window switch.
5.	Gain access to the power window motor and disconnect the harness. With a DVOM, back probe the red wire (CKT 227) and the yellow wire (CKT 226). Operate the power window switch and watch the voltage. Is the specified voltage present and does it change from positive to negative with the action of the switch.	+12v to -12v.	Replace the passenger front window motor.	Repair the open or bad connection on either CKTs 226 or 227 between the power window motor and switch.

(Passenger/Drivers) Rear Door Power Window Inoperative

NOTE: Refer to the wiring diagram for the circuit numbers.

Step	Action	Values	Yes	No
1.	Do all the other windows operate as designed?	—-	Go to step 2.	Refer to the proper chart.

(Passenger/Drivers) Rear Door Power Window Inoperative

NOTE: Refer to the wiring diagram for the circuit numbers.

Step	Action	Values	Yes	No
2.	Gain access to the right rear power window switch harness. Turn the ignition switch to the run position. With a DVOM, check the voltage at the purple wire (CKT 170). Is the specified voltage present?	+12v	Go to step 3.	Repair the open or bad connection in CKT 170 between the power window switch and the power window lock out switch.
3.	Disconnect the power window switch from the harness. Using a DVOM, check for resistance to ground on the brown (CKT 319) wire and the light green wire (CKT 320) Does the resistance meet the specifications?	<.2 Ω	Go to step 4.	Repair the open or bad connection on (CKT 319) or (CKT 320) between the door window switch and the console window switch.
4.	Connect the power window switch to the harness and make sure that the ignition switch is in the run position. With a DVOM, back probe terminals 1 and 5 at the same time. Check the voltage while operating the switch from “Up” to “Down”. Is the specified voltage present and does the polarity change from positive to negative with the action of the switch?	+12v to -12v	Go to step 5.	Replace the power window switch.
5.	Gain access to the power window motor and disconnect the harness. With a DVOM, back probe the red wire (CKT 227) and the yellow wire (CKT 226), Operate the power window switch and watch the voltage. Is the specified voltage present and does it change from positive to negative with the action of the switch.	+12v to -12v.	Replace the window motor.	Repair the open or bad connection on (CKT 227) or (CKT 226) between the power window motor and switch.

POWER DOOR LOCKING AND KEYLESS ENTRY SYSTEM

System Description

Operation of the power door locks starts with activation of the door lock switch or remote transmitter (Figure 12-61). A signal is received by the remote keyless entry module. The module will then activate the door locks.

The keyless entry system allows convenient operation of the vehicle door locks from a distance. Equipped vehicles are supplied with two, three button remote transmitters used to operate the system. Two additional remote transmitters can be added.

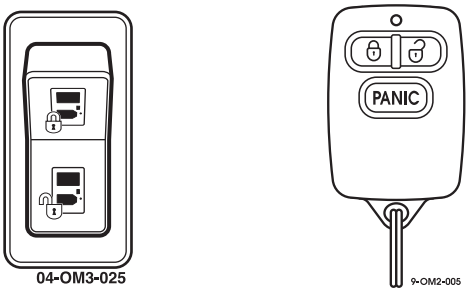


Figure 12-61: Door Lock Switch and Remote

Power Door Lock Switch Replacement

NOTE: Switch replacement is the same for all doors.

Removal

1. Remove the screws, and the bezel (Figure 12-62).
2. Disconnect the console harness from the switch.
3. Separate the switch from the mounting plate.

Installation

1. Install the switch in the bezel.
2. Connect the switch to the console harness.
3. Install the switch in the bezel and secure with the screws.

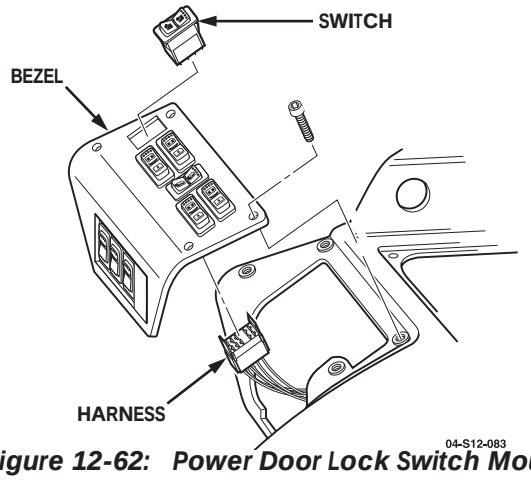


Figure 12-62: Power Door Lock Switch Mounting

Power Door Lock Actuator Replacement

Removal

NOTE: Actuator replacement is the same for all doors.

1. Raise the window.
2. Remove the door trim panel.
3. Remove the vapor barrier (Figure 12-63).
4. Detach the door harness connector from the door actuator.
5. Remove the actuator attaching screws.
6. Remove the actuator from the door and disconnect the actuator rod from the clips and actuator.

Installation

NOTE: The color coding on actuator rod is positioned away from the actuator during installation. The actuator rods are color coded as follows: left front, red; right front, green; left rear, yellow; and right rear, blue.

1. Connect the clip and actuator rod to the lock lever (Figure 12-63).
2. Install the opposite clip on the actuator and connect the rod to the actuator.
3. Secure the actuator with the mounting screws.
4. Connect the harness wires to the actuator.

NOTE: The vapor barrier must be completely sealed at all edges to prevent water entry into the interior of the vehicle.

5. Install the vapor barrier.
6. Install the door trim panel.

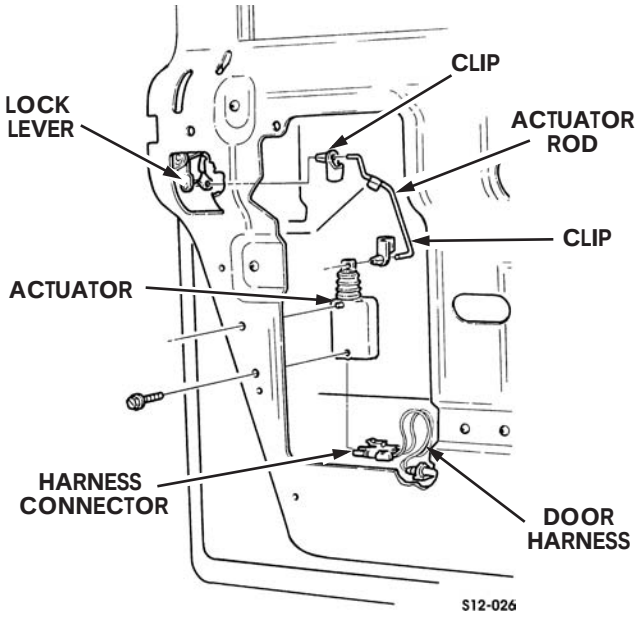


Figure 12-63: Door Lock Actuator Removal

Remote Entry Receiver Replacement

Removal

1. Remove the glove box to gain access to receiver (Section 10).
2. Disconnect the two receiver harness connectors from the receiver (Figure 12-64).
3. Remove the receiver from the two velcro strips.

Installation

4. Install the receiver on the two velcro strips.
5. Connect the receiver harness connectors to the receiver.
6. Program the receiver to accept the remotes.

7. Check the remote entry system for proper operation.
8. Install the glove box (Section 10).

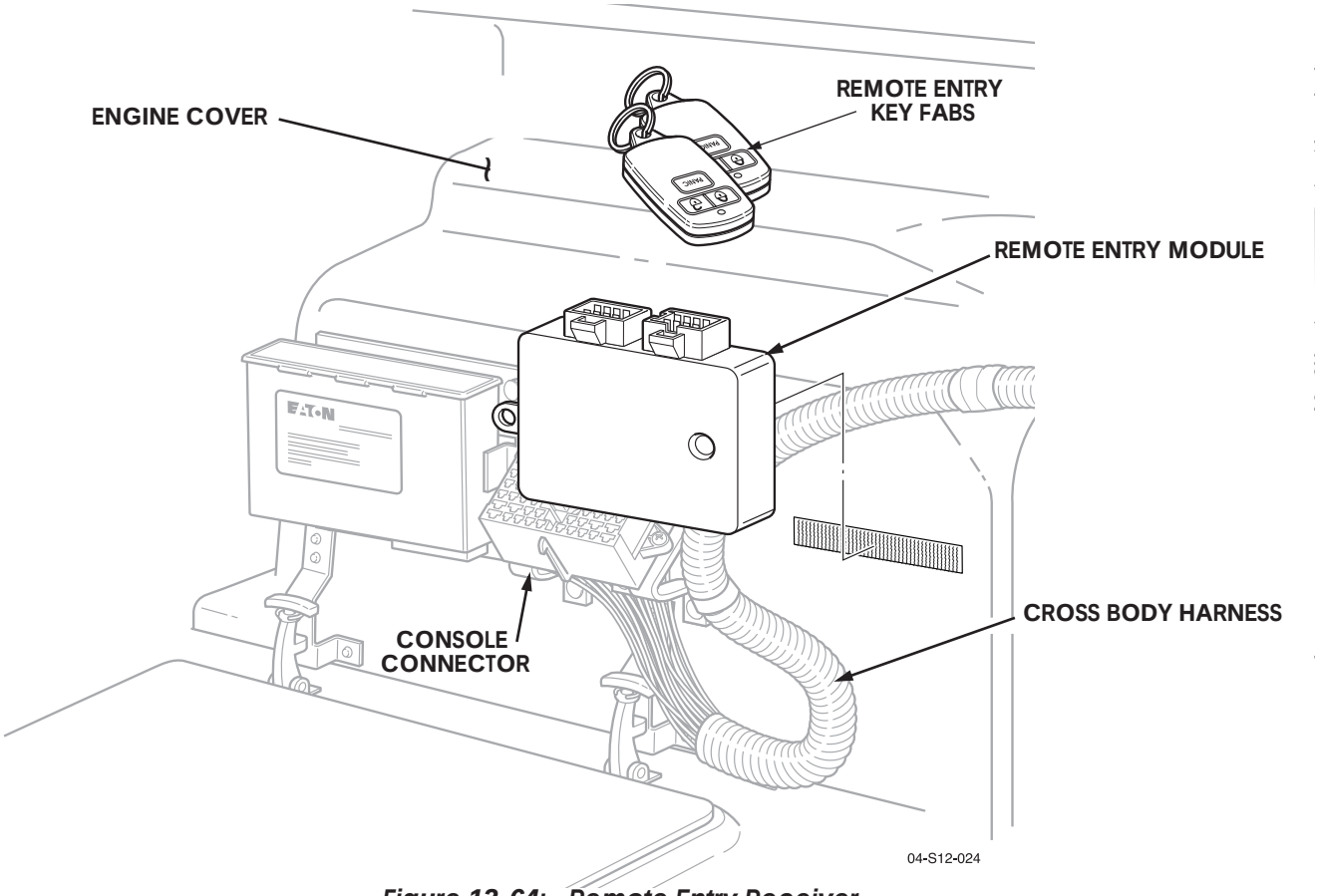


Figure 12-64: Remote Entry Receiver

KEYLESS ENTRY SYSTEM OPERATING INSTRUCTIONS (FIGURE 12-65)

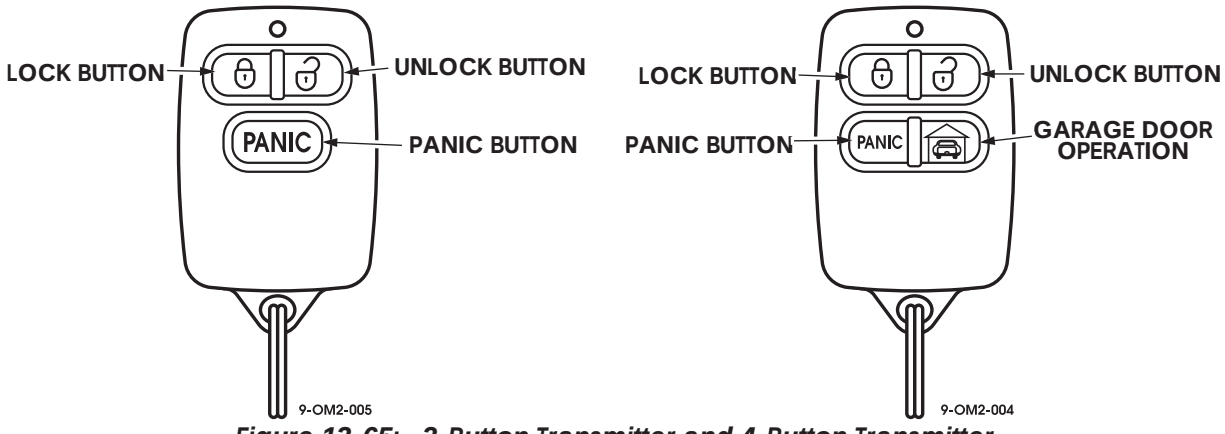


Figure 12-65: 3-Button Transmitter and 4-Button Transmitter

Remote Entry Transmitters Operation

There are three basic functions to the standard 3 button transmitter: lock the doors and arm the theft deterrent system, unlock the doors and disarm the theft deterrent system, and activate the panic alarm. If a replacement transmitter is ordered it will contain a forth button for activation of a garage door opener. The 4 button transmitters function the same as the three button transmitter. The forth button is inactive unless a receiver is installed in the garage door opener.

Locking the Doors

To lock the vehicle doors, press the lock button on the remote transmitter once. A red L.E.D. on the remote transmitter will illuminate while the button is depressed, indicating that the remote transmitter is functioning. The vehicle parking lights will flash once, and the horn will beep softly to confirm that the command was recieved.The theft deterrent system arms at this time. The theft deterrent system will beep the horn and flash the lights if any door is opened before disarming with the remote transmitter by unlocking the doors .

Unlocking the Doors

When approaching the vehicle press the unlock button on the remote transmitter once. This will unlock the drivers door. The vehicle lights will flash 2 times, and the horn will beep twice softly to confirm that the command was received. The interior lights will turn on and remain activated for approximately 30 seconds, and the theft deterrent system will disarm. To unlock the remaining doors, press the unlock button on the remote transmitter a second time.

Panic Activation

The panic feature can be used to activate the vehicle audio and visual theft deterrent features to draw attention to yourself during an emergency situation. Simply press and hold the PANIC button for 3 seconds. This will cause the vehicle horn and lights to pulse on and off for approximately 30 seconds. To deactivate the panic feature before the time period expires, press and release the panic button.

Optional Garage Door Accessory Package

The Garage Door Accessory Package provides the owner with the ability to operate their existing garage door opener with the same keyless entry remote transmitter used to open and lock your HUMMER H1. This system includes two 4-button remote transmitters and a garage door receiver that must be installed in your existing garage door system. The package must be purchased from a HUMMER dealership and the remote transmitters programmed to the HUMMER H1. Installation of the garage door receiver is the responsibility of the HUMMER H1 Owner.

Synchronizing the Remote Transmitters

If the keyless entry remote transmitter is operated 50 times or more outside the range of the vehicle, the remote transmitter codes will not match the code that the receiver expects. If the remote transmitter does not activate the lock system, and the batteries are not dead, the remote transmitter may need to be synchronized with the receiver. Stand close to the vehicle and press the lock button twice within one second. If there is no response, try pressing the button twice faster, then slower. If there is still no response, the system must be checked.

Battery Replacement

It is suggested that the batteries in your remote transmitters be replaced every 12 months to maintain optimum performance. Should the remote transmitter range begin to decrease or the red L.E.D. on the remote transmitter stop functioning, the battery will need to be replaced.To replace the batteries:

1. Remove the phillips screw from the back of the transmitter
2. Carefully pry the top of the transmitter away from the bottom.
3. Remove the old battery making note of battery polarity.
4. Replace the old battery with a new GP27A type.
5. Assemble the remote transmitter.

PROGRAMMING NEW OR REPLACEMENT REMOTE TRANSMITTERS

Programming The Keyless Entry Remote Transmitters

You should have access to all keyless entry remote transmitters that will ultimately operate the unit, even if they are currently programmed to do so.

Each keyless entry receiver module will learn and store up to four different remote transmitter codes. When a fifth remote transmitters programmed, the first remote transmitter that was originally programmed to the unit will be bumped out of the system memory.

1. To start programming, make sure that the Theft Deterrent System is disarmed, either by using a remote transmitter that is currently programmed, or by using the The Deterrent System Override procedure explained in the operating instructions.

2. Gain access to the programming push-button switch located on the keyless entry control module, which is mounted under the glove box of the vehicle.
3. Turn the ignition key to the ON position.
4. Within 15 seconds, press and release the programming switch 3 times. The vehicle horn will sound one time indicating that the system is in program mode
5. Press and hold the LOCK button on the remote transmitter until the vehicle horn sounds one long chirp.
6. Repeat step 5 for all the remote transmitters that you wish to program (up to four).
7. Turn the ignition key to the OFF position, or wait 15 seconds, and the system will automatically terminate the programming mode. This is indicated by a 3 chirp signal from the vehicle horn.

Remote Transmitter Programming Hints

1. If you wait more than 15 seconds between steps In the programming mode, the system will automatically terminate the programming mode. This is indicated by the 3 chirp signal from the vehicles horn. Simply start over to complete programming of all remote transmitters,

2 Test all programmed remote transmitters to be sure that all buttons are operating, Remember the system will not remotely lock the doors while the ignition key is in the ON position.

Keyless Entry Remote Transmitter Troubleshooting

1. If the customer's complaint indicates a gradual decrease in range of the remote transmitter, or intermittent operation of the remote transmitter, the battery may need replacement. The red Light Emitting Diode on the keyless entry remote transmitter should illuminate brightly when a remote transmitter button is pressed.
2. The remote transmitter may operate when the battery voltage drops below 4.0V DC, however range and reliability will be sacrificed at this level. When this same battery is measured under load, the voltage will drop close to or below the 3.0 VDC level. Battery replacement is usually recommended when the voltage drops to or below 5.0 VDC with no load.
3. If the battery voltage is at an acceptable level, but the remote transmitter will not activate the system, it may need to be synchronized. To re-synchronize the remote transmitter to the receiver, stand close to the vehicle and press and release the LOCK button 2 times within one second. The vehicle's horn should chirp one time indicating that you have locked the doors and armed the system. If re-synchronizing does not work on your first attempt, try again slower, then again faster.

FEATURES OF THE KEYLESS ENTRY AND THEFT DETERRENT SYSTEM

Anti Lockout Feature

When the doors are locked using the lock switch on the door panel, and the ignition key is in the ignition switch lock cylinder and a front door is opened, the driver’s door will immediately unlock. This prevents accidentally locking the keys in the vehicle.

Horn Chirp

This feature chirps the horn when the doors are locked and unlocked. The 1 chirp (LOCK) and 2 chirp (UNLOCK) are only active in the security mode. When the unit is in the keyless mode, only the parking light flasher will indicate lock and unlock.

In the security mode, the arm and disarm chirps can be turned on and off To disable the horn chirp:

1. Press and release the unlock button on the remote transmitter button once.
2. Open the drivers door and leave it open.
3. Turn the ignition “ON” then “OFF” 5 times in 5 seconds. Do not start the vehicle.
4. When the key is turned on for the fifth time, the horn will chirp twice to indicate that the feature has been disabled.
5. Turn the ignition off and test the system with the remote transmitter
6. To activate the horn chirp, repeat the procedure.

Selectable Features

Some of the features of the keyless entry and theft deterrent system can be tailored to the needs of the owner.The following is a list of alterable features included in the HUMMER H1 remote entry system

Feature Number	Function	ON One Chip Indication	OFF Two Chip Indication
1	Auto ignition lock. ON or OFF Factory preset = ON	When this feature is selected “ON”, 3 seconds after the ignition key is turned on, all doors will automatically lock. If a door is opened when the key is turned on, the doors will not auto lock.	When this feature is selected “Off”, The doors will not automatically lock when the ignition key is turned on.
2	Auto Ignition Driver’s Door Unlock. ON or OFF Factory Pre Set = ON	When this feature is selected “ON”, the driver’s door will automatically unlock immediately after the ignition key is switched from the “ON” to the “OFF” position.	When this feature is selected “OFF”, the driver’s door will not automatically unlock when the ignition key is turned “OFF”
3	Auto Ignition Passenger Doors Unlock. ON or OFF Factory Pre Set = OFF	When this feature is selected “ON”, the remaining passenger doors will automatically unlock immediately after the ignition key is switched from the “ON” to the “OFF” position.	When this feature is selected “OFF” the remaining passenger doors will not automatically unlock when the ignition key is turned “OFF”.
4	Active or Passive Alarm Arming. Factory Pre Set = Active	When this feature is selected “ON” or “ACTIVE” the Theft Deterrent System will only arm after the “LOCK” button on the transmitter is pressed. (The doors will automatically lock).	When this feature is selected “OFF” or “PASSIVE”, the Theft Deterrent System will automatically arm 30 seconds after the ignition key is turned off and a door is opened then all doors are closed.
5	Active or Passive Door Locking Factory Pre Set = Active	When this feature is selected “ON” or “ACTIVE”, the vehicle’s doors will only lock when the “LOCK” button on the transmitter is pressed.	When this feature is selected ”OFF” or “PASSIVE”, and feature number 4 is set to “PASSIVE”, all doors will automatically lock 30 seconds after the ignition key is turned “OFF” and a door is opened then all doors are closed.

Programming the Selectable Features

1. To start programming, make sure that the Theft Deterrent System is disarmed, either by using a remote transmitter that is currently programmed, or by using the Theft Deterrent System Override procedure.
2. Gain access to the programming push button switch located on the keyless entry control module, which is mounted in the center console of the vehicle.
3. Turn the ignition key to the “ON” position.
4. Within 15 seconds, press and release the programming Switch 3 times. The vehicle's horn will sound one time indicating that the system is in remote transmitter program mode.
5. Immediately turn the ignition key off (3 chirps indicates exit remote transmitter program mode) and then back on. The vehicle's horn will sound 2 chirps indicating that the system is in feature programming mode.
6. Press and release the programming switch on the keyless entry module 1 time to advance to feature number 1. The vehicle's horn will chirp 1 time if feature 1 is in the “ON” position, or 2 times if feature 1 is in the “OFF” position
7. To change the feature, press and release the “LOCK” button on the keyless entry remote transmitter, and the appropriate 1 or 2 chirp signal from the horn will identify the new selection for that feature (Refer to the table shown above).
8. To advance to selectable feature number 2, press and release the programming switch on the keyless entry module a second time, and again the vehicle's horn will identify the selection of that feature. Use the lock button on the keyless entry remote transmitter to change the feature or proceed to the next step if no change is desired

9. To advance to the next selectable feature press and release the programming switch on the keyless entry module. The vehicle's horn will identify the selection of the next feature. Continue this way until all desired features are activated or disabled per customers request.
10. Turn the ignition key off or allow 15 seconds to pass, and the vehicle's horn will sound 3 chirps indicating programming mode has been terminated.

Feature Programming Hints

1. Unless otherwise specified, if you wait more than 15 seconds between steps in the programming mode, the system will automatically terminate the programming mode. This is indicated by the 3 chirp signal from the vehicle's horn. Simply start over to complete programming of all features.
2. Test the system to be sure that all selectable features are functioning according to your customers requests. If you have missed a feature or changed the wrong feature, simply re-enter the feature programming mode to make the appropriate changes.

Power Door Locks Inoperative (Figure 12-127)

Step	Action	Value(s)	Yes	No
1	Remove the drivers door lock switch from the bezel. Using a DVOM, measure voltage on the orange wire (CKT 517). Is the specified voltage present?	+12v	Go to step 2.	Repair the open, or bad connection in CKT 517.
2	Disconnect the drivers door lock switch from the harness. Using a DVOM, check the resistance to ground at the light green wire (CKT 120), and the tan wire (CKT 119). Does the resistance meet the specified value?	<.2 Ω	Go to step 5.	Go to step 3.
3	Remove the passenger door lock switch from the bezel and disconnect it from the harness. On the drivers door lock harness, place a jumper wire between the light green wire (CKT 120) and the tan wire (CKT 119). With a DVOM, check for continuity between the light green wire (CKT 120) and the tan wire (CKT 119) on the drivers door lock harness. Does the resistance meet the specified value?	<.2 Ω	Go to step 4.	Repair the open, or bad connection in CKT 120, and/or CKT 119.
4	Remove the jumper wire from the passenger door lock switch harness. With a DVOM, check the resistance to ground on the passenger door lock switch at one black wire (CKT 56) and the other black wire (CKT 56). Does the resistance meet the specified value on both pins?	<.2 Ω	Replace the drivers door lock switch.	Repair the open or bad connection in CKT 56.
5	Connect the door lock switches to their harnesses. Using a DVOM, back probe the purple wire and the yellow wire of the drivers door lock switch. Move the switch to "Lock", then "Unlock". Does the voltage alternate between +12v and –12v?	+12v and –12v	Go to step 6.	Replace the drivers door lock switch.
6	Locate connector C31 under the center console. Using a DVOM, probe the yellow wire (CKT 121), and the purple wire (CKT 122). Move the drivers lock switch to "Lock" then "Unlock". Does the voltage alternate between +12v and –12v?	+12v and –12v	Go to step 7	Locate the open or bad connection in CKTs 121 or 122.

Power Door Locks Inoperative (Cont'd) (Figure 12-127)

Step	Action	Value(s)	Yes	No
7	Using a DVOM, Check the voltage drop between connector C31 at the orange wire (CKT 517) and connector C30 at the black wire (CKT 56). Is the specified voltage present?	+12v	Go to step 9.	Go to step 8.
8	Using a DVOM, measure resistance to ground at C30 the black wire (CKT 56). Does the resistance meet the specified value?	<.2 Ω	Repair the open or bad connection in CKT 517.	Repair the open or bad connection in CKT 56.
9	Using a DVOM, check the voltage drop on C30 at the grey wire (CKT 554) and the black wire (CKT 56). Is the specified voltage present?	+12v	Go to step 10.	Repair the open or bad connection in CKT 554.
10	Harness should be connected to the module. Using a DVOM, set to measure voltage, back probe C31 at the pink wire (CKT 117) and the brown wire (CKT 118). Move the lock switch from "Lock" to "Unlock" and observe the voltage polarity. Does the voltage switch from +12v to -12v?	+12v and –12v	Repair the open or bad connection in CKT 117 or 118.	Replace remote entry module.

Cargo Door Lock Inoperative (model 84) (Figure 12-129)

Step	Action	Value(s)	Yes	No
1	Does power the lock system on vehicle operate correctly?		Go to step 2.	Refer to the diagnostic charts that apply.
2	Open the primary cargo door. Using a DVOM, measure the voltage across the brass door contacts on the body. Operate the door locks in both "Lock" and "Unlock". Does the voltage pulse +12v then –12v?	+12v then –12v	Go to step 3.	Go to step 4.
3	Remove the inner door panel and disconnect the door lock actuator. Using a DVOM, set to measure resistance, measure continuity between the door contacts and door lock actuator connector on the pink wire (CKT 117) and the yellow wire (CKT 121). Does the resistance meet the specification?	<.2 Ω	Replace the door lock actuator.	Locate the open or bad connection in CKT 117 or 121.
4	Gain access to the cargo door lock delay module. Disconnect the module connector. Using a DVOM, set to measure voltage, probe the orange wire (CKT 517), and the black wire (CKT 56). Is the specified voltage present?	+12v	Go to step 6.	Go to step 5.
5	Check the voltage drop on the orange wire (CKT 517). Is the specified voltage present?	+12v	Repair the open or bad connection in CKT 56 between the cargo door lock delay module and G4.	Repair the open or bad connection in CKT 517 between the cargo door lock delay module and fuse 3H.

Cargo Door Lock Inoperative (model 84) (Figure 12-129)

Step	Action	Value(s)	Yes	No
6	Using a DVOM, set to measure voltage, probe the brown wire (CKT 118) of the cargo door lock delay module and the black wire. Move a door switch to "Unlock". Is the specified voltage present?	+12v	Go to step 7.	Repair the open or bad connection, in CKT118 between the cargo door lock module and door lock switches.
7	Using a DVOM, probe the pink wire (CKT 117), and the yellow wire (CKT 121) at the cargo door lock delay module connector. Operate the door lock switch in both "Lock" and "Unlock". Does the voltage alternate between +12v and -12v?	+12v and –12v	Repair the open or bad connection in CKT 117 or 118 between the cargo door lock delay module and the door contacts.	Replace the cargo door lock delay module.

Remote Entry System Inoperative (Figure 12-138)

Step	Action	Value(s)	Yes	No
1	Does the panic feature operate when the button is depressed on the transmitter?		Go to step 6.	Go to step 2.
2	Does the L.E.D. illuminate on the keyless transmitter when a button is depressed?		Go to step 4.	Go to step 3.
3	Measure the battery voltage of the transmitter battery. Is the specified voltage present?	+5v	Replace the transmitter.	Replace the transmitter battery
4	Attempt to re-synchronize the transmitter to the receiver. Is the problem repaired.		No further action required.	Go to step 5.
5	Reprogram the receiver to the transmitters. Is the problem solved?		No further action required.	Go to step 6.
6	Gain access to the receiver under the console. Disconnect connector C30 from the receiver. Using a DVOM, measure the voltage drop between the grey wire (CKT 554) and the black wire (CKT 56). Is the specified voltage present?	+12v	Go to step 8.	Go to step 7.
7	Using a DVOM, measure the resistance between ground and the black wire (CKT56) at C30. Does the resistance meet the specified value?	<.2 Ω	Repair the open or bad connection in CKT 554 between the receiver and fuse 1H	Repair the open or bad connection in CKT 56 between receiver and G4
8	Using a DVOM, check the voltage drop between C30 the black wire (CKT 56) and C31 the orange wire (CKT 517). Is the specified voltage present?	+12v	Go to step 9.	Repair the open or bad connection in CKT 517.

Remote Entry System Inoperative (Figure 12-138)

Step	Action	Value(s)	Yes	No
9	Reconnect connectors C30, and C31 to the remote entry module. Using a DVOM, back probe C31, the pink wire (CKT 117) and the brown wire (CKT 118). Using the remote entry transmitter, attempt to lock and unlock the drivers door. Does the voltage alternate between +12v and –12v?	+12v and –12v	Refer to the "PowerLock Inop" diagnostic chart.	Replace the remote entry receiver.

Anti-Lock Out Inoperative

Step	Action	Value(s)	Yes	No
1	Does the basic power lock system operate normally?	—	Go to step 2.	Refer to the proper repair procedure.
2	With the key in the ignition switch, open the drivers door. Does the warning buzzer sound?	—	Go to step 5.	Go to step 3.
3	Gain access to the back of the drivers door jam switch. Back probe the white wire (CKT 159) with a DVOM, and check for voltage. Is the specified voltage present?	+12v	Go to step 5.	Go to step 4.
4	Using a DVOM, check for voltage on the dark green wire (CKT 54) Is the specified voltage present?	+12v	Replace the driver door jam switch.	Repair the open or short on CKT 54.
5	Gain access to the diode block. With the drivers door open, check for voltage on the white wire (CKT 159) at the diode. Is the specified voltage present?	+12v	Go to step 6.	Repair the open on CKT 159.
6	Check for resistance between ground and the black wire (CKT 158) at the diode. Is the specified resistance present?	<0.2Ω	Go to step 8.	Go to step 7.
7	Check continuity on the black wire (CKT 158) between the diode block and the key warning switch. Is the specified resistance present?	<0.2Ω	Replace the ignition tumbler/key warning switch.	Repair the open on CKT 158.
8	Check the diodes in the diode block. Are they still functioning as designed?	—	Go to step 9.	Replace the diode block.
9	Gain access to the remote entry module. With a DVOM, check the resistance between ground and the black wire (CKT 56) at C30. Is the specified resistance present?	<0.2Ω	Go to step 10	Repair the open or short on CKT 56.
10	With C30 disconnected and the key in the ignition check for ground on the tan wire (CKT 150) at C30. Is a ground signal present?	—	Go to step 11	Repair CKT 150 between the diode block and the remote entry module.
11	With C30 disconnected check the red wire (CKT 160) at C30 for a + signal. Is the specified voltage present?	+12v	Replace the remote entry module.	Repair CKT 160 between the remote entry module and the diode block.

AUTO-DIMMING REAR VIEW MIRROR WITH ELECTRONIC COMPASS AND TEMPERATURE (OPTION)

Description

The Auto-Dimming rear view mirror has the capability to change the opacity of the mirror glass to prevent glare. When a following vehicles head lamps hit the rear light detection sensor, the mirror's opacity will lessen. The now translucent mirror will allow light to pass through it. This effectively lessens the glare on the driver, much like moving the angle on a manual mirror.

Removal

1. Disconnect the mirror jumper harness from the rear of the mirror assembly (Figure 12-66).
2. Gently push upward on the mirror head and the compass pod together until the mirror assembly is free of the windshield button.

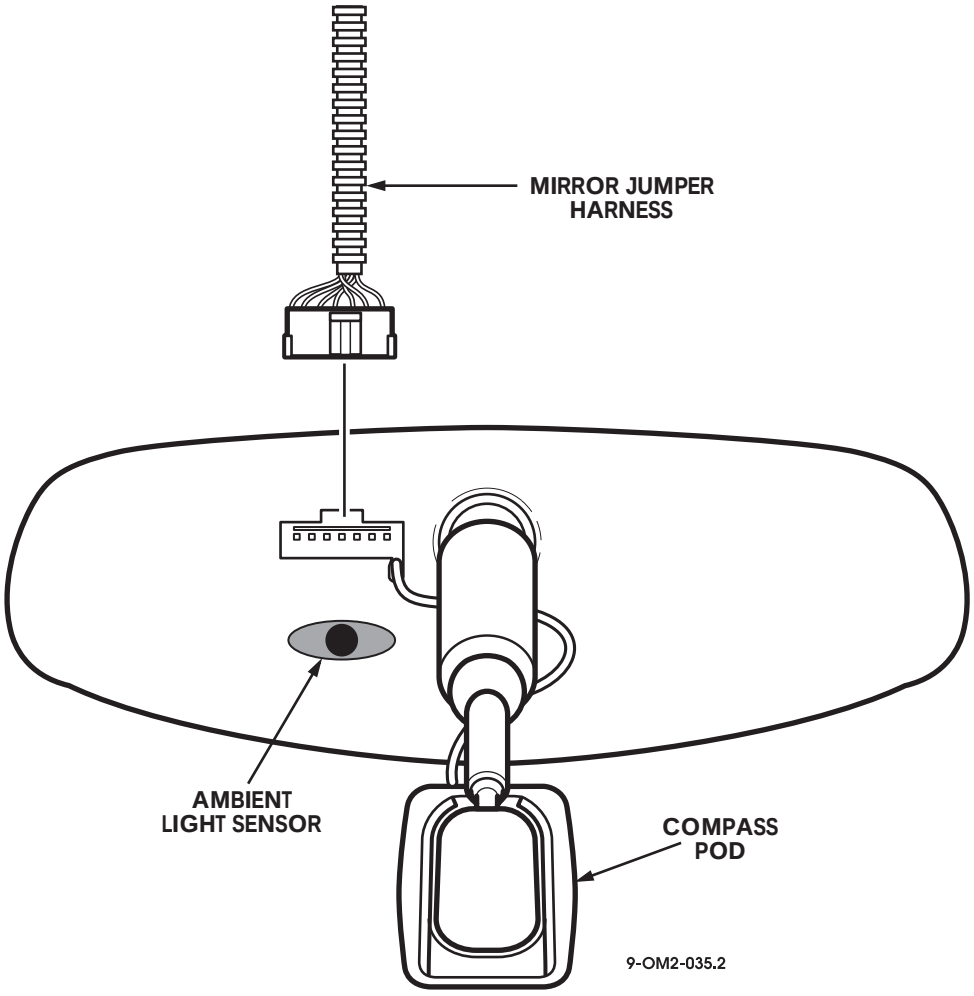


Figure 12-66: Auto-Dimming Mirror Jumper Harness Connection

Installation

1. Grasp the mirror head with both hands
2. Slide the mirror down onto the window mount and gently rock side to side until mirror base is seated. Do not force the mirror onto the mount.
3. Connect the mirror jumper harness to the rear of the newly installed mirror.
4. Set calibration and zone adjustments. (Refer to Auto-Dimming compass mirror calibration and zone adjustment).

AUTO-DIMMING COMPASS MIRROR CALIBRATION AND ZONE ADJUSTMENTS

Calibration Adjustment

1. Start the engine.
2. Press and hold the auto-dimming power button until “CAL” appears in the display and release (Figure 12-67).
3. Drive **slowly** in a circle away from large metal buildings and power lines until the “CAL” disappears.

Zone Adjustment

1. Press and hold the mode button until “ZONE” appears in the display (Figure 12-67).
2. Each depression of the mode button will change the zone number in sequence. Refer to the zone chart below for the zone number of your area of operation (Figure 12-68).
3. When the desired zone is reached, allow the mirror to go to normal mode then turn off the ignition.

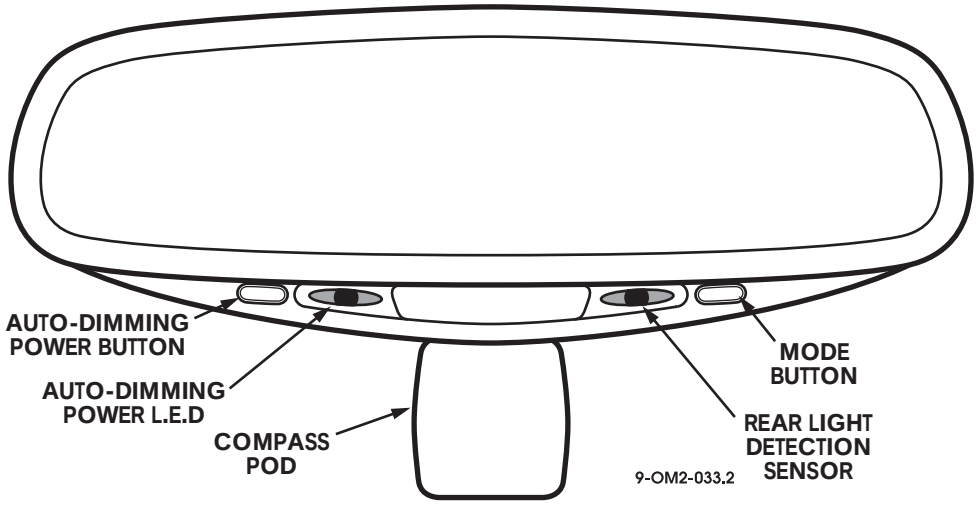


Figure 12-67: Auto-Dimming Rear View Mirror

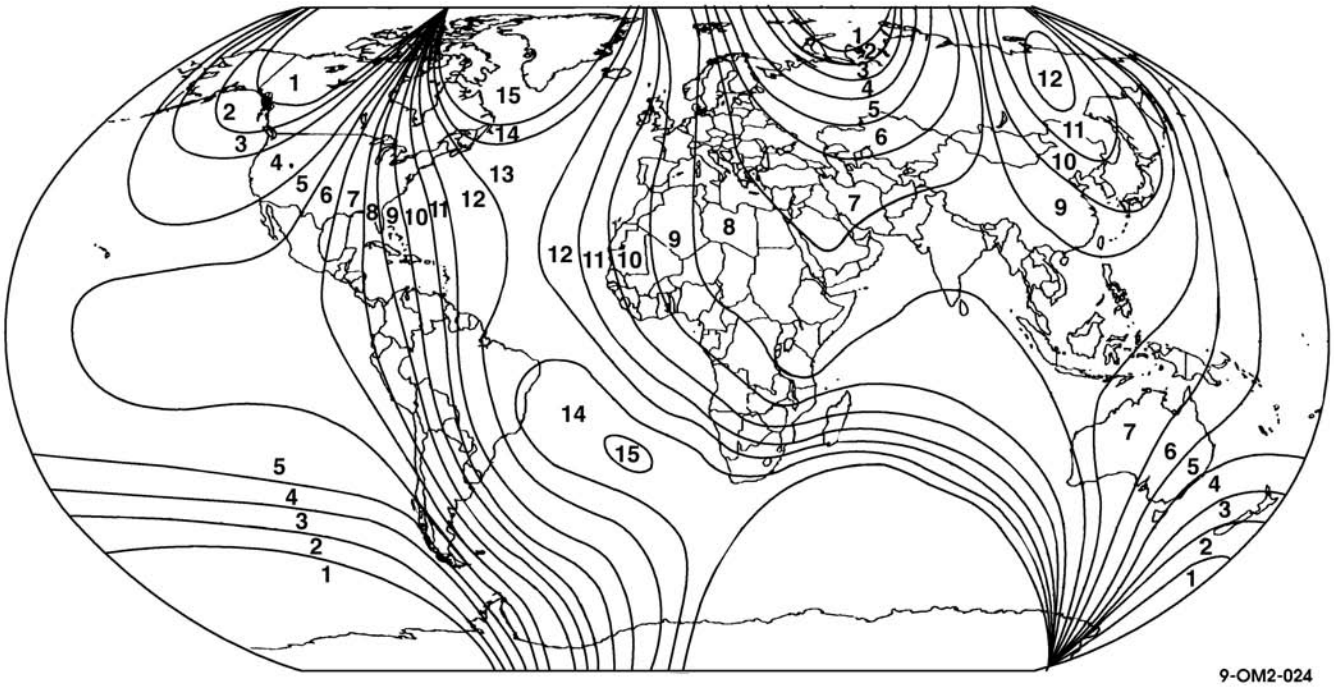


Figure 12-68: Magnetic Zone Chart

AMBIENT TEMPERATURE SENSOR

Removal

1. Remove the existing nut, cushioned clamp, and the ambient temperature sensor jumper harness from the body harness (Figure 12-69).
2. Disconnect the ambient temperature sensor jumper harness from the sensor.
3. Remove the self-tapping screw and the ambient temperature sensor from the frame.

Installation

1. Install the ambient temperature sensor to the frame with the self-tapping screw (Figure 12-69).
2. Connect the ambient temperature sensor harness to the sensor.
3. Connect the ambient temperature sensor harness to the body harness.
4. Using the cushioned clamp, secure the jumper harness to the body harness mounting clamp with existing nut and the bolt.

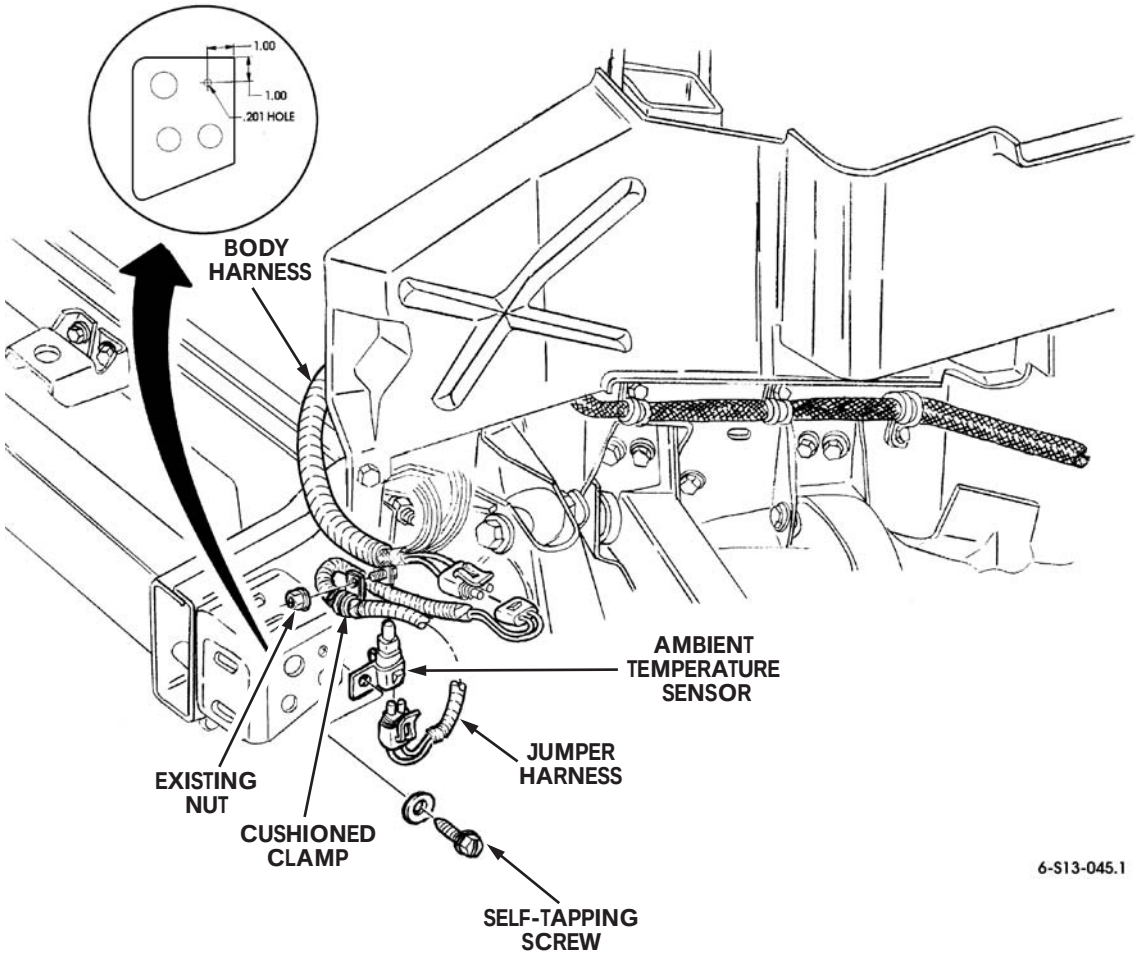


Figure 12-69: Ambient Temperature Sensor

Compass Mirror Display Inoperative (Figure 12-96)

Step	Action	Value(s)	Yes	No
1	Turn the ignition to the ON position, and heated windshields OFF. Is the compass mirror display operating?		No problem found, or intermittent.	Go to step 2.
2	Gain access to C13, with the ignition ON measure voltage on the pink wire. Is voltage present?	Approximate battery voltage	Go to step 4.	Go to step 3.
3	Check for open, or short to ground in CKT 407 between compass cutout relay and compass mirror, and CKT 400 between compass cutout relay and fuse 2C in the interior fuse box. Are any problems found?		Repair open or short to ground in CKT 407 and CKT 400.	Replace mirror cutout relay.
4	Check continuity to ground at C13 on the black wire, is resistance to ground below specified?	>.2 Ω	Replace compass mirror	Go to step 5.
5	Check for open or bad connection on the black wire (CKT 59) between compass mirror and G4. Are any problems found?		Repair open or bad connection in CKT 59.	No problem found, go to step 1.

Compass Mirror Temperature Display Showing OC, SC or Wrong Temp (Figure 12-96)

Step	Action	Value(s)	Yes	No
1	Does compass mirror display show “OC” or “SC” in place of the temperature?		Go to step 3.	Go to step 2.
2	Gain access to C13, measure resistance between the brown wire (CKT 767), and ground. With the vehicle at room temperature (70°F), does resistance measured match specifications?	Approx.12 K Ω	Replace compass mirror.	Go to step 3.
3	Measuring resistance to ground on the brown wire (CKT 767), does meter display open?	OL	Go to step 4.	Repair bad connection at C13.
4	Disconnect temperature sensor from underbody harness. Measure resistance between the two pins of the sensor. With the vehicle at room temperature (70°F), is resistance in range specified? Higher temperature gives lower resistance readings.	Approx.12 K Ω	Go to step 5.	Replace the temperature sensor.
5	Measure resistance to ground at temperature sensor connector pin A. Is resistance below specified?	<.2 Ω	Go to step 6.	Repair open or bad connection in CKT 58 between temperature sensor and G2.
6	Check for open, bad connection, or short to ground on the brown wire (CKT 767)between temperature sensor and compass mirror. Are any problems found?		Repair open, bad connection, or short to ground in CKT 767.	Replace the compass mirror.

POWER SIDE MIRROR WITH HEATER MIRROR (OPTION)

Description

The side mirrors have an option of an internal heater element to aid in defrosting. Heated side mirrors will only be available if the truck is equipped with a heated windshield.

The power side mirror system components are: two side mirrors with internal vertical and horizontal control motors (and optional heater elements), the power mirror switch, and the heated windshield switch (optional).

Power Side Mirror Heater Operation

Circuit Description

The power side mirror heaters operate In conjunction with the heated windshields. The elements receive ground from circuit 59 (BK) and a power signal from circuit 580 (BR). The voltage signal supplied on circuit 580 (BR) is controlled by the heated windshield switch. When the heated windshield switch is activated, voltage runs through circuit 83 (TN) into the switch and activates an internal timer. This timer closes a pair of contacts which allows voltage to travel from pin B circuit 83 (TN) to pin A circuit 580 (BR). While the contacts are closed internally, voltage will travel on circuit 580 (BR) to the heated side mirrors.

Power Side Mirror Replacement

Removal

1. Remove the three mounting screws securing the power mirror assembly and the gasket to the mounting plate (Figure 12-70).
2. Disconnect the power mirror assembly connector from the door jumper harness.
3. Inspect the gasket and replace if damaged.

Installation

NOTE: Ensure the door jumper harness is routed through the gasket before connecting the harness to the power mirror assembly.

1. Connect the power mirror assembly connector to the door jumper harness (Figure 12-70).

NOTE: Wires from the power mirror assembly must be coiled in the mirror housing to ensure clearance to the attachment points.

2. Align the power side mirror and the gasket with the mounting plate on the door.
3. Install the three mounting screws

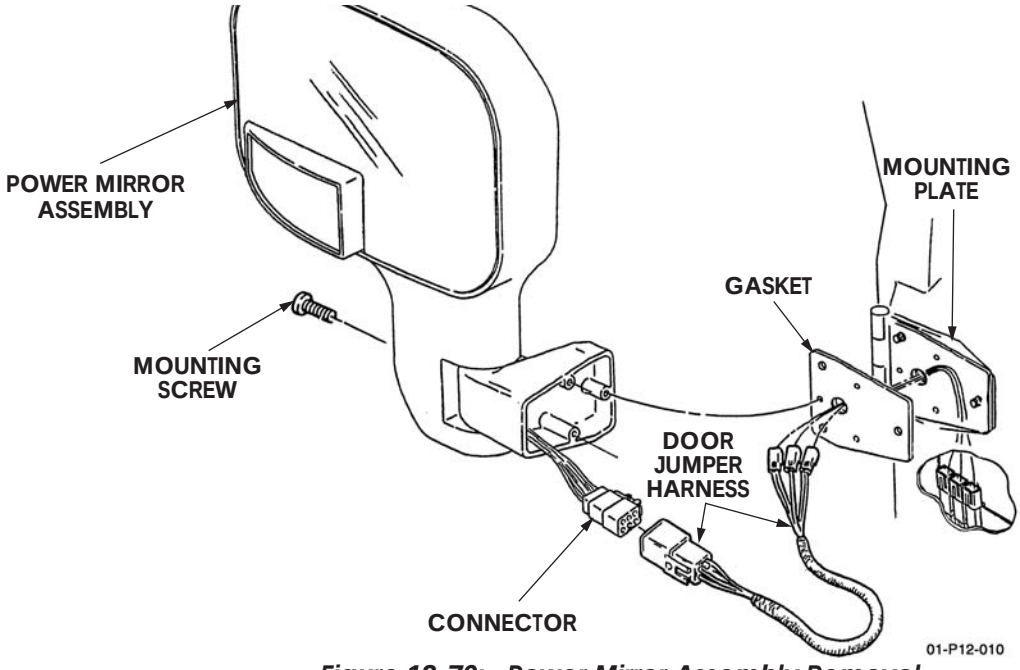


Figure 12-70: Power Mirror Assembly Removal

Power Side Mirrors Inoperative

Step	Action	Value(s)	Yes	No
1	Are both mirrors INOP?		Go to step 2.	Go to step 4.
2	Remove the power mirror switch. With a DVOM, check the pink wire (CKT 517) for battery voltage. Is the specified voltage present?	> 12.6v	Go to step 3.	Repair CKT 517 between the power mirror switch and fuse 3H in the interior fuse box.
3	With a DVOM, check the resistance to ground on the black wire (CKT 59). Does the resistance meet the specifications?	< 0.2 Ω	Replace the power mirror control switch.	Repair CKT 59 between the power mirror switch and ground G4.
4	Is only the left side power mirror INOP?		Go to step 5.	Go to step 7
5	Remove the left side power mirror. With a DVOM, back probe the orange wire (CKT 942) at C50 with the positive lead, and the black wire (CKT 59) with the negative lead. With the DVOM set to check voltage, move the power mirror switch to the left side and then up. In both cases the voltage should change from 0v to +12v. Does the voltage change?	0v - off +12v - left 0v - off +12v - up	Replace the power side mirror.	Go to step 6.
6	With a DVOM, check resistance on the orange wire (CKT 942) between the power side mirror and the power mirror control switch. Does the resistance on the circuit meet specifications?	< 0.2 Ω	Replace the power mirror switch.	Repair CKT 942 between the power side mirror and the power mirror switch.
7	Remove the left side power mirror. With a DVOM, back probe the orange wire (CKT 944) at C51 with the positive lead, and the black wire (CKT 59) with the negative lead. With the DVOM, set to check voltage move the power mirror switch to the left side and then up. In both cases the voltage should change from 0v to +12v. Does the voltage change?	0v - off +12v - left 0v - off +12v - up	Replace the power side mirror.	Go to step 8.
8	With a DVOM, check resistance on the orange wire (CKT 944) between the power side mirror and the power mirror control switch. Does the resistance on the circuit meet specifications?	< 0.2 Ω	Replace the power mirror switch.	Repair circuit CKT 944 between the power side mirror and the power mirror switch.

Power Side Mirror Heater Inoperative (Figure 12-132)

Step	Action	Value(s)	Yes	No
1	Remove the heated windshield switch from the bezel. Turn the ignition switch to the ”Run” position. Using a DVOM, check the voltage drop between the brown wire (CKT 580) and the black wire (CKT 58). Is the specified voltage present?	> 12.6v	Repair CKT 580 between the heated windshield switch and the relays.	Go to step 2.

Power Side Mirror Heater Inoperative (Figure 12-132)

Step	Action	Value(s)	Yes	No
2	Using a DVOM, measure the resistance to ground on the black wire (CKT 58) at the heated windshield switch. Does the resistance meet the specification?	< 0.2 Ω	Go to step 3.	Repair CKT 58 between the heated windshield switch and G4.
3	Place the ignition in the "Run" position and the heated windshield switch in the "On" position. Use a DVOM, to check for voltage at both tan wires (CKT 83) at the heated windshield switch. Is the specified voltage present?	> 12.6v	Replace the heated windshield switch.	Repair CKT 83 between the windshield switch and fuse 1C in the interior fuse box.

CRUISE CONTROL SYSTEMS (FIGURE 12-71)

WARNING: Testing of cruise control should only be preformed in areas were traffic is light and the road conditions are stable.

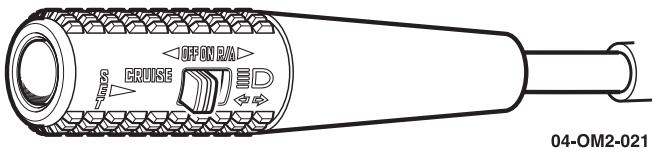


Figure 12-71: Cruise Control

Operation of Cruise Control

1. Move the cruise control switch to the "ON" position.
2. Accelerate to the desired speed.
3. Push in the "SET" button on the end of the turn signal lever and release it at the desired speed. This will set the vehicle speed. **NOTE:** *The vehicle speed will decrease while the "SET" button is pushed in.*

The cruise control will not operate under 35 MPH.

Accelerating with the Cruise Control On

Vehicle speed can be momentarily increased after the desired speed has been set. By pressing the accelerator pedal the speed will increase. This action will not interfere with the preset cruising speed. The preset speed will resume after the accelerator pedal is released.

Resetting the Cruise Control to a Higher Speed

There are two ways to reset the cruise control to a higher speed.

1. Press the accelerator pedal until the desired speed is reached. Push the "SET" button and release it. Speed should set like normal.
2. Move the cruise control switch from "ON" to "R/A". Hold the switch in place until you reach the desired speed and then hold the control switch in the "R/A" position for half a second and release. Each time this is done the vehicle speed will increase by 1 MPH.

Turning Off the Cruise Control

There are two ways to turn the cruise control off while driving:

1. Move the cruise control switch to the "OFF" position.

2. Depress the brake pedal slightly. This turns off the cruise control operation. but does not erase the speed memory. To resume cruise control after touching the brake pedal, follow the instructions under “Resuming a set Speed”.

In addition, the cruise control is automatically disabled each time you turn the engine off, Or shift into “P” (Park) “N” (Neutral) position, or if the “Check Throttle Light” is illuminated.

Resuming a Set Speed

If the cruise control was turned off by depressing the brake pedal slightly, move the cruise control switch from “ON” to “R/A” and hold for approximately one second and release. The vehicle will gradually return to the previously set speed and maintain it.

Resuming a set speed will not function if the cruise control was turned off using the cruise control switch, or if the vehicle speed is below cruise control minimum (35 MPH).

Using Cruise Control on Hills

Driving on a hill can affect the performance of the cruise control. This performance can be greatly affected if the vehicle is loaded or towing a trailer. Use of the accelerator pedal will help maintain vehicle speed but brakes will turn cruise off. If vehicle speed is being significantly reduced or increased when using the cruise control on a hill, turn the cruise control off and manually control the vehicle speed.

Inspection

When working on the cruise control system make sure that there are no other problems with the ECM or fueling system. Always road test and verify the problem before attempting any repairs.

Intermittent problems

All of the charts in this section are for use on current failures. Do not attempt to use these charts to diagnose a problem unless the problem has been verified and currently exists. If the problem is intermittent, parts will be replaced, or no problem will be found.

Cruise Control Inoperative (Figure 12-101)

Step	Action	Value(s)	Yes	No
1	Important: Before clearing the DTC’s, use the scan tool Capture Info in order to record the Freeze Frame and the failure records for reference, as the data will be lost when the Clear Info function is used. Was the Powertrain On-Board Diagnostic (OBD) System check performed?		Go to step 2.	Perform on-board diagnostic system check.
2	Disconnect cruise control lever from cross body harness under dash. Using a DVOM, set to measure resistance, Probe terminal A with the negative lead and terminal B with the positive lead. Turn the cruise on\off switch to “on”. Does the resistance meet specification?	<.2Ω	Go to step 3.	Replace cruise control arm.
3	Leave the negative lead in the terminal B, place the positive lead in terminal C. With the resume switch in the neutral position, the switch should be open. When the resume switch is moved to the spring loaded position, the switch should close and meet the resistance specification?	neutral-open closed<.2Ω	Go to step 4.	Replace cruise control arm.
4	Leave the negative lead in terminal B, place the positive lead in terminal D. With the set switch in the neutral position, the meter should display an open, with the switch pushed in the meter should display continuity, does it?	neutral-open closed<.2Ω	Go to step 5.	Replace cruise control arm.

Cruise Control Inoperative (Cont'd) (Figure 12-101)

Step	Action	Value(s)	Yes	No
5	Connect scan tool to vehicle, locate cruise control On/Off switch in the engine data list. When the switch is moved on and off, does the engine data list reflect the change?		Go to step 6.	Go to step 9.
6	Locate resume/accel switch in engine data list. When the switch is moved to the resume/accel position, does the engine data list reflect the change?		Go to step 7.	Go to step 10.
7	Locate set/coast in engine data list. When the switch is pushed, does the data list reflect the change?		Go to step 8.	Go to step 11.
8	Locate the brake switches in the engine data list, depress the brake pedal, does the data list reflect the change?		Check for loose or poor connection at ECM if none are found replace the ECM.	Go to step 16.
9	Using a DVOM, set to measure resistance, place the ground lead on the IP ground point. Back probe C27-59 (CKT 151GY) with the positive lead. With the cruise control switch on, does the resistance meet specification?	<.2Ω	Check for loose or poor connection at ECM if none are found replace the ECM.	Repair open, bad connection or short to ground in CKT 151GY between the ECM and cruise control arm.
10	Using a DVOM, set to measure resistance, place the ground lead on the IP ground point. Back probe cavity C27-58 (CKT 153LG) with the positive lead. With the ignition on and the cruise control resume/accel button depressed, does the resistance meet specification?	<.2Ω	Check for loose or poor connection at ECM if none are found replace the ECM.	Repair open, bad connection or short to ground in CKT 153LG between the ECM and cruise control arm.
11	Using a DVOM, set to measure resistance, place the ground lead on the IP ground point. Back probe cavity C27-60 (CKT 152DB) with the positive lead. With the ignition on and the cruise control set button depressed does the resistance meet specification?	<.2Ω	Check for loose or poor connection at ECM if none are found replace the ECM.	Repair open, bad connection or short to ground in CKT 152DB between the ECM and cruise control arm.
12	Using a DVOM, set to measure voltage, place the ground lead on the IP ground point. Back probe cavity C27-64 (CKT 22RD) with the positive lead. Depress the brake switch. Is voltage present?	+12v	Go to step 13.	Check for open or short to ground/voltage in CKT 22RD, if none found replace brake switch.
13	Using a DVOM, set to measure resistance, place the ground lead on the IP ground point. Back probe cavity C27-54 (CKT 809TN) with the positive lead. Does the resistance meet the specification?	BRAKE **Applied** OLΩ Not Applied <.2Ω	Check for loose or poor connection at ECM if none are found replace the ECM.	Check for open or short to ground/voltage in CKT 809TN, if none found replace brake switch.

AUDIO SYSTEM DESCRIPTION

Audio systems are available in two configurations:

The standard system, available on fleet only consists of an AM/FM radio and either two or four coaxial speakers (Figure 12-73).

The Monsoon system (Figure 12-72), available on models 84 and 90, uses a radio head and CD player with a total of six coaxial speakers and two subwoofers. The coaxial speakers are located in an overhead console and the two subwoofers are housed in a box located under the left rear seat. An amplifier producing 200 watts on eight channels is mounted in the overhead console. The amplifier is activated by output on the left rear channel from the radio. Rear seat audio, included in the monsoon package, provides second audio access to the radio system with the aid of headphones (Figure 12-74).

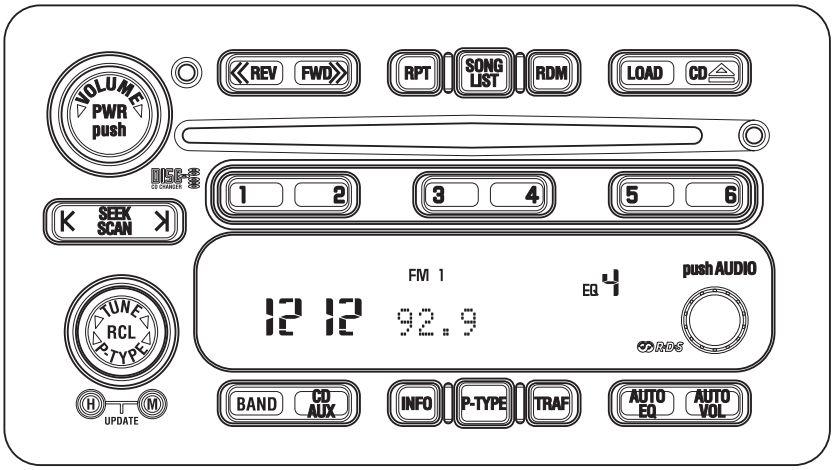


Figure 12-72: Monsoon Radio Face

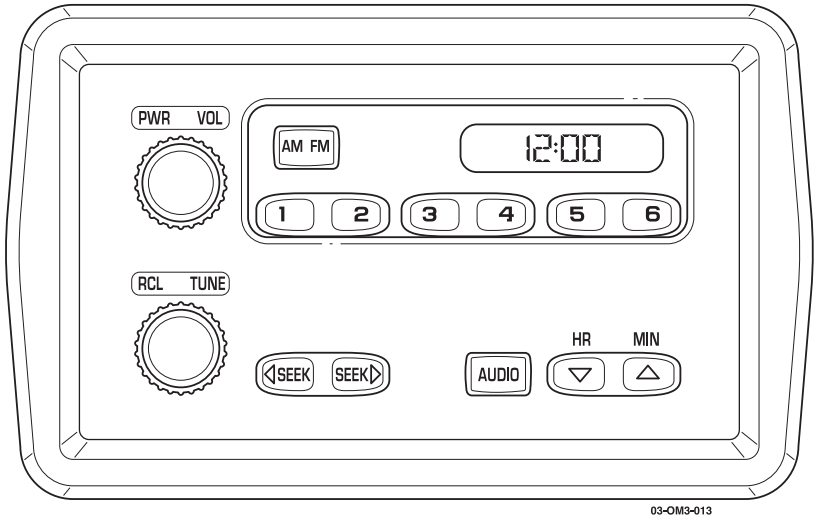


Figure 12-73: Standard Radio Face

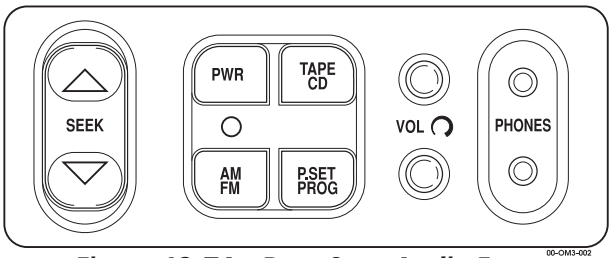


Figure 12-74: Rear Seat Audio Face

Radio Replacement

Removal

1. Remove the four screws securing the center dash bezel and the bezel (See Figure 12-75).
2. Remove the three screws securing the radio to the center dash assembly.
3. Pull the radio out far enough to gain access to the radio connector.
4. Disconnect the connector and remove the radio.

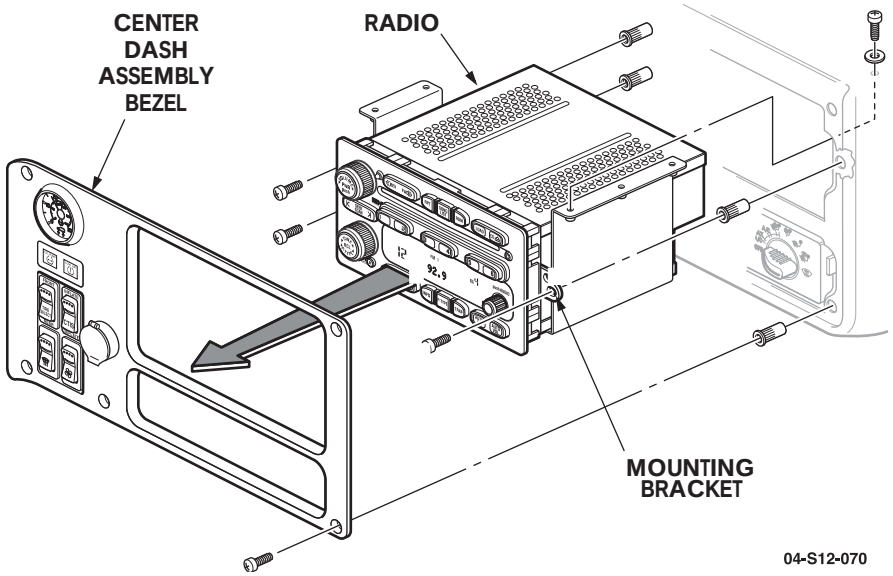


Figure 12-75: Radio Removal.

Installation

1. Connect the two harness connectors to the back of the radio.
2. Secure the radio to the center dash assembly with the three screws.
3. Line the trim piece with the radio and secure with the four mounting screws.

Overhead Console, Speaker And Amplifier Replacement (Monsoon Except Model 90)

Removal

1. Remove the four screws securing the speaker grill and the speaker to the roof. (See Figure 12-76)
2. Repeat step one for all four front speakers.
3. Remove the headliner.
4. Disconnect the 32 pin connector from the amplifier and the four screws securing the amplifier to the mounting bracket.
5. Remove the amplifier.

Installation

1. Mount the amplifier to the mounting bracket with the four screws, and connect the 32 pin connector to the amplifier.
2. Reinstall the head liner and re connect all the wiring.

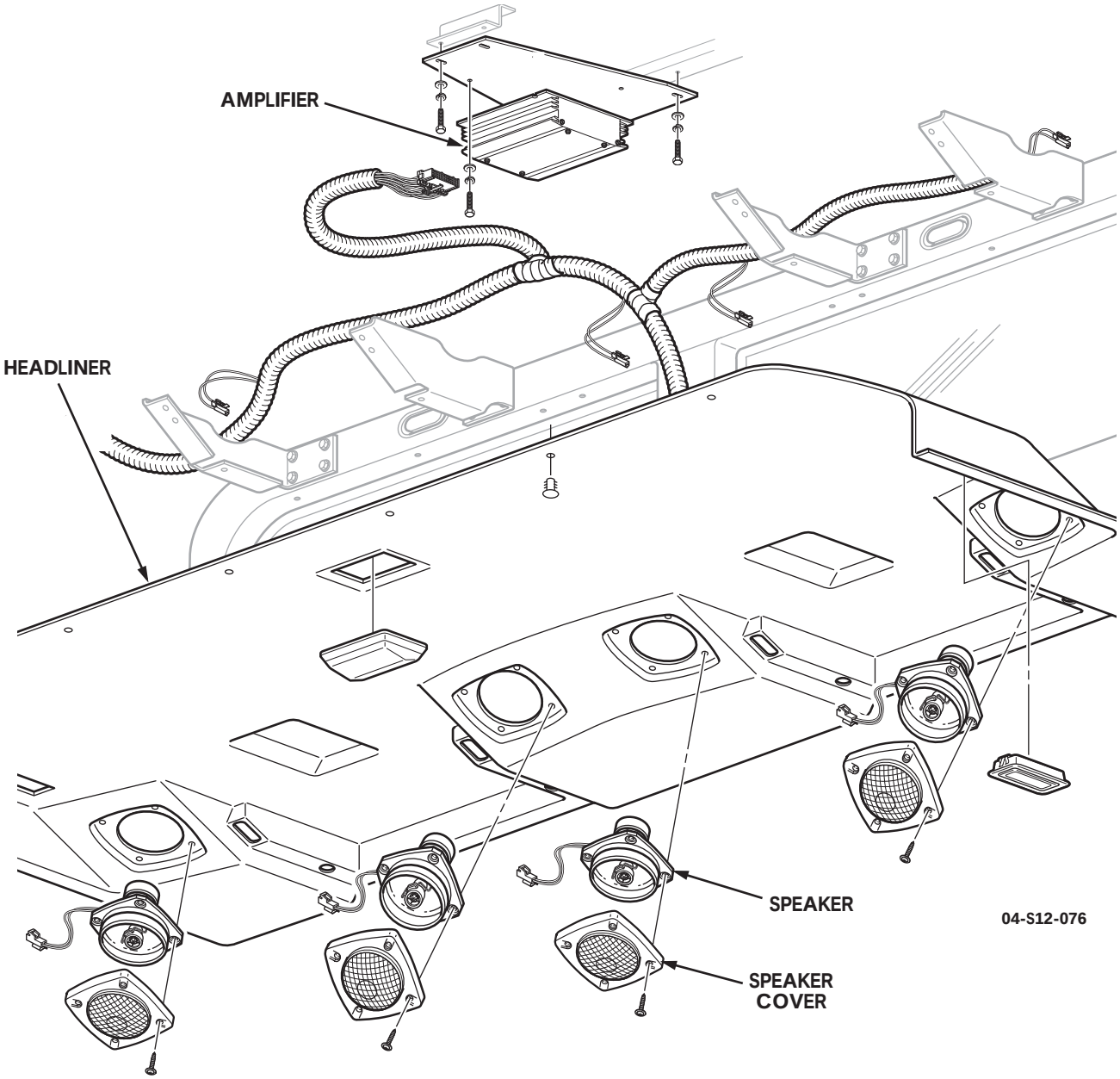


Figure 12-76: Overhead Speaker & Amplifier Removal.

Overhead Console, Speaker And Amplifier Replacement (Monsoon Model 90 Only)

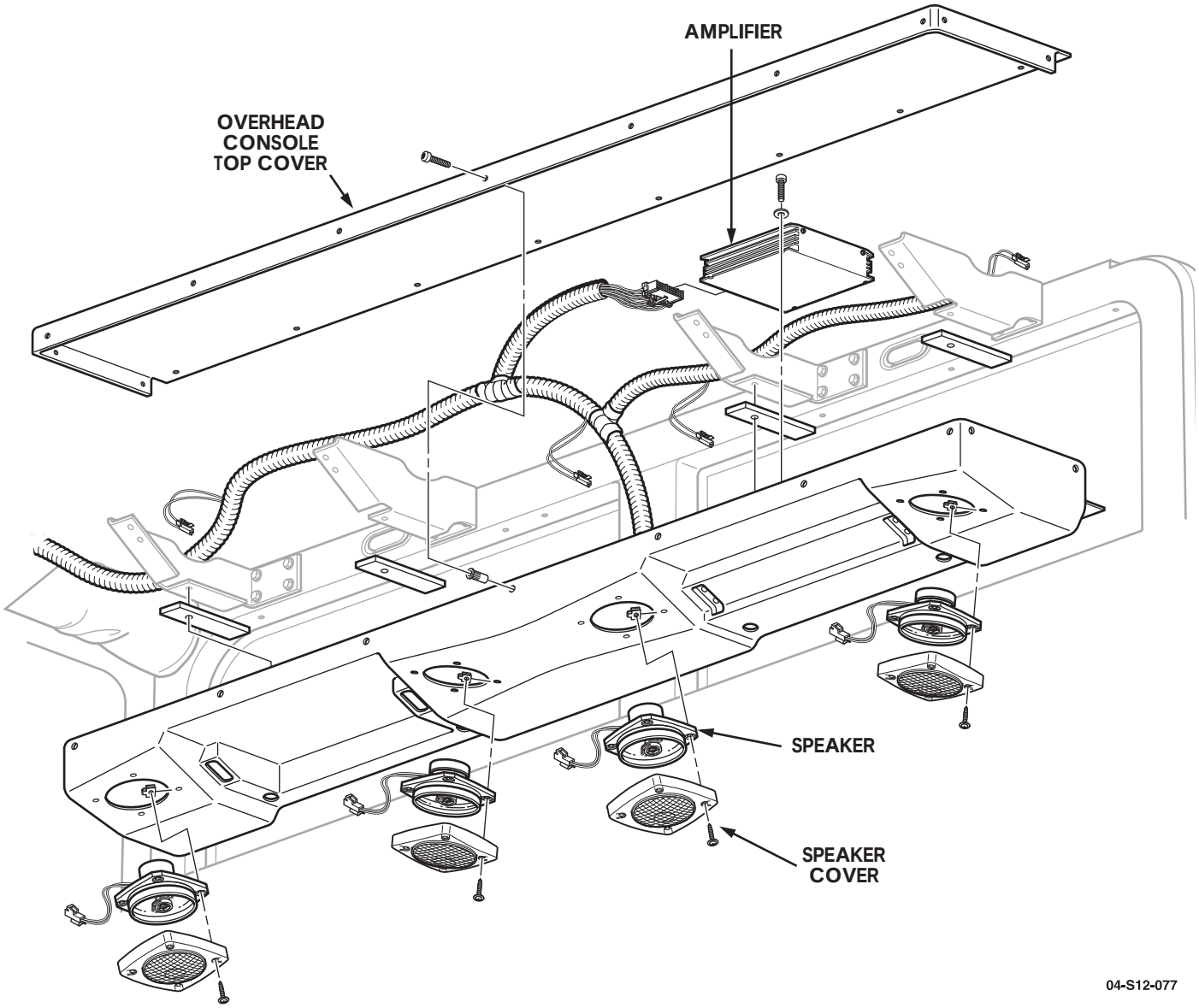


Figure 12-77: Overhead Console Removal (Model 90)

Removal

1. Remove the soft top
2. Remove the screws securing the sun visor to the over head console.
3. Remove the screws securing the top cover section of the overhead console, remove cover to gain access to the wiring (Figure 12-77).
4. Disconnect the speaker wiring harnesses from the roof harness.
5. Disconnect the 32 pin connector from the amplifier and the screws securing the amplifier to the lower half of the over head console.
6. Remove the amplifier.
7. Remove the speakers and wiring from the overhead console lower sections.
8. remove the screws securing the lower half of the over head console to the windshield frame.

Installation

1. Install the speakers and wiring in the overhead console lower sections.
2. Install the lower section to the windshield frame.
3. Install the amplifier and secure with the four mounting screws..
4. Connect the 32 pin connector to the amplifier.
5. Connect the speakers and overhead console wiring harnesses to the roof harness.
6. Install the over head console top cover.
7. Install the sun visors.

Rear Seat Audio (RSA) Unit Replacement

Removal

1. Remove the allen screws securing the center console rear bezel and remove the bezel (Figure 12-78).
2. Release the tension tabs securing the RSA unit to the center console rear bezel.
3. Pull the RSA unit out enough to expose the harness connector and disconnect the connector.

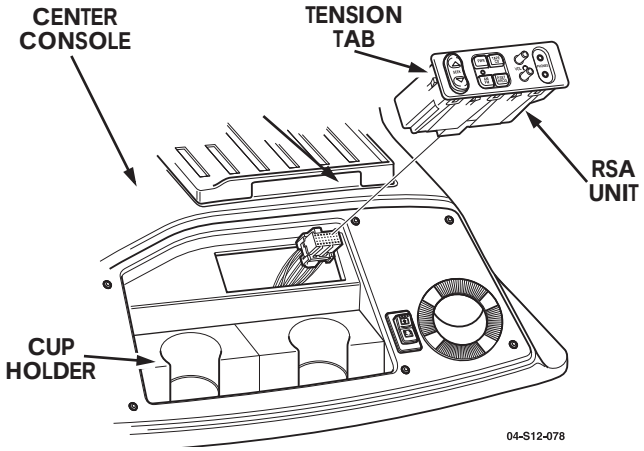


Figure 12-78: RSA Unit Replacement.

Installation

1. Connect the harness connector to the RSA unit and insert into the center console rear bezel. Push the RSA unit in until the tension tabs lock the unit in place.
2. Reinstall the center console rear bezel and secure with the allen screws.

Audio (Monsoon) Electrical Harness (Models 84 & 90) Replacement

Removal

1. Remove the radio.
2. Disconnect the harness connector from the radio (Figure 12-80).
3. Remove the center console.
4. Remove the Rear Seat Audio (RSA) unit from the center console rear bezel. Disconnect the RSA connector from the RSA unit.
5. Lower the headliner (Figure 12-79).
6. Disconnect the amplifier.
7. Disconnect the leads from the front speakers.
8. Remove the rear speaker from the trim.
9. Disconnect the leads from the rear speakers.
10. Disconnect the lead from the sub woofer under the left rear seat.

11. Remove the trim as necessary to gain access to the audio harness.
12. Remove the audio harness from the vehicle.

Installation

1. Route the audio harness to the approximate mounting position.
2. Secure the audio harness to the vehicle with duct tape, where necessary.
3. Connect the leads to the rear speakers.
4. Install the rear speakers and the covers.
5. Connect the lead to the sub woofer.
6. Connect the leads to the front speakers and the amplifier.
7. Install the headliner.
8. Connect the harness lead to the radio head and install the radio.
9. Connect the RSA connector to the RSA unit.
10. Install the center console.
11. Install the trim.

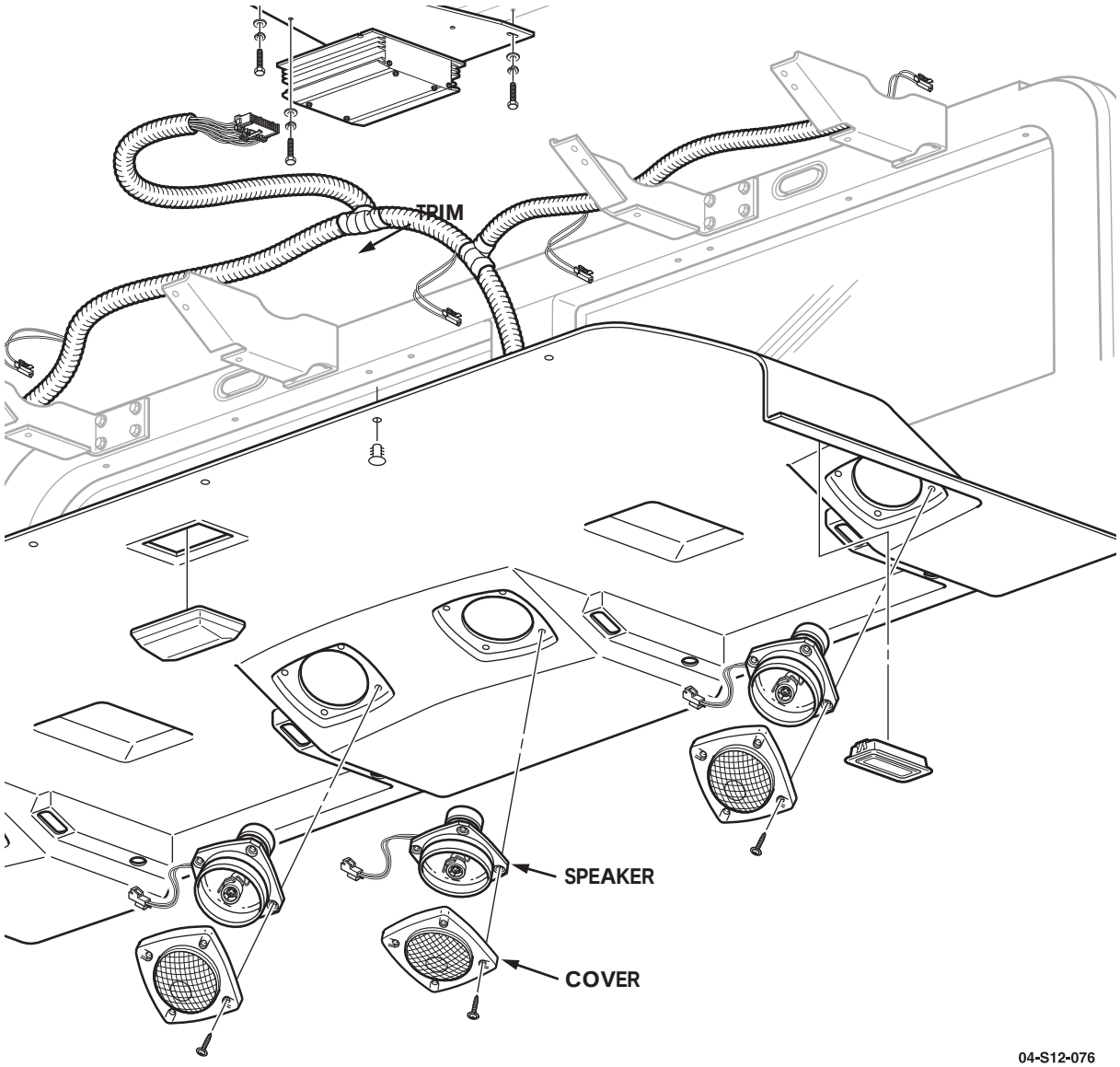


Figure 12-79: Front Speakers Models 83, 84 & 91.

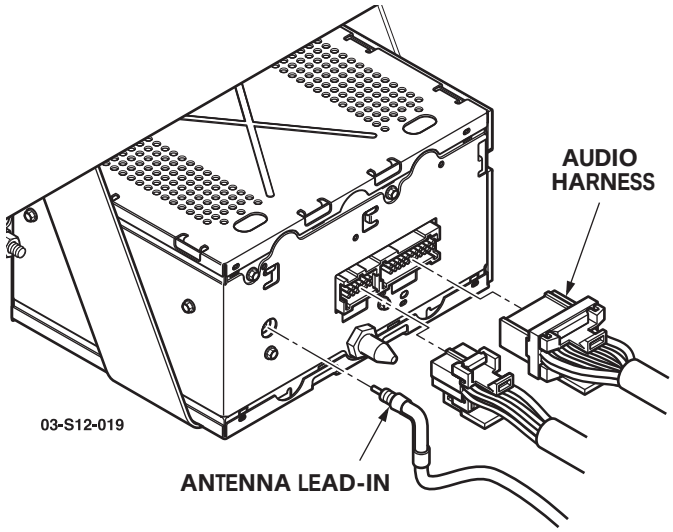


Figure 12-80: Audio Harness Connections.

DIAGNOSIS -AUDIO SYSTEM

1. Verify the customer complaint.
2. Follow the radio service procedures.
3. If any technical service is required, have all the pertinent information ready before placing the call.

NOTE: Before performing any diagnostic procedures or using any diagnostic tools, check wiring schematics for component circuitry to determine the location of fuses and circuit breakers in the circuit. Fuses and circuit breakers must be in good working order to perform proper diagnostic procedures.

Audio System Diagnostic Kit J–39916-A is available from Kent-Moore. The kit contains a diagnostic CD and cassette, a head cleaner cassette and instructions. This kit is designed to isolate the type of malady and the area of its origin by producing tones of various frequencies. By adjusting the fade and balance, a technician can evaluate the sound quality produced in different areas of the system.

Identifying Concerns

- Check for technical service bulletins.
- For reception concerns, determine if the station is obtainable in the customers listening area.
- To test for audio reception/noise, position the vehicle outside the building with the hood down.
- Duplicate the customers complaint before trying to diagnose the system. Have the customer demonstrate the condition. Test drive the vehicle with the customer and then test drive another similar model vehicle (with a similar audio system) to do a comparison of the two vehicles to determine if the condition is abnormal.
- Before diagnosing, identify components, their features and the customer’s complaint.
- Determine if any aftermarket equipment is installed on the vehicle. Disconnect the aftermarket equipment and determine if the customers complaint still exists.
- Perform the following steps to identify a noisy component:

1. Identify the ignition switch key position in which the noise appears, such as: accessory, key on engine not running, and key on engine running.
2. Remove the fuses one at a time until the complaint condition has been eliminated.
3. Mark the complaint fuse(s) and reinstall all the fuses and circuit breakers.
4. Identify all the systems and the components powered by the complaint fuse(s).
5. Disconnect the components powered by the complaint fuse(s) one at a time until the complaint condition has been eliminated and the noisy component has been identified.

6. Check the ground integrity of the complaint causing component.
   - An interference condition is not necessarily an audible noise.
   - Most noises can be found on weak stations near the low end of the band and are considered to be a normal condition.
   - Malfunctioning and marginal components, relays, and solenoids may induce noise and/or poor reception.
7. Check for a broken (or partially broken) wire inside of the insulation which could cause system malfunction but prove “good” in a continuity/voltage check with a system disconnected. These circuits may be intermittent or resistive when loaded, and if possible, should be checked by monitoring for a voltage drop with the system operational (under load).

Corrective Action

- Use proper tools for diagnostics and repairs.
- Follow electrical system diagnostic guidelines.
- Use available noise suppression devices:
  —Filter package P/N 05744279

Utilize the test tape /CD Diagnostic Kit Kent-Moore
P/N J–39916-A to optimize proper audio diagnostics.

- If the condition requires the radio to be sent to the service center, describe the symptoms on the warranty form exactly.
- Do not leave a CD disc or tape in the vehicle. Extreme heat could cause permanent damage.
- Cassette tapes could be damaged if not stored in the case. The vibration in the vehicle can cause the tape to unwind inside the cartridge.
- Use available trouble trees.
- Before removing speaker(s), check all connectors and wiring to the speakers. Examine the connectors for bent or loose pins. Refer to troubleshooting procedures.
- If a test antenna is used in diagnostics, ground the antenna base to the vehicle body and do not hold the mast.

NOTE: Check the antenna coax connectors for corrosion or bad connections/crimps. Route coax separately from the other wires. Shield antenna coax interconnections with aluminum or nickel tape. Check all vehicle grounds, not just antenna and radio grounds. Refer to the antenna diagnostic section.

- Coated screws or bolts can act as poor grounds.
- Always use a braided ground strap when applying grounds. Keep the ground strap as short as possible, the shorter the ground strap the better.
- When shielding the dash, wires, hoses (most hoses are conductive unless they have a white stripe), use aluminum foil tape or nickel tape to shield against magnetically induced interference. For optimum performance try varying the following ground techniques:
  —Add a ground at both ends of the tape.
  —Add a ground to just one end of the tape.
  —Do not add ground to the tape.
- When shielding a harness with tape, attach a ground strap to the end of the tape and then wrap the strap 360 degrees around the tape securing the other end of the strap to a known good chassis ground.
- Any interference is best corrected by suppression at the source of the interference, if possible.
- Care should be used when applying suppression. Signal wires (such as sensor outputs, clock, and communication circuits) cannot be suppressed. After adding any suppression, all vehicle systems (even those not related to the audio system) should be checked for proper operation and function.
- Interference can usually be eliminated by shielding/grounding or suppressing.
- Capacitors work best on switch pops and low frequency noise. Filters work best on high frequency whines and static.
- Whenever possible, make a test harness that includes filters and capacitors. Always check the effectiveness and operation before permanently installing a fix.

- Recommended capacitor application for an audible pop induced from a switching operation is:
  —Add a capacitor across the contacts of the switch.
  —Add a capacitor from the hot side of the switch to ground.
  —Add a capacitor to each side of the switch to ground.
- If a complaint condition is only present with the ignition key in the run position and the engine running, perform the following checks:
  —Check the integrity of the engine compartment grounds.
  —Check for malfunctioning relays, solenoids, or other components which may be inducing “noise” or poor reception.
  —Check the ground integrity of the complaint causing component.
- For noise and/or poor reception, perform the antenna system test and make the necessary repairs.

TEST ANTENNA

The test antenna is simply an antenna that is not mounted on the vehicle. This tool is used as a substitute for the antenna mounted on the vehicle. The technician should connect the test antenna to the antenna input of the radio. Ground the base of the antenna to the vehicle’s chassis. **Do not hold the mast of the antenna.** This will decrease the capability of the antenna to receive a station.

GENERATOR WHINE CONCERNS

- Check the ground terminal on the battery.
- Check for coated mounting bolts on the generator bracket.
- Check for a faulty mounting of the generator to the engine.
- Make sure grounds at starter and intake manifold are clean and tight.
- Try the following:

1. If a noise is still present, check the charging system.
2. If the charging system is functioning normally, check for technical service bulletins on generator whine.
3. Install a filter P/N 05744279 in the battery feed to the radio.
4. Try installing the filter with the following variations if the noise is not eliminated.
   a. Install the filter with the single wire side toward the radio and the ground wire attached to a good ground.
   b. Remove the ground to the filter.
   c. Reverse the filter so the two wire side is toward the radio with the ground wire attached to a good ground.
   d. Remove the ground from the filter.
5. If the noise is still present, install another filter P/N 05744279 in the ignition feed to the radio. Install using the same variations as the first filter. If the installation of this filter causes turn on or turn off delays or other noticeable performance concerns, remove it and install a 0.47 mf (microfarad) capacitor in its place.
6. Remove any unneeded filters after repair, before reassembling the vehicle.

Symptom Table

SYMPTOM	PROCEDURE	PAGE NUMBER
Display inoperative, no sound from any speaker.	Chart #1	12-119
No sound from one speaker (std.).	Chart #2	12-120
No sound from one speaker (Monsoon).	Chart #3	12-120
No sound from any speaker, radio display operates normally (Monsoon).	Chart #4	12-122
Antenna system test.	Chart #5	12-123
Rear seat audio does not operate.	Chart #6	12-123
Radio controls are inoperative.	Service radio.	
Radio does not turn off.	Service radio.	
Radio memory (clock and station presets) is inoperative.	Check ckt. 476 for an open or high resistance between radio connector terminal “7” and fuse 2H.	
Display dimming does not vary using the I/P dimmer switch (I/P dimming works).	Check ckt. 17 for an open or high resistance between radio connector terminal “6” and the panel light dimmer.	
Speaker output distorted at high volume (Monsoon).	Check for open or poor connection in ckt. 59 from amplifier terminals “E8” and “E9” to the I/P ground point. Check for open or poor connection in ckt. 829 from amplifier terminals “E11” and “E12” to fuse 1D. If OK, replace amplifier.	

DISPLAY IS INOPERATIVE, NO SOUND FROM ANY SPEAKER

CHART #1

STEP	ACTION	VALUE(S)	YES	NO
1	Disconnect radio connector. Ignition switch to “run”. With a DVOM, measure voltage between terminal B1 and ground.	Approximate battery voltage.	Go to step 2.	Repair poor connection or open in ckt. 476 between radio connector terminal B1 and fuse 2H.
2	With a DVOM, measure voltage at radio connector between terminal B1 and terminal A12.	Approximate battery voltage.	Go to step 3.	Repair poor connection or open in ckt. 59 between radio connector terminal A12 and ground point G4.
3	With a DVOM, measure voltage at radio connector between terminal B2 and terminal A12.	Approximate battery voltage.	Go to step 4.	Repair open in ckt. 137 between radio connector terminal B2 and fuse 4G.

CHART #1 (Cont'd)

STEP	ACTION	VALUE(S)	YES	NO
4	Check for poor connection at radio.			Go to step 5
5	Verify the radio is programmed with the Tech 2. If OK, service radio.			

NO SOUND FROM ONE SPEAKER (STANDARD)

CHART #2

	ACTION	VALUE(S)	YES	NO
1	Ignition switch "off". Disconnect radio connectors. With a DVOM, measure resistance at the radio connector between speaker + and - circuits (see schematics).	Approximately 4 ohms.	Go to step 3.	Go to step 2.
2	With a DVOM, measure the resistance at the speaker connection from terminal "A" to terminal "B".	Approximately 4 ohms.	Repair open or short circuit in speaker + and - circuits.	Replace speaker.
3	With a DVOM measure the resistance at the radio connector of the speaker + and - circuits to ground.	Infinite resistance.	Go to step 4.	Repair short to ground in speaker + or - circuit.
4	Check for poor connections at radio or speaker. If OK, service radio.			

NO SOUND FROM ONE SPEAKER (MONSOON) (FIGURE 12-87)

CHART #3

STEP	ACTION	VALUE(S)	YES	NO
1	Turn ignition switch to run. Turn radio on. Insert cassette or compact disc from Audio system Diagnostic Kit J–39916-A. Set radio balance and fade controls to the detent (center) position. Set volume at normal listening level. While playing the combination test tone from cassette or compact disc, use a DVOM, to back probe the speaker connector between terminals "A" and "B". Is the voltage greater than 0V AC?	> 0V AC	Go to step 2.	Go to step 3.

CHART #3 (Cont'd)

STEP	ACTION	VALUE(S)	YES	NO
2	Check for a poor connection at the inoperative speaker. If OK, replace the speaker. Is the repair complete?		System OK.	
3	Check the + and - speaker circuits for a short to B+ or ground between the speaker and amplifier. Is there a short?		Repair short to ground or B+.	Go to step 4.
4	Turn ignition switch off. Disconnect amplifier connector. Using a DVOM, set to measure resistance, probe the amplifier connector between the + and - speaker circuits of the inoperative speaker (see schematics). Is the resistance approximately 2-4 ohms?	2-4 ohms	Go to step 6.	Go to step 5.
5	Using a DVOM, check the resistance at the speaker connection between terminals "A" and "B". Is the resistance 2-4 ohms?	2-4 ohms	Repair open in speaker + or - circuit between speaker connection and amplifier connection.	Replace speaker.
6	Check for poor connection at amplifier connector. Is connection OK?		Replace amplifier.	Repair connection.

NO SOUND FROM ANY SPEAKER, RADIO DISPLAY OPERATES NORMALLY (MONSOON) (FIGURE 12-87)

CHART #4

STEP	ACTION	VALUE(S)	YES	NO
1	Disconnect amplifier connector. Turn ignition switch to run. Turn radio on. Insert cassette or compact disc from *f* Audio System Diagnostic Kit J–39916-A. Set radio balance and fade controls to the detent (center) position. Set radio volume at normal listening level. While playing the combination test tone from the cassette or compact disc, use a DVOM to measure AC voltage between amplifier connector terminals “E6” and “E7”. Is the voltage greater than 0V AC?	> 0V AC	Go to step 2.	Go to step 4.
2	Check for a poor connection at the amplifier connector terminals “E6” and “E7”. Was poor connection found?		Repair connection.	Go to step 3.
3	Using a DVOM, check for B+ between circuits 829 and 59 at the amplifier connection.	Battery +	Replace amplifier.	Repair open or poor connection in circuits 829 and 59.
4	Turn ignition switch to run. Turn radio on. Insert cassette or compact disc from the Audio System Diagnostic Kit J–39916-A. Set radio balance and fade controls to the detent (center) position. Set radio volume at normal listening level. While playing the combination test tone from the cassette or compact disc, use a DVOM and back probe radio connector between terminals “16” and “15”. Is the voltage greater than 0V AC?	> 0V AC	Go to step 5.	Go to step 6.
5	Repair open or short in circuit 821 or 820 between radio and amplifier. Is the repair complete?		System OK.	
6	Check for bad connection at radio connector 16 or 15. Is bad connection found?		Repair connection.	Replace radio.
7	Check for a short to B+ or ground in circuit 821 between radio and amplifier. Check for a poor connection at radio connector terminal “16”. If OK, replace radio. Is the repair complete?		System OK.	

ANTENNA SYSTEM TEST

CHART #5

STEP	ACTION	VALUE(S)	YES	NO
1	Disconnect negative battery cable. Disconnect antenna lead-in cable at the radio receiver. With a DVOM, measure resistance between the coax (outer conductor) connector and the negative battery cable. **NOTE:** To avoid misdiagnosis be sure to zero the meter before taking measurements. Is resistance value greater than.15 ohms?	>.15 ohms	Check the base of the antenna for a good connection to body ground. Check the coaxial cable interconnects for a poor connection or corrosion. Check the ground connection from the battery negative cable to the body. Repair the antenna ground circuit as necessary.	Go to step 2.
2	Grasp the antenna mast. While observing the DVOM, wiggle the antenna and the lead-in cable ground strap. Does the meter indicate intermittent continuity?		Check the lead-in cable ground strap for a good connection to body ground. Check the coaxial cable interconnects for a poor connection or corrosion. Check the ground connection from the battery negative cable to the body. Repair the antenna ground circuit as necessary.	Go to step 3.
3	With a DVOM, measure the resistance between the radio coax lead-in connector (center conductor) and the antenna mast. **NOTE:** To avoid misdiagnosis be sure to zero the meter before taking measurements. Does the measured resistance equal approximately the value listed?	Less than 3.5 ohms	Go to step 4.	Check the coaxial cable interconnects for a poor connection or corrosion. Repair/replace the antenna coaxial circuit as necessary.
4	While observing the DVOM, wiggle the antenna. Does the meter indicate intermittent continuity?		Check the coaxial cable interconnects for a poor connection or corrosion. Repair/replace the antenna coaxial circuit as necessary.	See troubleshooting hints for noise and poor reception.

REAR SEAT AUDIO (RSA) DOES NOT OPERATE

CHART #6

STEP	ACTION	VALUE(S)	YES	NO
1	With ignition on, check for voltage at RSA pin A8 (RSA ignition signal). Is voltage present?	Approximate battery voltage.	Go to step 2.	Check/repair open circuit between RSA pin A8 and radio pin A6.

CHART #6

STEP	ACTION	VALUE(S)	YES	NO
2	With ignition on and radio on, check for voltage at RSA pin B5 (RSA enable signal). Is voltage present?	Approximate battery voltage.	Go to step 3.	Check/repair open circuit between RSA pin B5 and radio pin A3.
3	Check for continuity between radio pin A12 and ground. Is there continuity?	< 0.2 Ω.	Go to step 5.	Repair circuit 59 between radio and ground point G4.
4	Check for continuity between radio pin A12 and RSA pin B6. Is there continuity?	< 0.2 Ω.	Go to step 5.	Repair circuit 59 between radio and RSA.
5	With ignition on and RSA on, check for voltage at RSA pin A5 (RSA control signal). Is voltage present?	+ 5 VDC.	Replace RSA unit.	Go to step 6.
6	With ignition on and RSA on, check for voltage at radio pin B7 (RSA control signal). Is voltage present?	+ 5 VDC.	Go to step 7.	Check/repair open circuit between RSA pin A5 and radio pin B7.
7	Check for an open circuit between radio pin B8 and RSA pin A4 (left rear +). Is there continuity?	< 0.2 Ω.	Go to step 8.	Check/repair open circuit between RSA pin A4 and radio pin B8.
8	Check for an open circuit between radio pin B9 and RSA pin A3 (left rear -). Is there continuity?	< 0.2 Ω.	Go to step 9.	Check/repair open circuit between RSA pin A3 and radio pin B9.
9	Check for an open circuit between radio pin A11 and RSA pin A2 (right rear +). Is there continuity?	< 0.2 Ω.	Go to step 10.	Check/repair open circuit between RSA pin A2 and radio pin B11.
10	Check for an open circuit between radio pin A18 and RSA pin A1 (right rear -). Is there continuity?	< 0.2 Ω.	Go to step 1.	Check/repair open circuit between RSA pin A1 and radio pin A18.

HEATED LEATHER SEATS

The vehicle may come equipped with front heated leather seats. The switch for the drivers seats is on the drivers side of the center console (See Figure 12-82). When seated, the left side of the switch is the high setting, the right side is the low setting and the center position is off. Passenger heated seat switch is located on the drivers side of the center console (See Figure 12-81). Service to the seat heater is limited to switch replacement and module replacement. All other repairs must be performed in conjunction with the heated seat kit.

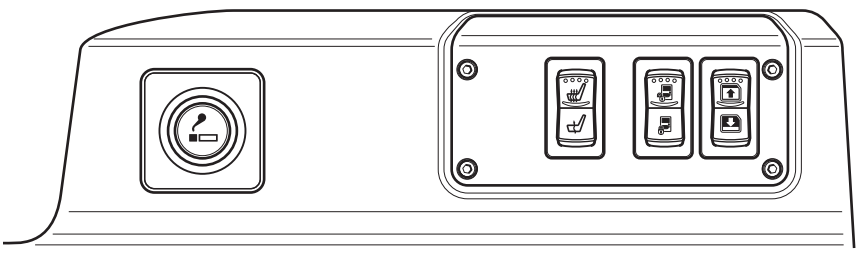


Figure 12-81: Passengers Control Panel

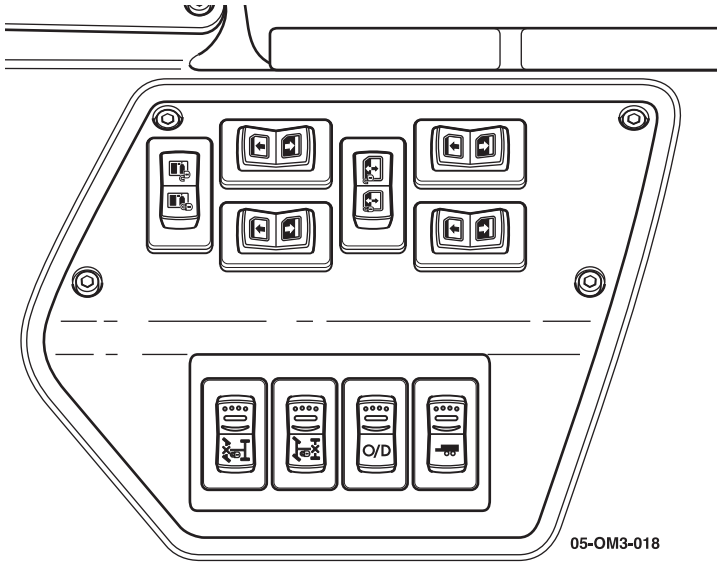


Figure 12-82: Drivers Control Panel

Seat Heater Does Not Heat (Figures 12-139 and 12-140)

Step	Action	Value(S)	Yes	No
1	**NOTE:** The control box contains a timer that will shut the heater off after one hour of use. The switch must be cycled "OFF" and "ON" to restart the heat cycle. Turn ignition to the "ON" position. Position the seat heater switch to one of the heat positions. Does the switch illuminate?	Switch light "ON"	Go to step 2.	Check ckt 241 RD at the control box connector C9 for +12v and If circuits OK and switch is not illuminated, replace the switch.
2	Cycle seat heater switch "OFF and "ON". Do you hear an audible click coming from the control box?	Audible relay click.	Go to step 4.	Go to step 3.
3	Check switch output power at the control box connection. In high position check for voltage on the white wires. In low position check for voltage on the orange wires.	Approximate battery + voltage.	Go to step 4.	Replace the switch.
4	Check resistance at terminals "A" and "D" of 4 position cushion connector. Is the resistance within specification?	3.2 Ω +/-10% (resistance of back and cushion element in series)	Go to step 6.	Go to step 5.
5	Isolate the back element and check its resistance. Is the resistance within specification?	1.2 Ω +/- 10%	Replace the cushion element.	Replace the back element.
6	Check resistance of NTC heat sensor in the cushion element. Is the resistance within specification?	10K Ω +/- 10% at 77° F	Replace the control box.	Replace cushion element.

NEUTRAL START BACK UP (NSBU) SWITCH

The vehicle is equipped with a console style shift selector. In addition to the console shift selector provided for the operator, another component associated with the shift selector is the neutral start back up (NSBU) switch mounted on the selector shaft of the transmission. The NSBU switch transmits selector position information to the TCM. The NSBU switch mounts directly onto the transmission housing from the outside and detects the angular position of the shift selector shaft. this position is communicated to the TCM so that certain vehicle control functions can be coordinated with the position of the shift controls. The NSBU switch has redundant circuitry to alert the TCM in the event of a single wire or switch failure. The neutral signal output of the NSBU switch is used as confirmation that the transmission is in neutral before the engine starter is engaged. The NSBU switch is interfaced to the starter circuit. The reverse signal is used for back up lights, auto dimming mirror defeat and may be used for back up warning devices.

WIRING SCHEMATICS

ABS/TT4 POWER, GROUND AND WARNING LAMP CIRCUIT

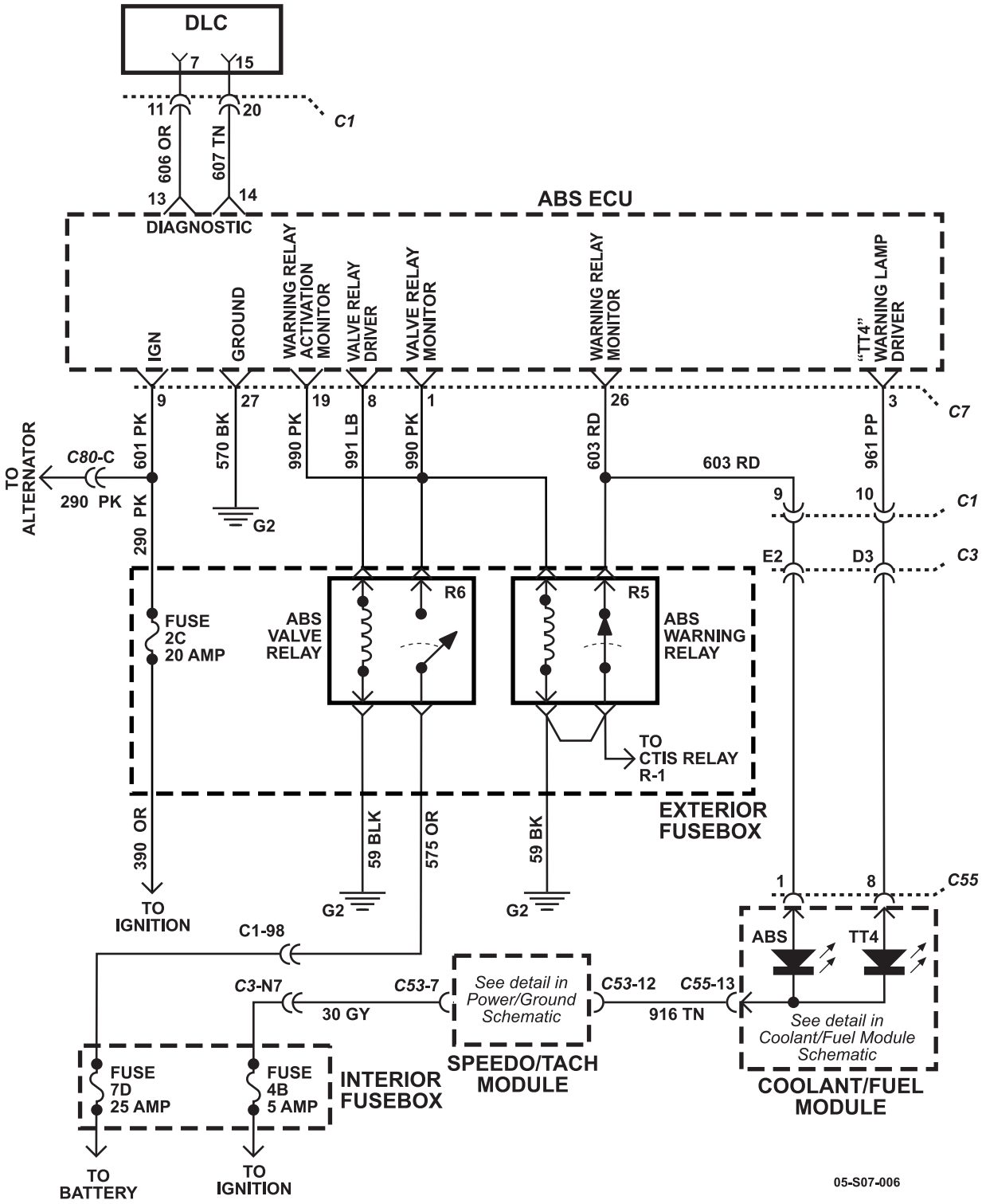


Figure 12-83: ABS/ TT4 Wiring Schematic

ABS/ TT4 MAIN SYSTEM DIAGRAM

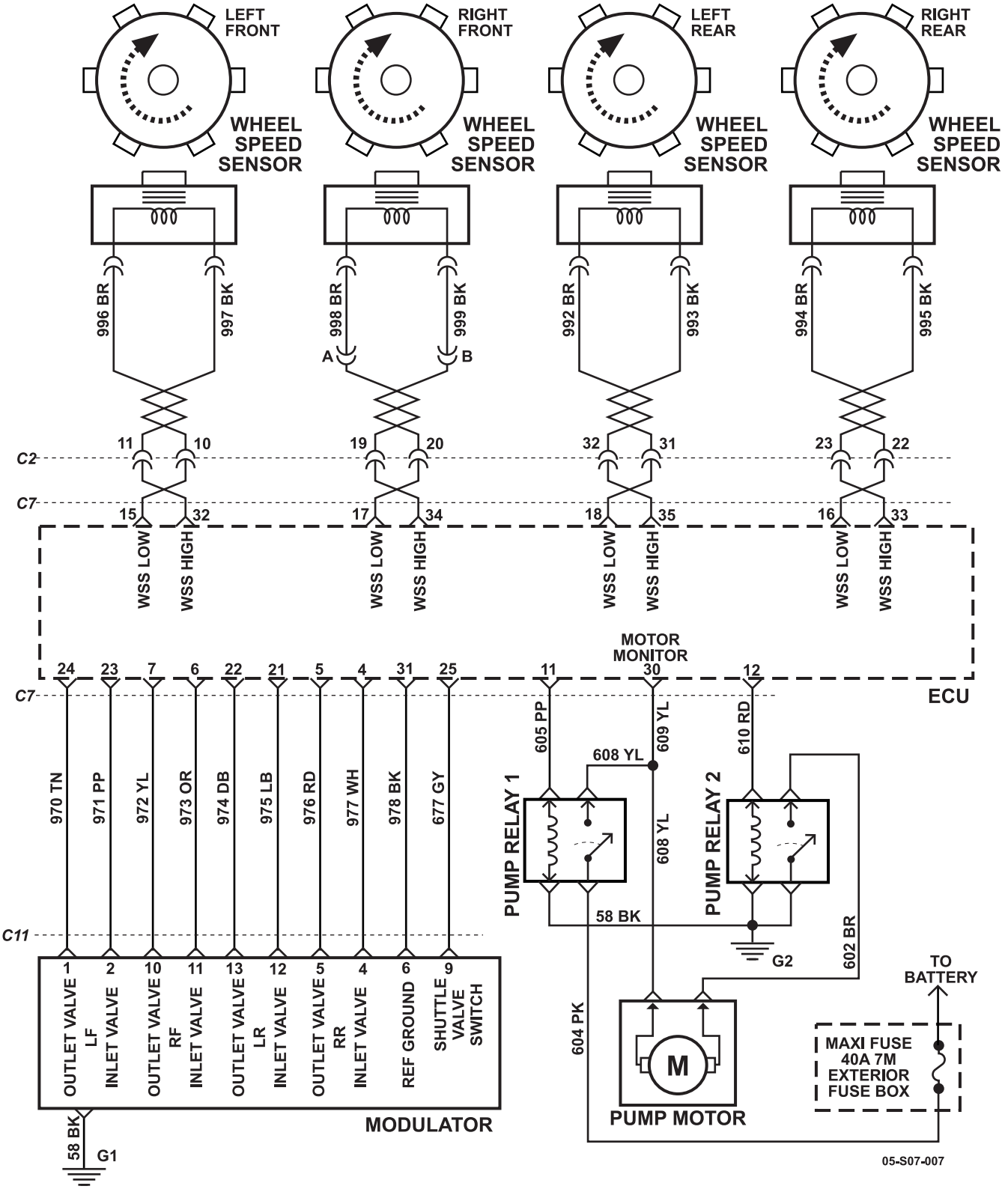


Figure 12-84: ABS/ TT4 Wiring Schematic

ACCELERATOR PEDAL POSITION (APP) CIRCUIT

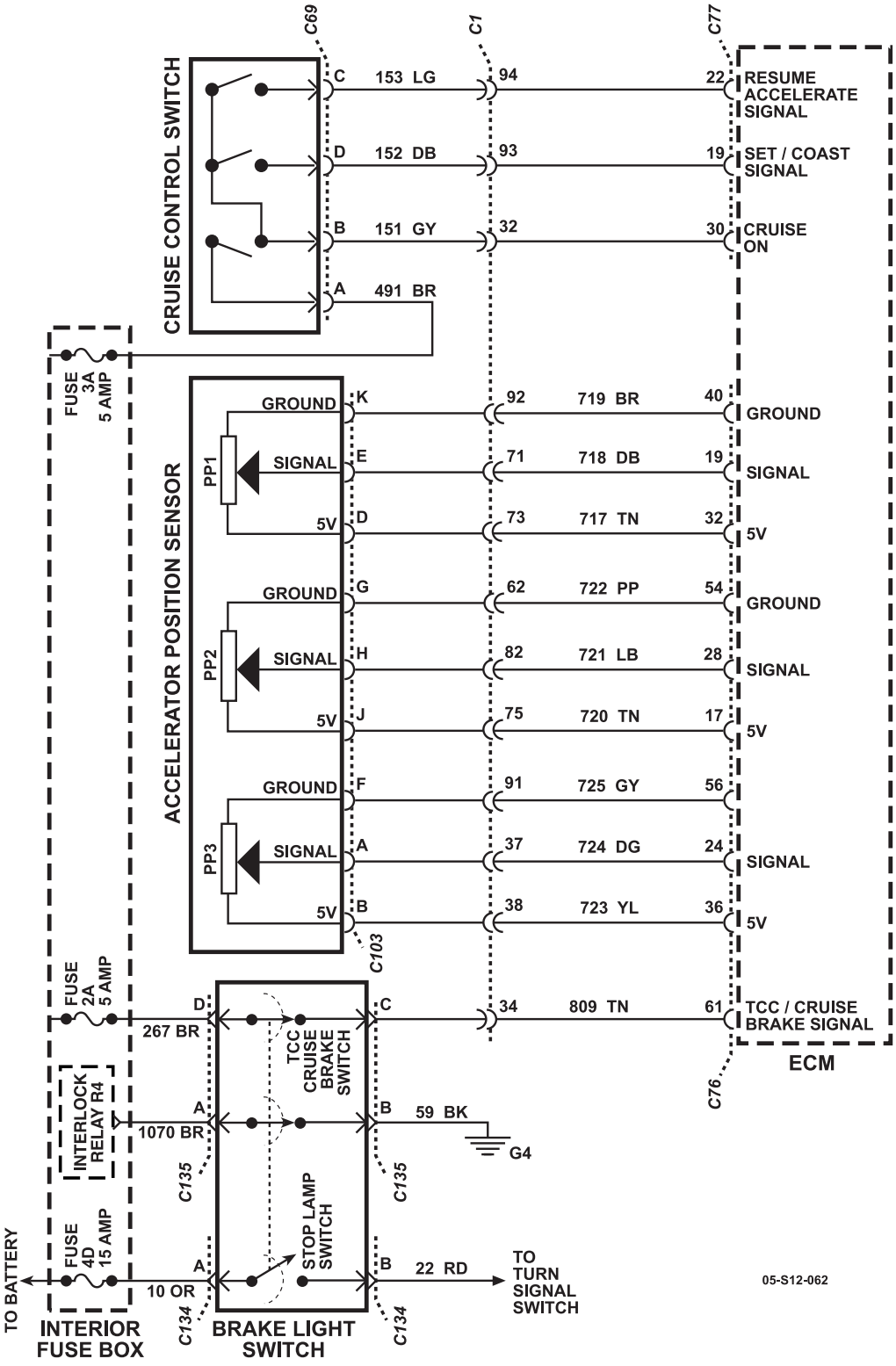


Figure 12-85: Accelerator Pedal Position Wiring Schematic

ALTERNATOR

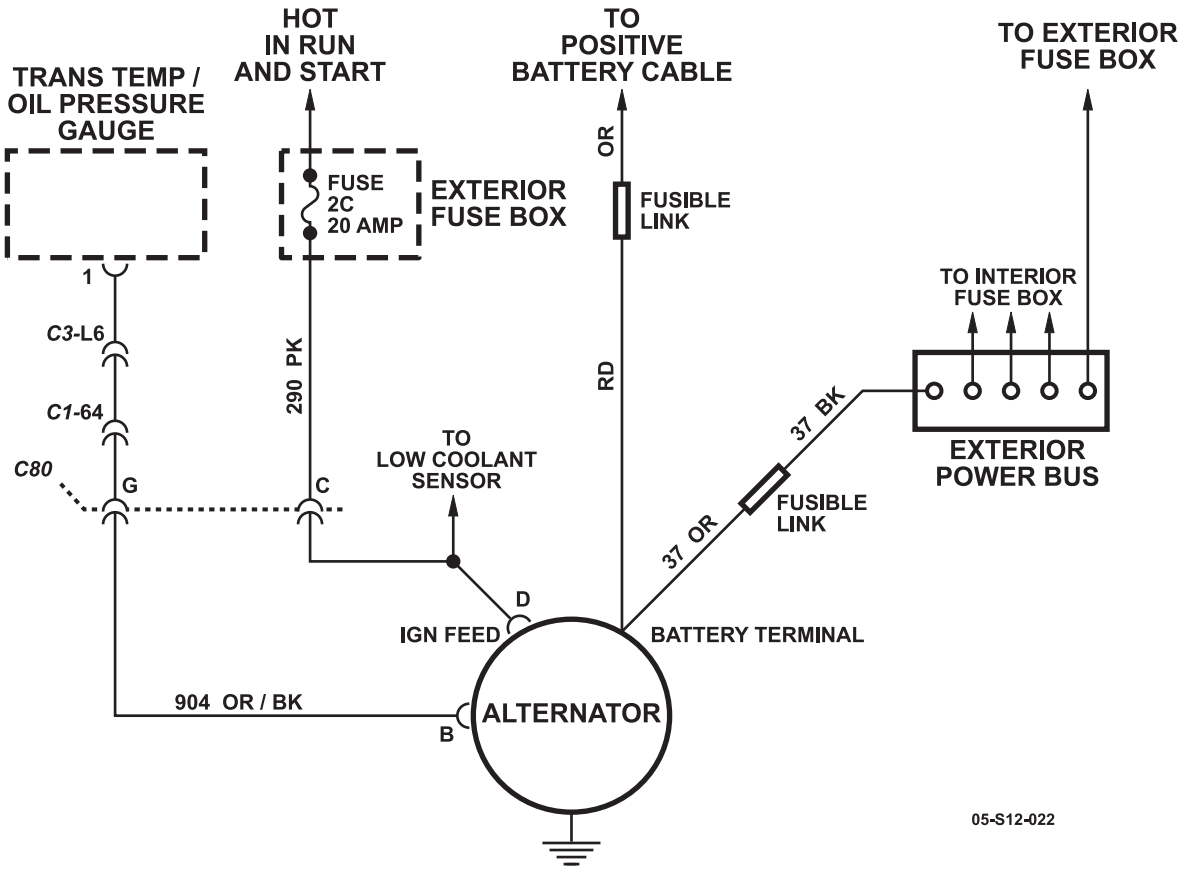


Figure 12-86: Alternator Wiring Schematic

AUDIO

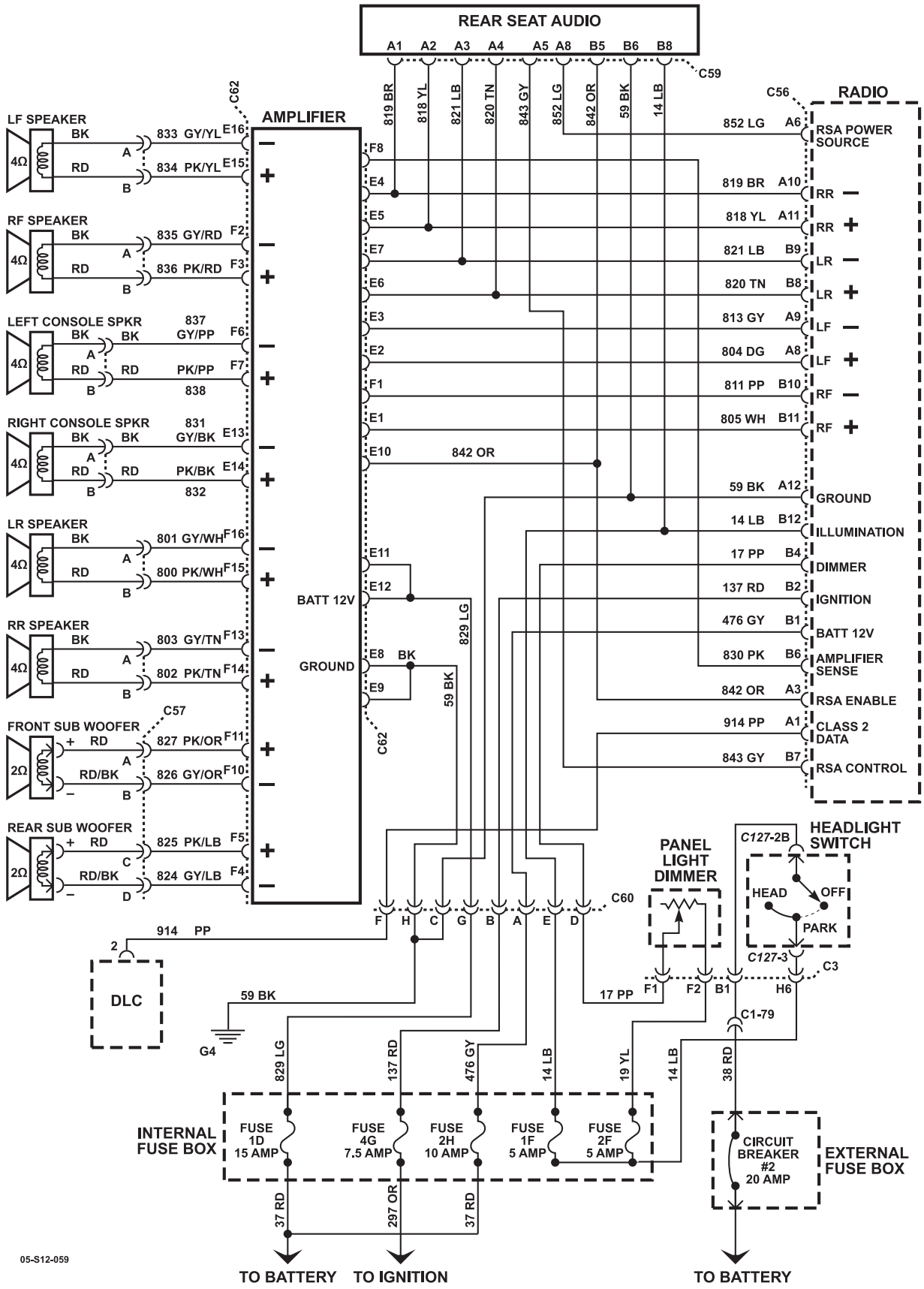


Figure 12-87: Audio Wiring Schematic

BAROMETRIC PRESSURE (BARO) SENSOR

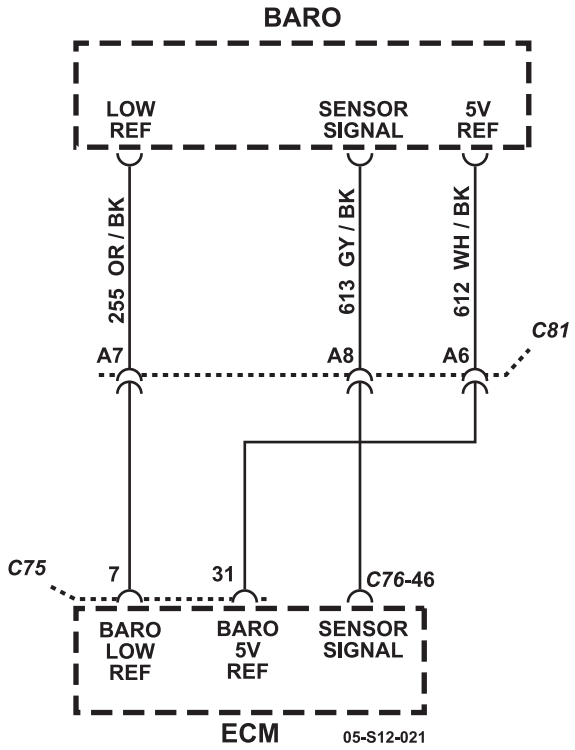


Figure 12-88: Barometric Pressure Sensor Wiring Schematic

BLOWER MOTOR (AUXILIARY)

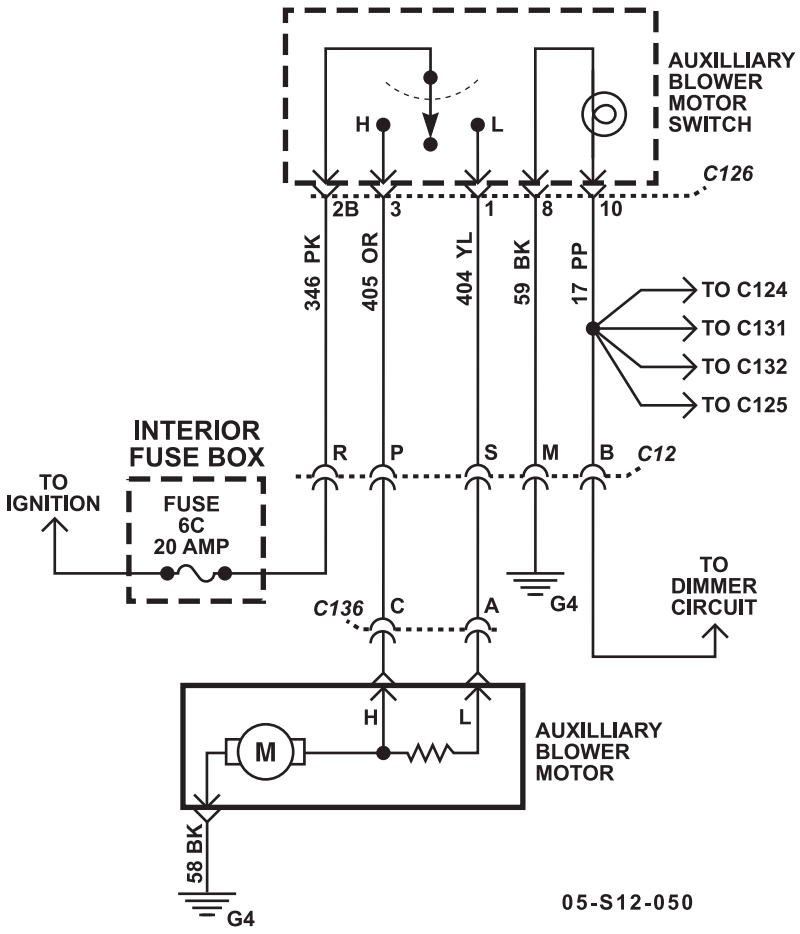


Figure 12-89: Auxiliary Blower Motor Wiring Schematic

BLOWER MOTOR (MAIN)

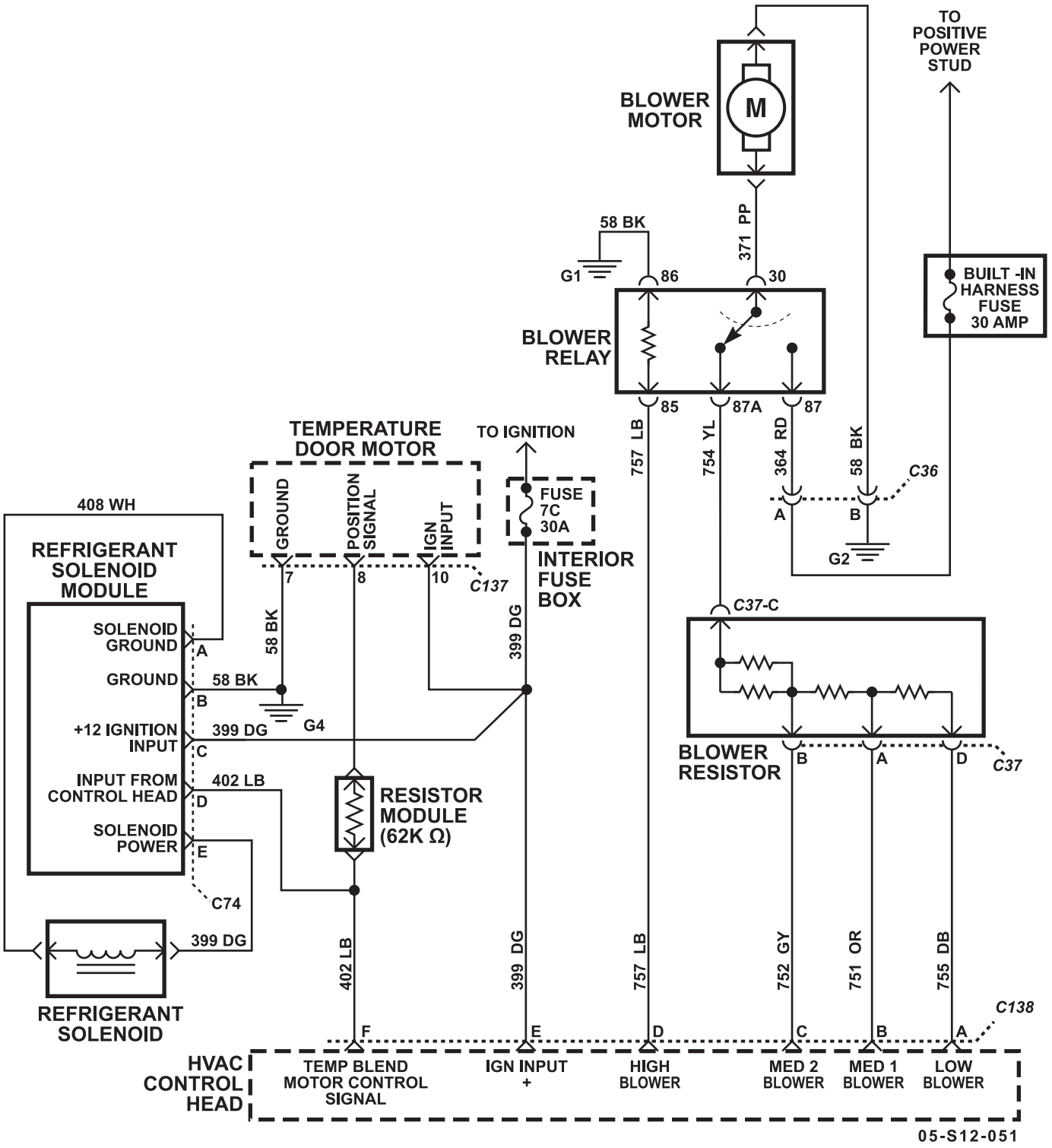


Figure 12-90: Blower Motor Wiring Schematic

BOOST SENSOR

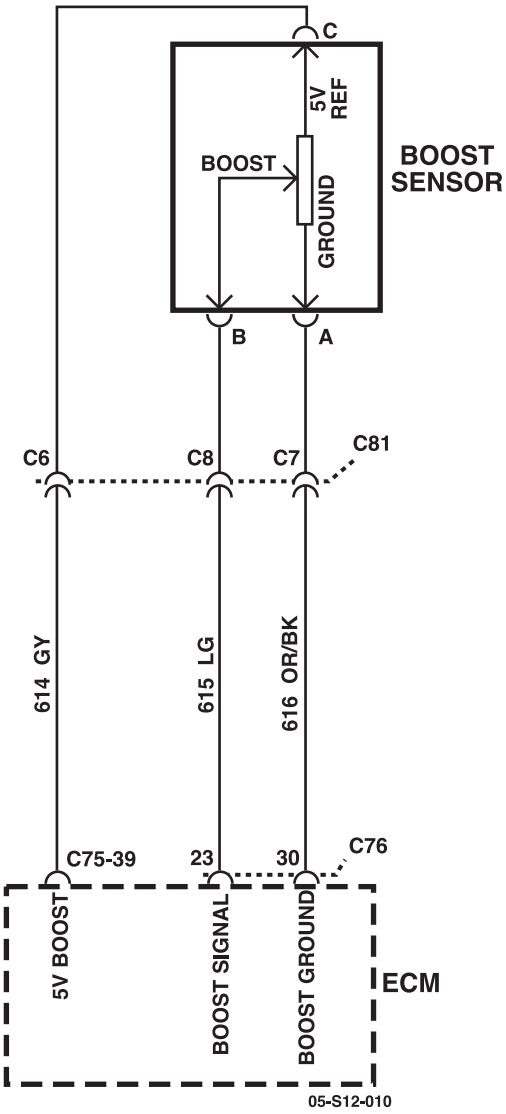


Figure 12-91: Boost Sensor Wiring Schematic

BACK UP LIGHTS

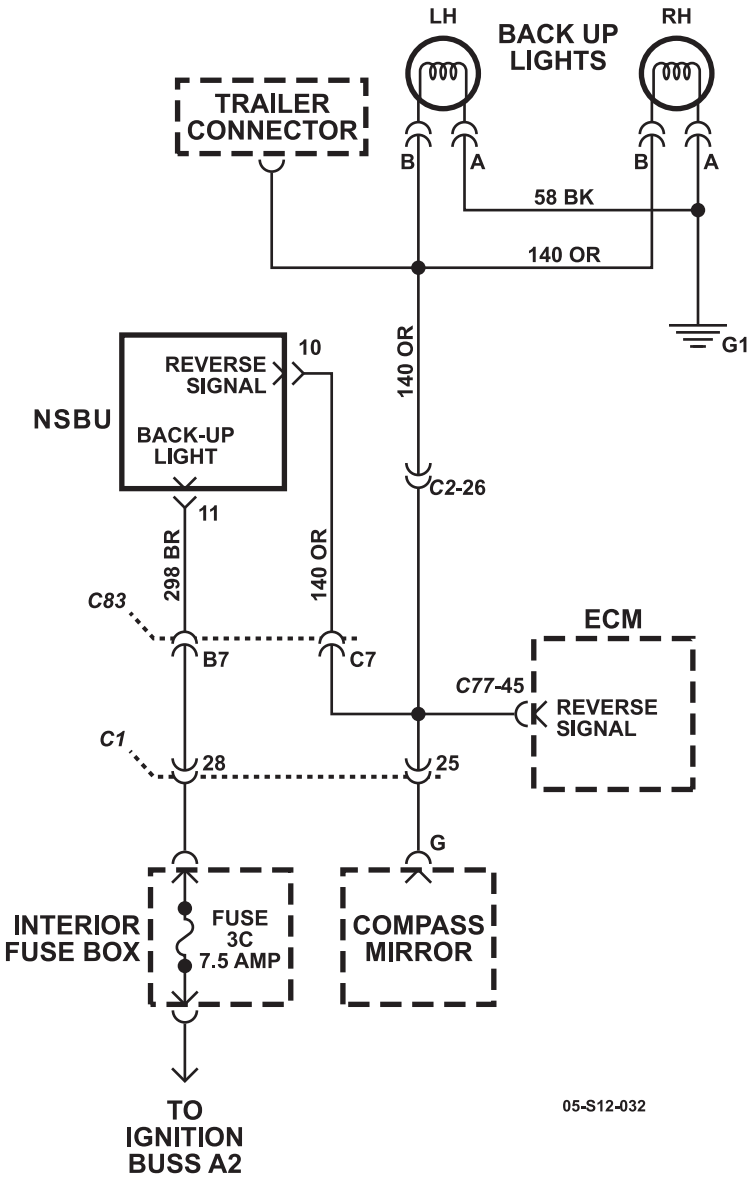


Figure 12-92: Back Up Lights Wiring Schematic

BRAKE LIGHTS

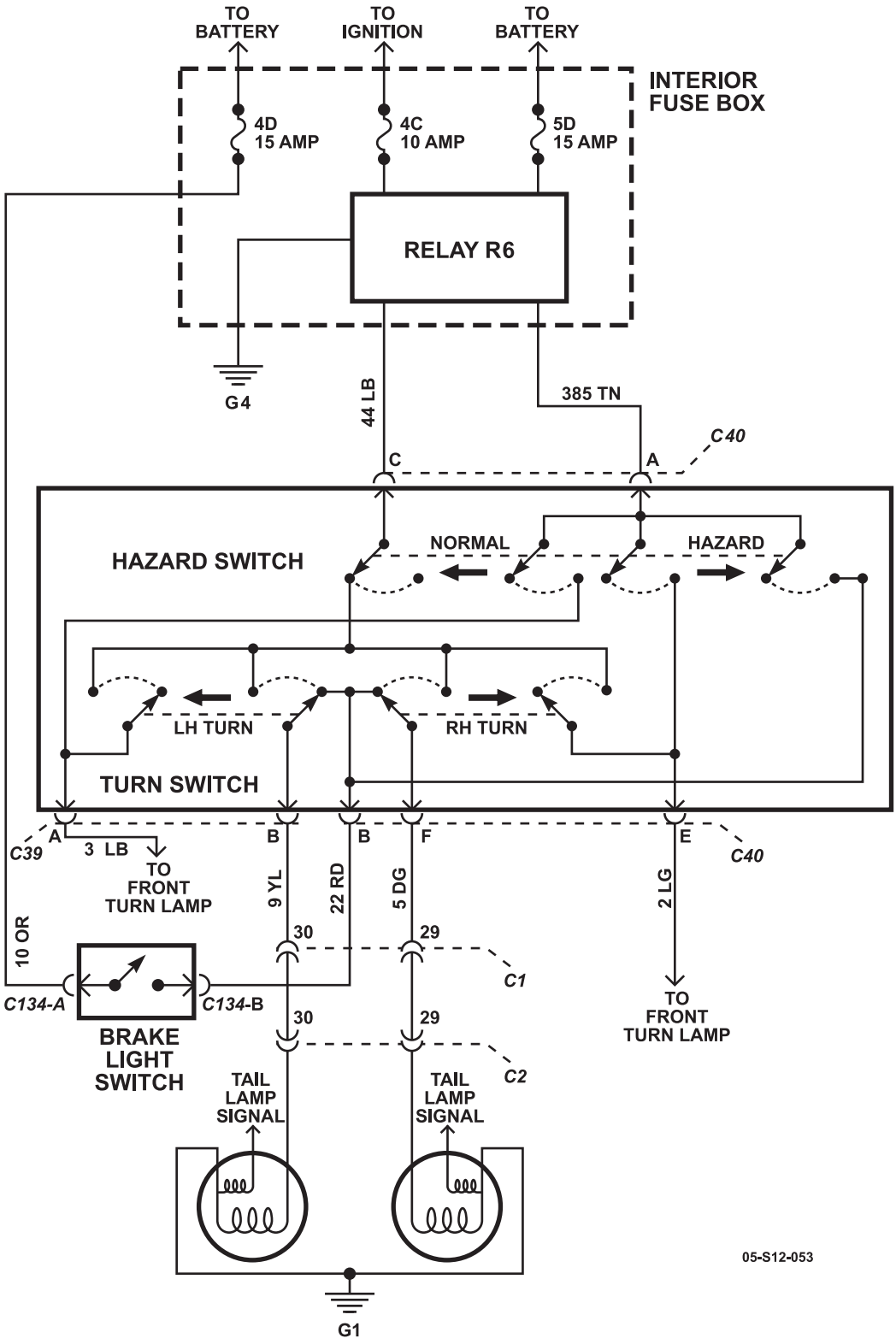


Figure 12-93: Brake Lights Wiring Schematic

CAM SENSOR/ CRANK SENSOR

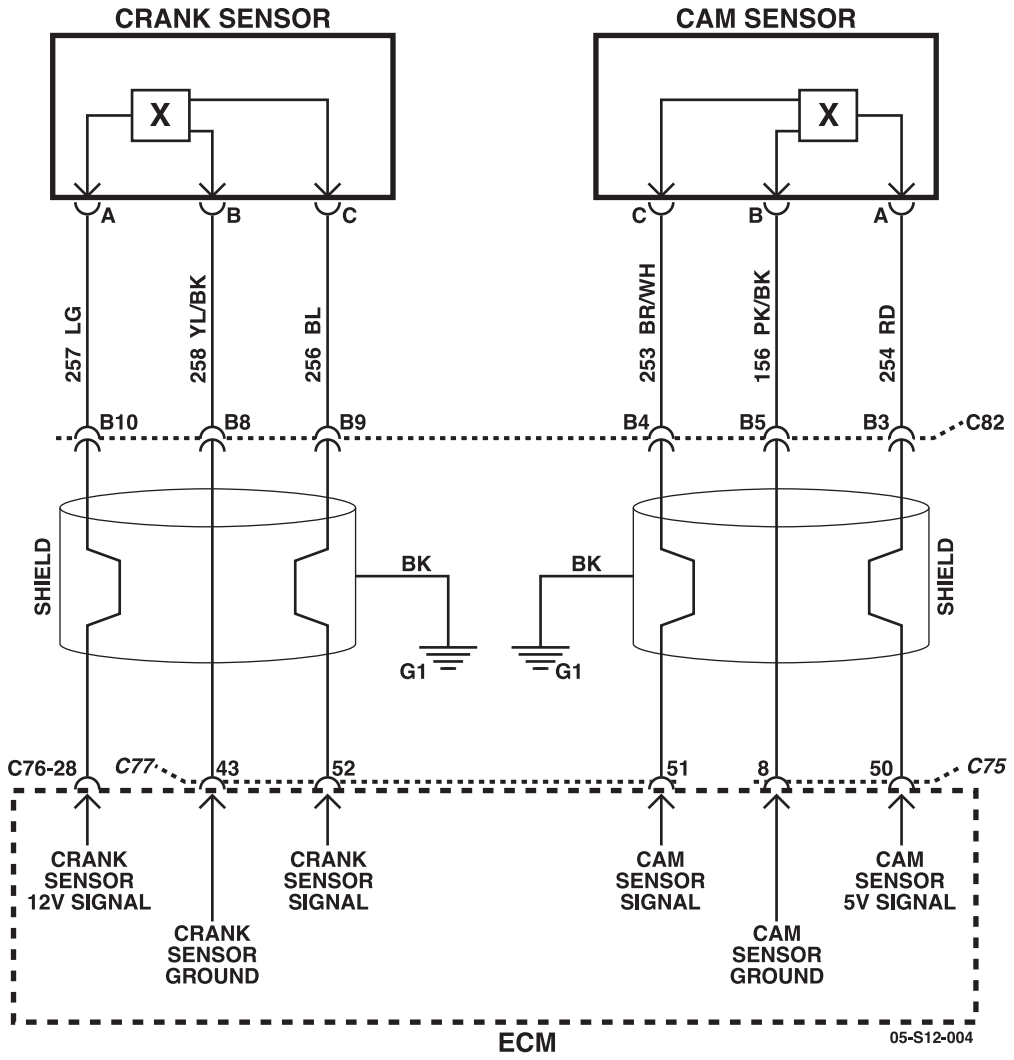


Figure 12-94: Cam/ Crank Sensor Wiring Schematics

CHIME MODULE

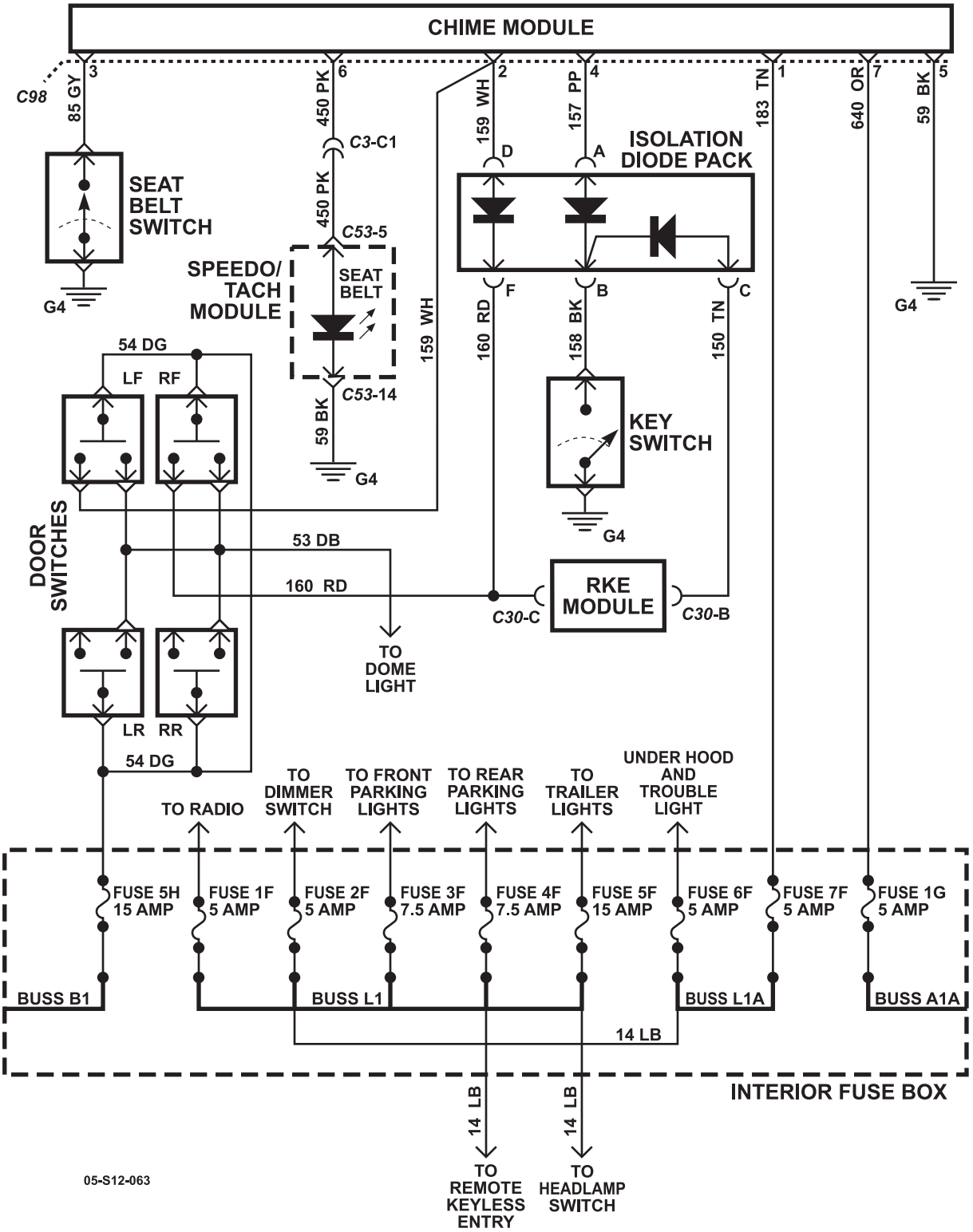


Figure 12-95: Chime Module Wiring Schematic

COMPASS MIRROR

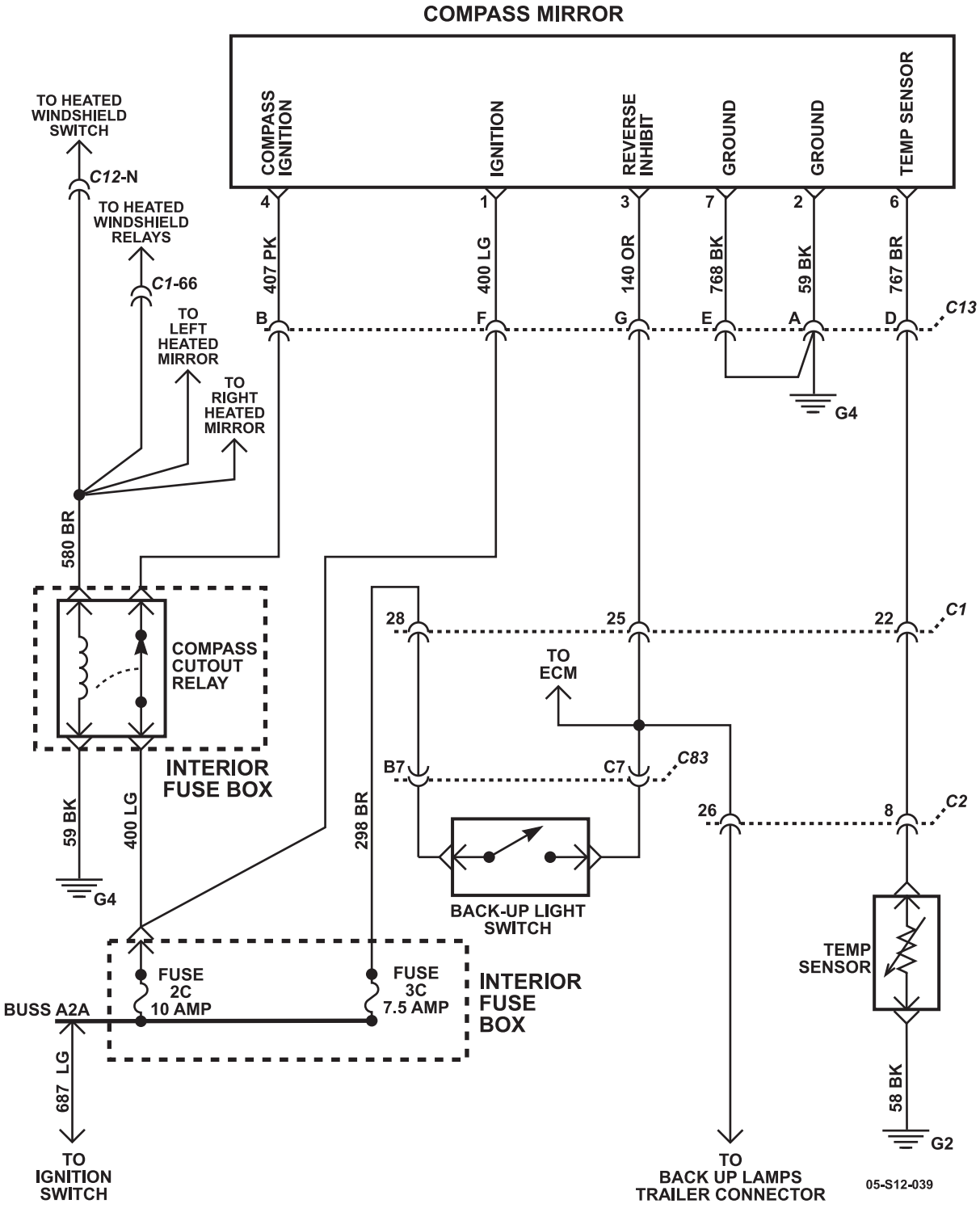


Figure 12-96: Compass Mirror Wiring Schematic

COOLANT GAUGE

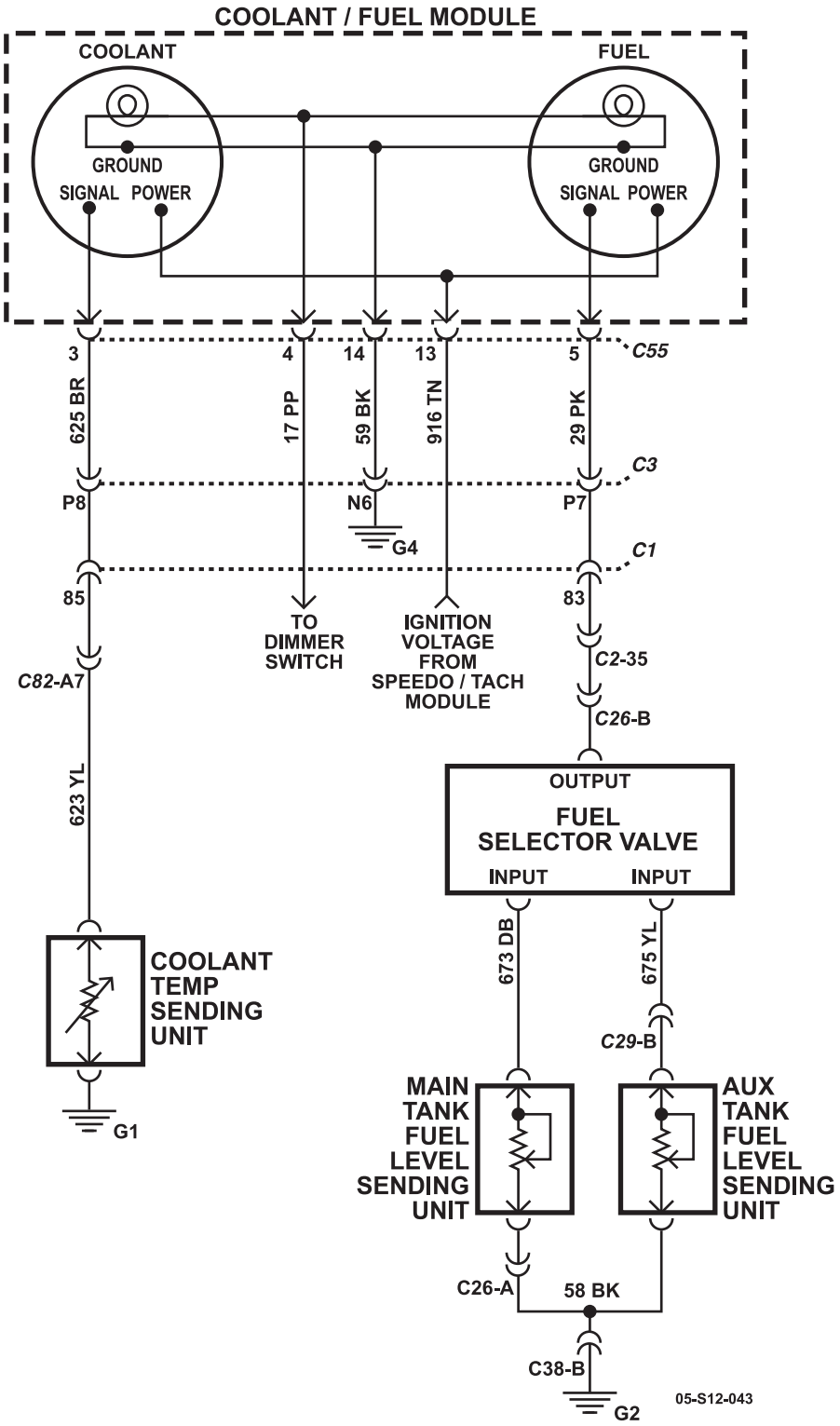


Figure 12-97: Coolant Gauge Wiring Schematic

COOLANT PUMP AUXILIARY

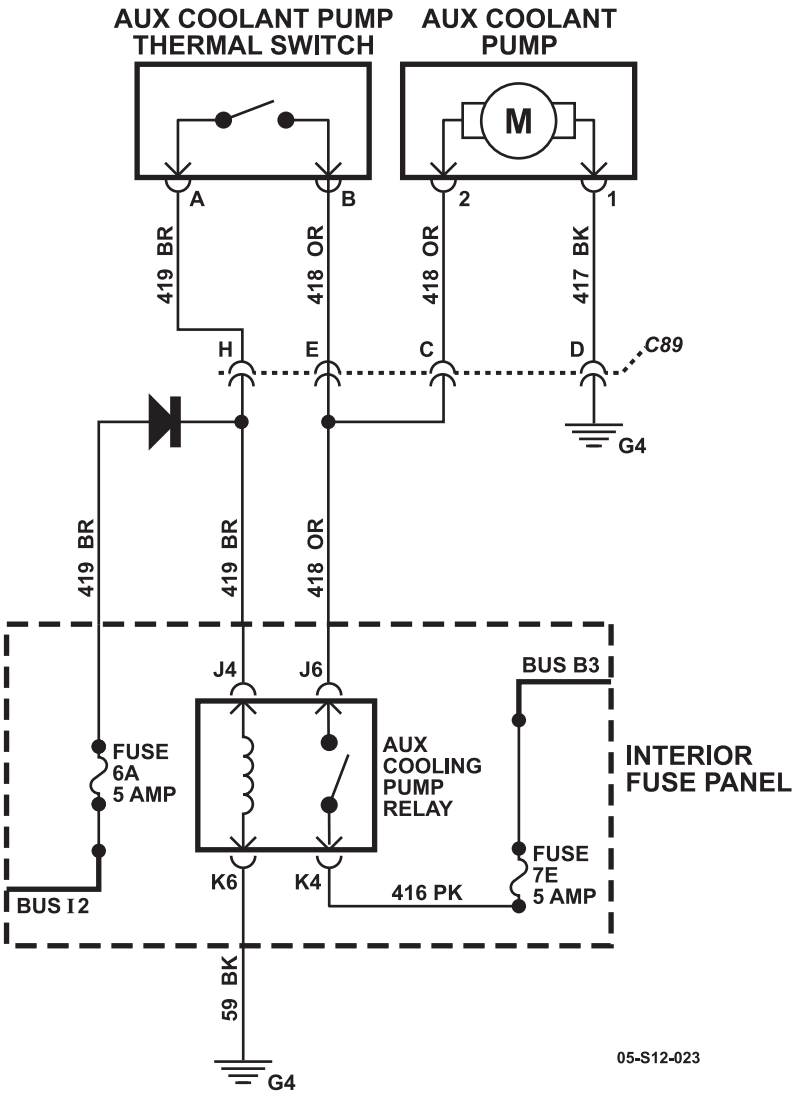


Figure 12-98: Auxiliary Coolant Pump Wiring Schematic

COOLANT TEMP SENSOR/ LOW COOLANT SWITCH/ COOLANT MODULE WARNING LIGHTS

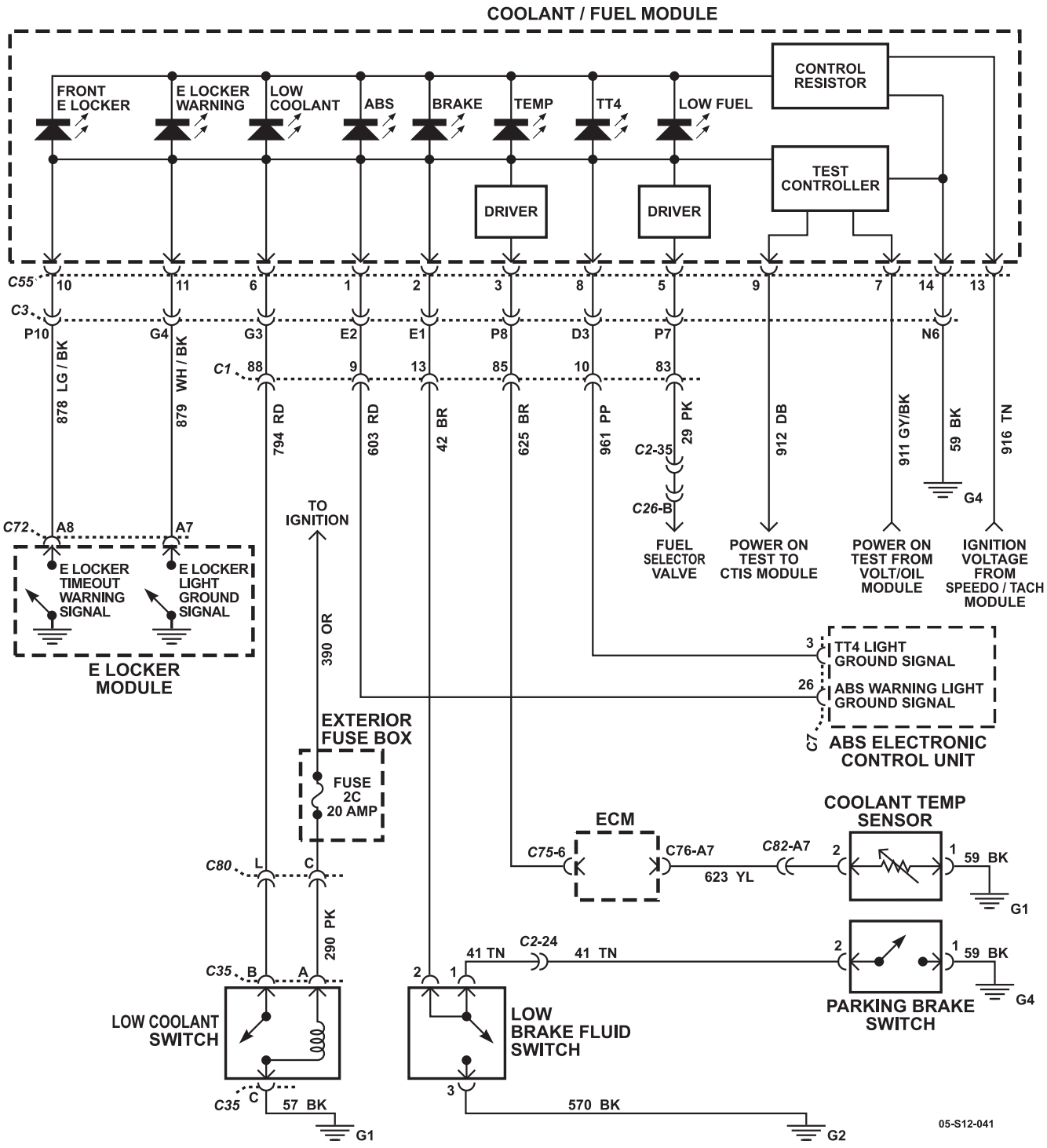


Figure 12-99: Coolant Module Warning Lights Wiring Schematic

COOLANT TEMPERATURE SENSOR

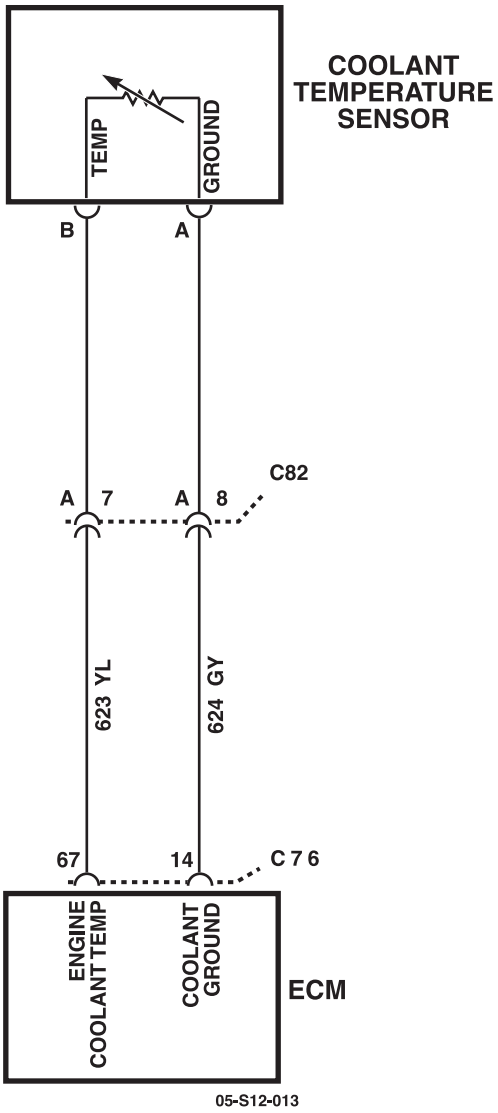


Figure 12-100: Coolant Temperature Sensor Wiring Schematic

CRUISE CONTROL

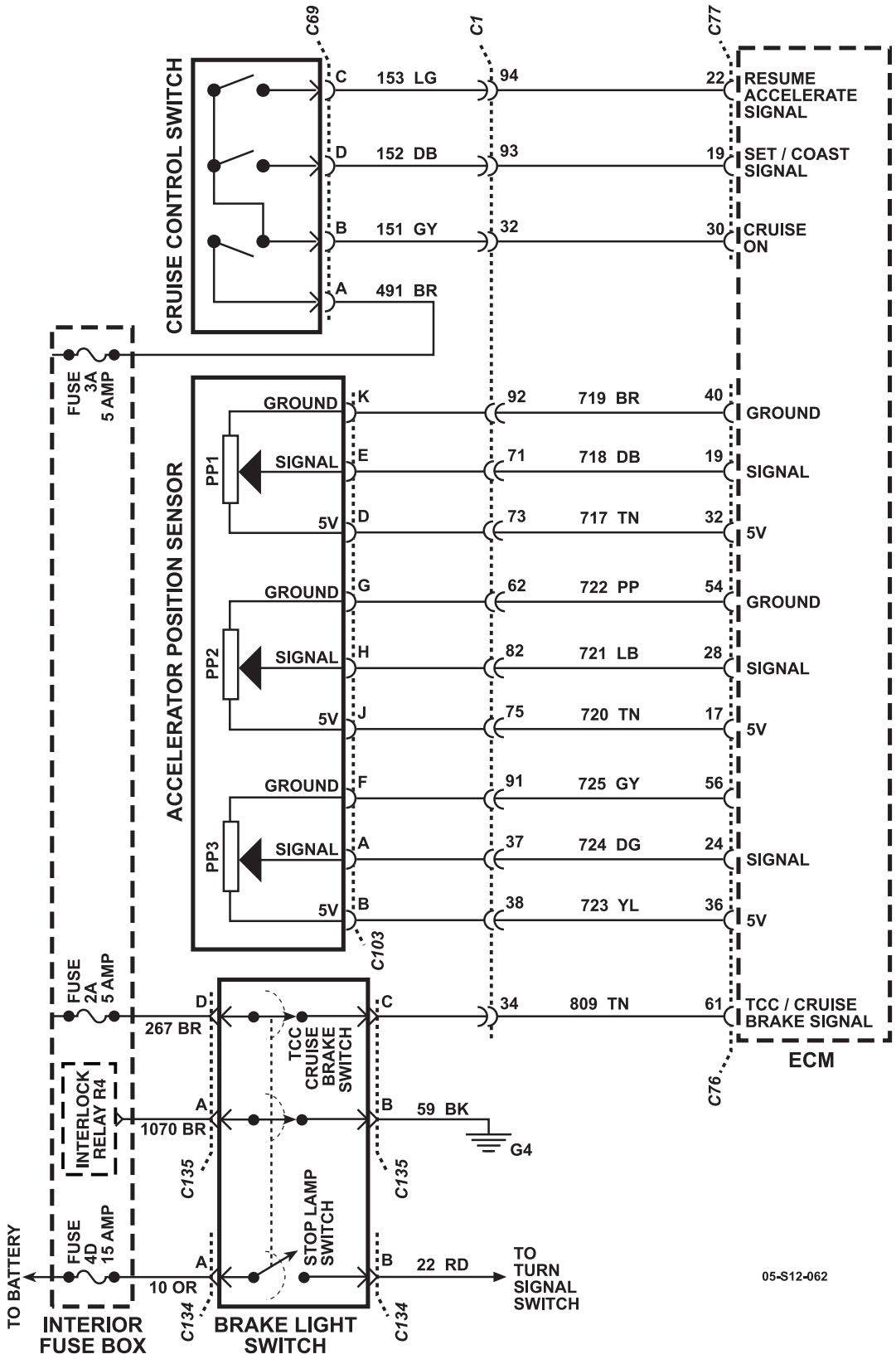


Figure 12-101: Cruise Control Wiring Schematic

CTIS SYSTEM

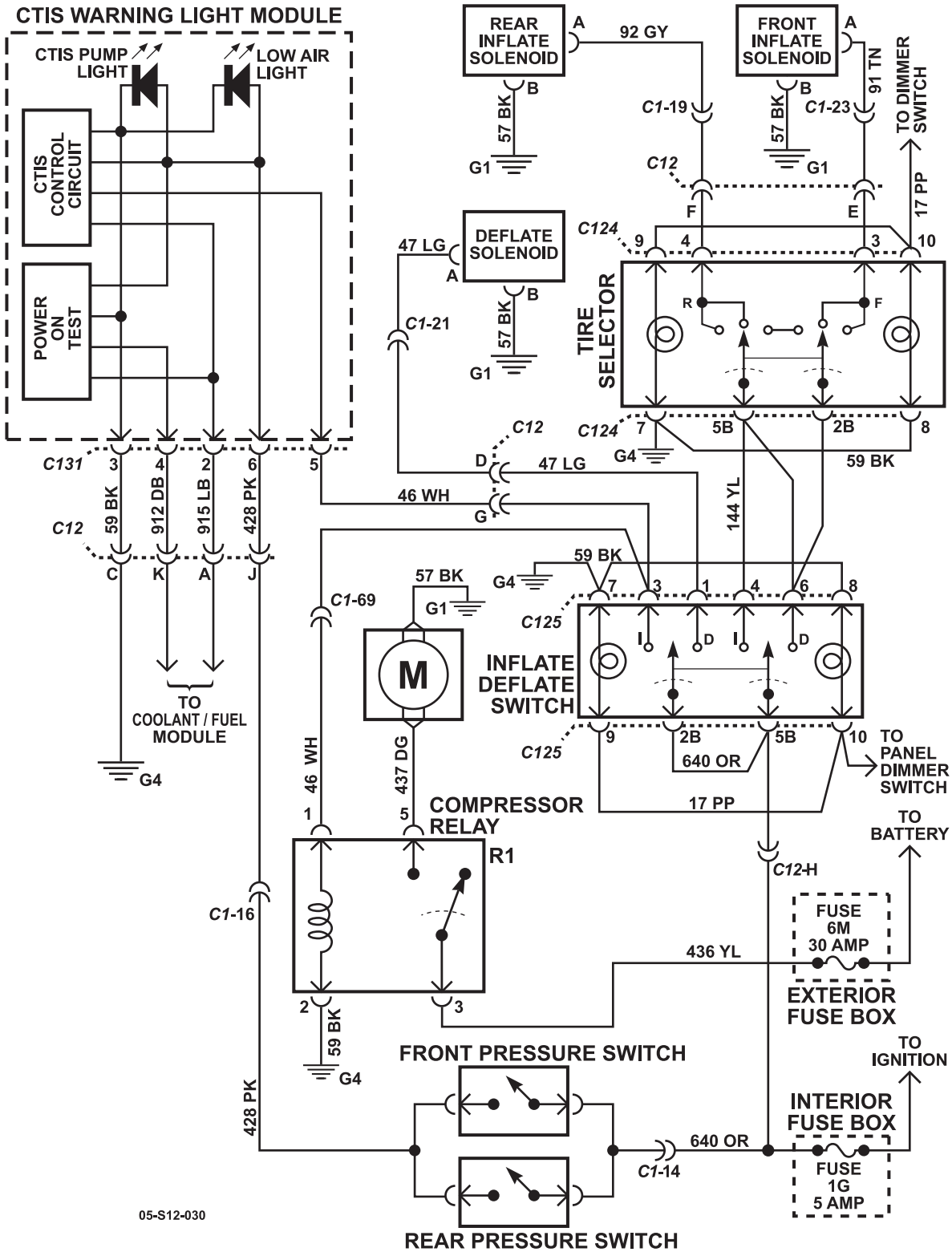


Figure 12-102: CTIS Wiring Schematic

DIAGNOSTIC LINK CONNECTOR

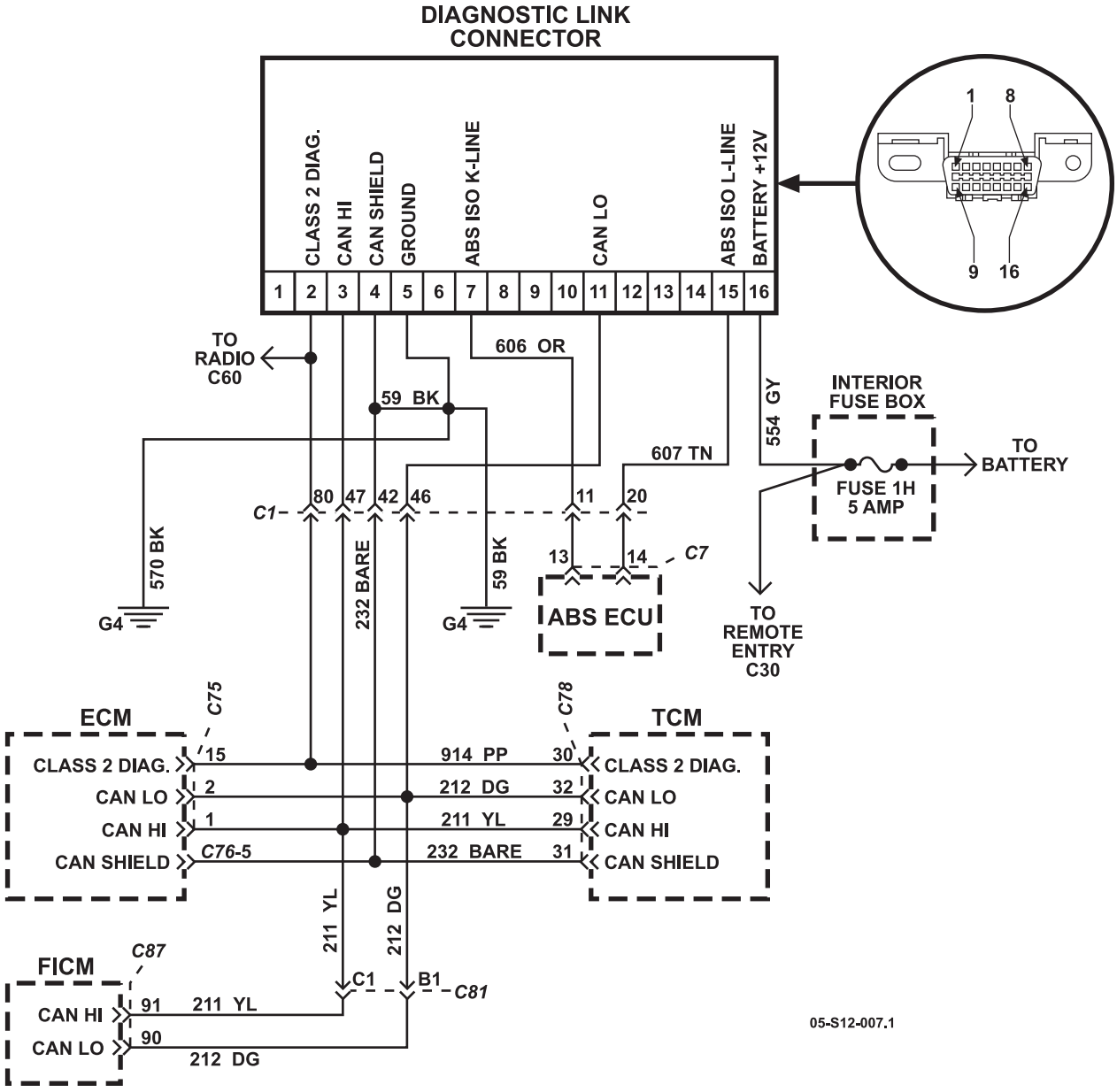


Figure 12-103: Diagnostic Link Connector Wiring Schematic

DOME/ COURTESY LIGHTS (OPEN TOP)

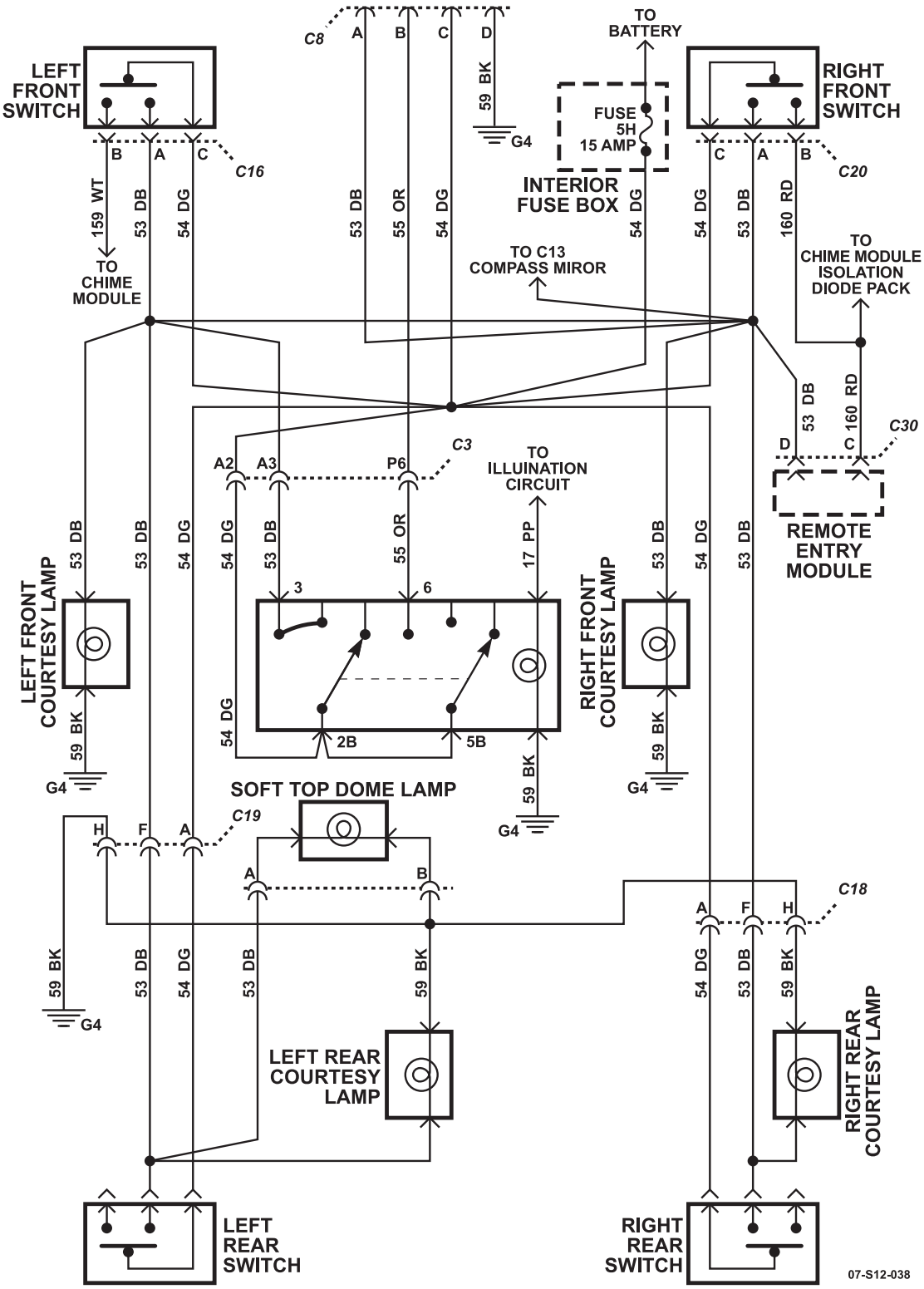


Figure 12-104: Dome/ Courtesy Lights (Open Top) Wiring Schematic

DOME/ COURTESY LIGHTS (WAGON)

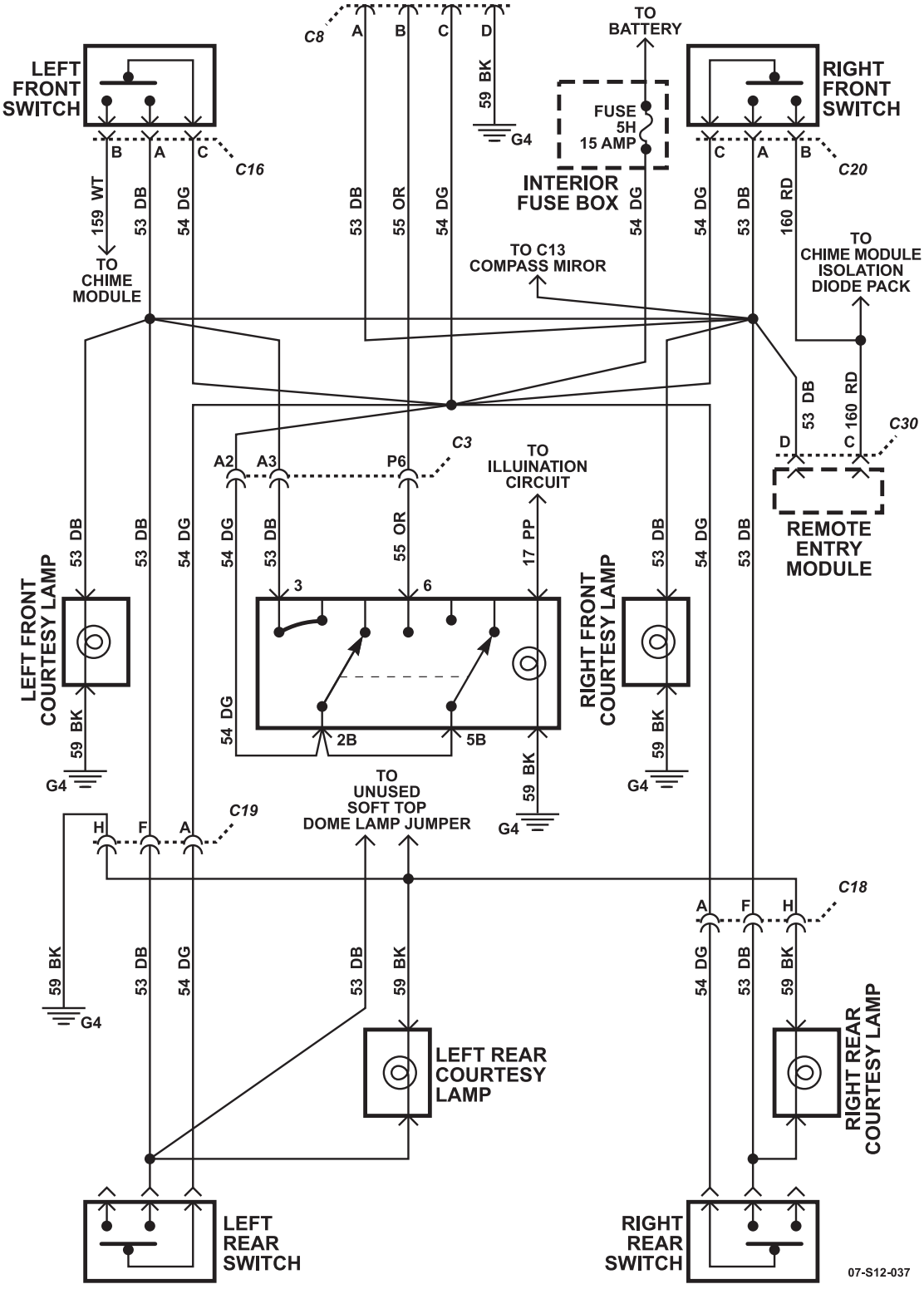


Figure 12-105: Dome/ Courtesy Lights (Wagon) Wiring Schematic

DOME/ MAP/ VANITY LIGHTS (WAGON)

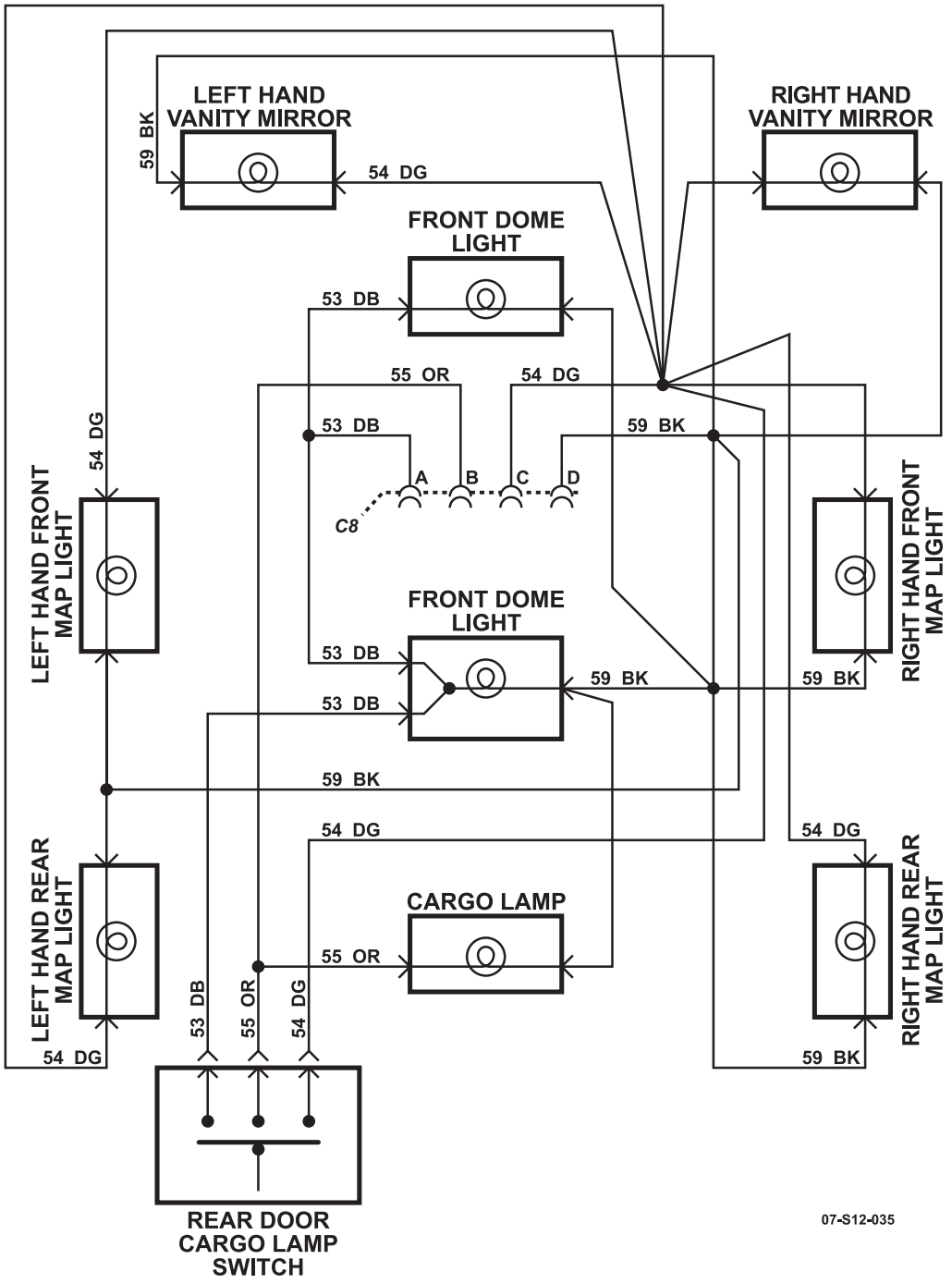


Figure 12-106: Dome/ Map/ Vanity Lights (Wagon) Wiring Schematic

EGR SOLENOID

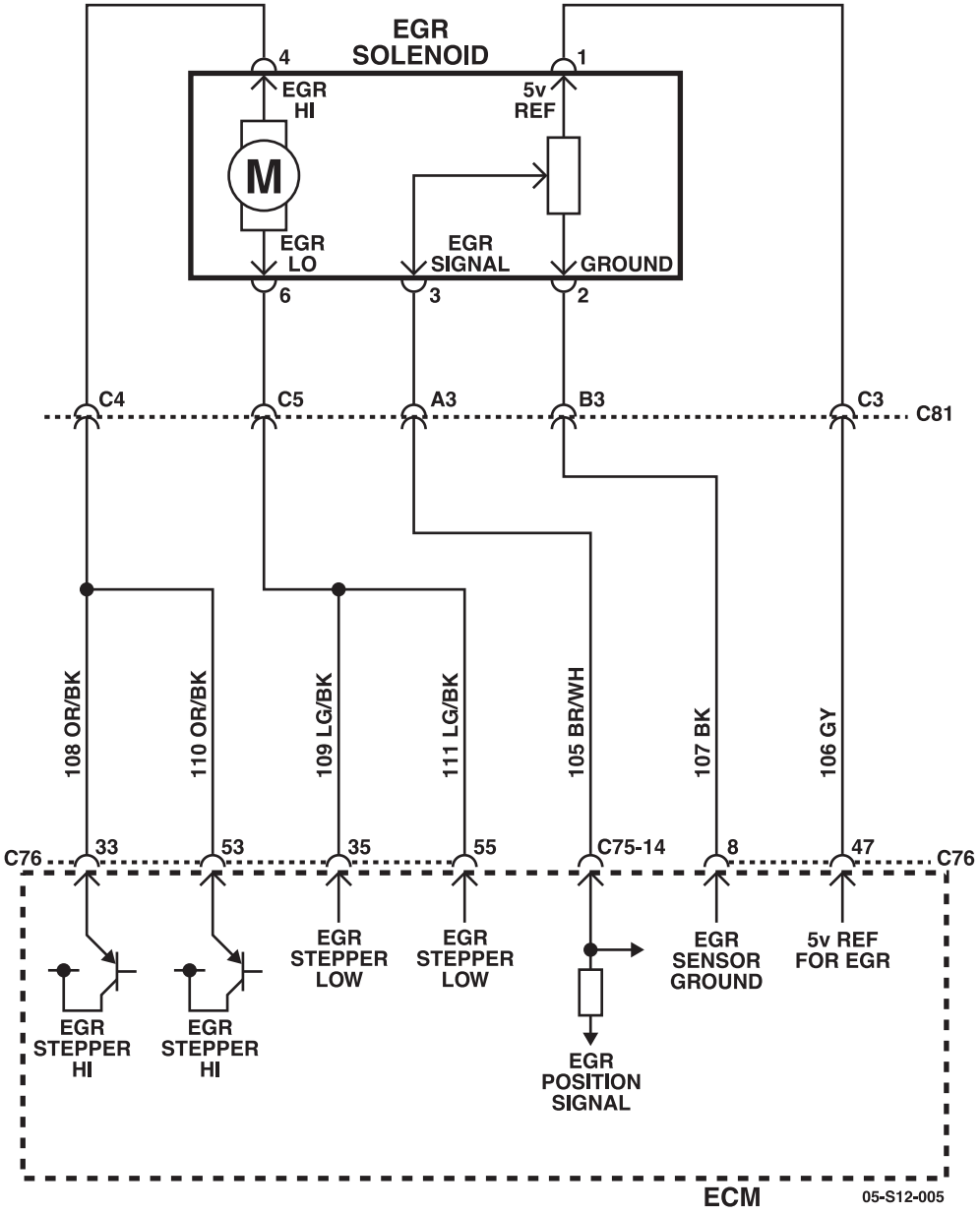


Figure 12-107: EGR Solenoid Wiring Schematic

E LOCKER

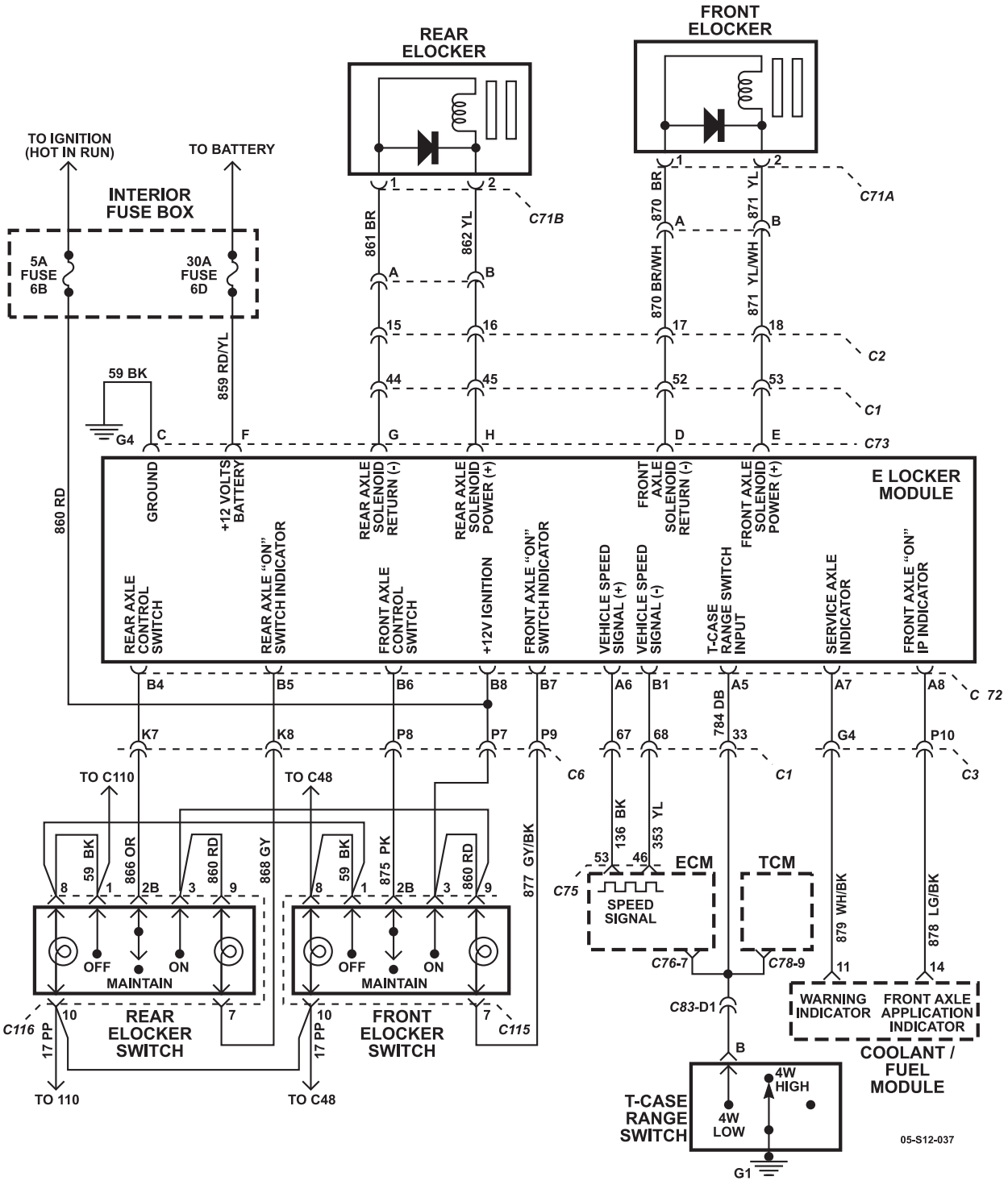


Figure 12-108: E Locker Wiring Schematic

EXPRESS DOWN MODULE/ POWER WINDOWS

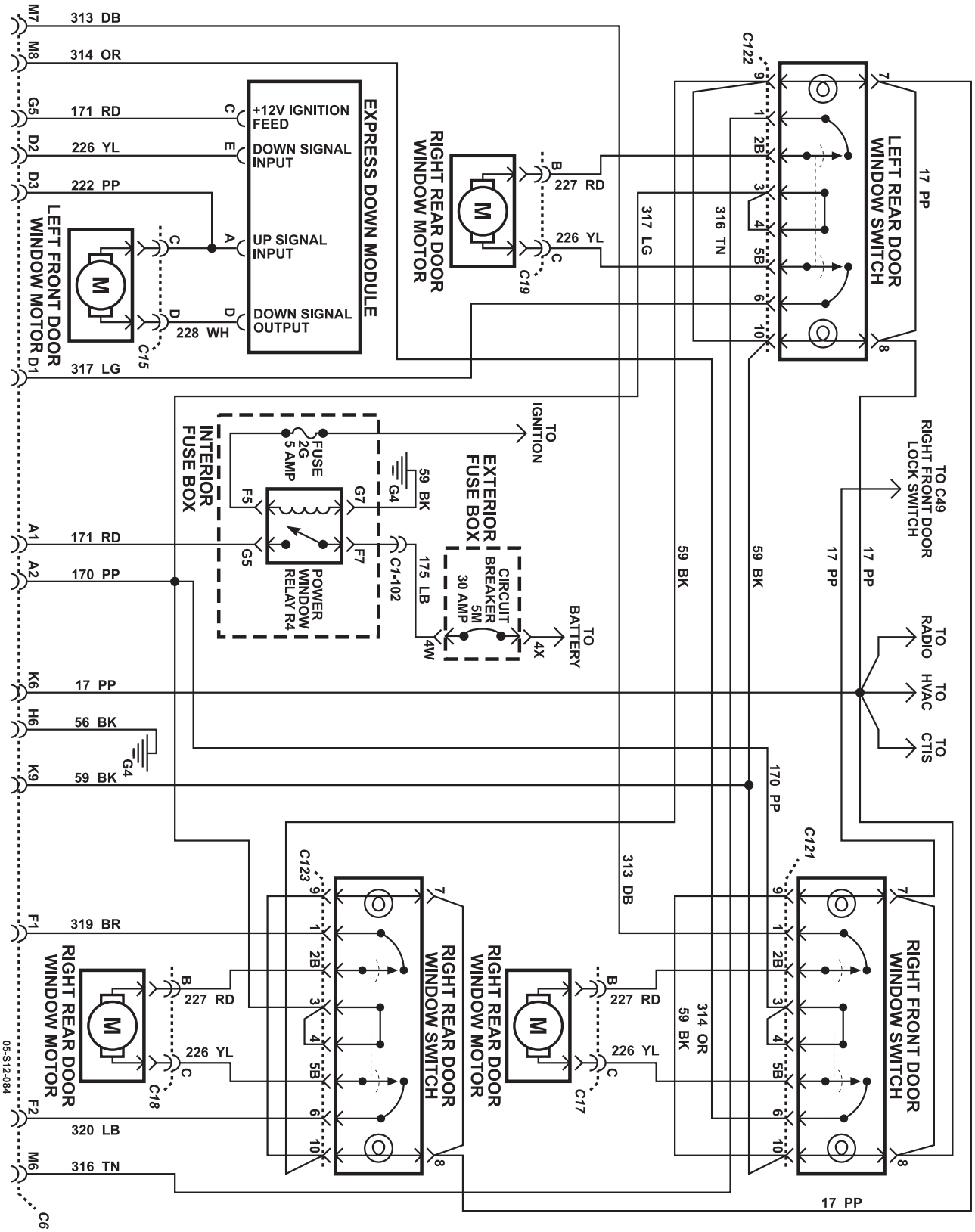


Figure 12-109: Express Down Module Wiring Schematic

FUEL GAUGE

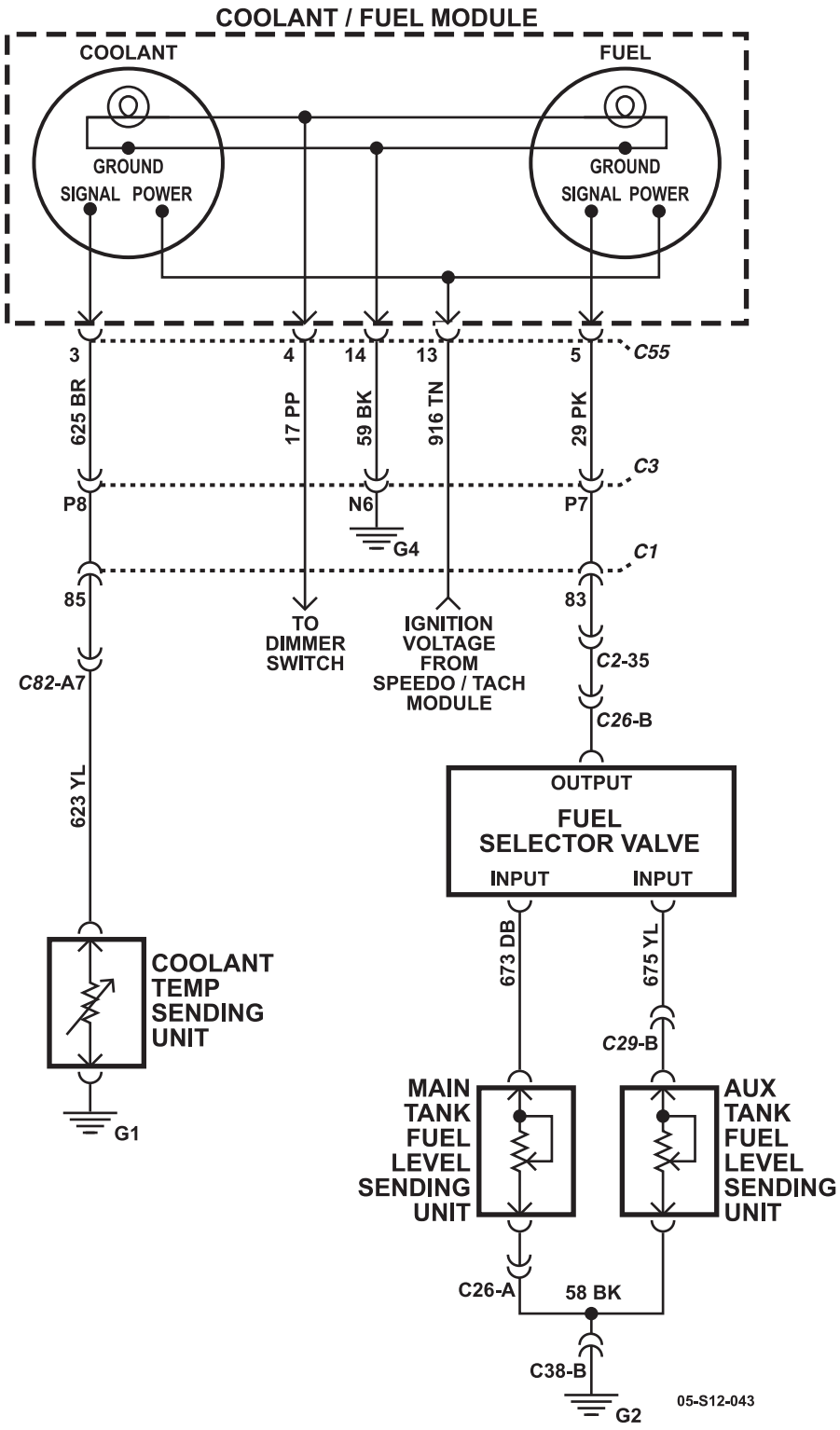


Figure 12-110: Fuel Gauge Wiring Schematic

FUEL INJECTORS/ FUEL INJECTION CONTROL MODULE (FICM)

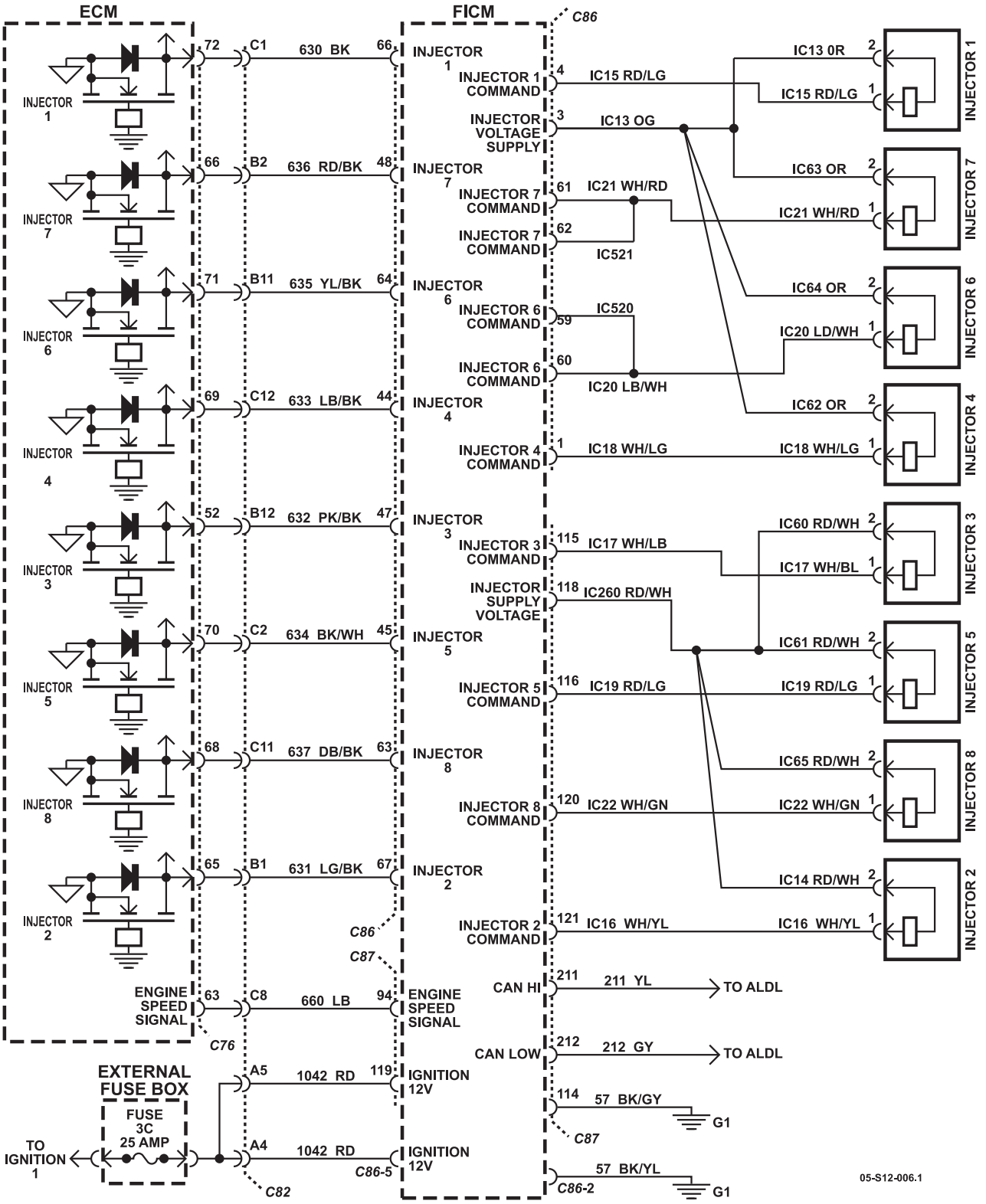


Figure 12-111: Fuel Injection Wiring Schematic

FUEL MODULE WARNING LIGHTS

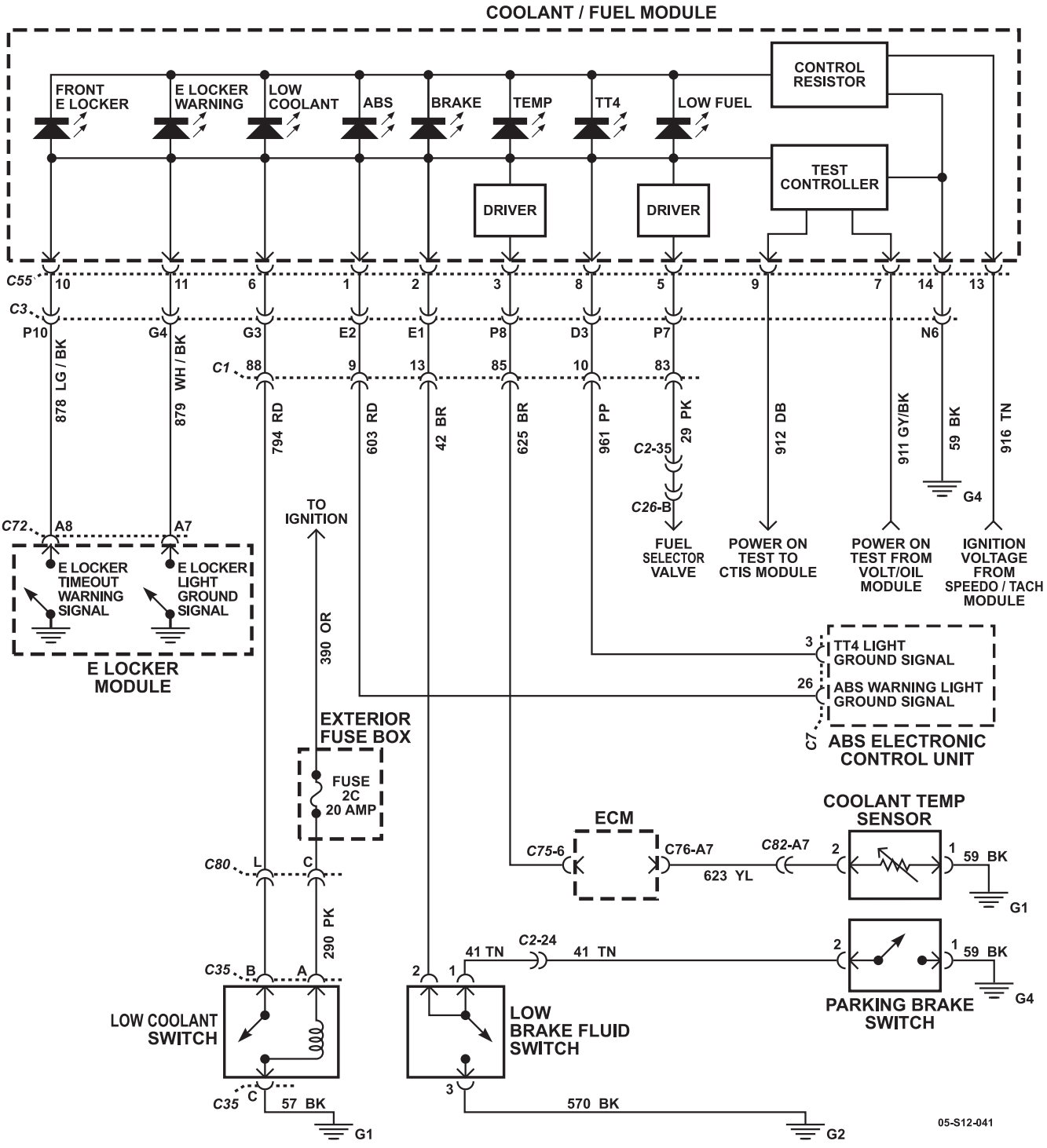


Figure 12-112: Fuel Module Warning Lights Wiring Schematic

FUEL PRESSURE REGULATOR/ FUEL RAIL PRESSURE SENSOR

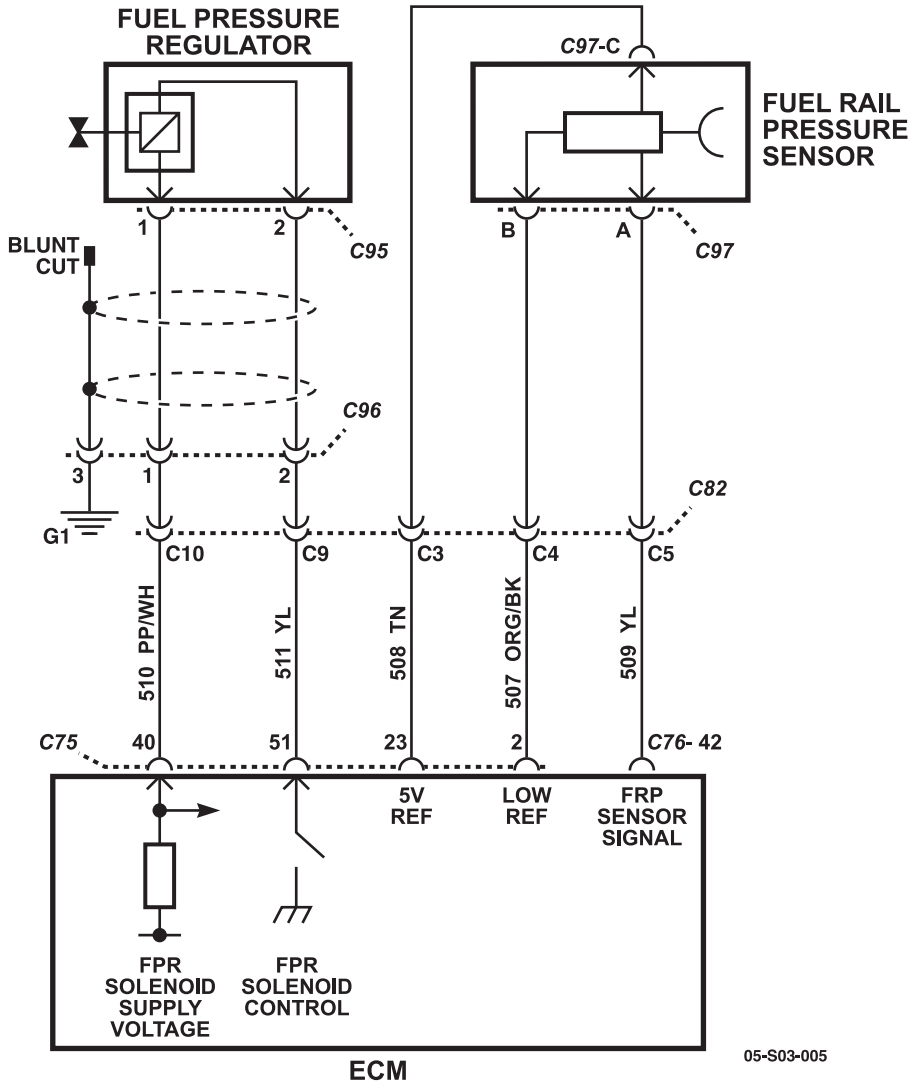


Figure 12-113: Fuel Pressure Sensor/ Fuel Pressure Sensor Wiring Schematic

FUEL SELECTOR/ SENDING UNIT

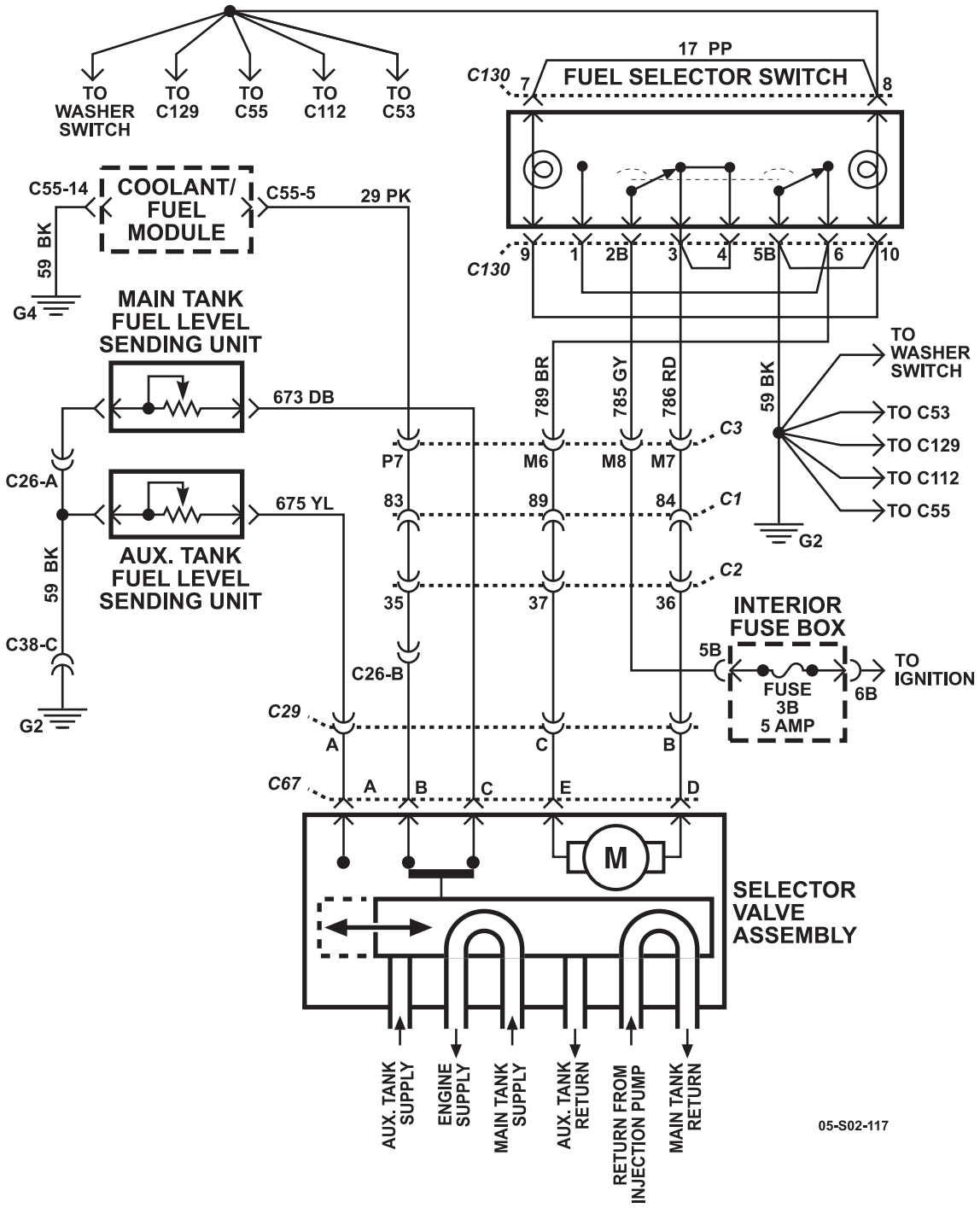


Figure 12-114: Fuel Selector/ Sending Unit Wiring Schematic

FUEL TEMPERATURE SENSOR

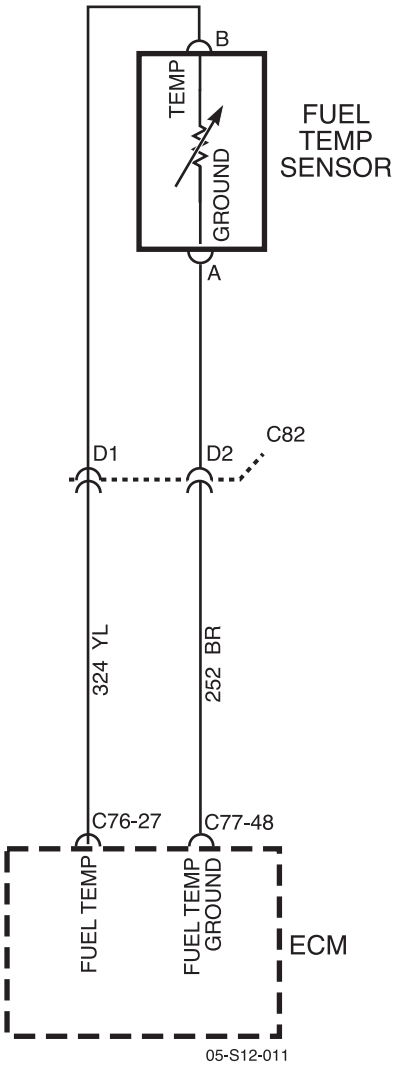


Figure 12-115: Fuel Temperature Sensor Wiring Schematic

GAUGE MODULES POWER AND GROUNDS

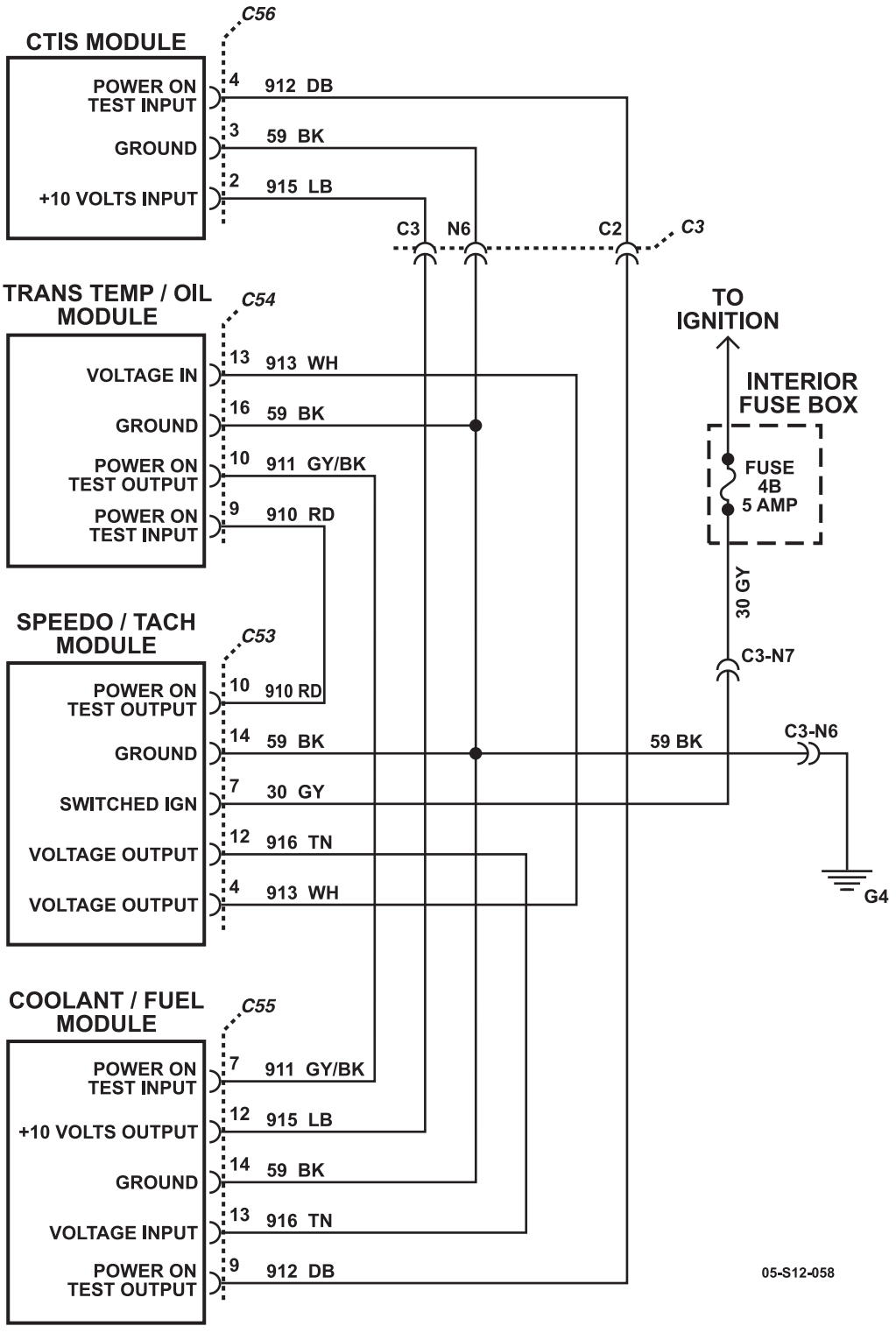


Figure 12-116: Gauge Module Wiring Schematic

GLOW PLUG CONTROL MODULE

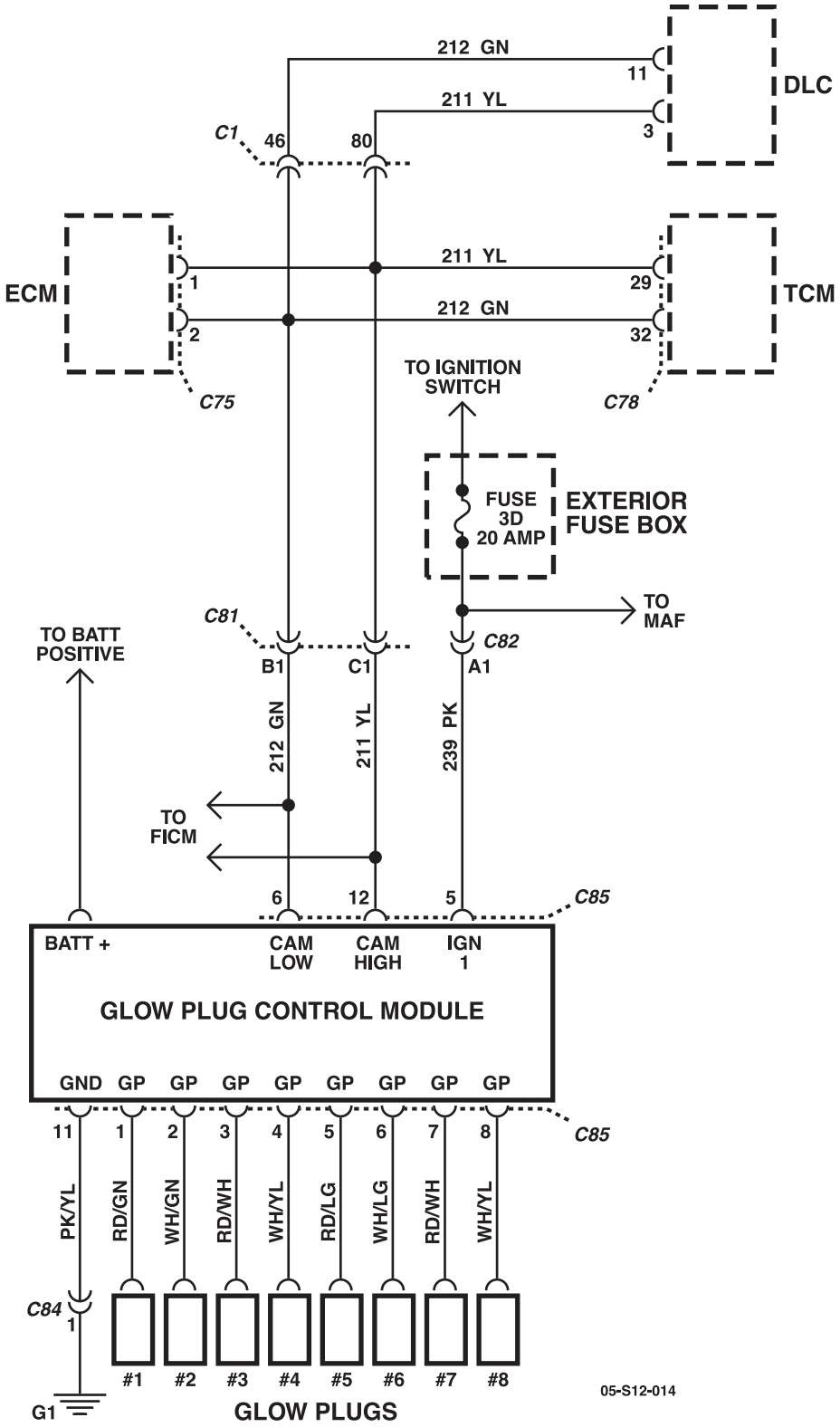


Figure 12-117: Glow Plug Wiring Schematic

HEAD LAMP/ DIMMER SWITCH

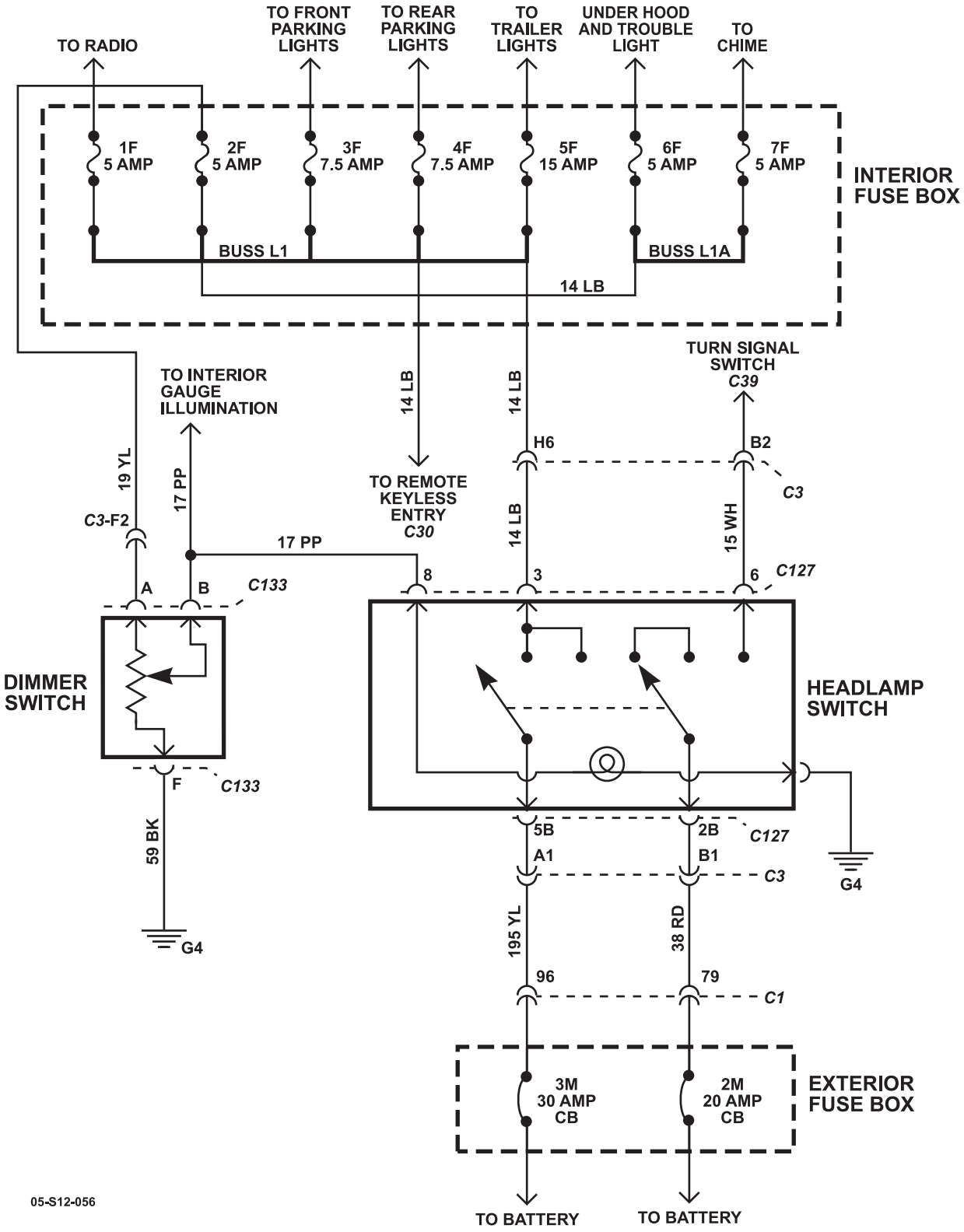


Figure 12-118: Head Lamp/ Dimmer Switch Wiring Schematic

HEAD LIGHTS

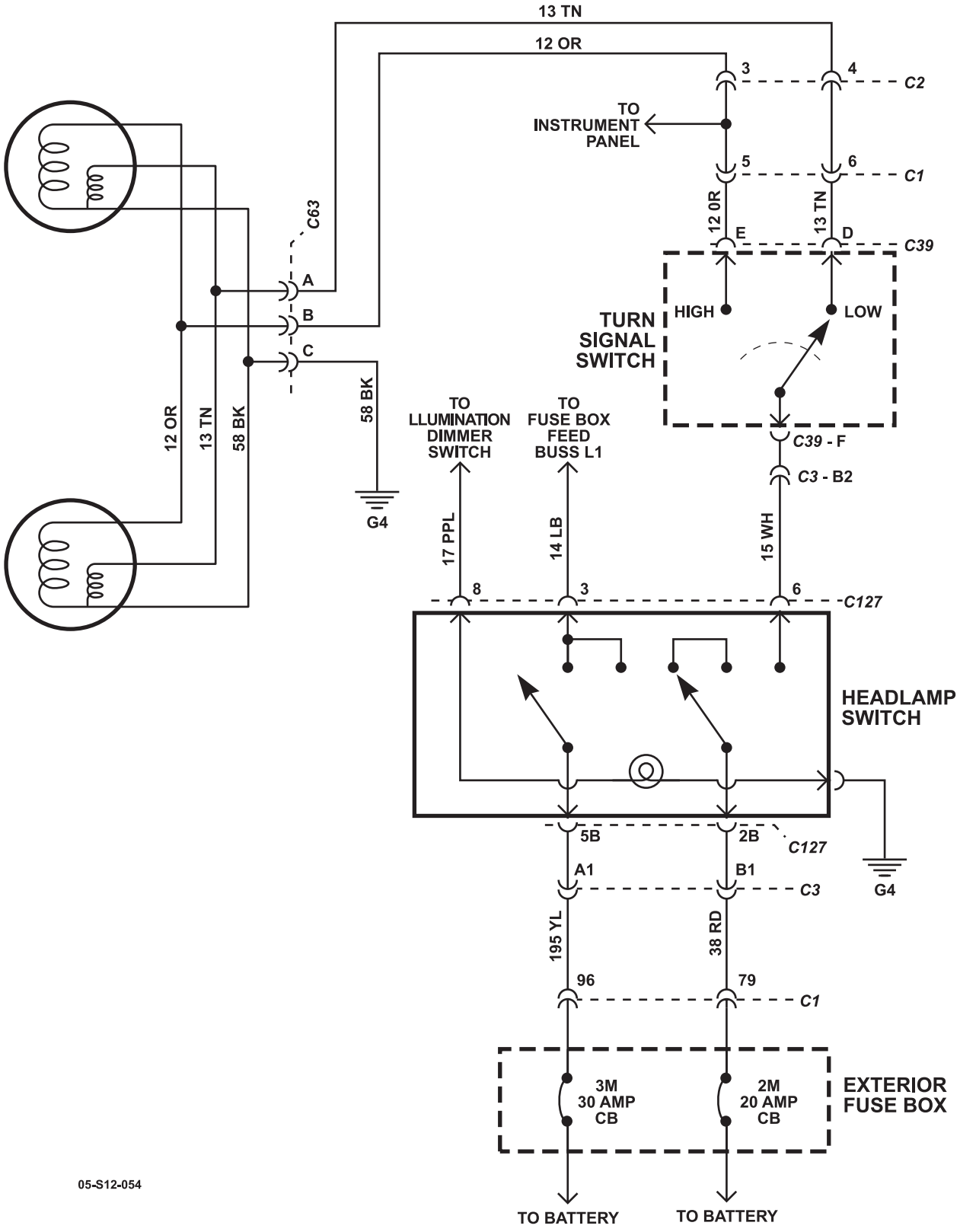


Figure 12-119: Head Lights Wiring Schematic

HORN

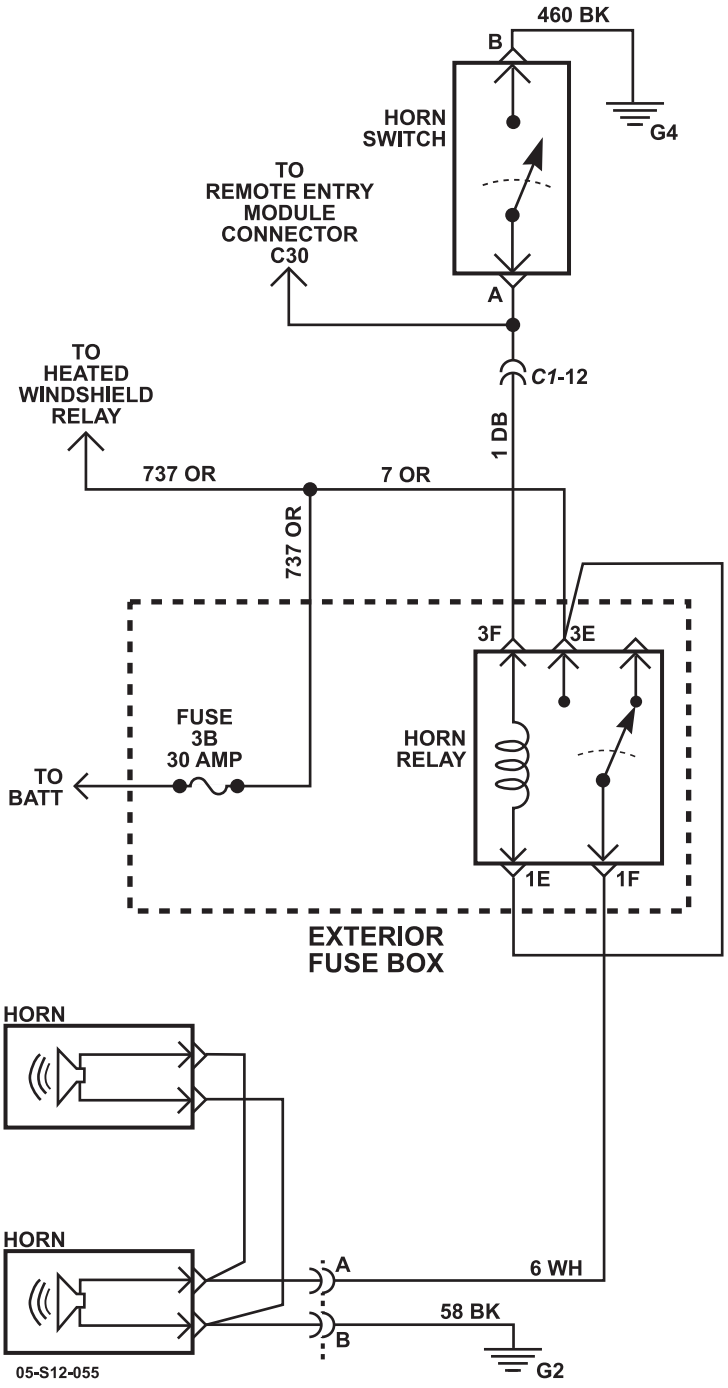


Figure 12-120: Horn Wiring Schematic

HVAC

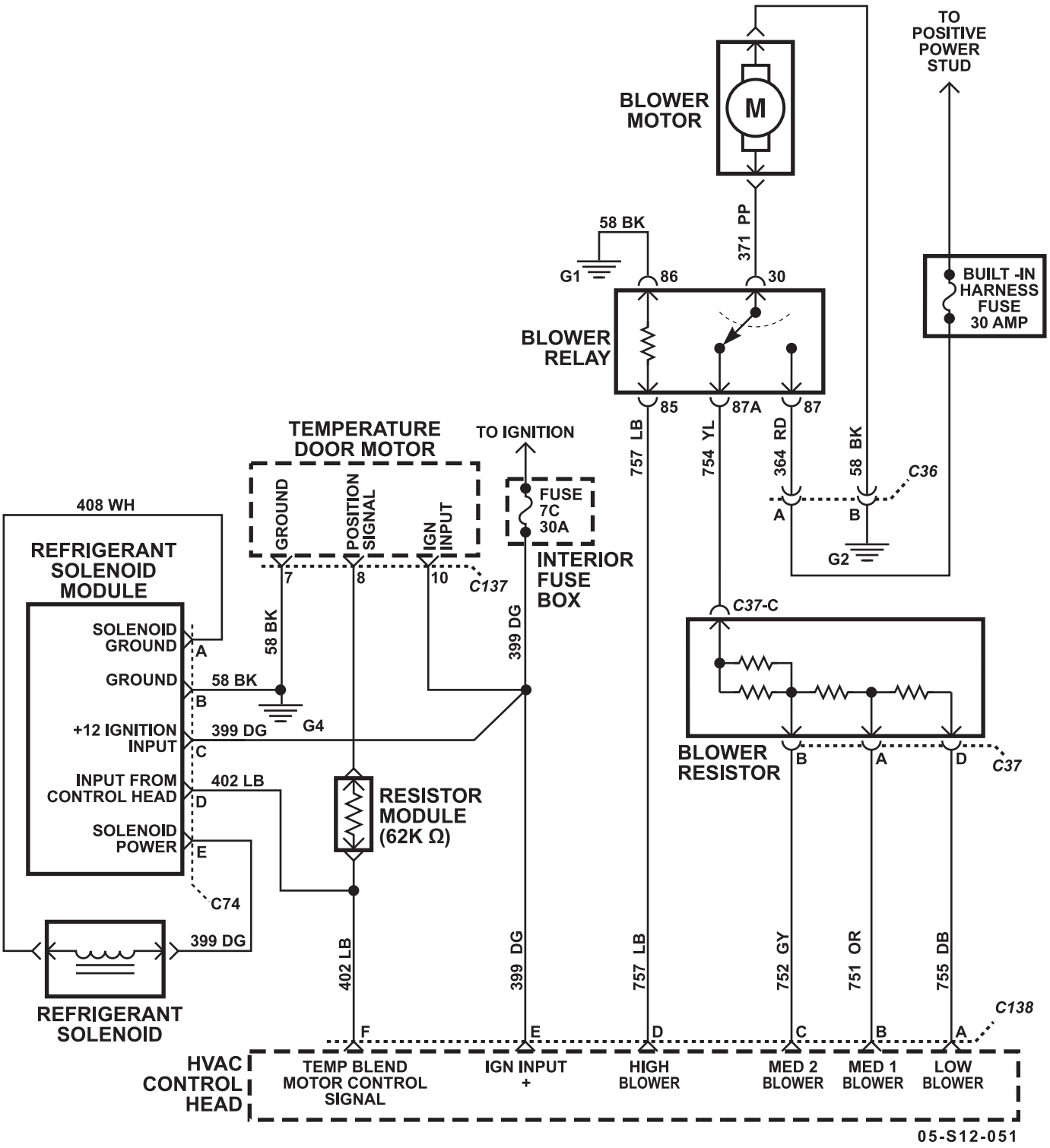


Figure 12-121: HVAC Wiring Schematic

HVAC (AUXILLARY)

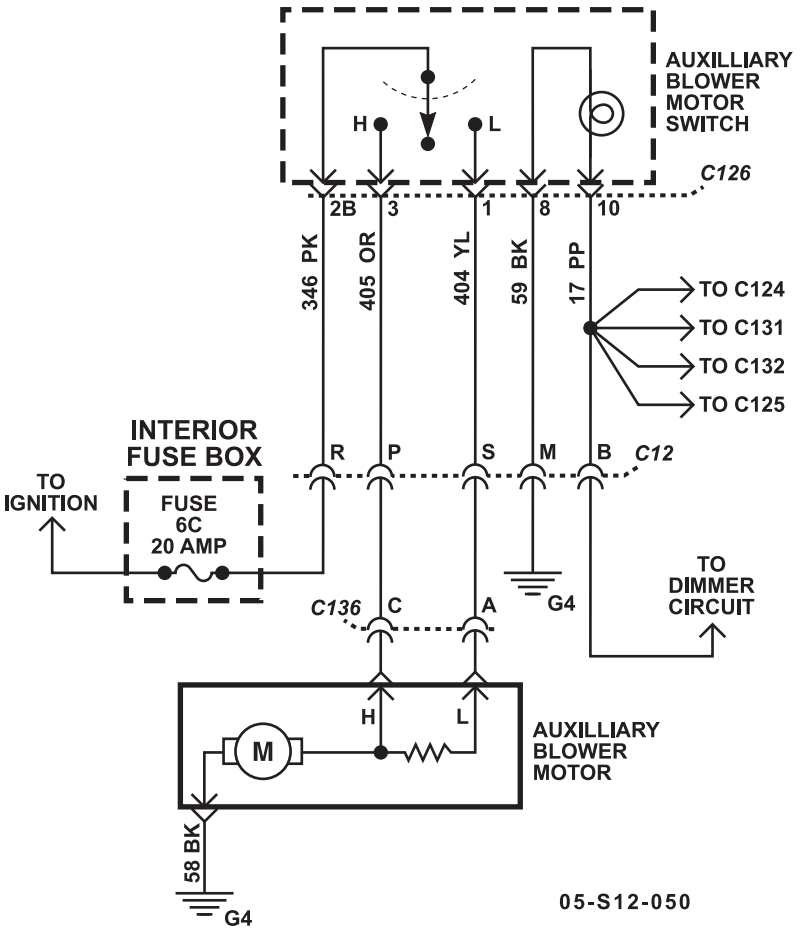


Figure 12-122: Auxiliary HVAC Wiring Schematic

HVAC COMPRESSOR

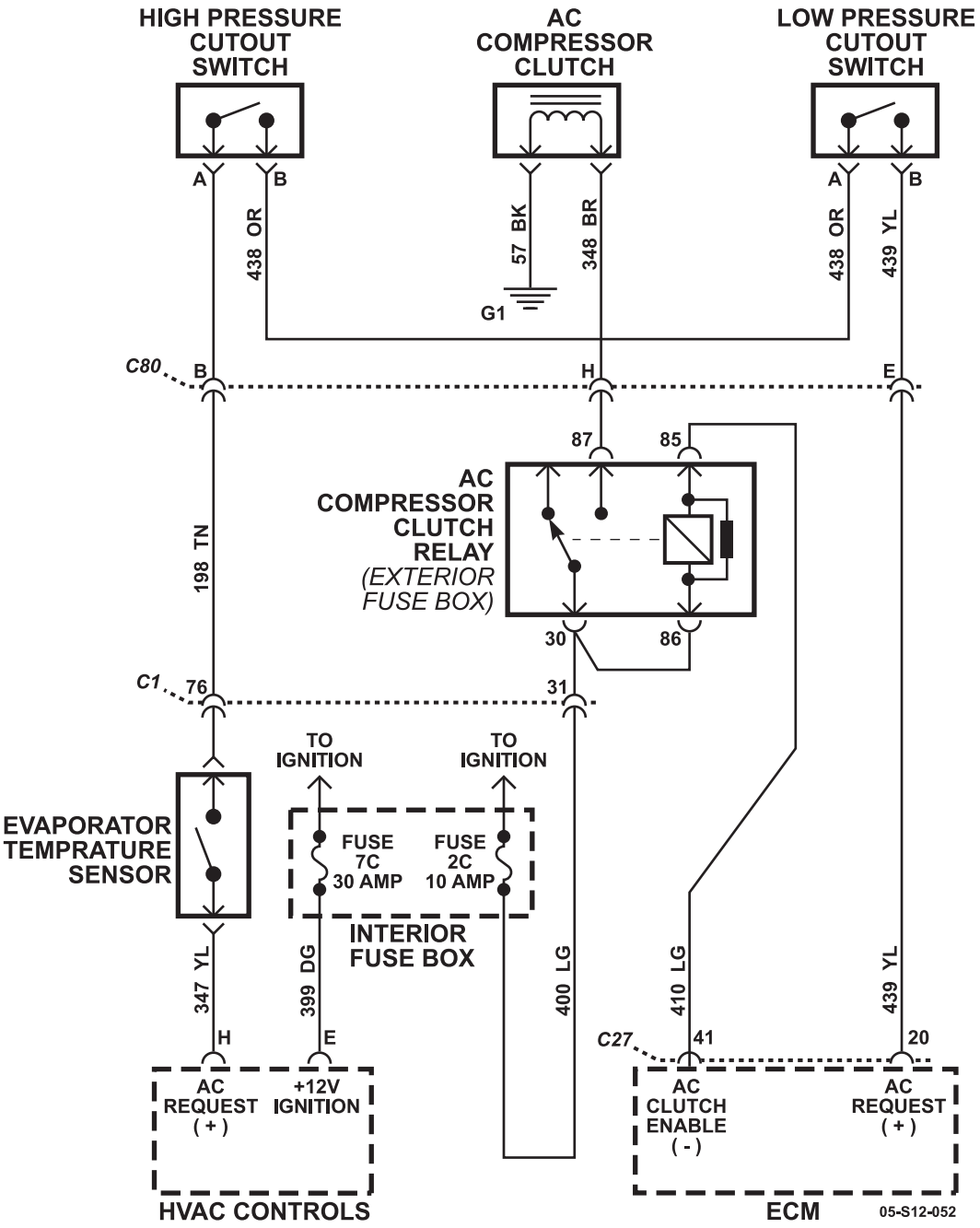


Figure 12-123: HVAC Compressor Wiring Schematic

IGNITION SWITCH

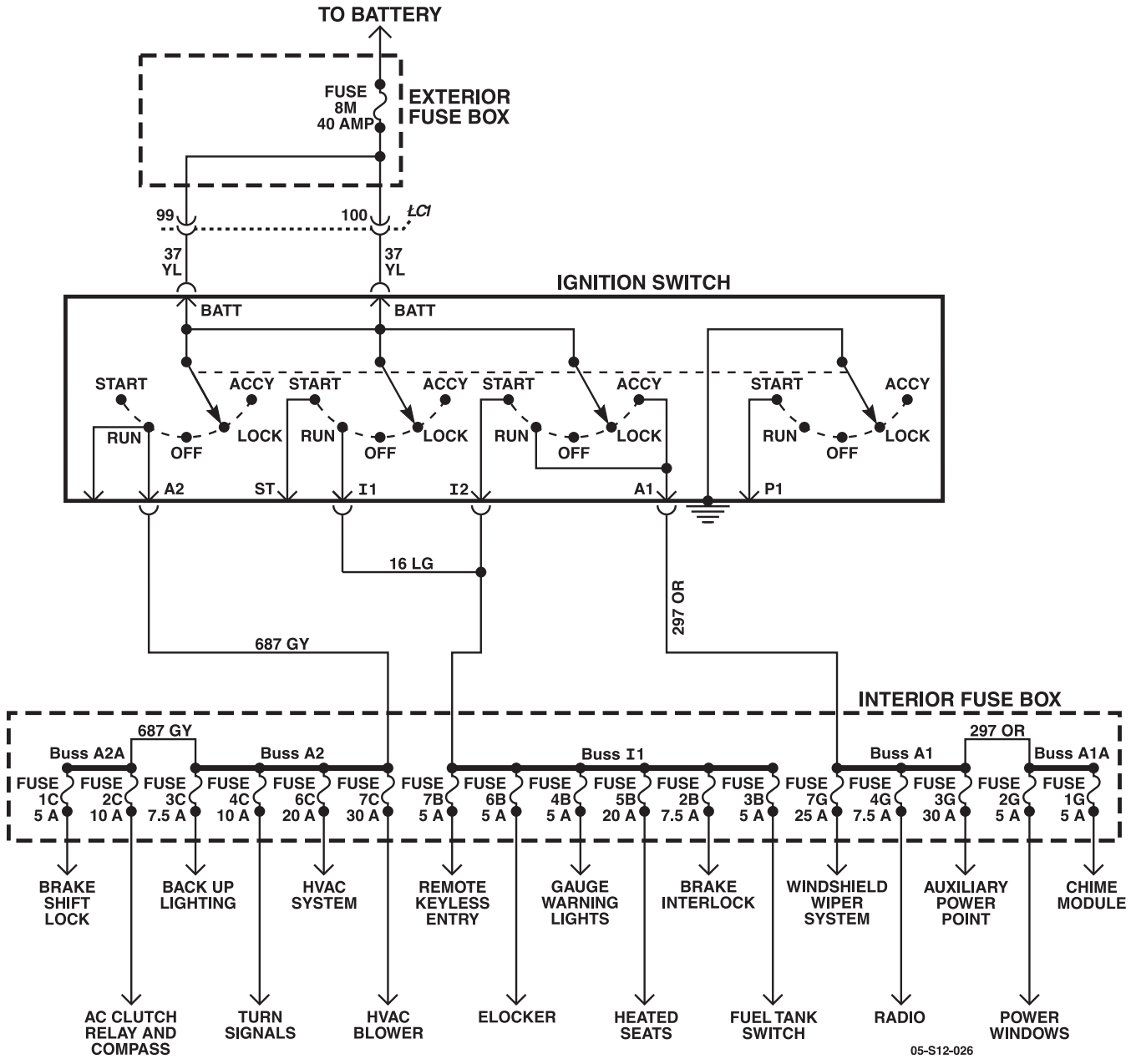


Figure 12-124: Ignition Switch Wiring Schematic

INTAKE AIR TEMPERATURE SENSOR

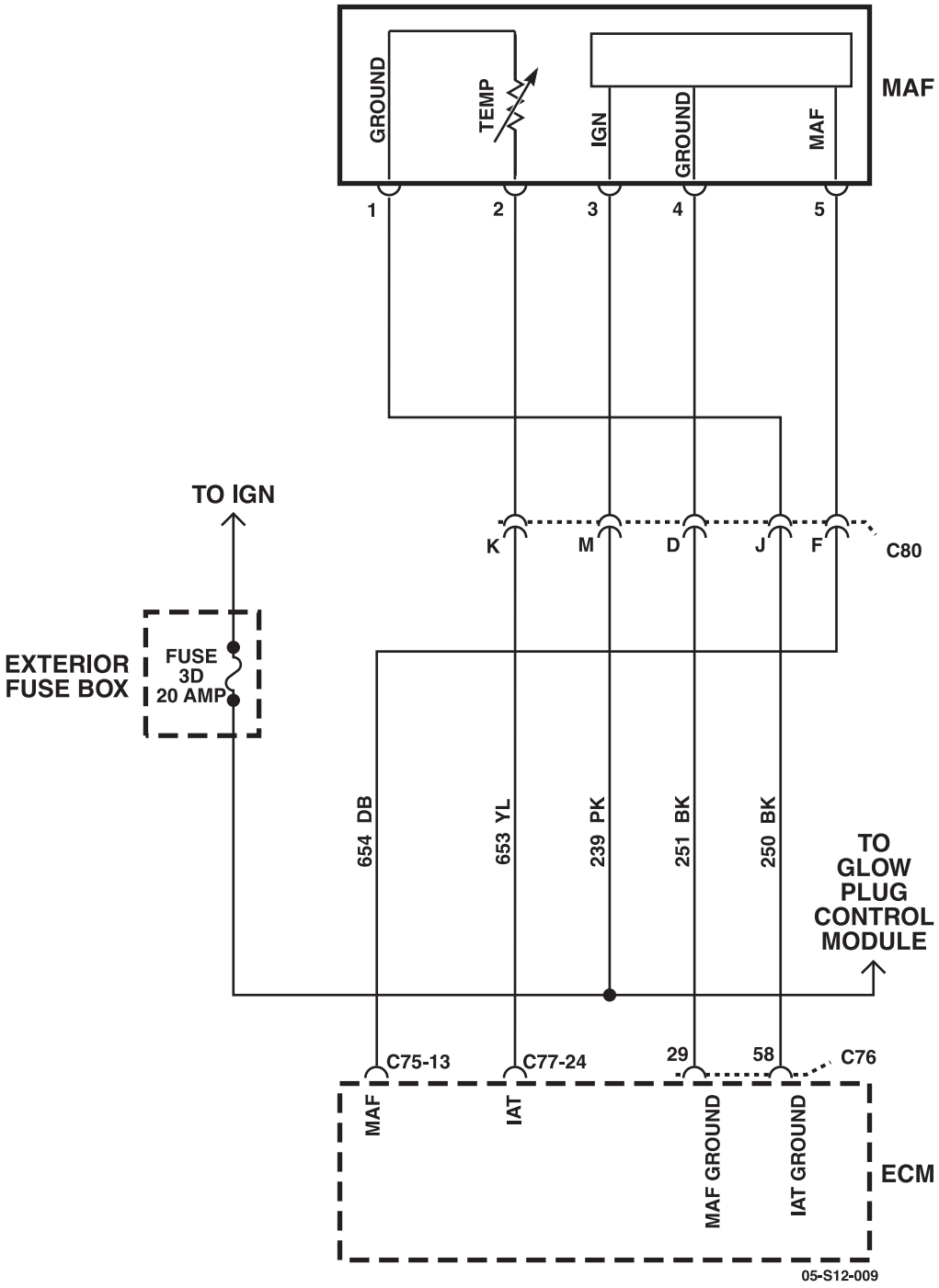


Figure 12-125: Intake Air Temperature Sensor Wiring Schematic

LIGHTING BUSS/ FUSES

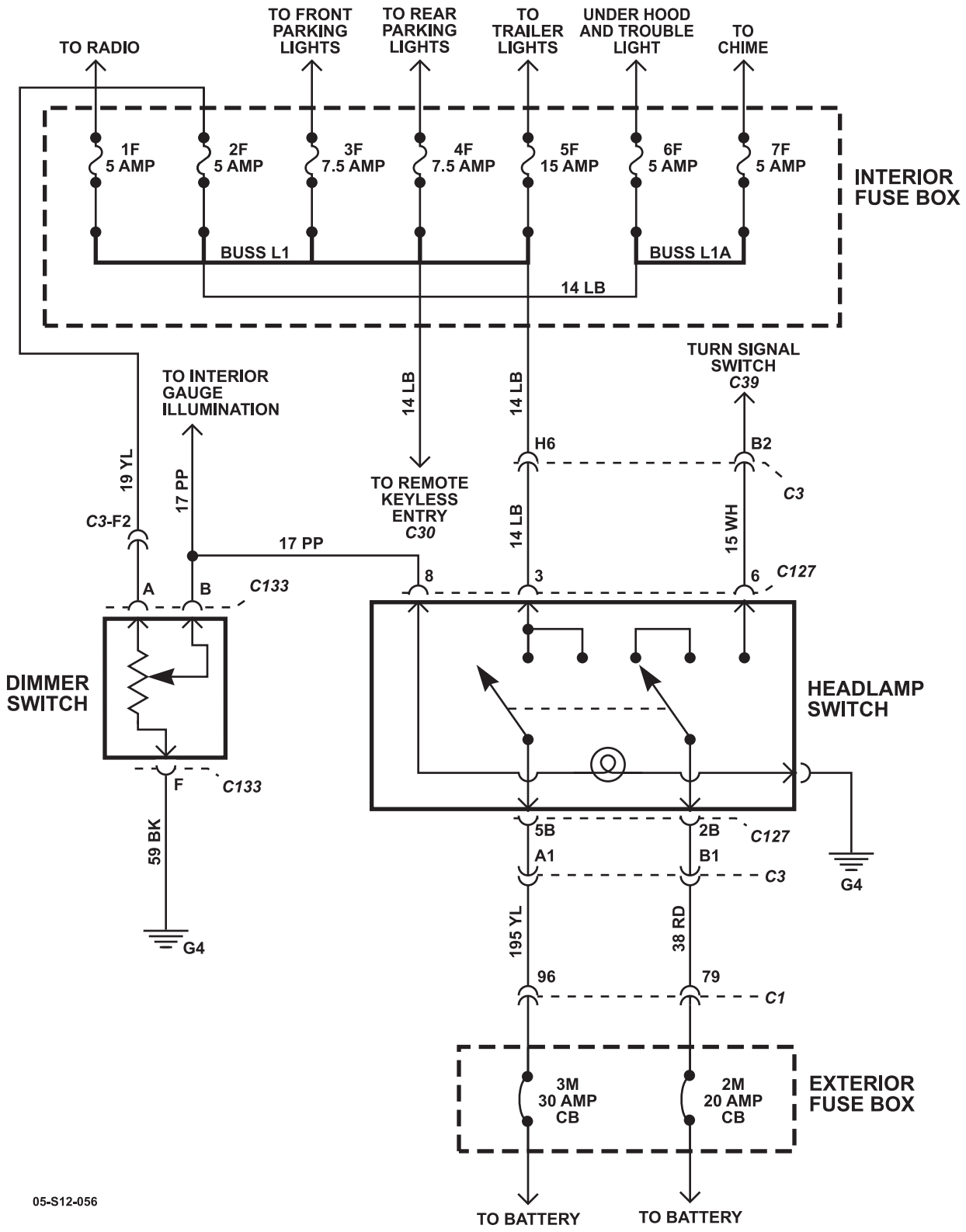


Figure 12-126: Lighting Bus/ Fuses

LOCKS POWER HMCS W/ INCANDESCENT BULBS THROUGH VIN 226860

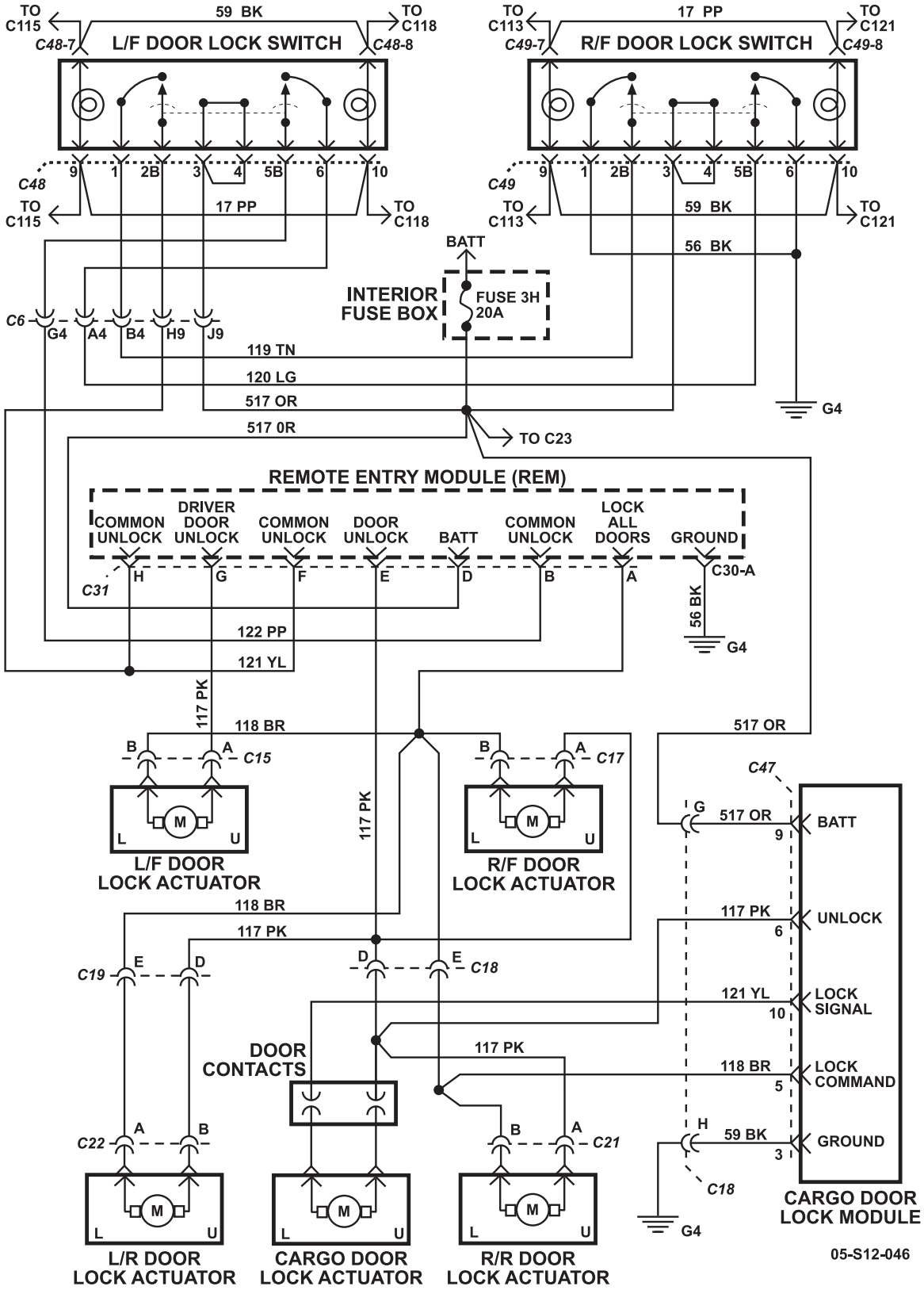


Figure 12-127: Locks Power With Incandescent Bulbs Wiring Schematic

LOCKS POWER HMCS W/ LED BULBS FROM VIN 226861

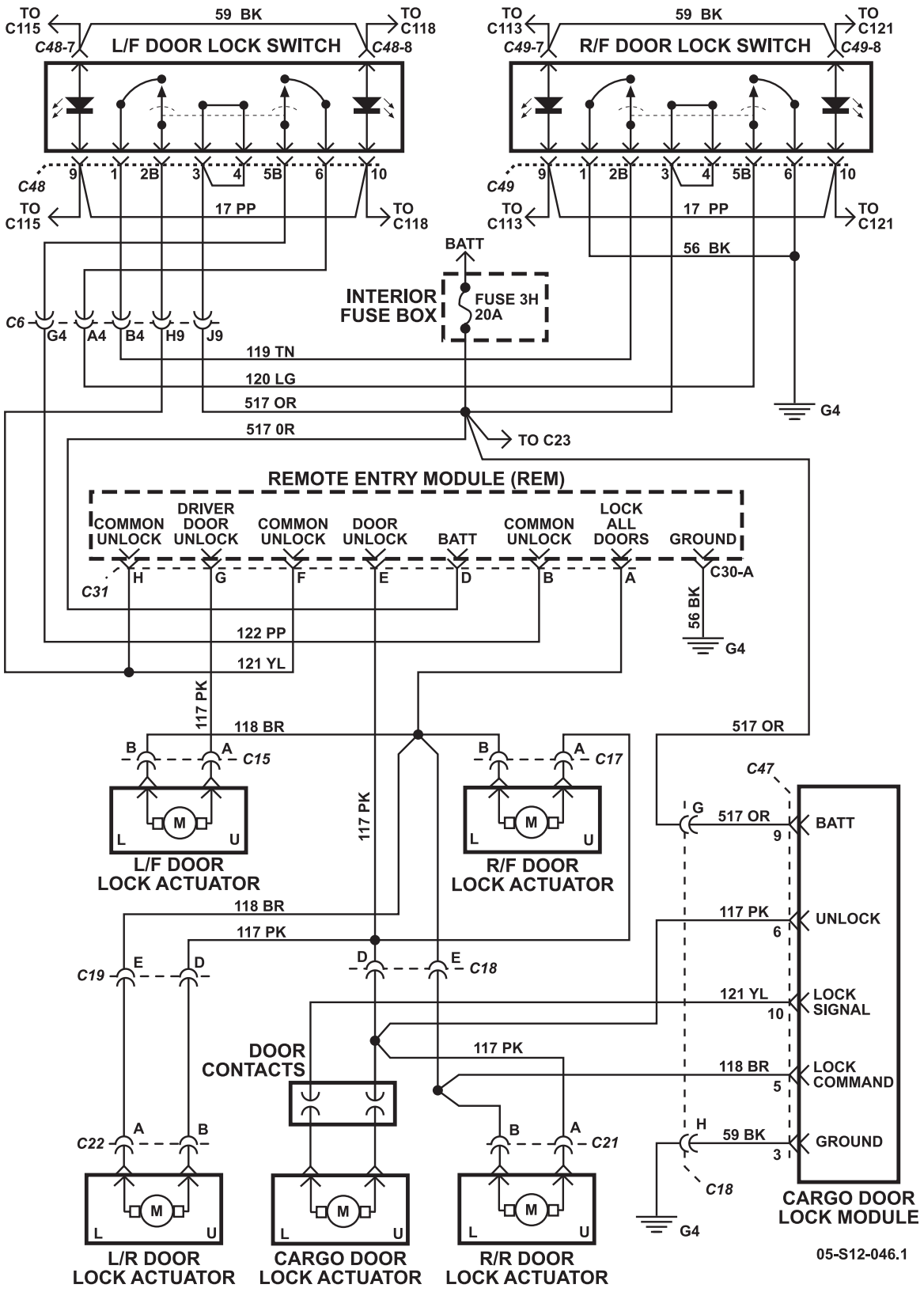


Figure 12-128: Locks power With LED Bulbs Wiring Schematic

LOCKS POWER HMCO W/ INCANDESCENT BULBS THROUGH VIN 226860

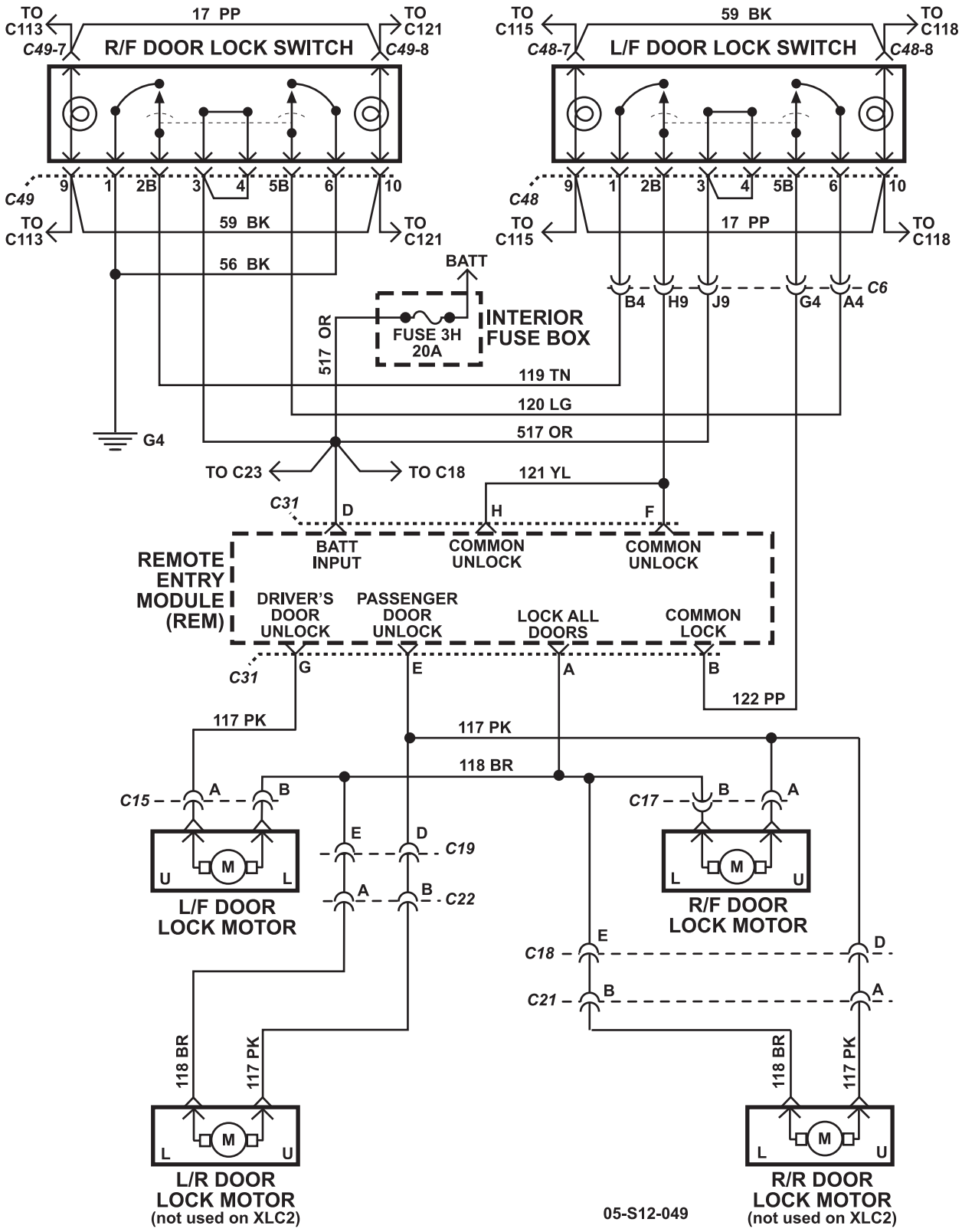


Figure 12-129: Locks Power With Incandescent Bulbs Wiring Schematic

LOCKS POWER HMCO W/ LED BULBS FROM VIN 226861

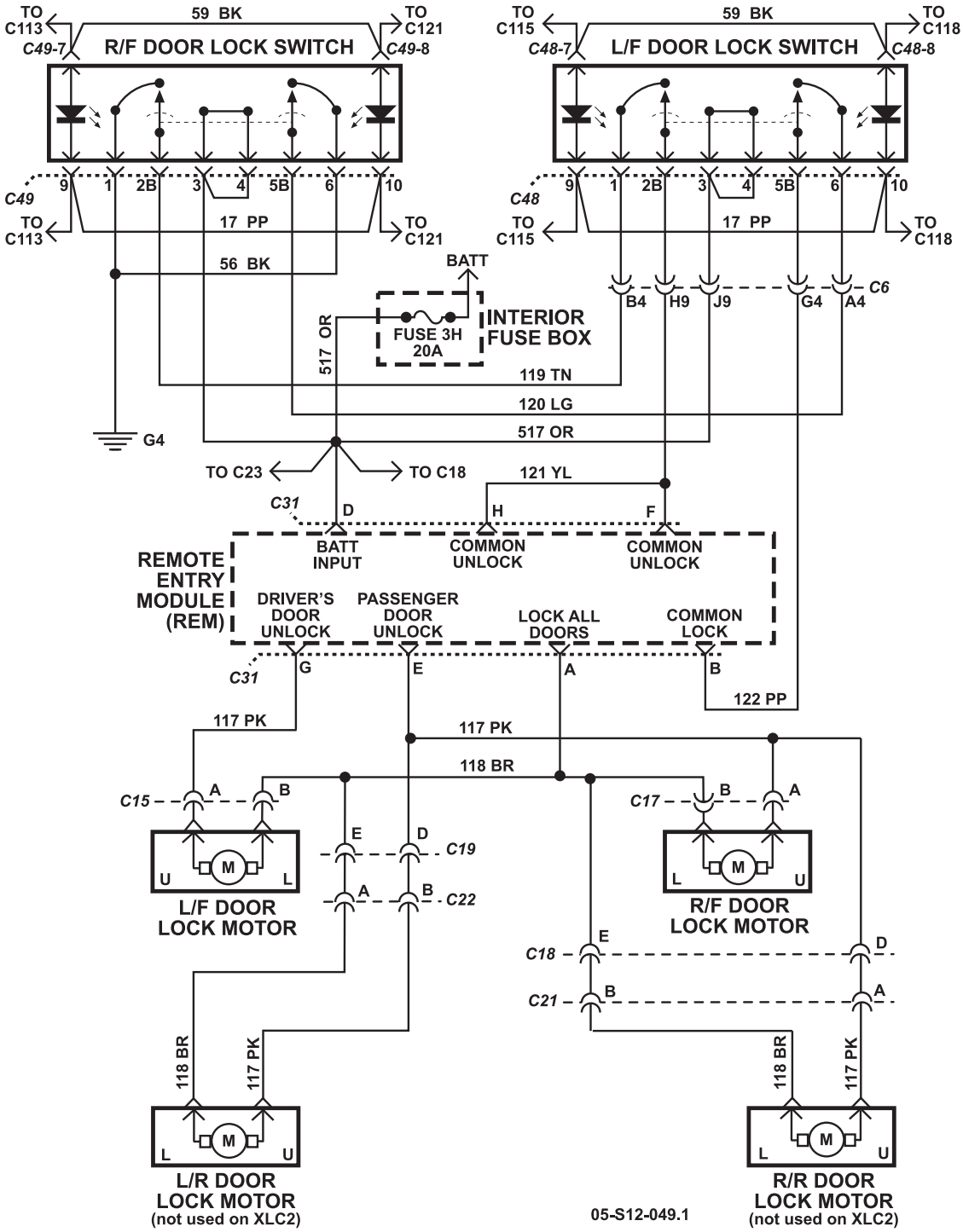


Figure 12-130: Locks Power With LED Wiring Schematic

MASS AIR FLOW SENSOR (MAF)

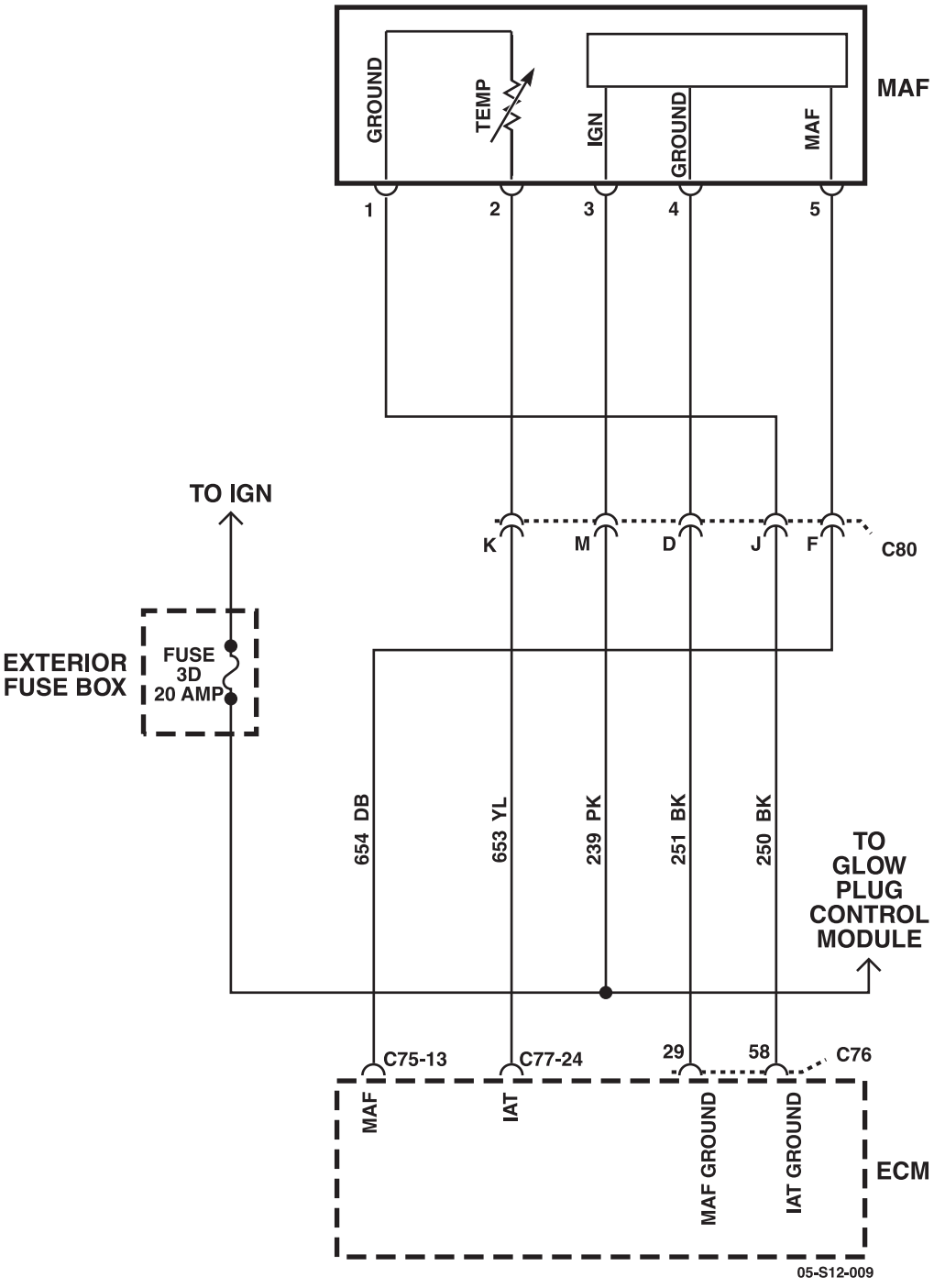


Figure 12-131: Mass Air Flow Sensor Wiring Schematic

MIRROR POWER HEATED

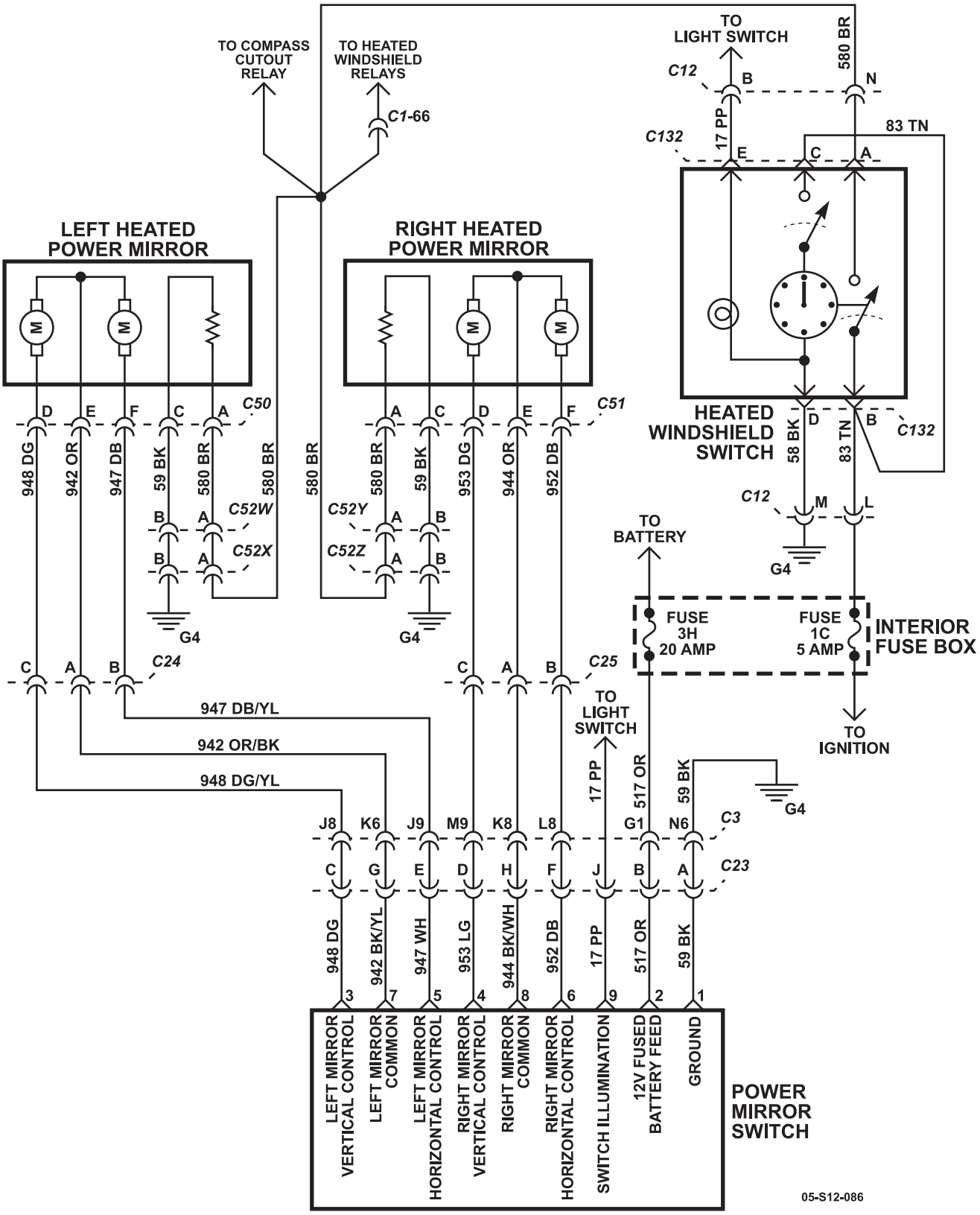


Figure 12-132: Mirror Power Heated Wiring Schematic

NEUTRAL SAFETY BACK UP (NSBU) SWITCH

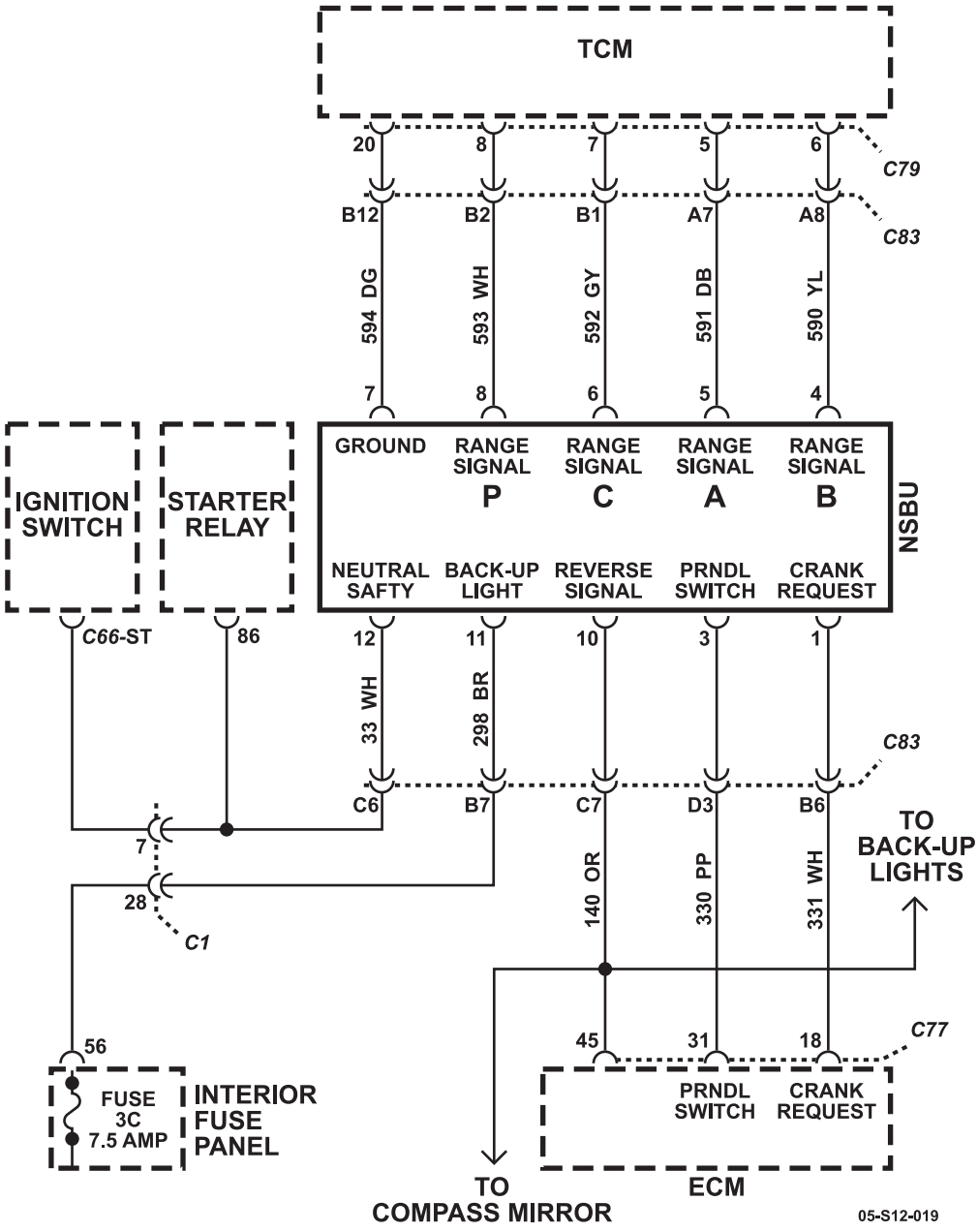


Figure 12-133: Neutral Safety Back Up Switch Wiring Schematic

OIL PRESSURE MODULE

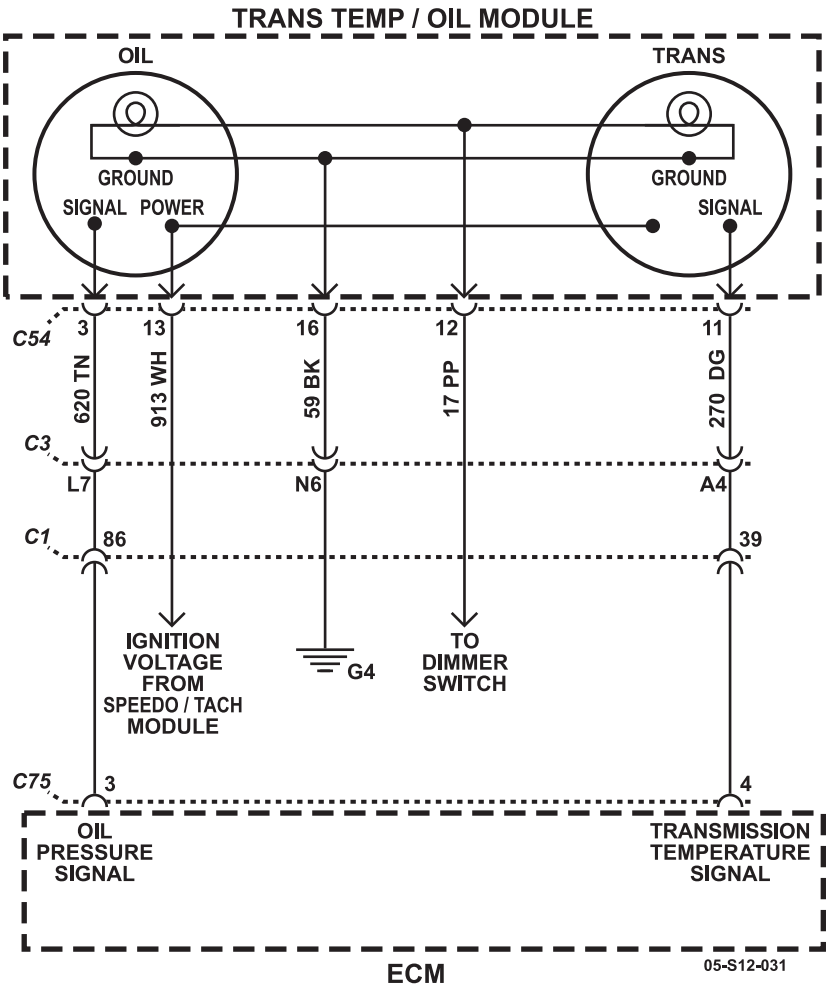


Figure 12-134: Oil Pressure Module Wiring Schematic

OIL PRESSURE SENDING UNIT/ OIL PRESSURE MODULE WARNING LIGHTS

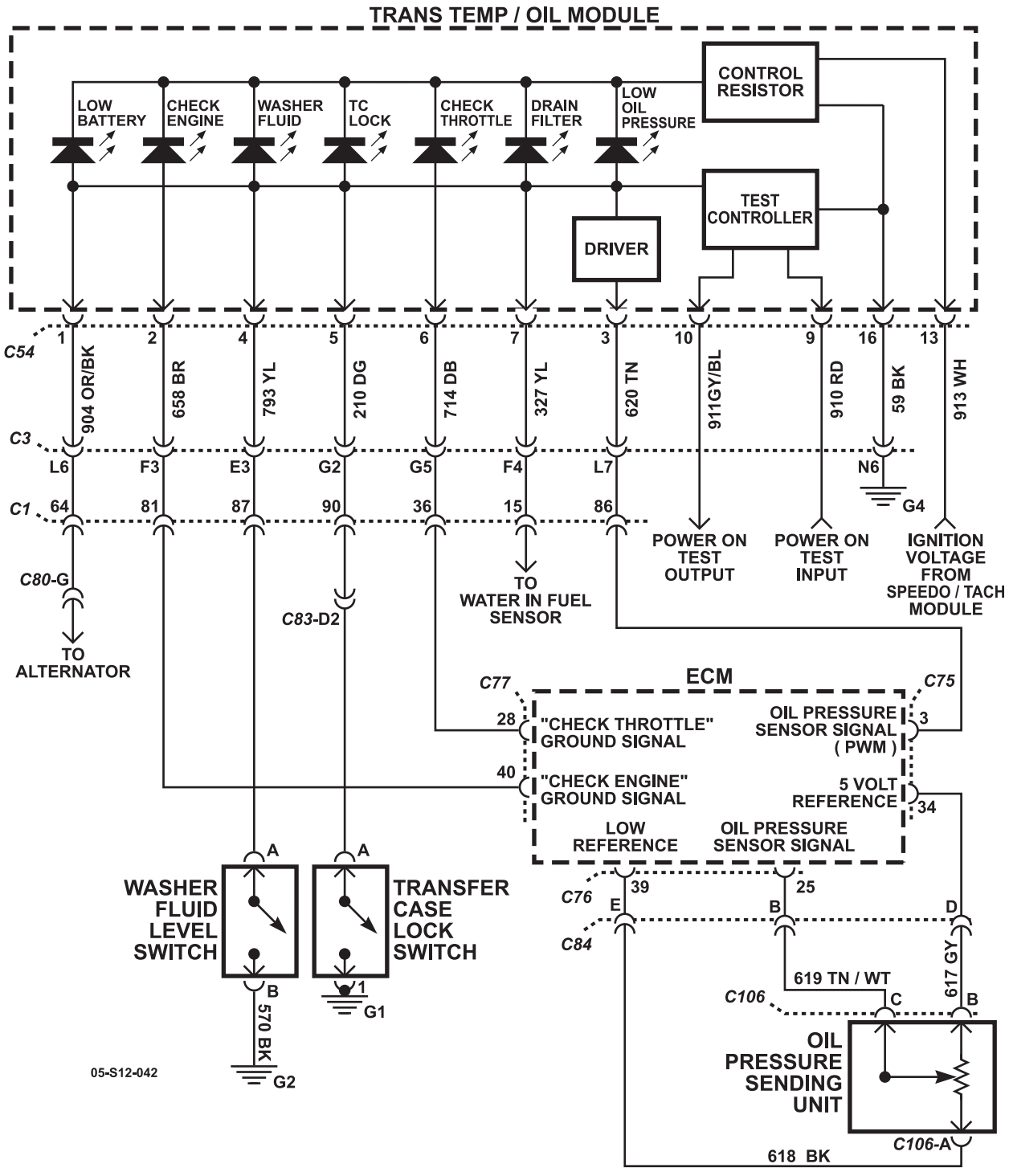


Figure 12-135: Oil Pressure Sending Unit Wiring Schematic

OIL PRESSURE SENSOR

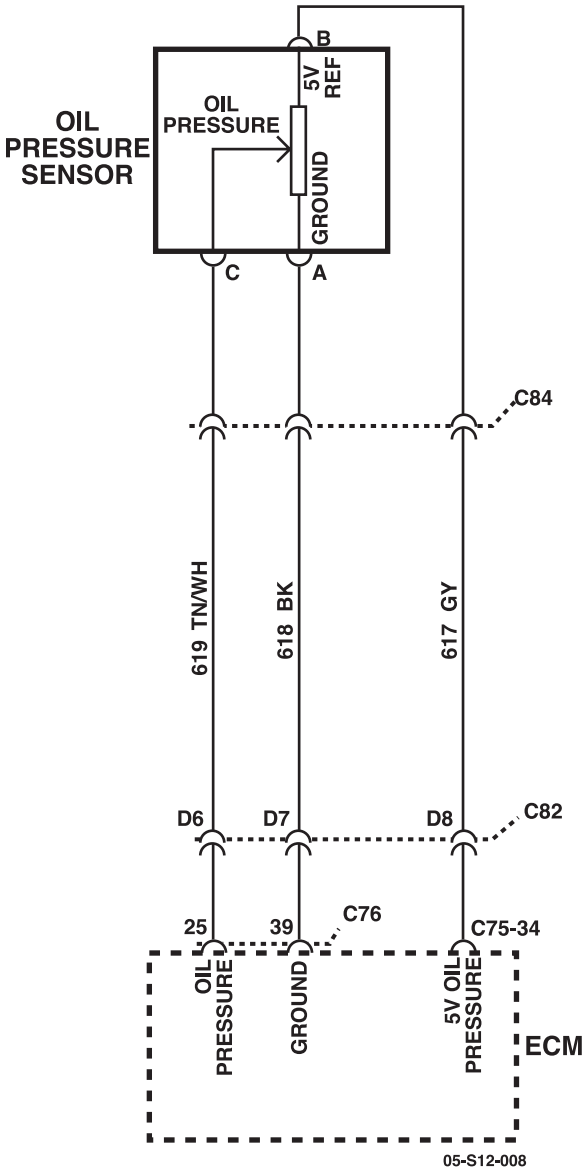


Figure 12-136: Oil Pressure Sensor Wiring Schematic

OVER DRIVE SWITCH

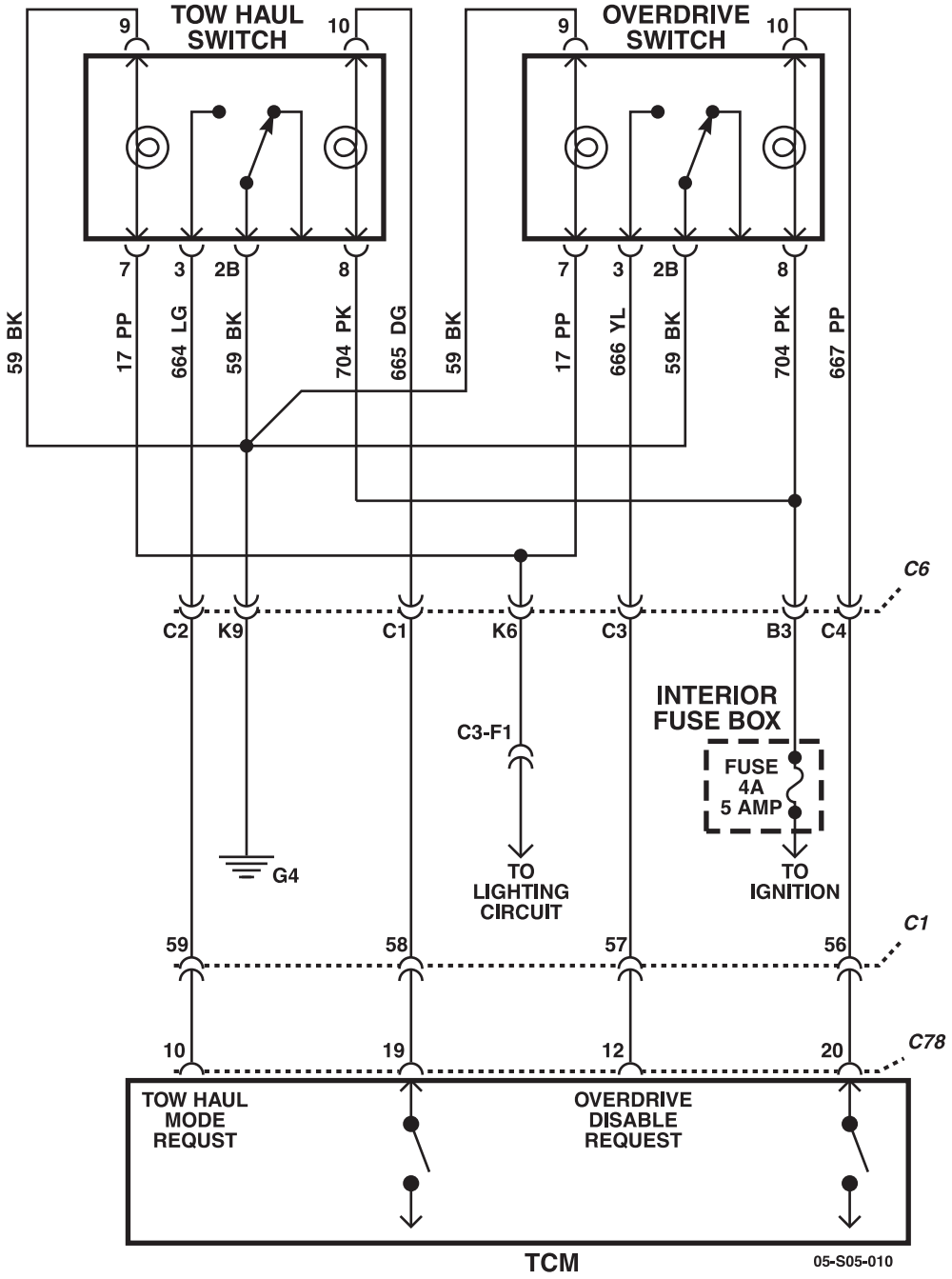


Figure 12-137: Over Drive Switch Wiring Schematic

REMOTE ENTRY

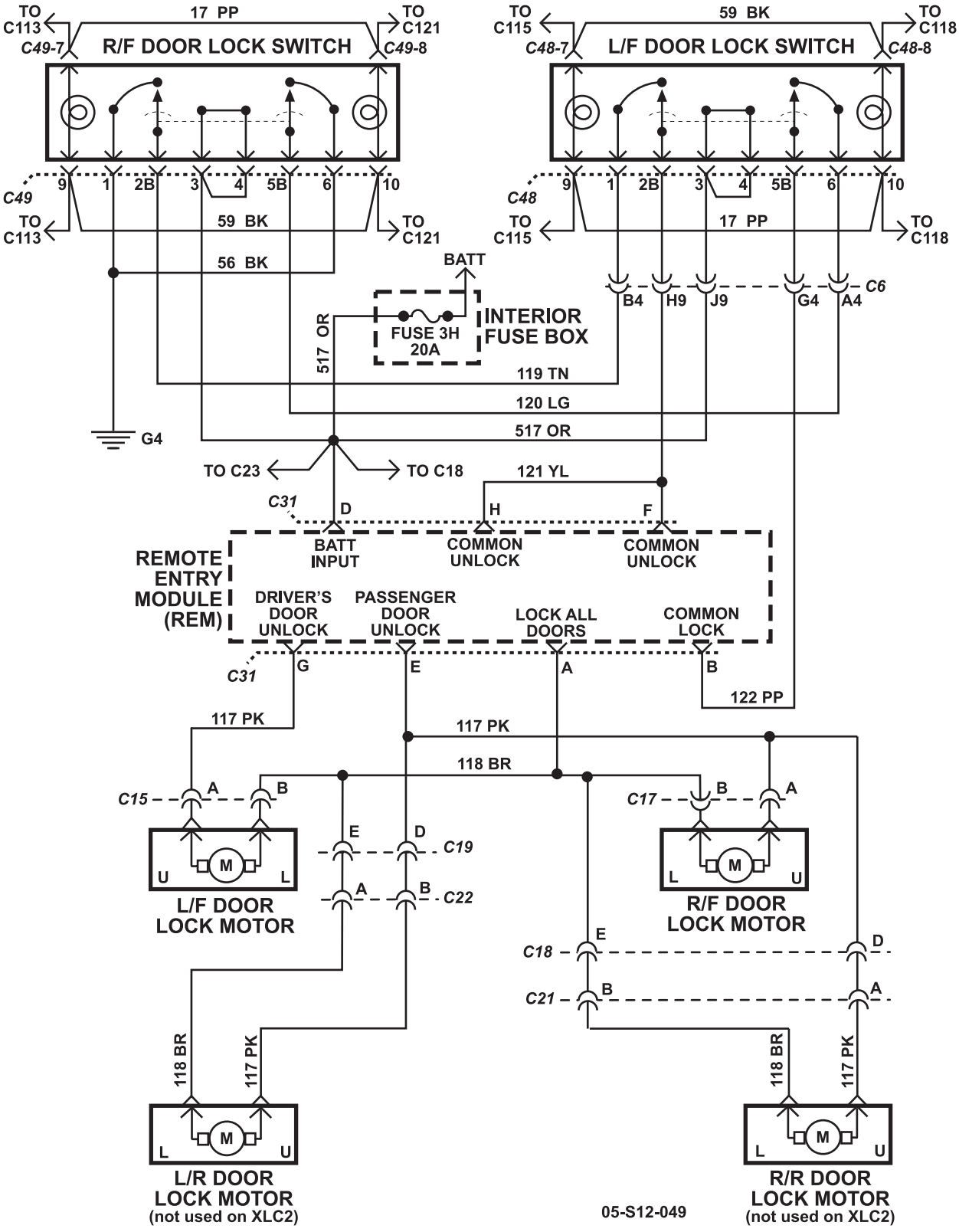


Figure 12-138: Remote Entry Wiring Schematic

SEAT DRIVERS HEATED

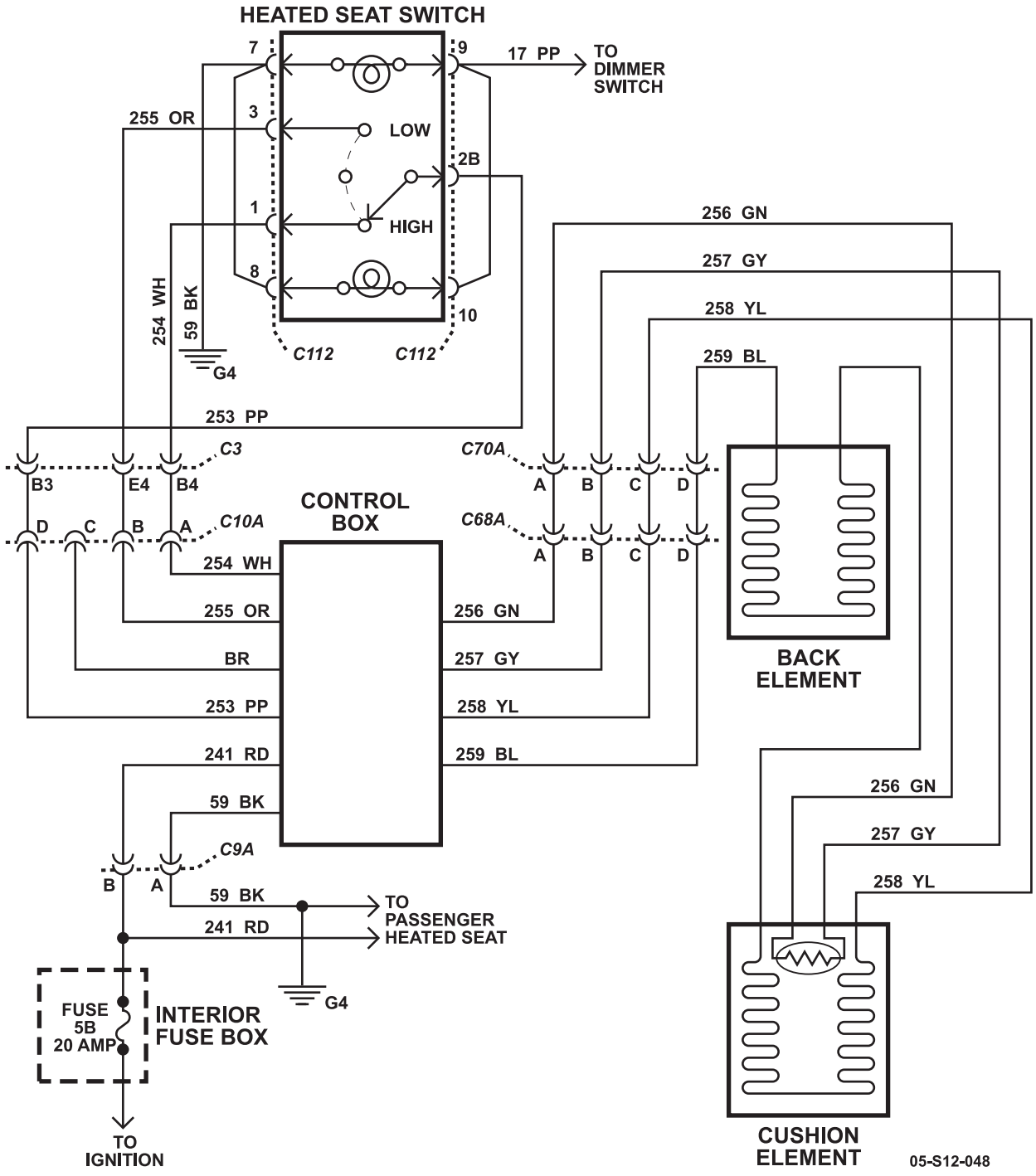


Figure 12-139: Seat Drivers Heated Wiring Schematic

SEAT PASSENGER HEATED

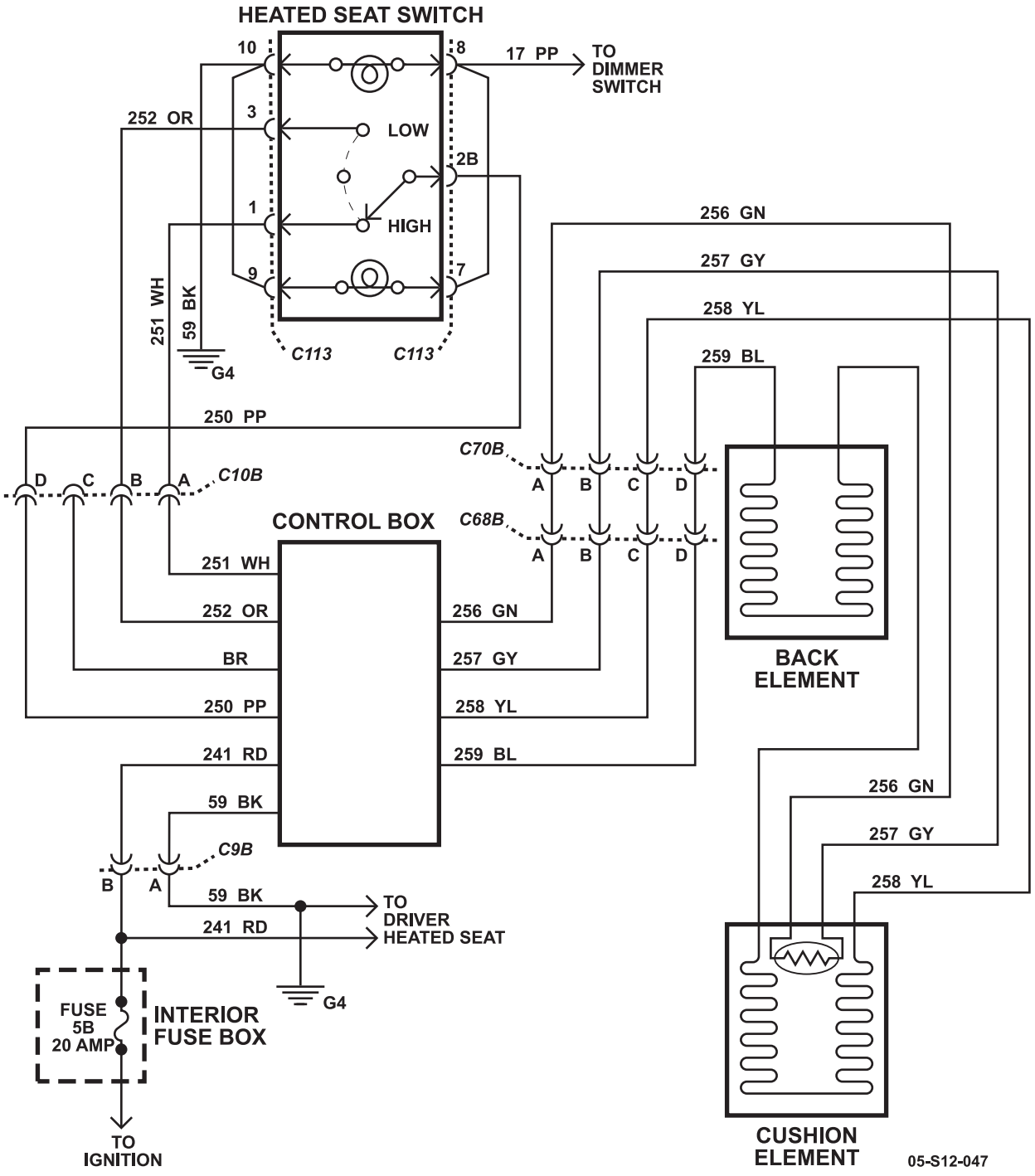


Figure 12-140: Seat Drivers Heated Wiring Schematic

SHIFTER/ SHIFT INTERLOCK

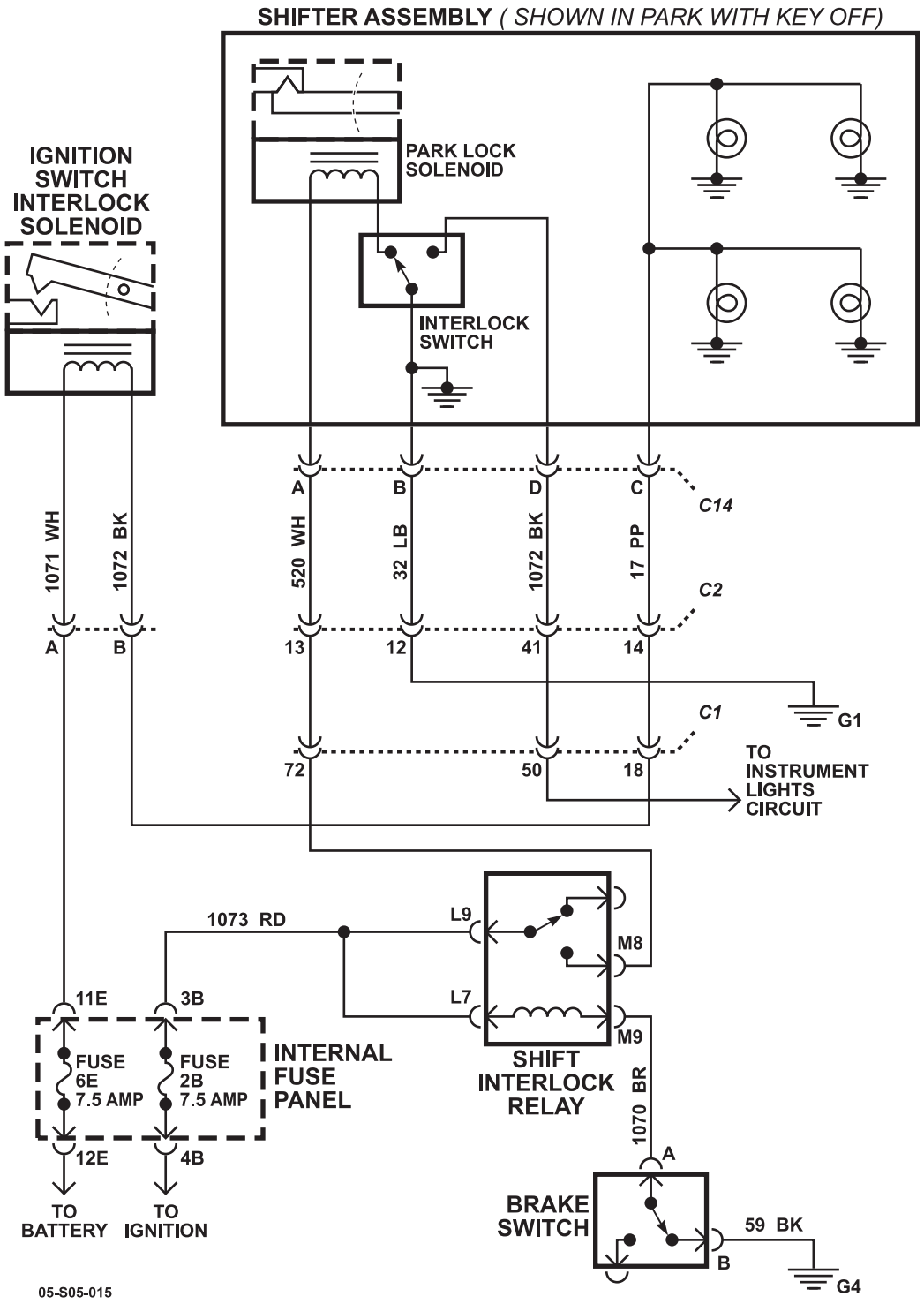


Figure 12-141: Shifter/ Shift InterLock Wiring Schematic

SPEED SENSORS

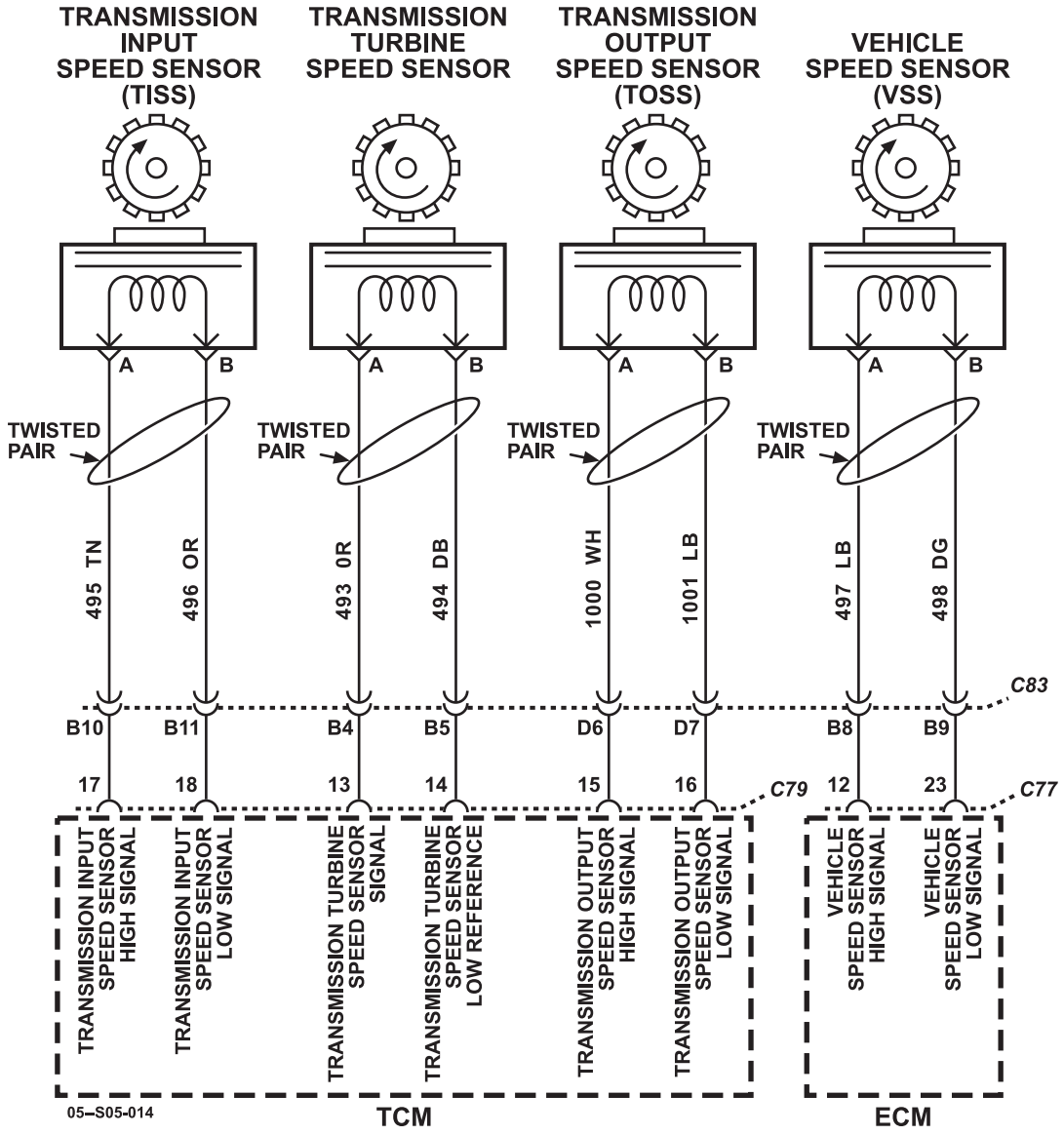


Figure 12-142: Speed Sensors Wiring Schematic

SPEEDO MODULE INDICATOR LIGHTS

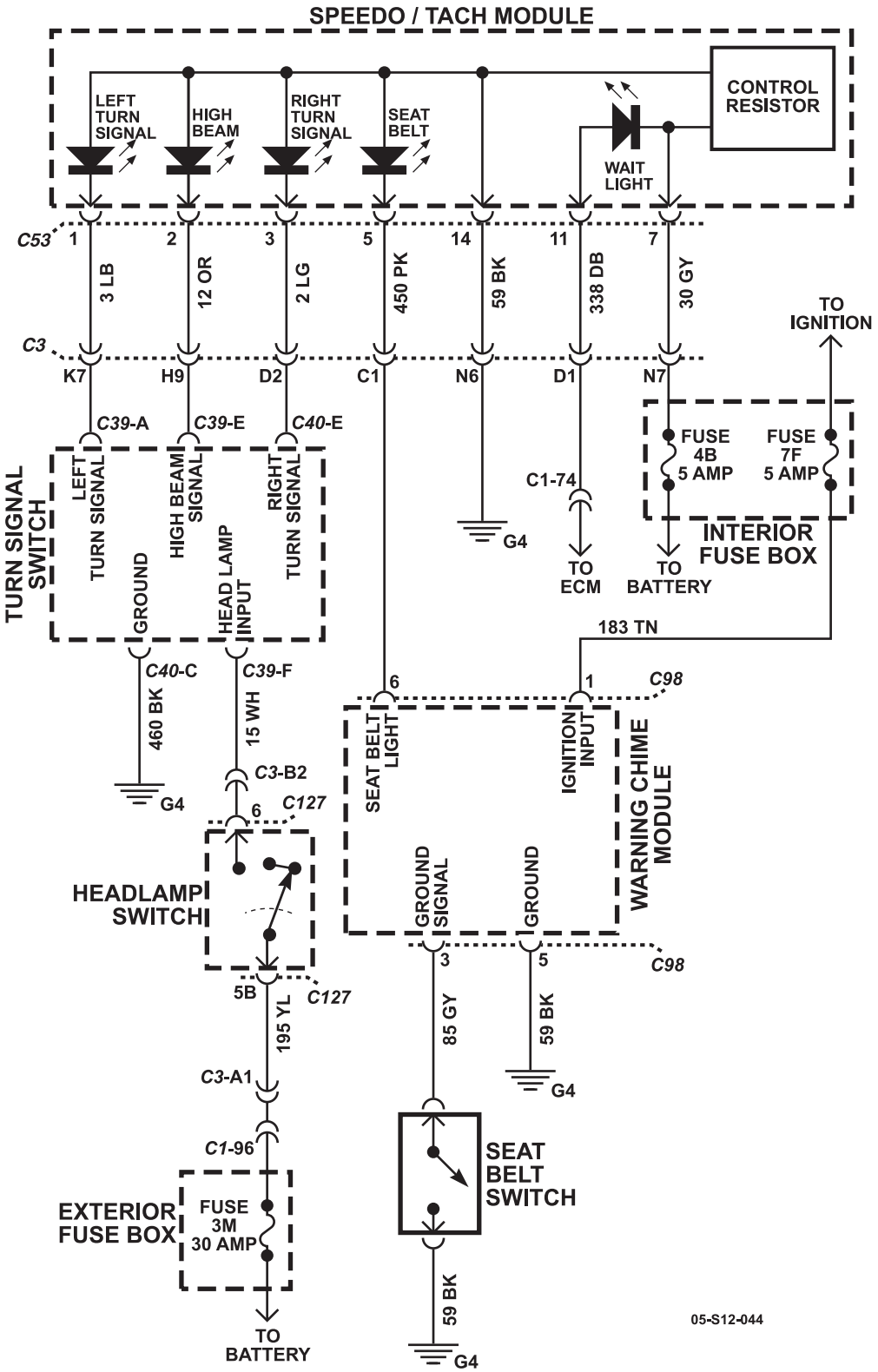


Figure 12-143: Speedo Module Indicator Lights Wiring Schematic

SPEEDO MODULE

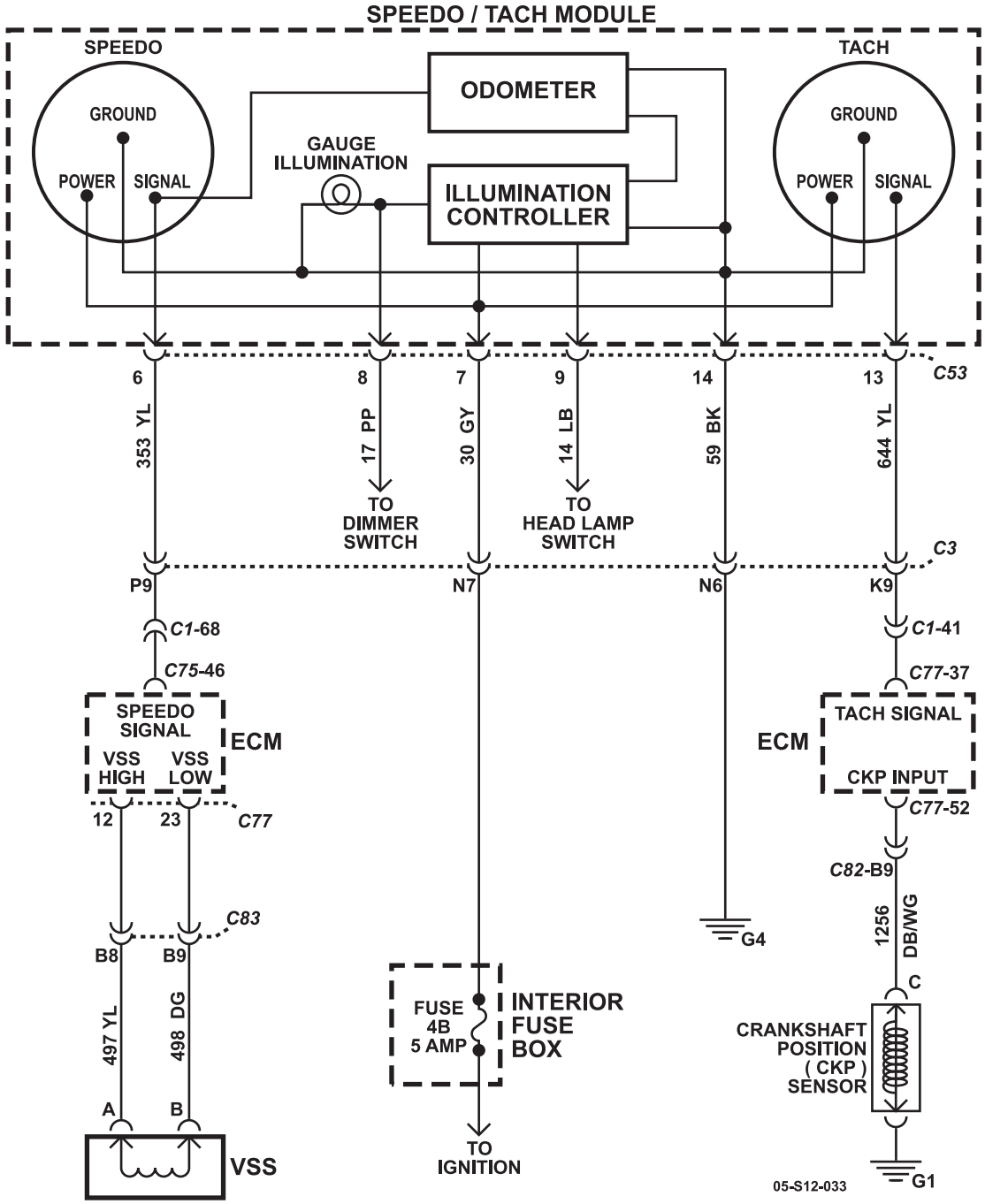


Figure 12-144: Speedo Module Wiring Schematic

STARTER SYSTEM

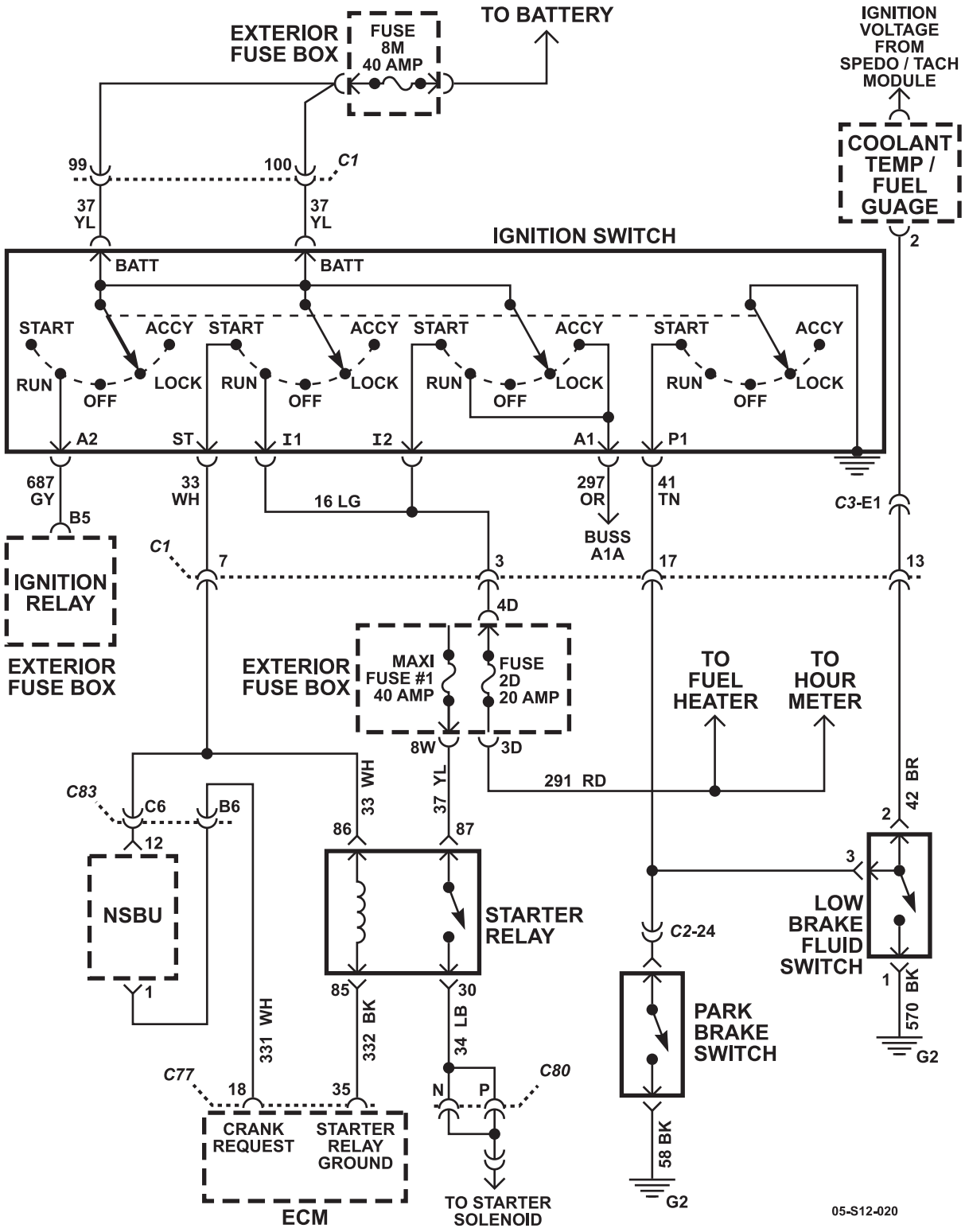


Figure 12-145: Starter System Wiring Schematic

TACHOMETER MODULE

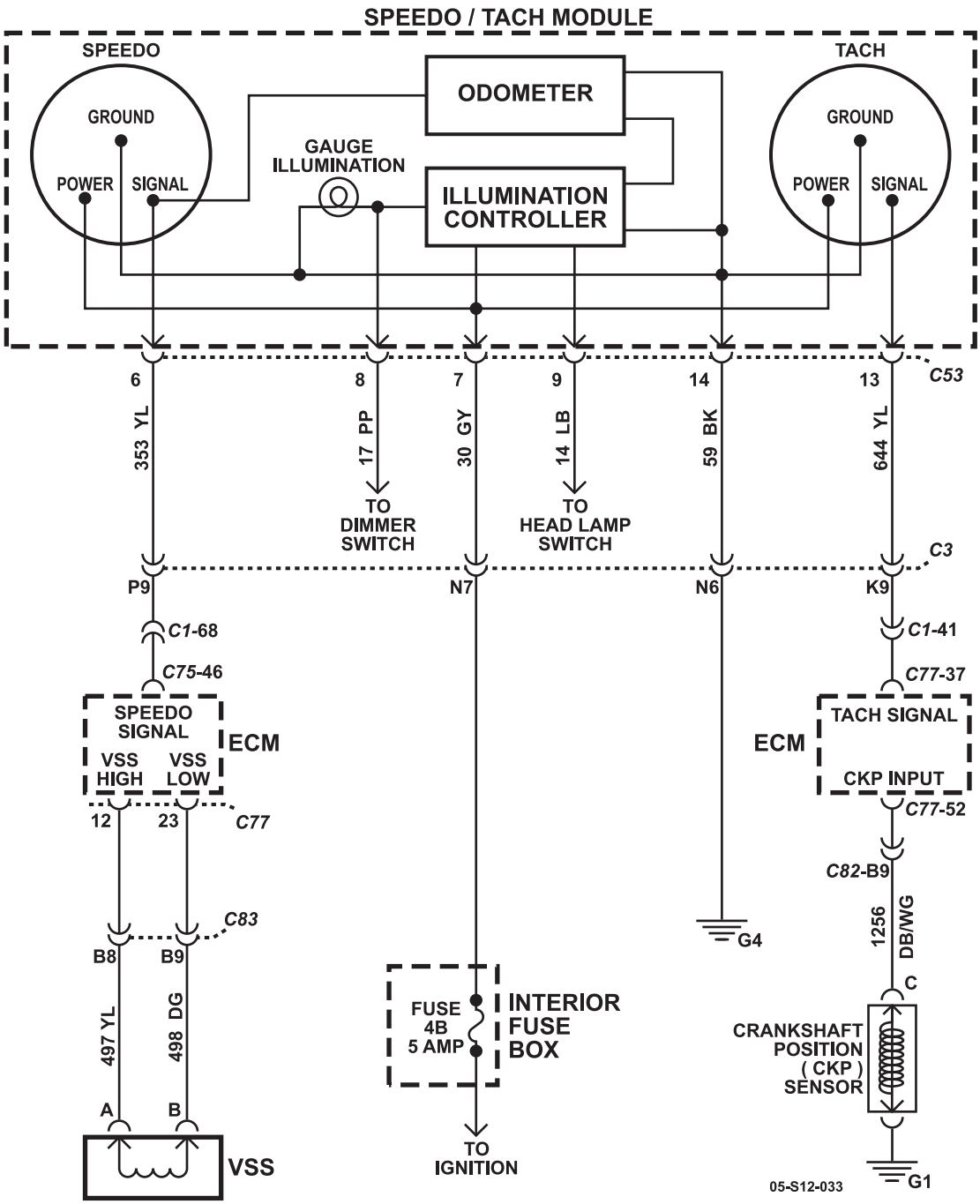


Figure 12-146: TACH Module Wiring Schematic

TACHOMETER MODULE INDICATOR LIGHTS

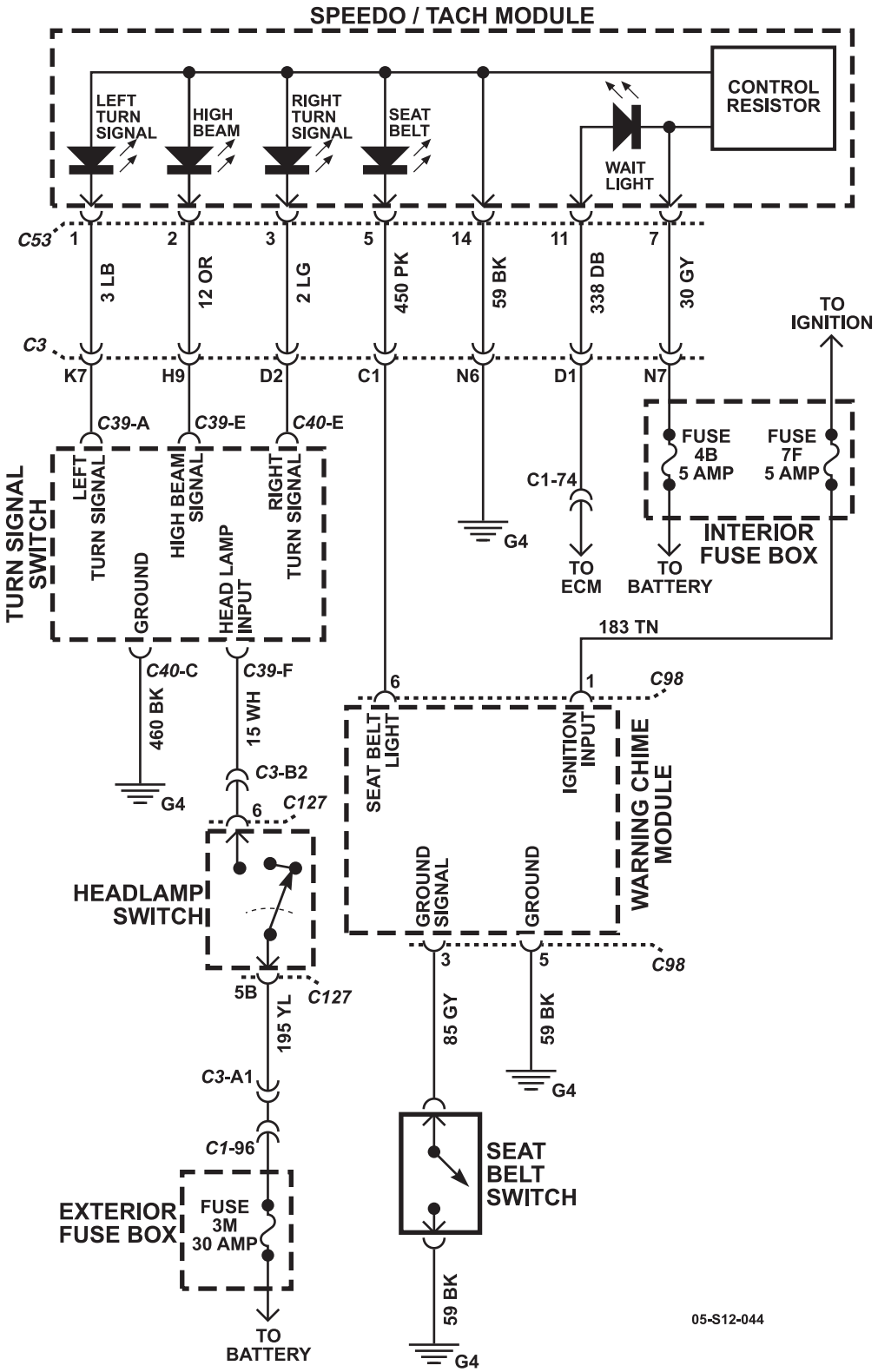


Figure 12-147: TACH Module Indicator Lights Wiring Schematic

TURN SIGNAL SWITCH

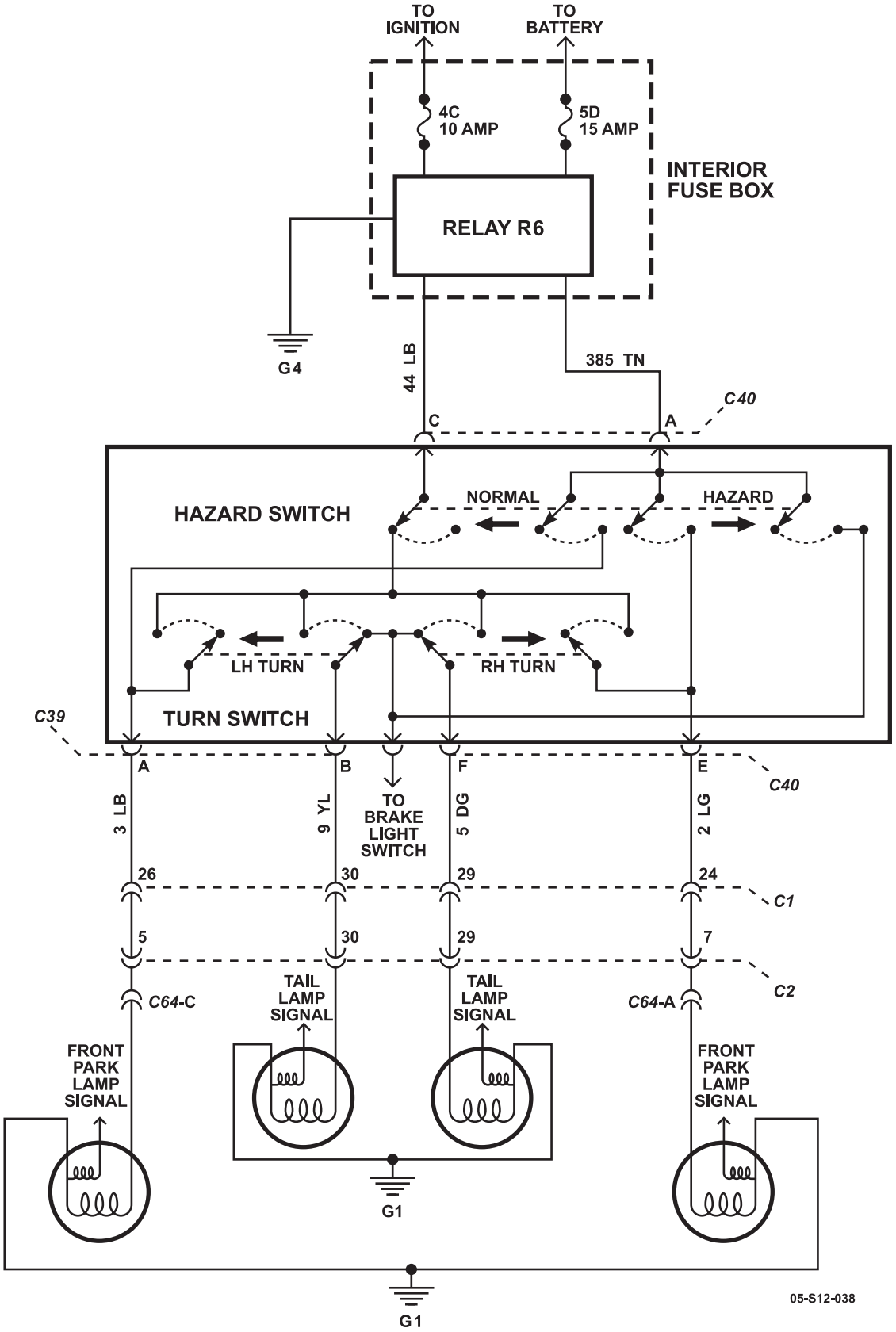


Figure 12-148: Turn Signal Switch Wiring Schematic

TOW HAUL SWITCH

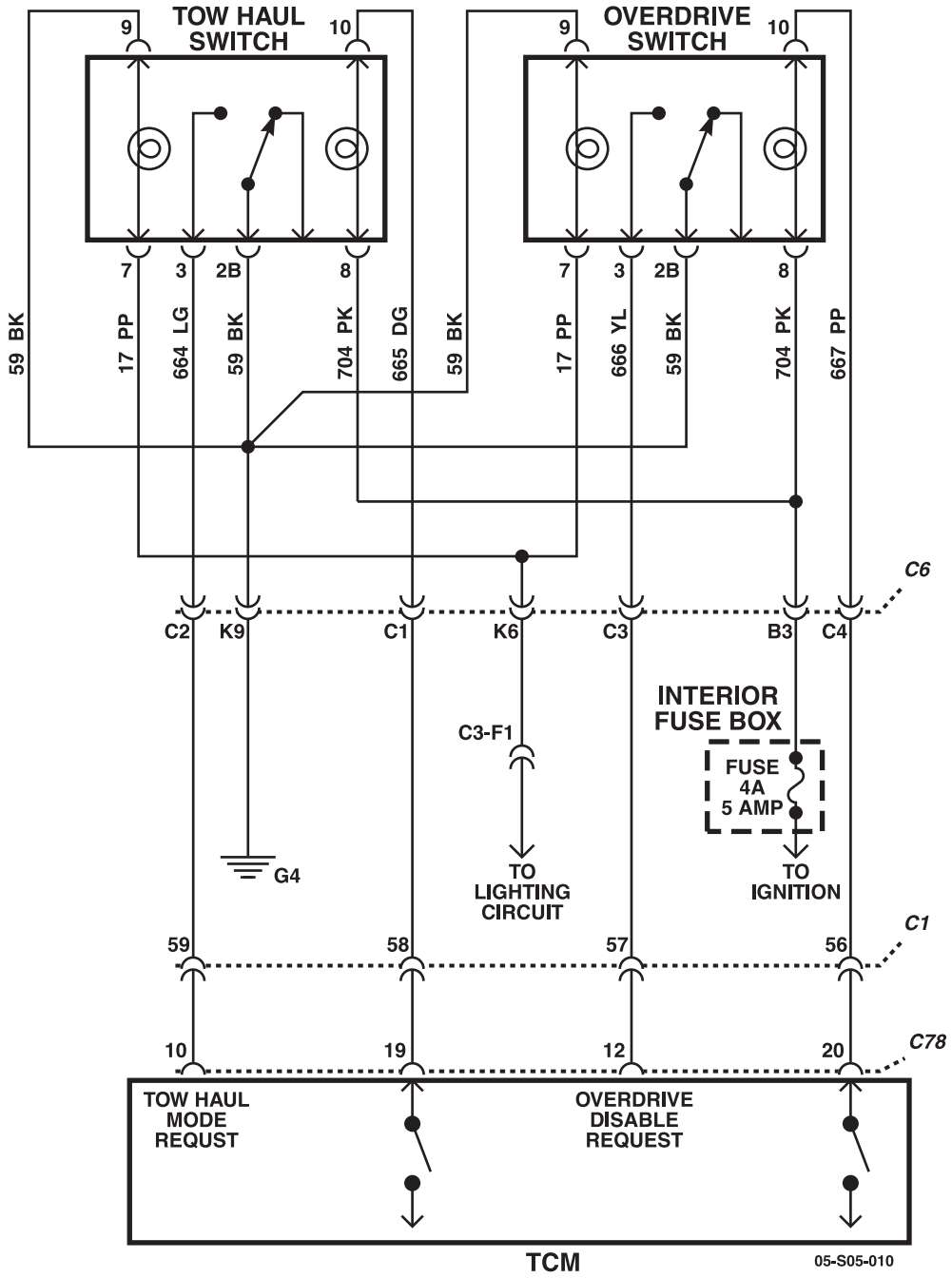


Figure 12-149: Tow Haul Switch Wiring Schematic

TRANSMISSION TEMPERATURE MODULE

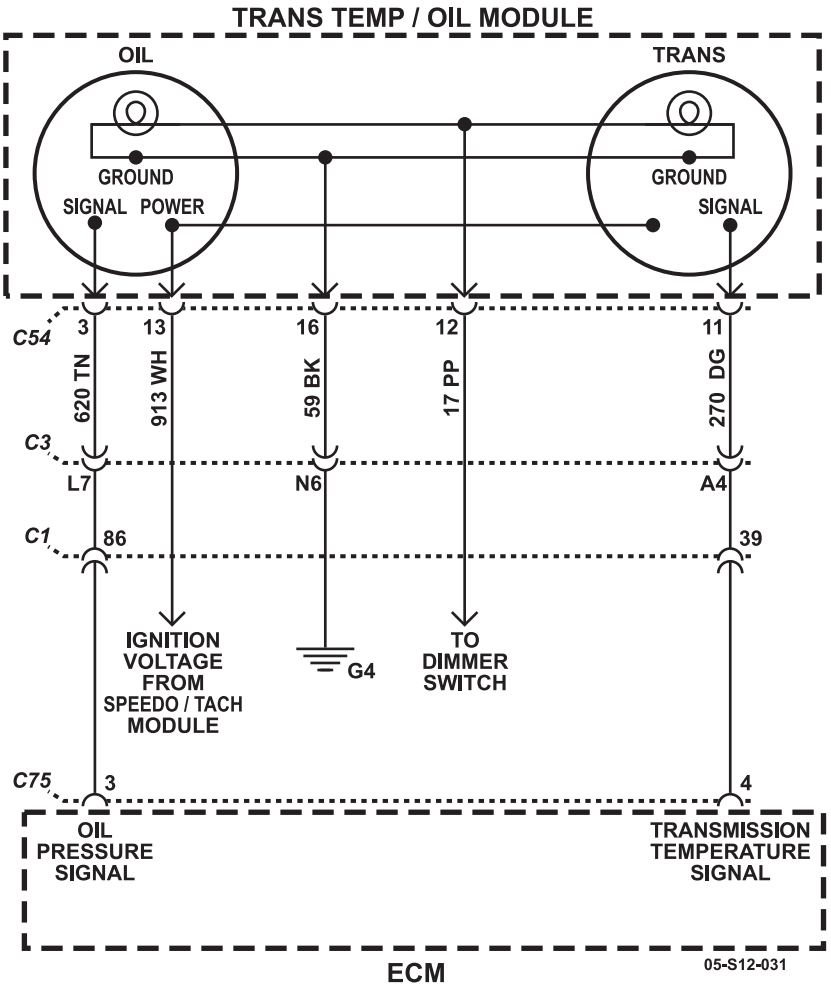


Figure 12-150: Transmission Temperature Module Wiring Schematic

TRANSMISSION TEMPERATURE/ OIL MODULE WARNING LIGHTS

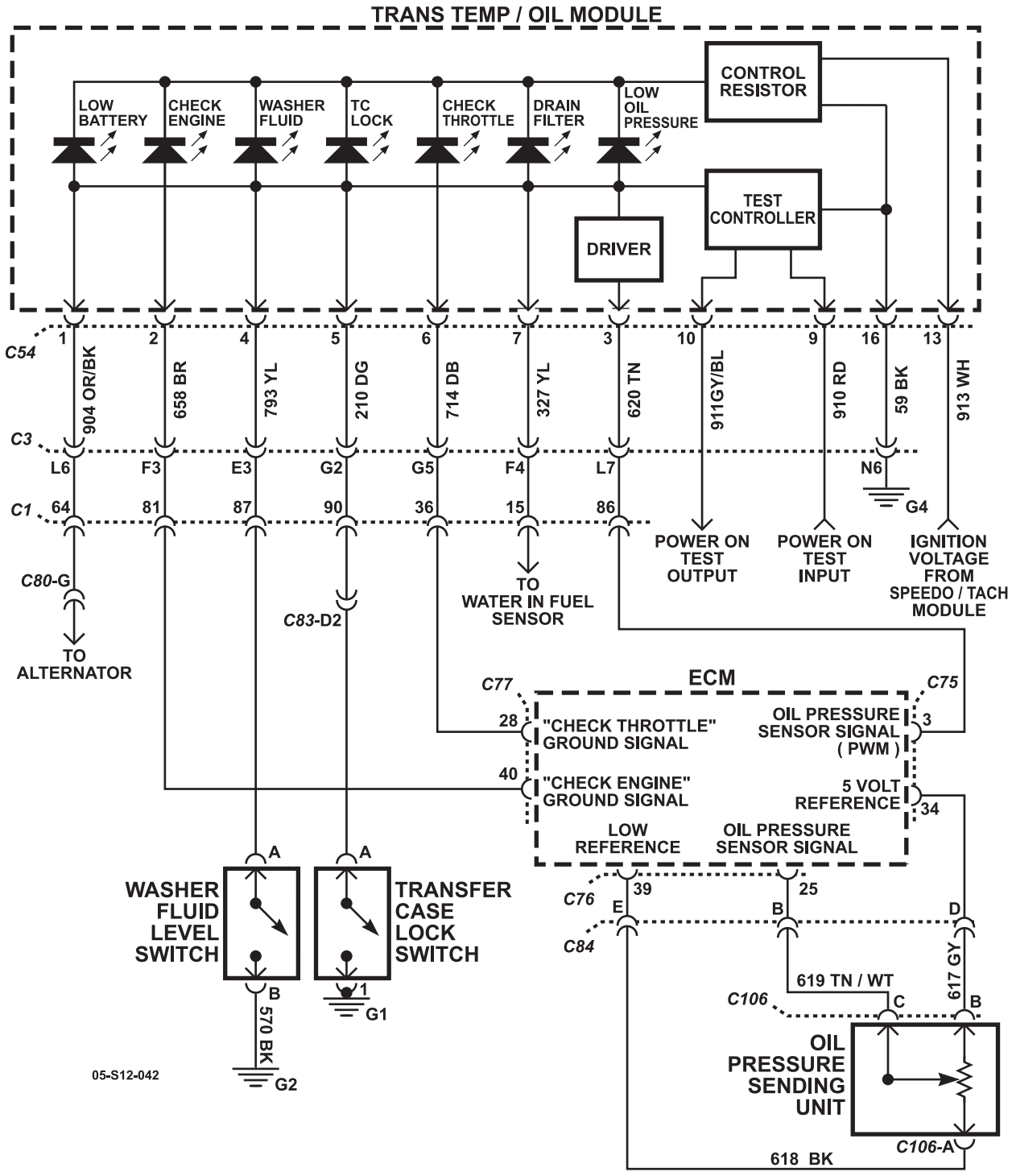


Figure 12-151: Transmission Temperature Module Warning Lights Wiring Schematic

TRANSMISSION SOLENOIDS

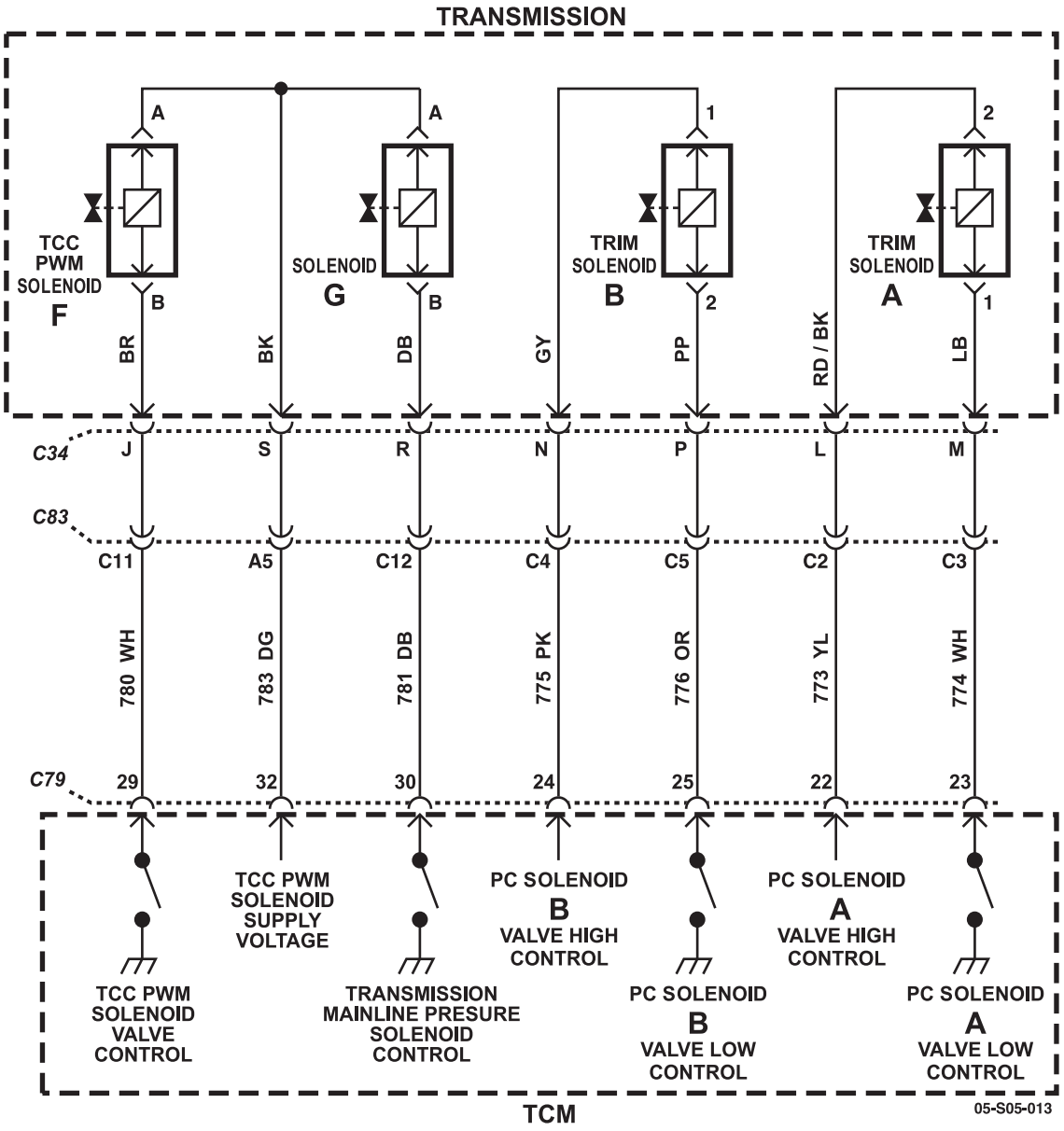


Figure 12-152: Transmission Solenoids Wiring Schematic

TRANSMISSION SOLENOIDS

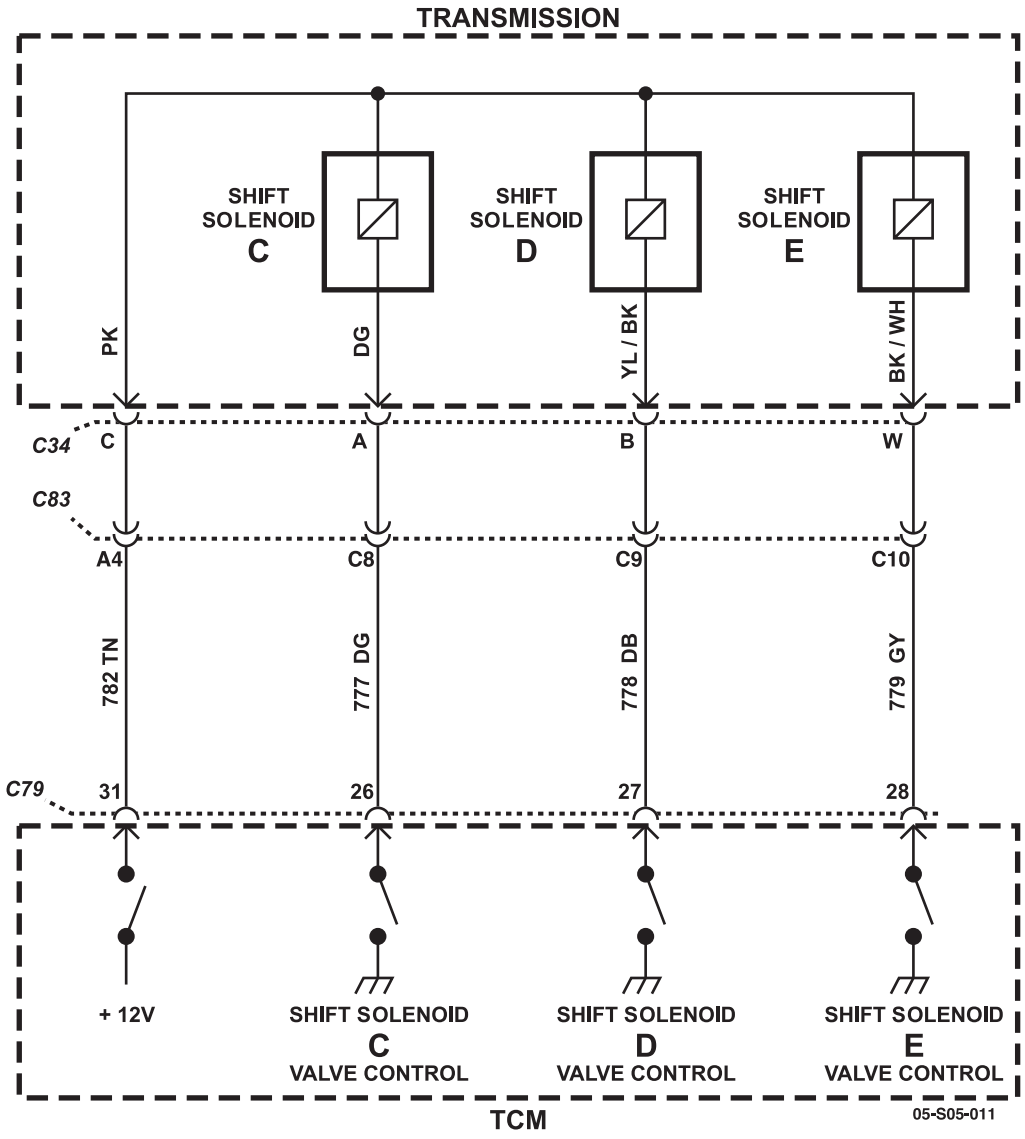


Figure 12-153: Transmission Solenoids Wiring Schematic

TURBO VANE POSITION SENSOR/ TURBO VANE SOLENOID

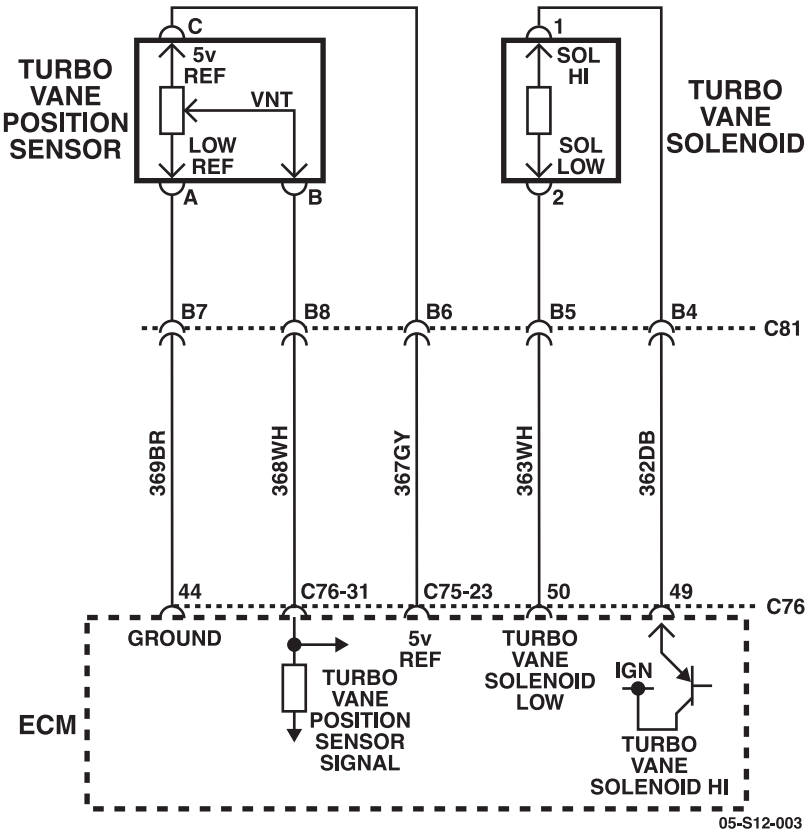


Figure 12-154: Turbo Vane Position/ Turbo Vane Solenoid Wiring Schematic

WINDOWS SWITCHES W/INCANDESCENT BULBS (DRIVERS CONSOLE) THROUGH VIN 226860

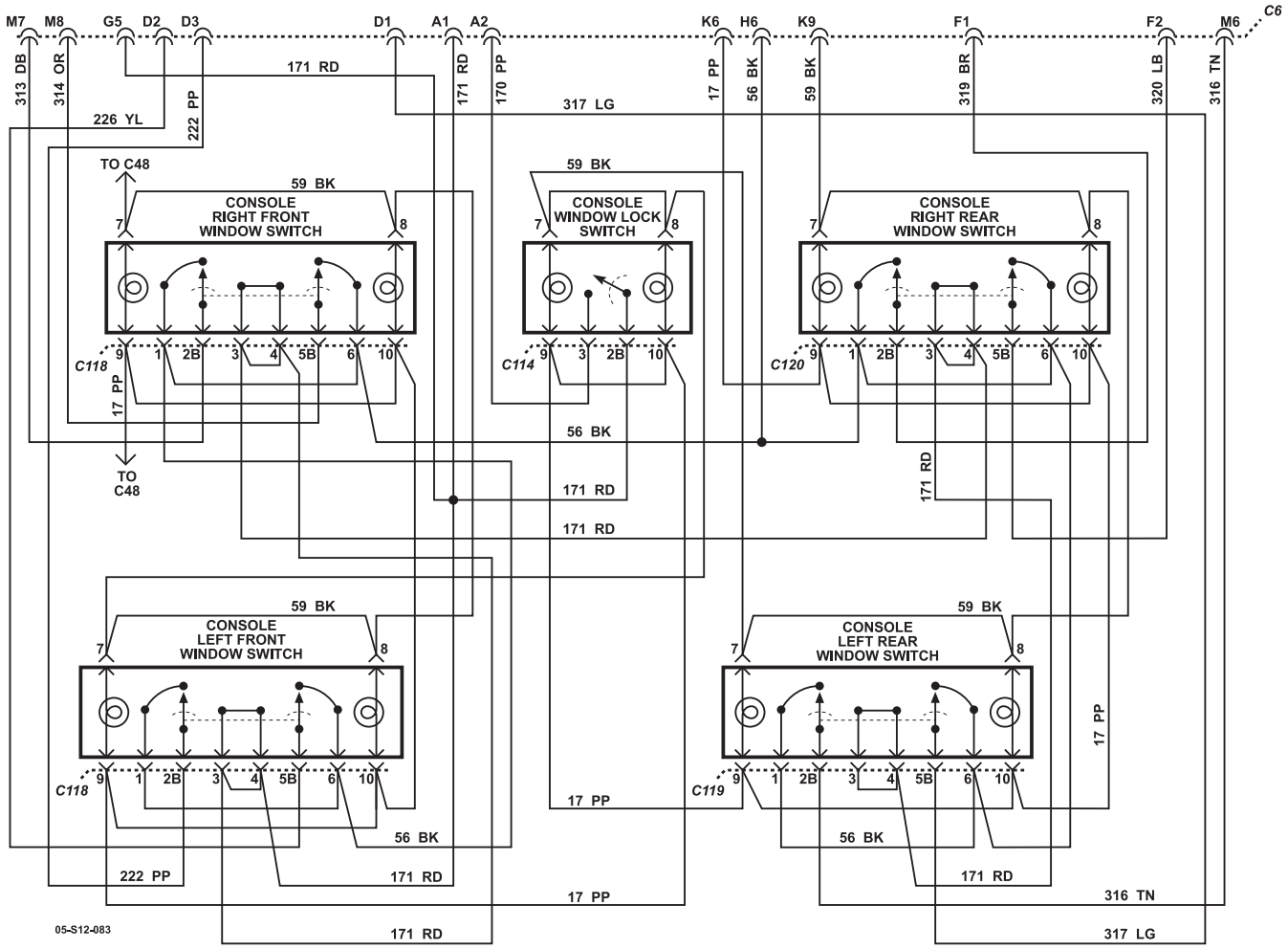


Figure 12-155: Window Switches With Incandescent Wiring Schematic

WINDOWS POWER W/ INCANDESCENT BULBS THROUGH VIN 226860

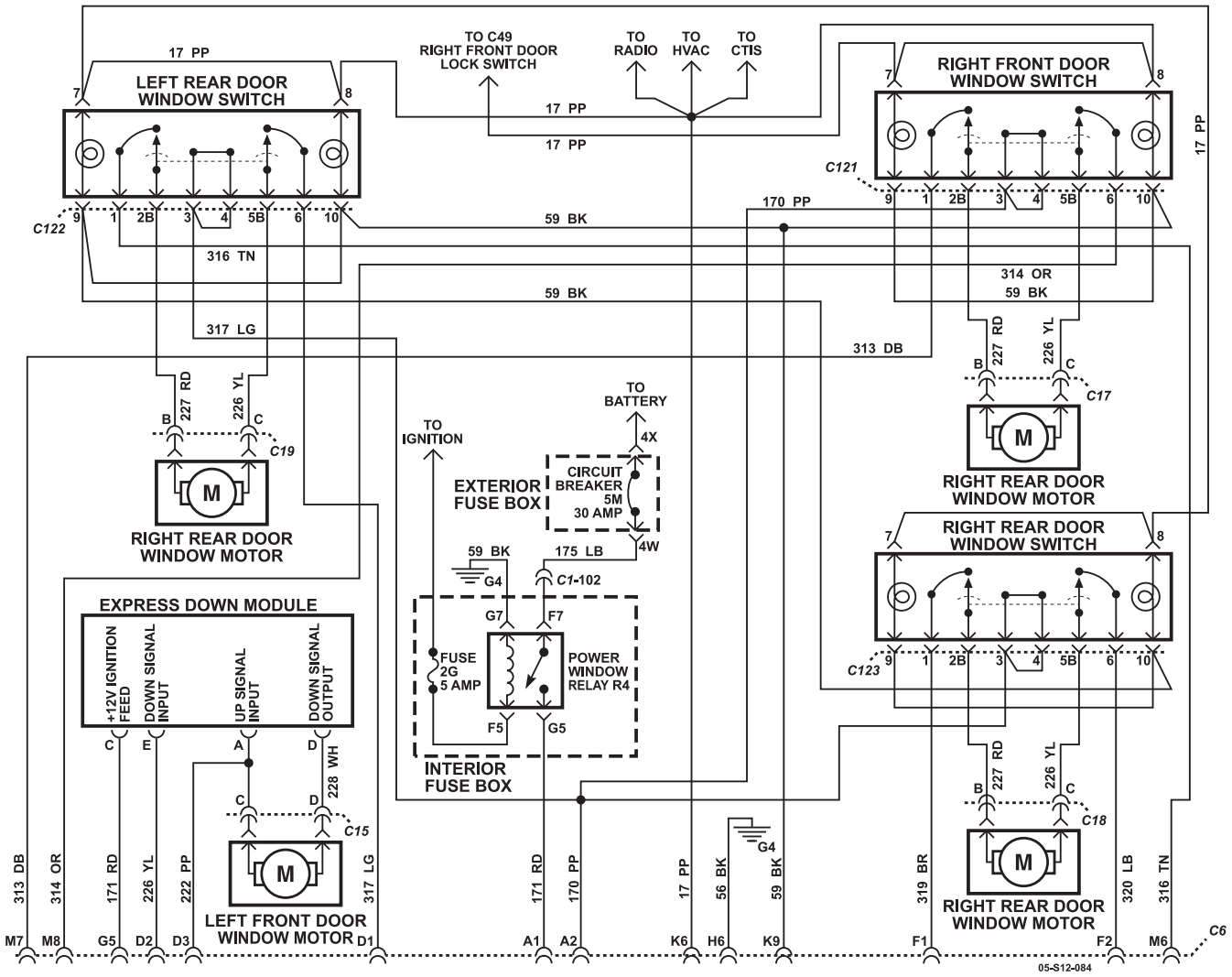


Figure 12-156: Window Power With Incandescent Wiring Schematic

WINDSHIELD (HEATED)

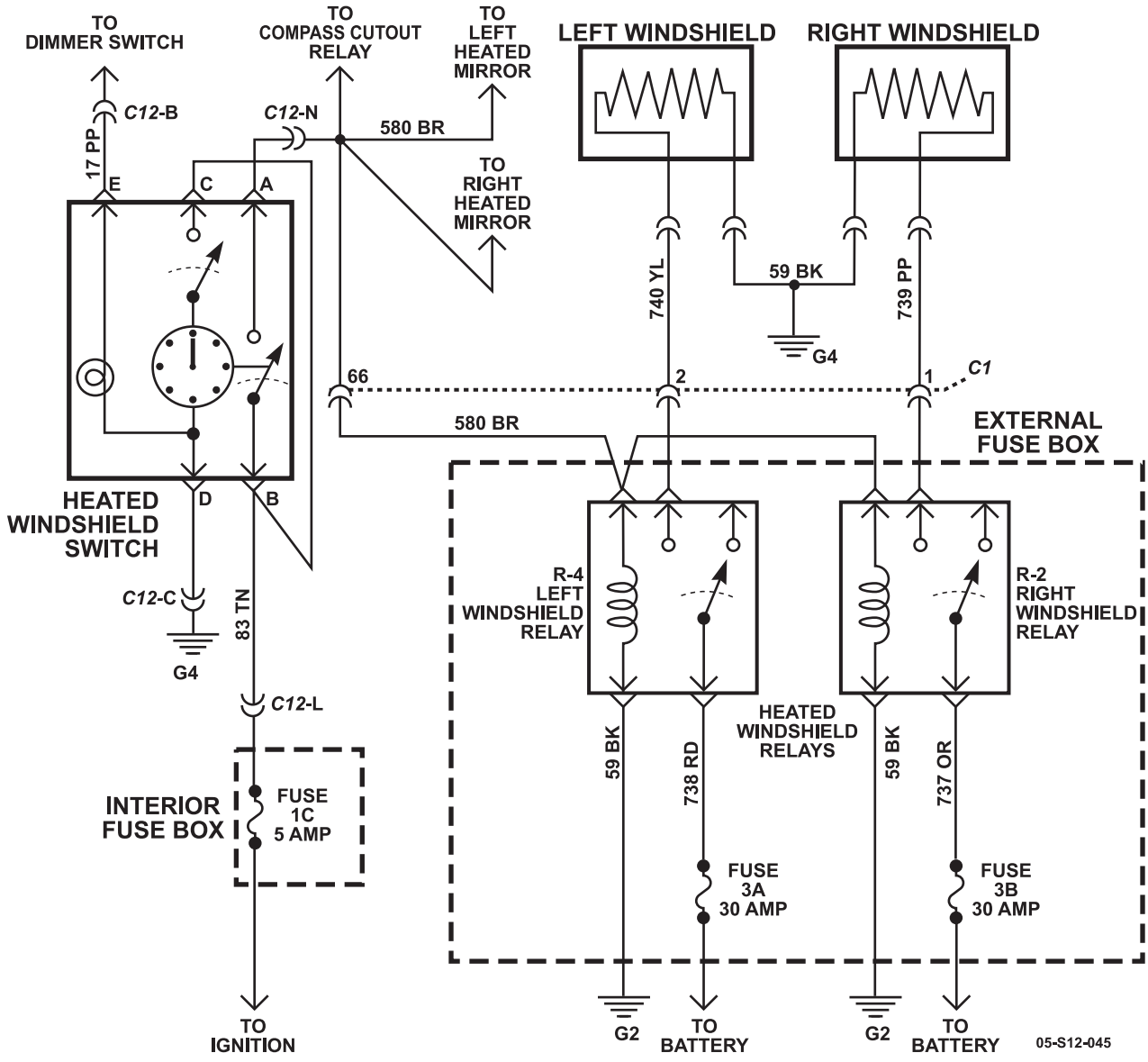


Figure 12-157: Windshield Heated Wiring Schematic

WIPER/ WASHER

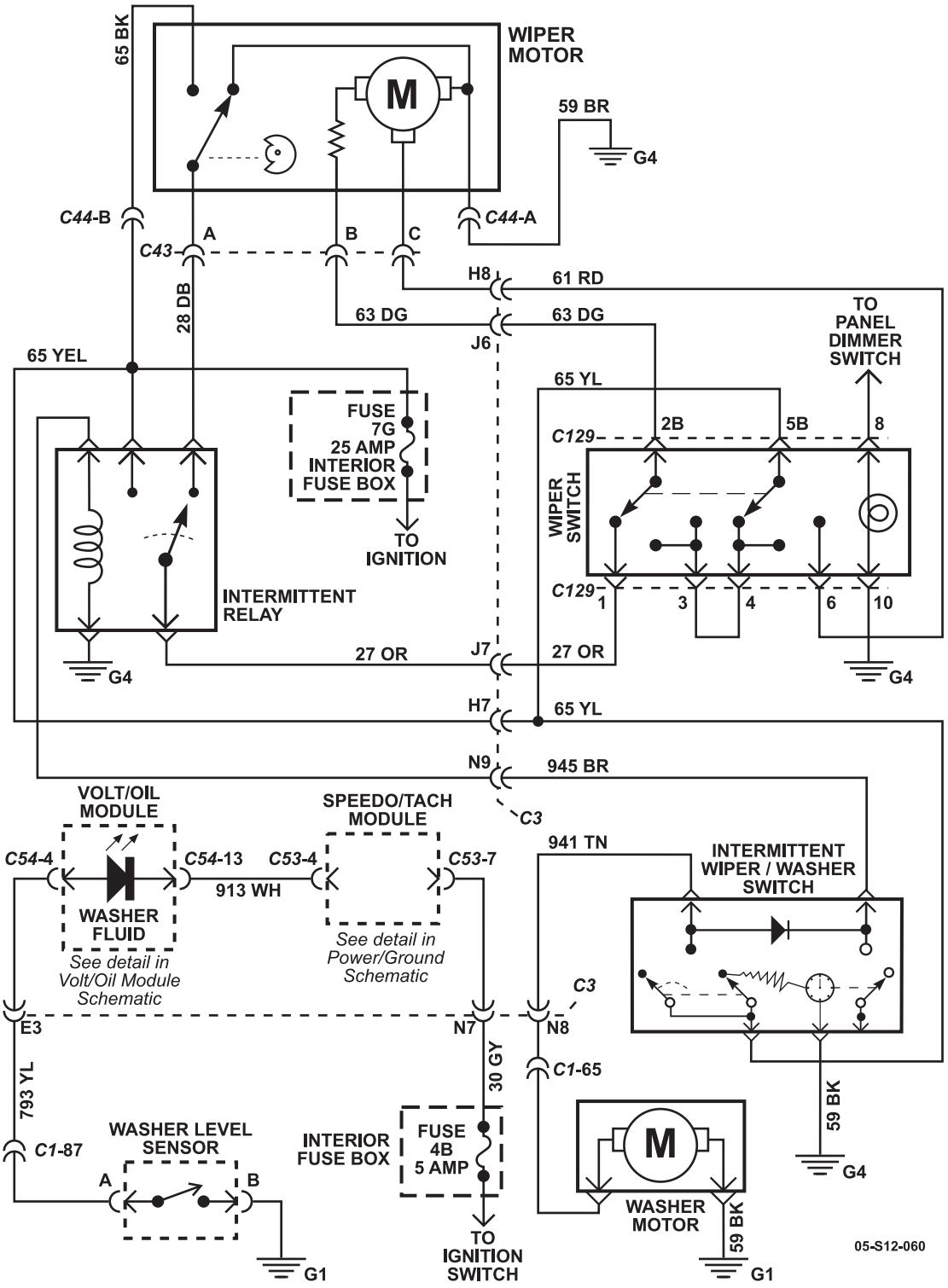


Figure 12-158: Wiper/ Washer Wiring Schematic

VACUUM PUMP

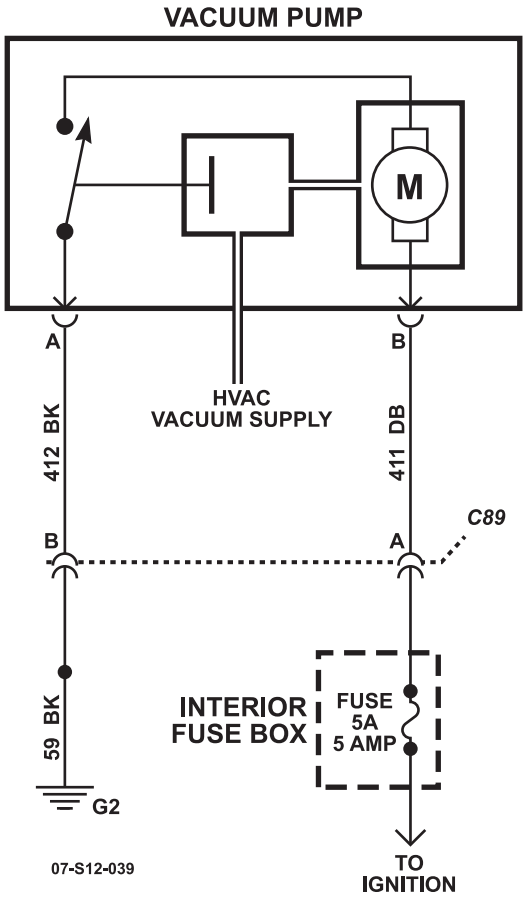
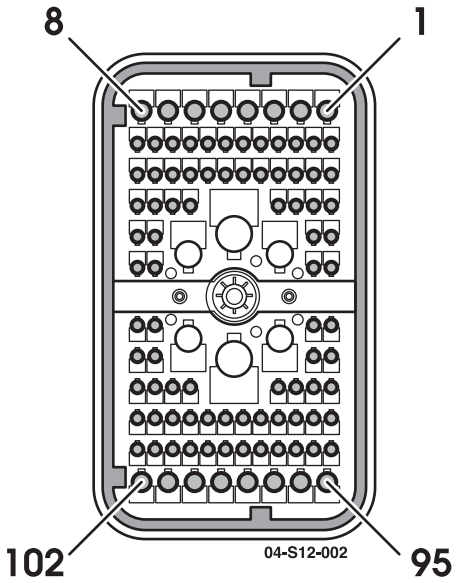


Figure 12-159: Vacuum Pump Wiring Schematic

CONNECTOR LEGEND

C1/ 102 WAY BULKHEAD LOCATION: LEFT SIDE FIREWALL



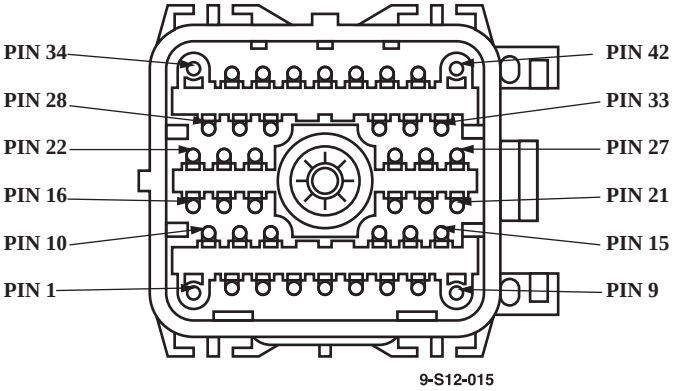
pin	ckt	Color	circuit description
1	739	PP	Left heated windshield power +
2	740	YL	Right heated windshield power +
3	16	LG	Ignition relay signal +
4	20	RD	Left rear turn signal
5	12	OR	Head lamp high beam feed
6	13	TN	Head lamp low beam feed
7	33	WH	neutral safety switch feed
8	962	BR	Trailer lights
9	603	RD	ABS lamp activation
10	961	PP	TT4 lamp activation
11	606	OR	ABS diagnostic line
12	1	DB	Horn relay activation
13	42	BR	Low brake fluid lamp activation
14	640	OR	IGN+ CTIS warning circuits
15	327	YL	Water-in-fuel lamp activation
16	428	PK	CTIS buzzer activation
17	41	TN	Brake fluid level sensor feed
18	17	PP	Illumination circuit (+)
19	92	GY	CTIS rear inflate solenoid activation
20	607	TN	ABS module diagnostic line
21	47	LG	Deflate solenoid activation
22	767	BR	Compass mirror temperature signal

pin	ckt	Color	circuit description
23	91	TN	CTIS front inflate solenoid activation
24	2	LG	Right front turn signal
25	140	OR	Reverse signal
26	3	LB	Left front turn signal
27	21	GY	Rear tail lamp feed
28	298	BR	Backup light switch feed
29	5	DG	Right rear turn signal
30	9	YL	Backup light activation
31	400	LG	Ignition +12v
32	151	GY	Cruise control ON/OFF signal
33	784	DB	T-case range switch input to the ECM (-)
34	809	TN	Brake light input for the ECM
35	242	PK	Ignition 1 Voltage
36	714	DB	Check throttle lamp activation
37	724	DG	APP sensor 3 signal
38	723	YL	APP sensor 3 (5 volt signal)
39	270	DG	Transmission temperature signal
40	520	WH	Brake lamp switch
41	644	YL	Tachometer signal
42	232	___	Shield
43	--	--	--
44	861	BR	Rear Elocker activation signal (-)
45	862	YL	Rear Elocker activation signal (+)
46	212	DG	SAE J1939 CAN LO
47	211	YL	SAE J1939 CAN HI
48	37	YL	Batt feed to interior fuse box
49	--	--	--
50	1072	BK	Shift interlock cable
51	--	--	--
52	870	BR/WH	Front Elocker activation signal (-)
53	871	YL/BK	Front Elocker activation signal (+)
54	37	YL	Ignition relay feed
55	37	YL	Battery feed to interior accessories
56	667	PP	Over drive disable switch light activation (ground)
57	666	YL	Over drive disable request
58	665	DG	Tow haul switch light activation (ground)
59	664	LG	Tow Haul switch request
60	--	--	--
61	--	--	--
62	722	PP	Accelerator pedal position sensor 2 (+)
63	80	WH	Underhood lamp power

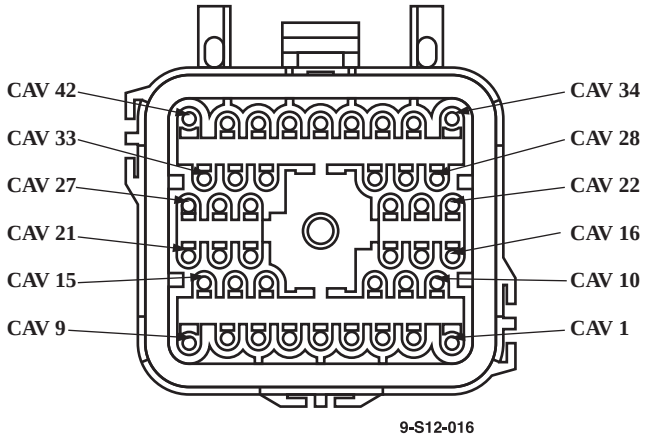
pin	ckt	Color	circuit description
64	904	OR/BK	Alternator signal to instrument panel
65	941	TN	Lower windshield washer pump activation
66	580	BR	Fused battery input to the heated mirror.
67	136	BK	Vehicle speed sensor
68	353	YL	Speedometer signal (+)
69	46	WH	CTIS compressor relay activation
70	--	--	--
71	718	DB	Accelerator pedal position sensor 1 signal (PWM)
72	520	WH	Brake lamp switch
73	717	TN	APP sensor 1 (5 volt signal)
74	338	DB	Wait lamp activation
75	720	TN	Accelerator pedal position sensor 1 (+)
76	198	TN	A/C request
77	663	PK	Range limited circuit
78	662	WH	High trans temp signal
79	38	RD	Head lamp switch feed
80	914	PP	Class II (J1850 data link)
81	658	BR	Check engine lamp activation
82	721	LB	Accelerator pedal position sensor 2 signal (PWM)
83	29	PK	Fuel gauge signal
84	786	RD	Fuel selector valve control
85	625	BR	Coolant temperature signal
86	620	TN	Oil pressure reference signal
87	793	YL	Low air warning lamp activation
88	794	RD	Low coolant lamp activation
89	789	BR	Fuel selector valve control
90	210	DG	Transfer case lock lamp activation
91	725	GY	APP 3
92	719	BR	Accelerator pedal position sensor 1 (-)
93	152	DB	Cruise set/coast signal
94	153	LG	Cruise resume/accelerate signal
95	43	DB	Trailer Brake activation
96	195	YL	Headlight switch feed
97	--	--	--
98	575	OR	ABS valve relay (+)
99	37	YL	start relay feed
100	37	YL	Ignition switch feed
101	688	RD	Rear window defrost feed
102	175	LB	Power window relay feed

C2/42 WAY UNDERBODY LOCATION: LOWER LEFT FOOT WELL NEAR ENGINE

MALE



FEMALE

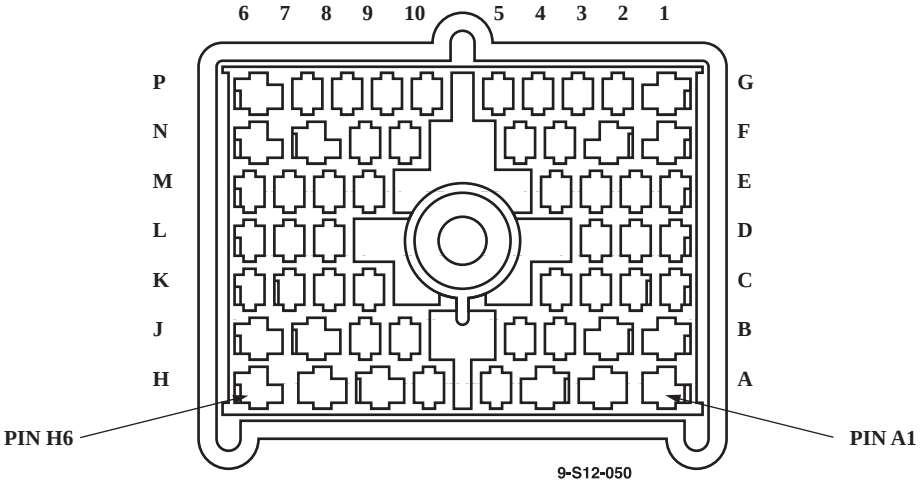


PIN	CKT	COLOR	DESCRIPTION
1	43	DB	Trailer brake activation
2	20	RD	Front parking lamp feed
3	12	OR	Head lamp high beam feed
4	13	TN	Head lamp low beam feed
5	3	LB	Left front turn signal
6	80	WH	Underwood lamp power
7	2	LG	Right front turn signal
8	767	BR	Compass mirror temperature signal
9	49	OR	Battery power to trailer connector
10	996	BR	Left front wheel speed sensor low signal
11	997	BK	Left front wheel speed sensor high signal
12	32	LB	Neutral safety switch feed to start relay
13	520	WH	Shift interlock solenoid
14	17	PP	Light power from dimmer module
15	861	BR	Rear axle solenoid (-)
16	862	YL	Rear axle solenoid (+)
17	870	BR/WH	Front axle solenoid (-)

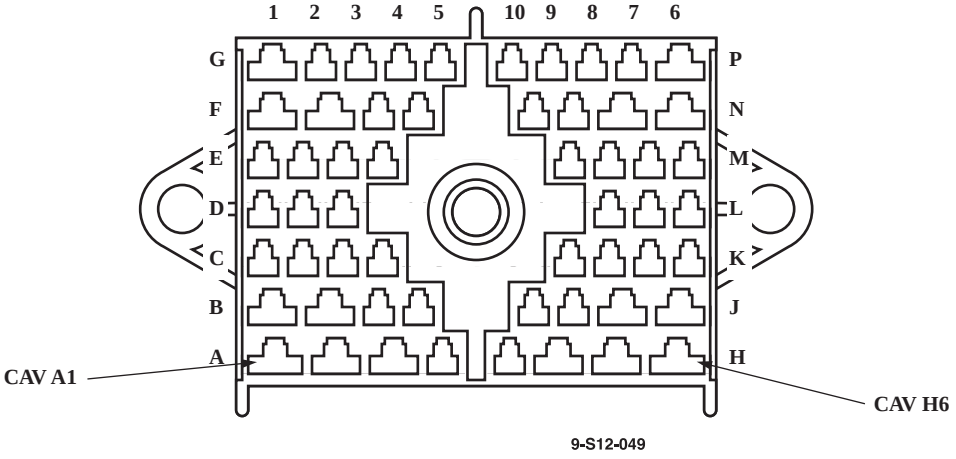
PIN	CKT	COLOR	DESCRIPTION
18	871	YL/WH	Front axle solenoid (+)
19	999	BK	Right front wheel speed sensor high signal
20	998	BR	Right front wheel speed sensor low signal
21	--	--	--
22	994	BR	Right rear wheel speed sensor low signal
23	995	BK	Right rear wheel speed sensor high signal
24	41	TN	Parking brake lamp activation
25	21	GY	Rear marker lamp feed
26	140	OR	Reverse lamp feed for the rear view mirror
27	--	--	--
28	--	--	--
29	5	DG	Right rear turn signal
30	9	YL	Left rear turn signal
31	992	BR	Left rear wheel speed sensor low signal
32	993	BK	Left rear wheel speed sensor high signal
33	--	--	--
34	--	--	--
35	29	PK	Fuel gauge signal
36	786	RD	Fuel selector valve control
37	789	BR	Fuel selector valve control
38	--	--	--
39	--	--	--
40	962	BR	Trailer tail lamps
41	1072	BK	Ignition switch interlock
42	--	--	--

C3/ 56 WAY INSTRUMENT PANEL LOCATION: BEHIND INSTRUMENT PANEL

MALE



FEMALE

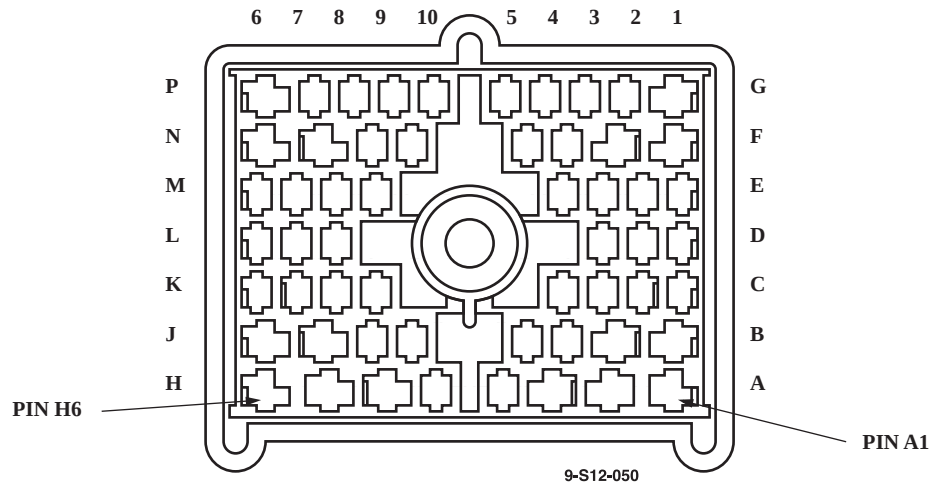


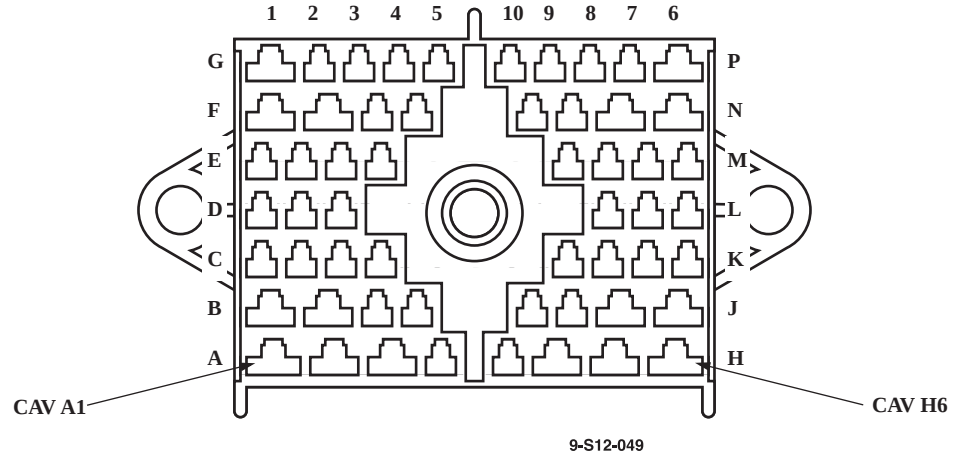
PIN	CKT	COLOR	DESCRIPTION
A1	195	YL	Headlight switch feed
A2	54	DG	Dome lamp switch feed
A3	53	DB	Dome lamps feed
A4	270	DG	Transmission temperature signal
B1	38	RD	Head lamp switch feed
B2	15	WH	Head lamp feed to dimmer module
B3	253	PP	Output +12v to switch
B4	254	WH	Low temp request to module
C1	450	PK	Seat belt lamp activation
C2	912	DB	“Bulb Check” input from the coolant/fuel module
C3	915	LB	+10 volt supply to the CTIS module
C4	--	--	--
D1	338	DB	Glow plug wait lamp activation
D2	2	LG	Right turn indicator lamp activation
D3	961	PP	TT4 indicator lamp activation
E1	42	BR	Brake indicator lamp activation

PIN	CKT	COLOR	DESCRIPTION
E2	603	RD	ABS indicator lamp activation
E3	793	YL	Low washer fluid activation
E4	255	OR	High temp request to heated seat module
F1	17	PP	+ from dimmer module
F2	19	YL	Power supply to dimmer module
F3	658	BR	Check engine lamp activation
F4	327	YL	Drain Filter lamp activation
G1	517	OR	Power mirror switch battery feed
G2	210	DG	Transfer case lock lamp activation
G3	794	RD	Low coolant lamp activation
G4	879	WH/BK	Warning light activation
G5	714	DB	Check throttle lamp activation
H6	14	LB	Head lamp switch feed
H7	65	YL	Ignition feed to intermittent wiper switch
H8	61	RD	High speed windshield wiper signal
H9	12	OR	High Beam indicator lamp activation
J6	63	DG	Low speed windshield wiper signal
J7	27	OR	Intermittent wiper signal
J8	948	DG/YL	Left hand power mirror up/down signal
J9	947	DB/YL	Left hand power mirror left/right signal
K6	942	OR/BK	Left hand power mirror common +/–
K7	3	LB	Left turn indicator lamp activation
K8	944	OR	Right hand power mirror common +/–
K9	644	YL	Tachometer signal
L6	904	OR/BK	Low oil level signal
L7	620	TN	Oil pressure reference signal
L8	952	DB	Right hand power mirror left/right signal
M6	789	BR	Fuel selector valve control
M7	786	RD	Fuel selector valve control
M8	785	GY	Fuel selector switch feed +12v fuse 3B (Interior fuse box)
M9	953	DG	Right hand power mirror up/down signal
N6	59	BK	Ground
N7	30	GY	Ignition feed to gauges
N8	941	TN	Windshield wiper washer pump activation
N9	945	BR	Intermittent wiper relay activation
P6	55	OR	Rear cargo lamp activation
P7	29	PK	Fuel gauge signal
P8	625	BR	Coolant temperature signal
P9	353	YL	Speedometer signal
P10	878	LG/BK	Front ELocker time out light signal

C6/56 WAY CONSOLE LOCATION: CENTER CONSOLE

MALE



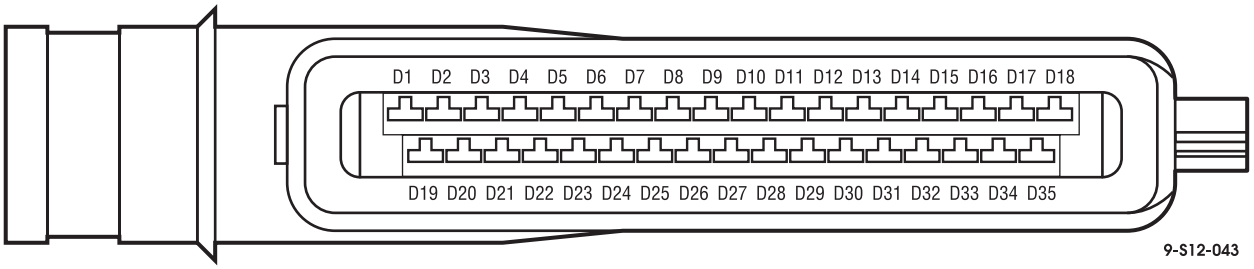


PIN	CKT	COLOR	DESCRIPTION
A1	171	RD	Feed to RF, RR, LR power window switches in drivers console
A2	170	PP	Feed to RF, RR, LR the passenger door power window switches
A3	--	--	--
A4	120	LG	Oscillating power/ground circuit
B1	--	--	--
B2	--	--	--
B3	704	PK	Tow haul / Over drive disable light circuit
B4	119	TN	Oscillating power/ground circuit
C1	665	DG	Tow haul switch light activation (ground)
C2	664	LG	Tow haul request

PIN	CKT	COLOR	DESCRIPTION
C3	666	YL	Over drive disable request
C4	667	PP	Over drive disable light activation (ground)
D1	317	LG	Left rear power window switch
D2	226	YL	Drivers front door power window signal
D3	222	PP	Passenger front door power window signal
E1	--	--	--
E2	--	--	--
E3	--	--	--
E4	--	--	--
F1	319	BR	To right rear power window master switch
F2	320	LG	To right rear power window master switch
F3	--	--	--
F4	--	--	--
G1	--	--	--
G2	--	--	--
G3	--	--	--
G4	122	PP	Lock signal from the switch to the module
G5	171	RD	Feed to RF, RR, LR power window switches
H6	56	BK	Ground
H7	--	--	--
H8	--	--	--
H9	121	YL	Unlock signal from the switch to the module
J6	--	--	--
J7	--	--	--
J8	--	--	--
J9	517	OR	Fused battery input to the drivers door lock switch
K6	17	PP	Feed from dimmer module
K7	866	OR	Rear locker switch input signal
K8	868	GY	Axle “ON” indicator signal (-)
K9	59	BK	Ground
L6	--	--	--
L7	--	--	--
L8	--	--	--
M6	316	TN	To left rear power window master switch
M7	313	DB	To right front power window master switch
M8	314	OR	To right front power window master switch

PIN	CKT	COLOR	DESCRIPTION
M9	--	--	--
N6	--	--	--
N7	--	--	--
N8	--	--	--
N9	--	--	--
P6	--	--	--
P7	860	RD	+12v fused ignition input
P8	875	PK	Front locker switch input signal
P9	877	GY/BK	Axle “ON” indicator signal (-)
P10	--	--	--

C7/35 WAY ABS ECULOCATION: WSW RESERVOIR RECESS



PIN	CKT	COLOR	DESCRIPTION
1	990	PK	ABS valve relay input
2	--	--	--
3	961	PP	TT4 lamp activation
4	977	WH	Right rear inlet valve activation
5	976	RD	Right rear outlet valve activation
6	973	OR	Right front inlet valve activation
7	972	YL	Right front outlet valve activation
8	991	LB	ABS valve relay activation
9	601	PK	Ignition feed
10	--	--	--
11	605	PP	Positive pump relay activation
12	610	RD	Negative pump relay activation
13	606	OR	Diagnostic line

PIN	CKT	COLOR	DESCRIPTION
14	607	TN	Diagnostic line
15	997	BK	Left front wheel speed sensor low
16	995	BK	Right rear wheel speed sensor low
17	999	BK	Right front wheel speed sensor low
18	993	BK	Left rear wheel speed sensor low
19	990	PK	ABS valve relay redundant input
20	--	--	--
21	975	LB	Left rear inlet valve activation
22	974	DB	Left rear outlet valve activation
23	971	PP	Left front inlet valve activation
24	970	TN	Left front outlet valve activation
25	677	GY	Shuttle valve switch signal
26	603	RD	ABS warning lamp activation
27	570	BK	Ground
28	--	--	--
29	--	--	--
30	609	YL	Pump motor monitor
31	978	BK	Reference ground
32	996	BR	Left front wheel speed sensor high
33	994	BR	Right rear wheel speed sensor high
34	998	BR	Right front wheel speed sensor high
35	992	BR	Left rear wheel speed sensor high

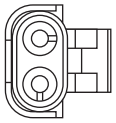
C8/ 6 WAY ROOF HARNESS LOCATION: CENTER WINDSHIELD PILLAR TRIM



9-S12-078

PIN	CKT	COLOR	DESCRIPTION
A	53	DB	Dome lamps feed
B	55	OR	Cargo lamp feed
C	54	DG	Map light feed
D	59	BK	Ground
E	--	--	--
F	--	--	--

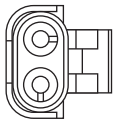
C9-A/ 2 WAY DRIVERS HEATED SEAT CONNECTOR LOCATION: UNDER THE CENTER CONSOLE



04-S12-028

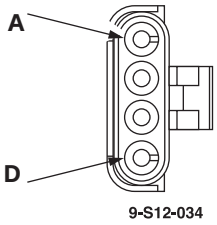
PIN	CKT	COLOR	DESCRIPTION
A	59	BK	Ground G4
B	241	RD	+12v ignition voltage

C9-B/ 2 WAY PASSENGER HEATED SEAT CONNECTOR LOCATION: UNDER THE CENTER CONSOLE



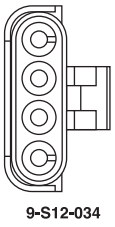
PIN	CKT	COLOR	DESCRIPTION
A	59	BK	Ground G4
B	241	RD	+12v ignition voltage

C10-A/ 4 WAY DRIVERS HEATED SEAT CONNECTOR LOCATION: UNDER THE CENTER CONSOLE



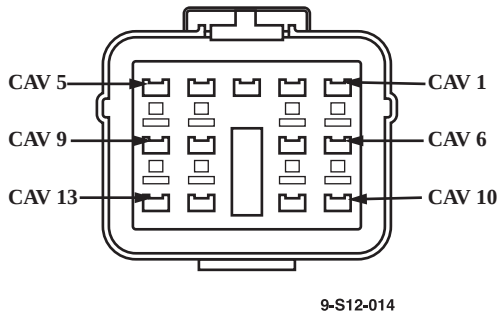
PIN	CKT	COLOR	DESCRIPTION
A	254	WH	Low temp request to module
B	255	OR	High temp request to module
C	--	--	--
D	253	PP	Output +12v to switch input

C10-B/ 4 WAY PASSENGER HEATED SEAT CONNECTOR LOCATION: UNDER THE CENTER CONSOLE



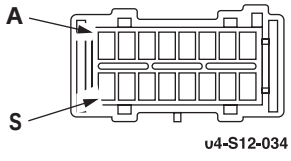
PIN	CKT	COLOR	DESCRIPTION
A	251	WH	Low temp request to module
B	252	OR	High temp request to module
C	--	--	--
D	250	PP	Output +12v to switch input

C11/ 13 WAY ABS MODULATOR LOCATION: BELOW BRAKE MASTER CYLINDER

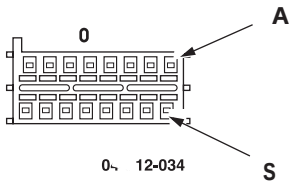


PIN	CKT	COLOR	DESCRIPTION
1	970	TN	Left front outlet valve activation
2	971	PP	Left front inlet valve activation
3	--	--	--
4	977	WH	Right rear inlet valve activation
5	976	RD	Right rear outlet valve activation
6	978	BK	Reference ground
7	--	--	--
8	--	--	--
9	677	GY	Shuttle valve switch signal
10	972	YL	Right front outlet valve activation
11	973	OR	Right front inlet valve activation
12	975	LB	Left rear inlet valve activation
13	974	DB	Left rear outlet valve activation

C12/10 WAY CTIS LOCATION INSTRUMENT PANEL, RIGHT



MALE

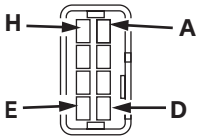


FEMALE

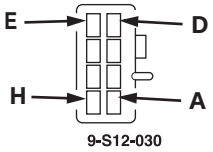
PIN	CKT	COLOR	DESCRIPTION
A	915	LB	+10 volt supply to the CTIS module
B	17	PP	Gauge illumination voltage
C	59	BK	Ground G4
D	47	LG	Deflate solenoid activation

PIN	CKT	COLOR	DESCRIPTION
E	91	TN	Front inflate/deflate solenoid activation
F	92	GY	Rear inflate/deflate solenoid activation
G	46	WH	Compressor Relay activation
H	640	OR	Fused battery voltage
J	428	PK	Low air warning light signal
K	912	DB	“Bulb Check” input from the coolant/fuel module
L	83	TN	+12v ignition to heated windshield switch
M	59	BK	Ground G4
N	580	BR	Fused battery input to the heated mirror.
P	405	OR	Rear blower high
R	346	PK	Rear blower switch input (+12v)
S	404	YL	Rear blower low

C13/ 8 WAY COMPASS MIRROR LOCATION: WINDSHIELD CENTER PILLAR TRIM



MALE



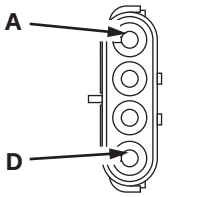
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	59 768	BK BK	Ground (G4)
B	407	PK	Compass Cutout Circuit
C	841	RD	Not Used
D	767	BR	Temperature signal from sensor
E	768	BK	Ground (G4)
F	400	LG	Ignition feed
G	140	OR	Reverse Inhibit
H	53	DB	Not Used

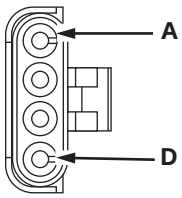
C14/ 4 WAY SHIFTER CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	520	WH	12 Volt Input From Brak Switch
B	32	LB	Ground
C	17	PP	Illumination
D	1072	BK	Ground

C15/4 WAY LF DOOR LEFT FRONT OUTSIDE KICK PANEL



MALE



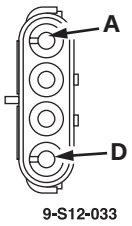
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	117	PK	Unlock signal to the drivers door lock actuators
B	118	BR	Lock signal to the drivers door lock actuators
C	222	PP	Drivers front door power window signal
D	228	WH	Drivers front door power window signal

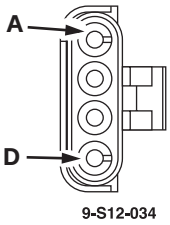
C16/3 WAY LF DOOR JAM SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	53	DB	To Dome Lamp
B	159	WH	To Chime Module
C	54	DG	12 Volt Power

C17/ 4 WAY RF DOOR RIGHT FRONT OUTSIDE KICK PANEL



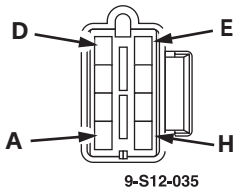
MALE



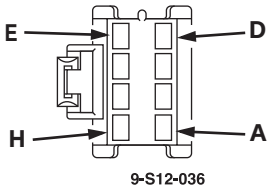
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	117	PK	Unlock signal to the passenger front door lock actuator
B	118	BR	Lock signal to the passenger front door lock actuator
C	226	YL	Passenger front power window signal
D	227	RD	Passenger front power window signal

C18/8 WAY RR DOOR RIGHT FRONT OUTSIDE KICK PANEL



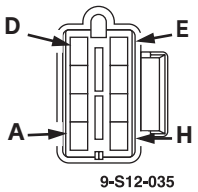
MALE



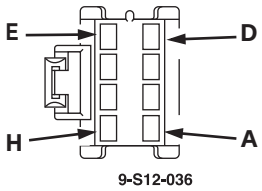
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	54	DG	Map light activation
B	227	RD	Up/down signal to the power window motor
C	226	YL	Down/up signal to the power window motor
D	117	PK	Unlock signal to the power lock actuator
E	118	BR	Lock signal to the power lock actuator
F	53	DB	Dome lamps activation
G	517	OR	Fused battery input
H	59	BK	Ground G4

C19/8 WAY LR DOOR LEFT FRONT OUTSIDE KICK PANEL



MALE



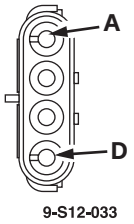
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	54	DG	Map lights activation
B	227	RD	Up/down signal to the power window motor
C	226	YL	Down/up signal to the power window motor
D	117	PK	Lock signal to the drivers side rear door lock actuator
E	118	BR	Unlock signal to the drivers side rear door lock actuator
F	53	DB	Dome lamps activation
G	--	--	--
H	59	BK	Ground G4

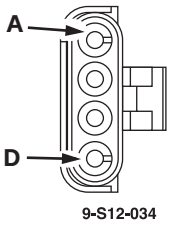
C20/ 3 WAY RF DOOR JAM SWITCH

PIN	CKT	COLOR	DESCRIPTION
A	53	DB	Dome Lamp Signal
B	160	RD	To RKE Module
C	54	DG	12 Volt Power

C21/4 WAY RR DOOR JUMPER LOCATION: RIGHT LOWER B PILLAR



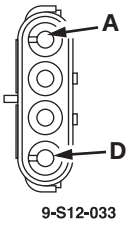
MALE



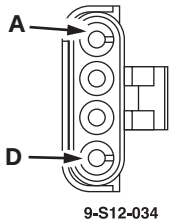
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	117	BR	Unlock signal to the passenger side rear door lock actuator
B	118	PK	Lock signal to the passenger side rear door lock actuator
C	227	RD	Up/down signal to the power window motor
D	226	YL	Down/up signal to the power window motor

C22/4 WAY LR DOOR JUMPER LOCATION: LEFT LOWER B PILLAR



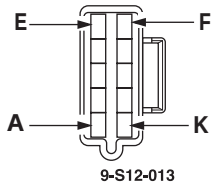
MALE



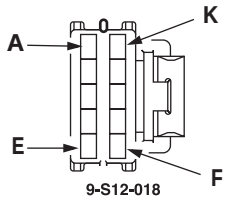
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	118	BR	Lock signal to the drivers side rear door lock actuator
B	117	PK	Unlock signal to the drivers side rear door lock actuator
C	227	RD	Up/down signal to the power window motor
D	226	YL	Down/up signal to the power window motor

C23/ 10 WAY POWER MIRROR SWITCH LOCATION: INSTRUMENT PANEL, LEFT



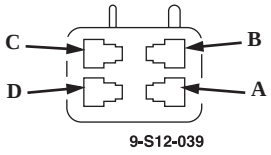
MALE



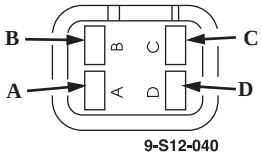
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	59	BK	Ground G4
B	517	PK	Fused battery input to the power mirror switch
C	948	DG/YL	Left power mirror vertical control
D	953	DG	Right hand power mirror horizontal control
E	947	DG/YL	Left power mirror horizontal control
F	952	DB	Right power mirror vertical control
G	942	OR/BK	Left power mirror common
H	944	OR	Right power mirror common
J	17	PP	Power mirror switch illumination
K	--	--	--

C24/ 4 WAY LH POWER MIRROR LOCATION: LEFT DOOR



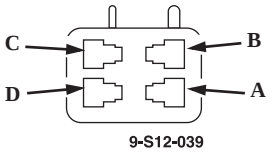
MALE



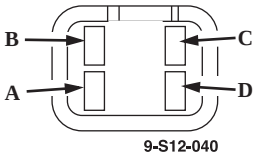
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	942	OR/BK	Left power mirror common
B	947	DG/YL	Left power mirror horizontal control
C	948	DG/YL	Left power mirror vertical control.
D	--	--	--

C25/ 4 WAY RH POWER MIRROR LOCATION: RIGHT DOOR



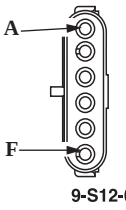
MALE



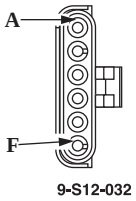
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	944	OR	Right power mirror common
B	952	DB	Right power mirror horizontal control
C	953	DG	Right power mirror vertical control
D	--	--	--

C26/ 6 WAY FUEL TANK JUMPER LOCATION: C BEAM ABOVE PROP SHAFT



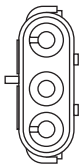
MALE



FEMALE

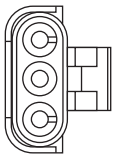
PIN	CKT	COLOR	DESCRIPTION
A	59	BK	Ground
B	29	PK	Fuel level signal to fuel gauge
C	--	--	--
D	--	--	--
E	--	--	--
F	--	--	--

C28/3 WAY FUEL TANK JUMPER LOCATION: C BEAM ABOVE PROP SHAFT



9-S12-151

MALE

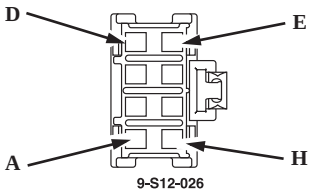


9-S12-152

FEMALE

PIN	CKT	CKT	DESCRIPTION
A	675	YL	Fuel level signal from the auxiliary tank
B	786	RD	Fuel selector valve control
C	789	BR	Fuel selector valve control -/+

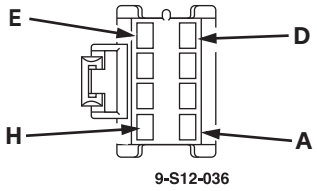
C30/ 8 WAY REMOTE ENTRY, GRAY LOCATION: CENTER CONSOLE



9-S12-026

PIN	CKT	COLOR	DESCRIPTION
A	56	BK	Module ground G4
B	150	TN	Key sensor input
C	160	RD	Front door jam input
D	53	LB	Dome lamp activation
E	1	DB	Horn activation
F	840	DG	Fused ignition input to the remote entry module
G	554	GY	Fused battery input to the remote entry module
H	14	LB	Parking lamps activation

C31/ 8 WAY REMOTE ENTRY, BLACK LOCATION: CENTER CONSOLE



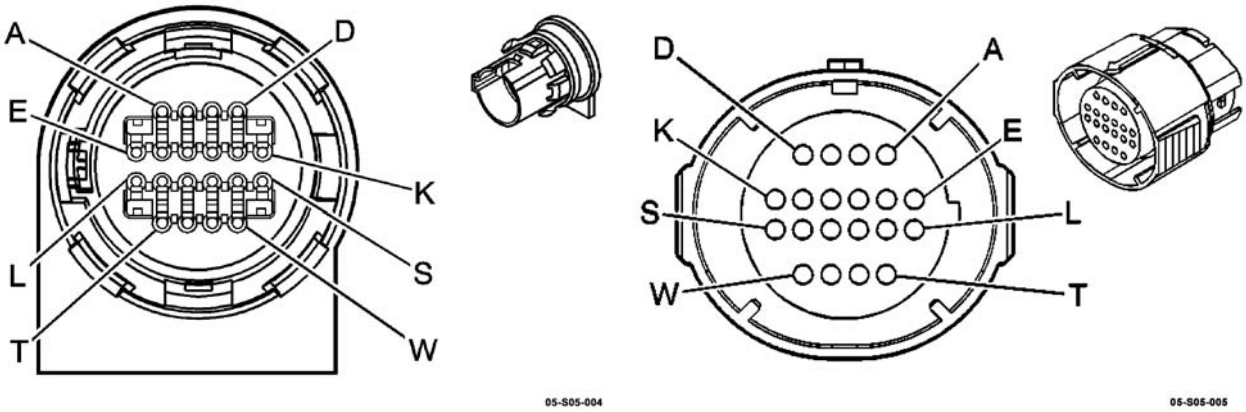
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	118	BR	Lock signal to the door lock actuators
B	122	PP	Lock signal from the switch to the module
C	--	--	--
D	517	OR	Fused battery input
E	117	PK	Unlock signal to the door lock actuators
F	121	YL	Unlock signal from the switch to the module
G	117	PK	Unlock signal to the drivers door lock actuator
H	121	YL	Unlock signal from the switch to the module

C33/ 16 WAY ALDL CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2	914	PP	Class 2
3	211	YL	CAN High
4	232	BK	CAN Low
5	57	BK	Ground
6	--	--	--
7	606	OR	ABS Diagnostic K Line
8	--	--	--
9	--	--	--
10	--	--	--
11	212	DG	CAN Low
12	--	--	--
13	--	--	--
14	--	--	--
15	607	TN	ABS Diagnostic L Line
16	554	GY	12 Volt Battery

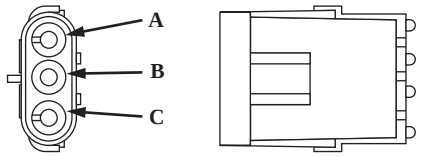
C34/ 20 WAY TRANSMISSION PASS-THROUGH LOCATION: TRANSMISSION, LEFT



MALE **FEMALE**

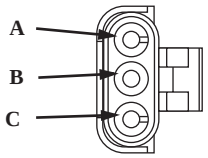
PIN	CKT	COLOR	DESCRIPTION
A	777	DG	Shift solenoid C valve control
B	778	DB	Shift solenoid D valve control
C	782	TN	+12 volt reference
D	769	DB	Fluid pressure switch signal C
E	771	WH	Fluid pressure switch signal E
F	770	PK	Fluid pressure switch signal D
G	923	TN	TFT sensor signal
H	594	DG	Ground
J	780	WH	TCC PWM solenoid valve control
K	772	DG	Fluid pressure switch reverse signal
L	773	YL	PPC solenoid A valve high control
M	774	WH	PPC solenoid A valve low control
N	775	PK	PPC solenoid B valve high control
P	776	OR	PPC solenoid B valve low control
R	781	DB	Modulated main pressure
S	783	DG	TCC PWM solenoid supply voltage
T	272	YL	Trans ID
U	--	--	--
V	--	--	--
W	779	GY	Shift solenoid E valve control

C35/ 3 WAY LOW COOLANT SENSOR LOCATION: SURGE TANK



9-S12-091

FEMALE

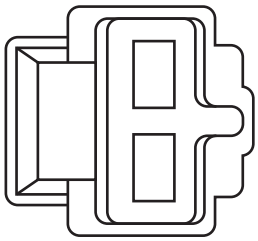


9-S12-090

MALE

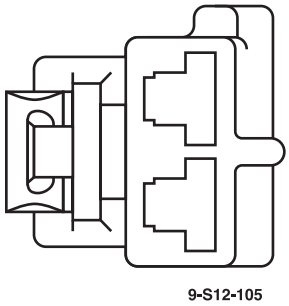
PIN	CKT	COLOR	DESCRIPTION
A	290	PK	Ignition power
B	794	RD	Signal output
C	57	BK	Ground

C36/ 2 WAY HVAC BLOWER LOCATION: RIGHT A-PILLAR



9-S12-106

MALE

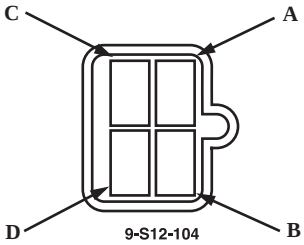


9-S12-105

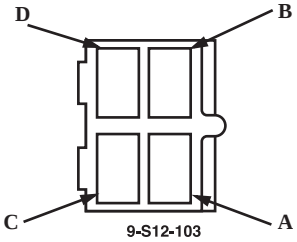
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	364	RD	Blower relay power
B	58	BK	Blower motor ground

C37/ 4 WAY HVAC BLOWER RESISTOR HARNESS LOCATION: RIGHT A-PILLAR



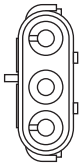
MALE



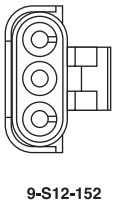
FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	751	OR	Medium 1 blower
B	752	GY	Medium 2 blower
C	754	YL	Blower activation
D	755	DB	Low blower

C38/ 3 WAY COWL TO UNDERBODY JUMPER LOCATION: LEFT A-BEAM NEAR FUEL MANAGER



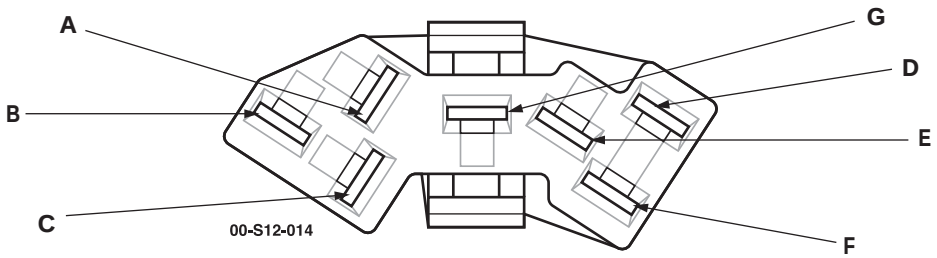
MALE



FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	206	WH	Trailer connector ground
B	58	BK	Ambient temp sensor ground
C	58	BK	Main and auxiliary fuel sending units, rear lamps ground

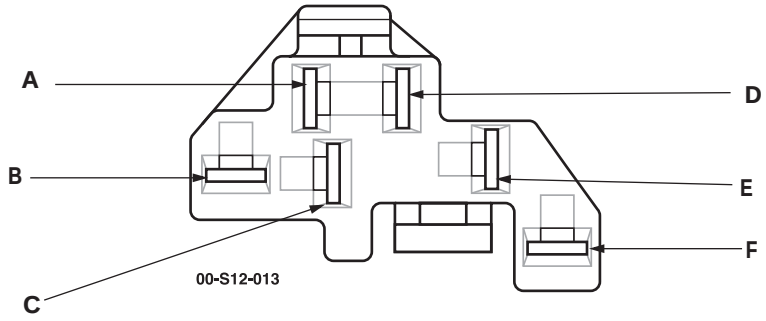
C39/ 7 WAY TURN SIGNAL SWITCH LOCATION: STEERING COLUMN



FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	3	LB	Left front turn signal, status center signal.
B	9	YL	Left rear turn signal
C	--	--	--
D	13	TN	Low beam circuit
E	12	OR	High beam signal
F	15	WH	Head lamp feed
G	--	--	--

C40/6 WAY TURN SIGNAL SWITCH LOCATION: STEERING COLUMN



FEMALE

PIN	CKT	COLOR	DESCRIPTION
A	385	TN	Hazard signal ground
B	22	RD	Brake lamp switch signal (receives 12v with brakes applied.)
C	460	BK	Ground
D	44	LB	Indicator signal ground
E	2	LG	Right turn signal, status center signal
F	5	DG	Right rear turn signal

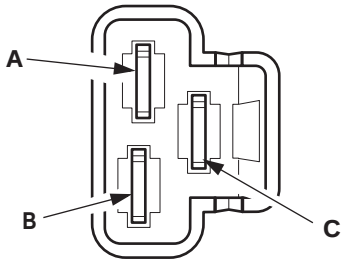
C41/ 8 WAY TRAILER CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	140	BK	Back Up Lamps
B	43	DB	Trailer Brake
C	--	--	--
D	49	OR	12 Volt From Alternator
E	206	WH	Ground
F	962	BR	Running Lights
G	9	YL	Left Turn
H	5	DG	Right Turn

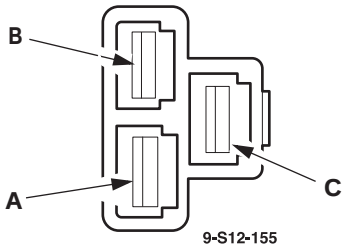
C42/ 6 WAY WASHER SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	65	YL	Ignition 12 Volt Power
B	59 59	BK BK	Ground Ground
C	945	BR	Ignition 12 Volt Feed To Intermittent Relay
D	17	PP	Illumination
E	941	TN	12 Volt Feed To Washer Pump
F	59	BK	Ground

C43/3 WAY FRONT WIPER NEAR MOTOR BEHIND A-PILLAR TRIM



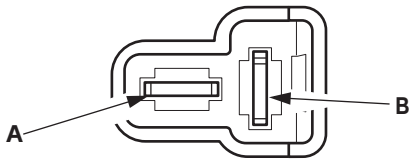
MALE



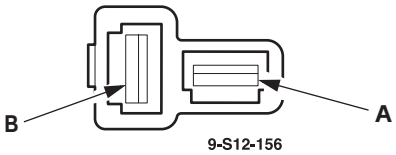
FEMALE

pin	ckt	color	description
A	28	DB	Intermittent Power Supply
B	63	DG	Low Speed Power Supply
C	61	RD	High Speed Power Supply

C44/2 WAY WIPER MOTOR NEAR MOTOR BEHIND THE A-PILLAR TRIM



MALE



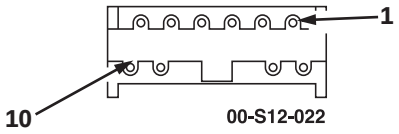
FEMALE

pin	ckt	color	description
A	59	BR	Ground G4
B	650	BK	Intermittent start supply

C46/ 5 WAY EXPRESS DOWN MODULE CONNECTOR

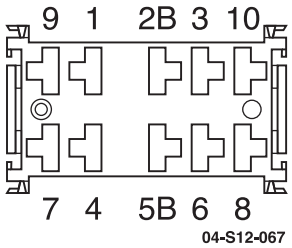
PIN	CKT	COLOR	DESCRIPTION
A	222	PP	Up Signal (Input)
B	--	--	--
C	171	RD	12 Volt Ignition
D	228	WH	Down Signal (Output)
E	226	YL	Down Signal (Input)

C47/ 10 WAY CARGO DOOR LOCK DELAY MODULE LOCATION: ON MODULE



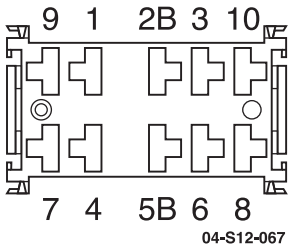
PIN	CKT	COLOR	DESCRIPTION
1.	--	--	--
2.	--	--	--
3.	59	BK	Ground G4
4.	--	--	--
5.	118	BR	Lock signal to the cargo door lock delay module
6.	117	PK	Unlock signal to the cargo door lock delay module
7.	--	--	--
8.	--	--	--
9.	517	OR	Fused battery input to the cargo door lock delay module
10.	121	YL	Lock signal to the cargo door lock actuator

C48/10 WAY DOOR LOCK SWITCH LOCATION: IN THE CENTER CONSOLE



PIN	CKT	COLOR	DESCRIPTION
1	119	LG	Oscillating power/ground circuit
2B	121	YL	Unlock signal from the switch to the module
3	517 517	OR OR	Fused battery input to the passenger door lock switch
4	517	OR	Fused battery input to the passenger door lock switch
5B	122	PP	Lock signal from the switch to the module
6	120	LG	Oscillating power/ground circuit
7	59 59	BK BK	Ground G4 for the illumination circuit
8	59 59	BK BK	Ground G4 for the illumination circuit
9	17 17	PP PP	Illumination circuit for switch
10	17 17	PP PP	Illumination circuit for switch

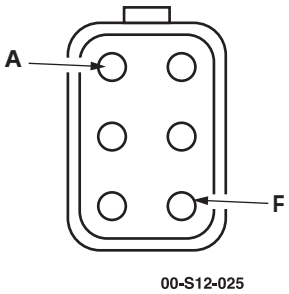
C49/10 WAY PASSENGER SIDE, DOOR LOCK SWITCH LOCATION: ON THE PASSENGER SIDE OF CONSOLE



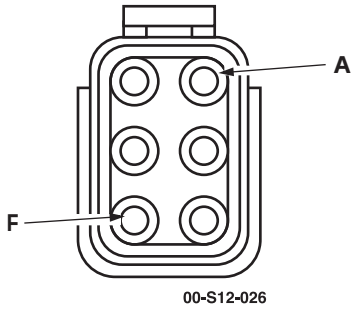
PIN	CKT	COLOR	DESCRIPTION
1	56	BK	Ground G4
2B	119	TN	Oscillating power/ground circuit
3	517 517	OR OR	Fused battery input to the drivers door lock actuator
4	517	OR	Fused battery input to the drivers door lock actuator
5B	120	LG	Oscillating power/ground circuit.

PIN	CKT	COLOR	DESCRIPTION
6	56	BK	Ground G4
7	17 17	PP PP	Illumination circuit for switch
8	17 17	PP PP	Illumination circuit for switch
9	59 59	BK BK	Ground G4 for the illumination circuit
10	59 59	BK BK	Ground G4 for the illumination circuit

C50/ 6 WAY LEFT HEATED POWER MIRROR LOCATION: IN THE DRIVERS DOOR.



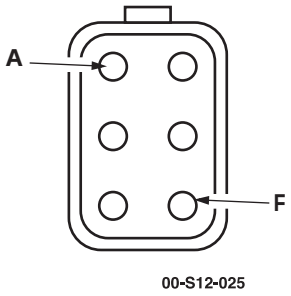
MALE



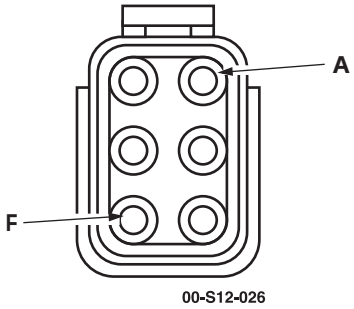
FEMALE

PIN	CKT	COLORS	DESCRIPTION
A	580	BR	Fused battery input to the heated mirror.
B	--	-	--
C	59	BK	Ground G4
D	948	DG/YL	Left mirror vertical control
E	942	OR/BK	Left mirror common
F	947	DB/YL	Left mirror horizontal control

C51/ 6 WAY RIGHT HEATED POWER MIRROR LOCATION: IN THE PASSENGER DOOR



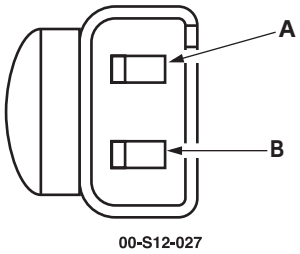
MALE



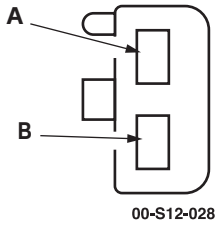
FEMALE

PIN	CKT	COLORS	DESCRIPTION
A	580	BR	Fused battery input to the heated mirror.
B	--	--	--
C	59	BK	Ground G4
D	953	DG	Right mirror vertical control
E	944	OR	Right mirror common
F	952	DB	Right mirror horizontal control

C52/ 2 WAY HEATED POWER MIRROR ELEMENT LOCATION: W AND X ARE IN THE LEFT FRONT DOOR AND Y AND Z ARE IN THE RIGHT FRONT DOOR.



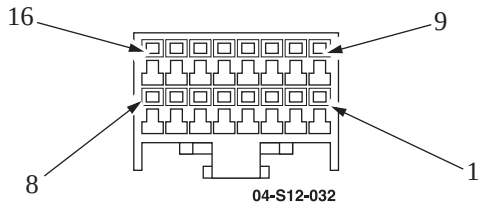
MALE



FEMALE

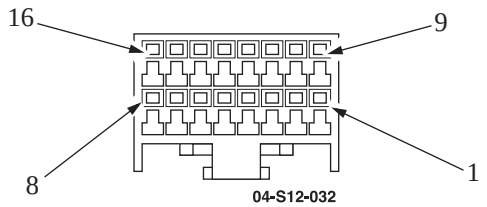
PIN	CKT	COLOR	DISCRIPTION
A	580	BR	Fused battery input to the heated mirror
B	59	BK	Ground G4

C53/ 16 WAY SPEEDO/TACH MODULE LOCATION: CENTER OF INSTRUMENT PANEL



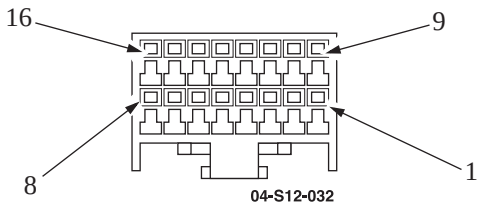
pin	ckt	color	description
1.	3	LB	Left turn indictor signal
2.	12	OR	High beam indicator signal
3.	2	LG	Right turn indicator signal
4.	913	WH	Battery voltage output to the volt/oil module
5.	450	PK	Seat belt warning light signal
6.	353	YL	Speed reference signal
7.	30	GY	Fused battery input to the speedo/tach module
8.	17	PP	Gauge illumination voltage
9.	14	LB	Headlight input signal
10.	910	RD	“Bulb Check” signal to the volt/oil module
11.	338	DB	Wait indicator signal
12.	916	TN	Battery voltage output to the coolant/fuel module
13.	644	YL	Tachometer reference signal
14.	59	BK	Ground G4
15.	--	--	--
16.	--	--	--

C54/ 16 WAY TRANS TEMP/OIL MODULE LOCATION: LEFT SIDE OF INSTRUMENT PANEL



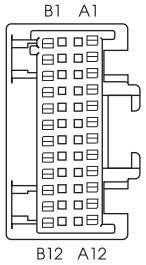
pin	ckt	color	description
1.	904	OR/BK	Low battery signal
2.	658	BR	Check engine signal
3.	620	TN	Oil pressure gauge signal
4.	793	YL	Low washer fluid signal
5.	210	DG	TC lock signal
6.	714	DB	Check throttle signal
7.	327	YL	Drain filter signal
8.	662	WH	High trans temp signal (LED)
9.	910	RD	“Bulb Check” input signal from the speedo/tach module
10.	911	GY/BK	“Bulb Check” output signal to the coolant/fuel module
11.	270	DG	Transmission temp signal (gauge)
12.	17	PP	Gauge illumination voltage
13.	913	WH	Battery voltage input for module
14.	663	PK	Range limited signal
15.	--	--	--
16.	59	BK	Ground G4

C55/ 16 WAY COOLANT/FUEL MODULE LOCATION: RT. SIDE OF INSTRUMENT PANEL



pin	ckt	color	description
1.	603	RD	ABS warning light signal
2.	42	BR	Brake warning light signal
3.	625	BR	Coolant temperature signal from ECM
4.	17	PP	Gauge illumination voltage
5.	29	PK	Fuel level reference signal for the gauge
6.	794	RD	Low coolant warning light signal
7.	911	GY/BK	“Bulb Check” input signal from the volt/oil module
8.	961	PP	TT4 indictor light signal
9.	912	DB	“Bulb Check” output signal to the CTIS module
10.	878	LG/BK	Front ELocker time out light signal
11.	879	WH/BK	ELocker warning light signal
12.	915	LB	+10 volt supply to the CTIS module
13.	916	TN	Battery voltage input for the module
14.	59	BK	Ground G4
15.	--	--	--
16.	--	--	--

C56/ 24 WAY RADIO HARNESS LOCATION: BACK OF THE RADIO



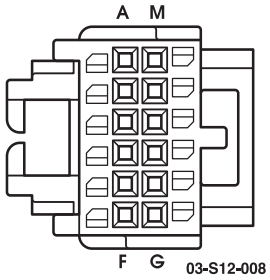
03-S12-007

Pin	CKT	Colors	Description
A1	914	PP	Class 2 data link
A2	--	--	--
A3	842	OR	Rear seat audio enable
A4	--	--	--
A5	--	--	--
A6	--	--	--
A7	--	--	--
A8	804	DG	Left front speaker signal (Positive)
A9	813	GY	Left front speaker signal (Negative)
A10	819	BR	Right rear speaker signal (Negative)
A11	818	YL	Right rear speaker signal (Positive)
A12	59	BK	Ground G4
B1	476	GY	Fused radio memory feed (Battery)
B2	137	RD	Fused battery input to the radio (Ignition)
B3	--	--	--
B4	17	PP	Dimmer circuit
B5	--	--	--
B6	830	PK	Amplifier sense
B7	843	GY	Rear sear audio control
B8	820	TN	Left rear speaker signal (Positive)
B9	821	LB	Left rear speaker signal (Negative)
B10	811	PP	Right front speaker signal (Negative)
B11	805	WH	Right front speaker signal (Positive)
B12	14	LB	Radio illumination

C57/ 4 WAY SUB WOOFER CONNECTOR

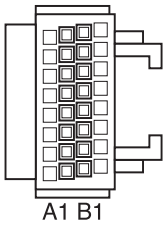
PIN	CKT	COLOR	DESCRIPTION
A	827	PK/OR	Front Sub Woofer +
B	826	GY/OR	Front Sub Woofer -
C	825	PK/LB	Rear Sub +
D	824	GY/LB	Rear Sub -

C58/ 12 WAY RADIO JUMPER CONNECTOR LOCATION: BACK OF THE RADIO



pin	ckt	color	description
A	844	PP	Aux Mono Enable
B	--	--	--
C	850	GY	Shield
D	--	--	--
E	--	--	--
F	--	--	--
G	851	BR	Class 2 data buss
H	848	RD	Audio common
J	847	WH	Left audio signal
K	849	BK	Right audio signal
L	846	OR	Aux mono +
M	845	TN	Aux mono -

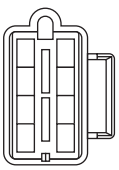
C59/ 16 WAY REAR SEAT AUDIO LOCATION: BACK OF THE REAR SEAT AUDIO CONTROL HEAD



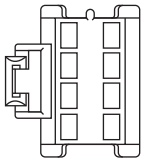
01-S12-028

pin	ckt	color	description
A1	819	BR	Right rear speaker signal (Negative)
A2	818	YL	Right rear speaker signal (Positive)
A3	821	LB	Left rear speaker signal (Negative)
A4	820	TN	Left rear speaker signal (Positive)
A5	843	GY	Rear seat audio control
A6	--	--	--
A7	--	--	--
A8	137	RD	Fused battery input to the rear seat audio (Ignition)
B1	--	--	--
B2	--	--	--
B3	--	--	--
B4	--	--	--
B5	842	OR	Rear seat audio enable
B6	59	BK	Ground G4
B7	--	--	--
B8	14	LB	Rear seat audio illumination

C60/8 WAY RADIO HARNESS CONNECTOR LOCATION: BEHIND THE CENTER CONSOLE


9-S12-035

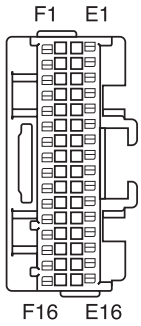
MALE


9-S12-036

FEMALE

Pin	ckt	color	description
A	476	GY	Fused radio memory input (Battery)
B	137	RD	Fused battery input to the radio (Ignition)
C	59	BK	Ground G4
D	17	PP	Dimmer Circuit
E	14	LB	Radio Illumination
F	914	PP	Class 2 data line from the diagnostic link controller
G	829	LG	Fused battery input to the amplifier
H	59	BK	Ground G4

C62/ 32 WAY AMPLIFIER CONNECTOR LOCATION: ON THE AMPLIFIER

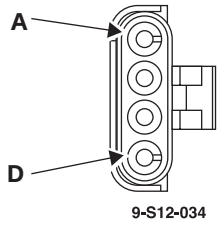


01-S12-027

pin	ckt	color	description
E1	805	WH	Right front channel positive input
E2	804	DG	Left front channel positive input
E3	813	GY	Left front channel negative input
E4	819	BR	Right rear channel negative input

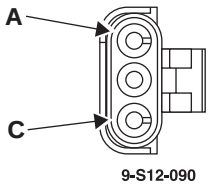
pin	ckt	color	description
E5	818	YL	Right rear channel positive input
E6	820	TN	Left rear channel positive input
E7	821	LB	Left rear channel negative input
E8	59	BK	Ground G4
E9	59	BK	Ground G4
E10	842	OR	Rear seat audio enable
E11	829	LG	+12v battery input
E12	829	LG	+12v battery input
E13	831	GY/BK	Right console speaker negative signal
E14	832	PK/BK	Right console speaker positive signal
E15	834	PK/YL	Left front speaker positive signal
E16	833	GY/YL	Left front speaker negative signal
F1	811	PP	Right front channel negative input
F2	835	GY/YL	Right front speaker negative signal
F3	836	PK/RD	Right front speaker positive signal
F4	824	GY/LB	Rear sub-woofer negative signal
F5	825	PK/LB	Rear subwoofer positive signal
F6	837	GY/PP	Left console negative signal
F7	838	PK/PP	Left console positive signal
F8	830	PK	Amplifier sense circuit
F9	--	--	--
F10	826	GY/ OR	Front subwoofer negative signal
F11	827	PK/OR	Front subwoofer positive signal
F12	--	--	--
F13	803	GY/TN	Right rear speaker negative signal
F14	802	PK/TN	Right rear speaker positive signal
F15	800	PK/WH	Left rear speaker positive signal
F16	801	BK	Left rear speaker negative signal

C63/ 4 WAY HOOD CONNECTOR LOCATION: BEHIND THE SPLASH SHIELD NEAR THE LEFT FRONT CORNER OF THE RADIATOR



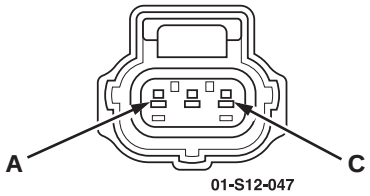
pin	ckt	colors	description
A	13	TN	Head lamp low beam signal
B	12	OR	Head lamp high Beam signal
C	58	BK	Ground G3
D	20	RD	Power feed for the front park lights

C64/ 3 WAY UNDER HOOD CONNECTOR LOCATION: BEHIND THE SPLASH SHIELD NEAR THE LEFT FRONT CORNER OF THE RADIATOR



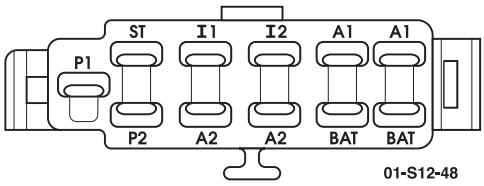
Pin	ckt	color	description
A	2	LG	Right front turn signal
B	80	WH	Under hood illumination
C	3	LB	Left front turn signal

C65/ 3 WAY LOW BRAKE FLUID SWITCH CONNECTOR LOCATION: ON THE MASTER CYLINDER



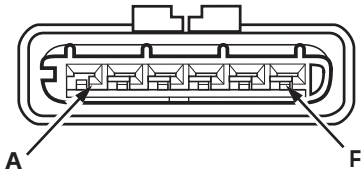
PIN	CKT	COLOR	DESCRIPTION
A	570	BK	Ground G2
B	42	BR	Brake warning light circuit
C	41	TN	Park brake switch circuit

C66/ 11 WAY IGNITION SWITCH CONNECTOR LOCATION: ON STEERING COLUMN



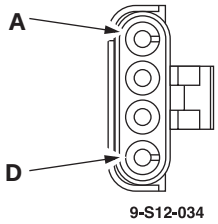
Pin	Ckt	color	description
P1	41	TN	Brake light test circuit
ST	33	WH	Start circuit
I1	16	LG	Ignition feed for Buss I1
I2	16	LG	Ignition feed for Buss I1
A1	--	--	--
A1	297	OR	Ignition feed for Buss A1
P2	--	--	--
A2	687	GY	Ignition feed for Buss A2
A2	--	--	--
BAT	37	YL	+12v feed for the ignition switch
BAT	37	YL	+12v feed for the ignition switch

C67/ 6 WAY FUEL SELECTOR VALVE CONNECTOR LOCATION: ON THE FUEL SELECTOR VALVE.



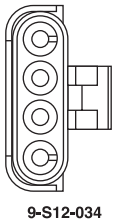
PIN	CKT	COLOR	DESCRIPTION
A	675	YL	Auxiliary tank fuel level signal from the sending unit
B	29	PK	Fuel gauge signal
C	673	DB	Main tank fuel level signal from the sending unit
D	786	RD	Selector valve actuation signal for the main tank
E	789	BR	Selector valve actuation signal for the auxiliary tank
F	--	--	--

C68-A/ 4 WAY HEATED SEAT MODULE CONNECTOR LOCATION: UNDER THE CENTER CONSOLE



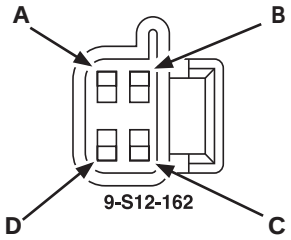
pin	ckt	color	description
A	256	GN	To temp sensor (+)
B	257	GY	To temp sensor (-)
C	258	YL	To heated seat element
D	259	BL	To heated seat element

C68-B/ 4 WAY HEATED SEAT MODULE CONNECTOR LOCATION: UNDER THE CENTER CONSOLE

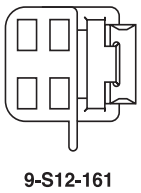


pin	ckt	color	description
A	256	GN	To temp sensor (+)
B	257	GY	To temp sensor (-)
C	258	YL	To heated seat element
D	259	BL	To heated seat element

C69/ 4 WAY CRUISE CONTROL SWITCH CONNECTOR LOCATION: IN THE STEERING COLUMN



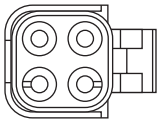
MALE



FEMALE

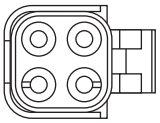
Pin	CKT	COLOR	DESCRIPTION
A	491	BK	ECM supplied ground
B	151	GY	ON/OFF signal to the ECM
C	153	LG	Resume/Accelerate signal to the ECM
D	152	DB	Set/Continue signal to the ECM

C70-A/ 4 WAY HEATED SEAT ELEMENT CONNECTOR LOCATION: UNDER DRIVERS SEAT



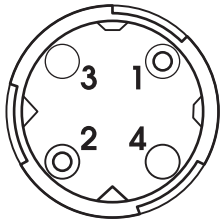
PIN	CKT	COLOR	Description
A	256	GN	To temp sensor (+)
B	257	GY	To temp sensor (-)
C	258	YL	To heated seat element
D	259	BL	To heated seat element

C70-B/ 4 WAY HEATED SEAT ELEMENT CONNECTOR LOCATION: UNDER PASSENGER SEAT



PIN	CKT	COLOR	Description
A	256	GN	To temp sensor (+)
B	257	GY	To temp sensor (-)
C	258	YL	To heated seat element
D	259	BL	To heated seat element

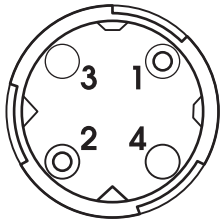
C71-A/ 4 WAY FRONT DIFFERENTIAL LOCK SOLENOID LOCATION: ON TOP OF THE REAR DIFFERENTIAL



03-S12-001

Pin	CKt	color	description
1	870	BR/WH	Front axle solenoid (-)
2	871	YL/WH	Front axle solenoid (+)
3	--	--	--
4	--	--	--

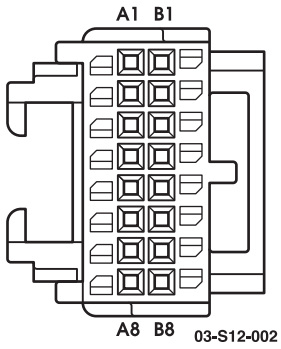
C71-B/ 4 WAY REAR DIFFERENTIAL LOCK SOLENOID LOCATION: ON TOP OF THE REAR DIFFERENTIAL



03-S12-001

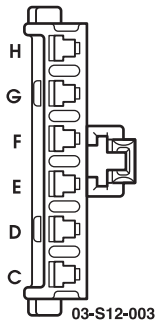
Pin	CKt	color	description
1	861	BR	Rear axle solenoid (-)
2	862	YL	Rear axle solenoid (+)
3	--	--	--
4	--	--	--

C72/16 WAY LOCKING DIFFERENTIAL CONTROL MODULE CONNECTOR LOCATION BEHIND CENTER CONSOLE.



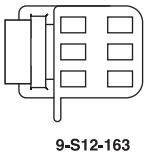
pin	ckt	color	description
A1	--	--	--
A2	--	--	--
A3	--	--	--
A4	--	--	--
A5	784	DB	Low range switch signal (-)
A6	136	BK	Vehicle speed input (+)
A7	879	WH/BK	Warning light activation signal
A8	878	LG/BK	Warning light activation signal
B1	352	BK	Vehicle speed input (-)
B2	--	--	--
B3	--	--	--
B4	866	OR	Rear locker switch input signal
B5	868	GY	Axle “ON” indicator signal (-)
B6	875	PK	Front locker switch input signal
B7	877	GY/BK	Axle “ON” indicator signal (-)
B8	860	RD	+12v fused ignition input

C73/ 6 WAY LOCKING DIFFERENTIAL CONTROL MODULE CONNECTOR LOCATION: BEHIND CENTER CONSOLE.



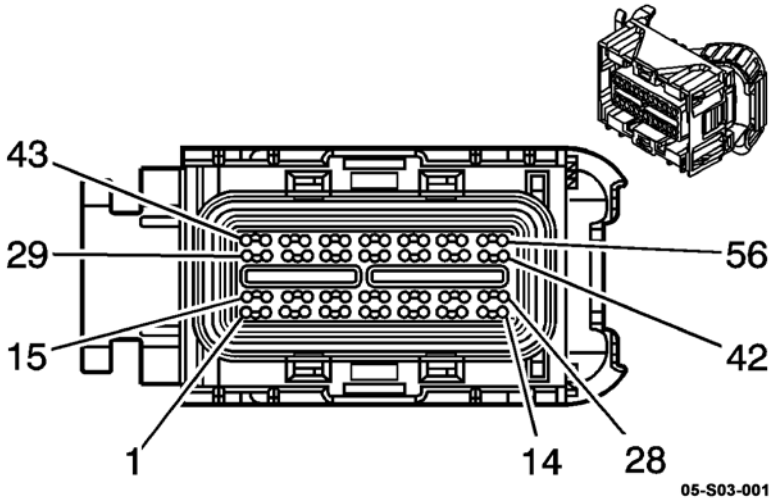
pin	ckt	color	description
C	59	BK	Ground G4
D	870	BR/WH	Front axle solenoid (-)
E	871	YL/WH	Front axle solenoid (+)
F	859	RD/YL	+12v fused battery voltage
G	861	BR	Rear axle solenoid (-)
H	862	YL	Rear axle solenoid (+)

C74/ 6 WAY REAR A/C REFRIGERANT SOLENOID MODULE LOCATION: BEHIND CENTER CONSOLE



Pin	ckt	color	description
A	408	WH	Solenoid ground signal
B	58	BK	Ground G4
C	399	DG	+12v ignition input
D	402	LB	Input from control head
E	399	DG	Solenoid power signal
	--	--	--

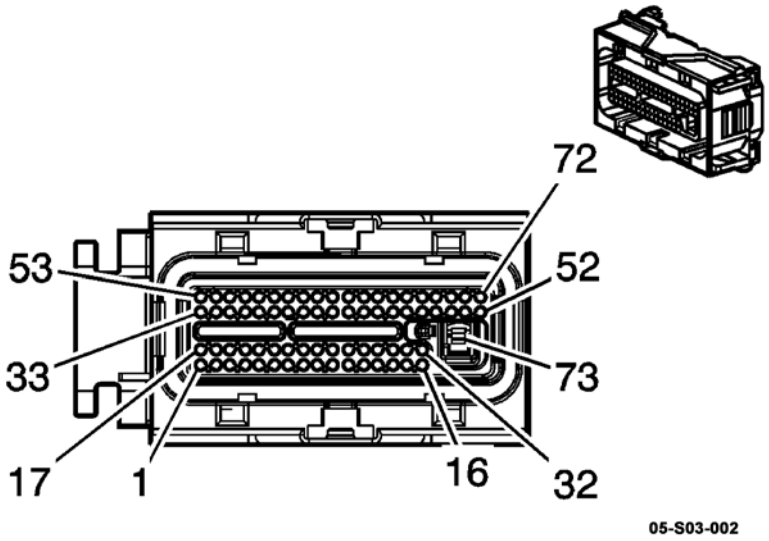
C75/56 WAY ECM J1 (BLUE) LOCATION: DRIVERSIDE COWL TOP UNDER ECM



PIN	CKT	COLOR	DESCRIPTION
1	211	YL	SAE J1939 CAN HI
2	212	DG	SAE J1939 CAN LO
3	620	TN	Oil pressure reference signal
4	270	GN	Transmission temperature signal
5	1037	RD	+12 Battery voltage
6	625	BR	Coolant temperature signal
7	255	OR/BK	Baro sensor ground
8	156	PK/BK	Cam sensor ground
9	244	BK	Ground
10	242	PK	Ignition 1 Voltage
11	--	--	--
12	--	--	--
13	654	DB	MAF sensor signal
14	105	BR/WH	EGR valve position signal
15	914	PP	Class II (J1850 data link)
16	--	--	--
17	720	TN	5 volt reference
18	243	PK	+12v Ignition feed ECM
19	242	PK	Ignition 1 voltage
20	1037	RD	Battery positive voltage
21	--	--	--
22	--	--	--
23	367	GY	5 volt reference turbo vein position sensor
24	--	--	--

PIN	CKT	COLOR	DESCRIPTION
25	--	--	--
26	338	DB	Wait to start indicator control
27			
28	721	LB	APP sensor 2 (5 volt signal)
29	--	--	--
30	--	--	--
31	612	WH/BK	Baro pressure (5 volt signal)
32	717	TN	APP sensor 1 (5 volt signal)
33	508	TN	Fuel rail pressure sensor (5 volt signal)
34	617	GY	Engine oil pressure (5 volt signal)
35	--	--	--
36	723	YL	APP sensor 3 (5 volt signal)
37	513	YL	Fuel pressure regulator solenoid control
38	--	--	--
39	614	GY	MAP sensor (5 volt signal)
40	510	PP/WH	Fuel pressure regulator solenoid control
41	--	--	--
42	514	PK	Generator field duty cycle signal
43	--	--	--
44	--	--	--
45	--	--	--
46	353	YL	Speed Signal
47	106	GY	EGR valve (5 volt signal)
48	--	--	--
49	--	--	--
50	254	RD	CAM sensor (5 volt signal)
51	511	YL	Fuel pressure regulator solenoid control
52	516	GY/BK	FICM relay control
53	136	BK	
54	512	PP/WH	Fuel pressure regulator solenoid supply voltage
55	--	--	--
56	514	PK	Ignition voltage +12v

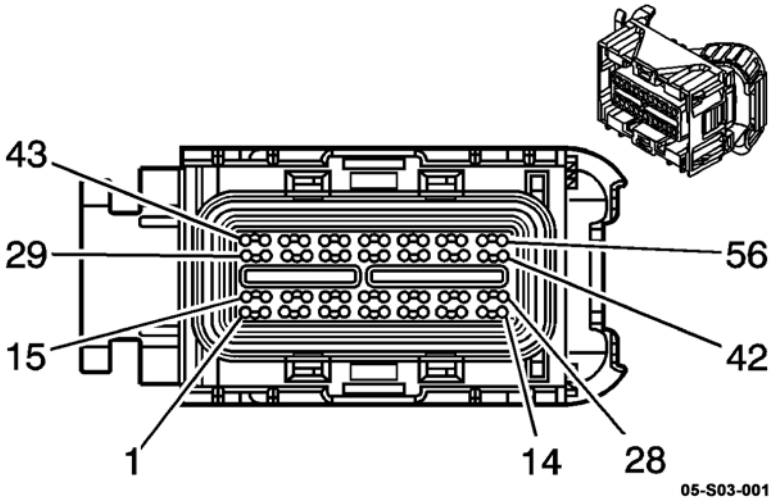
C76/ 72 WAY ECM J2 (BLACK) LOCATION: DRIVERSIDE COWL TOP UNDER ECM



PIN	CKT	COLOR	DESCRIPTION
1			
2	507	OR/BK	Fuel rail pressure signal
3	--	--	--
4	--	--	--
5	232	BR	CAN shield
6	--	--	--
7	784	DB	T-case range switch input to the ECM (-)
8	107	BK	EGR stepper motor
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--
13	--	--	--
14	624	GY	Coolant temperature sensor
15	--	--	--
16	--	--	--
17	--	--	--
18	--	--	--
19	718	DB	APP sensor 1 signal
20	--	--	--
21	661	GN	Transmission control module MIL request
22	--	--	--
23	615	LG	MAP sensor signal
24	724	DG	APP sensor 3 signal
25	619	TN/WH	Oil pressure sensor signal

PIN	CKT	COLOR	DESCRIPTION
26			
27	324	YL	Fuel temperature sensor signal
28	257	LG	Crank shaft sensor signal
29	251	BK	MAF sensor ground
30	616	OR/BK	MAP
31	368	WH	VNT valve position
32	--	--	--
33	108	OR/BK	EGR valve high control
34	244	BK	Ground
35	109	LG/BK	EGR valve low control
36	244	BK	Ground
37	--	--	--
38	--	--	--
39	618	BK	Engine oil pressure
40	719	BR	APP 1
41	--	--	--
42	509	YL	Fuel pressure regulator sensor signal
43	--	--	--
44	369	BR	VNT position sensor
45			
46	613	GY/BK	Baro sensor signal
47	--	--	--
48	--	--	--
49	362	DB	Turbocharger vane position control solenoid valve high
50	363	WH	Turbocharger vane position control solenoid valve low
51	--	--	--
52	632	PK/BK	Injector 3 request
53	110	OR/BK	EGR valve, high control
54	722	PP	APP 2
55	111	LG/BK	EGR valve, low control
56	725	GY	APP 3

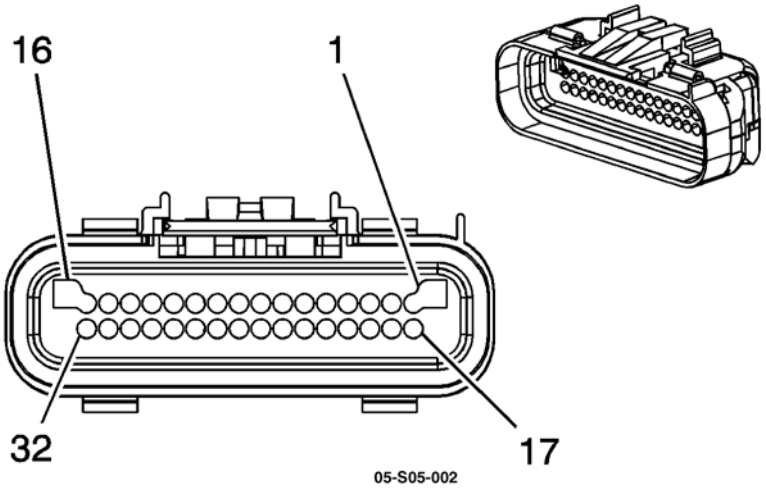
C77/ 56 WAY ECM (GRAY) LOCATION: DRIVERSIDE COWL TOP UNDER ECM



PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2	--	--	--
3	--	--	--
4	--	--	--
5	--	--	--
6	--	--	--
7	--	--	--
8	243	PK	+12v Ignition input
9	--	--	--
10	514	PK	Ignition 1 Voltage
11	--	--	--
12	497	YL	Vehicle speed sensor high
13	--	--	--
14	514	PK	Ignition 1 Voltage
15	--	--	--
16	--	--	--
17	--	--	--
18	331	WH	Crank request
19	152	DB	Cruise control SET/COAST switch signal
20	439	YL	A\C request
21	--	--	--
22	153	LG	Cruise RESUME\ACCELERATE
23	498	DG	Vehicle speed sensor low
24	653	YL	Intake air temperature signal
25	--	--	--
26	--	--	--

PIN	CKT	COLOR	DESCRIPTION
27	--	--	--
28	714	DB	Check throttle lamp activation
29			
30	151	GY	Cruise control “ON” switch signal
31	330	PP	PRNDL switch
32	--	--	--
33	--	--	--
34	--	--	--
35	332	BK	Starter relay
36	--	--	--
37	644	YL	Tach signal
38	--	--	--
39	--	--	--
40	658	BR	Malfunction indicator lamp
41	410	LG	A\C clutch relay
42			
43	258	YL/BK	Crank sensor
44	244	BK	Ground
45	140	OR	Transmission reverse switch
46	--	--	--
47	--	--	--
48	252	BR	Fuel temperature sensor
49	--	--	--
50	--	--	--
51	253	BR/WH	Cam sensor signal
52	266	DB/WH	Crank sensor signal
53	--	--	--
54	--	--	--
55	--	--	--
56	--	--	--

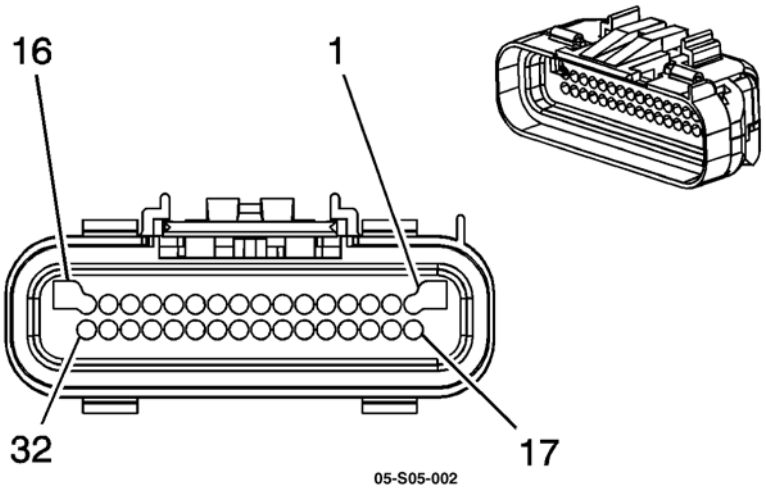
C78/ 32 WAY TCM (GRAY) LOCATION: DRIVERSIDE COWL ON TOP OF TCM



PIN	CKT	COLOR	DESCRIPTION
1	244	BK	Ground
2	243	PK	+12v Ignition input
3	1037	RD	+12v Battery input
4	243	PK	+12v Ignition input
5	244	BK	Ground
6	--	--	--
7	520	WH	TCC brake switch/cruise control release signal
8	--	--	--
9	784	DB	T-case range switch input to the ECM (-)
10	664	LG	Tow Haul switch request
11	--	--	--
12	666	YL	Over drive disable request
13	1012	PK	ABS activation signal (disables TCC during ABS activation)
14	--	--	--
15	--	--	--
16	--	--	--
17	--	--	--
18	--	--	--
19	665	DG	Tow haul switch light activation (ground)
20	667	PP	Over drive disable switch light activation (ground)
21	--	--	--
22	--	--	--
23	663	PK	Range limited circuit
24	662	WH	High trans temp signal
25	661	GN	Transmission control module MIL request signal
26	--	--	--

PIN	CKT	COLOR	DESCRIPTION
27	--	--	--
28	244	BK	Ground
29	211	YL	SAE J1939 CAN HI
30	914	PP	Class II (J1850 data link)
31	232	---	Shield
32	212	DG	SAE J1939 CAN LO

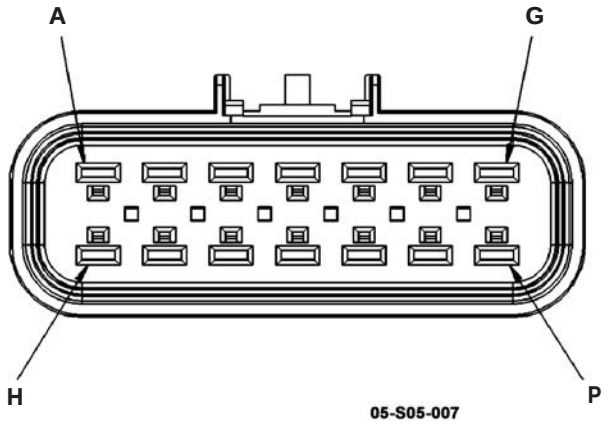
C79/ 32 WAY TCM (RED) LOCATION: DRIVERSIDE COWL ON TOP OF TCM



PIN	CKT	COLOR	DESCRIPTION
1	769	DB	Fluid pressure switch signal C
2	770	PK	Fluid pressure switch signal D
3	771	WH	Fluid pressure switch signal E
4	772	DG	Fluid pressure switch reverse signal
5	591	DB	Transmission range switch signal A
6	590	YL	Transmission range switch signal B
7	592	GY	Transmission range switch signal C
8	593	WH	Transmission range switch signal P
9	--	--	--
10	923	TN	TFT sensor signal
11	--	--	--
12	--	--	--
13	493	OR	Transmission Turban speed switch signal
14	494	DB	Transmission turbine speed switch low reference
15	1000	WH	Vehicle speed sensor high
16	1001	LB	Transmission OSS Low
17	495	TN	AT ISS High signal
18	496	OR	AT ISS low signal
19	--	--	--
20	594	DG	Ground
21	272	YL	Trans ID
22	773	YL	PPC solenoid A valve high control
23	774	WH	PPC solenoid A valve low control
24	775	PK	PPC solenoid B valve high control
25	776	OR	PPC solenoid B valve low control
26	777	DG	Shift solenoid C valve control

PIN	CKT	COLOR	DESCRIPTION
27	778	DB	Shift solenoid D valve control
28	779	GY	Shift solenoid E valve control
29	780	WH	TCC PWM solenoid valve control
30	781	DB	Modulated main pressure
31	782	TN	+12 volt reference
32	783	DG	TCC PWM solenoid supply voltage

C80/ 14 WAY ENGINE POWER HARNESS LOCATION: ON TOP OF ENGINE

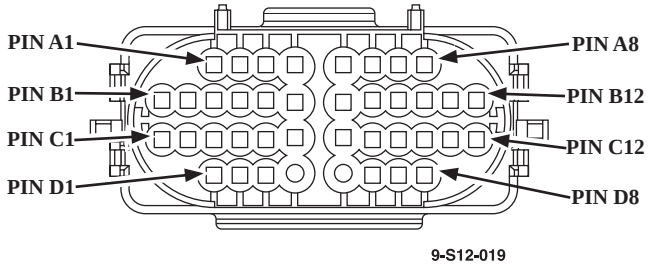


PIN	CKT	COLOR	DESCRIPTION
A	--	--	--
B	198	TN	A/C request
C	290	PK	Alternator field wire
D	1251	BK	Ground circuit to MAF (ECM supplied)
E	439	YL	A\C request
F	654	DB	MAF sensor
G	904	OR/BK	Alternator signal to instrument panel
H	348	BR	AC compressor signal
J	1250	BK	Intake air temperature sensor
K	653	YL	Intake air temperature signal
L	794	RD	Low coolant lamp activation
M	239	PK	Engine ignition feed
N	34	LB	Starter solenoid signal
P	34	LB	Starter solenoid signal

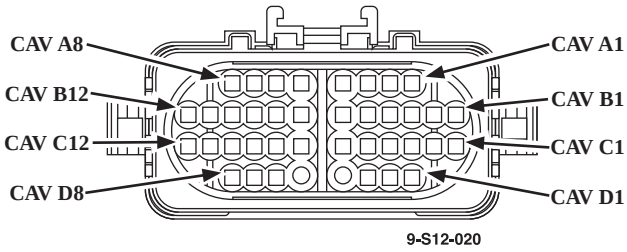
C81/ 24 WAY ENGINE CONNECTOR HARNESS LOCATION: ON TOP OF ENGINE

PIN	CKT	COLOR	DESCRIPTION
A1	--	--	--
A2	--	--	--
A3	105	BR/WH	EGR valve position signal
A4	--	--	--
A5	--	--	--
A6	612	WH/BK	Baro pressure (5 volt signal)
A7	255	OR/BK	Baro sensor
A8	613	GY/BK	Baro sensor signal
B1	212	DG	SAE J1939 CAN LO
B2	--	--	--
B3	107	BK	EGR stepper motor
B4	362	DB	Turbocharger vane position control solenoid valve high
B5	363	WH	Turbocharger vane position control solenoid valve low
B6	367	GY	5v Ref for the turbo vein position sensor
B7	369	BR	VNT position sensor
B8	368	WH	VNT valve position
C1	211	YL	SAE J1939 CAN HI
C2			
C3	106	GY	EGR valve (5 volt signal)
C4	108	OR/BK	EGR valve high control
C5	109	LG/BK	EGR valve low control
C6	614	GY	MAP sensor (5 volt signal)
C7	616	OR/BK	MAP
C8	615	LG	MAP sensor signal

C82/ 40 WAY ENGINE CONNECTOR HARNESS LOCATION: ON TOP OF ENGINE



MALE

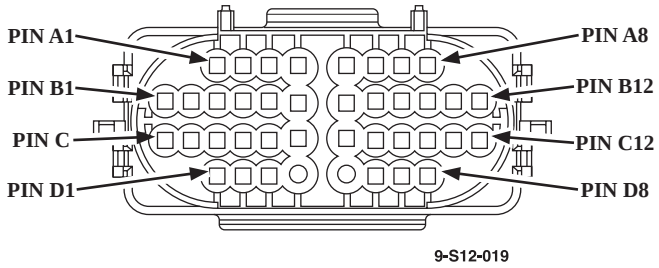


FEMALE

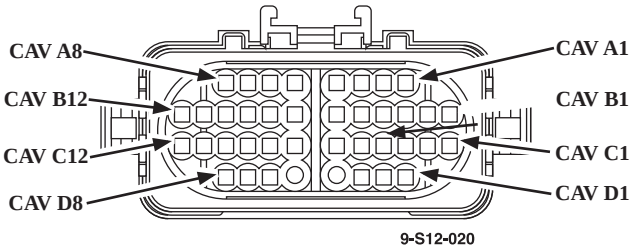
PIN	CKT	COLOR	DESCRIPTION
A1	239	PK	Engine ignition feed
A2	--	--	--
A3	--	--	--
A4	1042	RD	Ignition 1 voltage
A5	1042	RD	Ignition 1 voltage
A6 Female		BR	Not used
A7	623	YL	Engine coolant temperature signal
A8	624	GY	Coolant temperature sensor
B1	631	LG/BK	Fuel injector 2 request
B2	636	RD/BK	Injector 7 request
B3	1254	RD	CAM sensor (5 volt signal)
B4	1253	BR/WH	Cam sensor signal ref 4X
B5	156	PK/BK	Cam sensor ground
B6	--	--	--
B7	--	--	--
B8	1258	YL/BK	Crank sensor
B9	1256	DB/WH	Crank sensor signal
B10	1257	LG	Crank shaft sensor signal
B11	635	YL/BK	Fuel injector 6 request
B12	632	PK/BK	Injector 3 request
C1	630	BK	Fuel injector 1 request
C2	634	BK/WH	Injector 5 request
C3	508	TN	Fuel rail pressure sensor (5 volt signal)
C4	507	OR/BK	Fuel rail pressure signal
C5	509	YL	Fuel pressure regulator sensor signal
C6	--	--	--
C7	--	--	--
C8	660	LB	Engine speed signal to FICM
C9	511	YL	Fuel pressure regulator solenoid control

PIN	CKT	COLOR	DESCRIPTION
C10	510	PP/WH	Fuel pressure regulator solenoid control
C11	637	DB/BK	Fuel injector 8 request
C12	633	LB/BK	Injector 4 request
D1	324	YL	Fuel temperature sensor signal
D2	1252	BR	Fuel temperature sensor
D3	--	--	--
D4	--	--	--
D5	--	--	--
D6	619	TN/WH	Oil pressure sensor signal
D7	618	BK	Engine oil pressure
D8	617	GY	Engine oil pressure (5 volt signal)

C83/ 40 WAY TRANSMISSION CONNECTOR HARNESS LOCATION: ON DRIVERS SIDE OF ENGINE



MALE



FEMALE

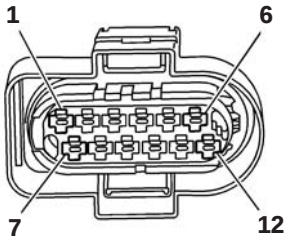
PIN	CKT	COLOR	DESCRIPTION
A1	769	DB	Fluid pressure switch signal C
A2	770	PK	Fluid pressure switch signal D
A3	771	WH	Fluid pressure switch signal E
A4	782	TN	+12 volt reference
A5	783	DG	TCC PWM solenoid supply voltage
A6	772	DG	Fluid pressure switch reverse signal
A7	591	DB	Transmission range switch signal A
A8	590	YL	Transmission range switch signal B
B1	592	GY	Transmission range switch signal C
B2	593	WH	Transmission range switch signal P
B3	923	TN	TFT sensor signal
B4	493	OR	Transmission Turbin speed switch signal
B5	494	DB	Transmission turbine speed switch low reference
B6	331	WH	Crank request
B7	298	BR	Backup light switch feed
B8	497	YL	Vehicle speed sensor high
B9	498	DG	Vehicle speed sensor low
B10	495	TN	AT ISS High signal
B11	496	OR	AT ISS low signal
B12	594	DG	Ground
C1	272	YL	Trans ID
C2	773	YL	PPC solenoid A valve high control
C3	774	WH	PPC solenoid A valve low control
C4	775	PK	PPC solenoid B valve high control
C5	776	OR	PPC solenoid B valve low control
C6	33	WH	neutral safety switch feed
C7	140	OR	Reverse signal
C8	777	DG	Shift solenoid C valve control

PIN	CKT	COLOR	DESCRIPTION
C9	778	DB	Shift solenoid D valve control
C10	779	GY	Shift solenoid E valve control
C11	780	WH	TCC PWM solenoid valve control
C12	781	DB	Modulated main pressure
D1	784	DB	T-case range switch input to the ECM (-)
D2	210	DG	Transfer case lock lamp activation
D3	330	PP	PRNDL switch
D4	--	--	--
D5	--	--	--
D6	1000	WH	Transmission OSS High
D7	1001	LB	Transmission OSS Low
D8	--	--	--

C84/ 6 WAY CONNECTOR OIL PRESSURE JUMPER HARNESS LOCATION: ON DRIVERS SIDE TOP OF ENGINE

PIN	CKT	COLOR	DESCRIPTION
A	59	PK/YL	Glow Plug Controller Ground
B	619	TN/WH	Oil Pressure Sensor Signal To ECM
C	--	BR	Not Used
D	617	GY	Oil Pressure Sensor 5 Volt Reference
E	618	BK	Low Reference
F	--	--	--

C85/ 12 WAY CONNECTOR GLOW PLUG CONTROL MODULE

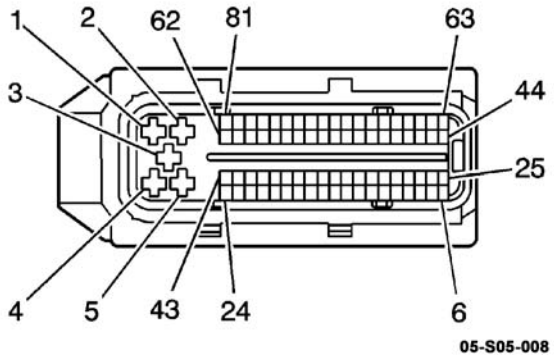


05-S12-068

PIN	CKT	COLOR	DESCRIPTION
1	HB11	RD/GR	Glow plug # 1 supply voltage
2	HB12	WH/GR	Glow plug # 2 supply voltage
3	HB13	RD/WH	Glow plug # 3 supply voltage
4	HB14	WH/YL	Glow plug # 4 supply voltage
5	239	PK	Ignition feed
6	212	GN	Can low
7	HB15	RD/LG	Glow plug # 5 supply voltage

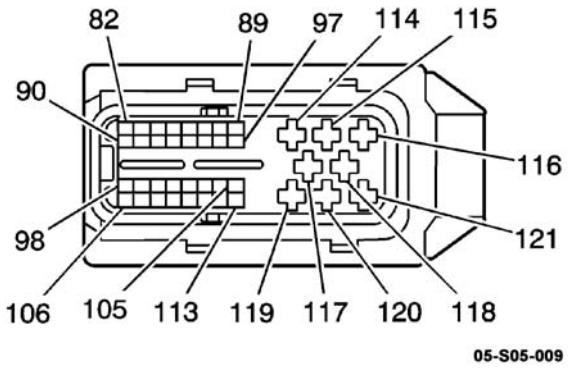
PIN	CKT	COLOR	DESCRIPTION
8	HB16	WH/LG	Glow plug # 6 supply voltage
9	HB17	RD/WH	Glow plug # 7 supply voltage
10	HB18	WH/YL	Glow plug # 8 supply voltage
11	59	PK/YL	Glow plug controller ground
12	211	YL	Can high

C86/ 80 WAY FICM CONNECTOR LOCATION: ON THE FUEL INJECTION CONTROL MODULE



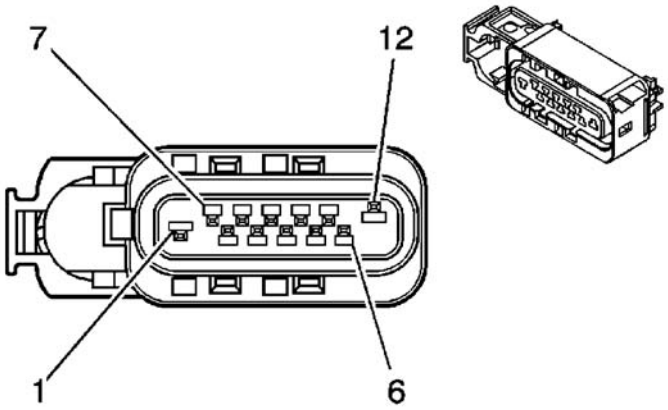
PIN	CKT	COLOR	DESCRIPTION
1	IC18	WH/LG	Fuel injector 4 command
2	57	BK/YL	Ground G1
3	IC13	OR	Injectors 1-4-6-7 supply voltage
4	IC15	RD/LG	Fuel injector 1 command
5	1042	PK	Ignition 1 voltage
6-43	--	--	--
44	633	LB/BK	Injector 4 request
45	634	BK/WH	Injector 5 request
46	--	--	--
47	632	PK/BK	Injector 3 request
48	636	RD/BK	Injector 7 request
49-58	--	--	--
59	IC20	DB/WH	Fuel injector 6 command
60	IC520	DB/WH	Fuel injector 6 command
61	IC21	WH/RD	Fuel injector 7 command
62	IC521	WH/RD	Fuel injector 7 command
63	637	DB/BK	Fuel injector 8 request
64	635	YL/BK	Fuel injector 6 request
65	--	--	--
66	630	BK	Fuel injector 1 request
67	631	LG/BK	Fuel injector 2 request
68-81	--	--	--

C87/ 40 WAY FICM CONNECTOR LOCATION: ON THE FUEL INJECTION CONTROL MODULE



PIN	CKT	COLOR	DESCRIPTION
82-89	--	--	--
90	212	GR	SAE J1939 CAN LO
91	211	YL	SAE J1939 CAN HI
92	--	--	--
93	--	--	--
94	660	LB	Engine speed signal to the FICM
95-113	--	--	--
114	57	BK/GR	Ground G1
115	IC17	WH/LB	Fuel injector 3 command
116	IC19	RD/LG	Fuel injector 5 command
117	--	--	--
118	IC60	RD/WH	Injectors 2-3-5-8 supply voltage
119	1042	PK	Ignition 1 voltage
120	IC22	WH/GR	Fuel injector 8 command
121	IC16	WH/YL	Fuel injector 2 command

C88/ 12 WAY NEUTRAL SAFETY BACKUP SWITCH CONNECTOR LOCATION: ON SIDE OF THE TRANS.

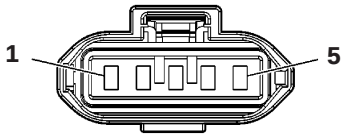


PIN	CKT	COLOR	DESCRIPTION
1	331	WH	Crank request
2	--	--	--
3	330	PP	PRNDL switch
4	590	YL	Transmission range switch signal B
5	591	DB	Transmission range switch signal A
6	592	GY	Transmission range switch signal C
7	594	DG	Ground
8	593	WH	Transmission range switch signal P
9	--	--	--
10	140	OR	Reverse signal
11	298	BR	Backup light switch feed
12	33	WH	neutral safety switch feed

C90/ 4 WAY ALTERNATOR CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	--	--	--
B	904	OR/BK	To Low Voltage Warning Lamp
C	--	--	--
D	290	PK	Ignition 12 Volt

C91/ 5 WAY MASS AIRFLOW/AIR INTAKE TEMPERATURE SENSOR CONNECTOR



05-S12-070

PIN	CKT	COLOR	DESCRIPTION
1	1250	BK	Low Reference
2	653	YL	IAT Sensor Signal
3	239	PK	Ignition 1 Voltage
4	1251	BK	Low Reference
5	654	DB	MAF Sensor Signal

C92/ 2 WAY AC/COMPRESSOR CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	57	BK	Ground
B	348	BR	Supply Voltage

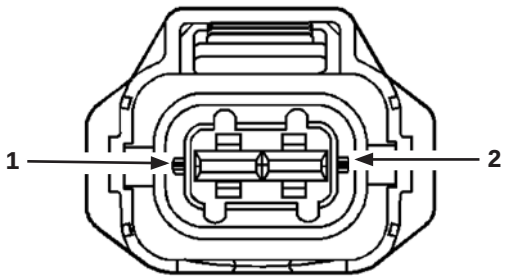
C93/ 2 WAY A/C HIGH PRESSURE CUT-OUT SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	438	OR	To Low Pressure Cut Out Switch
B	198	TN	From Evaporator Temperature Sensor

C94/ 2 WAY A/C LOW PRESSURE SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	438	OR	From High Pressure Cutout Switch
B	439	YL	To ECM

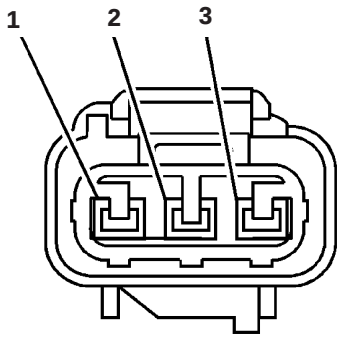
C95/ 2 WAY FUEL PRESSUR REGULATOR CONNECTOR



05-S12-081

PIN	CKT	COLOR	DESCRIPTION
1	510	PP/WH	Fuel Pressure Regulator Solenoid Supply Voltage
2	511	YL	Fuel Pressure Solenoid Control

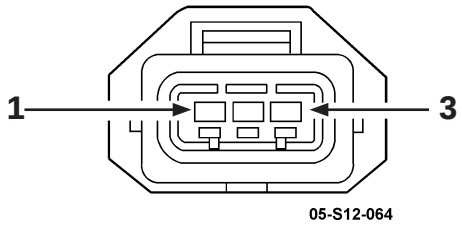
C96/ 3 WAY FUEL PRESSURE REGULATOR JUMPER CONNECTOR



05-S12-076

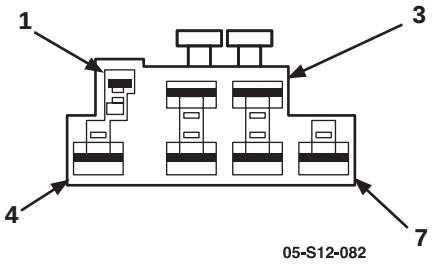
PIN	CKT	COLOR	DESCRIPTION
1		BARE	Drain Wire
2	511	YL	Fuel Pressure Solenoid Control
3	510	PP/WH	Fuel Pressure Regulator Solenoid Supply Voltage

C97/ 3 WAY FUEL RAIL PRESSURE (FRP) SENSOR CONNECTOR



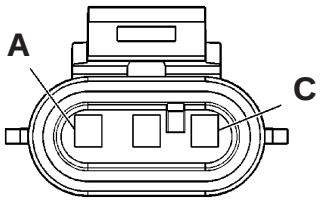
PIN	CKT	COLOR	DESCRIPTION
1	507	OR/BK	Low Reference
2	509	YL	FRP Sensor Signal
3	508	TN	5- Volt Reference

C98/ 7 WAY CHIME MODULE CONNECTOR



PIN	CKT	COLOR	DESCRIPTION
1	183	TN	Park Lamp Input
2	159	WH	Door Ajar Input
2	159	WH	Isolation Diode
3	85	GY	Seat Belt Switch Ground Signal
4	157	PP	Key In Ignition Switch Ground Signal
5	59	BK	Ground
6	450	PK	Seat Belt Warning Light Signal
7	640	OR	12- Volt Fused Ignition

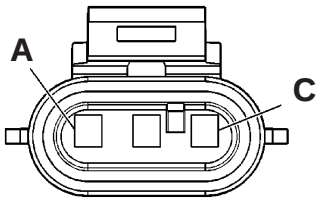
C99/ 3 WAY MAP SENSOR CONNECTOR



05-S12-071

PIN	CKT	COLOR	DESCRIPTION
A	616	OR/BK	Low Reference
B	615	LG	MAP Sensor Signal
C	614	GY	5- Volt Reference

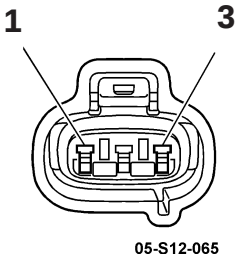
C100/ 3 WAY BARO SENSOR CONNECTOR



05-S12-071

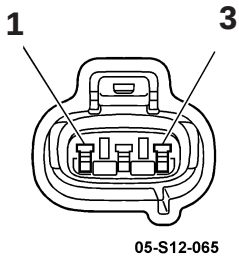
PIN	CKT	COLOR	DESCRIPTION
A	255	OR/BK	Low Reference
B	613	GY/BK	BARO Sensor Signal
C	612	WH/BK	5- Volt Reference

C101/ 3 WAY CAMSHAFT POSITION (CMP) SENSOR CONNECTOR



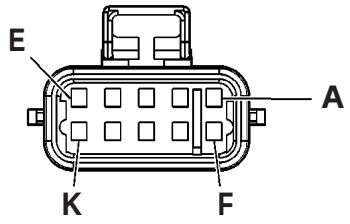
PIN	CKT	COLOR	DESCRIPTION
1	253	BR/WH	CMP Sensor Signal
2	156	PK/BK	Low Reference
3	254	RD	5- Volt Reference

C102/ 3 WAY CRANKSHAFT POSITION (CKP) SENSOR CONNECTOR



PIN	CKT	COLOR	DESCRIPTION
1	256	DB/WH	CKP Sensor Signal
2	258	YL/BK	Low Reference
3	257	LG	12- Volt Reference

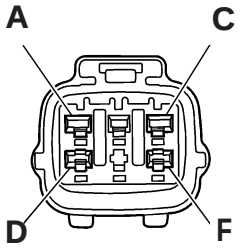
C103/ 10 WAY ACCELERATOR PEDAL POSITION (APP) SENSOR CONNECTOR



05-S12-069

PIN	CKT	COLOR	DESCRIPTION
A	724	DG	APP Sensor 3 Signal
B	723	YL	5- Volt Reference
C	--	--	--
D	717	TN	5- Volt Reference
E	718	DB	APP Sensor 1 Signal
F	725	GY	Low Reference
G	722	PP	5- Volt Reference
H	721	LB	APP Sensor 2 Signal
J	720	TN	Low Reference
K	719	BR	Low Reference

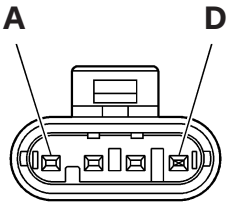
C104/ 6 WAY EXHAUST GAS RECIRCULATION (EGR) VALVE CONNECTOR



05-S12-066

PIN	CKT	COLOR	DESCRIPTION
A	106	GY	5- Volt Reference
B	107	BK	Low Reference
C	105	BR/WH	EGR Valve Position Signal
D	108	OR/BK	EGR Motor High Control
E	--	--	--
F	109	LG/BK	EGR Motor Low Control

C105/ 4 WAY TURBOCHARGER VANE POSITION SENSOR CONNECTOR



05-S12-067

PIN	CKT	COLOR	DESCRIPTION
A	367	GY	5- Volt Reference
B	369	BR	Low Reference
C	368	WH	Turbocharger Vane Position Sensor Signal
D	--	--	--

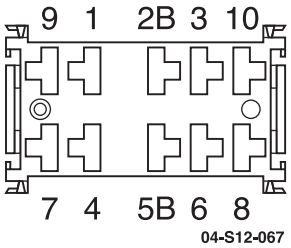
C107/ 2 WAY VNT SOLENOID VALVE

PIN	CKT	COLOR	DESCRIPTION
A	362	DB	Turbo Vane Control Solenoid Valve HI
B	363	WH	Turbo Vane Control Solenoid Valve LOW

C108/ 3 WAY WATER IN FUEL (WIF) SENSOR CONNECTOR

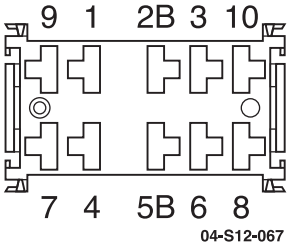
PIN	CKT	COLOR	DESCRIPTION
A	57	BK	Ground
B	291	RD	12 Volt Ignition
C	327	YL	Indicator Lamp Signal

C110/ 10 WAY OVER DRIVE DISABLE SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



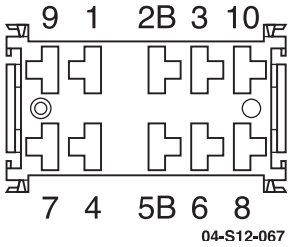
PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2B	59	BK	Ground
2B	59	BK	Ground
3	666	YL	Out Put Signal
4	--	--	--
5B	--	--	--
6	--	--	--
7	704	PK	12 Volt Ignition
8	59	BK	Ground
8	59	BK	Ground
9	667	PP	Over Drive Disable Indicator
10	17	PP	Illumination
10	17	PP	Illumination

C111/ 10 WAY TRAILER TOW SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



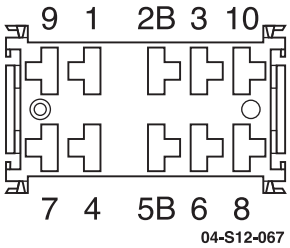
PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2B	59	BK	Ground
3	664	LG	Tow/ Hall Out Put Signal
4	--	--	--
5B	--	--	--
6	--	--	--
7	704	PK	12 Volt Ignition
8	59	BK	Ground
8	59	BK	Ground
9	665	DG	Tow/ Hall Indicator
10	17	PP	Illumination

C112/ 10 WAY DRIVERS HEATED SEAT SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



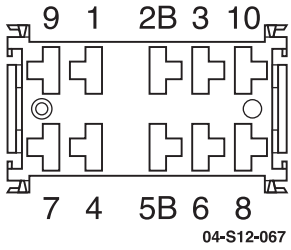
PIN	CKT	COLOR	DESCRIPTION
1	251	WH	High Out Put Signal
2B	250	PP	12 Volt Feed
3	252	OR	Low Out Put Signal
4	--	--	--
5B	--	--	--
6	--	--	--
7	17	PP	Illumination
8	17	PP	Illumination
8	17	PP	Illumination
9	598	BK	Ground For The Illumination Circuit (G4)
10	598	BK	Ground For The Illumination Circuit (G4)
10	598	BK	Ground For The Illumination Circuit (G4)

C113/ 10 WAY PASSENGER HEATED SEAT SWITCH CONNECTOR LOCATION: PASSENGER CONSOLE



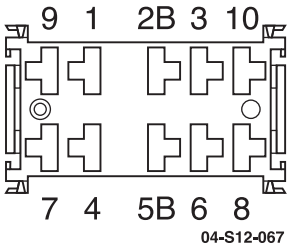
PIN	CKT	COLOR	DESCRIPTION
1	251	WH	High Out Put Signal
2B	250	PP	12 Volt Feed
3	252	OR	Low Out Put Signal
4	--	--	--
5B	--	--	--
6	--	--	--
7	17	PP	Illumination
8	17	PP	Illumination
8	17	PP	Illumination
9	598	BK	Ground For The Illumination Circuit (G4)
10	598	BK	Ground For The Illumination Circuit (G4)
10	598	BK	Ground For The Illumination Circuit (G4)

C114/ 10 WAY WINDOW LOCK OUT SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2B	171	RD	12 Volt Ignition Feed
3	170	PP	12 Volt Feed Out
4	--	--	--
5B	--	--	--
6	--	--	--
7	59	BK	Ground
7	59	BK	Ground
8	59	BK	Ground
8	59	BK	Ground
9	17	PP	Illumination
9	17	PP	Illumination
10	17	PP	Illumination
10	17	PP	Illumination

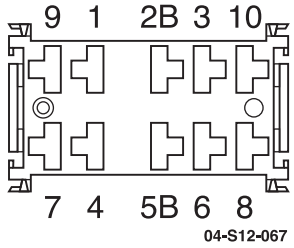
C115/ 10 WAY FRONT E LOCKER SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



PIN	CKT	COLOR	DESCRIPTION
1	59	BK	Ground
1	59	BK	Ground
2B	875	PK	Out Put Signal
3	860	RD	12 Volt Ignition Feed
3	860	RD	12 Volt Ignition Feed
4	--	--	--
5B	--	--	--

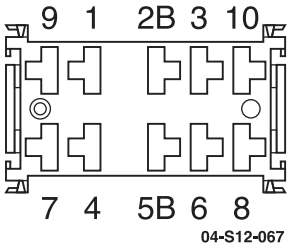
PIN	CKT	COLOR	DESCRIPTION
6	--	--	--
7	877	GY/BK	Lock Indicator
8	59	BK	Ground
8	59	BK	Ground
9	860	RD	12 Volt Ignition Feed
10	17	PP	Illumination
10	17	PP	Illumination
8	59	BK	Ground

C116/ 10 WAY REAR E LOCKER SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



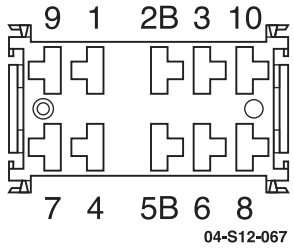
PIN	CKT	COLOR	DESCRIPTION
1	59	BK	Ground
1	59	BK	Ground
2B	866	OR	Out Put Signal
3	860	RD	12 Volt Ignition Feed
3	860	RD	12 Volt Ignition Feed
4	--	--	--
5B	--	--	--
6	--	--	--
7	868	GY	Lock Indicator
8	59	BK	Ground
8	59	BK	Ground
9	860	RD	12 Volt Ignition Feed
10	17	PP	Illumination
10	17	PP	Illumination

C117/ 10 WAY LEFT FRONT WINDOW SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



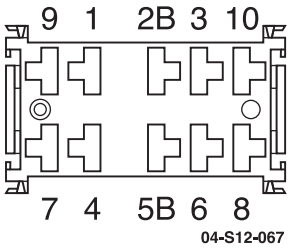
PIN	CKT	COLOR	DESCRIPTION
1	56	BK	Ground
2B	222	PP	Power Up
3	171	RD	12 Volt Ignition
3	171	RD	12 Volt Ignition
4	171	RD	12 Volt Ignition
4	171	RD	12 Volt Ignition
5B	226	YL	Power Down
6	56	BK	Ground
6	56	BK	Ground
7	59	BK	Ground
7	59	BK	Ground
8	59	BK	Ground
8	59	BK	Ground
9	17	PP	Illumination
9	17	PP	Illumination
10	17	PP	Illumination
10	17	PP	Illumination

C118/ 10 WAY RIGHT FRONT WINDOW SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



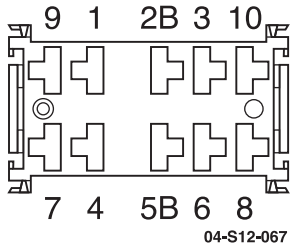
PIN	CKT	COLOR	DESCRIPTION
1	56	BK	Ground
1	56	BK	Ground
2B	313	DB	Power Up
3	171	RD	12 Volt Ignition
3	171	RD	12 Volt Ignition
4	171	RD	12 Volt Ignition
4	171	RD	12 Volt Ignition
5B	314	OR	Power Down
6	56	BK	Ground
6	56	BK	Ground
7	59	BK	Ground
7	59	BK	Ground
8	59	BK	Ground
8	59	BK	Ground
9	17	PP	Illumination
9	17	PP	Illumination
10	17	PP	Illumination
10	17	PP	Illumination

C119/ 10 WAY LEFT REAR WINDOW SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



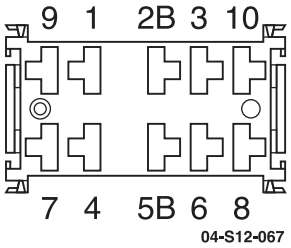
PIN	CKT	COLOR	DESCRIPTION
1	56	BK	Ground
2B	316	TN	Power Up
3	171	RD	Ignition Feed
4	171	RD	Ignition Feed
4	171	RD	Ignition Feed
5B	317	LG	Power Down
6	56	BK	Ground
6	56	BK	Ground
7	59	BK	Ground
7	59	BK	Ground
8	59	BK	Ground
8	59	BK	Ground
9	17	PP	Illumination
9	17	PP	Illumination
10	17	PP	Illumination
10	17	PP	Illumination

C120/ 10 WAY RIGHT REAR WINDOW SWITCH CONNECTOR LOCATION: DRIVERS CONSOLE



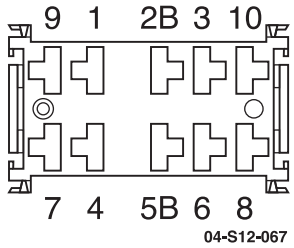
PIN	CKT	COLOR	DESCRIPTION
1	56	BK	Ground
1	56	BK	Ground
2B	319	BR	Power Up
3	171	RD	Ignition Feed
3	171	RD	Ignition Feed
4	171	RD	Ignition Feed
4	171	RD	Ignition Feed
5B	320	LB	Power Down
6	56	BK	Ground
6	56	BK	Ground
7	59	BK	Ground
7	59	BK	Ground
8	59	BK	Ground
8	59	BK	Ground
9	17	PP	Illumination
9	17	PP	Illumination
10	17	PP	Illumination
10	17	PP	Illumination

C121/ 10 WAY RIGHT FRONT WINDOW SWITCH CONNECTOR



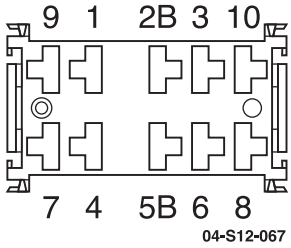
PIN	CKT	COLOR	DESCRIPTION
1	313	DB	Up Input
2B	227	RD	Up Output
3	170	PP	Supply Voltage From Window Lock Switch
3	170	PP	Supply Voltage From Window Lock Switch
4	170	PP	Supply Voltage From Window Lock Switch
5B	226	YL	Down Output
6	314	OR	Down Input
7	17	PP	Illumination
7	17	PP	Illumination
8	17	PP	Illumination
8	17	PP	Illumination
9	59	BK	Ground
9	59	BK	Ground
10	59	BK	Ground
10	59	BK	Ground

C122/ 10 WAY LEFT REAR WINDOW SWITCH CONNECTOR LOCATION: REAR CONSOLE



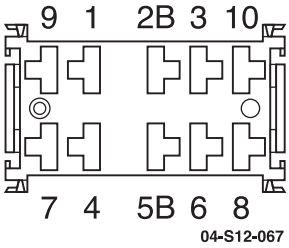
PIN	CKT	COLOR	DESCRIPTION
1	316	TN	Up Input From Master Switch
2B	227	RD	Up Output To Power Window Motor
3	170	PP	12-Volt Power From Power Window Lock Switch
3	170	PP	12-Volt Power From Power Window Lock Switch
4	170	PP	12-Volt Power From Power Window Lock Switch
5B	226	YL	Down Out Put
6	317	LG	Down In Put
7	17	PP	Illumination
7	17	PP	Illumination
8	17	PP	Illumination
8	17	PP	Illumination
9	59	BK	Ground
9	59	BK	Ground
10	59	BK	Ground
10	59	BK	Ground

C123/ 10 WAY RIGHT REAR WINDOW SWITCH CONNECTOR LOCATION: REAR CONSOLE



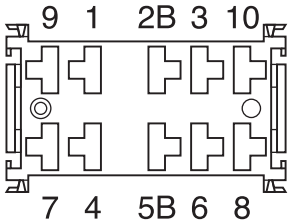
PIN	CKT	COLOR	DESCRIPTION
1	319	BR	Up Input
2B	227	RD	Up Output
3	170	PP	12 Volt From Window Lock Switch
3	170	PP	12 Volt From Window Lock Switch
4	170	PP	12 Volt From Window Lock Switch
5B	226	YL	Down Output
6	320	LB	Down Input
7	17	PP	Illumination
8	17	PP	Illumination
8	17	PP	Illumination
9	59	BK	Ground
10	59	BK	Ground
10	59	BK	Ground

C124/ 10 WAY C.T.I.S. TIRE SELECTOR SWITCH CONNECTOR



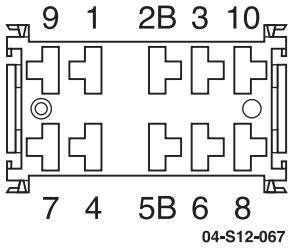
PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2B	144	YL	12 Volt Ignition
3	91	TN	To Front Solenoid
4	92	GY	To Rear Solenoid
5B	144	YL	12 Volt Ignition
5B	144	YL	12 Volt Ignition
6	--	--	--
7	59 59	BK BK	Ground Ground
8	59	BK	Ground
9	17	PP	Illumination
10	17 17	PP PP	Illumination Illumination

C125/ 10 WAY C.T.I.S. INFLATE/ DEFLATE SWITCH CONNECTOR



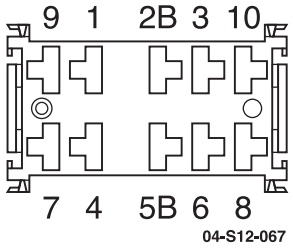
PIN	CKT	COLOR	DESCRIPTION
1	47	LG	CTIS Deflate
2B	640	OR	12 Volt Ignition
3	46 46	WH WH	CTIS Inflate CTIS Inflate
4	144	YL	Switched Ignition Voltage
5B	640 640	OR OR	Ignition Voltage Ignition Voltage
6	144 144	YL YL	Switched Ignition Voltage Switched Ignition Voltage
7	59 59	BK BK	Ground Ground
8	59	BK	Ground
9	17	PP	Illumination
10	17 17	PP PP	Illumination Illumination

C126/ 10 WAY AUXILIARY BLOWER SWITCH CONNECTOR



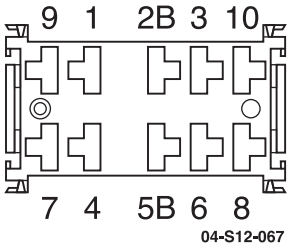
PIN	CKT	COLOR	DESCRIPTION
1	404	YL	Low Out Put
2B	346	PK	12 Volt Ignition
3	405	OR	High Out Put
4	--	--	--
5B	--	--	--
6	--	--	--
7	--	--	--
8	59	BK	Ground
9	--	--	--
10	17	PP	Illumination[

C127/ 10 WAY MASTER LIGHT SWITCH CONNECTOR



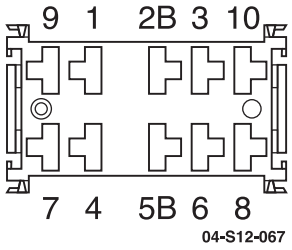
PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2B	38	RD	12 Volt Power
3	14	LB	Output To Buss L1
4	--	--	--
5B	195	YL	12 Volt Power
6	15	WH	Output To Head lamp Dimmer Switch
7	--	--	--
8	17	PP	Illumination
9	--	--	--
10	59	BK	Ground

C128/ 10 WAY DOME LIGHT SWITCH CONNECTOR



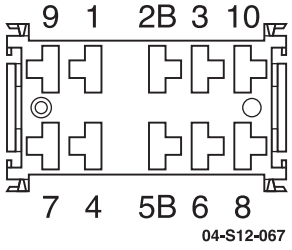
PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2B	54 54	DG DG	12 Volt Power 12 Volt Power
3	53	DB	Output To Dome Lamp
4	--	--	--
5B	54	DG	12 Volt Power
6	55	OR	Output To Cargo Lamp
7	--	--	--
8	17	PP	Illumination
9	--	--	--
10	59	BK	Ground

C129/ 10 WAY WIPER SWITCH CONNECTOR



PIN	CKT	COLOR	DESCRIPTION
1	27	OR	Relay Input
2B	63	DG	Low Output
3	60	DB	Low Speed Jumper
4	60	DB	Low Speed Jumper
5B	65	YL	Ignition
6	61	RD	High Output
7	--	--	--
8	17	PP	Illumination
9	--	--	--
10	59	BK	Ground

C130/ 10 WAY FUEL TANK SELECTOR SWITCH



PIN	CKT	COLOR	DESCRIPTION
1	789	BR	Oscillating Power/ Ground Circuit
2B	785	GY	12 Volt Ignition
3	786 786	RD RD	Oscillating Power/ Ground Circuit Oscillating Power/ Ground Circuit
4	786	RD	Oscillating Power/ Ground Circuit
5B	59 59	BK BK	Ground Ground
6	789 789	BR BR	Oscillating Power/ Ground Circuit Oscillating Power/ Ground Circuit
7	17	PP	Illumination
8	17 17	PP PP	Illumination Illumination
9	59	BK	Ground
10	59 59	BK BK	Ground Ground

C131/ 16 WAY C.T.I.S. WARNING INDICATORS CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
1	17	PP	Illumination
2	915	LB	10 Volt Power on Test
3	59	BK	Ground
4	912	DB	Power On Test
5	46	WH	Inflate Input
6	428	PK	Low Pressure Input
7	--	--	--
8	--	--	--
9	--	--	--
10	--	--	--
11	--	--	--
12	--	--	--
13	--	--	--
14	--	--	--
15	--	--	--
16	--	--	--

C132/ 5 WAY HEATED WINDSHIELD SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	580	BR	Relay Control Output
B	83 83	TN TN	12 Volt Ignition 12 Volt Ignition
C	83	TN	12 Volt Ignition
D	58	BK	Ground
E	17	PP	Illumination

C133/ 6 WAY DIMMER SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	19	YL	Fused 12 Volt power (Fuses 2 F)
B	--	--	--
C	17	PP	Illumination (Output)
D	59	BK	Ground
E	--	--	--
F	--	--	--

C134/ 2 WAY BRAKE SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	22	RD	Output To Turn Signal Switch
B	10	OR	12 Volt

C135/ 4 WAY BRAKE SWITCH CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	1070	BR	Interlock Relay Input
B	59	BK	Ground
C	809	TN	Brake Signal To ECM
D	267	BR	12 Volt Ignition Feed

C136/ 3 WAY AUXILIARY BLOWER MOTOR CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	404	YL	Low Speed
B	--	--	--
C	405	OR	High Speed

C137/ 10 WAY BLENDAIR DOOR MOTOR CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
1	--	--	--
2	--	--	--
3	--	--	--
4	--	--	--
5	--	--	--
6	--	--	--
7	58	BK	Ground
8	402	LB	Position Signal
9	--	--	--
10	399	DG	Ignition Input

C138/ 8 WAY HVAC CONTROL HEAD CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	755	DB	Low Blower Signal Output To Blower Motor
B	751	OR	Medium 1 Signal Output To Blower Motor
C	752	GY	Medium 2 Signal Output To Blower Motor
D	757	LB	High Blower Signal Output To Blower Motor
E	399	DG	12 Volt Ignition Power
F	402	LB	Blend Air Door Motor Control Signal

PIN	CKT	COLOR	DESCRIPTION
G	401	WH	
H	347	YL	A/C Request To A/C Compressor

C139/ 4 WAY HVAC CONTROL HEAD CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	688	RD	Not Used
B	399	DG	12 Volt Ignition Power
C	59	BK	Ground
D	689	PK	Not Used

C140/ 3 WAY HVAC CONTROL HEAD CONNECTOR

PIN	CKT	COLOR	DESCRIPTION
A	401	WH	
B	59	BK	Ground
C	17	PP	Illumination

INTERIOR MINI FUSE BLOCK 1 (LOWER) (Figure 12-160)

Buss	Cavity	CKT. No.	Color & Ga.	Fuse
I1	1A	–	–	ES (5 AMP) -1A-
	2A	BUSS I2A		
	3A	267 A	18 BR	ES (5 AMP) -2A-
	4A	16F BUSS I2A	12 LG	
	5A	491A	18 BR	ES (5AMP) -3A-
	6A	16F BUSS I2	12 LG	
	7A	704A	18 PK	ES (5 AMP) -4A-
	8A	BUSS I2	–	
	9A	411A	18 DB	ES (5 AMP) -5A-
	10A	BUSS I2	–	
	11A	419A	18 BR	ES (5 AMP) -6A-
	12A	BUSS I2	–	
	13A	24A	18RD	ES (5 AMP) -7A-
	14A	16E BUSS I2	12 LG	
	1B	–	–	– -1B-
	2B	16E BUSS IA	12 LG	
	3B	1073 A	18 RD	ET (7.5 AMP) -2B-
	4B	BUSS IA	12 LG	
	5B	785A	16GY	ES (5 AMP) -3B-
	6B	(BUSS I1)	LG	
	7B	30 A	16 GY	ES (5 AMP) -4B-
	8B	(BUSS I1)	–	
	9B	241 A	14 RD	EX (20 AMP) -5B-
	10B	(BUSS I1)	–	
	11B	860 A	18 RD	ES (5 AMP) -6B-
	12B	16 D (BUSS I1)	12 LG	
	13B	840 A	18 DG	ES (5 AMP) -7B-
	14B	16 C (BUSS I1)	12 LG	

INTERIOR MINI FUSE BLOCK 1 (LOWER) (Cont'd) (Figure 12-160)

Buss	Cavity	CKT. No.	Color & Ga.	Fuse
A2A	1C	83 C	16 TN	ES (5 AMP) -1C-
	2C	(BUSS A2A)	–	
	3C	400 A 400 B	14 LG 18 LG	EU (10 AMP)
	4C	687 C (BUSS A2A)	14 LG	-2C-
A2	5C	298 A	16 BR	ET (7.5 AMP) -3C-
	6C	687 C (BUSS A2)	14 LG	
	7C	8 A	14 PP	EU (10 AMP) -4C-
	8C	(BUSS A2)	–	
	9C			-5C-
	10C	(BUSS A2)	–	
	11C	346 A	14 PK	EX (20 AMP) -6C-
	12C	(BUSS A2)	–	
	13C	399 B	12 DG	EZ (30 AMP) -7C-
	14C	687 B (BUSS A2)	10LLG	
B2A	1D	829 A	14 LG	EW (15 AMP) 1D
	2D	(BUSS B2A)	–	
	3D	841 A	18 RD	ES (5 AMP) -2D-
	4D	37 M (BUSS B2A)	14 RD	
B2	5D	40 A	14 DB	EX (20 AMP) -3D
	6D	37 M (BUSS B2)	14 RD	
	7D	10 A	14 OR	EW (15 AMP) -4D-
	8D	(BUSS B2)	–	
	9D	383 A	14 YL	EW (15 AMP) -5D-
	10D	(BUSS B2)	–	
	11D	859 A	14 RD/YL	EZ (30 AMP) -6D-
	12D	(BUSS B2)	–	
	13D	575 A	12OR	EY (25 AMP) -7D-
	14D	37 b (BUSS B2)	10 RD	

INTERIOR MINI FUSE BLOCK 2 (UPPER) (Figure 12-160)

Buss	Cavity	CKT. No.	Color & Ga.	Fuse
L1	1E	–	–	ES (5 AMP) -1E-
	2E	–	–	
	3E	–	–	– -2E-
	4E	–	–	
	5E	–	–	ET (7.5 AMP) -3E-
	6E	BUSS B3	–	
	7E	–	–	– -4E-
	8E	BUSS B3	–	
	9E	–	–	EW (15 AMP) -5E-
	10E	–BUSS B3	–	
	11E	1071A	18 WH	ET (7.5 AMP) -6E-
	12E	BUSS B3	-	
	13E	416A	18 PK	ES (5 AMP) -7E-
	14E	37F BUSS B3	14 LG	
	1F	14 D	16 LB	ES (5 AMP) -1F-
	2F	(BUSS L1)	–	
	3F	19 A	14 YL	ES (5 AMP) -2F-
	4F	14 B (BUSS L1)	14 LB	
	5F	20 A 20 B	14 RD 18 RD	ET (7.5 AMP)
	6F	(BUSS L1)	–	-3F-
	7F	21 A	14 GY	ET (7.5 AMP) -4F-
	8F	14 C (BUSS L1)	14 LB	
	9F	962 A	14 BR	EW (15 AMP) -5F-
	10F	14 A (BUSS L1)	12 LB	
L1A	11F	80 A	16 WH	ES (5 AMP) -6F-
	12F	14 B (BUSS L1A)	14 LB	
	13F	183 A	18 TN	ES (5 AMP) -7F-
	14F	(BUSS L1A)	–	
A1A	1G	640 D	16 OR	ES (5 AMP) -1G-
	2G	(BUSS A1A)	–	
	3G	296 A	16 DG	ES (5 AMP) -2G-
	4G	297 B (BUSS A1A)	14 OR	
A1	5G	71 A	12 WH	EZ (30 AMP) -3G-
	6G	297 B (BUSS A1)	14 OR	
	7G	137 A	16 RD	ET (7.5 AMP) -4G-
	8G	(BUSS A1)	–	
	9G	–	–	– -5G-
	10G	(BUSS A1)	–	
	11G			– -6G-
	12G	(BUSS A1)	–	
	13G	65 B	14 YL	EY (25 AMP) -7G-
	14G	297 A (BUSS A1)	12 OR	
B1A	1H	554 A 554 B	18 GY 18 GY	ES (5 AMP)
	2H	(BUSS B1A)	–	-1H-
	3H	476 A	16 GY	EU (10 AMP) -2H-
	4H	37 D (BUSS B1A)	10 RD	

INTERIOR MINI FUSE BLOCK 2 (UPPER) (Figure 12-160) (Cont'd)

Buss	Cavity	CKT. No.	Color & Ga.	Fuse
B1	5H	517 A	12 OR	EX (20 AMP) -3H-
	6H	37 D (BUSS B1)	10 RD	
	7H	70 A	12 YL	EZ (30 AMP) -4H-
	8H	(BUSS B1)	–	
	9H	54 B	14 DG	EW (15 AMP) -5H-
	10H	(BUSS B1)	–	
	11H	45 A	14 WH	EX (15AMP) -6H-
	12H	(BUSS B1)	–	
	13H	51 A	12 YL	– -7H-
	14H	37 A (BUSS B1)	10 RD	

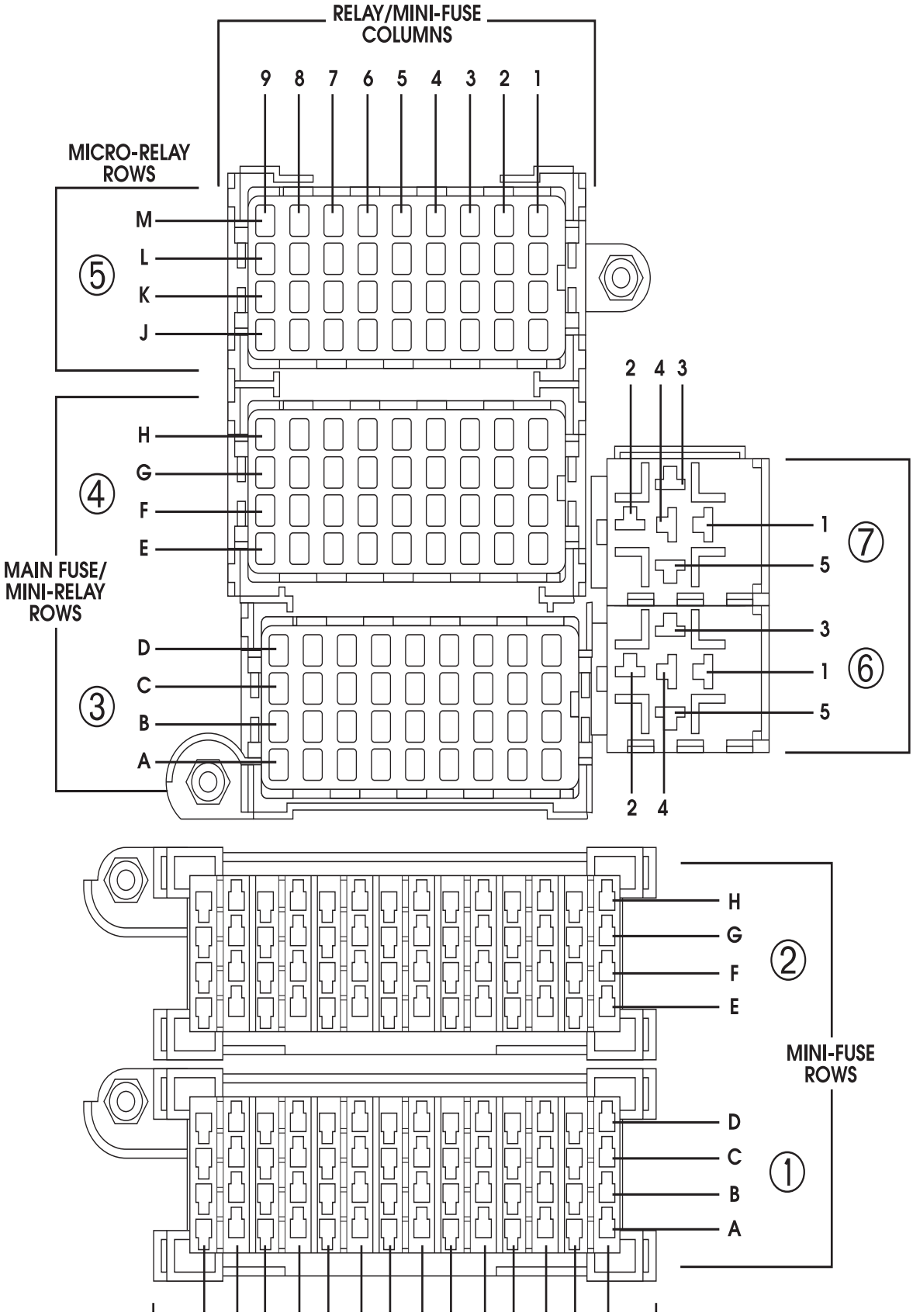


Figure 12-160: Interior Mini-Fuse Block

IGNITION RELAY RY-1				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
MINI- FUSE / RELAY BLOCK ③	B5	687 A	12 GY	FB
	C7	59 H 59 A	18 BK 18 BK	
	B7	37 C	10 RD	
	C6	–	–	
	C5	687 B	10 LG	

WIPER RELAY RY-2				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
MINI- FUSE / RELAY BLOCK ③	B1	945 A	16 BR	FB
	C3	59 A 59 B	18 BK 18 BK	
	B3	27 A	14 OR	
	C2	28 A	14 DB	
	C1	65 C	14 YL	

RELAY RY-3				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
MINI- FUSE / RELAY BLOCK ④	F1			
	G3	59 B 59 C	18 BK 18 BK	
	F3			
	G2			
	G1			

POWER WINDOW RELAY RY-4				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
MINI- FUSE / RELAY BLOCK ④	F5	296 A	16 DG	FB
	G7	59 C 59 D	18 BK 18 BK	
	F7	175 A	12 LB	
	G6	–	–	
	G5	171 A	12 RD	

MIRROR CUT-OUT RELAY RY-5				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
MICRO RELAY BLOCK ⑤	J7	580 E	18 BR	FA
	K9	59 D 59 E	18 BK 18 BK	
	J9	–	–	
	J8	400 C 400 B	18 LG 18 LG	
	K7	407 A	18 PK	

AUX COOLANT PUMP RELAY RY-3				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
MICRO RELAY BLOCK ⑤	J4	419C	18 BR	FA
	J6	418A	18 OR	
	K4	416A	18 PK	
	K6	59CA	18 BK	

Interlock RELAY RY-4				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
MICRO RELAY BLOCK ⑤	M9	1070A	18 BR	FA
	M8	520A	18 WH	
	L9	1073B	18 RD	
	L7	1073C	18 RD	

IGNITION RELAY RY-1				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
	J1	24A/24B	18 RD	
MICRO RELAY BLOCK ⑤	J3	242A	16 PK	FA
	K1	24B	18 RD	
	K3	59CC	18 BK	
TURN / HAZARD FLASHER RELAY RY-6				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
⑥	1	44 A	14 LB	EM
	2	8 A	14 PP	
	3	383 A	14 YL	
	4	385 A	14 TN	
	5	59 G	14 BK	
CTI BUZZER RELAY RY-7				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
⑦	1	59 E 59 F	18 BK 18 BK	NOT INSTALLED
	2	DIODE 428 A	20 PK	
	3	–	–	
	4	–	–	
	5	DIODE 428 B	16 PK	

EXTERIOR MINI FUSE BLOCK

Buss	Cavity	CKT. No.	Color & Ga.	Fuse
B1	1A	–	–	(FOR DIODE USE ONLY) -1A-
	2A	–	–	
	3A			-2A-
	4A	37M	10 YL	
	5A	738A	10 RD	30 AMP -3A-
	6A	(BUSS B1)	–	
	1B	–	–	(FOR DIODE USE ONLY) -1B-
	2B	–	–	
B2	3B	1037A	16 RD	10 AMP -2B-
	4B	37N	10 YL	
	5B	737A	10 OR	30 AMP -3B
	6B	(BUSS B2)		
I1	1C	514A	14 PK	15 AMP -1C-
	2C	(BUSS I1)	–	
	3C	290A	16 PK	20 AMP -2C-
	4C	390A	10 OR	
	5C	1042A	12 PK	25 AMP -3C-
	6C	(BUSS I1)	–	
I2	1D	243A	16 PK	10 AMP -1D-
	2D	(BUSS I2)	–	
	3D	291A	14 RD	20 AMP -2D-
	4D	16A	12 LG	
	5D	239A	14 PK	20 AMP -3D-
	6D	(BUSS I2)	–	

EXTERIOR MINI FUSE BLOCK (Cont'd)

Buss	Cavity	CKT. No.	Color & Ga.	Fuse
	1E	7B	18 OR	D (HORN RELAY)
	2E	–	–	-1E-
	3E	7A/7B	14 OR/18 OR	-
	4E	400A	18 LG	-2E-
	5E	–	–	D (A/C CLUTCH RELAY)
	6E	400A/400B	14 LG/18 LG	-3E-
	1F	6A	16 WH	-
	2F	–	–	-1F-
	3F	1A	18 DB	-
	4F	348A	16 BR	-2F-
	5F	–	–	–
	6F	410A	20 LG	-3F-

EXTERIOR MAXI FUSE BLOCK

Buss	Cavity	CKT. No.	Color & Ga	Fuse or Circuit Breaker
BUSS BAR	8W	37F	10 YL	(40 AMP FUSE)
	8X	BUSS	–	-IM-
	7W	38A	14 RD	(20 AMP CD)
	7X	BUSS	–	-2M-
	6W	195A	12 YL	(30 AMP CB)
	6X	BUSS	–	-3M-
	5W	688A	12 RD	(30 AMP CB)
	5X	BUSS	–	-4M-
	4W	175A	12 LB	(30 AMP CB)
	4X	BUSS	–	-5M-
	3W	436A	12 YL	(30 AMP FUSE)
	3X	BUSS	–	-6M-
	2W	604A	10 PK	(40 AMP FUSE)
	2X	BUSS	–	-7M-
	1W	37 D/37 E	12 YL/12 YL	(40 AMP FUSE)
	1X	BUSS	–	-8M-
M8 BUSS	2Y	–	–	(30 AMP FUSE)
	2Z	M8 BUSS	–	SPARE STUD A -(9M)-
	1Y	–	–	(30 AMP FUSE)
	1Z	M8 BUSS	–	SPARE STUD B -(10M)-
	Q1	37M	10 YL	(TO MINI FUSE BUSS B1)
	Q2	37N	10 YL	(TO MINI FUSE BUSS B2)

EXTERIOR FUSE BOX RELAYS (Figure 12-161)

RELAY R-6				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
ABS VALVE RELAY	1	991A	18 LB	E
	2	59G	16 BK	
	3	575A	12 OR	
	4	–	–	
	5	990A	12 PK	
RELAY R-5				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
ABS WARNING RELAY	1	990B	16 PK	D
	2	59B 59C	16 BK 16 BK	
	3	603A	18 RD	
	4	59A 59B	16 BK 16 BK	
	5	–	–	
RELAY R-4				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
HEATED WINDSHIELD RELAY	1	580A 580B	18 BR 18 BR	E
	2	59F 59G	16 BK 16 BK	
	3	738A	10 RD	
	4	–	–	
	5	740A	12YL	
RELAY R-3				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
TRANSMISSION RELAY	1	1058B	18 BK	D
	2	605C	18 PP	
	3	1012A	18 PK	
	4			
	5	1058C	18 BK	
RELAY R-2				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
HEATED WINDSHIELD RELAY	1	580A	18 BR	E
	2	59F 59E	16 BK 16 BK	
	3	737 B	10 OR	
	4	–	–	
	5	739A	12PP	
RELAY R-1				
	Cavity	**CKT. No**	**Color & Ga.**	**Relay**
CTIS COMPRESSOR RELAY	1	46A	16 WH	E
	2	59C	16 BK	
	3	436 A	12 YL	
	4	–	–	
	5	437A	12 DG	

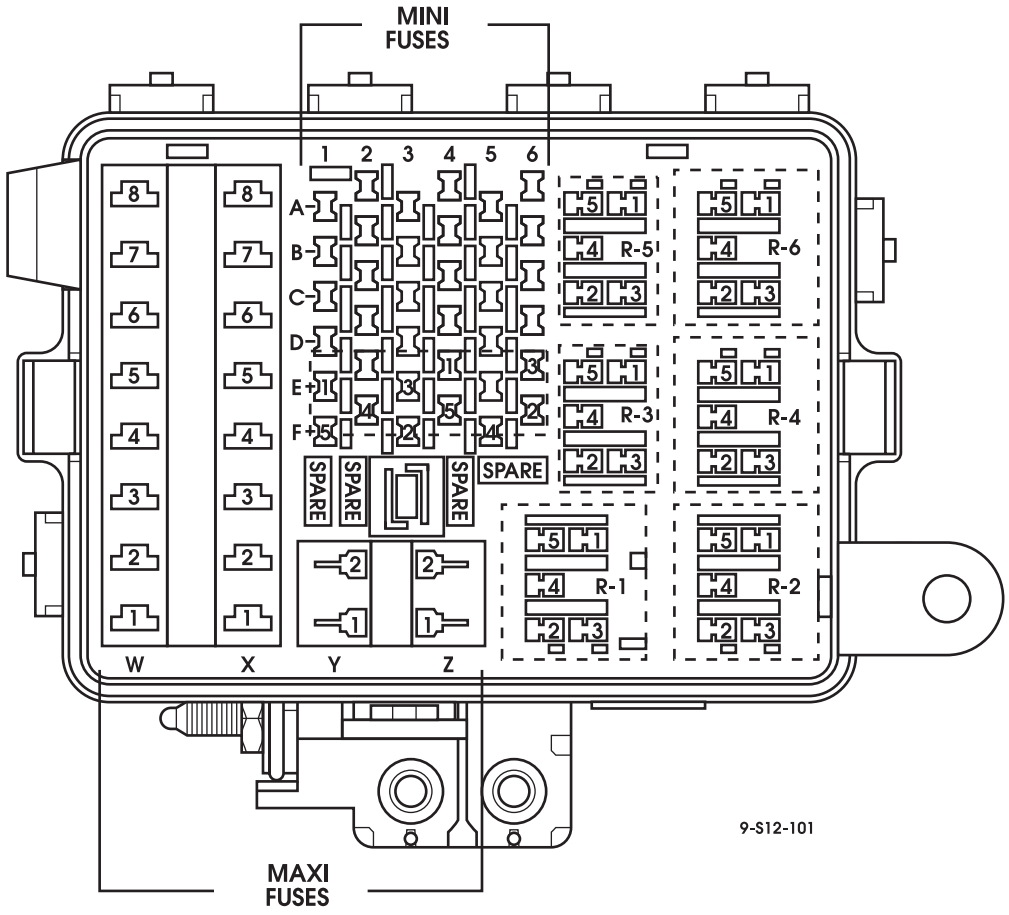
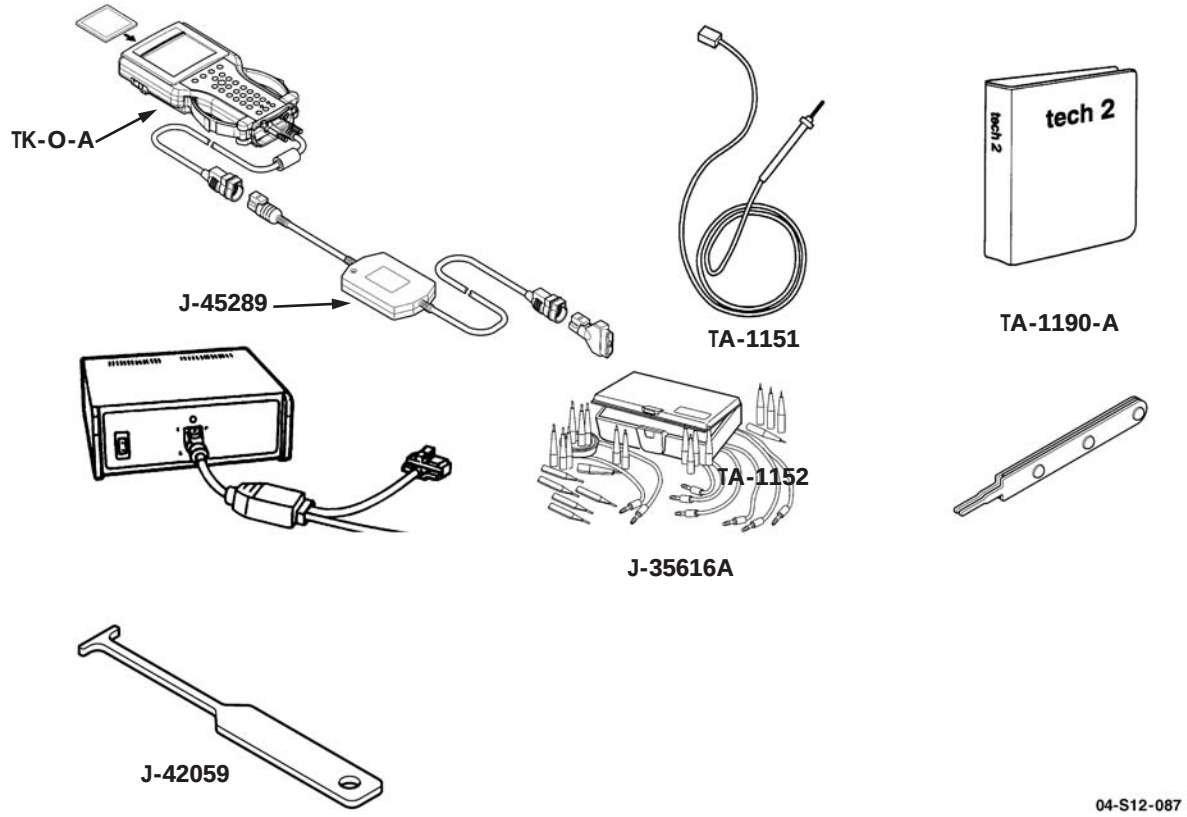


Figure 12-161: Exterior Fuse Box Relay Cavity I.D.

ESSENTIAL TOOLS



Tool No.	Description
TK-O-A	Tech 2 Diagnostic Scanner Kit
TA-1151	Tech 2 Adapter, part of TK-O-A
TA-1152	Tech 2 Test Lead, part of TK-O-A
TA-1190-A	Operators Manual, Tech 2, part of TK-O-A
J–35616-A	Connector Test Adapter Set
J–43160	Adapter Cable, Tech 2A (14/16 pin) (not shown)
J–44237	ABS, DLC Jumper
J–24538-B	Tester, Gauge
J–35592	Pinout Box, ABS
J–42645-99SW	Software Package
7000041	Vehicle Interface Module (VIM) (not shown)
J-45289	**C**ontroller **A**rea **N**etwork **d**iagnostic **i**nterface (CAN di module)
J-39200	Fluke 87 digital volt/ohm meter
j-42059	Cigarette Lighter Socket Remover

Procure from Kent-Moore.

THIS PAGE INTENTIONALLY BLANK.

Section 13 Accessories

TABLE OF CONTENTS

Air Restriction Gauge 13-41
Auxiliary Seat
- Belt Replacement 13-44
- Frame Replacement 13-45
- Leather Upholstery 13-46
- Locking Pin Replacement 13-45
- Replacement 13-43

Bedliner 13-48
Brushguard Assembly Replacement 13-38
Cargo Area Liner 13-50
Center Closeout Panel, Rear Bumper 13-31
Dual Oil Filter 13-42
Fender Flares 13-39
Hourmeter 13-41
Off-Road Accessory Kit 13-47
Racks
- Center Tunnel 13-51
- Roof 13-25
- Wheel House 13-52

Side Step Bars (Tubular) 13-24
Soft Slant Back 13-28
Soft Square Back 13-30
Spare Tire Carrier
- Aluminum Wheel Adapter 13-21
- Cargo Deck Mounted 13-19
- Swing-Away 13-16

Stainless Steel Appliques
- Front Bumper Cover (with Brushguard and w/o Winch) 13-32
- Front Bumper Cover (with Winch) 13-33
- Hitch Receiver 13-37
- Hood Latch Trim 13-36
- Hood Trim 13-35
- Rear Bumper Cover 13-33
- Tailgate Hinge Trim 13-34
- Upper Grille Cover 13-36

Trailer Hitch Replacement 13-23
Trailer Towing Connector 13-22
Winch
- Assembly Repair 13-4
- Cable Replacement 13-4
- Electric Thermal Switch/Brush Assembly 13-13
- Replacement 13-1

WINCH

NOTE: Individual parts may not be available for some of the following repair procedures. Assemblies must be used in place of individual parts. Check for parts availability before disassembly.

Winch Troubleshooting

Winch Inoperative

1. Check for a jammed winch cable.
2. Check the winch control cable connector for corrosion or a loose connection. Clean the corroded connector or secure the loose connection.
3. Check for a loose or damaged winch power cables. Using a voltmeter, connect the positive meter lead to the positive power cable (red) at the winch motor, and the negative meter lead to the winch motor ground cables (black). If the voltage is not present, repair or replace the winch power cables.
4. Disconnect the winch control from the winch. Using an ohmmeter, check for continuity between the common terminal and the other two terminals on winch control cable connector. Check for continuity one at a time, while holding the control in the OUT position and the IN position. If continuity is present in both positions, repair the winch. If continuity is not present in both positions, replace the winch control.

Winch Replacement

Removal

WARNING: To avoid personal injury or damage, support winch during removal.

1. Disconnect the battery ground cables (Section 12).
2. Remove the two battery cable bolts, battery cables, and the winch cables from the battery (Figure 13-1).

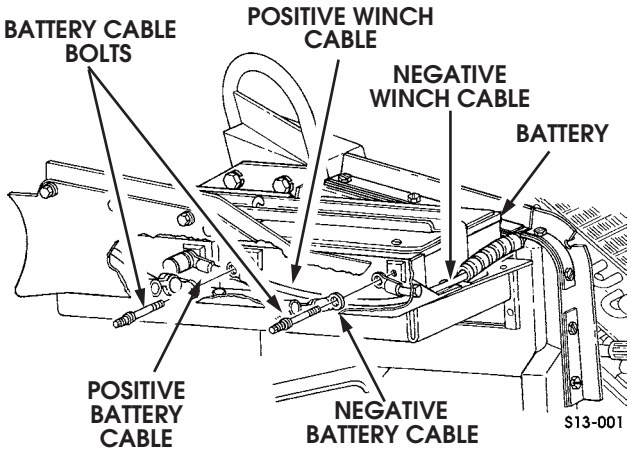


Figure 13-1: Winch Cables On Battery

3. Remove the nut, lockwasher, capscrew, and the clamp from the right frame extension. Discard the lockwasher. Pull the winch cables through the splash shield to the front of the vehicle (Figure 13-2).

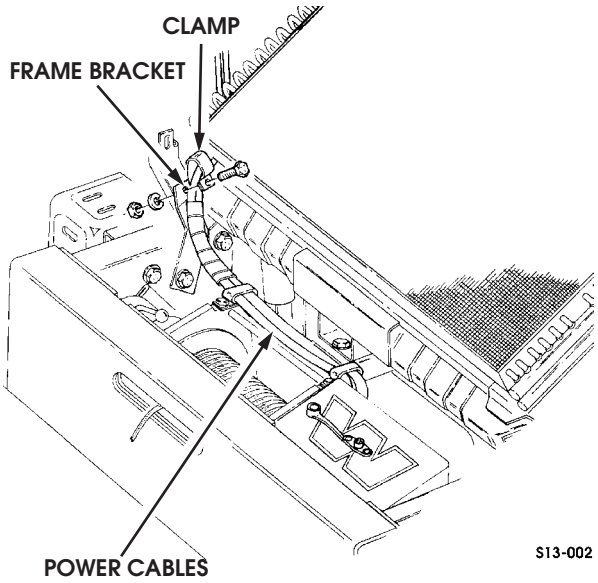


Figure 13-2: Frame Bracket

4. Remove the four nuts, washers, bolts, and the winch from the front bumper13-3.

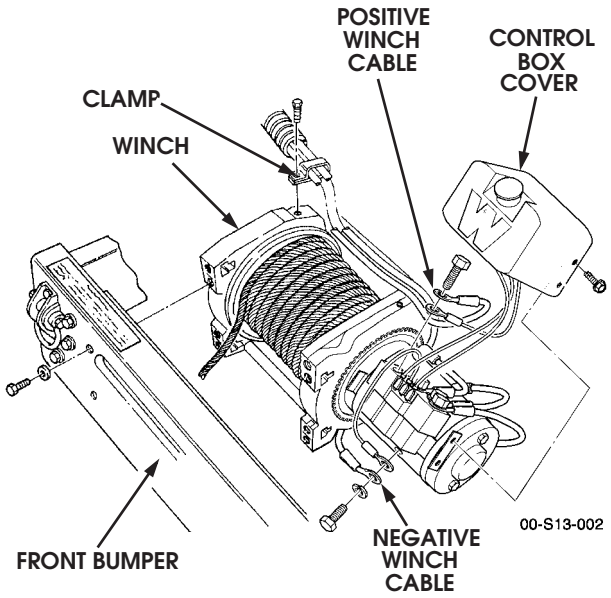


Figure 13-3: Winch and Winch Cables

5. Remove the two bolts and the clamps securing the winch cables to the winch.
6. Remove the bolt and the control box cover from the winch.
7. Remove the capscrew, washer, and the negative winch cable from the winch.
8. Remove the bolt and the positive winch cable from the winch.

Installation

1. Install the positive winch cable on the winch with the bolt13-3.
2. Install the negative winch cable on the winch with the washer and the capscrew.
3. Coat the motor end of the winch with coating compound.
4. Install the control box cover on the winch with the bolt.
5. Secure the two winch cables to the winch with the two clamps and the bolts.
6. Install the winch on the front bumper with the four washers, bolts, and the nuts. Tighten the bolts to 60 lb-ft (81 N•m).

7. Route the winch power cables through the splash shield.
8. Install the winch cables on the frame bracket with the clamp, capscrew, lockwasher, and the nut (Figure 13-2).
9. Connect the battery ground cables (Section 12).

Winch Cable Replacement

WARNING: To avoid injury, wear gloves when handling the winch cable.

Removal

1. Remove the cotter key from the clevis pin and discard. Seperate the clevis pin from the hook and remove the hook from the winch cable.
2. Unwind the winch cable.
3. Remove the set screw and winch cable from the drum assembly (Figure 13-4).

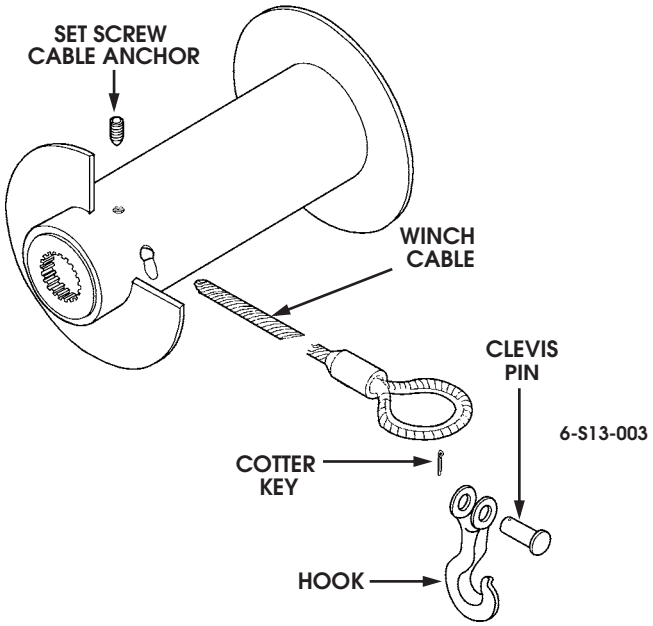


Figure 13-4: Winch Cable

Installation

1. Install the hook and clevis assembly on the winch cable
2. Attach the winch cable to the drum and secure with the set screw.

CAUTION: *Install the winch cable on the drum under a load of at least 500 lb (227 kg), or the outer wraps will draw into the inner wraps and damage cable.*

NOTE: Spool the winch cable according to the rotation label on the winch or the brake will not function.

3. Rewind and lubricate the winch cable.

Winch Assembly Repair

Disassembly

1. Remove the winch and the winch cable.

NOTE: Tag the leads for assembly.

2. Remove the three nuts and the control leads from the motor (Figure 13-5).

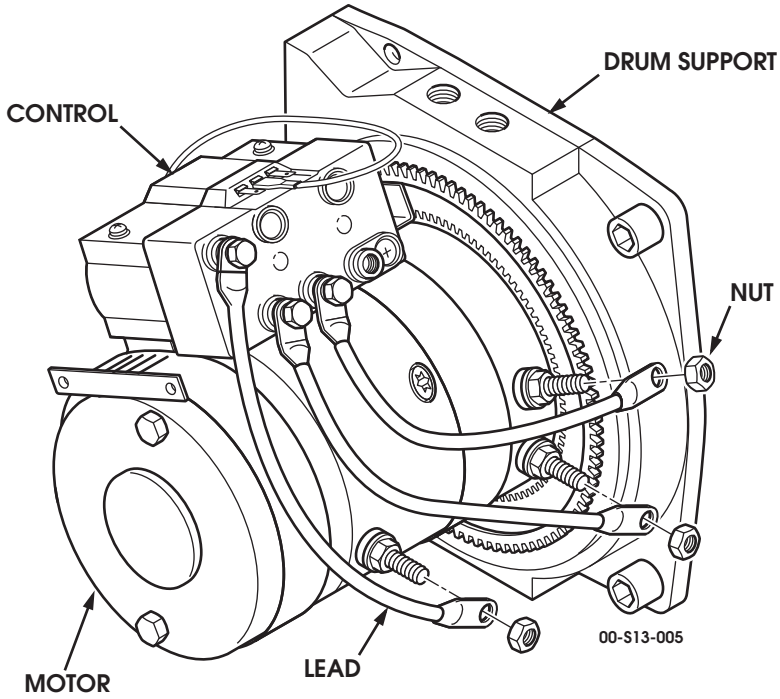


Figure 13-5: Control Leads

3. Loosen the clamps and remove the control from the motor (Figure 13-6).

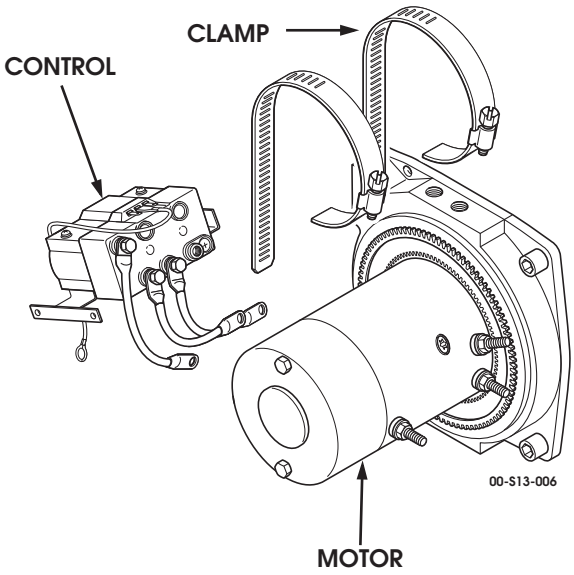


Figure 13-6: Control Unit

4. Remove the clamps from the motor.
5. Mark the motor end drum support, gear train assembly, and the gear end drum support for assembly (Figure 13-7).

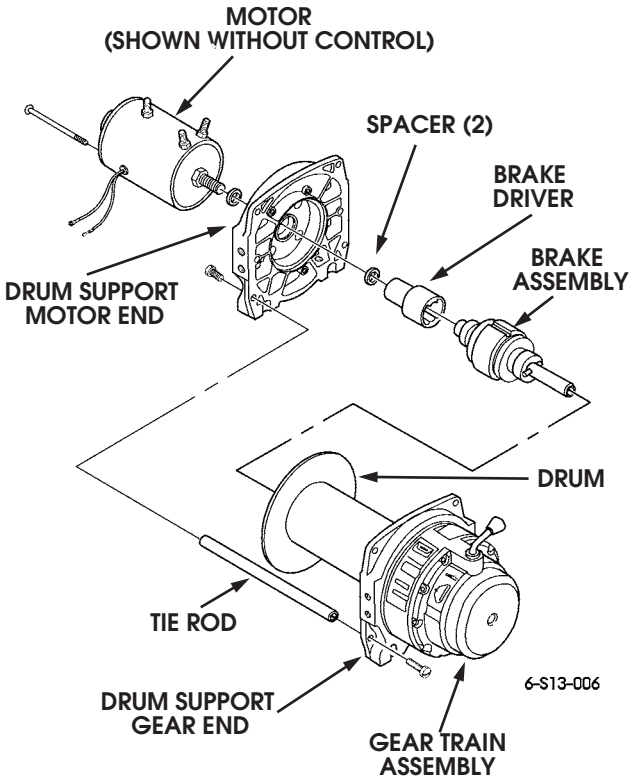


Figure 13-7: Drum Support and Gear Train Assembly

6. Remove the six bolts, three tie rods and the gear end drum support from the winch.
7. Remove the motor, and the motor end drum support from the drum assembly.
8. Remove the motor brake driver and the spacer from the motor shaft.
9. Remove the drum assembly from the gear train assembly (Figure 13-7).
10. Remove the two nylon thrust washers from the drum (Figure 13-8).

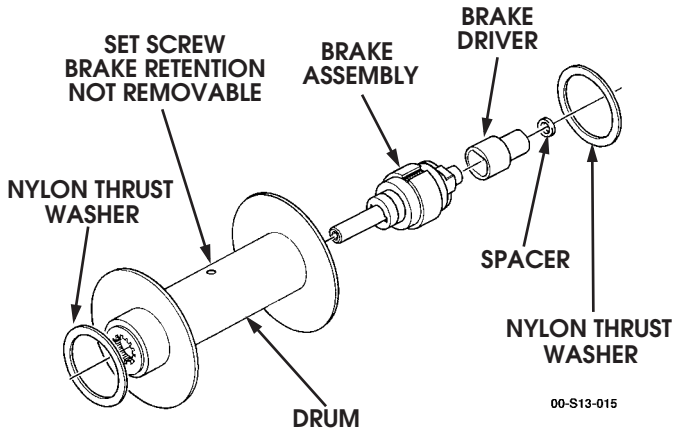


Figure 13-8: Thrust Washers and Brake

11. Loosen the set screw that retains the brake.
12. Push the brake through the open end of the drum and remove (Figure 13-8).
13. Remove the driveshaft from the gear train assembly (Figure 13-9).
14. Turn the gear train assembly over with the gear end drum support down. Remove the ten hex-head screws and the gear housing from the gear end drum support.
15. Remove the gasket from the gear end drum support and discard the gasket (Figure 13-9).

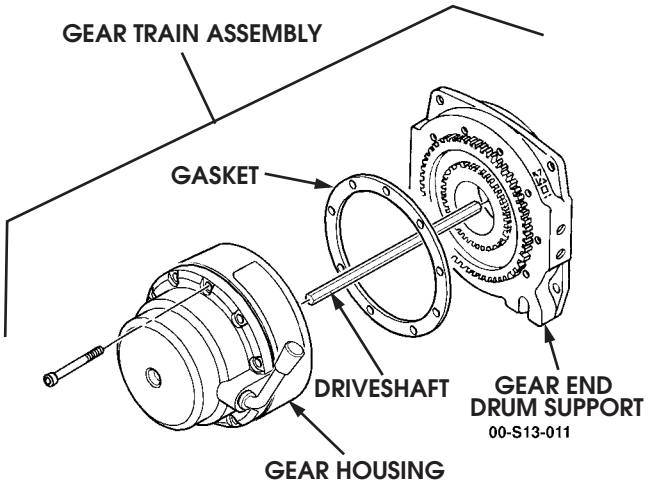


Figure 13-9: Gear Train Assembly

16. Remove the detent spacer, spring, and the detent ball from the gear housing (Figure 13-10).

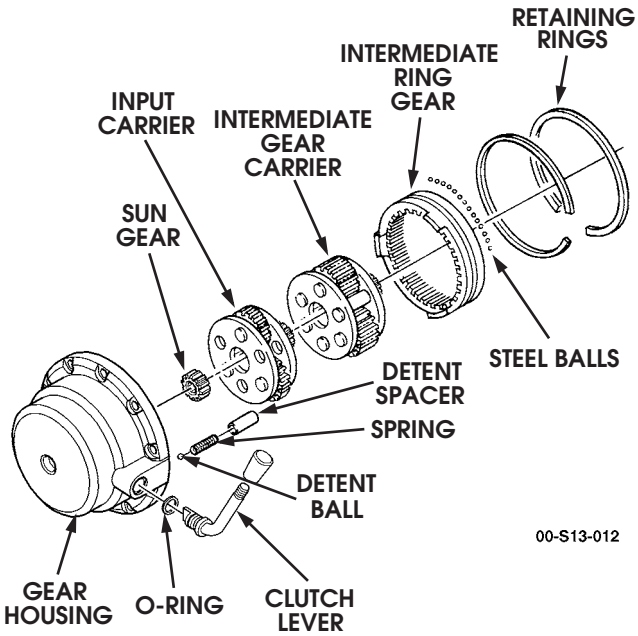


Figure 13-10: Gear Housing

17. Remove the clutch lever and the O-ring seal from the gear housing. Discard the O-ring seal.
18. Remove the two retaining rings from the gear housing (Figure 13-10).
19. Remove the intermediate ring gear from the gear housing.
20. Remove the input and the intermediate gear carrier assembly from the gear housing (Figure 13-10).
21. Remove the output gear carrier from output ring gear and the gear end drum support (Figure 13-11)

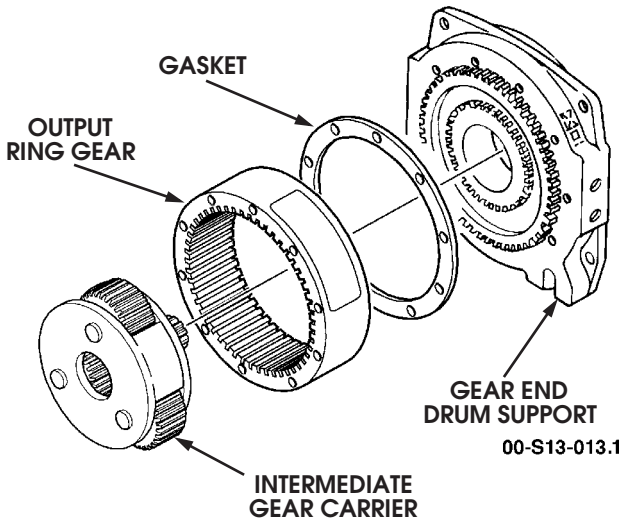


Figure 13-11: Gear Carriers

22. Remove the output ring gear and the gasket from the gear end drum support.

Cleaning

CAUTION: *To avoid damage to equipment, do not clean brake assembly. Clean and inspect all winch components. Replace defective parts.*

Inspection

1. Inspect the drum for damage to the splined end flanges and the tube (Figure 13-12). Replace the winch if damaged.

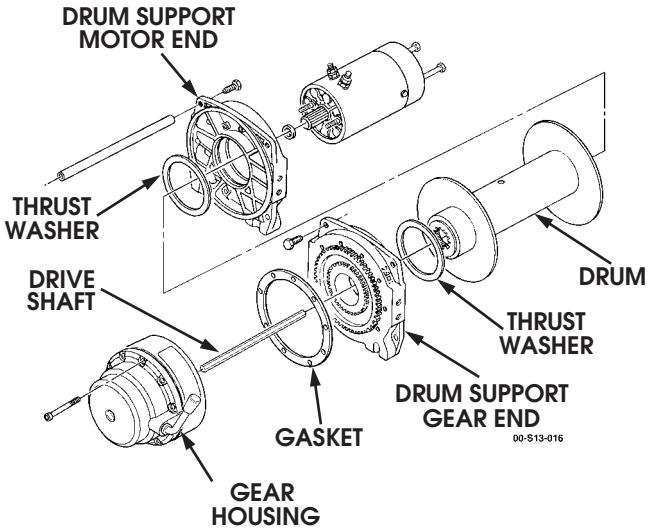


Figure 13-12: Drum Assembly and Gear Housing Assembly

2. Inspect the gear end and the motor end drum supports for damage. Replace if damaged.
3. Inspect the gear housing for damage. Replace if damaged.
4. Inspect the thrust plate for damage or wear. Replace if damaged or worn. Apply grease on the thrust plate for assembly.
5. Inspect the clutch lever and the driveshaft for damage. Replace if damaged.
6. Inspect the gear teeth and the machined surfaces of the intermediate ring gear for damage. Replace if damaged.
7. Inspect the gear teeth, splines, and the machined surfaces of the output ring gear, output gear carrier, intermediate gear carrier, and the input gear carrier assembly for damage. Replace any damaged parts (Figure 13-13).

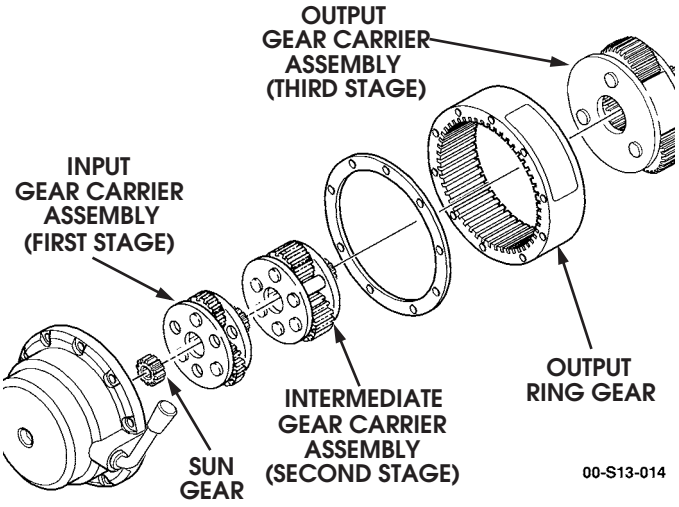


Figure 13-13: Gear Carriers

8. Inspect the brake assembly for damage (Figure 13-18).
9. Inspect the motor, spline, mating surface, and the terminals for damage. Replace the motor if damaged (Figure 13-14).

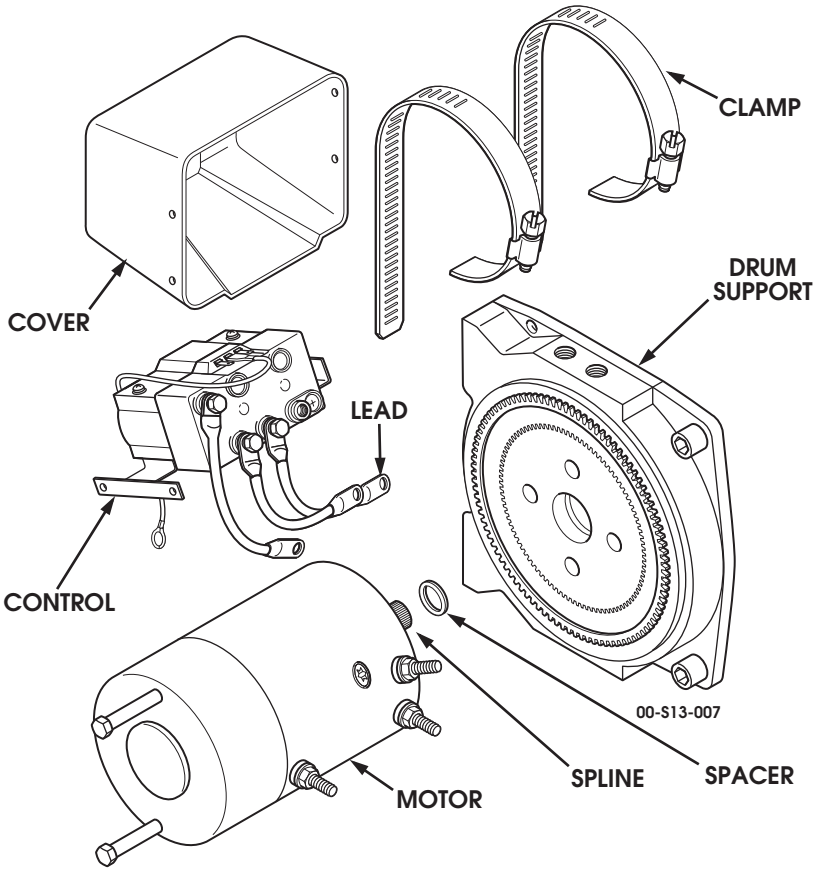


Figure 13-14: Motor and Control Unit

10. Inspect the cover for damage. Replace if damaged.
11. Inspect the control for damaged leads and damaged mounting base. Replace the control if damaged.

Assembly

1. Install the intermediate ring gear in the gear housing (Figure 13-15).

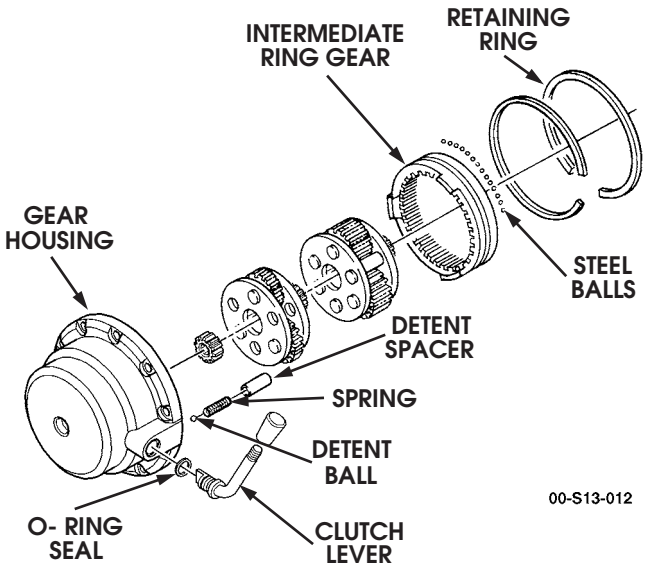


Figure 13-15: Intermediate Ring Gear and Gear Housing

2. Install the retaining rings in the gear housing.
3. Apply grease to the clutch lever hole and install the O-ring seal and the clutch lever in the gear housing.
4. Install the detent ball, spring, and the detent spacer in the gear housing.
5. Apply aircraft grease to the output gear carrier, intermediate gear carrier, and the input gear carrier assembly (Figure 13-16).

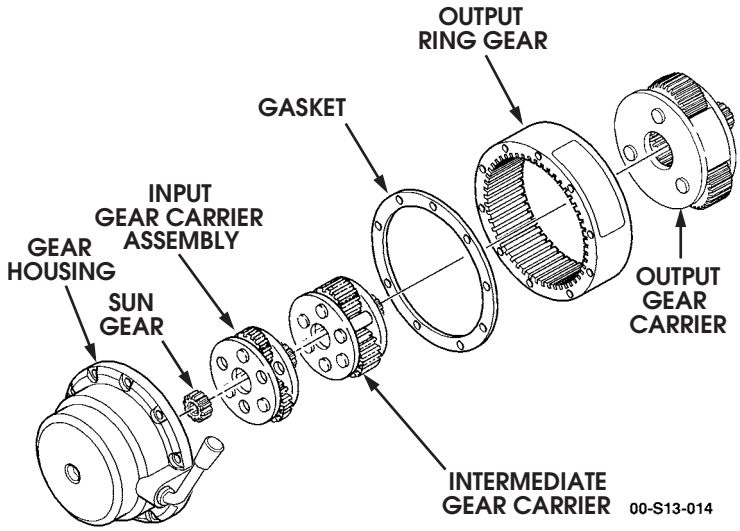


Figure 13-16: Gear Carriers

6. Install the input gear carrier assembly in the gear housing.

NOTE: Be sure the ring gear engages in the gear housing.

7. Install the gasket and the output ring gear on the gear housing.
8. Install the intermediate gear carrier on the gear housing.
9. Install the output gear carrier on the intermediate gear carrier.
10. Install the gasket on the output ring gear (Figure 13-17).

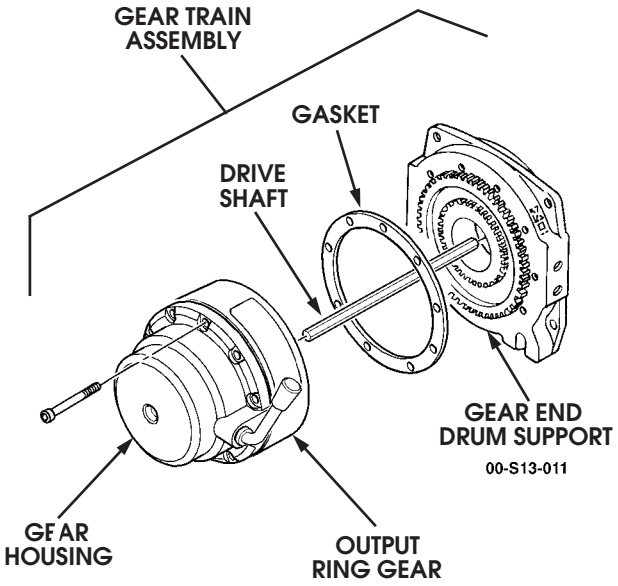


Figure 13-17: Gear Train Assembly

NOTE: Ensure the spline on the drum support engages in the output ring gear.

11. Install the gear end drum support on the output ring gear and the gear housing.
12. Secure the gear housing assembly to the drum support with the ten socket-head cap screws. Tighten the hex-head screws to 100 lb-in. (11 N•m).
13. Turn the gear train assembly over with the drum support facing up.
14. Install the driveshaft in the gear train assembly (Figure 13-17).
15. Apply grease to the drum bushings, seals, and the output spline.

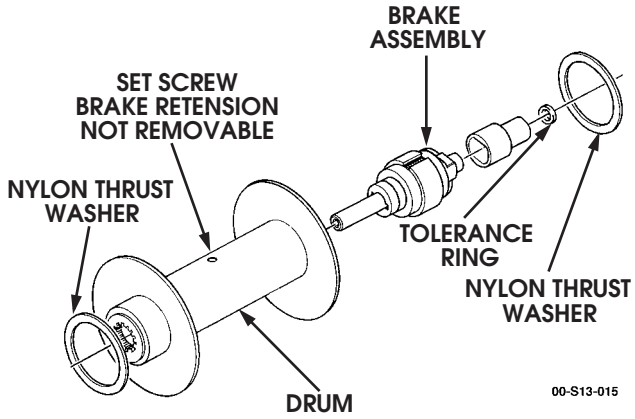


Figure 13-18: Thrust Washers and Brakes

16. With the drum horizontal, install the brake into the drum (Figure 13-18).
17. Tighten the brake retaining set screw to 18-22 ft-lb (24-30 N•m) torque.
18. Install the two nylon thrust washers on the drum.
19. Install the drum assembly on the gear train assembly. Rotate the drum assembly as needed to engage the driveshaft, brake, and the output spline (Figure 13-19).

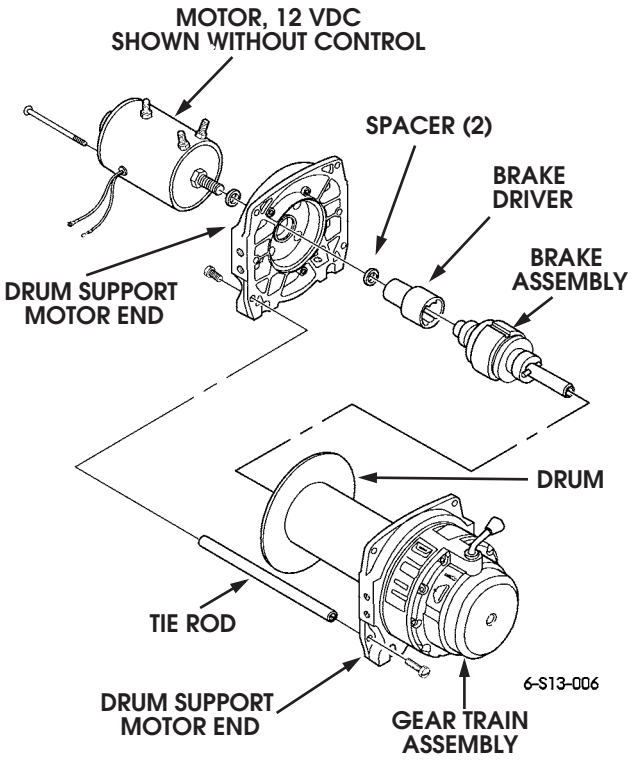


Figure 13-19: Drum Assembly and Gear Train Assembly

20. Install the brake drive and the spacer to the motor shaft.
21. Install the motor end drum support on the drum assembly.
22. Install the motor on the motor end drum support, ensuring to engage the brake drive with the brake shaft end.
23. Install the three tie rods between the drum supports and secure with the six bolts. Tighten the bolts to 18 lb-ft (24 N•m).

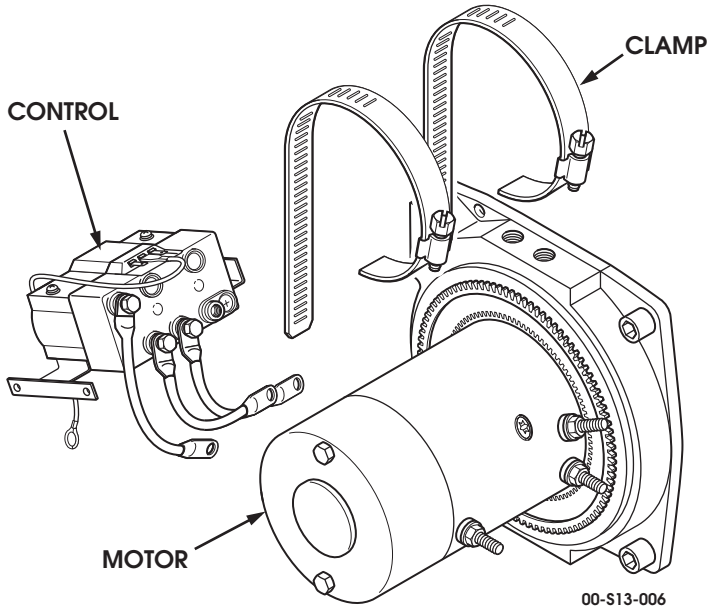


Figure 13-20: Control Unit and Motor

24. Connect the three control leads to the terminals and secure with the nuts (Figure 13-21).
25. Secure the control to the motor with the clamps13-20.
26. Install the winch assembly and the winch cable.

Winch Electric Thermal Switch/Brush Assembly Replacement

Removal

1. Remove the winch and the winch cable.

NOTE: Tag the leads for assembly.

2. Remove the three nuts and the control leads from the motor (Figure 13-21).
3. Loosen the clamps and remove the control from the motor (Figure 13-22).

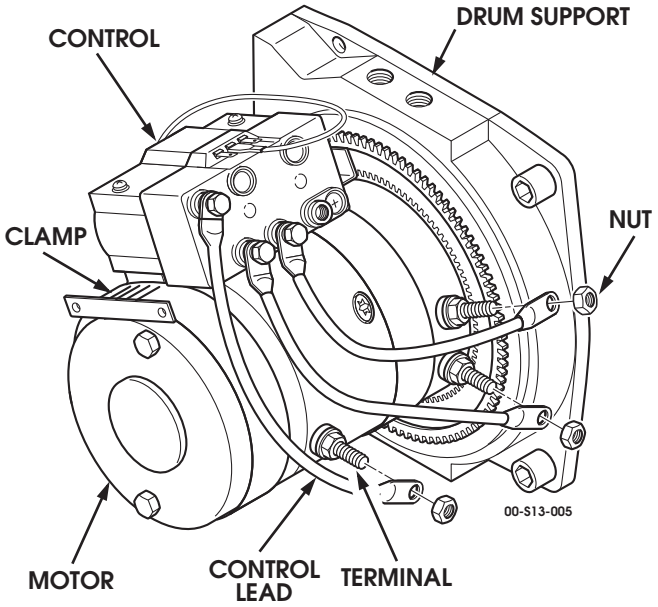


Figure 13-21: Control Leads

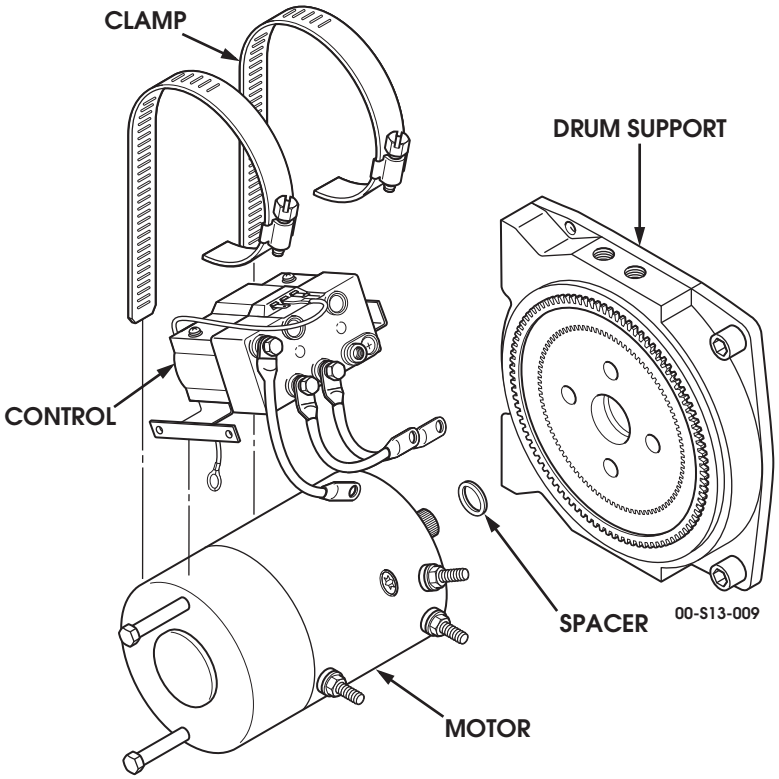


Figure 13-22: Control Unit and Motor

4. Remove the clamps from the motor.
5. Place the winch on the end with the motor end up (Figure 13-25).
6. Remove the two bolt assemblies and the rear cover from the motor housing.

NOTE: Perform steps 7 through 11 only if replacing the brush assembly.

7. Remove the electric thermal switch from the two electric thermal switch leads.
8. Remove the motor housing from the drum support and the armature assembly from the brush assembly (Figure 13-24).
9. Remove the nut, lockwasher, washer, and the insulator securing the brush assembly power stud to the motor housing. Discard the lockwasher.
10. Remove the three nuts, screws, and the brush assembly from the motor housing.
11. Remove the spacer, insulator, and the washer from the brush assembly power stud.

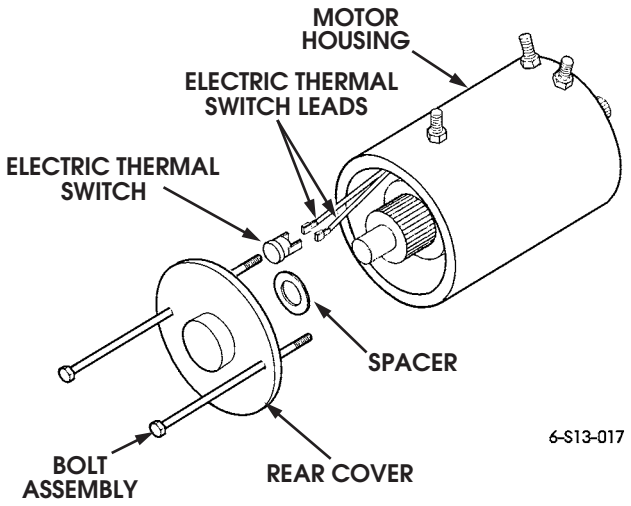


Figure 13-23: Motor and Gasket

Installation

NOTE: Do not apply coating to any electrical contacts of the armature assembly. Perform steps 1 through 5 only if replacing brush assembly.

1. Install the washer, insulator, and the spacer on the brush assembly power stud (Figure 13-24).
2. Install the brush assembly in the motor housing with the three screws and the nuts
3. Secure the brush assembly power stud to the motor housing with the insulator, washer, lockwasher, and the nut.
4. Coat the armature shaft with lubricant and install in the brush assembly.
5. Coat the head of the electric thermal switch with lubricant and connect to the two electric thermal switch leads (Figure 13-23).

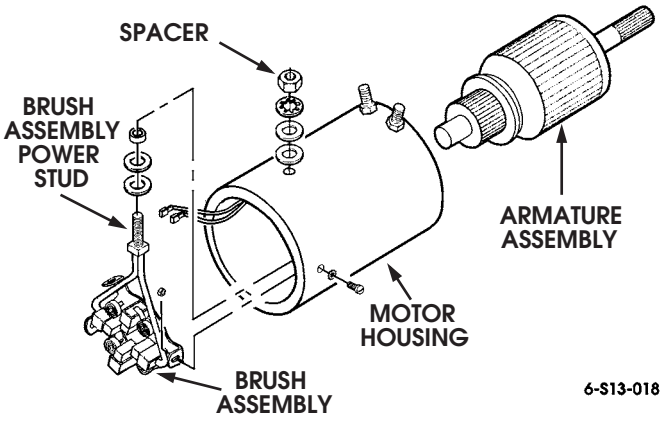


Figure 13-24: Brush Assembly and Armature Assembly

6. Position the spacer in the drum support, and install the rear cover on the motor housing.
7. Install the motor on the drum support ensuring to engage the motor shaft into the brake drum.
8. Secure the motor to the motor end drum support with the two bolt assemblies. Tighten the hex-head bolt to 60-70 lb-in. (7-8 N•m) (Figure 13-25).

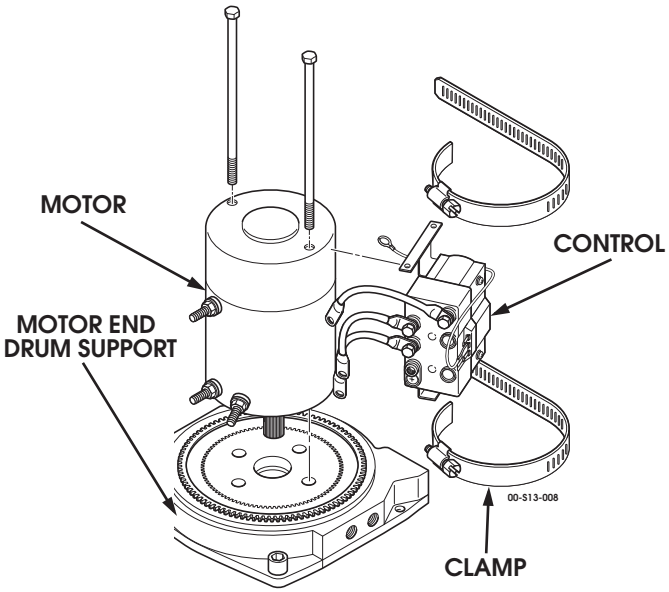


Figure 13-25: Control Unit and Motor

9. Install the clamps on the motor.
10. Install the control on the motor.
11. Connect the three control leads to the terminals and secure with the nuts (Figure 13-21).
12. Secure the control to the motor with the clamps.
13. Install the winch assembly and the winch cable.

Winch Roller Fairlead (Option) Replacement

The winch roller fairlead provides greater functional versatility. The winch cable can be routed at much sharper angles since the fairlead rollers will keep it from binding on the bumper edges.

Removal

WARNING: To avoid injury or damage, support winch during removal.

1. Remove the circlips on the one vertical and the one horizontal roller.
2. Remove the one vertical and the one horizontal roller.
3. Remove the washers, bolts, and the roller fairlead from the front bumper (Figure 13-26).

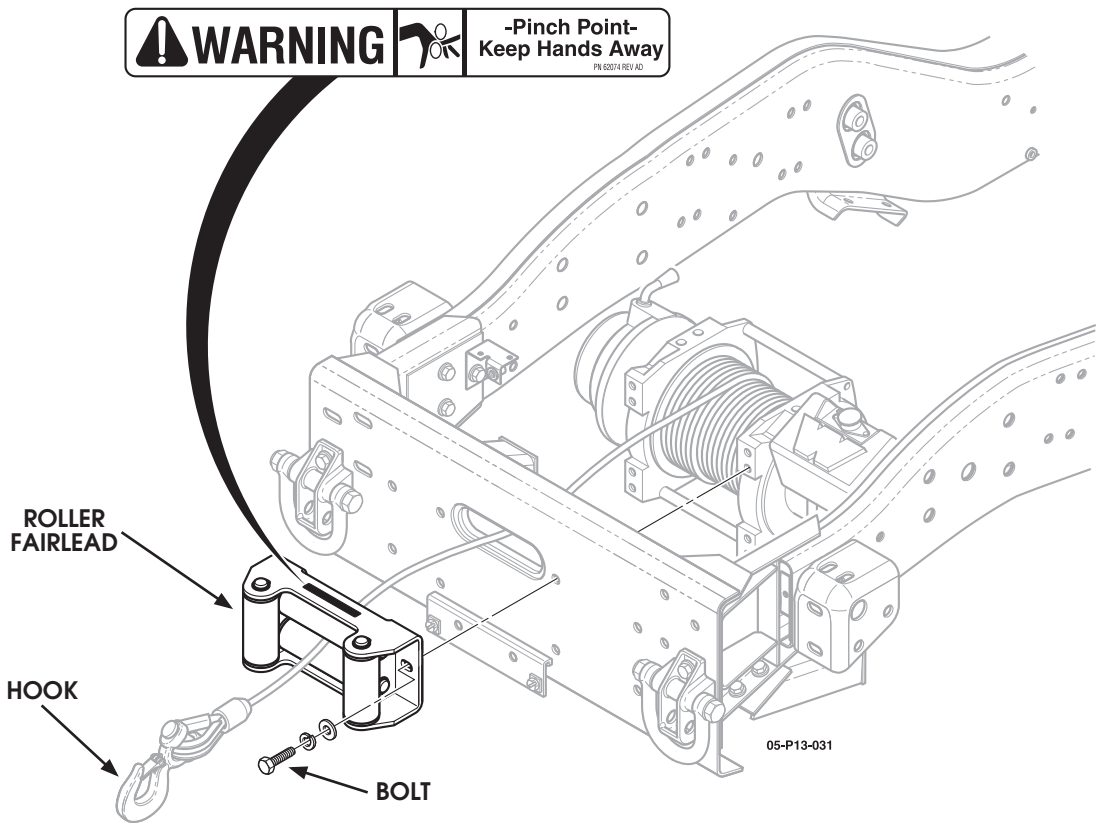


Figure 13-26: Winch Roller Fairlead

Installation

1. Place the winch cable and the hook assembly through the roller fairlead and install the fairlead on the front bumper with washers and the bolts. Tighten the bolts to 60 lb-ft (81 N•m) (Figure 13-26).
2. Install the horizontal and the vertical rollers and the circlips.

SWING-AWAY SPARE TIRE CARRIER REPLACEMENT

Removal

WARNING: Support tire when removing lug nuts. The spare tire and wheel assembly weighs approximately 150 lbs (68 kg) and personal injury may result if the assembly is not properly supported.

1. Remove the lug nuts and the wheel/tire assembly from the frame assembly (Figure 13-27).
2. Remove the self-tapping screw and the washer securing the lanyard to the frame and remove the lanyard and the lock pin.
3. Remove the self-tapping screws and the guide block from the rear bumper.
4. Remove the locknuts, washers, bolts, and the stop bracket from the rear bumper.
5. Remove the bolts, washers, and the hold-down bracket from the stop bracket.
6. Remove the bolt, washer, and the retaining plate from the mounting bracket.
7. Remove the frame assembly from the mounting bracket.
8. Remove the end caps from the frame assembly.
9. Remove the locknuts, washers, spacer, bolts, washers, and the mounting bracket from the rear bumper.
10. Remove the grease fitting from the mounting bracket.

Installation

1. Install the grease fitting in the mounting bracket (Figure 13-27).

2. Attach the mounting bracket and the spacer to the rear bumper with the bolts, washers, and the locknuts. Raise the mounting bracket to the highest position possible and tighten the nuts to 90 lb-ft (122 N•m).
3. Secure the guide block on the rear bumper with the self-tapping screws.
4. Attach the hold-down bracket to the stop bracket with the washers, and the bolts. Do not tighten.
5. Attach the stop bracket to the rear bumper with the bolts, washers, and the locknuts. Do not tighten.
6. Lubricate the frame assembly. Slide the frame assembly into the mounting bracket and fasten with the bolt, washer and the retaining plate.
7. Push the three end caps into the open ends of the frame assembly.
8. Adjust the stop and the hold-down brackets that were previously installed.
    a. Set the frame assembly in the locked position so that it rests on the bumper guide block. If the weight of the frame assembly does not rest on the guide block, lower the mounting bracket until it does.
    b. Insert the locking pin through the frame assembly and into the stop bracket.
    c. Mark the position of the stop bracket.
    d. Move the frame assembly out of the way and tighten the stop bracket assembly securely.
    e. Move the frame assembly back to the locked position and align the hold-down bracket as close to the frame assembly as possible.
    f. Tighten the hold-down bracket securely.
9. Secure the lanyard assembly to the frame assembly with the washer and the self-tapping screw.
10. Apply a cushion of tape to the frame assembly on the surfaces closest to the rear of the vehicle body.
11. Install the lock pin in the frame assembly.
12. Secure the wheel/tire assembly to the frame assembly with the lug nuts.
13. Lubricate the mounting bracket with multi-purpose grease using the grease fitting.

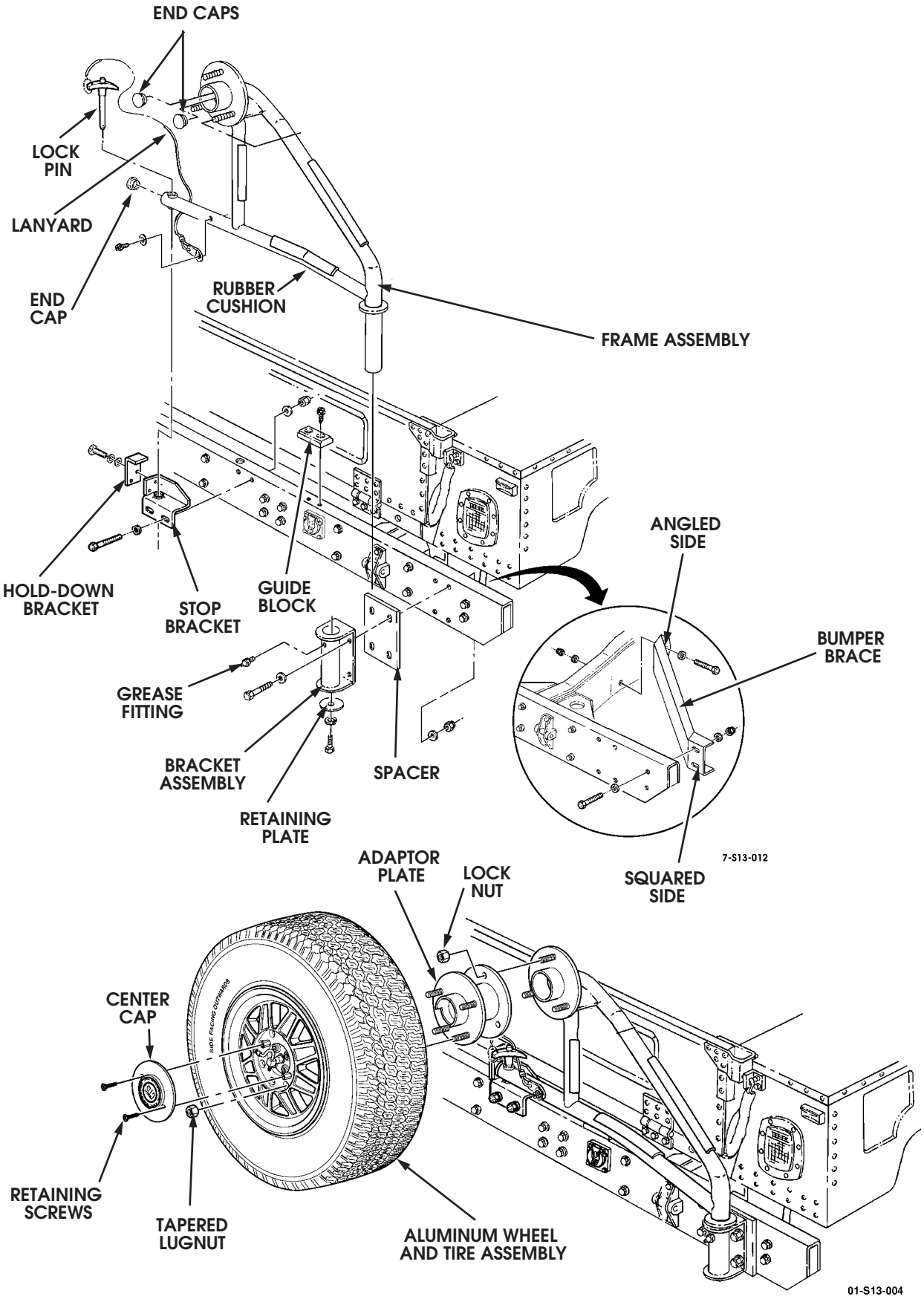


Figure 13-27: Swing-Away Spare Tire Carrier Breakdown

CARGO BED-MOUNTED SPARE TIRE CARRIER REPLACEMENT

WARNING: Always support the tire and wheel assembly when removing the lug nuts. The tire and wheel assembly weighs approximately 160 lbs (72 kgs) and may cause personal injury if it is not supported properly.

NOTE: Cargo bed-mounted spare tire carrier may be located either directly behind the cab or at the left wheelhouse on two door models. On four door models, the spare tire carrier will be located at the left wheelhouse.

Removal

NOTE: Perform steps 1 and 2 on vehicles with frame assembly stowed in the down position.

1. Disconnect the lock pins and raise the frame assembly to the upright position (Figure 13-28).

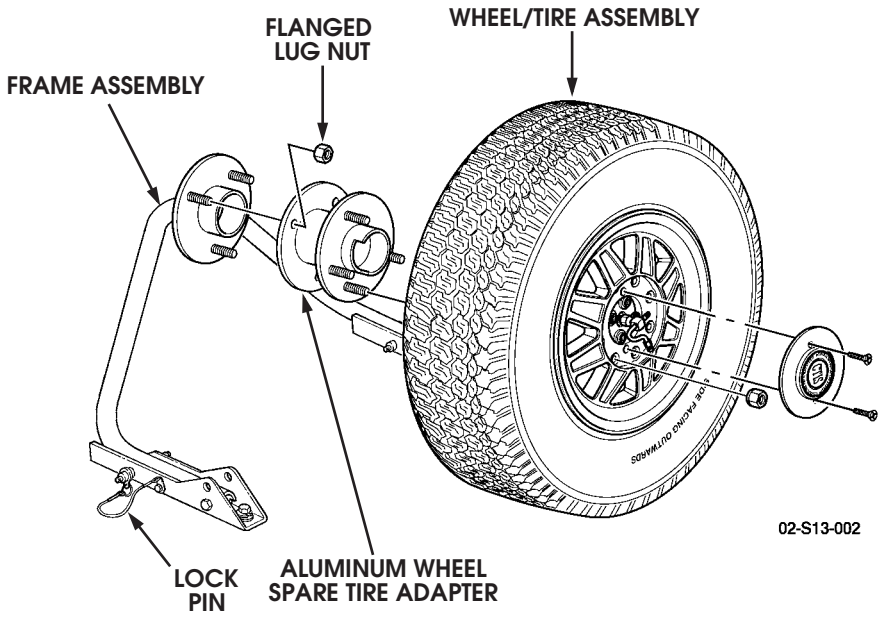


Figure 13-28: Cargo Bed-Mounted Spare Tire Carrier Appearance

2. Secure the frame assembly in the upright position with the lock pins.
3. Remove the lug nuts securing the tire to the frame assembly and remove the wheel/tire assembly.
4. Remove the self-tapping screws, lockwashers, and the lanyard/lock pin assemblies from the mounting brackets (Figure 13-29).
5. Remove the locknuts, bolts and the frame assembly from the mounting brackets.
6. Remove the screws securing the mounting brackets to the cargo floor (Figure 13-30).
7. Remove the bolts, lockwashers, washers, and the mounting brackets from the cargo floor.

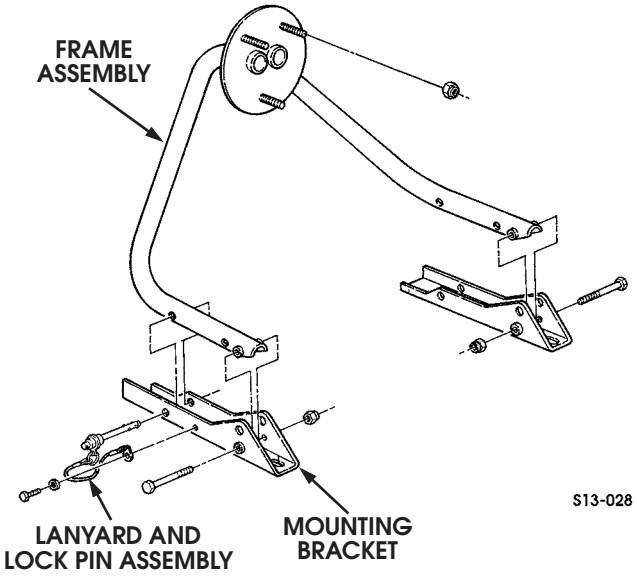


Figure 13-29: Frame Assembly Mounting

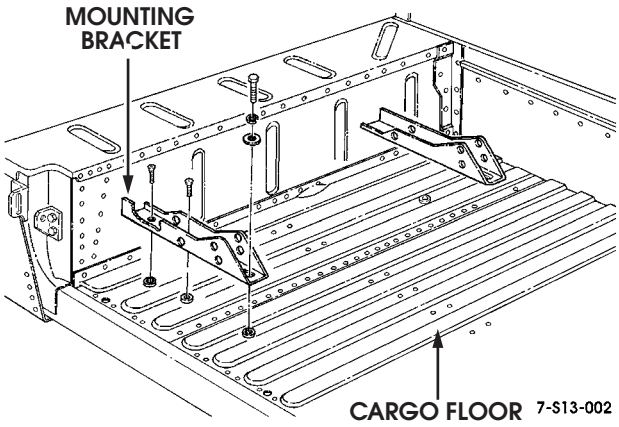


Figure 13-30: Mounting Bracket Positioning

Installation

1. Install the mounting brackets on the cargo floor with the washers, lockwashers, and the bolts (Figure 13-30).
2. Secure the mounting brackets to the cargo floor with the screws. Tighten the screws to 44 lb-ft (60 N•m).
3. Install the frame assembly on the mounting brackets with the bolts and the locknuts (Figure 13-29).
4. Install the lanyard/lock pin assemblies on the mounting brackets and the frame assembly with the lockwashers and the self-tapping screws.
5. With the carrier in the upright position, install the tire on the frame assembly with the three lug nuts (Figure 13-28).

NOTE: Perform steps 6 and 7 to stow frame assembly in down position.

6. Disconnect the lock pins and lower the frame assembly to the down position.
7. Connect the lock pins.

ALUMINUM WHEEL SPARE TIRE CARRIER ADAPTER

Installation

NOTE: This kit is an accessory for the swing-away spare tire carrier PN 5744642 and the bed mounted spare tire carrier PN 5742944. The swing-away or bed mounted spare tire carrier must be installed before this kit can be used. Refer to the installation instructions of the swing-away spare tire carrier on page 13–16 or the bed mounted spare tire carrier on page 13–19 .

1. Install the Aluminum Wheel Spare Tire Carrier Adapter on the mounting flange of the spare tire carrier frame (See Figure 13-31).
2. Secure the Aluminum Wheel Spare Tire Carrier Adapter using the three 9/16" flanged lug nuts that are supplied with the spare tire carrier kit.
3. Install the aluminum spare wheel on the Aluminum Wheel Spare Tire Carrier Adapter securing it with the four supplied tapered lug nuts.
4. Place the caution decal on the angled support bar of the tire carrier frame, just below the cushion.

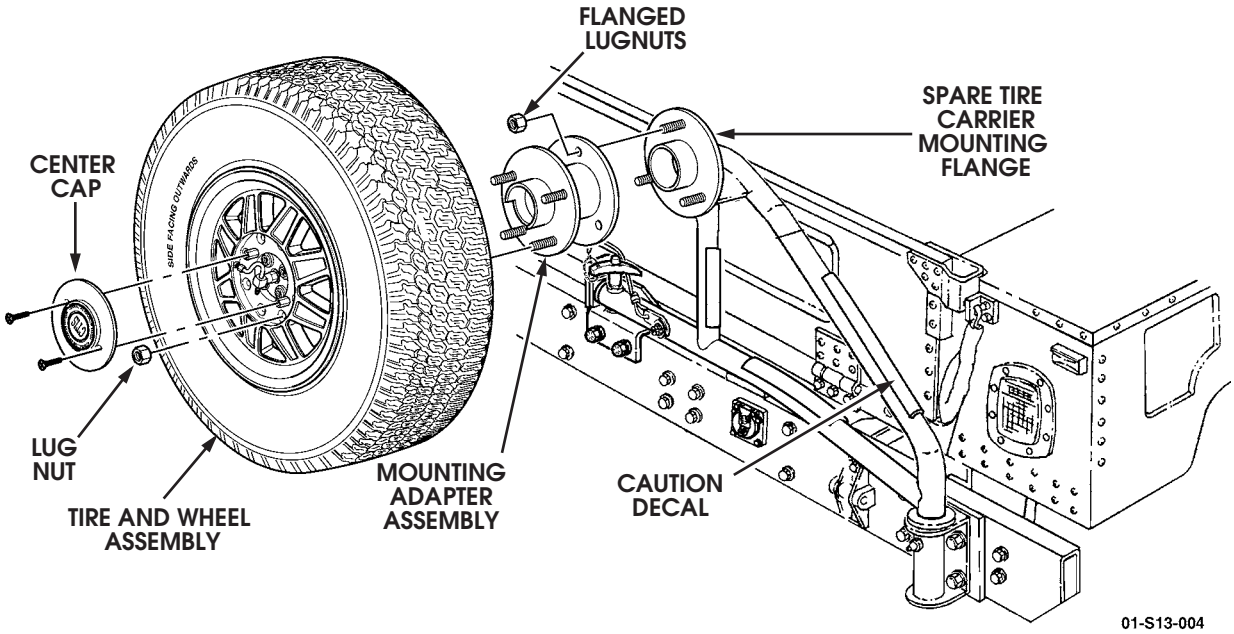


Figure 13-31: Adapter installation.

Trailer Towing

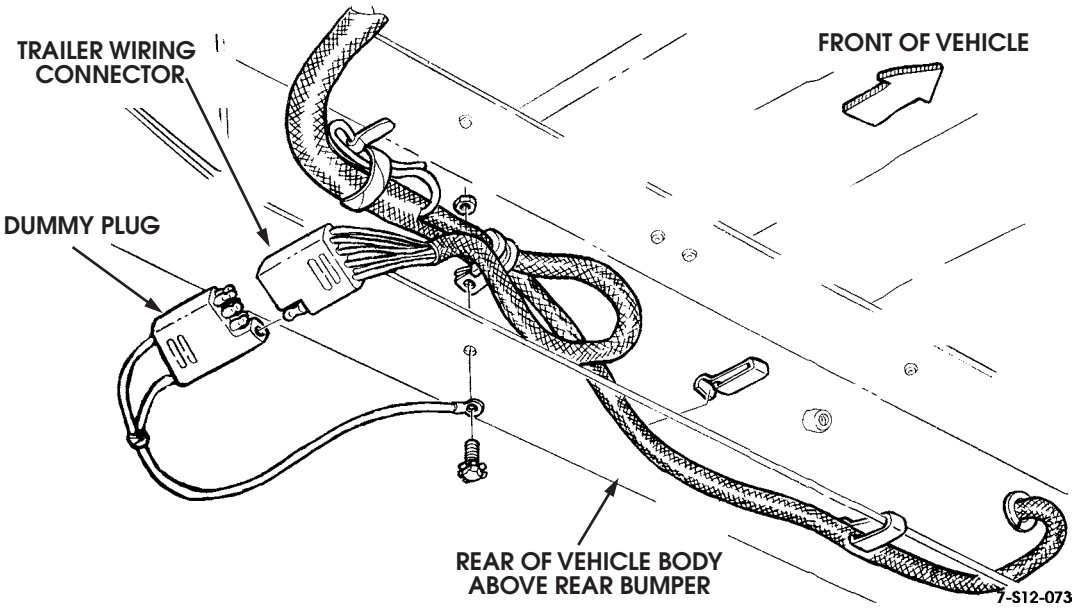


Figure 13-32: Trailer Wiring Connector and Dummy Plug Location

Trailer Jumper Harness

HUMMER H1 vehicles come from the factory equipped for easy installation of the trailer jumper harness. The trailer jumper harness may be installed as part of the factory trailer towing package or an add-on kit. Body wiring harnesses are designed with a trailer wiring connector at the rear of the vehicle body above the rear bumper (Figure 13-32). Rear bumpers are manufactured with a cut-out for the trailer harness receptacle.

Installation

1. Insert the trailer jumper harness through the rear bumper cutout and bolt the receptacle in place (Figure 13-33).
2. Remove the dummy plug and plug the trailer jumper harness connector into the trailer wiring connector.

Trailer Brake Controller

Spare wires have been provided in the body harness and routed from the instrument panel/fuse box area to the trailer connector at the rear of the vehicle. Install the trailer brake controller using the manufacturer's instructions.

The following information about the HUMMER H1 electrical system is necessary for installation:

1. Three shrink-wrapped wire leads can be found under the instrument panel (Figure 13-34), they are:

   Yellow—power

   Red—stop light signal

   Dark blue—trailer brake

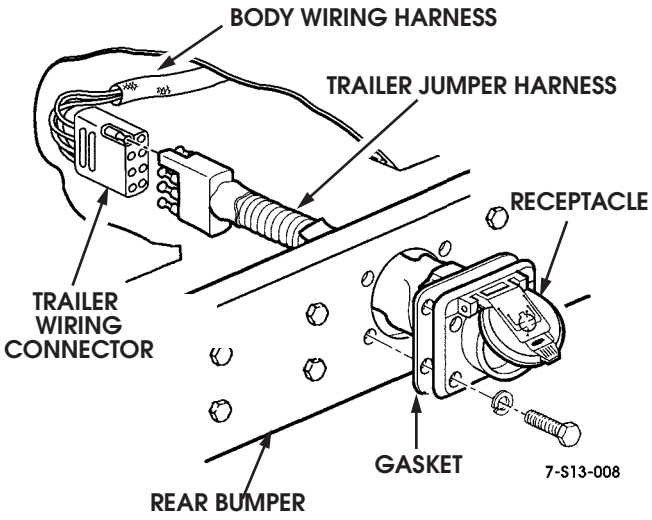


Figure 13-33: Trailer Jumper Harness Mounting

2. The trailer brake circuit will not have power until a fuse (of required amperage) is installed in the fuse block position 7H—the far upper right hand corner of the fuse block.

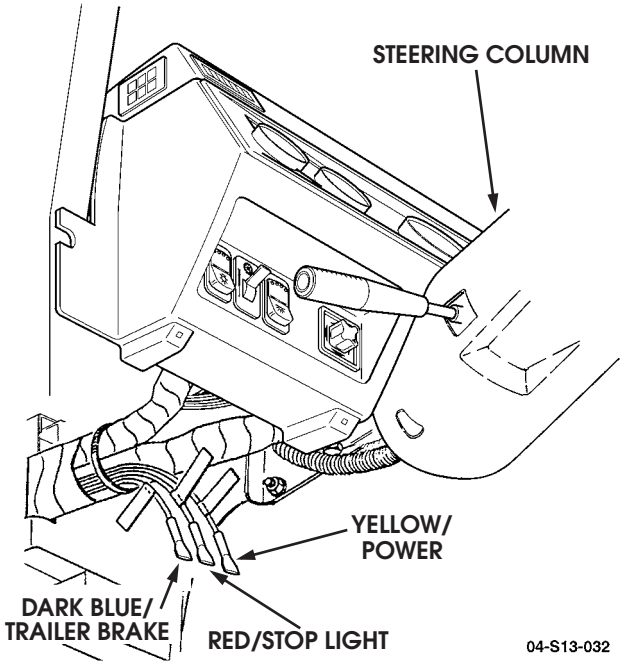


Figure 13-34: Trailer Brake Controller Wiring

TRAILER HITCH REPLACEMENT

Removal

1. Remove the locknuts, washers, receiver assembly mounting blocks, bolts, and the washers from the body mount bracket (Figure 13-35).
2. Remove the bolts, lockwashers, washers from the lower brace weld nuts. Remove the brace from the bumper and the trailer hitch mounting brackets.
3. Remove the bolts, washers, and the trailer hitch from the rear bumper weld nuts.

Installation

1. Position the trailer hitch receiver on the rear bumper and secure with the weld nuts, bolts and the washers (Figure 13-35). Do

not tighten at this time.

2. Secure the trailer hitch to the body mount bracket with the locknuts, washers, receiver assembly mounting blocks, bolts, and the washers.
3. Install the lower brace to the bumper and the trailer hitch mounting bracket with the bolts, lockwashers, washers and the weld nuts.
4. Tighten all the locknuts to 90 lb-ft (122 N•m).

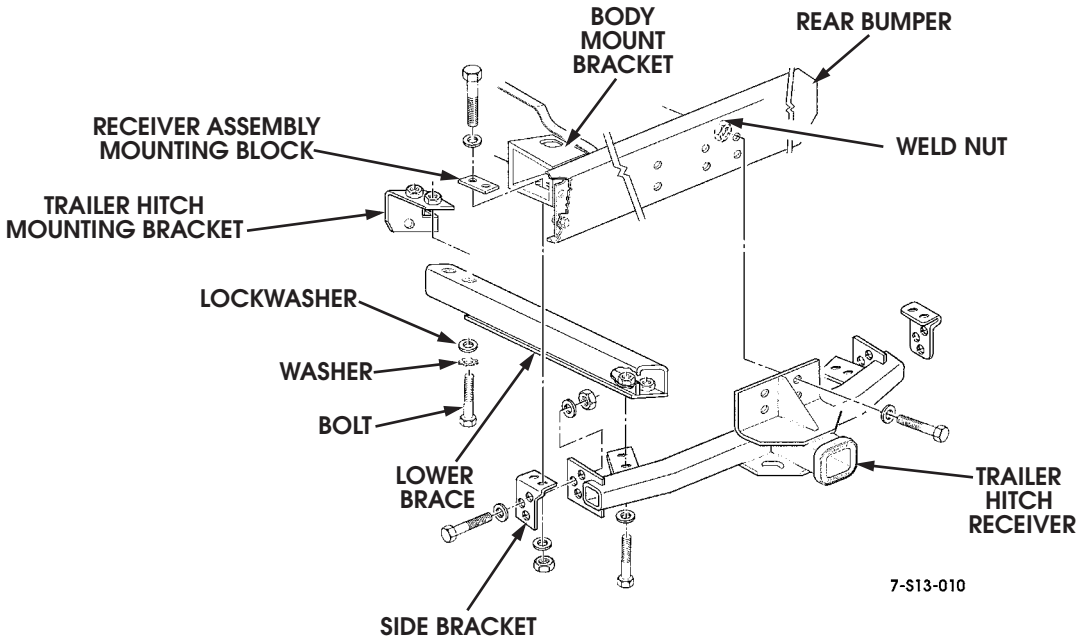


Figure 13-35: Trailer Hitch

SIDE STEP BARS (TUBULAR)

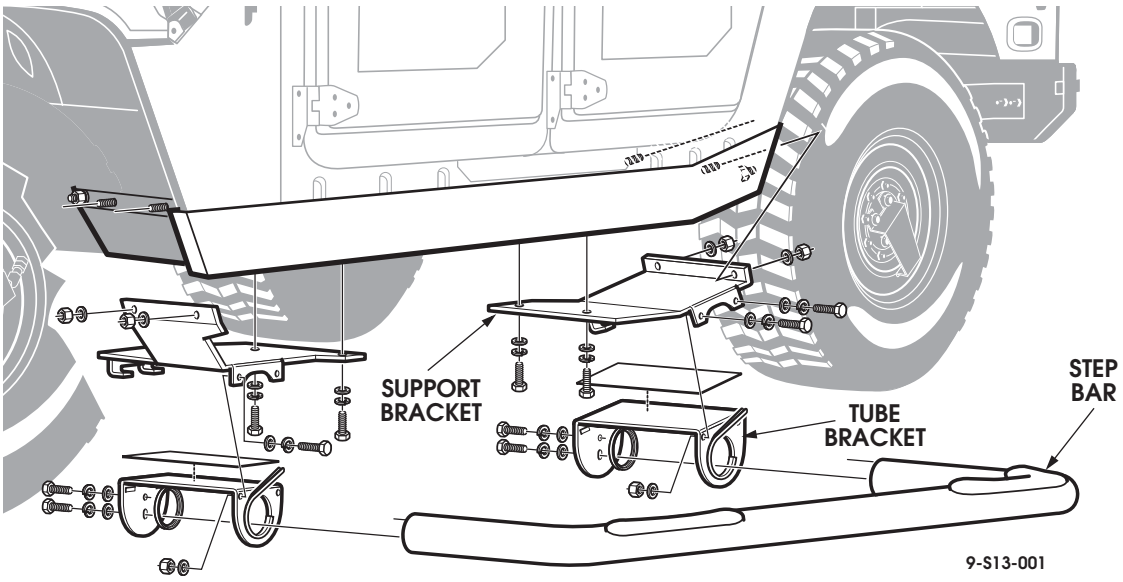


Figure 13-36: Side Step Bar Installation

NOTE: This procedure covers the left side of the vehicle. The procedure for the right side is the same.

Removal

1. Remove the four bolts securing the tube brackets to the support brackets (See Figure 13-36).
2. Swing the step bar and the angle bracket assembly down, disengage the tube brackets from the support brackets and remove the assembly.
3. Remove the four bolts securing the step bar to the tube bracket and slide the step bar and the end cap out of the tube bracket.
4. Remove the two support bracket mounting nuts bolts and the washers in the rear wheel well.
5. Remove the two bolts and the washers going through the rear support bracket into the rocker panel protection floor area and remove the support bracket.
6. Remove the two support bracket mounting nuts bolts and washers in the front wheel well.
7. Remove the two bolts and the washers going through the front support bracket into the rocker panel protection floor area and remove the support bracket.

Installation

1. Install the front and rear support brackets on the rocker panel protection with the bolts, washers and the nuts (See Figure 13-36).
2. Slide the tube brackets onto the bar in their respective positions (angled bracket to the rear).
3. Place the bar end caps on the ends of the bar and install the bolts, washers and the lockwashers through the tube brackets into the bar. Do not tighten at this time.
4. Hang the bar assembly on the tabs of the support brackets, swing the bar up and secure the tube brackets to the support brackets with the bolts, washers, lockwashers and the nuts.
5. Tighten the remaining hardware now.

ROOF RACK

Removal

WARNING: Roof rack is extremely heavy. Several people may be required to remove and install rack safely. Use care in determining ability to lift the rack. Failure to do so may result in injury.

1. Remove the two mounting bolts and adjusting the nut on each “L” bracket (Figure 13-37).
2. Remove the “L” brackets.
3. Remove the rack from the vehicle.

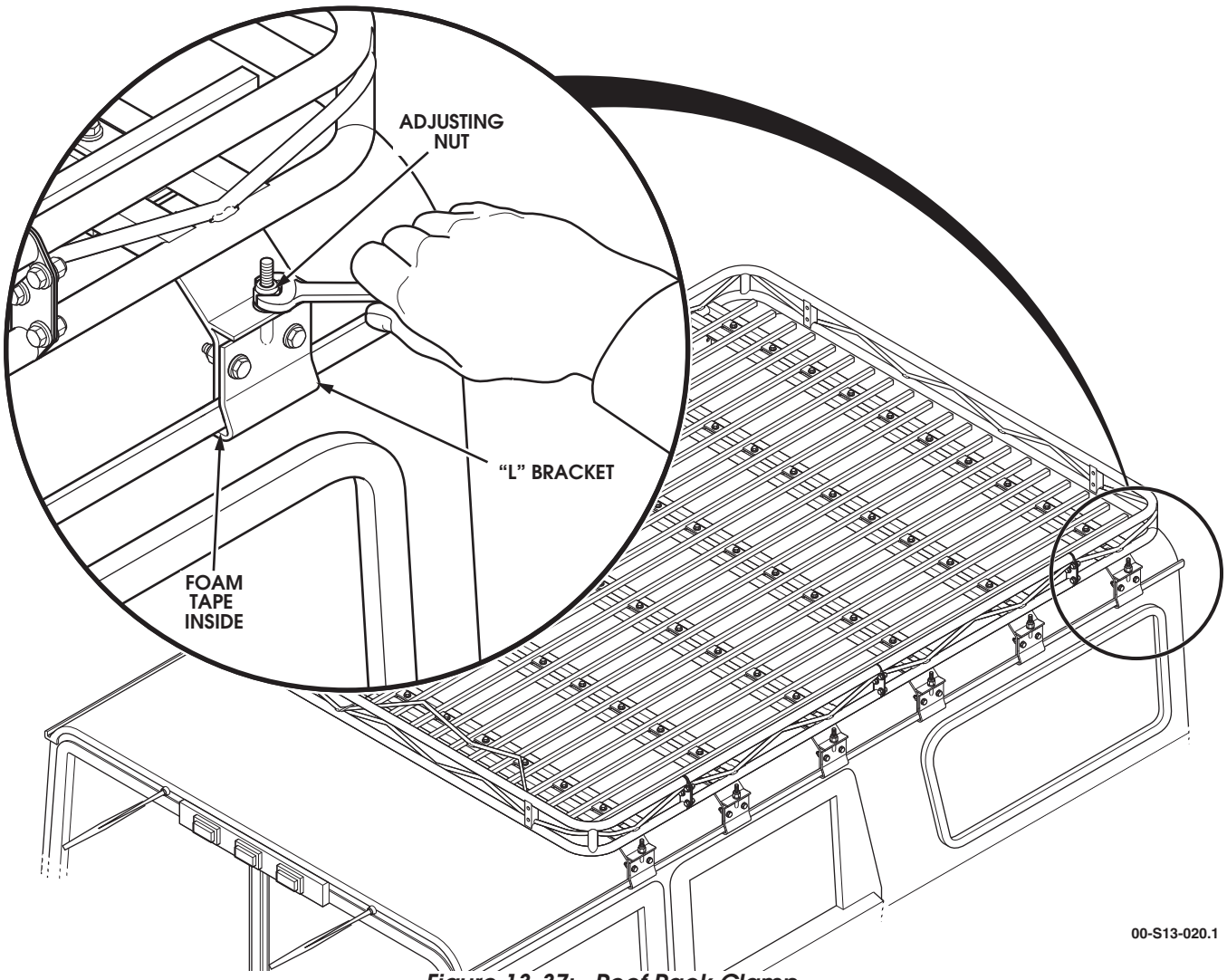


Figure 13-37: Roof Rack Clamp

Installation

CAUTION: *Clamps are made of aluminum. Overtightening may cause the clamps to crack.*

1. With the help of an assistant, place the rack assembly on the rain gutters of the vehicle and adjust it for the best load carrying position, while staying within the confines of the roof edges (Figure 13-37).
2. Cut pieces of foam tape to fit the lower section of the "L" bracket and place on the inside lower portion of the brackets. Reinstall the "L" brackets on the clamp assemblies and lightly snug the "L" bracket retaining bolts.
3. Alternate from side to side and tighten the adjusting nut of each clamp assembly until the clamp assemblies are secure in the rain gutters.

Roof Rack Floor Piece Replacement

Removal

1. Remove the bolts, lockwashers and the nuts holding the floor piece to the mounting points (Figure 13-38).
2. Remove the floor piece.

Installation

1. Align the floor rail assemblies to have a equal distacne between each assembly and tihgten the hardware to 20-25 lb-ft (27-34 N•m).

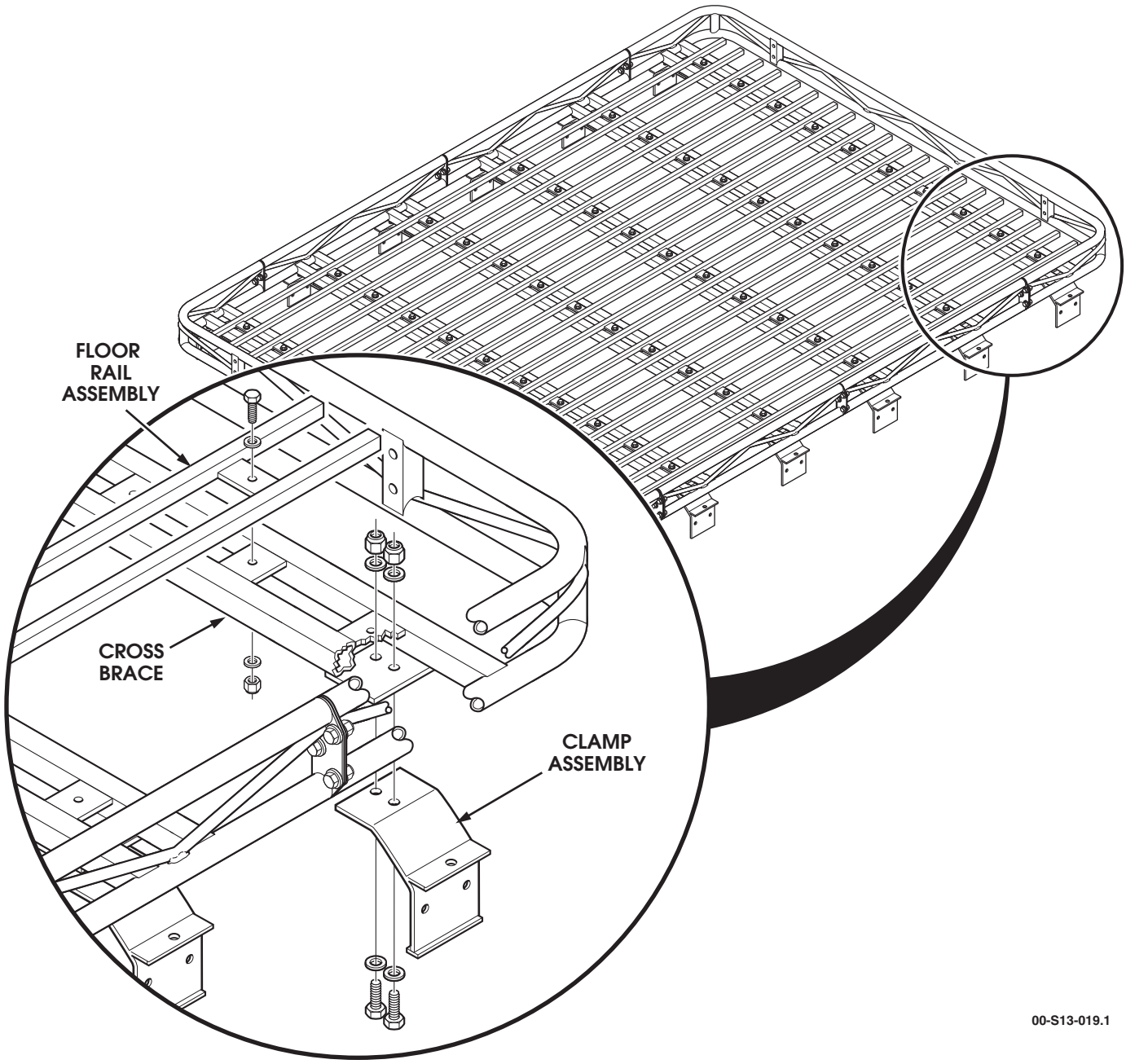


Figure 13-38: Floor Rail and Clamp Assembly

Roof Rack Crossbar Replacement

Removal

1. Remove the roof rack from the vehicle.
2. Remove the floor pieces from the roof rack.
3. Remove the locknuts, washers, bolts, washers, and the crossbar from the sides (Figure 13-39).

Installation

1. Install the crossbar on the sides with the washers, bolts, washers, and the locknuts. Tighten the locknuts to 25 lb-ft (34 N•m) (Figure 13-39).
2. Install the floor pieces on the roof rack.

3. Install the roof rack onto the vehicle.

Roof Rack End Replacement

Removal

Remove the bolts, locknuts, and the rack end from the sides (Figure 13-39).

Installation

Install the rack end with the hardware and tighten the nuts to 20-20 lb-ft (27-34 N•m) (Figure 13-39).

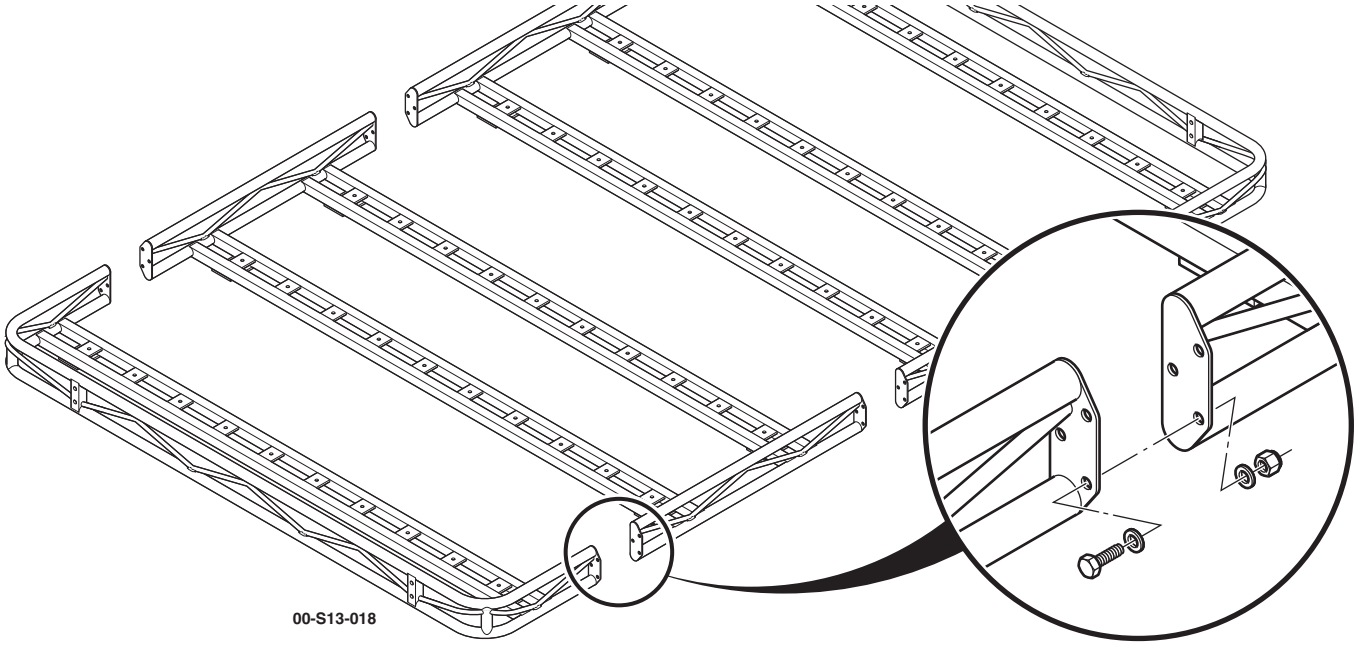


Figure 13-39: End and Center Assembly Layout

SOFT SLANT BACK (MODEL 90)

Removal

1. Unzip the forward portion of the slant back cover from the soft top cover.
2. Release the hook and loop the fasteners on the lower sides and the lower rear of the slant back cover.
3. Release the hook and the loop fasteners on the inside of the cover securing the cover to the support structure.
4. Remove the slant back cover from the slant back support assembly.
5. Release the hook and the loop straps securing the formers to the support structure and remove the formers.
6. Loosen the support structure retaining straps and release the strap hooks from the footman loops.
7. Remove the screws securing the hinge brackets to the wheel houses and remove the support structure.

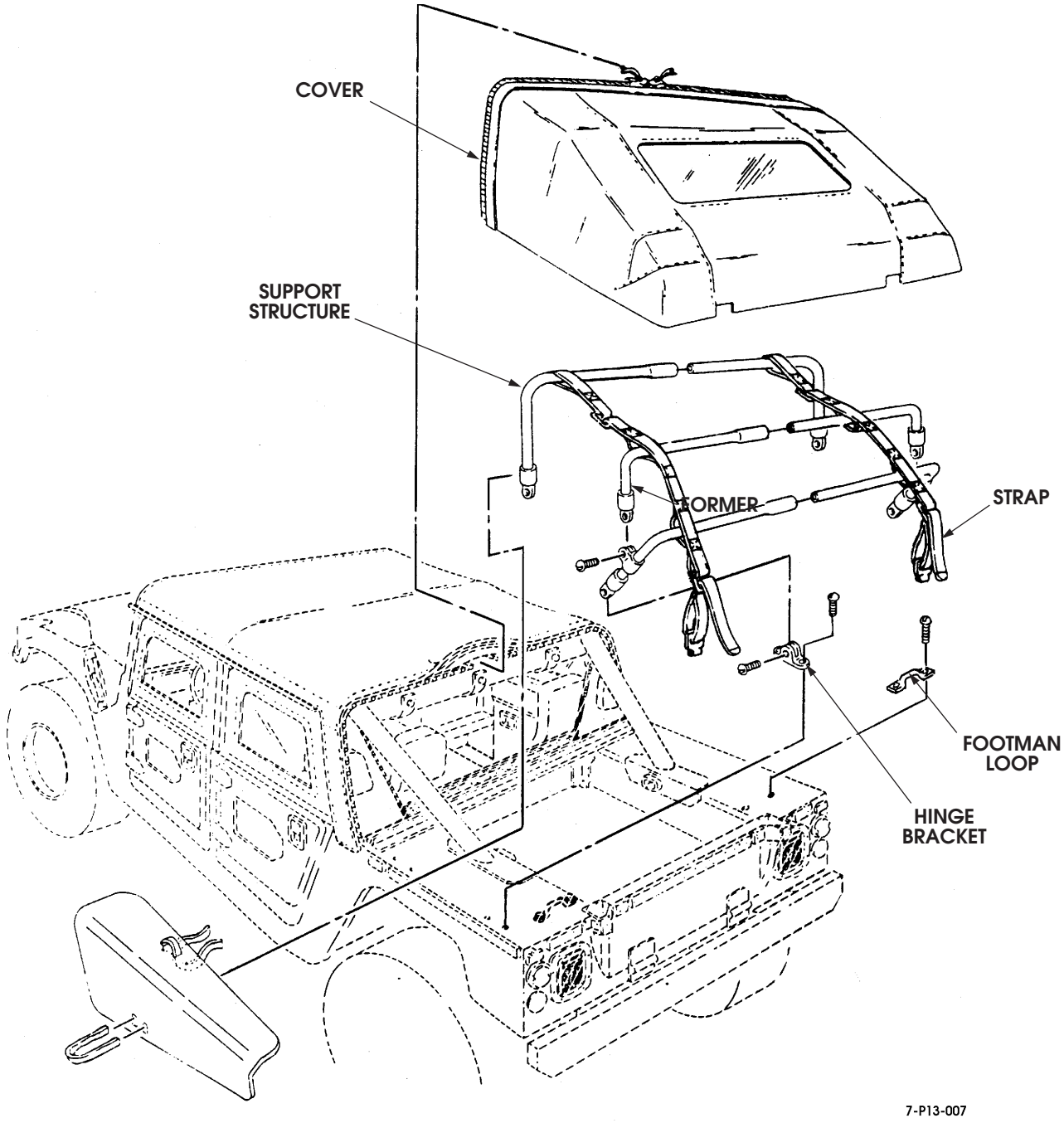


Figure 13-40: Soft Slant Back R & I.

Installation

1. Place the support structure on the wheelhouses and install the screws through the hinge brackets into the wheelhouses.
2. Insert the retaining strap hooks in the footman loops and adjust the retaining straps.
3. Place the formers on the forward top corners of the support structure and secure with the hook and loop straps.
4. Engage the hook and loop fasteners on the inside of the cover.
5. Place the cover on the support structure and zip the forward edge to the soft top cover.
6. Pull the rear edge of the cover tight and engage the hook and loop on the tailgate.
7. Pull the sides of the cover tight and engage the hook and loop on the sides of the wheelhouses.

SOFT SQUARE BACK (MODEL 90)

Removal

1. Unzip the forward portion of the square back cover from the soft top cover.
2. Release the hook and loop fasteners on the lower sides and the lower rear of the square back cover.
3. Release the hook and loop fasteners on the inside of the cover securing the cover to the support structure.
4. Remove the square back cover from the square back support assembly.
5. Loosen the support structure retaining straps and release the strap hooks from the footman loops.
6. Remove the screws securing the hinge brackets to the wheel houses and remove the support structure.

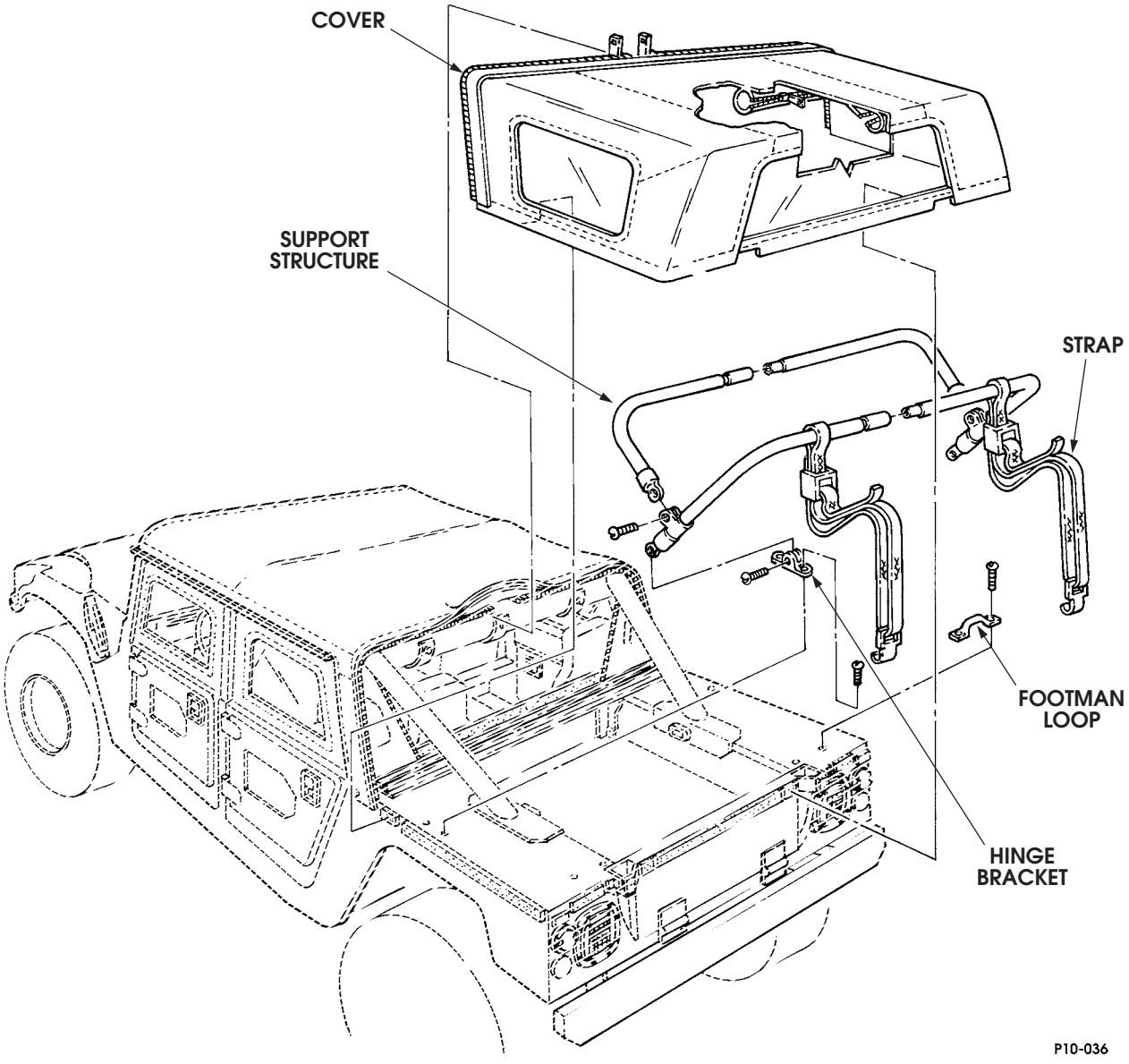


Figure 13-41: Soft Square Back R & I.

Installation

1. Place the support structure on the wheelhouses and install the screws through the hinge brackets into the wheelhouses.
2. Insert the retaining strap hooks in the footman loops and adjust the retaining straps.

3. Place the cover on the support structure and zip the forward edge to the soft top cover.
4. Engage the hook and loop fasteners on the inside of the cover.
5. Pull the rear edge of the cover tight and engage the hook and loop on the tailgate.
6. Pull the sides of the cover tight and engage the hook and loop on the sides of the wheelhouses.

REAR BUMPER CENTER CLOSEOUT PANEL

Installation

NOTE: This panel is designed to be installed with or without the right and left closeout panels.

Center Panel Only:

1. Clean any debris from the bumper and the lower edge of the body.
2. Insert the upper edge of the panel under the body and let the lower edge rest on top of the bumper (See Figure 13-42).

Center the panel on the body and use a non-marring blunt instrument, the rubber coated handle end of a hammer works well, to pop the lower edge of the panel down in front of the bumper.

Center Panel On Vehicles With Side Panels Previously Installed:

1. Clean any debris from the bumper and the lower edge of the body.
2. Hold the center panel up between the side panels and determine if the panel will align properly with the side panels (See Figure 13-42).
   - If the alignment looks good, do the following procedure:
   a. Insert the upper edge of the panel under the body and let the lower edge rest on top of the bumper.
   b. Align the center panel between the side panels and use a non-marring blunt instrument, the rubber coated handle end of a hammer works well, to pop the lower edge of the panel down in front of the bumper. Install two clips per side on the panel flanges to keep the center panel aligned with the side panels.
   - If the alignment does not look good, remove the side panels from the vehicle and attach them to the center panel with the clips supplied.
   a. Center the assembly on the body and use a non-marring blunt instrument, the rubber coated handle end of a hammer works well, to pop the lower edge of the panel down in front of the bumper.
   b. Check the alignment, adjust as necessary and secure the side panels with the supplied pop rivets.

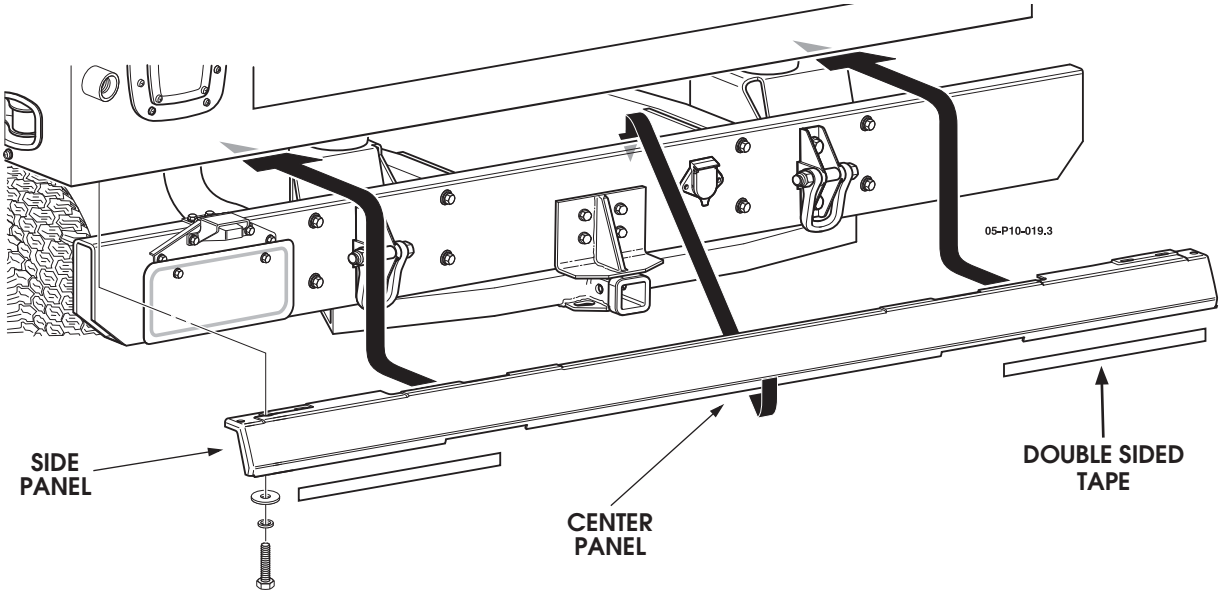


Figure 13-42: Closeout panel installation.

STAINLESS STEEL FRONT BUMPER COVER (WITH BRUSHGAURD AND W/O WINCH)

Removal

1. Remove the two bolts and the licence plate mount bracket (See Figure 13-43).
2. Remove the four bolts, washers and the two tow bracket/lifting the shackle assemblies.
3. Pull the SS cover free from the bumper and clean the double sided foam tape from the cover and bumper.

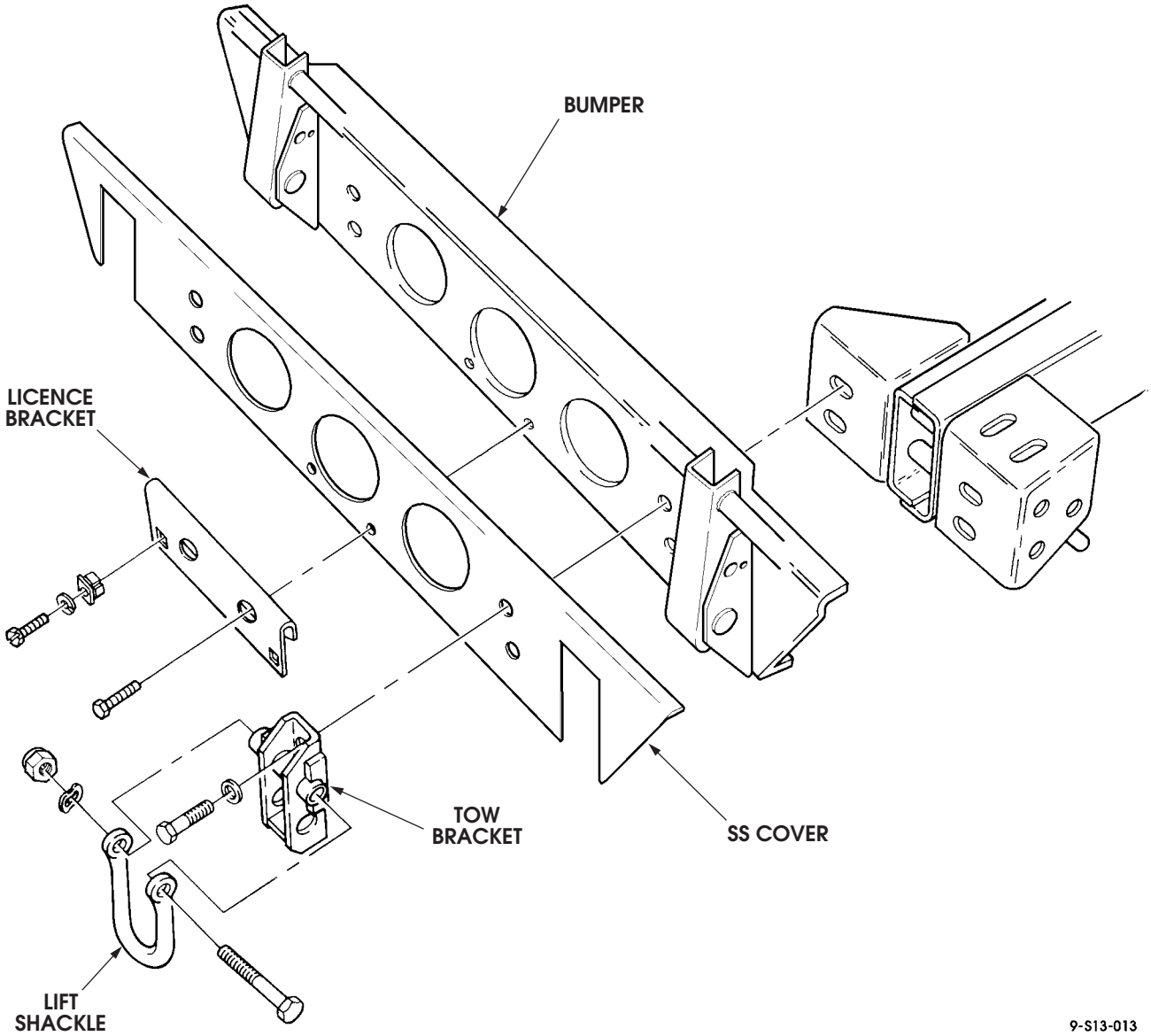


Figure 13-43: SS Front Bumper Cover W/O Winch

Installation

1. Clean all grease and dirt from the front bumper and cover and prep the surfaces with alcohol.
2. Apply new double sided foam tape to the back of the cover and press the cover on the bumper.
3. Install the two tow bracket/lifting shackle assemblies, four bolts and the washers. Torque the bolts to 90 lb-ft (122 N•m).
4. Install the licence plate mounting bracket with the two bolts and torque to 8-13 lb-ft (11-18 N•m).

STAINLESS STEEL FRONT BUMPER COVER (WITH WINCH)

Removal

1. Remove the two bolts and the licence plate mount bracket (See Figure 13-44).
2. Remove the four bolts, washers and the two tow bracket/lifting shackle assemblies.
3. Support the winch and remove the bolts and the washers securing the bumper to the winch.
4. Pull the cover free from the bumper and clean the double sided foam tape from the bumper and cover.

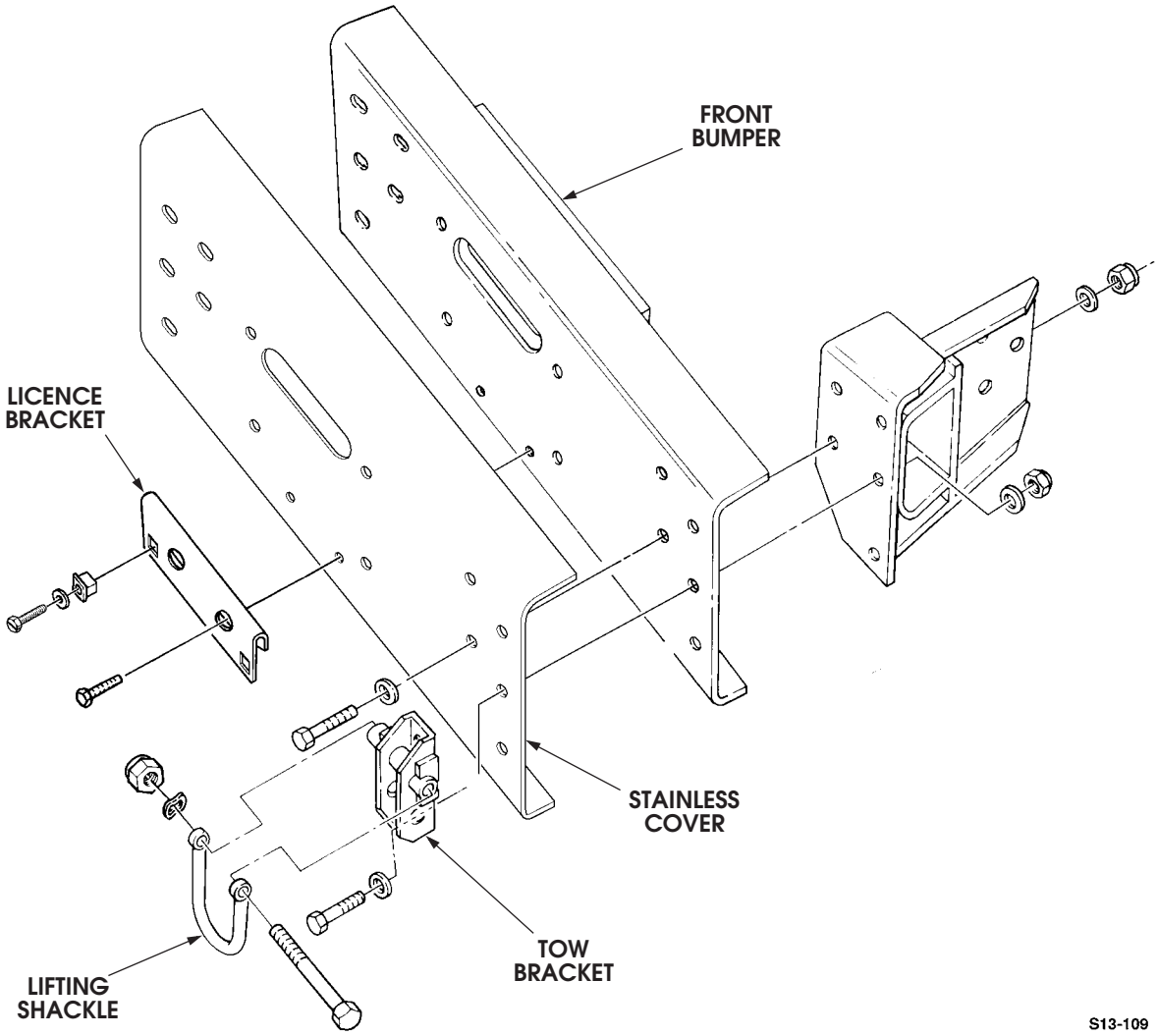


Figure 13-44: SS Front Bumper Cover W/Winch

Installation

1. Clean all grease and dirt from the front bumper and cover and prep the surfaces with alcohol.
2. Apply new double sided foam tape to the back of the cover and press the cover on the bumper.
3. Install the two tow bracket/lifting shackle assemblies, four bolts and the washers. Torque the bolts to 90 lb-ft (122 N•m).
4. Install the winch mounting bolts and the washers. Torque to 60 lb-ft (81 N•m).
5. Install the licence plate mounting bracket with the two bolts and torque to 8-13 lb-ft (11-18 N•m).

STAINLESS STEEL REAR BUMPER COVER

Removal

1. Remove the two bolts and the licence plate mount bracket (See Figure 13-45).

2. Remove the four bolts, washers and the two tow bracket/lifting shackle assemblies.
3. Remove the bolt covers from the bolt heads.
4. Pull the SS cover free from the bumper and clean the double sided foam tape from the cover and bumper.

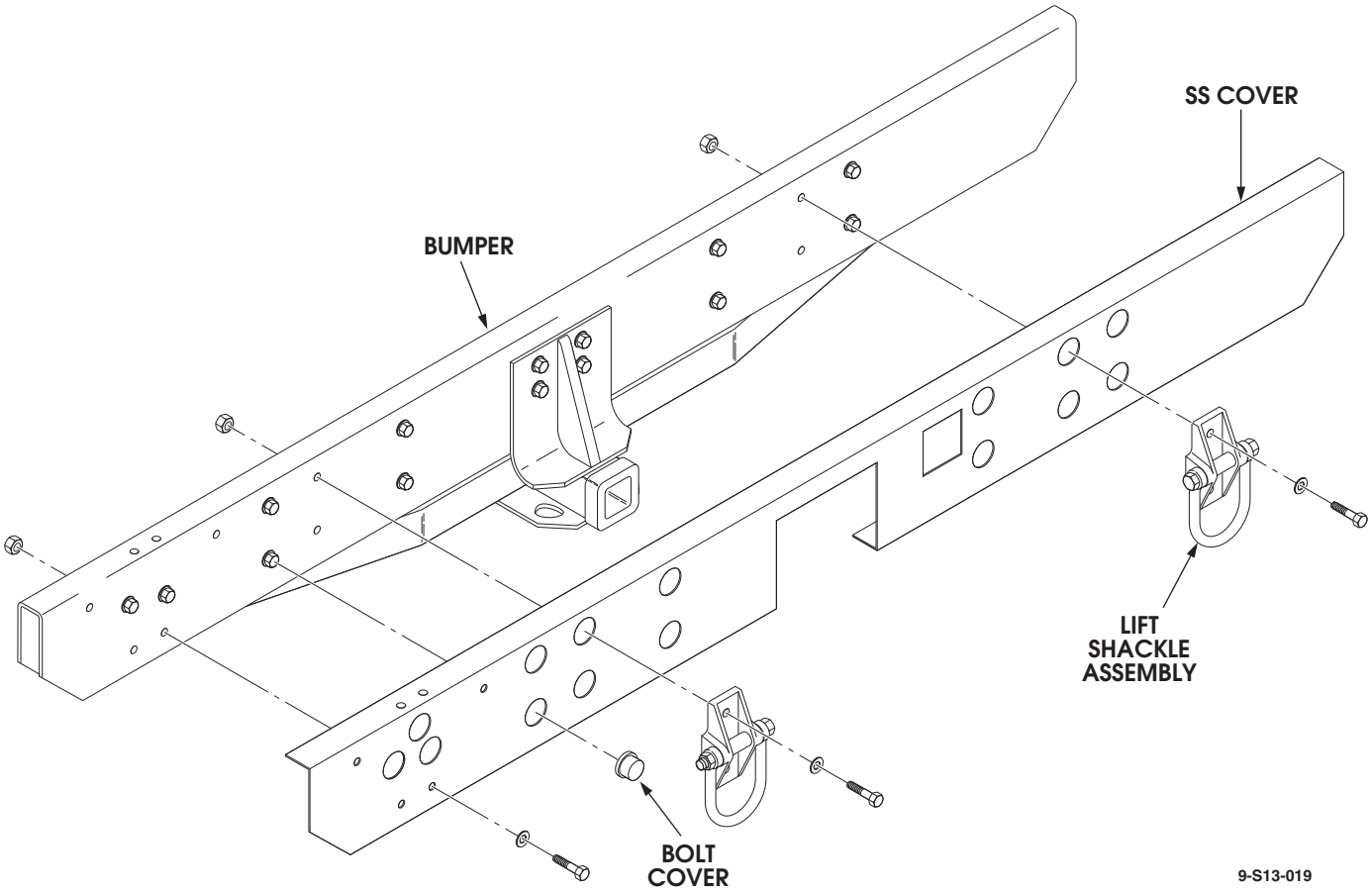


Figure 13-45: SS Rear Bumper Cover

Installation

1. Clean all grease and dirt from the front bumper and cover and prep the surfaces with alcohol.
2. Apply new double sided foam tape to the back of the cover and press the cover on the bumper.
3. Install two tow bracket/lifting shackle assemblies, four bolts and washers. Torque the bolts to 90 lb-ft (122 N•m).
4. Install the licence plate mounting bracket with two bolts and torque to 8-13 lb-ft (11-18 N•m).
5. Install the bolt covers on the bolt heads.

TAILGATE HINGE TRIM

1. Clean all grease, dirt and loose paint from the hinges and prep the surface with alcohol to ensure a good bond to the double-sided tape on the trim.
2. Test fit the stainless steel trim to the hinges before removing the backing on the double-sided tape (See Figure 13-46).
3. Peel the backing off the double-sided tape and place the stainless steel trim on the hinges. Hold pressure over the taped areas for 30 seconds to one minute.
4. Keep the vehicle dry for 24 hours allowing the double-sided tape adhesive to fully cure.

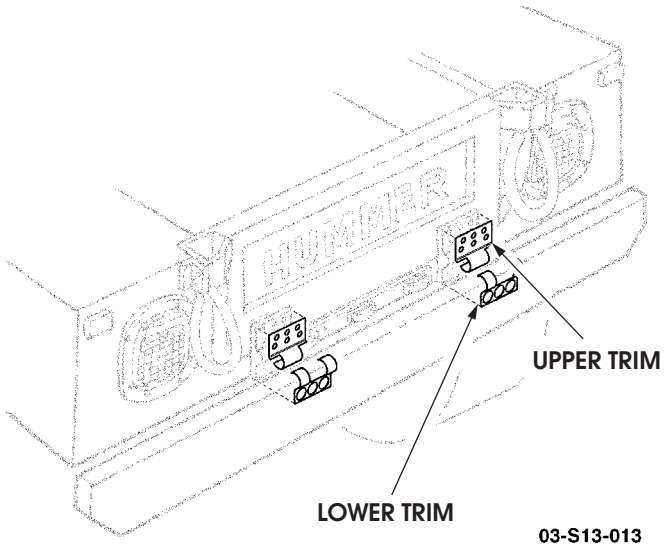


Figure 13-46: Tailgate hinge trim installation.

STAINLESS STEEL HOOD TRIM

Installation

1. Clean all grease, dirt and loose paint from the hood front corner area and prep the surface with alcohol to ensure a good bond to the double-sided tape on the trim.
2. Test fit the stainless steel trim to the hood front corner area before removing the backing on the double-sided tape (See Figure 13-47).
3. Peel the backing off the double-sided tape and place the stainless steel trim on the hood front corner area. Hold pressure over the taped areas for 30 seconds to one minute.
4. Peel the protective coating off the trim and keep the vehicle dry for 24 hours allowing the double-sided tape adhesive to fully cure.

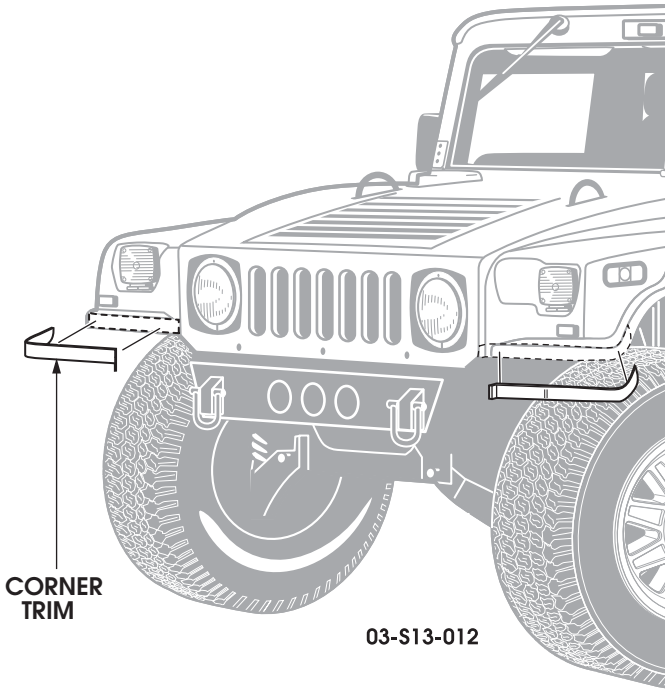


Figure 13-47: Hood corner trim installation.

STAINLESS STEEL HOOD LATCH TRIM

Installation

1. Clean all grease, dirt and loose paint from the hood latch handles and prep the surface with alcohol to ensure a good bond to the double-sided tape on the trim.
2. Test fit the stainless steel trim to the hood latch handles before removing the backing on the double-sided tape (See Figure 13-48).
3. Peel the backing off the double-sided tape and place the stainless steel trim on the hood latch handles. Hold pressure over the taped areas for 30 seconds to one minute.
4. Keep the vehicle dry for 24 hours allowing the double-sided tape adhesive to fully cure.

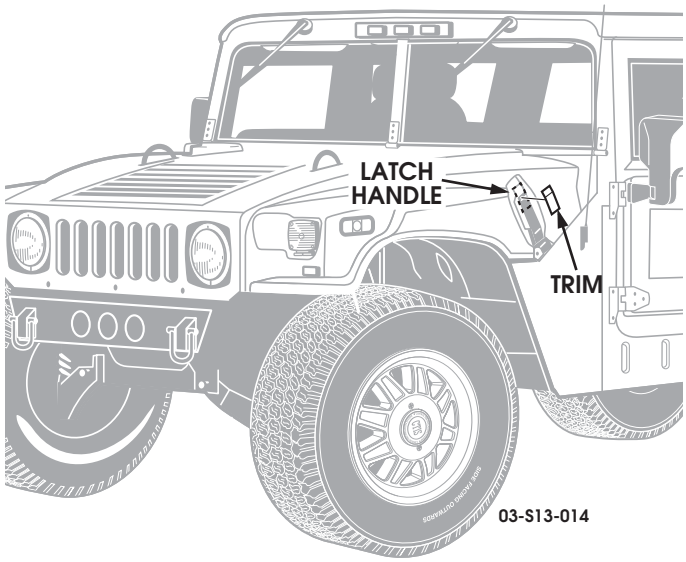


Figure 13-48: Hood Latch Trim installation.

STAINLESS STEEL UPPER GRILLE COVER REPLACEMENT

Removal

1. Remove the six screws, washers and the nuts securing the SS grille frame to the original grille frame and remove the SS grille frame (See Figure 13-49).

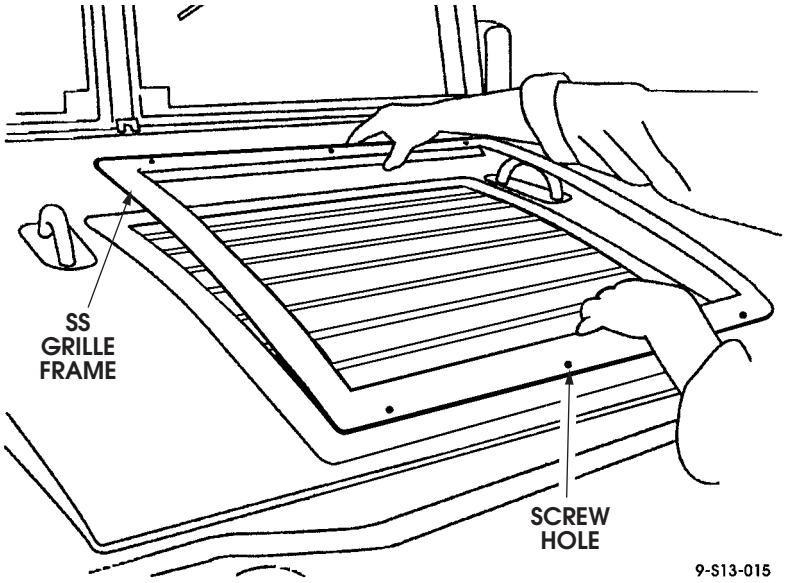


Figure 13-49: SS Upper Grille Frame R&I

2. Peel the eight SS grille slats off from the original grill slats and remove the double-sided tape with an adhesive remover.

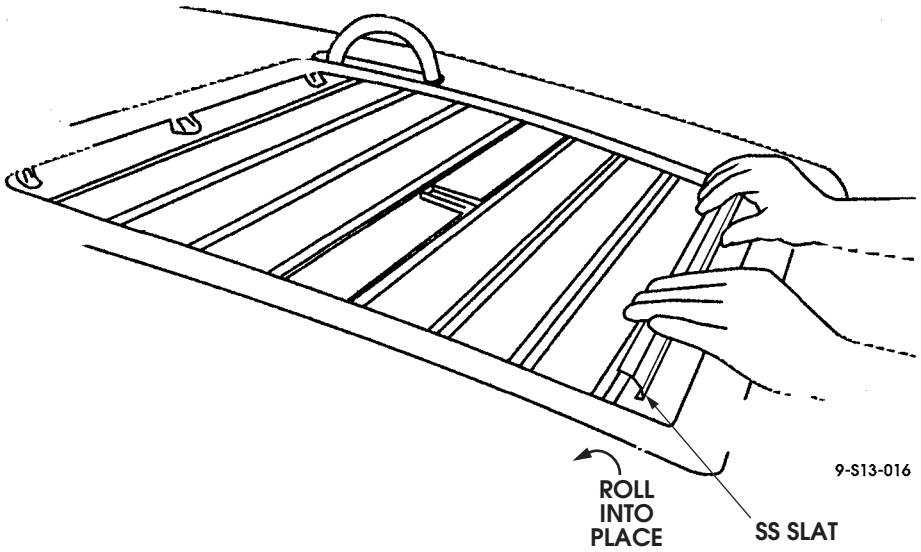


Figure 13-50: SS Upper Grille Slat R&I

Installation

1. Clean all the original and the SS grille slats with alcohol.
2. Place the SS grille frame over the original grille frame and loosely install the six SS screws, washers and nuts.
3. Use an alternate tightening sequence and torque the screws to 7 lb-ft (9 N•m).
4. Place two 3 inch pieces of double-sided tape on the back side of the eight SS slats, approximately 2 inches from each end of the slat.
5. Starting with the bottom grille slat, peel the backing off the double-sided tape and hook the front edge of the SS slat on the front edge of the original slat and roll the SS slat into place. Press and hold momentarily to ensure a good bond.
6. Continue installing the remaining slats noting that the fourth slat has the tab to cover the grille mesh mounting screw area.

STAINLESS STEEL HITCH RECEIVER APPLIQUE

Installation

1. Clean all grease, dirt and loose paint from the trailer hitch receiver area and prep the surface with alcohol to ensure a good bond to the double-sided tape on the trim.
2. Test fit the stainless steel trim to the receiver area before removing the backing on the double-sided tape (See Figure 13-51).
3. Peel the backing off the double-sided tape and place the stainless steel trim on the receiver. Hold pressure over the taped areas for 30 seconds to one minute.
4. Peel the protective coating off the trim and attach the load rating label to the face of the applique.
5. Keep the vehicle dry for 24 hours allowing the double-sided tape adhesive to fully cure.

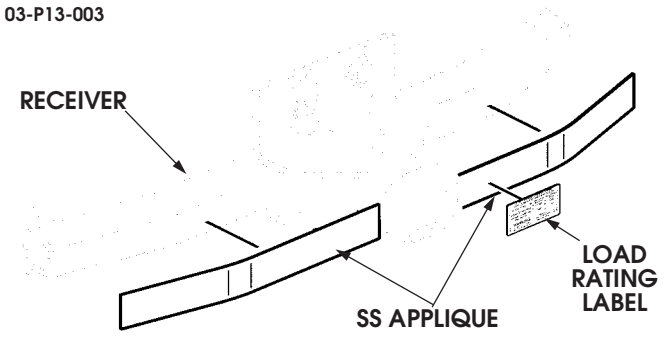


Figure 13-51: Stainless steel receiver trim installation.

BRUSHGUARD ASSEMBLY REPLACEMENT

NOTE: Brushguard assemblies may be used on vehicles with or without a winch assembly. The following procedure applies to vehicles with a winch assembly.

Removal

1. Have an assistant hold the brushguard while removing the four bolts, nuts and eight washers securing the brushguard mount brackets to the frame brackets13-52.
2. Remove the brushguard assembly.

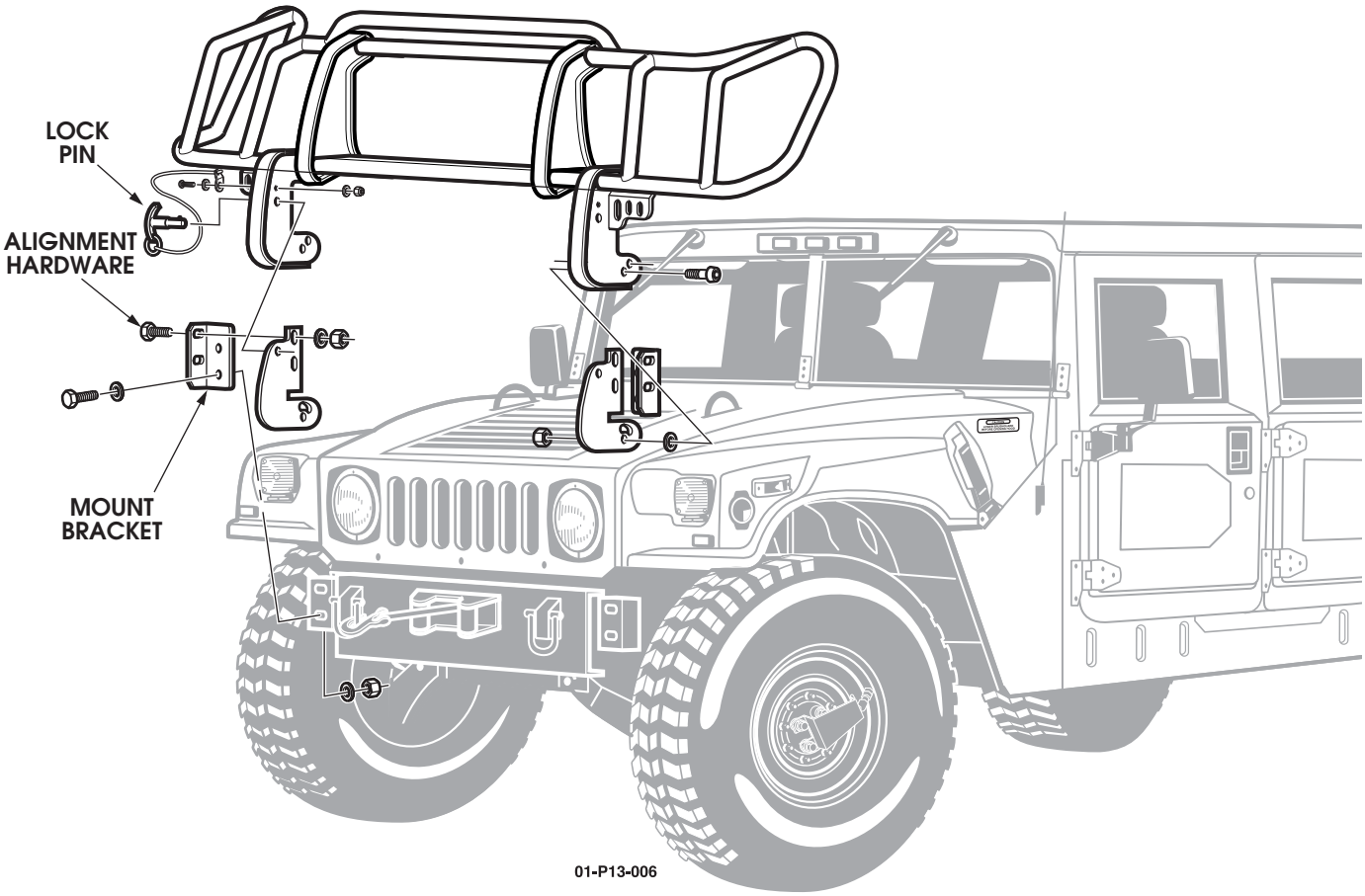


Figure 13-52: Brushguard Installation (Vehicle w/Winch Shown)

Installation

1. Using an assistant, place the brushguard on the frame brackets or bumper if the vehicle does not have a winch, and install four bolts, nuts and washers. Torque the hardware to 81-99 lb-ft (110-134 N•m).
2. Check the brushguard for level and equal, side to side, spacing from the hood. If adjustment is necessary, loosen the four alignment bolts and move the brushguard accordingly. Tighten the alignment hardware to 81-99 lb-ft (110-134 N•m).
3. Remove the lock pins and check for free movement and clearance to the roller fairlead if equipped. Adjust as needed and reinstall the lock pins.

BRUSHGUARD ASSEMBLY REPLACEMENT

NOTE: Brushguard assemblies may be used on vehicles with or without a winch assembly. The following procedure applies to vehicles with a winch assembly.

Removal

1. Have an assistant hold the brushguard while removing the four bolts, nuts and eight washers securing the brushguard mount

brackets to the frame brackets (Figure 13-52).

2. Remove the brushguard assembly.

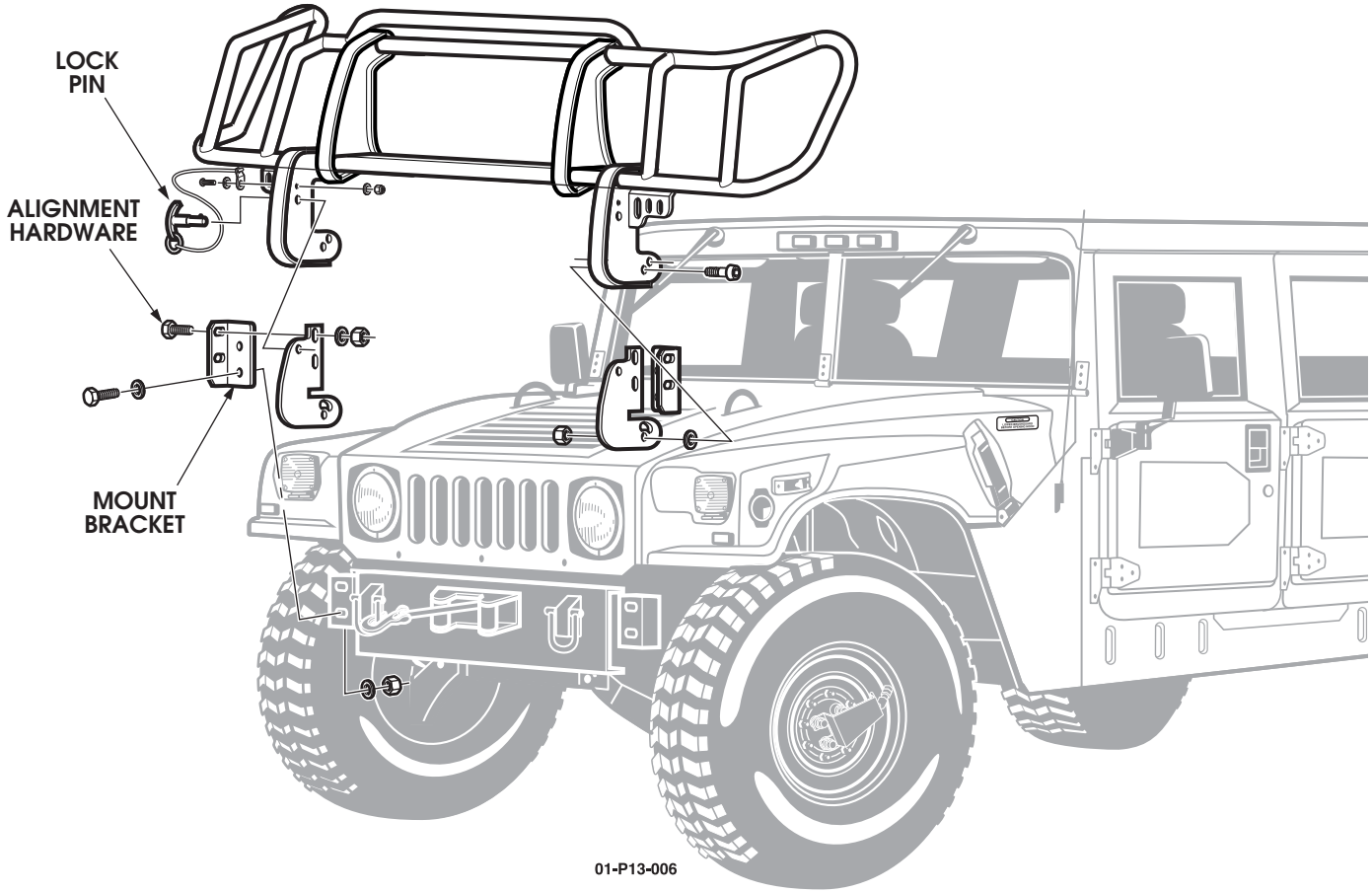


Figure 13-53: Brushguard Installation (Vehicle w/Winch Shown)

Installation

1. Using an assistant, place the brushguard on the frame brackets or bumper if the vehicle does not have a winch, and install four bolts, nuts and washers. Torque the hardware to 81-99 lb-ft (110-134 N•m).
2. Check the brushguard for level and equal, side to side, spacing from the hood. If adjustment is necessary, loosen the four alignment bolts and move the brushguard accordingly. Tighten the alignment hardware to 81-99 lb-ft (110-134 N•m).
3. Remove the lock pins and check for free movement and clearance to the roller fairlead if equipped. Adjust as needed and reinstall the lock pins.

FENDER FLARES

Front Fender Flares

Installation

1. Clean the debris from the wheel well opening.

NOTE: RTV compound may be used between the flares and the wheel well openings to maintain a 100% seal against water and fine grit.

2. Align the fender flares with the wheel well opening to locate the best position for installation (See Figure 13-54).

NOTE: Dimples have been placed in the fender flares to provide a reference for spacing of the large-flange rivets. You may need to adjust the drilling position slightly inboard or outboard to maintain adequate material in the wheel well opening for the rivets to grasp.

CAUTION: *Use a drill stop to keep from drilling through the hood outer skin.*

3. Locate the center of the fender flare radius and drill a 3/16” hole through the fender flare and the hood substructure.
4. Install a 3/16” large-flange pop rivet in the hole and secure the rivet.
5. Install two evenly spaced rivets in the remaining rear half of the fender flare.
6. Remove the outboard screw from the clearance light access panel and discard.
7. Using the supplied screw, install the front L-bracket to the back of the access panel and against the flare.
8. The bracket should pinch the fender flare to the inside of the wheel well opening (See Figure 13-54).
9. The lower fender flare extension for the front should be installed on the rear side of the front wheel well opening. The extensions have been dimpled to provide drill and rivet installation points.

Rear Fender Flares

Installation

1. Clean the debris from the wheel well opening.
2. Align the fender flares and extensions with the wheel well opening to locate the best position for installation. The lower fender flare extension should be installed on the front of the rear wheel well opening.
3. Position the fender flares and extensions in the wheel wells so the inner edge aligns with the inner lip of the wheel well openings.

NOTE: Dimples have been placed in the fender flare to provide a reference for installation of the large-flange rivets.

4. Drill a 3/16” hole in the front of the fender flares and install a 3/16” large-flange rivet.
5. Install 4 more rivets in the fender flares working from the front to the rear.
6. Install the rear fender flare extensions using the dimples as a reference for the large-flange rivet placement.

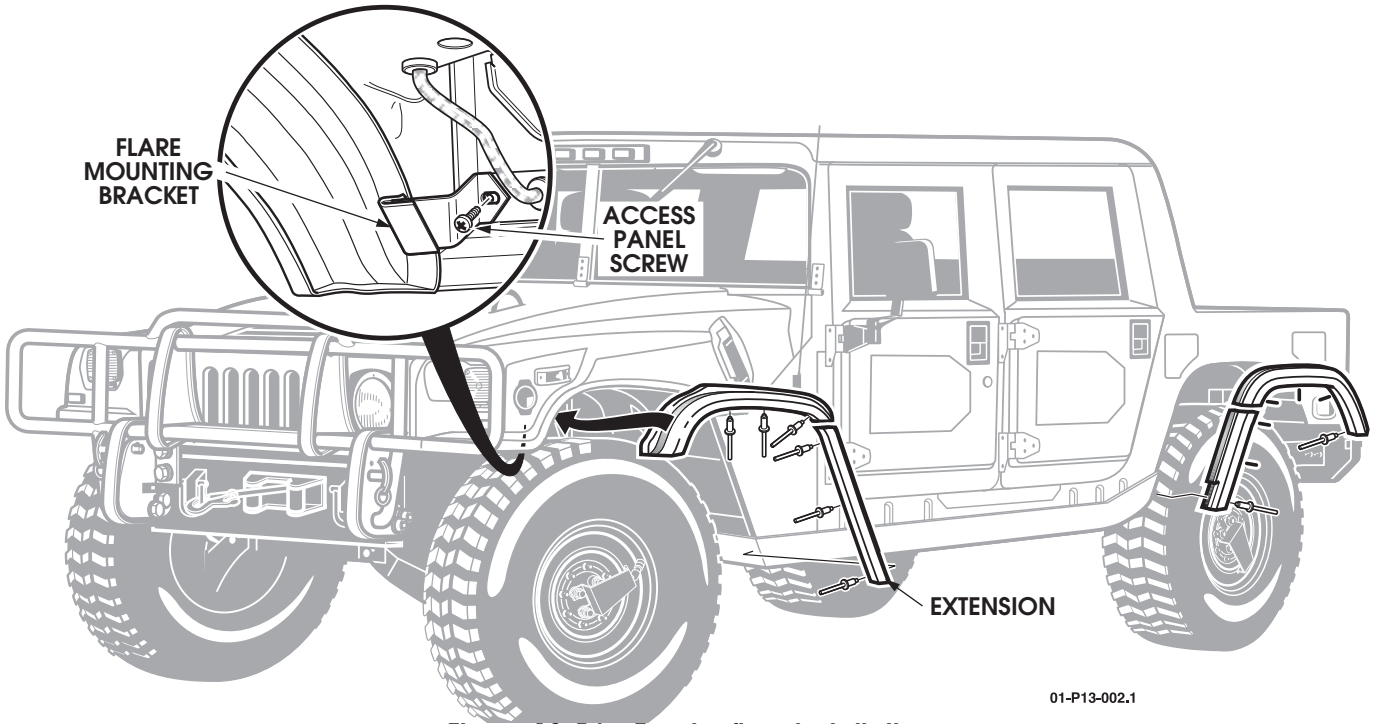


Figure 13-54: Fender flare installation.

AIR RESTRICTION GAUGE

Removal

1. Disconnect the hose from the air restriction gauge and the hose barb in the air cleaner and remove the hose (Figure 13-55).
2. Remove two screws securing the gauge and bezel to the mounting bracket and remove the gauge and bezel.
3. Remove the hose barb from the air cleaner housing.
4. Using a 1/8” drill bit, drill out two rivets securing the mounting bracket to the A-frame and remove the mounting bracket.

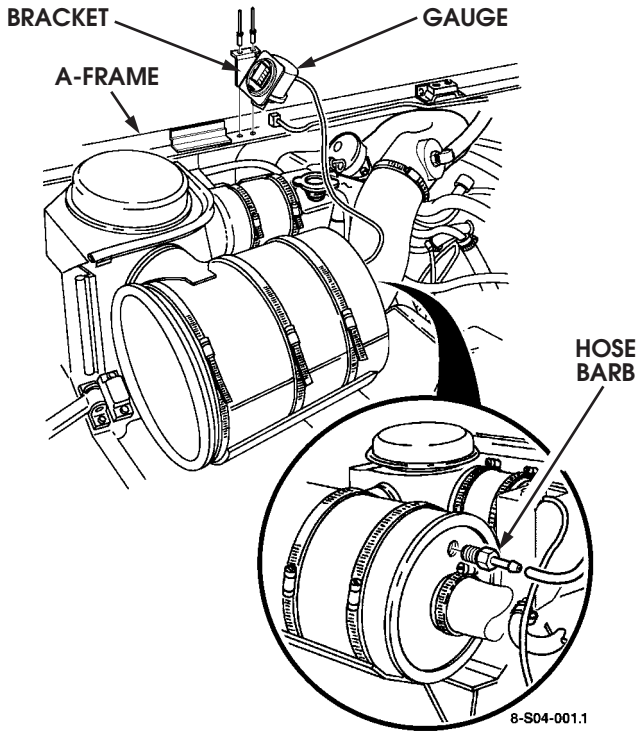


Figure 13-55: Air Filter Restriction Gauge Mounting

Installation

1. Position the mounting bracket on the A-frame and secure with two 1/8” pop rivets.
2. Install the air restriction gauge from the engine side and the bezel from the street side of the bracket and secure with two screws through the bezel into the gauge.
3. Use pipe thread sealant (Loctite 592) and install the brass hose barb in the air cleaner housing.
4. Install the hose from the gauge to the hose barb in the air cleaner housing.

HOURMETER

By tying into the fuel pump relay hot lead, the hourmeter records engine running time. This is especially useful in fleet applications where vehicles experience extensive idling. The electrical connector is wired into the engine harness, ready for hourmeter installation.

Removal

1. Remove the left side cowl cover13-56.
2. Pull the tabs on either side of the spring clip while simultaneously pulling the spring clip away from the mounting bracket (Figure 13-56).

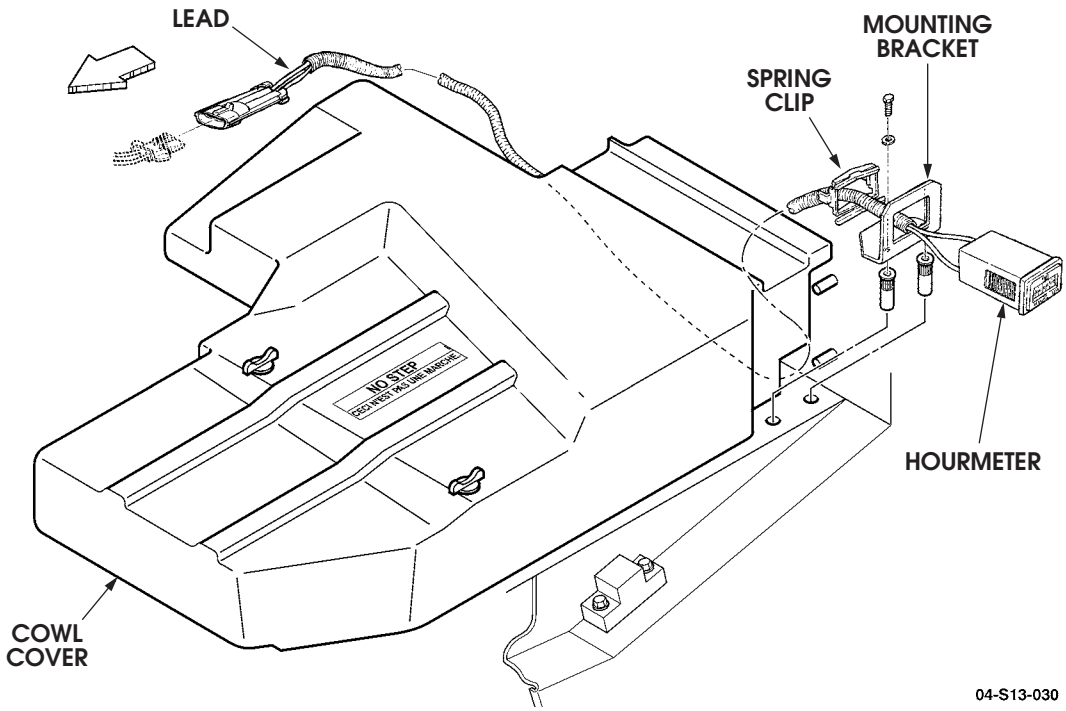


Figure 13-56: Hourmeter Removal

3. Pull the hourmeter out of the mounting bracket far enough to access the mounting bracket bolts.
4. Remove the bolts and the washers securing the mounting bracket to the cowl.
5. Follow the lead from the hourmeter to the electrical connectors and unplug the connectors (Figure 13-56).

CAUTION: *Use a suitable drill stop to protect wiring behind the instrument panel from being damaged during drilling.*

6. Mount the switch under the dash on the left side of the steering column using the panel provided.
   a. Use the closeout panel mount screw nearest the steering column for the left side of the switch panel and drill the right side switch panel mount hole. Mark (using panel as template) and drill a 5/64” hole for mounting of the panel.
   b. Mount the panel to the dash with one of the screws provided and the original closeout panel screw. Drill a 5/16” hole in the closeout panel forward of the switch for the wires to pass through the closeout panel.
   c. Mount the switch in the panel and place the decal on the panel under the switch.

DUAL OIL FILTER

Removal

1. Remove the oil filters from the oil filter adapter.
2. Remove the bolt, gasket and the two small o-rings securing the adapter to the engine block and remove the adapter.
3. Remove the large o-ring, plug and the two connectors from the adapter.

Installation

1. Use pipe thread sealant (Loctite 592) on the threads of the pipe plug and install the pipe plug in the oil filter adapter. Remove any sealant that might have gotten into the oil passage during the pipe plug installation13-57.
2. Install the two oil filter connectors in the oil filter adapter and tighten to 25 lb ft (34 Nm).
3. Install the large o-ring in the groove on the oil filter adapter.
4. Install the two small o-rings in the grooves in the oil filter bolt.
5. Install the oil filter adapter gasket onto the oil filter bolt with the smooth side facing the bolt head.

6. Lubricate all the o-rings and the oil filter gasket with clean engine oil, insert the oil filter bolt through the oil filter adapter and mount the adapter to the engine block. Position the adapter for easy removal and replacement of the oil filters and tighten the oil filter bolt to 50 lb ft (68 Nm).
7. Lubricate the rubber sealing surface on both oil filters and install the filters on the oil filter adapter. Tighten the oil filters until the sealing surface contacts the adapter then 3/4 turn tighter.
8. Refill the engine with fresh oil if previously drained, or top up the oil level if not previously drained and run the engine until warm while checking for leaks. Your oil capacity should increase by approximately one quart (2.8 ml).

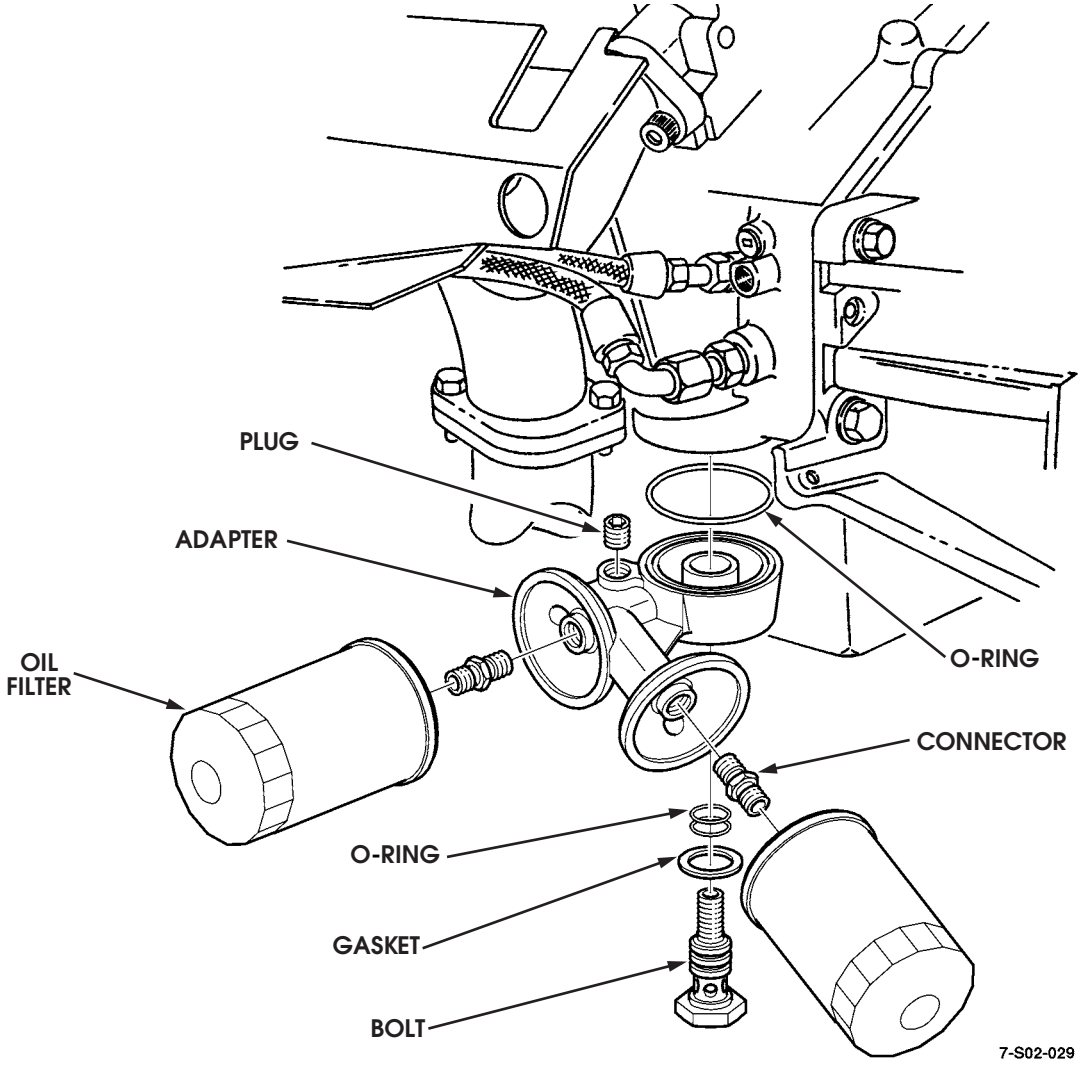


Figure 13-57: Dual Oil Filter Assembly

AUXILIARY SEAT

Auxiliary Seat Replacement

Removal

1. Release and remove the four locking pins from the auxiliary seat frame and the auxiliary seat (Figure 13-58).
2. Remove the auxiliary seat from the auxiliary seat frame.

Installation

1. Install the auxiliary seat on the auxiliary seat frame.
2. Install and fasten the four locking pins to the auxiliary seat frame and the auxiliary seat. (Locking pins are properly installed when the balls near the end of the pins are visible.)

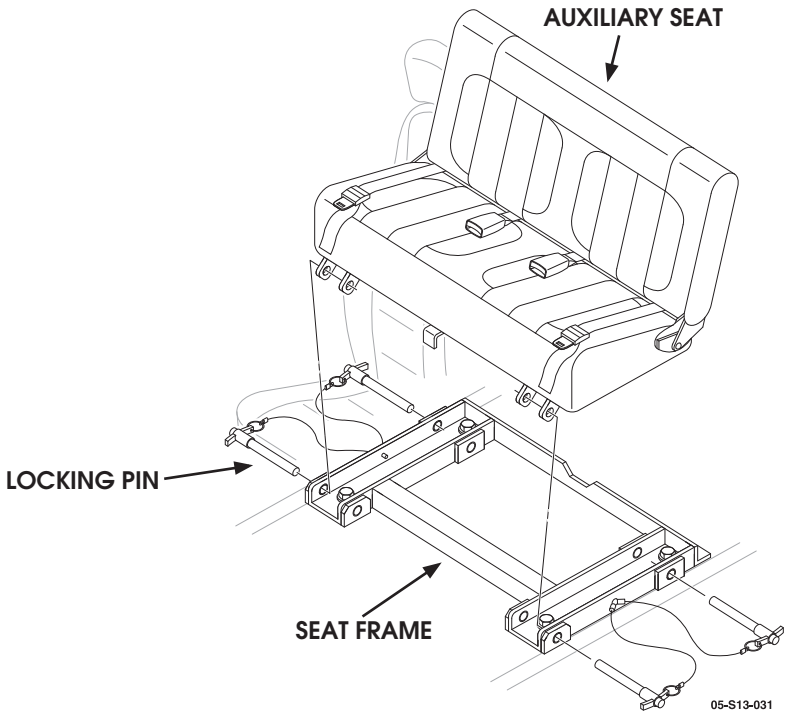


Figure 13-58: Auxiliary Seat

Auxiliary Seat Belt Replacement

Removal

1. Release and tilt forward the auxiliary seat.

NOTE: Retain the initial seat belt mounting positions during installation.

2. Remove the four bolts, washers, and the two auxiliary seat belt assemblies from the auxiliary seat (Figure 13-59).

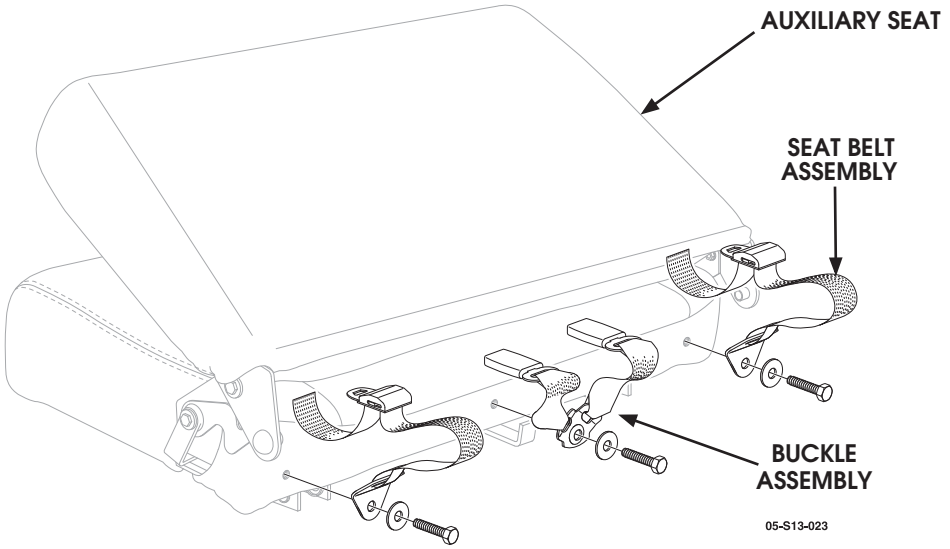


Figure 13-59: Auxiliary Seat Belt

Installation

1. Install the two auxiliary seat belt assemblies on the auxiliary seat with the four washers and the bolts (Figure 13-59). Torque to 72-78 ft-lb (98-106 N•m).
2. Tilt and fasten the auxiliary seat back to the normal position.

Auxiliary Seat Frame Replacement

Removal

1. Remove the auxiliary seat locking pins.
2. Remove the auxiliary seat.
3. Remove the four bolts, washers, and the auxiliary seat frame from the tunnel floor (Figure 13-60).

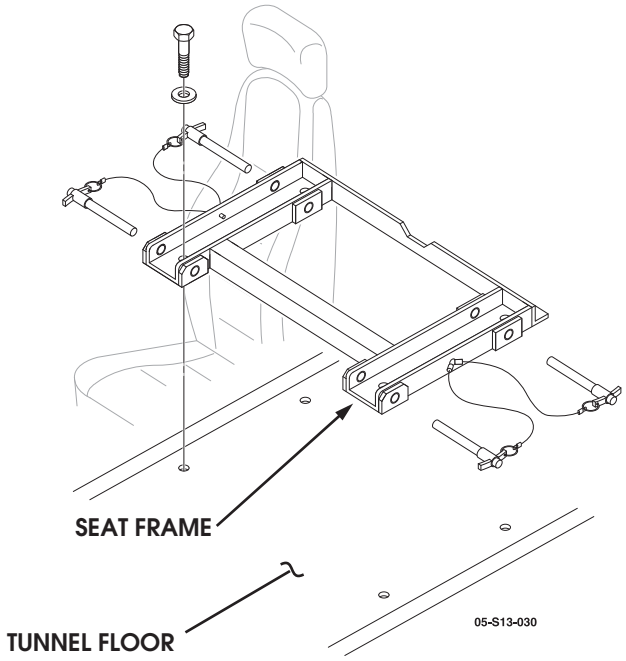


Figure 13-60: Auxiliary Seat Frame

Installation

1. Install the auxiliary seat frame on the tunnel floor with the four washers and the bolts (Figure 13-60). Torque the bolts to 27-30 lb-ft (36-40 N•m).
2. Install the auxiliary seat.
3. Attach the auxiliary seat locking pins to the seat frame.

Auxiliary Seat Locking Pin Replacement

Removal

NOTE: Left and right side locking pins are replaced the same. This procedure covers the left side only.

1. Remove the two screws and the locking pin cables from the auxiliary seat frame (Figure 13-61).
2. Release and remove the two locking pins from the auxiliary seat frame and the auxiliary seat.

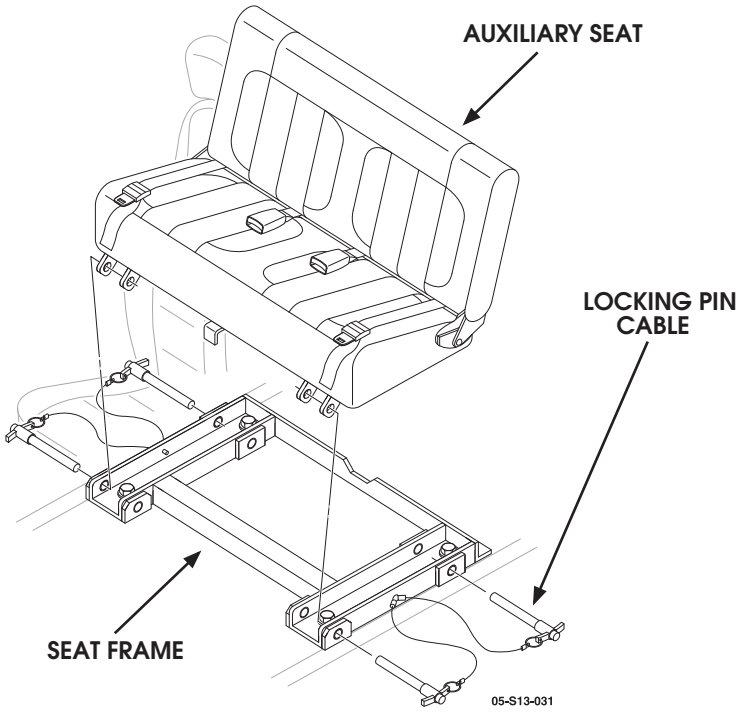


Figure 13-61: Auxiliary Seat Locking Pin

Installation

1. Install and fasten the two locking pins on the auxiliary seat frame and the auxiliary seat (Figure 13-61).
2. Install the two locking pin cables on the auxiliary seat frame with the two screws.

LEATHER AUXILIARY SEAT UPHOLSTERY

Removal

1. Remove the four locking pins securing the auxiliary seat to the seat frame (See Figure 13-62).
2. Remove the auxiliary seat from the seat frame.
3. Seat Base:
   a. Remove the bolts securing the safety belts to the rear of the auxiliary seat cushion frame.
   b. Remove the safety belts from the auxiliary seat cushion frame.
   c. Release the plastic “J” retainers from the seat cushion frame and remove the fabric from the seat cushion.
4. Seat Back:
   a. Release the hook and loop securing the front portion of the fabric to the rear fabric at the bottom of the seat back.
   b. Pull the fabric upward and remove it from the seat back.

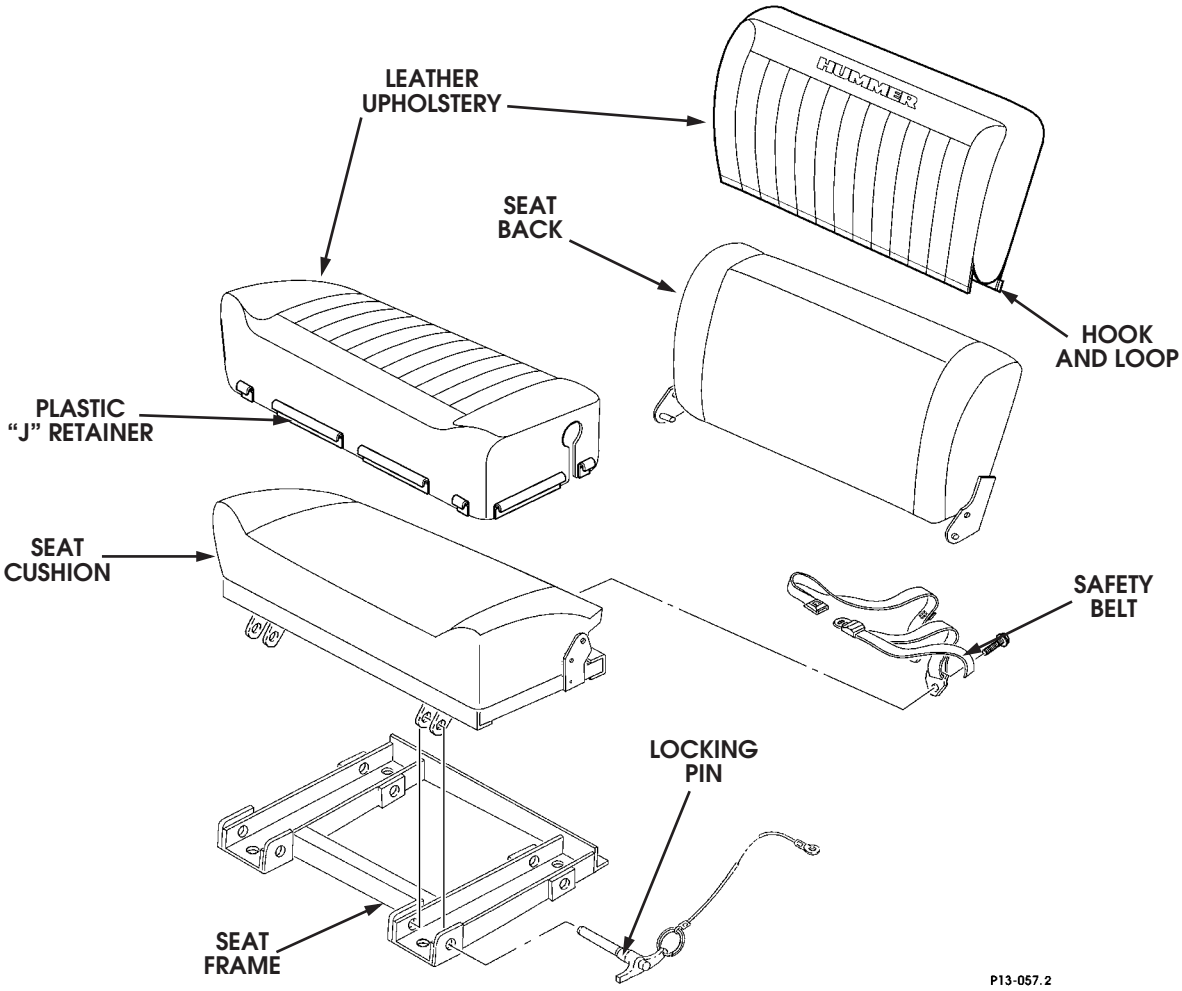


Figure 13-62: Auxiliary Seat Cover Installation.

Installation

1. Seat Base:
   a. Using the original fabric as a template, mark and cut the leather seat cushion upholstery for the safety belt mounting hardware.
   b. Position the leather on the seat cushion and secure the plastic "J" retainers to the seat cushion frame.
   c. Install the safety belts through the leather upholstery into the seat frame and torque the fasteners to 72-78 lb-ft (98-106 N•m).
2. Seat Back:
   a. Slide the leather upholstery down onto the seat back and secure the hook and loop at the bottom of the seat back.
3. Install the auxiliary seat on the seat frame and secure with the four locking pins.

CAUTION: *Locking pins must be fully inserted into the seat frame. The balls near the end of the pins must be visible at the inboard side of the seat frame bracket.*

OFF-ROAD ACCESSORY KIT (MODEL 84)

Removal

1. Remove the four bolts, locknuts, 8 retainer plates and the gaskets securing the box to the wheelhouse (See Figure 13-63).
2. Lift the box off the wheelhouse and out of the vehicle.

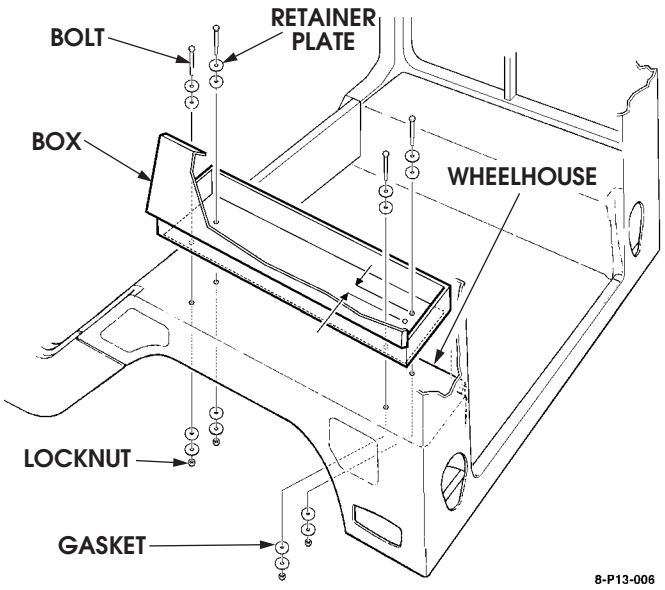


Figure 13-63: Off-Road Accessory Box Mounting

Installation

1. Position the tool box on the drivers side rear wheel house flush with the inside edge and centered front to rear making sure that the lid will open without contacting the side window or the upper trim panel.
2. Using the forward inboard and the two outboard holes in the bottom of the tool box as a template, mark the carpet and drill 1/4" holes through the carpet and the wheel house (See Figure 13-63).
3. Mount the tool box by installing three 1/4" bolts, retainer plates and Gaskets from the box side through the wheel house and three gaskets, retainer plates and locknuts on the wheel side.
4. Measure two inches inboard from the rear inboard mount hole in the bottom of the box and mark the box for drilling.
5. Drill a 1/4" hole at the marked position through the box, the carpet and the wheelhouse.
6. Install a 1/4" bolt, retainer plate and Gasket from the box side through the wheel house and a gasket, retainer plate and locknut on the wheel side. Torque all the fasteners to 12 lb ft.
7. Place the kit contents in the tool box and latch the lid before operating the vehicle.

CAUTION: *Box contents should not exceed 60 pounds.*

BEDLINER (MODELS 83, 85 AND 90)

Removal

1. Using a sharp knife or gasket scraper cut the edge trim adhesive between the vehicle and the edge trim all around the upper edge of the bedliner. Take care not to damage the edge trim so it can be reused.
2. Remove all the tiedowns in the bed area.
3. Remove the two plastic caps, screws and washers securing the top of the tailgate liner. Pull the tailgate liner off the tailgate.
4. If your vehicle is a soft top model, remove the bolts and nuts securing the "C" pillar rear support bars to the wheelhouse (See Figure 13-64). Remove the shims from between the support bar brackets.
5. Remove the bedliner.
6. Cut the edge trim off the tailgate.
7. Clean all the remaining adhesive off the bed and tailgate areas and the backside of the edge trim with an adhesive remover.

Installation

8. Place the bedliner into the vehicle. If your vehicle is a soft top model, perform the following steps:

- Slide the bedliner into the bed from the rear until the front of the bedliner is against the rear support bar brackets.
- Raise the rear of the bedliner.
- Make sure that both sides of the liner start sliding under the support bar brackets.
- Push the liner all the way forward until there is approximately 1/8" clearance between the rear floor edge of the liner and the vehicles “D” beam assembly (rear floor flange).

9. Align the tiedown holes in the liner with the holes in the vehicle. Install all the tiedowns loosely. Adjust the liner in the bed and torque the tiedowns to 27-30 lb-ft (36-40 N•m)
10. If your vehicle is a soft top model, use the holes in the “C” pillar rear support bar mount brackets as a template and drill 1/2" holes through the liner. Reinstall the previously removed shims between the liner and the support bar brackets, leaving out one shim on each side to make up for the thickness of the liner. Install the original bolts and nuts through the support bar mount brackets, the shims, the liner and the wheel houses, but do not tighten. Recheck the fit of the liner and torque the bolts to 31 lb-ft (42 N•m).
11. Use rubbing alcohol to clean the body along the top of the liner on the right and left sides. The edge trim will be installed in this area and the vehicle must be clean to insure proper adhesion.

NOTE: The edge trim should not be installed over the vertical angle brackets in the front corners of the bed.

NOTE: If you are reusing the original edge trim you will need to install a double sided foam tape such as 3M 06382 to the back-side of the edge trim pieces.

12. Mark the lengths of edge trim to be used on the right and left sides of the liner. Do not use edge trim under the support tube brackets on soft top models or under the tonneau cover bow bracket on hard top models. Once the proper lengths of edge trim have been marked, cut the edge trim to length. Install the edge trim onto the top edge of the bedliner, but do not remove the adhesive film backing yet. The edge trim must be installed loosely onto the top edge of the bedliner. A 1/8" gap should be left between the inside edge of the trim and the top of the bedliner to allow for expansion.
13. When all the pieces of edge trim are in their correct location, remove the adhesive film backing from one piece of trim and press it into place. Repeat until all the pieces of trim are in place.
14. Clean the vehicle tailgate. Center the tailgate cover side to side and push the cover forward until the cover is tight against the top of the tailgate. Using the holes in the upper corners of the cover, mark the tailgate and drill two 5/32" holes in the tailgate for the cover retaining screws. Redrill the holes in the tailgate **cover only** out to 3/8". Fasten the tailgate cover to the tailgate by installing the screws and washers. Snap a plastic cap over each washer.
15. Clean the tailgate along the bottom edge of the cover with rubbing alcohol to insure proper adhesion of the edge trim. Install the edge trim leaving a 1/8" gap between the inside edge of the trim and the cover for expansion. Remove the adhesive film backing and press the trim into place.

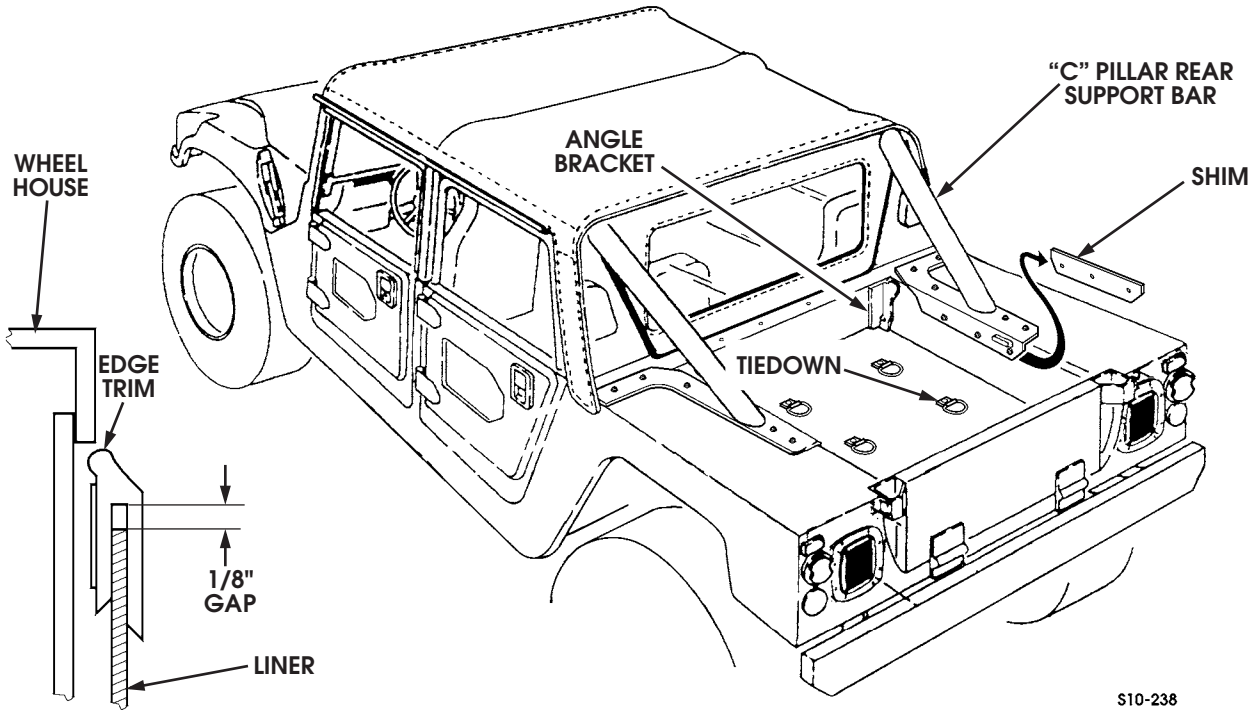


Figure 13-64: Bedliner Installation In Soft top vehicle.

CARGO AREA LINER

1. Lay the cargo liner loosely in the rear cargo area (See Figure 13-65).
2. Remove the removable load barrier from the retaining brackets.
3. Remove the backing strip from the hook and loop at the lower portion of the load barrier coverage area (it should line up with the bottom of the load barrier).
4. Secure the hook and loop to the bottom of the load barrier.
5. Reinstall the load barrier.
6. Remove the backing strip from the hook and loop at the upper portion of the load barrier coverage area and install it on the top edge of the load barrier.
7. Peel the cargo area carpet back from under the side windows, exposing the hook and loop that retains the carpet.
8. Install the hook on the cargo area liner to the loop on the back of the carpet.
9. Place the carpet back under the side windows securing the loop on the cargo area liner to the hook on the wheel house.
10. Secure the plastic retainers on the vertical door end of the cargo liner to the edge of the cargo area carpet.
11. Remove the original vertical door liners from the vertical doors (not shown).
12. Remove the hook and loop from the doors.
13. Peel the backing strip from the hook and loop on the replacement vertical door liners.
14. Install the replacement vertical door liners on the vertical doors in the same position as the originals.

Cleaning and Maintenance

NOTE: Most spills can be wiped down quickly and easily with common household detergent or a general purpose upholstery cleaner. Grease and oil stains should be spot cleaned with a citrus based degreaser.

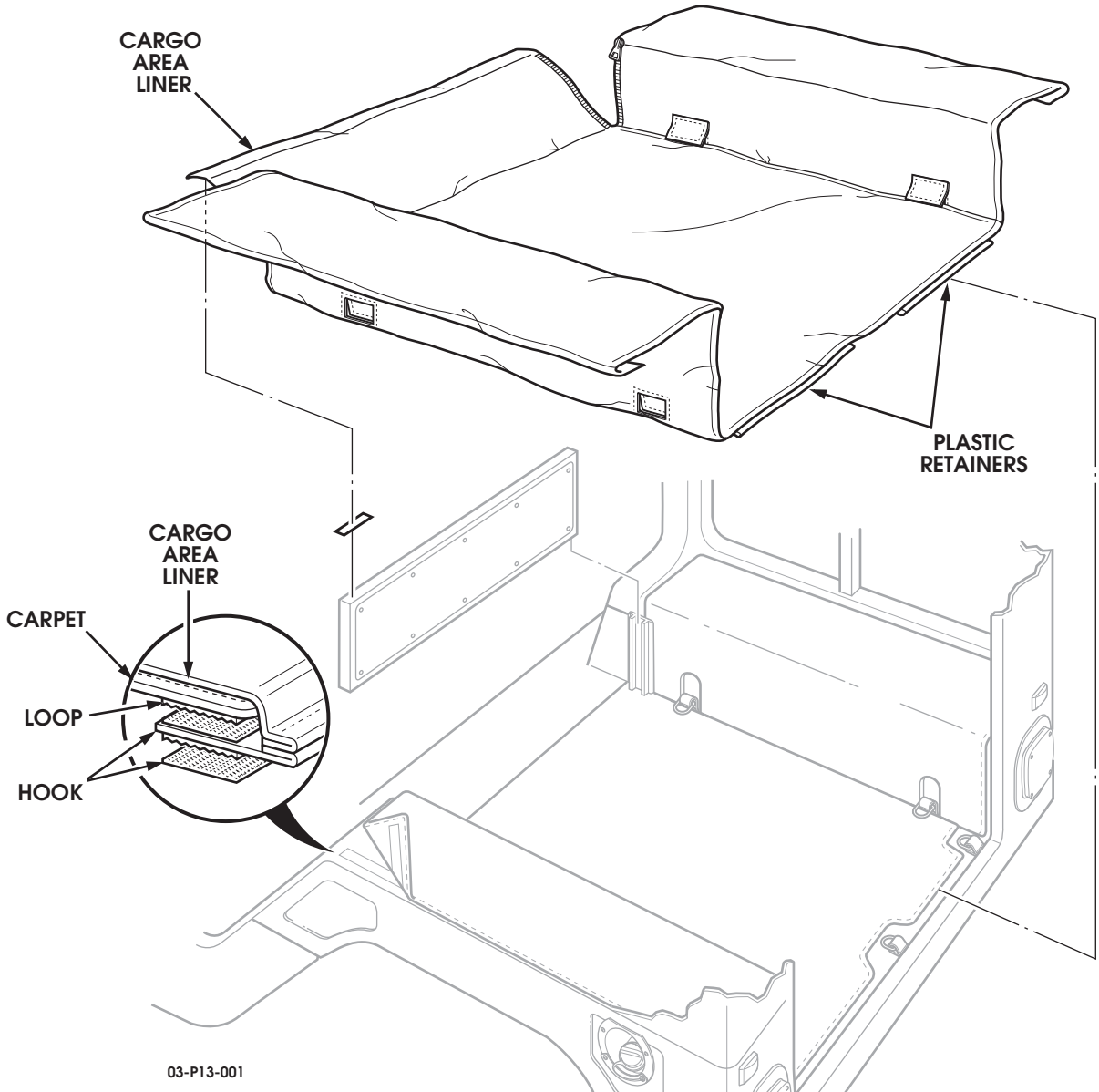


Figure 13-65: Cargo Area Liner installation.

CENTER TUNNEL RACK

Installation

1. Remove all four 1/2" bolts and cargo tie down rings located between the rear seats on top of the driveline tunnel (do not remove the spacers under the tie down rings).
2. Place the tunnel rack on the driveline tunnel (See Figure 13-66) and align the holes in the tunnel rack mount plates with the holes in the driveline tunnel.
3. If you prefer not to use the cargo tie down rings, use the original bolts to secure the tunnel rack and torque to 27-30 lb-ft (36-40 N•m).
4. If you would like to use the cargo tie down rings, use the longer supplied bolts and cargo tie down rings to secure the rack and torque to 27-30 lb-ft (36-40 N•m).

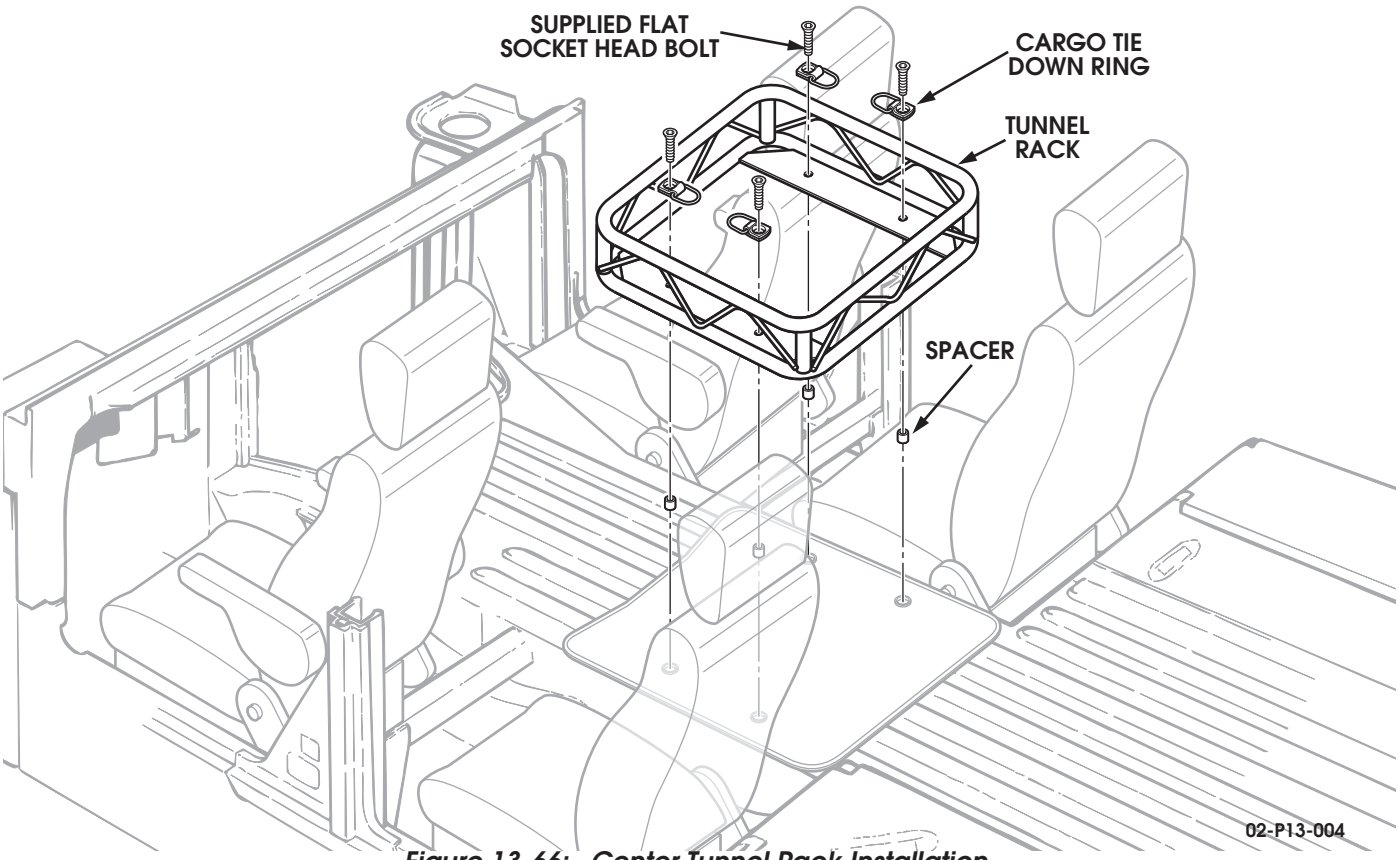


Figure 13-66: Center Tunnel Rack Installation.

WHEEL HOUSE RACK

Installation

NOTE: The Wheel House Rack is intended for use on the driver's side wheel house only. Installation on the passenger side wheel house may obstruct the driver's view through the window.

1. Position the rack on the driver's side rear wheel house flush with the inside edge and centered front to rear.
2. Using the four holes in the bottom of the rack as a template, mark the carpet and drill 1/4" holes through the carpet and the wheel house (See Figure 13-67).
3. Mount the rack by installing four 1/4" bolts , retainer plates and gaskets from the rack side through the wheel house and four gaskets, retainer plates and locknuts on the wheel side.
4. Torque all the fasteners to 12 lb ft.

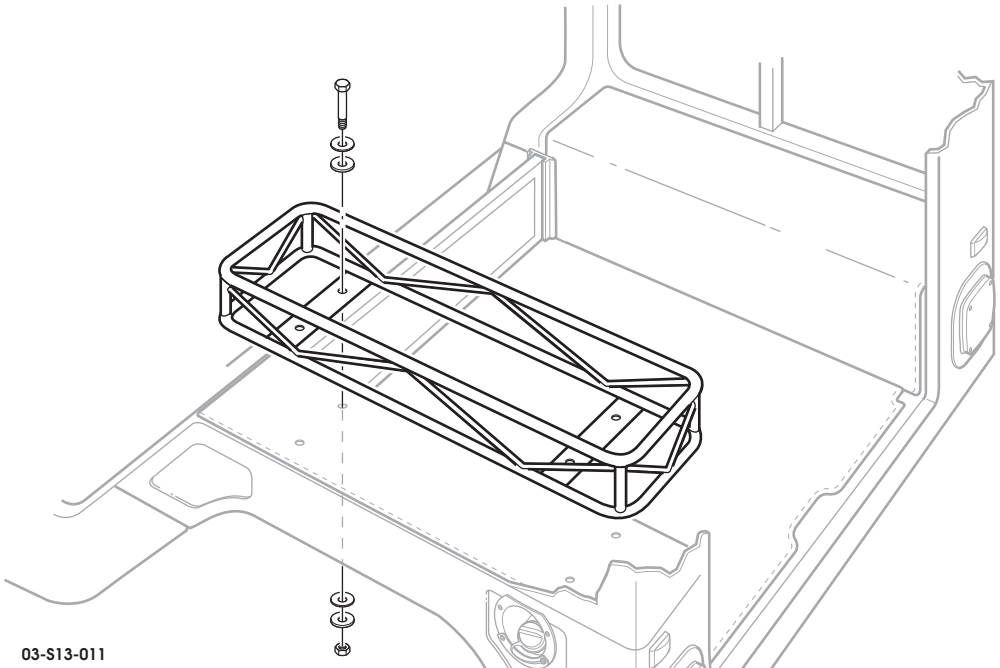


Figure 13-67: Wheel House Rack Installation.

THIS PAGE INTENTIONALLY BLANK.