

Indmar

MARINE ENGINES

Service and Diagnostic Manual For Electronic Fuel Injection Systems with MEFI 6 Controllers

Indmar Products Company, Inc.
5400 Old Millington Road
Millington, TN 38053

TABLE OF CONTENTS

Preface	0-0	Engine	9-3
Dangers, Warnings, and Cautions	0-3	Engine Controls and Fuel - Marine	9-3
General Information	1-3	Power and Signal Distribution	11-3
General Information	1-3	Data Communications	11-3
Diagnostic Overview, Starting Point, and Programming	6-3	Wiring Systems	11-6
Programming and Setup	6-3		
Vehicle Diagnostic Information	6-4		

DANGER

Danger: In order to reduce the chance of death, personal injury and/or property damage, carefully observe the instructions that follow:

The service manuals of General Motors are intended for use by professional, qualified technicians. Attempting repairs or service without the appropriate training, tools, and equipment could cause death or injury to you or others. This could also damage the vehicle, or cause the vehicle to operate improperly.

Proper vehicle service and repair are important to the safety of the service technician and to the safe, reliable operation of all motor vehicles. If you need to replace a part, use the same part number or an equivalent part. Do not use a replacement part of lesser quality.

The service procedures we recommend and describe in this service manual are effective methods of performing service and repair. Some of the procedures require the use of tools that are designed for specific purposes.

Accordingly, any person who intends to use a replacement part, a service procedure, or a tool that is not recommended by General Motors, must first establish that there is no jeopardy to personal safety or the safe operation of the vehicle.

This manual contains various “Dangers”, “Warnings” and “Cautions” that you must observe carefully in order to reduce the risk of personal injury during service or repair. Improper service or repair may damage the vehicle or render the vehicle unsafe. These “Dangers”, “Warnings” and “Cautions” are not exhaustive. General Motors can not possibly warn of all the potentially hazardous consequences of your failure to follow these instructions.

This manual covers service procedures to vehicles that are equipped with a Supplemental Inflatable Restraint. Refer to the “Warnings” in Dangers, Warnings and Cautions in Supplemental Inflatable Restraint. Refer to Supplemental Inflatable Restraint component and wiring location views in Supplemental Inflatable Restraint before performing a service on or around Supplemental Inflatable Restraint components or wiring. Failure to follow these “Dangers”, “Warnings” and “Cautions” could cause air bag deployment, personal injury, or otherwise unnecessary Supplemental Inflatable Restraint repairs.

In order to help avoid accidental air bag deployment and personal injury, whenever you service a vehicle that requires repair of the Supplemental Inflatable Restraint and another vehicle system, we recommend that you first repair the Supplemental Inflatable Restraint, then go on to the other system.

2011 Marine Electronic Fuel Injection (EFI) Service Manual

This manual provides information on the diagnosis, the service procedures, the adjustments, and the specifications for the marine engines.

Because the marine engines cover a broad range of uses, some of the instructions, figures, or references contained within this manual may not pertain to every customer or engine application. This information is furnished to ensure completeness and is to be followed only where appropriate.

The technicians who understand the material in this manual better serve the vehicle owners.

When this manual refers to a brand name, a part number, or a specific tool, you may use an equivalent product in place of the recommended item. All information, illustrations, and specifications in this manual are based on the latest product information available at the time of publication approval. General Motors LLC reserves the right to make changes at any time without notice.

Published by
North American Operations
General Motors LLC
Milford, Michigan 48380

©2011 GENERAL MOTORS LLC
ALL RIGHTS RESERVED

The information cutoff date is 01/03/11.

LITHO IN U.S.A.

No part of this manual may be reproduced, stored in any retrieval system, or transmitted in any form or by any means including, but not limited to, electronic, mechanical, photocopying, and recording without the prior written permission of General Motors LLC. This applies to all text, illustrations, and tables.

Error and Suggestion Reporting

If you find an error in a GM Service manual, or if you have a suggestion about a GM service manual, we want to hear from you.

When calling, be prepared with the following information:

- Your name
- The name of your dealership
- The phone number of your dealership
- The model year and the vehicle line
- The publication part number (if present)
- The vehicle identification number of the vehicle on which you are working
- The service category and page number(s)
- Any applicable electronic information element identification numbers
- A descriptive explanation of your concern

The GM service manual phone personnel will respond to your concerns in the following ways:

- By delivering your concern to the author of the manual.
- By eliciting a response from the author.
- By supplying you with an answer to your concerns.

For paper manual users: The GM service manual phone personnel will also explain how to send in examples or marked-up pages.

For Electronic Manual users: Be prepared to provide any applicable identification numbers pertaining to the electronic information in question.

The GM service manual comment telephone numbers do not provide technical assistance. For technical assistance, contact your regular technical assistance source.

United States and Canada General Motors Dealer Employees

Please call the following number with your comments: 1-800-828-6860.

You may call Monday through Friday, 8 a.m.–8 p.m. Eastern Time. In order to send a fax, use the following number: 248-265-9327.

Canada, French Speaking General Motors Dealer Employees

Please call the following number with your comments: 1-800-503-3222.

You may call Monday through Friday, 8 a.m.–5 p.m. Eastern Time. In order to send a fax, use the following number: 248-265-9327.

International English Speaking General Motors Dealer Employees

Please call the following number with your comments: 248-265-0840.

You may call Monday through Friday, 8 a.m.–8 p.m. Eastern Time. In order to send a fax, use the following number: 248-265-9327.

United States and Canadian Vehicle Owner/Operator

Vehicle owners or operators are encouraged to address their comments and concerns to the applicable Customer Assistance Center. The phone number and address of the Customer Assistance Center are in the Owner's Manual.

Section 0

Dangers, Warnings, and Cautions

Dangers, Warnings, and Cautions	0-3	Cover and Plug Openings Caution	0-5
Definition of Danger, Warning, Caution, and Note	0-3	Electrical Wiring Routing Caution	0-5
Actions to Take When Working with Fuel Warning	0-3	Excessive Force and Oxygen Sensor Caution	0-5
Batteries Produce Explosive Gases Warning	0-3	Fastener Caution	0-5
Battery Disconnect Warning	0-4	Fuel Injector Balance Test Caution	0-5
Camshaft Position Actuator Removal and Installation Warning	0-4	Fuel Pressure Caution	0-5
Exhaust Service Warning	0-4	Fuel Rail Caution	0-5
Fuel Pipe Fitting Warning	0-4	Handling Electrostatic Discharge Sensitive Parts Caution	0-5
Fuel Storage Warning	0-4	Heated Oxygen and Oxygen Sensor Caution	0-6
Fuel System Pressure Warning	0-4	Ignition OFF When Disconnecting Battery Caution	0-6
Gasoline/Gasoline Vapors Warning	0-4	J 35616-A Connector Test Adapter Kit Caution	0-6
On-Vehicle Fire Extinguisher Warning	0-4	Test Lamp to Test Continuity Caution	0-6
Relieving Fuel Pressure Warning	0-4	Test Probe Caution	0-6
Shop Towel Fuel Leak Warning	0-4	Three-Way Catalytic Converter Damage Caution	0-6
Clean Spark Plug Recess Caution	0-5		
Component Fastener Tightening Caution	0-5		

BLANK

Dangers, Warnings, and Cautions

Definition of Danger, Warning, Caution, and Note

The diagnosis and repair procedures in a GM Service Manual contain both general and specific Dangers, Warnings, Cautions, Notes or Importants. GM is dedicated to the presentation of service information that helps the technician to diagnose and repair the systems necessary for the proper operation of the vehicle, however, certain procedures may present a hazard to the technician if they are not followed in the recommended manner. Dangers, Warnings, Cautions and Notes or Importants are elements designed to prevent these hazards, however, not all hazards can be foreseen. This information is placed at strategic locations within the service manual. This information is designed to prevent the following from occurring:

- Serious bodily injury or death to the technician
- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper repair or replacement of vehicle components.
- Any warning or caution that appears in this service category is referenced from the individual service categories.

DANGER Defined

When encountering a DANGER, you will be asked to take a necessary action or not to take a prohibited action. If a DANGER is not heeded, the following consequences may occur:

- Serious bodily injury or death to the technician
- Serious bodily injury or death to other technicians in the workplace area

WARNING Defined

When encountering a WARNING, you will be asked to take a necessary action or not to take a prohibited action. If a WARNING is not heeded, the following consequences may occur:

- Serious bodily injury to the technician
- Serious bodily injury to other technicians in the workplace area
- Serious bodily injury to the driver and/or passenger(s) of the vehicle, if the vehicle has been improperly repaired

CAUTION Defined

CAUTIONS call special attention to a necessary action or to a prohibited action. If a CAUTION is not heeded, the following consequences may occur:

- Damage to the vehicle
- Unnecessary vehicle repairs
- Unnecessary component replacement
- Improper operation or performance of the system or component under repair

- Damage to any systems or components which are dependent upon the proper operation of the system or component under repair
- Improper operation or performance of any systems or components which are dependent upon the proper operation or performance of the system or component under repair
- Damage to fasteners, basic tools, or special tools
- The leakage of coolant, lubricant, or other vital fluids

NOTE or IMPORTANT Defined

NOTE and IMPORTANT statements emphasize a necessary characteristic of a diagnostic or repair procedure. NOTE or IMPORTANT statements are designed to do the following:

- Clarify a procedure
- Present additional information for accomplishing a procedure
- Give insight into the reason or reasons for performing a procedure in the manner recommended
- Present information that will help to accomplish a procedure in a more effective manner
- Present information that gives the technician the benefit of past experience in accomplishing a procedure with greater ease

Actions to Take When Working with Fuel Warning

Warning: Fuel Vapors can collect while servicing fuel system components in enclosed areas such as the vessels cabin or engine compartment. To reduce the risk of fire and increased exposure to vapors:

- **Use forced air ventilation such as a fan set outside of the vessels engine compartment.**
- **Plug or cap any fuel system openings in order to reduce fuel vapor formation.**
- **Clean up any spilled fuel immediately.**
- **Avoid sparks and any source of ignition.**
- **Use signs to alert others in the work area that fuel system work is in process.**

Batteries Produce Explosive Gases Warning

Warning: Batteries produce explosive gases. Batteries contain corrosive acid. Batteries supply levels of electrical current high enough to cause burns. Therefore, in order to reduce the risk of personal injury while working near a battery, observe the following guidelines:

- **Always shield your eyes.**
- **Avoid leaning over the battery whenever possible.**

0-4 Dangers, Warnings, and Cautions

- Do not expose the battery to open flames or sparks.
- Do not allow battery acid to contact the eyes or the skin.
 - Flush any contacted areas with water immediately and thoroughly.
 - Get medical help.

Battery Disconnect Warning

Warning: Unless directed otherwise, the ignition and start switch must be in the OFF or LOCK position, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power (RAP) should be allowed to time out or be disabled (simply opening the driver door should disable RAP) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with RAP activated may cause activation of the OnStar® Back-Up Battery (BUB) system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The BUB is not rechargeable and once activated the BUB must be replaced.

Camshaft Position Actuator Removal and Installation Warning

Warning: Do not push or pull on the reluctor wheel of the camshaft position (CMP) actuator during removal or installation. The reluctor wheel is retained to the front of the CMP actuator by 3 roll pins. Pushing or pulling on the wheel may dislodge the wheel from the front of the actuator. The actuator return spring is under tension and may rotate the dislodged reluctor wheel, causing personal injury.

Exhaust Service Warning

Warning: In order to avoid being burned, do not service the exhaust system while it is still hot. Service the system when it is cool.

Fuel Pipe Fitting Warning

Warning: Always apply a few drops of clean engine oil to the male pipe ends before connecting the fuel pipe fittings in order to reduce the risk of fire and personal injury. This will ensure proper reconnection and prevent a possible fuel leak. During normal operation, the O-rings located in the female connector will swell and may prevent proper reconnection if not lubricated.

Fuel Storage Warning

Warning: Do not drain the fuel into an open container. Never store the fuel in an open container due to the possibility of a fire or an explosion.

Fuel System Pressure Warning

Warning: Do not open the fuel system while the engine is running. Allow the fuel system pressure to drop before opening the system. The fuel system is under very high pressure. Failure to comply could result in personal injury.

Gasoline/Gasoline Vapors Warning

Warning: Gasoline or gasoline vapors are highly flammable. A fire could occur if an ignition source is present. Never drain or store gasoline or diesel fuel in an open container, due to the possibility of fire or explosion. Have a dry chemical (Class B) fire extinguisher nearby.

On-Vehicle Fire Extinguisher Warning

Warning: Place a dry chemical (Class B) fire extinguisher nearby before performing any on-vehicle service procedures. Failure to follow these precautions may result in personal injury.

Relieving Fuel Pressure Warning

Warning: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.

Shop Towel Fuel Leak Warning

Warning: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection

of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

Clean Spark Plug Recess Caution

Notice: Clean the spark plug recess area before removing the spark plug. Failure to do so could result in engine damage because of dirt or foreign material entering the cylinder head, or by the contamination of the cylinder head threads. The contaminated threads may prevent the proper seating of the new plug. Use a thread chaser to clean the threads of any contamination.

Component Fastener Tightening Caution

Caution: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.

Cover and Plug Openings Caution

Caution: Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering the open pipes and passages.

Electrical Wiring Routing Caution

Caution: Note the correct routing of the electrical wiring. Failure to reinstall the wiring properly could result in damage to the wiring.

Excessive Force and Oxygen Sensor Caution

Caution: The oxygen sensor may be difficult to remove when the engine temperature is below 48°C (120°F). Excessive force may damage threads in the exhaust manifold or the exhaust pipe.

Fastener Caution

Caution: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Do not use paints, lubricants, or corrosion inhibitors on fasteners, or fastener joint surfaces, unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems. When using fasteners that are threaded

directly into plastic, use extreme care not to strip the mating plastic part(s). Use hand tools only, and do not use any kind of impact or power tools. Fastener should be hand tightened, fully seated, and not stripped.

Fuel Injector Balance Test Caution

Caution: Do Not repeat any portion of this test before running the engine in order to prevent the engine from flooding.

Fuel Pressure Caution

Caution: Do not allow the fuel pressure to exceed the specified value because damage to the fuel pressure regulator or the fuel pressure gauge may result.

Fuel Rail Caution

Caution:

- Use care when servicing the fuel system components, especially the fuel injector electrical connectors, the fuel injector tips, and the injector O-rings. Plug the inlet and the outlet ports of the fuel rail in order to prevent contamination.
- Do not use compressed air to clean the fuel rail assembly as this may damage the fuel rail components.
- Do not immerse the fuel rail assembly in a solvent bath in order to prevent damage to the fuel rail assembly.

Handling Electrostatic Discharge Sensitive Parts Caution

Caution: Electrostatic discharge (ESD) can damage many solid-state electrical components. ESD susceptible components may or may not be labeled with the ESD symbol. Handle all electrical components carefully. Use the following precautions in order to avoid ESD damage:

- Touch a metal ground point in order to remove your body's static charge before servicing any electronic component; especially after sliding across the vehicle seat.
- Do not touch exposed terminals. Terminals may connect to circuits susceptible the ESD damage.
- Do not allow tools to contact exposed terminals when servicing connectors.
- Do not remove components from their protective packaging until required to do so.
- Avoid the following actions unless required by the diagnostic procedure:
 - Jumpering or grounding of the components or connectors.
 - Connecting test equipment probes to components or connectors. Connect the ground lead first when using test probes.
- Ground the protective packaging of any component before opening. Do not rest solid-state components on metal workbenches, or on top of TVs, radios, or other electrical devices.

Heated Oxygen and Oxygen Sensor Caution

Caution: Do not remove the pigtail from either the heated oxygen sensor (HO2S) or the oxygen sensor (O2S). Removing the pigtail or the connector will affect sensor operation.

Handle the oxygen sensor carefully. Do not drop the HO2S. Keep the in-line electrical connector and the louvered end free of grease, dirt, or other contaminants. Do not use cleaning solvents of any type.

Do not repair the wiring, connector or terminals. Replace the oxygen sensor if the pigtail wiring, connector, or terminal is damaged.

This external clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors, or terminals could result in the obstruction of the air reference and degraded sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor causing poor performance.
- Do not damage the sensor pigtail and harness wires in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Ensure the sensor or vehicle lead wires are not bent sharply or kinked. Sharp bends or kinks could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire, where applicable. Vehicles that utilize the ground wired sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will cause poor engine performance.
- Ensure that the peripheral seal remains intact on the vehicle harness connector in order to prevent damage due to water intrusion. The engine harness may be repaired using Packard's Crimp and Splice Seals Terminal Repair Kit. Under no circumstances should repairs be soldered since this could result in the air reference being obstructed.

Ignition OFF When Disconnecting Battery Caution

Caution: Always turn the ignition OFF when connecting or disconnecting battery cables, battery chargers, or jumper cables. Failing to do so may damage the Powertrain Control Module (PCM) or other electronic components.

J 35616-A Connector Test Adapter Kit Caution

Caution: Use the connector test adapter kit J 35616-A for any test that requires probing the following items:

- The ECM harness connectors
- The electrical center fuse/relay cavities
- The component terminals
- The component harness connector

Using this kit will prevent damage caused by the improper probing of connector terminals.

Test Lamp to Test Continuity Caution

Caution: Do not use a test lamp in order to test the continuity of the low reference circuit. Damage to the Engine Control Module (ECM) will result.

Test Probe Caution

Caution: Do not insert test equipment probes (DVOM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

Three-Way Catalytic Converter Damage Caution

Caution: In order to avoid damaging the replacement three-way catalytic converter, correct the engine misfire or mechanical fault before replacing the three-way catalytic converter.

Section 1

General Information

General Information	1-3	Visual/Physical Checks	1-5
Introduction	1-3	Electrostatic Discharge Damage	1-5
US English/Metric Conversion	1-3	Engine Wiring	1-5
Decimal and Metric Equivalents	1-3	Fasteners	1-6
Arrows and Symbols	1-4	Thread Inserts	1-8
Basic Knowledge and Tools Required	1-5	Abbreviations and Meanings	1-8

BLANK

General Information

Introduction

US English/Metric Conversion

English	Multiply/ Divide by	Metric
In order to calculate English measurement, divide by the number in the center column.		
In order to calculate metric measurement, multiply by the number in the center column.		
Length		
in	25.4	mm
ft	0.3048	m
yd	0.9144	
mi	1.609	km
Area		
sq in	645.2	sq mm
	6.45	sq cm
sq ft	0.0929	sq m
sq yd	0.8361	
Volume		
cu in	16,387.0	cu mm
	16.387	cu cm
	0.0164	L
qt	0.9464	
gal	3.7854	
cu yd	0.764	cu m
Mass		
lb	0.4536	kg
ton	907.18	
	0.907	tonne (t)
Force		
kg F	9.807	newtons (N)
oz F	0.2780	
lb F	4.448	
Acceleration		
ft/s ²	0.3048	m/s ²
in/s ²	0.0254	
Torque		
lb in	0.11298	N·m
lb ft	1.3558	
Power		
hp	0.745	kW
Pressure (Stress)		
inches of H2O	0.2488	kPa
lb/sq in	6.895	
Energy (Work)		
Btu	1055.0	J (J= one Ws)
lb ft	1.3558	
kW hour	3,600,000.0	

US English/Metric Conversion (cont'd)

English	Multiply/ Divide by	Metric
Light		
Foot Candle	10.764	lm/m ²
Velocity		
mph	1.6093	km/h
Temperature		
(°F – 32) 5/9	=	°C
°F	=	(9/5 °C + 32)
Fuel Performance		
235.215/mpg	=	100 km/L

Decimal and Metric Equivalents

Fraction (in)	Decimal (in)	Metric (mm)
1/64	0.015625	0.39688
1/32	0.03125	0.79375
3/64	0.046875	1.19062
1/16	0.0625	1.5875
5/64	0.078125	1.98437
3/32	0.09375	2.38125
7/64	0.109375	2.77812
1/8	0.125	3.175
9/64	0.140625	3.57187
5/32	0.15625	3.96875
11/64	0.171875	4.36562
3/16	0.1875	4.7625
13/64	0.203125	5.15937
7/32	0.21875	5.55625
15/64	0.234375	5.95312
1/4	0.25	6.35
17/64	0.265625	6.74687
9/32	0.28125	7.14375
19/64	0.296875	7.54062
5/16	0.3125	7.9375
21/64	0.328125	8.33437
11/32	0.34375	8.73125
23/64	0.359375	9.12812
3/8	0.375	9.525
25/64	0.390625	9.92187
13/32	0.40625	10.31875
27/64	0.421875	10.71562
7/16	0.4375	11.1125
29/64	0.453125	11.50937
15/32	0.46875	11.90625
31/64	0.484375	12.30312

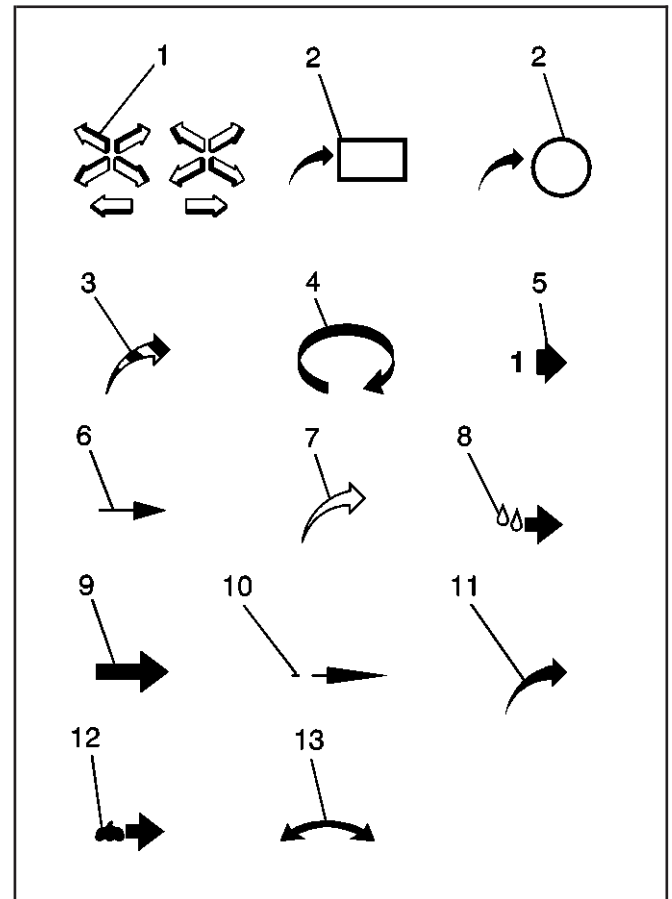
1-4 General Information

Decimal and Metric Equivalents (cont'd)

Fraction (in)	Decimal (in)	Metric (mm)
1/2	0.5	12.7
33/64	0.515625	13.09687
17/32	0.53125	13.49375
35/64	0.546875	13.89062
9/16	0.5625	14.2875
37/64	0.578125	14.68437
19/32	0.59375	15.08125
39/64	0.609375	15.47812
5/8	0.625	15.875
41/64	0.640625	16.27187
21/32	0.65625	16.66875
43/64	0.671875	17.06562
11/16	0.6875	17.4625
45/64	0.703125	17.85937
23/32	0.71875	18.25625
47/64	0.734375	18.65312
3/4	0.75	19.05
49/64	0.765625	19.44687
25/32	0.78125	19.84375
51/64	0.796875	20.24062
13/16	0.8125	20.6375
53/64	0.828125	21.03437
27/32	0.84375	21.43125
55/64	0.859375	21.82812
7/8	0.875	22.225
57/64	0.890625	22.62187
29/32	0.90625	23.01875
59/64	0.921875	23.41562
15/16	0.9375	23.8125
61/64	0.953125	24.20937
31/32	0.96875	24.60625
63/64	0.984375	25.00312
1	1.0	25.4

Arrows and Symbols

This service manual uses various symbols in order to describe different service operations.



196216

Legend

- (1) Front of Vehicle
- (2) View Detail
- (3) Ambient Air Mixed with Another Gas or Indicate Temperature Change
- (4) Motion or Direction
- (5) View Angle
- (6) Dimension (1:2)
- (7) Ambient/Clean Air Flow or Cool Air Flow
- (8) Lubrication Point – Oil or Fluid
- (9) Task Related
- (10) Sectioning (1:3)
- (11) Gas Other Than Ambient Air or Hot Air Flow
- (12) Lubrication Point – Grease or Jelly
- (13) Multidirectional Arrow

Basic Knowledge and Tools Required

To use this manual most effectively, a general understanding of basic electrical circuits and circuit testing tools is required. You should be familiar with wiring diagrams, the meaning of voltage, ohms, amps and the basic theories of electricity. You should also understand what happens if a circuit becomes open, shorted to ground or shorted to voltage.

To perform system diagnostics, several special tools and equipment are required. Please become acquainted with the tools and their use before attempting to diagnose the system. Special tools that are required for system service are illustrated in this section.

Visual/Physical Checks

Visual/Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to repairing the condition without further diagnosis. Inspect all vacuum hoses for correct routing, pinches, cracks or disconnects. Inspect all wires in the engine compartment for proper connections, pinched wires or contact with sharp edges or hot manifolds. The visual/physical inspection is very important. It must be done carefully and thoroughly.

Electrostatic Discharge Damage

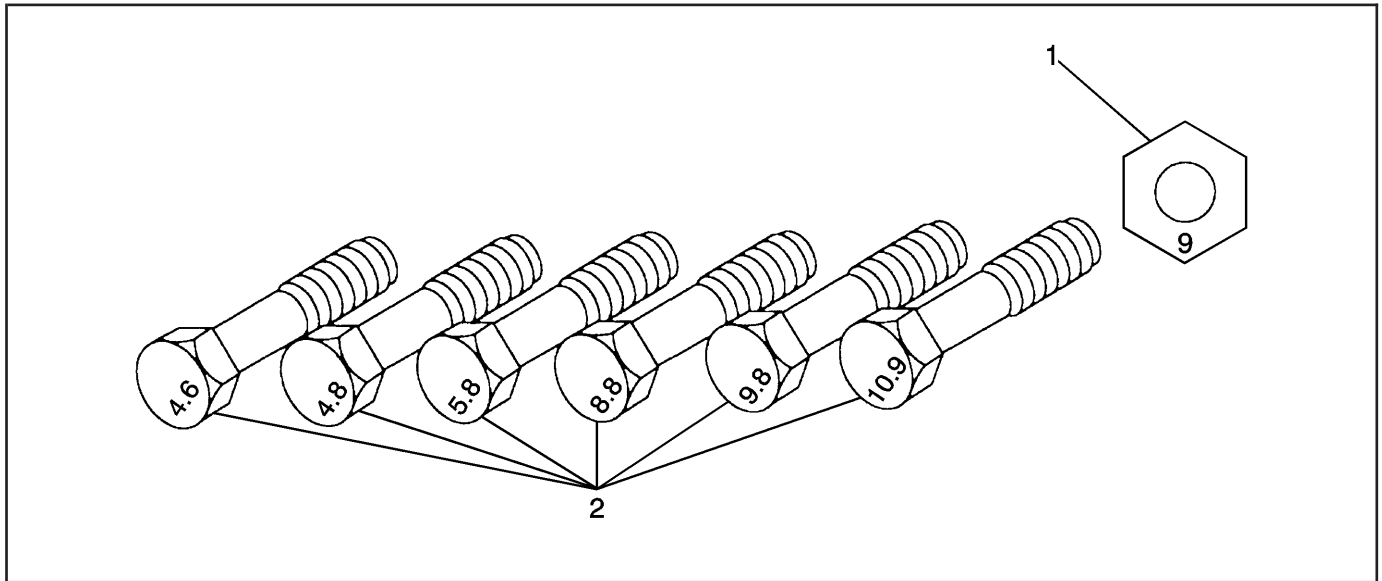
Electronic components used in control systems are often designed to carry very low voltage, and are very susceptible to damage caused by electrostatic discharge. It is possible for less than 100 volts of static electricity to cause damage to some electronic components. By comparison, it takes as much as 4,000 volts for a person to feel the zap of a static discharge.

There are several ways a person can become statically charged. The most common methods of charging are by friction and by induction. An example of charging by friction is a person sliding across a seat, in which a charge of as much as 25,000 volts can build up. Charging by induction occurs when a person with well insulated shoes stands near a highly charged object and momentarily touches ground. Charges of the same polarity are drained off, leaving the person highly charged with the opposite polarity. Static charges of either type can cause damage. Therefore, it is important to use care when handling and testing electronic components.

Engine Wiring

When it is necessary to move any of the wiring, whether to lift wires away from their harnesses or move harnesses to reach some component, take care that all wiring is replaced in its original position and all harnesses are routed correctly. If clips or retainers break, replace them. Electrical problems can result from wiring or harnesses becoming loose and moving from their original positions, or from being rerouted.

Fasteners



1245744

Fasteners

Application	Specification	
	Metric	English
M6 X 1.0		
4T–Low Carbon Steel	4.1–8.1 N·m	36–72 lb in
7T–High Carbon Steel	5.4–9.5 N·m	48–84 lb in
7T–Alloy Steel	—	—
M8 X 1.25		
4T–Low Carbon Steel	8.1–17.6 N·m	72–156 lb in
7T–High Carbon Steel	12.2–23.0 N·m	108–204 lb in
7T–Alloy Steel	16–30 N·m	12–22 lb ft
M10 X 1.25		
4T–Low Carbon Steel	20–34 N·m	15–25 lb ft
7T–High Carbon Steel	27–46 N·m	20–34 lb ft
7T–Alloy Steel	37–62 N·m	27–46 lb ft
M10 X 1.5		
4T–Low Carbon Steel	19–34 N·m	14–25 lb ft
7T–High Carbon Steel	27–45 N·m	20–33 lb ft
7T–Alloy Steel	37–60 N·m	27–44 lb ft
M12 X 1.25		
4T–Low Carbon Steel	49–73 N·m	36–54 lb ft
7T–High Carbon Steel	61–91 N·m	45–67 lb ft
7T–Alloy Steel	76–114 N·m	56–84 lb ft
M12 X 1.75		
4T–Low Carbon Steel	45–69 N·m	33–51 lb ft
7T–High Carbon Steel	57–84 N·m	42–62 lb ft
7T–Alloy Steel	72–107 N·m	53–79 lb ft

Fasteners (cont'd)

Application	Specification	
	Metric	English
M14 X 1.5		
4T–Low Carbon Steel	76–115 N·m	56–85 lb ft
7T–High Carbon Steel	94–140 N·m	69–103 lb ft
7T–Alloy Steel	114–171 N·m	84–126 lb ft
M14 X 2.0		
4T–Low Carbon Steel	72–107 N·m	53–79 lb ft
7T–High Carbon Steel	88–132 N·m	65–97 lb ft
7T–Alloy Steel	107–160 N·m	79–118 lb ft
M16 X 1.5		
4T–Low Carbon Steel	104–157 N·m	77–116 lb ft
7T–High Carbon Steel	136–203 N·m	100–150 lb ft
7T–Alloy Steel	160–240 N·m	118–177 lb ft
M16 X 2.0		
4T–Low Carbon Steel	100–149 N·m	74–110 lb ft
7T–High Carbon Steel	129–194 N·m	95–143 lb ft
7T–Alloy Steel	153–229 N·m	113–169 lb ft
M18 X 1.5		
4T–Low Carbon Steel	151–225 N·m	111–166 lb ft
7T–High Carbon Steel	195–293 N·m	144–216 lb ft
7T–Alloy Steel	229–346 N·m	169–255 lb ft
M20 X 1.5		
4T–Low Carbon Steel	206–311 N·m	152–229 lb ft
7T–High Carbon Steel	270–405 N·m	199–299 lb ft
7T–Alloy Steel	317–476 N·m	234–351 lb ft
M22 X 1.5		
4T–Low Carbon Steel	251–414 N·m	185–305 lb ft
7T–High Carbon Steel	363–544 N·m	268–401 lb ft
7T–Alloy Steel	424–636 N·m	313–469 lb ft
M24 X 2.0		
4T–Low Carbon Steel	359–540 N·m	265–398 lb ft
7T–High Carbon Steel	431–710 N·m	318–524 lb ft
7T–Alloy Steel	555–831 N·m	409–613 lb ft
*Diameter X pitch in millimeters		

Thread Inserts

Repair Procedure

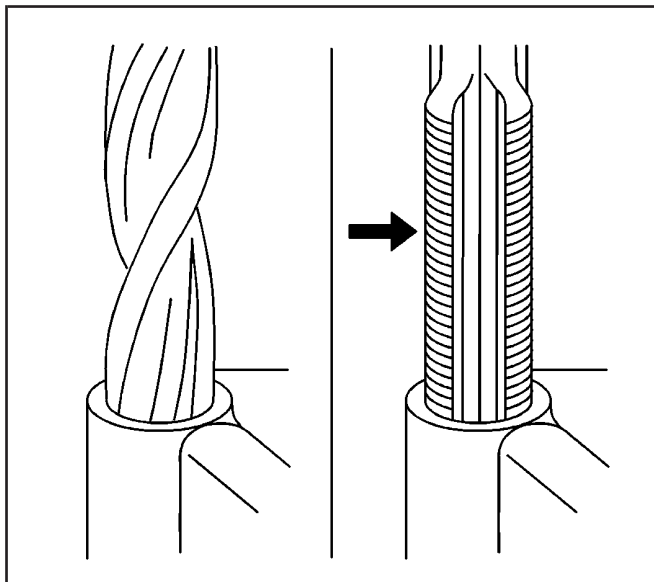
Tools Required

General purpose thread repair kits. These kits are available commercially.

Caution: Wear safety glasses in order to avoid eye damage.

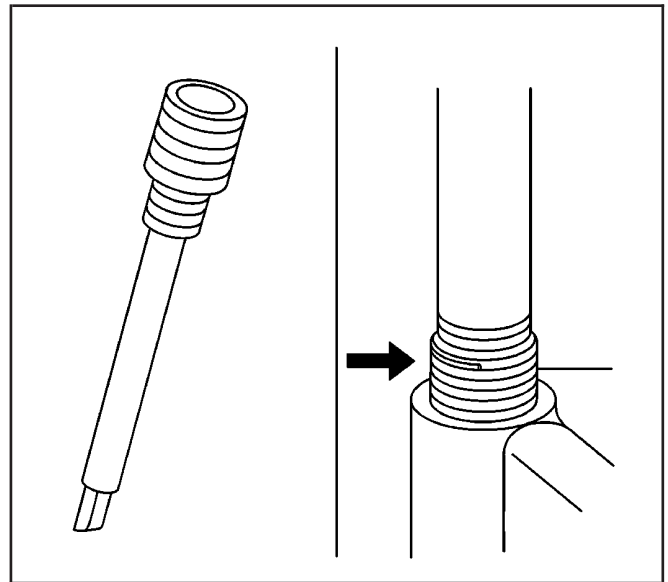
Important: Refer to the thread repair kit manufacturer's instructions regarding the size of the drill and tap to use.

Avoid any buildup of chips. Back out the tap every few turns and remove the chips.



4962

1. Determine the size, the pitch, and the depth of the damaged thread. If necessary, adjust the stop collars on the cutting tool and tap to the required depth.
2. Drill out the damaged threads. Clean out any chips.
3. Lubricate the tap with light engine oil. Tap the hole. Clean the threads.



4963

4. Thread the thread insert onto the mandrel of the installer. Engage the tang of the insert onto the end of the mandrel.

Important: The insert should be flush to one turn below the surface.

5. Lubricate the insert with light engine oil (except when installing in aluminum) and install the insert.
6. If the tang of the insert does not break off when backing out the installer, break the tang off with a drift.

Abbreviations and Meanings

Abbreviation	Meaning
A	
A	Ampere(s)
AC	Alternating Current
ACL	Air Cleaner
A/D	Analog to Digital
A/F	Air/Fuel Ratio
AM/FM	Amplitude Modulation/Frequency Modulation
ANT	Antenna
AP	Accelerator Pedal
API	American Petroleum Institute
APP	Accelerator Pedal Position
ATDC	After Top Dead Center
AUTO	Automatic
AVG	Average
AWG	American Wire Gauge
B	
B+	Battery Positive Voltage
BARO	Barometric Pressure
BATT	Battery

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
BHP	Brake Horsepower
BLK	Black
BLU	Blue
BP	Back Pressure
BRN	Brown
BTDC	Before Top Dead Center
BTU	British Thermal Units
C	
°C	Degrees Celsius
CAFE	Corporate Average Fuel Economy
CAL	Calibration
CAM	Camshaft
CAN	Controller Area Network
CARB	California Air Resources Board
CCP	CAN Communication Protocol
CEFI	Commercial Electronic Fuel Injection
CM ³	Cubic Centimeters
CFM	Cubic Feet per Minute
CG	Center of Gravity
CID	Cubic Inch Displacement
CKP	Crankshaft Position
CKT	Circuit
C/LTR	Cigar Lighter
CL	Closed Loop
CLS	Coolant Level Switch
CMP	Camshaft Position
CO	Carbon Monoxide
CO ₂	Carbon Dioxide
COAX	Coaxial
COMM	Communication
CONN	Connector
CPA	Connector Position Assurance
CPS	Central Power Supply
CPU	Central Processing Unit
CS	Charging System
CSFI	Central Sequential Fuel Injection
CTP	Closed Throttle Position
CU FT	Cubic Foot/Feet
CU IN	Cubic Inch/Inches
CYL	Cylinder(s)
D	
DB	Decibels
DBA	Decibels on A-weighted Scale
DC	Direct Current, Duty Cycle
DE	Drive End
DEC	Digital Electronic Controller
DI	Distributor Ignition
DIA	Diameter

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
DEG	Degrees
DI	Distributor Ignition
DIC	Driver Information Center
DIAG	Diagnostic
DIST	Distributor
DK	Dark
DLC	Data Link Connector
DMM	Digital Multimeter
DOHC	Dual Overhead Camshafts
DR, DRVR	Driver
DTC	Diagnostic Trouble Code
E	
EC	Electrical Center, Engine Control
ECL	Engine Coolant Level
ECM	Engine Control Module, Electronic Control Module
ECS	Emission Control System
ECT	Engine Coolant Temperature
EEPROM	Electrically Erasable Programmable Read Only Memory
EI	Electronic Ignition
E/M	English/Metric
EMF	Electromotive Force
EMI	Electromagnetic Interference
Eng	Engine
EOP	Engine Oil Pressure
EOT	Engine Oil Temperature
EPA	Environmental Protection Agency
EPROM	Erasable Programmable Read Only Memory
ESD	Electrostatic Discharge
ESN	Electronic Serial Number
EST	Electronic Spark Timing
E-STOP	Emergency Stop
ETC	Electronic Throttle Control, Electronic Temperature Control, Electronic Timing Control
Exh	Exhaust
F	
°F	Degrees Fahrenheit
FC	Fan Control
FED	Federal All United States except California
FEDS	Fuel Enable Data Stream
FI	Fuel Injection
FP	Fuel Pump
ft	Foot/Feet
FT	Fuel Trim
FL	Fuel Level
FMI	Failure Mode Indicator

1-10 General Information

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
G	
G	Grams, Gravitational Acceleration
GA	Gauge
GAL	Gallon
GAS	Gasoline
GCW	Gross Combination Weight
GEN	Generator
GL	Gear Lubricant
GM	General Motors
GM SPO	General Motors Service Parts Operations
GND	Ground
GOV	Governor
GPH	Gallons Per Hour
GPM	Gallons per Minute
GRN	Green
GRY	Gray
GVWR	Gross Vehicle Weight Rating
H	
H	Hydrogen
H ₂ O	Water
Harn	Harness
HC	Hydrocarbons
H/CMPR	High Compression
hex	Hexagon, Hexadecimal
Hg	Mercury
HI ALT	High Altitude
HO ₂ S	Heated Oxygen Sensor
HP	Horsepower
HPS	High Performance System
HPV	High Pressure Vapor
HTD	Heated
HTR	Heater
HZ	Hertz
I	
IAC	Idle Air Control
IAT	Intake Air Temperature
IC	Integrated Circuit, Ignition Control
ICM	Ignition Control Module
ID	Identification, Inside Diameter
IGN	Ignition
IN	Inch/Inches
INJ	Injection, Injector
I/O	Input/Output
IP	Instrument Panel
IPC	Instrument Panel Cluster
I/PEC	Instrument Panel Electrical Center
ISC	Idle Speed Control

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
ISO	International Standards Organization
ISS	Input Speed Shaft, Input Shaft Speed
K	
KAM	Keep Alive Memory
KG	Kilogram
KHZ	Kilohertz
KM	Kilometer
KM/H	Kilometers per Hour
KPA	Kilopascals
KS	Knock Sensor
KV	Kilovolts
L	
L	Liter
L4	Four Cylinder Engine, In-Line
LB	Pound
LB/FT	Pound Feet Torque
LB/IN	Pound Inch Torque
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LM	Lumens
LR	Left Rear
LT	Left
LT	Light
LT	Long Term
M	
MAF	Mass Air Flow
MAP	Manifold Absolute Pressure
MAT	Manifold Absolute Temperature
MAX	Maximum
M/C	Mixture Control
MDP	Manifold Differential Pressure
MEFI	Marine Electronic Fuel Injection
MFI	Multiport Fuel Injection
MI	Miles
MIL	Malfunction Indicator Lamp
MIN	Minimum
ML	Milliliter
MM	Millimeter
MPH	Miles per Hour
MS	Millisecond
MV	Millivolt
N	
NC	Normally Closed
NEG	Negative
NEU	Neutral
NI	Neutral Idle
NLGI	National Lubricating Grease Institute
N·m	Newton-meter Torque

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
NO	Normally Open
NOx	Oxides of Nitrogen
NPTC	National Pipe Thread Coarse
NPTF	National Pipe Thread Fine
NVRAM	Non-Volatile Random Access Memory
O	
O ₂	Oxygen
O ₂ S	Oxygen Sensor
OBD	On-Board Diagnostics
OBDM	On-Board Diagnostics Marine
OC	Oxidation Converter Catalytic
OD	Outside Diameter
ODM	Output Drive Module
ODO	Odometer
OE	Original Equipment
OEM	Original Equipment Manufacturer
OHC	Overhead Camshaft
Ω	Ohm
OL	Open Loop, Out of Limits
OPT	Optional
ORC	Oxidation Reduction Converter Catalytic
ORN	Orange
OSS	Output Shaft Speed
OZ	Ounce(s)
P	
PC	Personal Computer, Pressure Control
PCB	Printed Circuit Board
PCM	Powertrain Control Module
PCS	Pressure Control Solenoid
PCV	Positive Crankcase Ventilation
PFI	Port Fuel Injection
PID	Parameter Identification
P/N	Part Number
PNK	Pink
PNP	Park/Neutral Position
POS	Positive, Position
POT	Potentiometer Variable Resistor
PPL	Purple
PPM	Parts per Million
PPS	Pedal Position Sensor
PROM	Programmable Read Only Memory
PRNDL	Park, Reverse, Neutral, Drive, Low
P/S, PS	Power Steering
PSP	Power Steering Pressure
PSI	Pounds per Square Inch
PSIA	Pounds per Square Inch Absolute
PSIG	Pounds per Square Inch Gauge

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
PT	Pint
PTC	Positive Temperature Coefficient
PWM	Pulse Width Modulated
Q	
QDM	Quad Driver Module
QT	Quart(s)
R	
RAM	Random Access Memory, Non-permanent memory device, memory contents are lost when power is removed.
REF	Reference
RH	Right Hand
RLY	Relay
ROM	Read Only Memory, Permanent memory device, memory contents are retained when power is removed.
RPM	Revolutions per Minute Engine Speed
RPO	Regular Production Option
RR	Right Rear
RT	Right
S	
S	Second(s)
SAE	Society of Automotive Engineers
SC	Supercharger
SCB	Supercharger Bypass
SFI	Sequential Multiport Fuel Injection
SLV	Slave
SOL	Solenoid
SO ₂	Sulfur Dioxide
SP	Splice Pack
S/P	Series/Parallel
SPN	Suspect Parameter Number
SPO	Service Parts Operations
SPS	Service Programming System, Speed Signal
SQ FT, FT ²	Square Foot/Feet
SQ IN, IN ²	Square Inch/Inches
SRI	Service Reminder Indicator
ST	Scan Tool
SW	Switch
SYN	Synchronizer
T	
TAC	Throttle Actuator Control
TACH	Tachometer
TBI	Throttle Body Fuel Injection
TC	Turbocharger, Transmission Control
TDC	Top Dead Center
TEMP	Temperature
TERM	Terminal

1-12 General Information

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
TP	Throttle Position
TPA	Terminal Positive Assurance
TPS	Throttle Position Sensor
TSC	Throttle Shift Control
TT	Tell Tail Warning Lamp
TV	Throttle Valve
TWC	Three Way Converter Catalytic
TWC+OC	Three Way + Oxidation Converter Catalytic
U	
UART	Universal Asynchronous Receiver Transmitter
U-joint	Universal Joint
UV	Ultraviolet
V	
V	Volt(s), Voltage
V6	Six-Cylinder Engine, V-Type
V8	Eight-Cylinder Engine, V-Type

Abbreviations and Meanings (cont'd)

Abbreviation	Meaning
VAC	Vacuum
VIO	Violet
VIN	Vehicle Identification Number
VR	Voltage Regulator
V REF	Voltage Reference
VSS	Vehicle Speed Sensor
W	
W/	With
WHT	White
W/O	Without
WOT	Wide Open Throttle
W/P	Water Pump
W/S	Windshield
Y	
YD	Yard(s)
YEL	Yellow

Section 6

Diagnostic Overview, Starting Point, and Programming

Programming and Setup	6-3	On-Board Diagnostic System Check	6-8
Repair Instructions	6-3	Malfunction Indicator Lamp (MIL)	6-8
Engine Control Module Programming		Reading Suspect Parameter Numbers	6-8
and Setup	6-3	Clearing Suspect Parameter Numbers	6-8
Vehicle Diagnostic Information	6-4	Suspect Parameter Number (SPN) Type	
Diagnostic Information and Procedures	6-4	Definitions	6-9
Strategy Based Diagnosis	6-4	Failure Mode Indicator (FMI) Definitions	6-10
Diagnostic Procedure Instructions	6-5	Diagnostic Trouble Code (DTC) List	6-11
Non-Scan Diagnosis of Driveability		Data Link Connector Scan Tools	6-22
Concerns - No DTCs Set	6-7	Scan Tool Use with Intermittents	6-22
Engine Control Module (ECM)		Diagnostic Repair Verification	6-22
Self-Diagnosis	6-8		

BLANK

Programming and Setup

Repair Instructions

Engine Control Module Programming and Setup

For step-by-step programming instructions, please refer to the manufacturers guidelines.

Review the information below to ensure proper programming protocol.

Important:

- DO NOT program a control module unless you are directed by a service procedure or you are directed by the manufacturers service bulletin. Programming a control module at any other time will not permanently correct a customers concern.
- It is essential that the Scan Tool is equipped with the latest software before performing service programming.
- Due to the time requirements of programming a controller, it is recommended that an external power source be used to maintain system voltage. Stable battery voltage is critical during programming. Any fluctuation, spiking, over voltage or loss of voltage will interrupt programming.
- SPNs may set during programming. Clear DTCs after programming is complete.

Ensure the following conditions are met before programming a control module:

- Vehicle system voltage
 - There is not a charging system concern. All charging system concerns must be repaired before programming a control module.
 - Battery voltage is greater than 12 volts but less than 16 volts. The battery must be fully charged before programming the control module.
 - Turn OFF or disable any system that may put a load on the vehicles battery, such as the following components:
 - Engine electrical loads are turned OFF, radio, etc.

- The ignition switch must be in the proper position. Turn ON the ignition, with the engine OFF. DO NOT change the position of the ignition switch during the programming procedure, unless instructed to do so.
- Make certain all tool connections are secure, including the following components and circuits:
 - The connection at the data link connector (DLC)
 - The voltage supply circuits
- DO NOT disturb the tool harnesses while programming. If an interruption occurs during the programming procedure, programming failure or control module damage may occur.
- DO NOT turn OFF the ignition if the programming procedure is interrupted or unsuccessful. Ensure that all control module and DLC connections are secure and the operating software is up to date. Attempt to reprogram the control module. If the control module cannot be programmed, replace the control module.

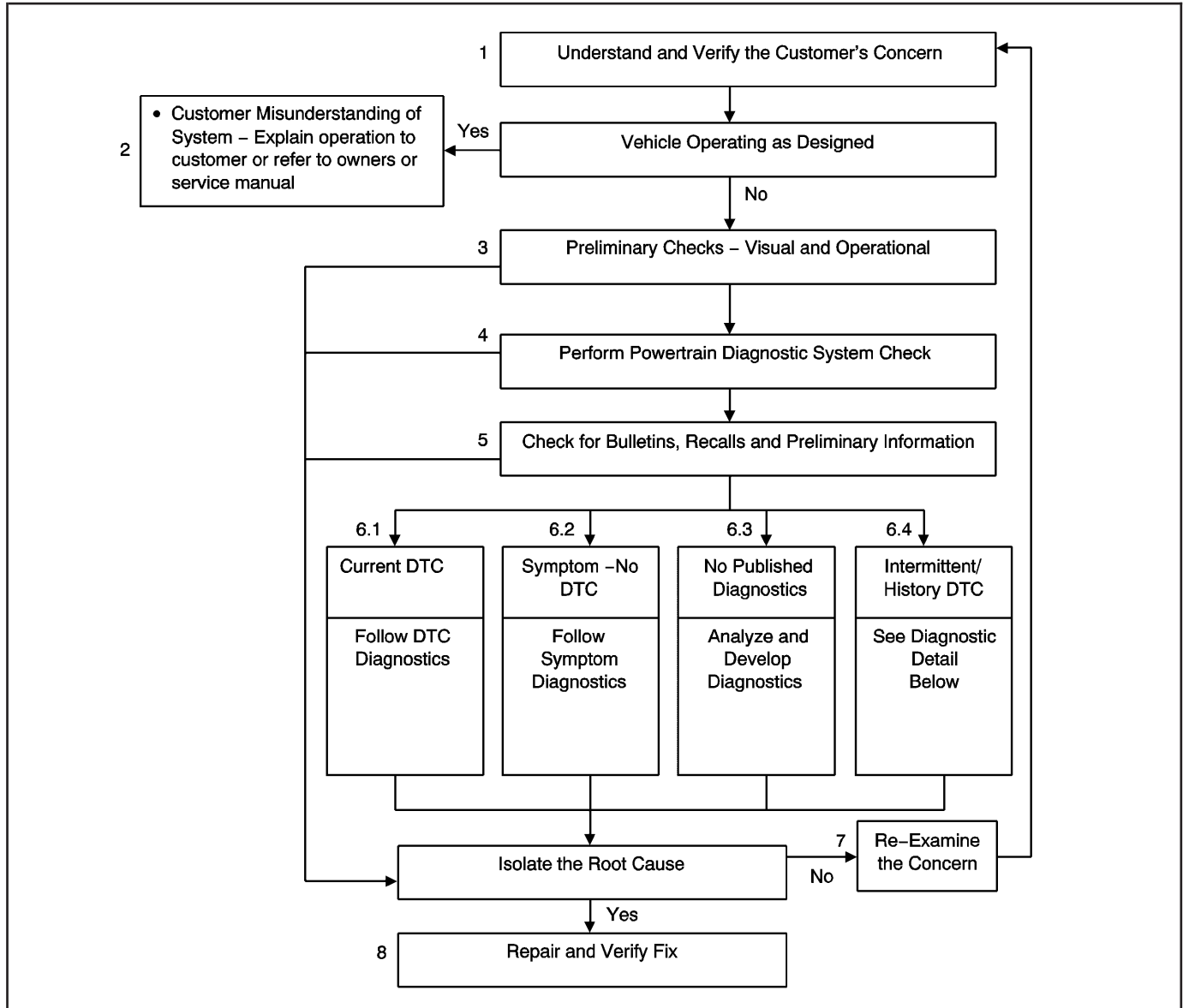
Vehicle Diagnostic Information

Diagnostic Information and Procedures

Strategy Based Diagnosis

The goal of Strategy Based Diagnosis is to provide guidance when you create a plan of action for each specific diagnostic situation. Following a similar plan for each diagnostic situation, you will achieve maximum efficiency when you diagnose and repair vehicles. Although each of the Strategy Based

Diagnosis boxes is numbered, you are not required to complete every box in order to successfully diagnose a customer concern. The first step of your diagnostic process should always be Understand and Verify the Customer's Concern. The final step of your diagnostic process should be Repair and verify the Fix. Refer to the following chart for the correct Strategy Based Diagnosis.



2002024

1. Understand and Verify the Customers Concern:
The first part of this step is to obtain as much information as possible from the customer. Are there aftermarket accessories on the vehicle? When does the condition occur? Where does the condition occur? How long does the condition last? How often does the condition occur?

In order to verify the concern, the technician should be familiar with the normal operation of the system and refer to the owner or service manual for any information needed.

2. **Vehicle Operating as Designed:** This condition exists when the vehicle is found to operate normally. The condition described by the customer may be normal. Explain your findings and the operation of the system to the customer.
3. **Preliminary Checks:** Conduct a thorough visual inspection. Review the service history. Detect unusual sounds or odors. Gather diagnostic trouble code (DTC) information in order to achieve an effective repair.
4. **The *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64** verifies the proper operation of the system. This will lead the technician in an organized approach to diagnostics.
5. Check Bulletins, or Recalls.
6. Diagnostic categories:
 - 6.1. **Current DTC:** Follow the designated DTC diagnostic in order to make an effective repair. Refer to DTC List.
 - 6.2. **Symptom - No DTC:** Select the appropriate symptom diagnostic. Follow the diagnostic steps or suggestions in order to complete the repair. Refer to *Symptoms - Engine Controls* on page 9-199.
 - 6.3. **No Published Diagnostics:** Analyze the Concern. Develop a plan for the diagnostics. The service manual schematics will help you to see system power, ground, input, and output circuits. You can also identify splices and other areas where multiple circuits are tied together. Look at component locations to see if components, connectors or harnesses may be exposed to extreme temperature, moisture, or corrosives (salt, battery acid, oil or other fluids). Utilize the wiring diagrams, system description.
 - 6.4. **Intermittent/History DTC:** An intermittent condition is one that does not occur continuously, may be difficult to duplicate, and will only occur when certain conditions are met. Generally, an intermittent is caused by faulty electrical connections and wiring, malfunctioning components, electromagnetic/radio frequency interference, driving conditions, or aftermarket equipment. The following approaches/tools may prove to be beneficial in locating and repairing an intermittent condition or history DTC.
 - Combining technicians knowledge with the available service information.
 - Follow the suggestions on *Testing for Intermittent Conditions and Poor Connections* on page 11-13.
 - Use the available scan tool or digital multi-meter.

7. **Re-examine the Concern:** If a technician cannot successfully find or isolate the concern, a re-evaluation is necessary. Re-verify the concern. The concern could be an intermittent or normal condition.
8. **Repair and Verify Fix:** After isolating the root cause, make the repairs and validate for the correct operation by performing the Diagnostic Repair Verification. Verifying that the DTC or symptom has been corrected may involve testing the vehicle.

Diagnostic Procedure Instructions

The following is an overview of instructions for all 16 categories which may be included in a diagnostic procedure.

Diagnostic Instructions

A link to the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 is provided here. This procedure should be performed prior to performing other diagnostic procedures, as this prevents misdiagnosis where there are integrated system dependencies.

A link to the *Strategy Based Diagnosis* on page 6-4 is provided here. This provides an overview on how a technician should diagnose a vehicle.

A link to the *Diagnostic Procedure Instructions* on page 6-5 is provided here. This information is an overview of instructions for all 16 categories which may be included in a diagnostic procedure.

DTC Descriptor

Describes what DTCs are diagnosed in this procedure. The DTC number, with Symptom Description when applicable, and descriptor are written out.

Diagnostic Fault Information

The diagnostic Fault Information table identifies each circuit that makes up an electrical subsystem and the associated circuit faults. DTCs and symptoms are listed in the table for all circuit fault modes. This information can be used to diagnose an electrical fault, or as a quick visual aid showing how the different symptoms and DTCs apply for the subsystem being diagnosed.

6-6 Vehicle Diagnostic Information

Even though all the DTCs and symptoms are shown in this table it does not mean they will all be diagnosed in the same procedure.

An example table from an engine coolant temperature (ECT) procedure:

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	110–4	110–3	110–3*	110–15
Low Reference	—	110–3	*	—
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

The Typical Scan Tool Data table identifies a scan tool data parameter and its value in reference to potential circuit faults.

An example table from an ECT procedure:

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: Varies with ambient temperature			
ECT Sensor Signal	152°C (305°F)	–40°C (–40°F)	–40°C (–40°F)*
Low Reference	—	–40°C (–40°F)	–40°C (–40°F)*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

Circuit/System Description identifies how a circuit/system normally functions.

Conditions for Running the DTC

Conditions for Running the DTC, identifies what conditions must be present to allow the diagnostic to run.

Conditions for Setting the DTC

Conditions for Setting the DTC, identifies the condition(s) that must be present in order to fail the diagnostic and when to set the DTC.

Action Taken When the DTC Sets

Actions Taken When the DTC sets, identifies the default actions taken when a control module sets a DTC.

Conditions for Clearing the DTC

Conditions for Clearing the DTC, identifies the conditions that must be met in order to clear the DTC.

Diagnostic Aids

Diagnostic Aids are suggestions which explain other methods to diagnose the condition. It also provides unique information about the system used to assist the technician in finding and repairing a vehicle condition.

Reference Information

Reference Information includes links providing additional information for the diagnostic procedure.

For example:

- Schematic Reference
- Connector End View Reference
- Description and Operation
- Electrical Information Reference
- DTC Type Reference
- Scan Tool Reference
- Special Tools Required

Circuit/System Verification

The diagnostic format does not force a technician to any of the 3 diagnostic categories (Circuit/System Verification, Circuit/System Testing and Component Testing). However, performing the Circuit/System Verification category first, aids in determining if a vehicle condition is current. This category also serves to route the technician to another diagnostic procedure which should be performed first; for example, a DTC with a higher priority.

Circuit/System Verification is a non-intrusive procedure outlining how to verify that a system or a portion of a system is functioning correctly. During the verification process, the vehicle is kept intact and tested as a complete system. This verification is used to assist the technician in determining whether a condition is current or intermittent. When a condition is determined to be intermittent, a technician can use the link in Electrical Information Reference: *Testing for Intermittent Conditions and Poor Connections on page 11-13*.

The technician should be able to identify if the fault is occurring on the input circuit – signal or on the output circuit – control when applicable. The technician will need to decide from the verification results if the system is working correctly or if further diagnosis needs to be performed in either Circuit/System Testing and/or Component Testing.

Circuit/System Testing

The diagnostic format does not force a technician to any of the 3 diagnostic categories (Circuit/System Verification, Circuit/System Testing and Component Testing). However, beginning with the Circuit/System Verification category aids in determining if a vehicle condition is current.

Circuit/System Testing is a step by step, positive-flow, testing sequence which allows the technician to perform each test step, in sequence, until a fault is detected. If the result of a test step is achieved, the normal flow is to proceed to the next step. If the result is NOT achieved, the repair arrow bullet (➤) will identify what actions need to take place.

Intrusive diagnostics are performed to locate the system fault. System harness connections are disconnected from the module or component to test individual circuit functions. The module or component will be used to assist in verifying the circuit function. When a test does not pass, the repair steps (➤) will indicate what circuit faults to test. For example, short to voltage, short to ground or open/high resistance.

When testing for individual circuit faults, the technician is expected to include terminal inspections such as connection surfaces and terminal tension at both the harness and component/module. Additionally, a technician can use the links in Electrical Information Reference: *Testing for Intermittent Conditions and Poor Connections on page 11-13* or *Circuit Testing on page 11-6*.

The control modules and components will also be diagnosed during these test steps. A retest of a control module or component should always be performed before replacement. For example, re-connect all components and modules and retest the system to verify the condition still exists before replacing modules or components.

Component Testing

The diagnostic format does not force a technician to any of the 3 diagnostic categories (Circuit/System Verification, Circuit/System Testing and Component Testing). However, beginning with the Circuit/System Verification category aids in determining if a vehicle condition is current.

Component Testing can offer static and/or dynamic component tests. These tests can be used to verify if a component is operating correctly to avoid unnecessary replacement.

Testing modules in this category will not be offered. In most cases, the module is used to verify the harness circuits in the Circuit/System Testing category and a retest of the module should always be performed before replacement.

Repair Instructions

Repair Instructions provides a link to *Diagnostic Repair Verification on page 6-22*. This link describes how to verify the vehicle is repaired.

All links to Repair or Replacement procedures are located here.

Repair Verification

Repair Verification describes how to verify the vehicle is repaired when additional instructions are needed beyond what is in Diagnostic Repair Verification.

Non-Scan Diagnosis of Driveability Concerns - No DTCs Set

If a driveability condition still exists after following the Powertrain OBD system check and reviewing the Symptoms tables, a sensor that is stuck in range may be the cause. In the case of a sensor or circuit malfunction, the ECM will replace sensed values with calibrated default values. This feature allows limited engine performance until the condition is repaired. If a sensor is stuck within the normal operating range, the condition may go undetected by the ECM, and could result in a driveability concern. A basic understanding of sensor operation is necessary in order to diagnose a sensor that is stuck in range.

An example of a sensor that is stuck in range would be if the coolant sensor is reading 10°C (50°F), but the actual coolant temperature is 66°C (150°F). This condition would cause the ECM to deliver more fuel than is actually required by the engine. This would result in an overly rich condition, and cause the engine to run rough. This condition would not set a diagnostic trouble code (DTC), because the ECT value is within the normal operating range. To help identify a sensor that is stuck in range, operate the engine under various conditions, while observing the appropriate scan tool parameter. The parameter value should vary as engine temperature, engine speed, or load is varied.

6-8 Vehicle Diagnostic Information

Resistance on a low reference circuit, or signal circuit may also cause a sensor value to be incorrect. If this condition is suspected, disconnecting the sensor and testing the circuits may isolate the condition. Refer to the appropriate Circuit/System Testing procedure for the applicable sensor to assist in testing the circuit.

Engine Control Module (ECM) Self-Diagnosis

The marine engine has electronic controls to reduce exhaust emissions while maintaining excellent driveability and fuel economy. The engine control module (ECM) is the control center of this system. The ECM performs continuous self diagnosis on numerous engine and vehicle functions. The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect vehicle performance and emissions. The ECM also performs the diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the malfunction indicator lamp (MIL), or a buzzer. When the ECM detects a malfunction, the ECM stores a diagnostic trouble code (DTC). The problem area is identified by the particular DTC that is set. The DTCs are identified by two sets of numbers. The first set of numbers is called the Suspect Parameter Number (SPN). This number identifies the system that has a condition. The second set of numbers is called the Failure Mode Indicator (FMI). This number identifies the condition that is occurring at the location. An example of this numbering strategy is as follows:

SPN 66003 FMI 3

- SPN 66003 is the Malfunction Indicator Lamp (MIL) Control Circuit
- FMI 3 indicates that the circuit is Shorted to a Voltage

Refer to *Failure Mode Indicator (FMI) Definitions on page 6-10* for further FMI information.

On-Board Diagnostic System Check

After performing the visual/physical inspection, the Powertrain On-Board Diagnostic (OBD) System Check is the starting point for all diagnostic procedures. Refer to *Powertrain On Board Diagnostic (OBD) System Check on page 9-64*.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) is located in the instrument panel cluster. The MIL indicates that an emissions related fault has occurred and vehicle service is required.

The following is a list of the modes of operation for the MIL:

- The MIL illuminates when the ignition is turned ON, with the engine OFF. This is a bulb test to ensure the MIL is able to illuminate.
- The MIL turns OFF after the engine is started if a diagnostic fault is not present.

- The MIL remains illuminated after the engine is started if the control module detects a fault. A diagnostic trouble code (DTC) is stored any time the control module illuminates the MIL due to an emissions related fault. The MIL turns OFF after three consecutive ignition cycles in which a Test Passed has been reported for the diagnostic test that originally caused the MIL to illuminate.
- The MIL flashes if the control module detects a misfire condition which could damage the catalytic converter.
- When the MIL is illuminated and the engine stalls, the MIL will remain illuminated as long as the ignition is ON.
- When the MIL is not illuminated and the engine stalls, the MIL will not illuminate until the ignition is cycled OFF and then ON.

Reading Suspect Parameter Numbers

The data link connector (DLC) provides the technician a means of accessing serial data for aid in diagnosis. This connector allows the technician to use a scan tool in order to monitor the various serial data parameters, and to display diagnostic trouble code (DTC) information. The DTCs are displayed on the scan tool as a SPN. The SPN(s) stored in the ECM memory can be retrieved through a hand-held diagnostic scanner plugged into the DLC, or through a PC based software program that is designed to interface with the ECM.

Clearing Suspect Parameter Numbers

1. Install scan tool or use PC based software.
 2. Engine idling, observe the scan tool diagnostic trouble code (DTC) information.
 3. Select clear DTC function.
 4. Clear DTC's.
- Important:** When clearing DTCs with the scan tool, the ignition must be cycled OFF or the DTCs will not clear.
5. Ignition OFF for 20 seconds.
 6. Engine idling, observe the scan tool DTC information. Verify no DTCs reset.
- ⇒ If any DTCs reset, refer to *Powertrain On Board Diagnostic (OBD) System Check on page 9-64* for further diagnosis.

Suspect Parameter Number (SPN) Type Definitions

Emissions Related SPNs

Action Taken When the SPN Sets – Type A

- 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 SPN Sets – Type B

- 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.
- The following applies to misfire SPNs
 - If the control module detects a low level or an emission level misfire condition during 2 consecutive trips, the control module illuminates the MIL.
 - If the control module detects a high level or catalyst damaging misfire, the control module flashes the MIL at a rate of once per second.
 - If the control module detects a misfire during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:
 - The engine load is within a certain percentage of the previous test that failed.
 - The engine speed is within a certain percentage of the previous test that failed.
 - The engine coolant temperature is in the same range of the previous test that failed.

- The following applies to fuel trim SPNs
 - If the control module detects a fuel trim condition during 2 consecutive trips, the control module illuminates the MIL.
 - If the control module detects a fuel trim condition during 2 non-consecutive trips, the stored conditions are compared with the current conditions. The control module illuminates the MIL when the following conditions occur:
 - The engine load is within a certain percentage of the previous test that failed.
 - The engine speed is within a certain percentage of the previous test that failed.
 - The engine coolant temperature is in the same range of the previous test that failed.

Action Taken When the SPN Sets – Type E

- The control module illuminates the MIL on the third 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 third 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/SPN – Type A, B or Type E

- The control module turns OFF the MIL after 3 consecutive ignition cycles that the diagnostic runs and does not fail.
- A current SPN, Last Test Failed, clears when the diagnostic runs and passes.
- A history SPN 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 SPN with a scan tool.

Non-Emissions Related SPNs

Action Taken When the SPN Sets – Type C

- The control module stores the SPN information into memory when the diagnostic runs and fails.
- The Service Vessel Soon (SVS) lamp, if equipped, will illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.

Action Taken When the SPN Sets – Type C1

- The control module stores the SPN information into memory when the diagnostic runs and fails.
- The DTC 1 lamp, if equipped, will illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.

Action Taken When the SPN Sets – Type C2

- The control module stores the SPN information into memory when the diagnostic runs and fails.
- The DTC 2 lamp, if equipped, will illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.

Action Taken When the SPN Sets – Type C3

- The control module stores the SPN information into memory when the diagnostic runs and fails.
- The DTC 3 lamp, if equipped, will illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.

Conditions for Clearing the SPN – Type C

- A current SPN Last Test Failed clears when the diagnostic runs and passes.
- A history SPN clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the SPN with a scan tool.

Failure Mode Indicator (FMI) Definitions

The DTCs are identified by two sets of numbers. The first set of numbers is called the Suspect Parameter Number (SPN). This number identifies the system that has a condition. The second set of numbers is called the Failure Mode Indicator (FMI). The following is a list of the possible FMIs that may be displayed.

Failure Mode Indicator (FMI) Definitions

FMI	Descriptor
FMI 0	Data valid but above normal
FMI 1	Data valid but below normal
FMI 2	Data erratic, intermittent or incorrect
FMI 3	Voltage above normal or shorted high
FMI 4	Voltage below normal or shorted low
FMI 5	Current below normal or open circuit
FMI 6	Current above normal or grounded circuit
FMI 7	Mechanical system not responding or out of adjustment
FMI 8	Abnormal frequency or pulse width
FMI 9	Abnormal update rate
FMI 10	Abnormal rate of change
FMI 11	Root cause unknown
FMI 12	Bad intelligent device or component
FMI 13	Out of calibration
FMI 14	Special instructions
FMI 15	Data valid but above normal range - Least Severe Level
FMI 16	Data valid but above normal range - Moderate Severe Level
FMI 17	Data valid but below normal range - Least Severe Level
FMI 18	Data valid but below normal range - Moderate Severe Level
FMI 19	Received network data error
FMI 20–30	Reserved for SAE assignment
FMI 31	Not available

Diagnostic Trouble Code (DTC) List

This master DTC list includes all applicable DTCs in alphanumeric order with descriptors.

Diagnostic Trouble Code (DTC) List

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
38	3	Fuel Level Sensor 2 Voltage Above Normal or Shorted High	SPN 38 or 96 on page 9-65
38	4	Fuel Level Sensor 2 Voltage Below Normal or Shorted Low	SPN 38 or 96 on page 9-65
51	0	Throttle Position (TP) Sensor Circuit Voltage Data Valid but Above Normal	SPN 51 on page 9-67
51	3	Throttle Position (TP) Sensor Circuit Voltage Above Normal or Shorted High	SPN 51 on page 9-67
51	4	Throttle Position (TP) Sensor Circuit Voltage Below Normal or Shorted Low	SPN 51 on page 9-67
84	1	Vehicle Speed Sensor Data Valid but Below Normal	SPN 84 on page 9-69
84	2	Vehicle Speed Sensor Data Erratic, Intermittent or Incorrect	SPN 84 on page 9-69
84	3	Vehicle Speed Sensor Voltage Above Normal or Shorted High	SPN 84 on page 9-69
84	4	Vehicle Speed Sensor Voltage Below Normal or Shorted Low	SPN 84 on page 9-69
94	3	Fuel Pressure Sensor Voltage Above Normal or Shorted High	SPN 94 on page 9-71
94	4	Fuel Pressure Sensor Voltage Below Normal or Shorted Low	SPN 94 on page 9-71
94	15	Fuel Pressure Data Valid But Above Normal Range-Least Severe Level	SPN 94 on page 9-71
94	17	Fuel Pressure Data Valid But Below Normal Range-Least Severe Level	SPN 94 on page 9-71
96	3	Fuel Level Sensor 1 Voltage Above Normal or Shorted High	SPN 38 or 96 on page 9-65
96	4	Fuel Level Sensor 1 Voltage Below Normal or Shorted Low	SPN 38 or 96 on page 9-65
98	17	Oil Level Data Valid But Below Normal Range-Least Severe Level	SPN 98 on page 9-73
100	3	Oil Pressure Sensor Voltage Above Normal or Shorted High	SPN 100 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-75 or SPN 100 (6.0L, 6.2L) on page 9-77
100	4	Oil Pressure Sensor Voltage Below Normal or Shorted Low	SPN 100 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-75 or SPN 100 (6.0L, 6.2L) on page 9-77
100	17	Oil Pressure Sensor Data Valid But Below Normal Range-Least Severe Level	SPN 100 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-75 or SPN 100 (6.0L, 6.2L) on page 9-77
105	3	Manifold Air Temperature Sensor Voltage Above Normal or Shorted High	SPN 105 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-79 or SPN 105 (2.4L, 6.0L, 6.2L) on page 9-81
105	4	Manifold Air Temperature Sensor Voltage Below Normal or Shorted Low	SPN 105 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-79 or SPN 105 (2.4L, 6.0L, 6.2L) on page 9-81

6-12 Vehicle Diagnostic Information

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
105	15	Manifold Air Temperature (MAT) Sensor Circuit Voltage Data Valid But Above Normal Range-Least Severe Level	SPN 105 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-79 or SPN 105 (2.4L, 6.0L, 6.2L) on page 9-81
106	0	MAP Sensor Data Valid But Above Normal	SPN 106 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-83 or SPN 106 (2.4L, 6.0L, 6.2L) on page 9-86
106	1	MAP Sensor Data Valid But Below Normal	SPN 106 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-83 or SPN 106 (2.4L, 6.0L, 6.2L) on page 9-86
106	2	MAP Sensor Data Erratic, Intermittent or Incorrect	SPN 106 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-83 or SPN 106 (2.4L, 6.0L, 6.2L) on page 9-86
106	3	MAP Sensor Voltage Above Normal or Shorted High	SPN 106 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-83 or SPN 106 (2.4L, 6.0L, 6.2L) on page 9-86
106	4	MAP Sensor Voltage Below Normal or Shorted Low	SPN 106 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-83 or SPN 106 (2.4L, 6.0L, 6.2L) on page 9-86
108	2	BARO Sensor Voltage Data Erratic, Intermittent or Incorrect	SPN 108 on page 9-89
108	3	BARO Sensor Voltage Above Normal or Shorted High	SPN 108 on page 9-89
108	4	BARO Sensor Voltage Below Normal or Shorted Low	SPN 108 on page 9-89
108	10	BARO Sensor Voltage Abnormal Rate of Change	SPN 108 on page 9-89
110	3	Engine Coolant Temperature Sensor Voltage Above Normal or Shorted High	SPN 110 on page 9-91
110	4	Engine Coolant Temperature Sensor Voltage Below Normal or Shorted Low	SPN 110 on page 9-91
110	15	Engine Coolant Temperature Sensor Data Valid But Above Normal Range-Least Severe Level	SPN 110 on page 9-91
110	16	Engine Coolant Temperature (ECT) Sensor Circuit Voltage Data Valid But Above Normal Range-Moderate Severe Level	SPN 110 on page 9-91
174	3	Fuel Temperature Sensor Voltage Above Normal or Shorted High	SPN 174 on page 9-94
174	4	Fuel Temperature Sensor Voltage Below Normal or Shorted Low	SPN 174 on page 9-94
175	3	Engine Oil Temperature (EOT) Sensor Circuit Voltage Above Normal or Shorted High	SPN 175 on page 9-96
175	4	Engine Oil Temperature (EOT) Sensor Circuit Voltage Below Normal or Shorted Low	SPN 175 on page 9-96
175	15	Engine Oil Temperature (EOT) Sensor Circuit Voltage Data Valid But Above Normal Range-Least Severe Level	SPN 175 on page 9-96
627	15	System Voltage Data Valid But Above Normal Range-Least Severe Level	SPN 627 on page 9-98

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
627	17	System Voltage Data Valid But Below Normal Range-Least Severe Level	SPN 627 on page 9-98
630	13	Cal Memory Out of Calibration	SPN 630, 65580, 65581, or 65582 on page 9-99
636	2	Crankshaft Position Sensor Data Erratic, Intermittent or Incorrect	SPN 636 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-100 or SPN 636 (6.0L, 6.2L) on page 9-102
636	8	Crankshaft Position Sensor Abnormal Frequency or Pulse Width	SPN 636 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-100 or SPN 636 (6.0L, 6.2L) on page 9-102
651	3	Fuel Injector 1 Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
651	5	Fuel Injector 1 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
652	3	Fuel Injector 2 Short Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
652	5	Fuel Injector 2 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
653	3	Fuel Injector 3 Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
653	5	Fuel Injector 3 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
654	3	Fuel Injector 4 Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
654	5	Fuel Injector 4 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
655	3	Fuel Injector 5 Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
655	5	Fuel Injector 5 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
656	3	Fuel Injector 6 Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
656	5	Fuel Injector 6 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
657	3	Fuel Injector 7 Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
657	5	Fuel Injector 7 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
658	3	Fuel Injector 8 Voltage Above Normal or Shorted High	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
658	5	Fuel Injector 8 Current Below Normal or Open Circuit	SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104
1765	3	Fuel Valve Voltage Above Normal or Shorted High	SPN 1765 (High-Side Driver) on page 9-106 or SPN 1765 (Low-Side Driver) on page 9-108
1765	4	Fuel Valve Voltage Below Normal or Shorted Low	SPN 1765 (High-Side Driver) on page 9-106 or SPN 1765 (Low-Side Driver) on page 9-108
1765	5	Fuel Valve Current Below Normal or Open Circuit	SPN 1765 (High-Side Driver) on page 9-106 or SPN 1765 (Low-Side Driver) on page 9-108

6-14 Vehicle Diagnostic Information

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
3563	0	Supercharger Inlet Pressure Sensor Voltage Data Valid but Above Normal	SPN 3563 on page 9-110
3563	1	Supercharger Inlet Pressure Sensor Data Valid but Below Normal	SPN 3563 on page 9-110
3563	2	Supercharger Inlet Pressure Sensor Data Erratic, Intermittent or Incorrect	SPN 3563 on page 9-110
3563	3	Supercharger Inlet Pressure Sensor Voltage Above Normal or Shorted High	SPN 3563 on page 9-110
3563	4	Supercharger Inlet Pressure Sensor Voltage Below Normal or Shorted Low	SPN 3563 on page 9-110
65541	4	EST 1 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65541	5	EST 1 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65542	4	EST 2 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65542	5	EST 2 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65543	4	EST 3 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65543	5	EST 3 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65544	4	EST 4 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65544	5	EST 4 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65545	4	EST 5 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65545	5	EST 5 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65546	4	EST 6 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65546	5	EST 6 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65547	4	EST 7 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65547	5	EST 7 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65548	4	EST 8 Voltage Below Normal or Shorted Low	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65548	5	EST 8 Current Below Normal or Open Circuit	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 on page 9-113
65551	1	Knock Sensor (KS) Bank 1 Data Valid, but Below Normal	SPN 65550, 65551, or 65552 on page 9-115
65551	3	Knock Sensor (KS) Bank 1 Voltage Above Normal or Shorted High	SPN 65550, 65551, or 65552 on page 9-115
65551	4	Knock Sensor (KS) Bank 1 Voltage Below Normal or Shorted Low	SPN 65550, 65551, or 65552 on page 9-115
65551	5	Knock Sensor (KS) Bank 1 Current Below Normal or Open Circuit	SPN 65550, 65551, or 65552 on page 9-115
65552	1	Knock Sensor (KS) Bank 2 Data Valid, but Below Normal	SPN 65550, 65551, or 65552 on page 9-115

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
65552	3	Knock Sensor (KS) Bank 2 Voltage Above Normal or Shorted High	SPN 65550, 65551, or 65552 on page 9-115
65552	4	Knock Sensor (KS) Bank 2 Voltage Below Normal or Shorted Low	SPN 65550, 65551, or 65552 on page 9-115
65552	5	Knock Sensor (KS) Bank 2 Current Below Normal or Open Circuit	SPN 65550, 65551, or 65552 on page 9-115
65555	1	Change Oil Now–Data Valid but Below Normal	SPN 65555 on page 9-117
65555	18	Change Oil Soon–Data Valid but Above Normal Range - Least Severe Level	SPN 65555 on page 9-117
65558	11	CAN 2 Bus Hardware Fault Root Cause Unknown	SPN 65558 or 65559 on page 9-118
65559	11	CAN 1 Bus Hardware Fault Root Cause Unknown	SPN 65558 or 65559 on page 9-118
65560	9	CAN Bus Governor Command Lost	SPN 65560 on page 9-120
65561	0	Oxygen Sensor Bank A Sensor 1 Data Valid But Above Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65561	1	Oxygen Sensor Bank A Sensor 1 Data Valid But Below Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65561	3	Oxygen Sensor Bank A Sensor 1 Voltage Above Normal or Shorted High	SPN 65561, 65562, 65563, or 65564 on page 9-122
65561	4	Oxygen Sensor Bank A Sensor 1 Voltage Below Normal or Shorted Low	SPN 65561, 65562, 65563, or 65564 on page 9-122
65561	5	Oxygen Sensor Bank A Sensor 1 Current Below Normal or Open Circuit	SPN 65561, 65562, 65563, or 65564 on page 9-122
65562	0	Oxygen Sensor Bank A Sensor 2 Data Valid But Above Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65562	1	Oxygen Sensor Bank A Sensor 2 Data Valid But Below Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65562	3	Oxygen Sensor Bank A Sensor 2 Voltage Above Normal or Shorted High	SPN 65561, 65562, 65563, or 65564 on page 9-122
65562	4	Oxygen Sensor Bank A Sensor 2 Voltage Below Normal or Shorted Low	SPN 65561, 65562, 65563, or 65564 on page 9-122
65562	5	Oxygen Sensor Bank A Sensor 2 Current Below Normal or Open Circuit	SPN 65561, 65562, 65563, or 65564 on page 9-122
65563	0	Oxygen Sensor Bank B Sensor 1 Data Valid But Above Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65563	1	Oxygen Sensor Bank B Sensor 1 Data Valid But Below Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65563	3	Oxygen Sensor Bank B Sensor 1 Voltage Above Normal or Shorted High	SPN 65561, 65562, 65563, or 65564 on page 9-122
65563	4	Oxygen Sensor Bank B Sensor 1 Voltage Below Normal or Shorted Low	SPN 65561, 65562, 65563, or 65564 on page 9-122
65563	5	Oxygen Sensor Bank B Sensor 1 Current Below Normal or Open Circuit	SPN 65561, 65562, 65563, or 65564 on page 9-122
65564	0	Oxygen Sensor Bank B Sensor 2 Data Valid But Above Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65564	1	Oxygen Sensor Bank B Sensor 2 Data Valid But Below Normal	SPN 65561, 65562, 65563, or 65564 on page 9-122
65564	3	Oxygen Sensor Bank B Sensor 2 Voltage Above Normal or Shorted High	SPN 65561, 65562, 65563, or 65564 on page 9-122

6-16 Vehicle Diagnostic Information

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
65564	4	Oxygen Sensor Bank B Sensor 2 Voltage Below Normal or Shorted Low	SPN 65561, 65562, 65563, or 65564 on page 9-122
65564	5	Oxygen Sensor Bank B Sensor 2 Current Below Normal or Open Circuit	SPN 65561, 65562, 65563, or 65564 on page 9-122
65565	0	Fuel Trim Bank A Data Valid But Above Normal	SPN 65565 or 65566 on page 9-125
65565	1	Fuel Trim Bank A Data Valid But Below Normal	SPN 65565 or 65566 on page 9-125
65566	0	Fuel Trim Bank B Data Valid But Above Normal	SPN 65565 or 65566 on page 9-125
65566	1	Fuel Trim Bank B Data Valid But Below Normal	SPN 65565 or 65566 on page 9-125
65567	8	Oxygen Sensor Bank A Sensor 1 Abnormal Frequency or Pulse Width	SPN 65567 or 65568 on page 9-127
65567	10	Oxygen Sensor Bank A Sensor 1 Abnormal Rate of Change	SPN 65567 or 65568 on page 9-127
65568	8	Oxygen Sensor Bank B Sensor 1 Abnormal Frequency or Pulse Width	SPN 65567 or 65568 on page 9-127
65568	10	Oxygen Sensor Bank B Sensor 1 Abnormal Rate of Change	SPN 65567 or 65568 on page 9-127
65570	2	Cam Phaser W Data Erratic, Intermittent or Incorrect	SPN 65570 (6.0/6.2L) on page 9-129 or SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65570	4	Cam Phaser W Voltage Below Normal or Shorted Low	SPN 65570 (6.0/6.2L) on page 9-129 or SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65570	5	Cam Phaser W Short High or Open	SPN 65570 (6.0/6.2L) on page 9-129 or SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65570	7	Cam Phaser W Accuracy Mechanical System Not Responding or Out of Adjustment	SPN 65570 (6.0/6.2L) on page 9-129 or SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65571	2	Cam Phaser X Data Erratic, Intermittent or Incorrect	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65571	4	Cam Phaser X Voltage Below Normal or Shorted Low	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65571	5	Cam Phaser X Short High or Open	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65571	7	Cam Phaser X Accuracy Mechanical System Not Responding or Out of Adjustment	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65572	2	Cam Phaser Y Data Erratic, Intermittent or Incorrect	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65572	4	Cam Phaser Y Voltage Below Normal or Shorted Low	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65572	5	Cam Phaser Y Short High or Open	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65572	7	Cam Phaser Y Accuracy Mechanical System Not Responding or Out of Adjustment	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65673	2	Cam Phaser Z Data Erratic, Intermittent or Incorrect	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65673	4	Cam Phaser Z Voltage Below Normal or Shorted Low	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
65673	5	Cam Phaser Z Short High or Open	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65673	7	Cam Phaser Z Accuracy Mechanical System Not Responding or Out of Adjustment	SPN 65570, 65571, 65572, or 65573 (2.4L) on page 9-132
65580	12	CPU Bad Intelligent Device or Component	SPN 630, 65580, 65581, or 65582 on page 9-99
65581	12	Mhc Failure Bad Intelligent Device or Component	SPN 630, 65580, 65581, or 65582 on page 9-99
65582	2	Nv Ram Failure Data Erratic, Intermittent or Incorrect	SPN 630, 65580, 65581, or 65582 on page 9-99
65585	2	Fuel Select Input Data Erratic, Intermittent or Incorrect	SPN 65585 on page 9-135
65586	3	Fuel Select Output 1 Voltage Above Normal or Shorted High	SPN 65586 or 65587 on page 9-137
65586	5	Fuel Select Output 1 Current Below Normal or Open Circuit	SPN 65586 or 65587 on page 9-137
65587	3	Fuel Select Output 2 Voltage Above Normal or Shorted High	SPN 65586 or 65587 on page 9-137
65587	5	Fuel Select Output 2 Current Below Normal or Open Circuit	SPN 65586 or 65587 on page 9-137
65590	7	Misfire Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65591	7	Misfire Cylinder 1 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65592	7	Misfire Cylinder 2 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65593	7	Misfire Cylinder 3 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65594	7	Misfire Cylinder 4 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65595	7	Misfire Cylinder 5 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65596	7	Misfire Cylinder 6 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65597	7	Misfire Cylinder 7 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65598	7	Misfire Cylinder 8 Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65599	7	Misfire Random Mechanical System Not Responding or Out of Adjustment	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599 on page 9-139
65601	2	ETC TPS 2 Data Erratic, Intermittent or Incorrect	SPN 65601, 65602, or 65610 on page 9-141
65602	2	ETC TPS 1 Data Erratic, Intermittent or Incorrect	SPN 65601, 65602, or 65610 on page 9-141
65604	2	ETC PPS 2 Data Erratic, Intermittent or Incorrect	SPN 65604, 65605, or 65613 on page 9-144
65605	2	ETC PPS 1 Data Erratic, Intermittent or Incorrect	SPN 65604, 65605, or 65613 on page 9-144
65610	2	ETC TPS 1-2 Data Erratic, Intermittent or Incorrect	SPN 65601, 65602, or 65610 on page 9-141
65613	2	ETC PPS 1-2 Data Erratic, Intermittent or Incorrect	SPN 65604, 65605, or 65613 on page 9-144

6-18 Vehicle Diagnostic Information

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
65615	7	ETC Actuation Fault Mechanical System Not Responding or Out of Adjustment	SPN 65615, 65616, or 65618 on page 9-147
65616	12	ETC Bad Intelligent Device or Component	SPN 65615, 65616, or 65618 on page 9-147
65618	7	ETC Return Fault Mechanical System Not Responding or Out of Adjustment	SPN 65615, 65616, or 65618 on page 9-147
65620	4	5 Volt Reference A Circuit Voltage Below Normal or Shorted Low	SPN 65620-65623 on page 9-149
65621	4	5 Volt Reference B Circuit Voltage Below Normal or Shorted Low	SPN 65620-65623 on page 9-149
65622	4	5 Volt Reference C Circuit Voltage Below Normal or Shorted Low	SPN 65620-65623 on page 9-149
65623	4	5 Volt Reference D Circuit Voltage Below Normal or Shorted Low	SPN 65620-65623 on page 9-149
65675	11	Catalytic Converter A Efficiency Root Cause Unknown	SPN 65675 or 65676 on page 9-151
65676	11	Catalytic Converter B Efficiency Root Cause Unknown	SPN 65675 or 65676 on page 9-151
65690	3	Variable Governor Voltage Above Normal or Shorted High	SPN 65690 on page 9-153
65690	4	Variable Governor Voltage Below Normal or Shorted Low	SPN 65690 on page 9-153
65701	31	General Warning 1 Not Available	SPN 65701 or 65702 on page 9-155
65702	31	General Warning 2 Not Available	SPN 65701 or 65702 on page 9-155
65710	31	Emergency Stop Warning Not Available	SPN 65710 on page 9-157
65723	2	Cam Sensor W Data Erratic, Intermittent or Incorrect	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65723	7	Cam Sensor W Mechanical System Not Responding or Out of Adjustment	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65723	8	Cam Sensor W Abnormal Frequency or Pulse Width	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65724	2	Cam Sensor X Data Erratic, Intermittent or Incorrect	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65724	7	Cam Sensor X Mechanical System Not Responding or Out of Adjustment	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
65724	8	Cam Sensor X Abnormal Frequency or Pulse Width	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65725	2	Cam Sensor Y Data Erratic, Intermittent or Incorrect	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65725	7	Cam Sensor Y Mechanical System Not Responding or Out of Adjustment	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65725	8	Cam Sensor Y Abnormal Frequency or Pulse Width	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65726	2	Cam Sensor Z Data Erratic, Intermittent or Incorrect	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65726	7	Cam Sensor Z Mechanical System Not Responding or Out of Adjustment	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
65726	8	Cam Sensor Z Abnormal Frequency or Pulse Width	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L) on page 9-158 or SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L) on page 9-160
66002	4	Starter Relay High Side Driver Voltage Below Normal or Shorted Low	SPN 66002 on page 9-162
66002	5	Starter Relay High Side Driver Current Below Normal or Open Circuit	SPN 66002 on page 9-162
66003	3	Malfunction Indicator Lamp Driver Voltage Above Normal or Shorted High	SPN 66003 on page 9-164
66003	5	Malfunction Indicator Lamp Driver Current Below Normal or Open Circuit	SPN 66003 on page 9-164
66004	3	Service Vehicle Soon Lamp Voltage Above Normal or Shorted High	SPN 66004 on page 9-166
66004	5	Service Vehicle Soon Lamp Current Below Normal or Open Circuit	SPN 66004 on page 9-166
66005	3	Governor Status Lamp Voltage Above Normal or Shorted High	SPN 66005 on page 9-168
66005	5	Governor Status Lamp Current Below Normal or Open Circuit	SPN 66005 on page 9-168
66006	3	DTC Lamp 3 Voltage Above Normal or Shorted High	SPN 66006, 66008, or 6609 on page 9-172

6-20 Vehicle Diagnostic Information

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
66006	5	DTC Lamp 3 Current Below Normal or Open Circuit	SPN 66006, 66008, or 6609 on page 9-172
66007	3	Buzzer Driver Short Voltage Above Normal or Shorted High	SPN 66007 on page 9-170
66007	5	Buzzer Driver Current Below Normal or Open Circuit	SPN 66007 on page 9-170
66008	3	DTC Lamp 1 Voltage Above Normal or Shorted High	SPN 66006, 66008, or 6609 on page 9-172
66008	5	DTC Lamp 1 Current Below Normal or Open Circuit	SPN 66006, 66008, or 6609 on page 9-172
66009	3	DTC Lamp 2 Voltage Above Normal or Shorted High	SPN 66006, 66008, or 6609 on page 9-172
66009	5	DTC Lamp 2 Current Below Normal or Open Circuit	SPN 66006, 66008, or 6609 on page 9-172
66010	3	Slow Mode Lamp Voltage Above Normal or Shorted High	SPN 66010 on page 9-174
66010	5	Slow Mode Lamp Current Below Normal or Open Circuit	SPN 66010 on page 9-174
66011	3	Speed Based Output Voltage Above Normal or Shorted High	SPN 66011 on page 9-176
66011	5	Speed Based Output Current Below Normal or Open Circuit	SPN 66011 on page 9-176
66013	3	Powertrain Relay Voltage Above Normal or Shorted High	SPN 66013 or 66014 on page 9-180
66013	5	Powertrain Relay Current Below Normal or Open Circuit	SPN 66013 or 66014 on page 9-180
66014	4	Powertrain Relay Contact Voltage Below Normal or Shorted Low	SPN 66013 or 66014 on page 9-180
66017	4	Fuel Pump Relay 1 Voltage Below Normal or Shorted Low	SPN 66017 on page 9-182
66017	5	Fuel Pump Relay 1 Current Below Normal or Open Circuit	SPN 66017 on page 9-182
66018	3	Tachometer Voltage Above Normal or Shorted High	SPN 66018 on page 9-184
66018	5	Tachometer Current Below Normal or Open Circuit	SPN 66018 on page 9-184
66019	3	Oxygen Sensor Bank A Sensor 1 Heater Voltage Above Normal or Shorted High	SPN 66019, 66020, 66021, or 66022 on page 9-186
66019	5	Oxygen Sensor Bank A Sensor 1 Heater Current Below Normal or Open Circuit	SPN 66019, 66020, 66021, or 66022 on page 9-186
66019	8	Oxygen Sensor Bank A Sensor 1 Heater Abnormal Frequency or Pulse Width	SPN 66019, 66020, 66021, or 66022 on page 9-186
66020	3	Oxygen Sensor Bank B Sensor 1 Heater Shorted High	SPN 66019, 66020, 66021, or 66022 on page 9-186
66020	5	Oxygen Sensor Bank B Sensor 1 Heater Shorted Low or Open	SPN 66019, 66020, 66021, or 66022 on page 9-186
66020	8	Oxygen Sensor Bank B Sensor 1 Heater Abnormal Frequency or Pulse Width	SPN 66019, 66020, 66021, or 66022 on page 9-186
66021	3	Oxygen Sensor Bank A Sensor 2 Heater Voltage Above Normal or Shorted High	SPN 66019, 66020, 66021, or 66022 on page 9-186
66021	5	Oxygen Sensor Bank A Sensor 2 Heater Current Below Normal or Open Circuit	SPN 66019, 66020, 66021, or 66022 on page 9-186

Diagnostic Trouble Code (DTC) List (cont'd)

SPN	FMI	DTC Descriptor	Diagnostic Procedure
Note: If multiple powertrain SPNs are stored, diagnose the SPNs in the following order: 1. Component level SPNs, such as sensor SPNs, solenoid SPNs, and relay SPNs. 2. System level SPNs, such as misfire SPNs and fuel trim SPNs.			
66021	8	Oxygen Sensor Bank A Sensor 2 Heater Abnormal Frequency or Pulse Width	SPN 66019, 66020, 66021, or 66022 on page 9-186
66022	3	Oxygen Sensor Bank B Sensor 2 Heater Voltage Above Normal or Shorted High	SPN 66019, 66020, 66021, or 66022 on page 9-186
66022	5	Oxygen Sensor Bank B Sensor 2 Heater Current Below Normal or Open Circuit	SPN 66019, 66020, 66021, or 66022 on page 9-186
66022	8	Oxygen Sensor Bank B Sensor 2 Heater Abnormal Frequency or Pulse Width	SPN 66019, 66020, 66021, or 66022 on page 9-186
66025	4	Fuel Pump Relay 2 Voltage Below Normal or Shorted Low	SPN 66025 on page 9-189
66025	5	Fuel Pump Relay 2 Current Below Normal or Open Circuit	SPN 66025 on page 9-189
66026	7	Shift Interrupt Mechanical System Not Responding or Out of Adjustment	SPN 66026 on page 9-191
66030	3	Intercooler Relay Voltage Above Normal or Shorted High	SPN 66030 on page 9-193
66030	5	Intercooler Relay Current Below Normal or Open Circuit	SPN 66030 on page 9-193
66035	0	Supercharger Boost Control Solenoid Data Valid but Above Normal	SPN 66035 on page 9-195
66035	3	Supercharger Boost Control Solenoid Data Valid but Below Normal	SPN 66035 on page 9-195
66035	5	Supercharger Boost Control Solenoid Current Below Normal or Open Circuit	SPN 66035 on page 9-195
66035	7	Supercharger Boost Control Solenoid Mechanical System Not Responding or Out of Adjustment	SPN 66035 on page 9-195
66040	3	OEM Output Driver 1 Voltage Above Normal or Shorted High	SPN 66040-66043 on page 9-198
66040	5	OEM Output Driver 1 Current Below Normal or Open Circuit	SPN 66040-66043 on page 9-198
66041	3	OEM Output Driver 2 Voltage Above Normal or Shorted High	SPN 66040-66043 on page 9-198
66041	5	OEM Output Driver 2 Current Below Normal or Open Circuit	SPN 66040-66043 on page 9-198
66042	3	OEM Output Driver 3 Voltage Above Normal or Shorted High	SPN 66040-66043 on page 9-198
66042	5	OEM Output Driver 3 Current Below Normal or Open Circuit	SPN 66040-66043 on page 9-198
66043	3	OEM Output Driver 4 Voltage Above Normal or Shorted High	SPN 66040-66043 on page 9-198
66043	5	OEM Output Driver 4 Current Below Normal or Open Circuit	SPN 66040-66043 on page 9-198

Data Link Connector Scan Tools

The engine control module (ECM) communicates information through the data link connector (DLC). This data is transmitted at a high frequency which requires a scan tool or PC based scan program in order to read. With an understanding of the data that the scan tool displays, and knowledge of the circuits involved, the scan tool can be very useful in diagnosing a condition. A scan tool does not make the use of diagnostic procedures unnecessary, nor does it indicate exactly where the problem is occurring in a particular circuit. Diagnostic procedures contain information that can only be obtained with a scan tool or PC based scan program.

Scan Tool Use with Intermittents

The scan tool provides the ability to perform a “wobble test” on wiring harnesses or components under various conditions, while observing the scan tool display. The scan tool parameters can be observed while operating the vehicle under the conditions for running a diagnostic trouble code (DTC), or when there is an engine driveability condition. If the condition appears to be related to certain parameters that can be verified with the scan tool, they should be observed while operating the vehicle. If there does not seem to be any correlation between the condition and any specific circuit, the scan tool can be observed on each position, for a period of time to verify if there is any change in the parameters that indicates an intermittent operation.

The scan tool can also be used to compare the operating parameters of a poorly operating engine with those of a known good engine. For example, a sensor may shift in value but not set a DTC. Comparing the sensor's readings with those of a known good identical vehicle may uncover the condition.

Proper use of the scan tool will save time in diagnosis and prevent the replacement of good parts. It is important for the technician to understand the system that is being diagnosed, as well as an understanding of the scan tool operation and limitations. The technician should read the tool manufacturer's operating manual to become familiar with the tool's operation.

Diagnostic Repair Verification

1. Install any components or connectors that have been removed or replaced during diagnosis.
2. Perform any adjustment, programming or setup procedures that are required when a component or module is removed or replaced.
3. Clear the SPNs.
4. Turn OFF the ignition for 60 seconds.
5. If the repair was related to a SPN, duplicate the Conditions for Running the SPN and use the Freeze Frame/Failure Records, if applicable, in order to verify the SPN does not reset. If the SPN resets or another SPN is present, refer to the *Diagnostic Trouble Code (DTC) List on page 6-11* and perform the appropriate diagnostic procedure.
6. Observe the Expanded Diagnostic Readiness Data to verify the SPN has run and passed. If the SPN has run and passed, the SPN will not appear in the list. If a SPN diagnostic has not run, or runs and fails, the SPN will remain in the list.
7. If the repair was symptom related, duplicate the conditions under which the customer concern occurred to verify the repair. If the customer concern reoccurs, return to *Symptoms - Engine Controls on page 9-199* and perform the appropriate symptom diagnostic.

Section 9

Engine

Engine Controls and Fuel - Marine	9-3	SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548	9-113
Specifications	9-3	SPN 65550, 65551, or 65552	9-115
Temperature Versus Resistance	9-3	SPN 65555	9-117
Altitude Versus Barometric Pressure	9-3	SPN 65558 or 65559	9-118
Ignition System Specifications (2.4L)	9-4	SPN 65560	9-120
Ignition System Specifications (3.0L)	9-4	SPN 65561, 65562, 65563, or 65564	9-122
Ignition System Specifications (4.3L, 5.0L, or 5.7L)	9-4	SPN 65565 or 65566	9-125
Ignition System Specifications (6.0L or 6.2L)	9-4	SPN 65567 or 65568	9-127
Fastener Tightening Specifications	9-5	SPN 65570 (6.0/6.2L)	9-129
Schematic and Routing Diagrams	9-5	SPN 65570, 65571, 65572, or 65573 (2.4L)	9-132
Engine Controls Schematics	9-6	SPN 65585	9-135
Visual Identification	9-30	SPN 65586 or 65587	9-137
Engine Control Module Connector End Views	9-30	SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599	9-139
Engine Controls Connector End Views	9-33	SPN 65601, 65602, or 65610	9-141
Diagnostic Information and Procedures	9-54	SPN 65604, 65605, or 65613	9-144
Diagnostic Starting Point - Engine Controls	9-54	SPN 65615, 65616, or 65618	9-147
Engine Control Module Scan Tool Information	9-54	SPN 65620-65623	9-149
Powertrain On Board Diagnostic (OBD) System Check	9-64	SPN 65675 or 65676	9-151
SPN 38 or 96	9-65	SPN 65690	9-153
SPN 51	9-67	SPN 65701 or 65702	9-155
SPN 84	9-69	SPN 65710	9-157
SPN 94	9-71	SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L)	9-158
SPN 98	9-73	SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L)	9-160
SPN 100 (3.0L, 4.3L, 5.0L, 5.7L)	9-75	SPN 66002	9-162
SPN 100 (6.0L, 6.2L)	9-77	SPN 66003	9-164
SPN 105 (3.0L, 4.3L, 5.0L, 5.7L)	9-79	SPN 66004	9-166
SPN 105 (2.4L, 6.0L, 6.2L)	9-81	SPN 66005	9-168
SPN 106 (3.0L, 4.3L, 5.0L, 5.7L)	9-83	SPN 66007	9-170
SPN 106 (2.4L, 6.0L, 6.2L)	9-86	SPN 66006, 66008, or 6609	9-172
SPN 108	9-89	SPN 66010	9-174
SPN 110	9-91	SPN 66011	9-176
SPN 174	9-94	SPN 66012	9-178
SPN 175	9-96	SPN 66013 or 66014	9-180
SPN 627	9-98	SPN 66017	9-182
SPN 630, 65580, 65581, or 65582	9-99	SPN 66018	9-184
SPN 636 (3.0L, 4.3L, 5.0L, 5.7L)	9-100	SPN 66019, 66020, 66021, or 66022	9-186
SPN 636 (6.0L, 6.2L)	9-102	SPN 66025	9-189
SPN 651, 652, 653, 654, 655, 656, 657, or 658	9-104	SPN 66026	9-191
SPN 1765 (High-Side Driver)	9-106	SPN 66030	9-193
SPN 1765 (Low-Side Driver)	9-108	SPN 66035	9-195
SPN 3563	9-110	SPN 66040-66043	9-198
		Symptoms - Engine Controls	9-199

9-2 Table of Contents

Engine Cranks But Does Not Run	9-201	Ignition Coil Replacement	
Run/Crank Relay Diagnosis	9-203	(4.3L, 5.0L, and 5.7L)	9-243
Supercharger Intercooler Relay		Ignition Coil Replacement (2.4L)	9-244
Diagnosis	9-204	Spark Plug Wire Inspection	9-245
Boost Control System Diagnosis	9-205	Spark Plug Wire Replacement	9-245
Fuel Pump Electrical Circuit Diagnosis	9-207	Spark Plug Inspection	9-245
Fuel System Diagnosis		Spark Plug Replacement	9-247
(with Returnless Fuel System)	9-208	Distributor Replacement (3.0L)	9-248
Fuel System Diagnosis		Distributor Replacement	
(without Returnless Fuel System)	9-210	(4.3L, 5.0L, 5.8L)	9-251
Fuel Injector Diagnosis	9-211	Camshaft Retard Offset Adjustment	
Alcohol/Contaminants-in-Fuel Diagnosis	9-213	(3.0L and 4.3L)	9-255
Distributor Ignition (DI) System		Camshaft Retard Offset Adjustment	
Diagnosis	9-214	(5.0L and 5.7L)	9-255
Electronic Ignition System Diagnosis	9-215	Crankshaft Position Sensor	
Slow Mode Switch Diagnosis	9-216	Replacement (3.0L)	9-256
Repair Instructions	9-217	Crankshaft Position Sensor	
Engine Control Module Replacement	9-217	Replacement (4.3/5.0/5.7L)	9-257
Engine Coolant Temperature Sensor		Crankshaft Position Sensor	
Replacement	9-218	Replacement (6.0/6.2L)	9-258
Manifold Air Temperature Sensor		Crankshaft Position Sensor	
Replacement	9-218	Replacement (2.4L)	9-261
Manifold Absolute Pressure Sensor		Camshaft Position Sensor Replacement	
Replacement (without Supercharger)	9-220	(4.3/5.0/5.7L)	9-262
Barometric Pressure Sensor		Camshaft Position Sensor Replacement	
Replacement	9-221	(with CMP Actuator)	9-268
Supercharger Air Inlet Pressure Sensor		Camshaft Position Sensor Replacement	
Replacement	9-222	(without CMP Actuator)	9-269
Charge Air Bypass Regulator Solenoid		Camshaft Position Sensor Replacement	
Valve Replacement	9-223	(2.4L Intake)	9-270
Supercharger Bypass Valve Actuator		Camshaft Position Sensor Replacement	
Replacement	9-224	(2.4L Exhaust)	9-270
Engine Oil Pressure Sensor		Camshaft Position Actuator Magnet	
Replacement	9-225	Replacement	9-271
Heated Oxygen Sensor Replacement	9-226	Camshaft Position Actuator Solenoid	
Throttle Position Sensor Replacement		Valve Replacement (6.0/6.2L)	9-272
(Non ETC)	9-227	Camshaft Position Actuator Solenoid	
Throttle Body Assembly Replacement	9-228	Valve Replacement (2.4L)	9-274
Fuel Pressure Gauge Installation and		Camshaft Position Actuator Magnet	
Removal	9-229	Cleaning and Inspection	9-275
Fuel Pressure Relief	9-230	Camshaft Position Actuator Solenoid	
Fuel Injection Fuel Rail Assembly		Valve Inspection	9-276
Replacement (3.0L)	9-230	Knock Sensor Replacement	
Fuel Injection Fuel Rail Assembly		(Except 2.4L)	9-277
Replacement (4.3L 5.0L and 5.7L)	9-231	Knock Sensor Replacement (2.4L)	9-278
Fuel Injection Fuel Rail Assembly		Description and Operation	9-279
Replacement (6.0L and 6.2L)	9-234	Engine Control Module Description	9-279
Fuel Injection Fuel Rail Assembly		Throttle Actuator Control (TAC) System	
Replacement (2.4L)	9-235	Description	9-279
Fuel Pressure Regulator Replacement	9-238	Camshaft Actuator System Description	9-281
Fuel Injector Replacement		Supercharger Description and Operation	9-282
(Except 2.4L)	9-238	Fuel System Description	9-284
Fuel Injector Replacement (2.4L)	9-240	Electronic Ignition System Description	9-286
Ignition Coil Replacement (3.0L)	9-241	Distributor Ignition (DI) System	
Ignition Coil Replacement		Description	9-287
(6.0L and 6.2L)	9-242	Special Tools and Equipment	9-289

Engine Controls and Fuel - Marine

Specifications

Temperature Versus Resistance

°C	°F	Ohms
Temperature vs Resistance Values (Approximate)		
150	302	47
140	284	60
130	266	77
120	248	100
110	230	132
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1,188
40	104	1,459
35	95	1,802
30	86	2,238
25	77	2,796
20	68	3,520
15	59	4,450
10	50	5,670
5	41	7,280
0	32	9,420
-5	23	12,300
-10	14	16,180
-15	5	21,450
-20	-4	28,680
-30	-22	52,700
-40	-40	100,700

Altitude Versus Barometric Pressure

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
Determine your altitude by contacting a local weather station or by using another reference source.		
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

Altitude Versus Barometric Pressure (cont'd)

Altitude Measured in Meters (m)	Altitude Measured in Feet (ft)	Barometric Pressure Measured in Kilopascals (kPa)
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

9-4 Engine Controls and Fuel - Marine

Ignition System Specifications (2.4L)

Application	Specification	
	Metric	English
Firing Order	1-3-4-2	
Spark Plug Wire Resistance	397–1,337 ohms	
Spark Plug Torque	20 N·m	15 lb ft
Spark Plug Gap	1.02 mm	0.40 in
Spark Plug Type	GM P/N 12598004 AC Spark Plug P/N 41-103	

Ignition System Specifications (3.0L)

Application	Specification	
	Metric	English
Firing Order	1-3-4-2	
Spark Plug Wire Resistance	397–1,337 ohms	
Spark Plug Torque	30 N·m	22 lb ft
Spark Plug Gap	1.27 mm	0.050 in
Spark Plug Type	GM P/N 19158043 AC Spark Plug P/N 41-950	

Ignition System Specifications (4.3L, 5.0L, or 5.7L)

Application	Specification	
	Metric	English
Firing Order	1-6-5-4-3-2 (4.3L) 1-8-4-3-6-5-7-2 (5.0/5.7L)	
Spark Plug Wire Resistance	1,200-1,500 ohms per ft	
Spark Plug Torque	15 N·m	11 lb ft
Spark Plug Gap	1.5 mm	0.060 in
Spark Plug Type	GM P/N 12607234 AC Spark Plug P/N 41-993	

Ignition System Specifications (6.0L or 6.2L)

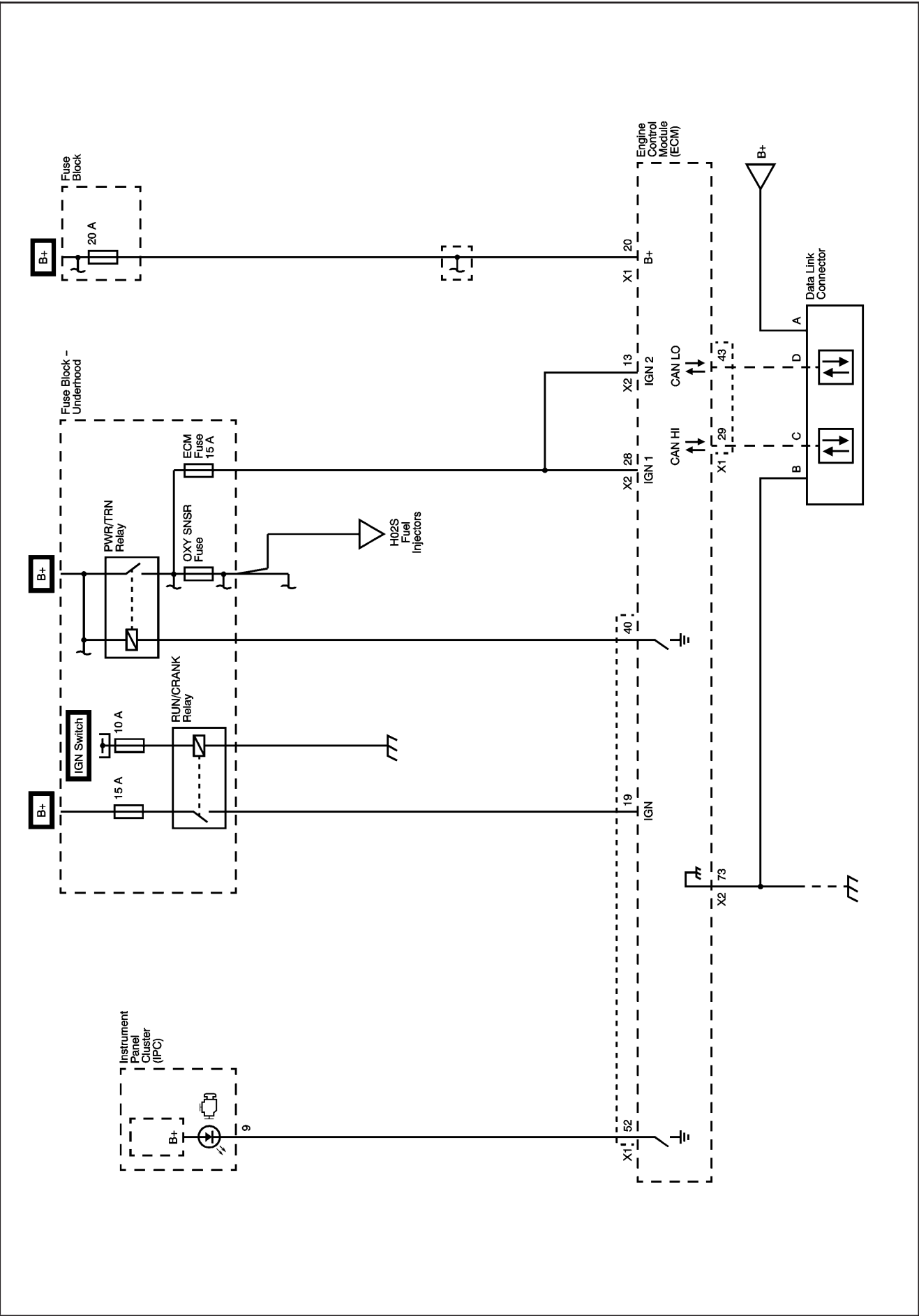
Application	Specification	
	Metric	English
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Wire Resistance	397–1,337 ohms	
Spark Plug Torque	15 N·m	11 lb ft
Spark Plug Gap	1.02 mm	0.040 in
Spark Plug Type	GM P/N 12571164 AC Spark Plug P/N 41-985	

Fastener Tightening Specifications

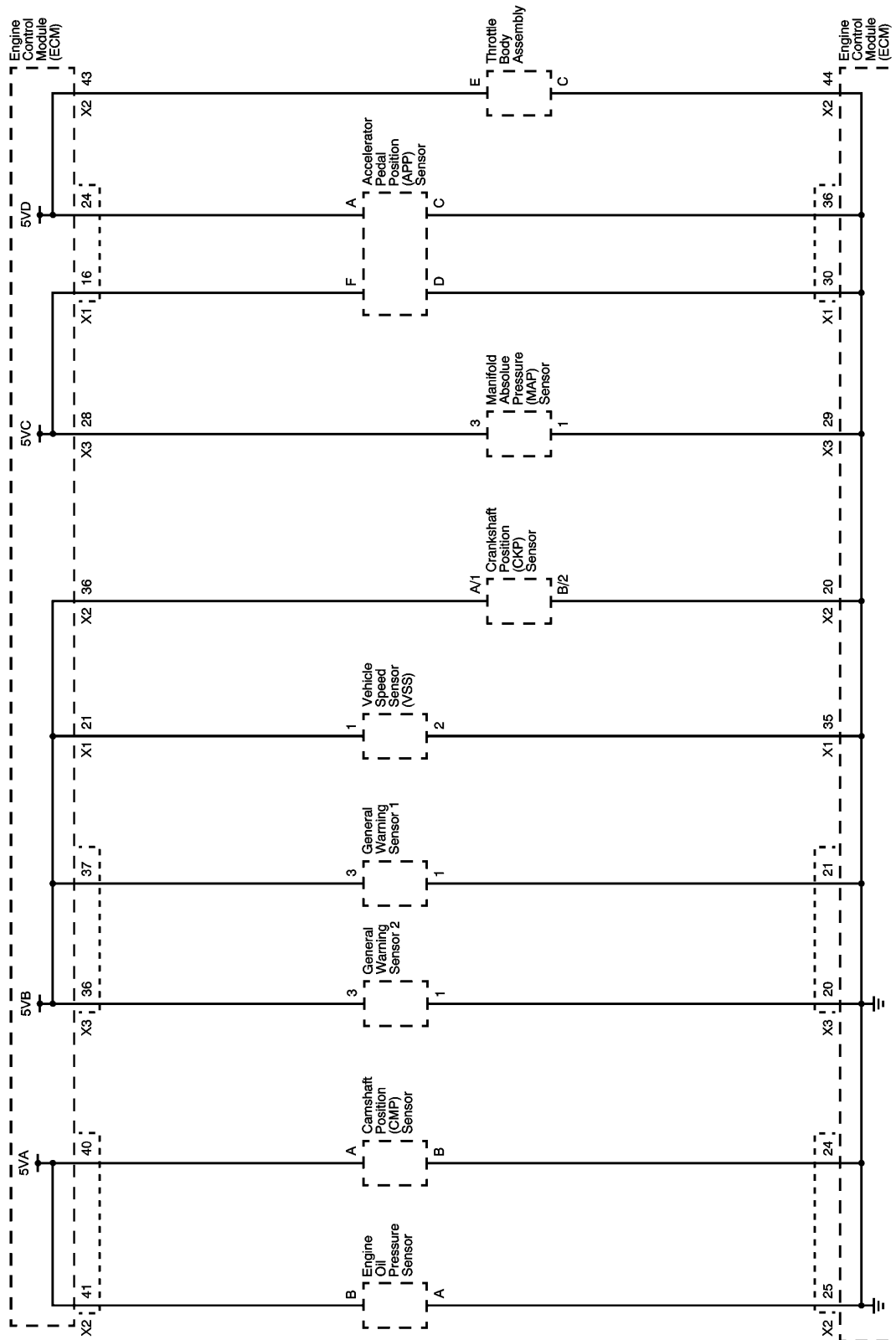
Application	Specifications	
	Metric	English
Air Cleaner Housing Screw	3 N·m	27 lb in
Air Cleaner Outlet Duct Clamp	4 N·m	35 lb in
Camshaft Position (CMP) Actuator Magnet Bolts	12 N·m	106 lb in
Camshaft Position (CMP) Actuator Solenoid Valve – First Pass	65 N·m	48 lb ft
Camshaft Position (CMP) Actuator Solenoid Valve – Final Pass	90 degrees	
Camshaft Position (CMP) Sensor Bolt	12 N·m	106 lb in
Camshaft Position (CMP) Sensor Wire Harness Bolt	12 N·m	106 lb ft
Chassis Wiring Harness Ground Bolt	18 N·m	13 lb ft
Crankshaft Position (CKP) Sensor Bolt	25 N·m	18 lb ft
Distributor Cap Screws	5 N·m	40 lb in
Distributor Hold Down Bolt	27 N·m	20 lb ft
Distributor Rotor Screws	2 N·m	20 lb in
Engine Coolant Temperature (ECT) Sensor	20 N·m	15 lb ft
Engine Wiring Harness Clip to Generator Bolt	9 N·m	80 lb in
Engine Wiring Harness Bracket Nut	5 N·m	44 lb in
Exhaust Gas Temperature (EGT) Sensor	42 N·m	31 lb ft
Fuel Line Bracket Bolt	12 N·m	106 lb in
Fuel Line Bracket Nut	18 N·m	13 lb ft
Fuel Pipe Bracket to Bellhousing Stud Nut	20 N·m	15 lb ft
Fuel Pressure Sensor	15 N·m	11 lb ft
Fuel Rail Bolt	10 N·m	89 lb in
Fuel Rail Crossover Pipe Retainer Screw	3.8 N·m	34 lb in
Fuel Tank Fill Hose Clamp	2.5 N·m	22 lb in
Heated Oxygen Sensor (HO2S)	42 N·m	31 lb ft
Ignition Coil Bolt	10 N·m	89 lb in
Knock Sensor (KS) Bolt	25 N·m	18 lb ft
Oil Level Indicator Switch	20 N·m	15 lb ft
Oil Pressure Sensor	35 N·m	26 lb ft
Spark Plug	15 N·m	11 lb ft
Supercharger Bolts (In sequence)	25 N·m	18 lb ft
Supercharger Bypass Regulator Solenoid Valve Bracket Bolt	9 N·m	80 lb in
Supercharger Bypass Valve Actuator Bolts	10 N·m	89 lb in
Supercharger Bypass Valve Actuator Cable Bracket Bolts	10 N·m	89 lb in
Supercharger Inlet Air Cooler Bolts	10 N·m	89 lb in
Throttle Body Bolt/Nut	10 N·m	89 lb in
Throttle Body Studs	6 N·m	53 lb in

Schematic and Routing Diagrams

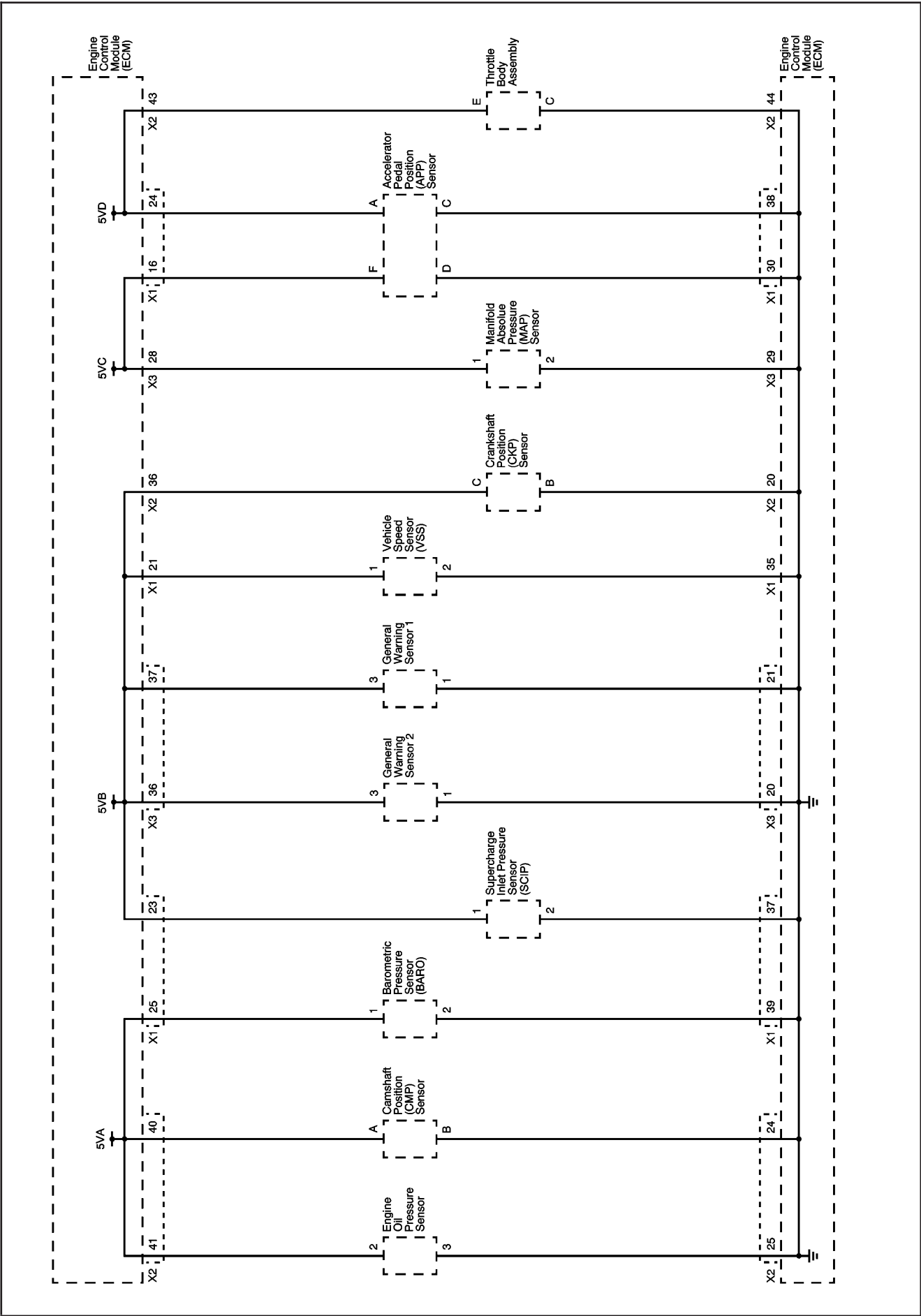
Engine Controls Schematics (Module Power, Ground, and Relays)



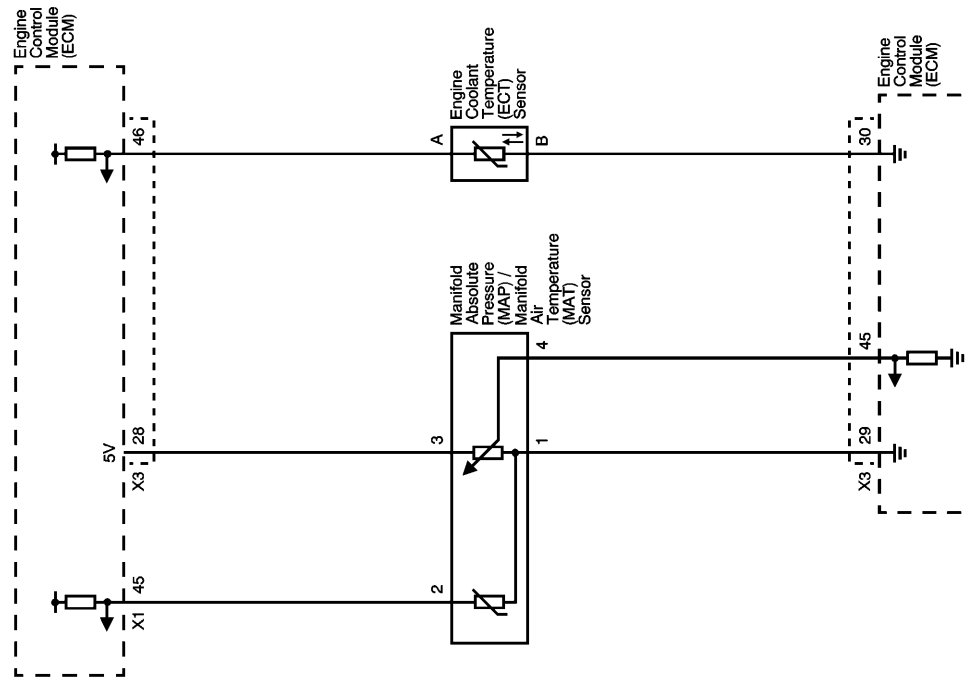
Engine Controls Schematics (Engine Data Sensors – 5-Volt and Low Reference with 3.0/4.3/5.0/5.7L)



Engine Controls Schematics (Engine Data Sensors – 5-Volt and Low Reference with 6.0/6.2L)

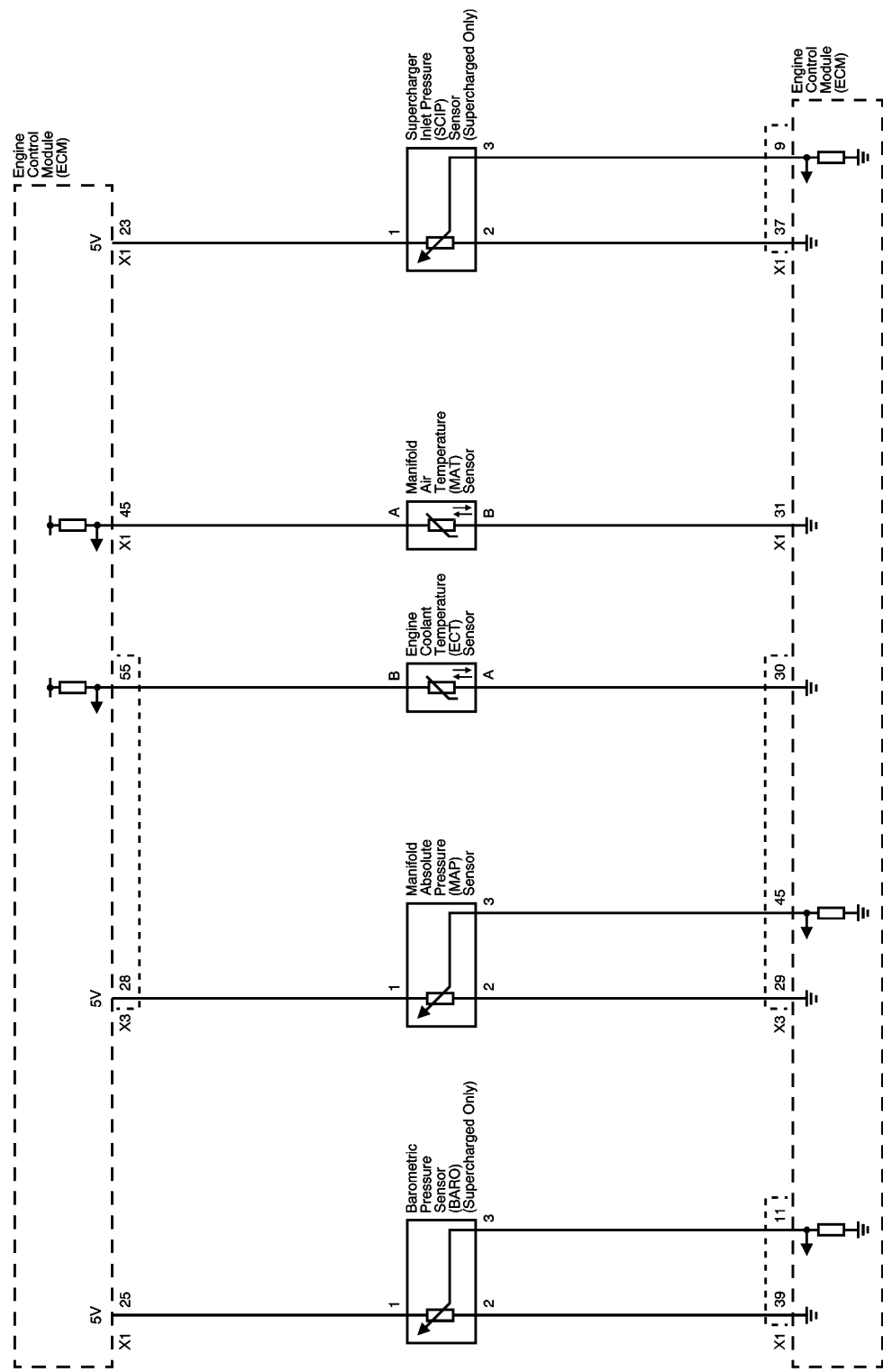


Engine Controls Schematics (Engine Data Sensors – with 3.0/4.3/5.0/5.7L)

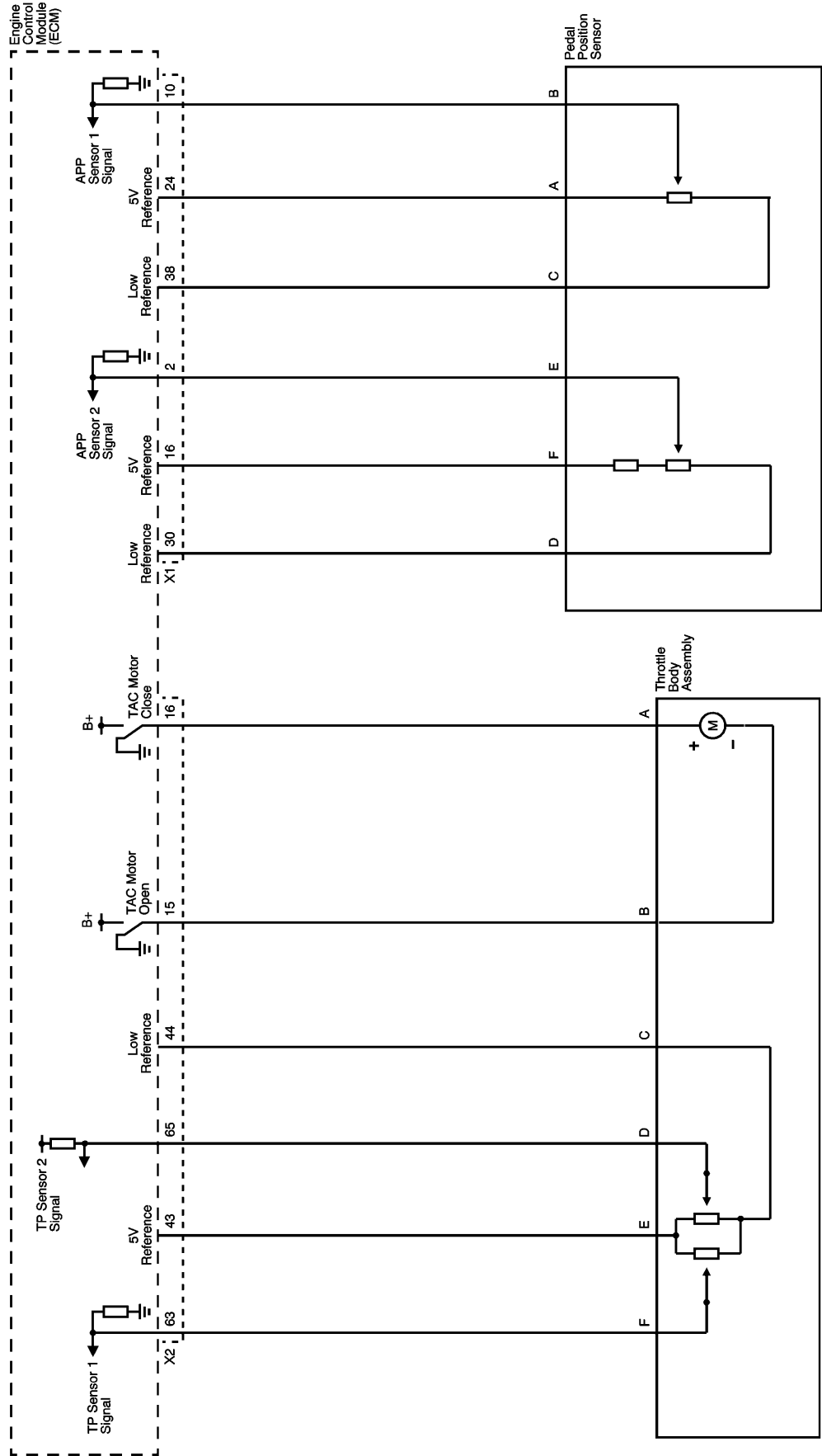


2444326

Engine Controls Schematics (Engine Data Sensors – with 6.0/6.2L)

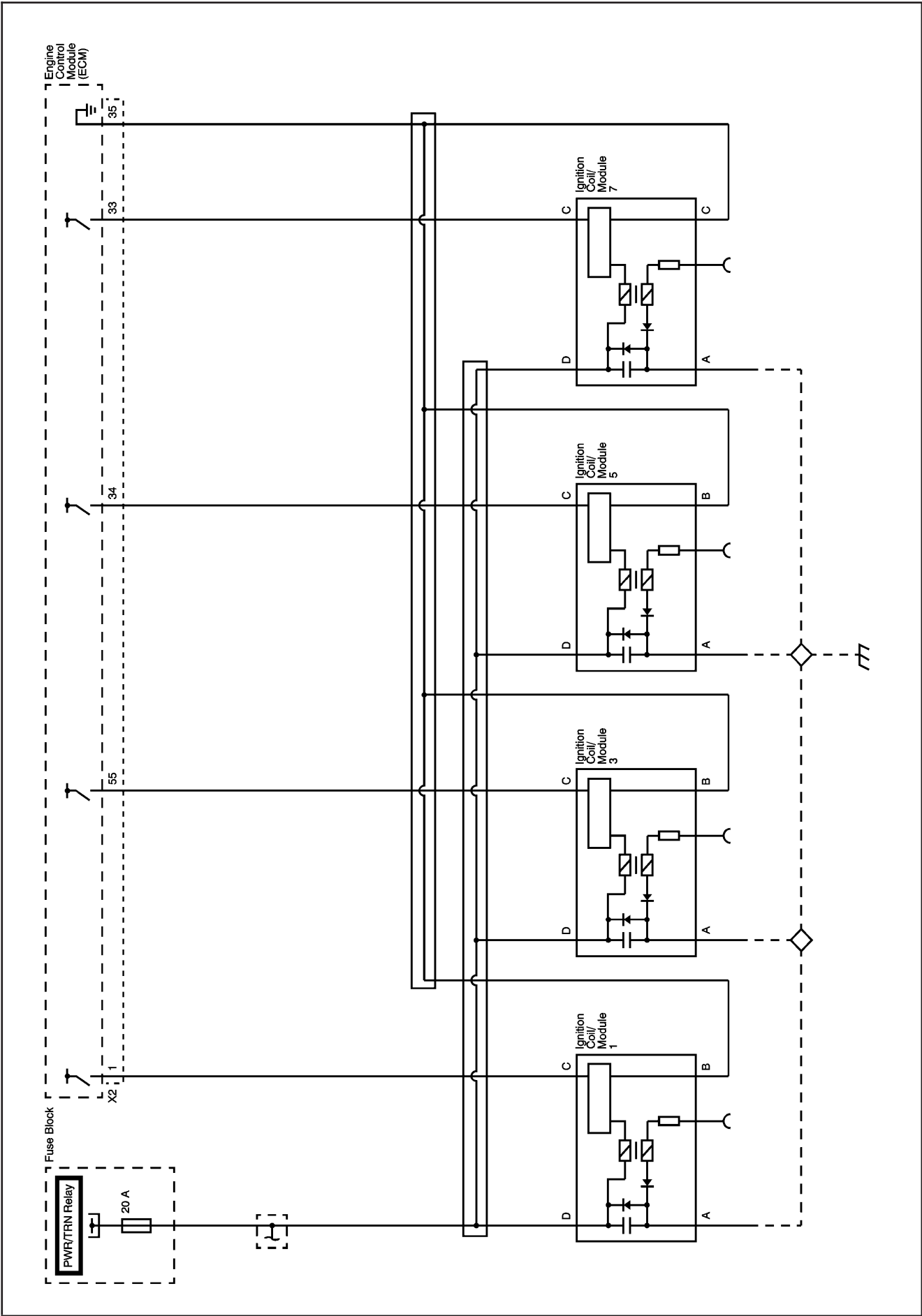


Engine Controls Schematics (Engine Data Sensors – Throttle Actuator Controls)

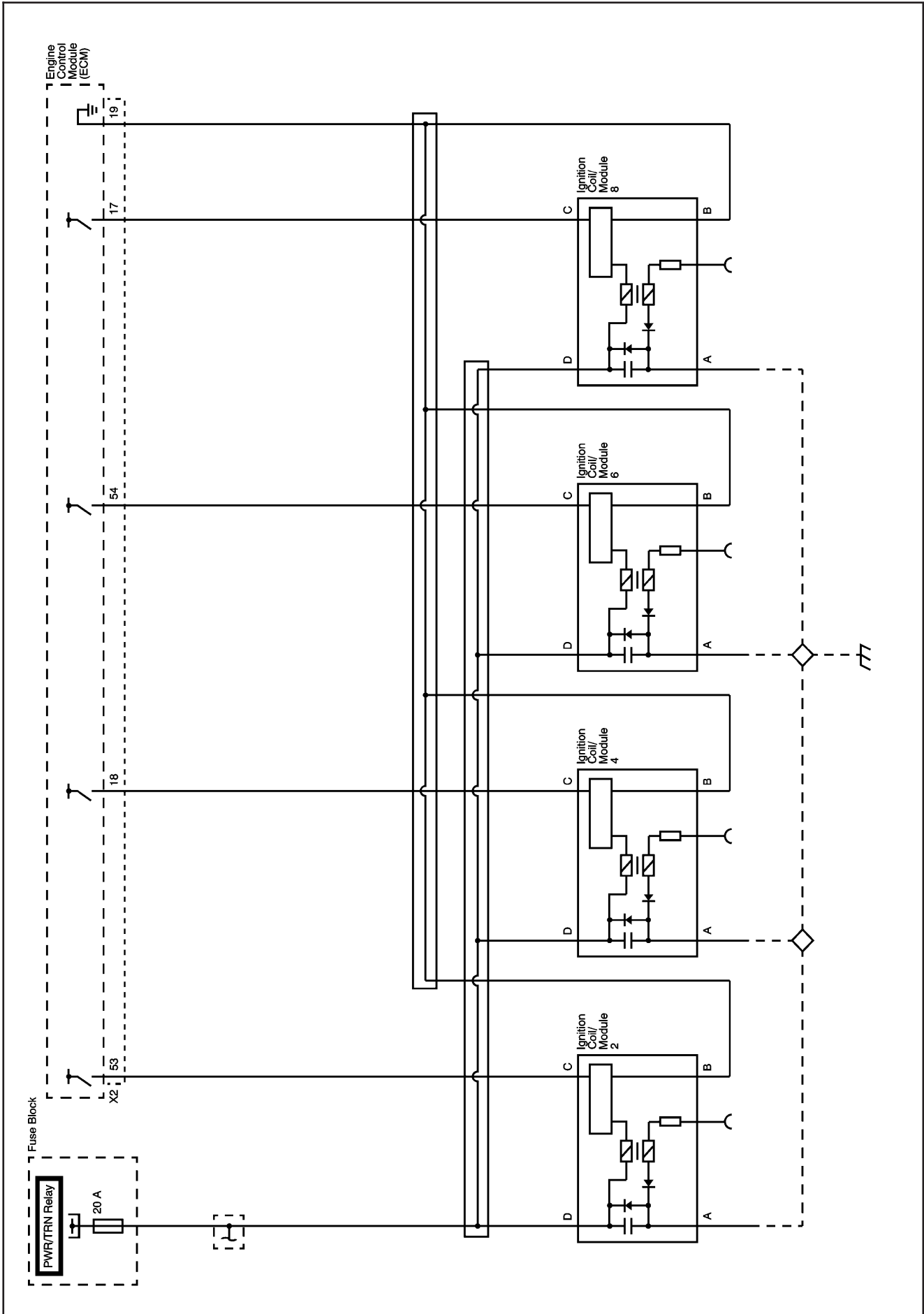


2444339

Engine Controls Schematics (Ignition Controls – Ignition 1)

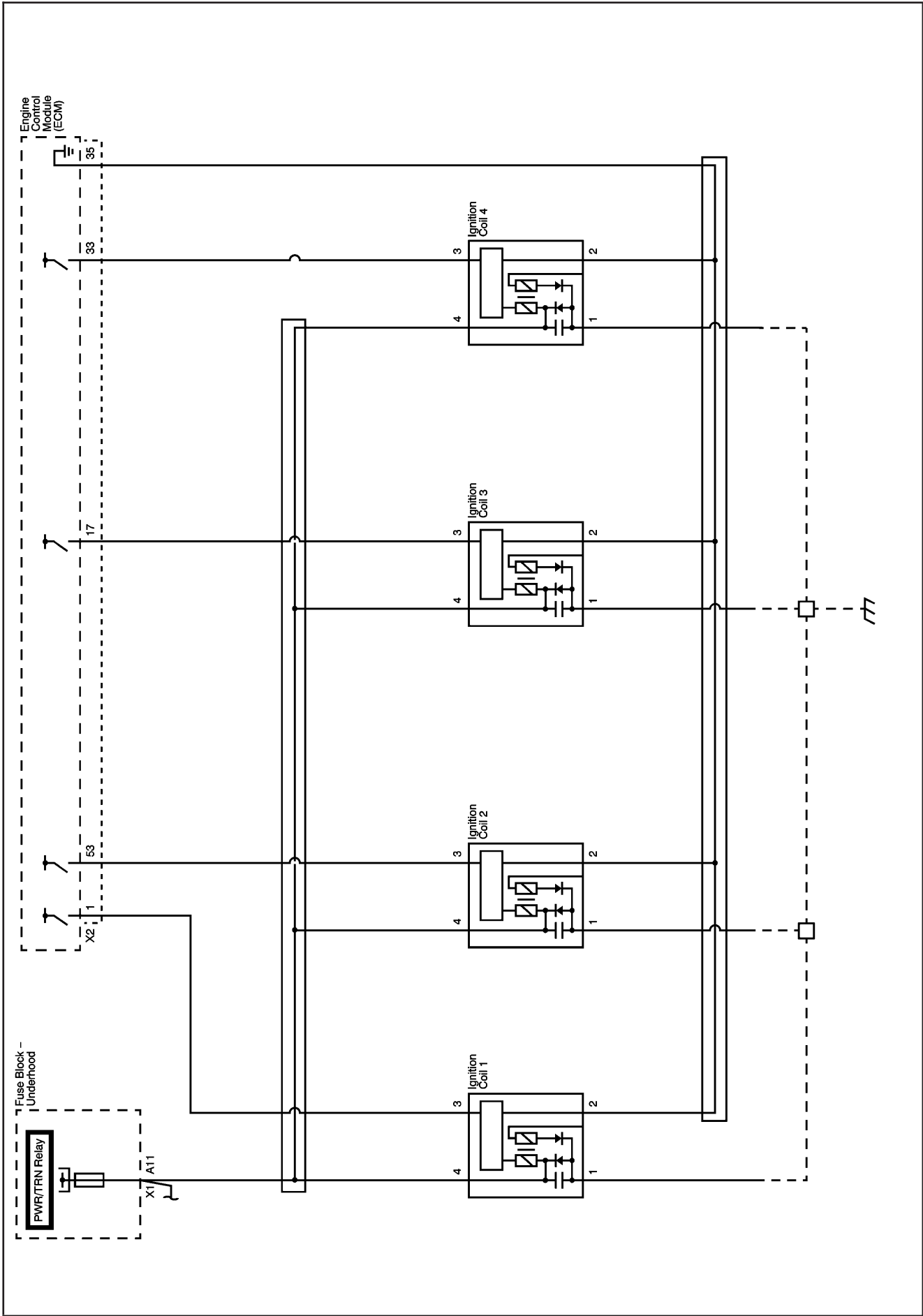


Engine Controls Schematics (Ignition Controls – Ignition 2)

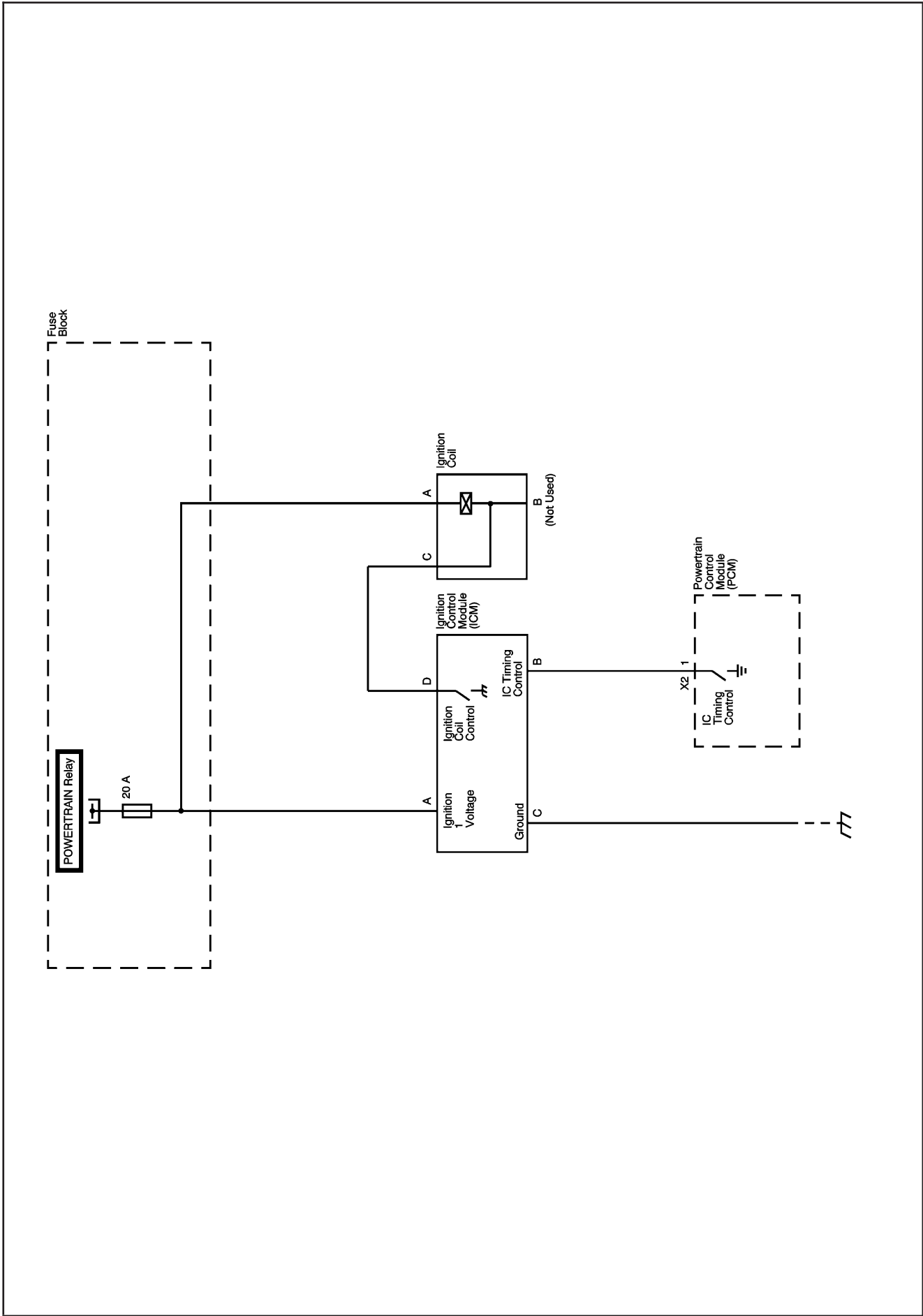


2444347

Engine Controls Schematics (Ignition Controls – Ignition System)

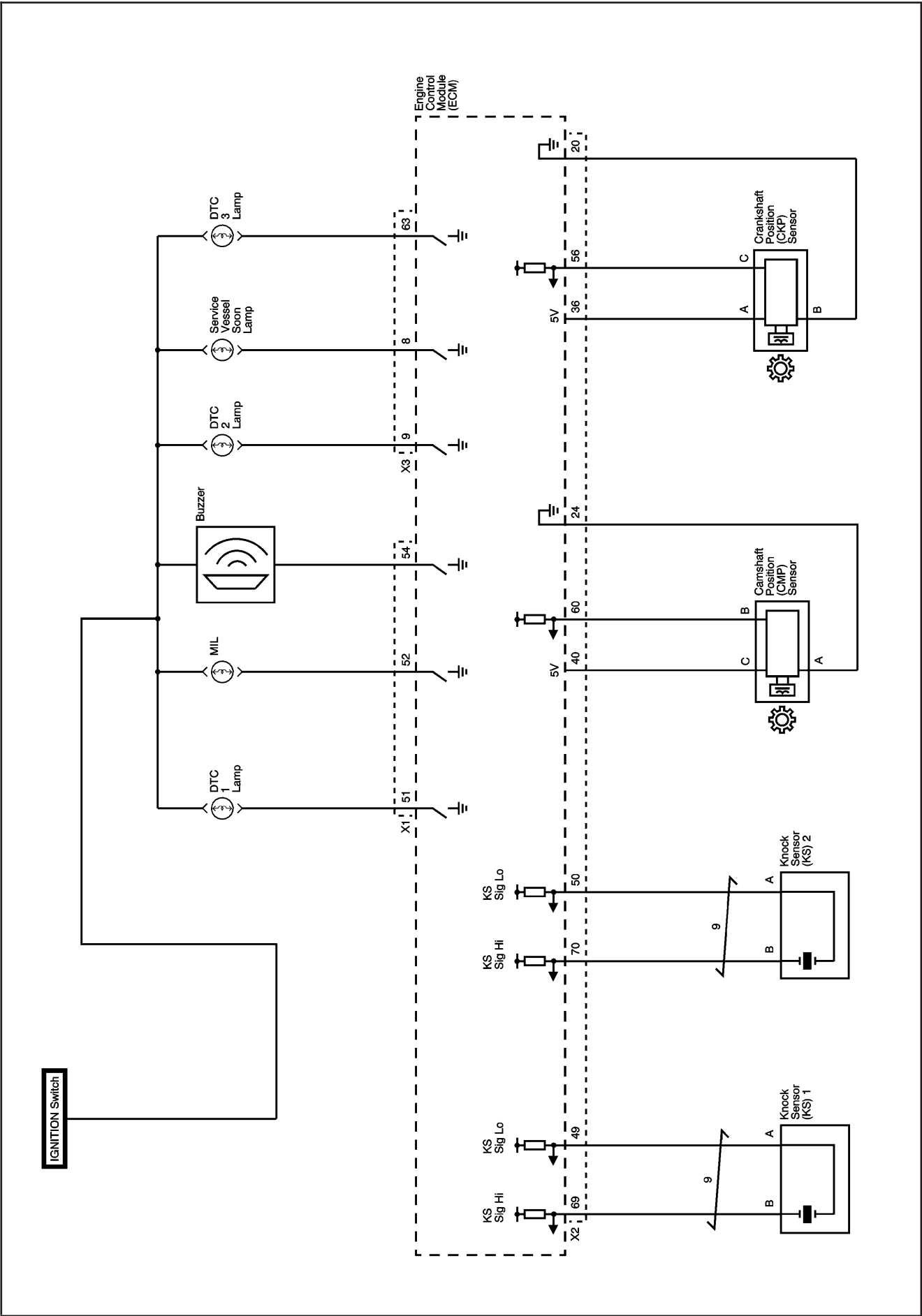


Engine Controls Schematics (Ignition Controls – Distributor Ignition System)

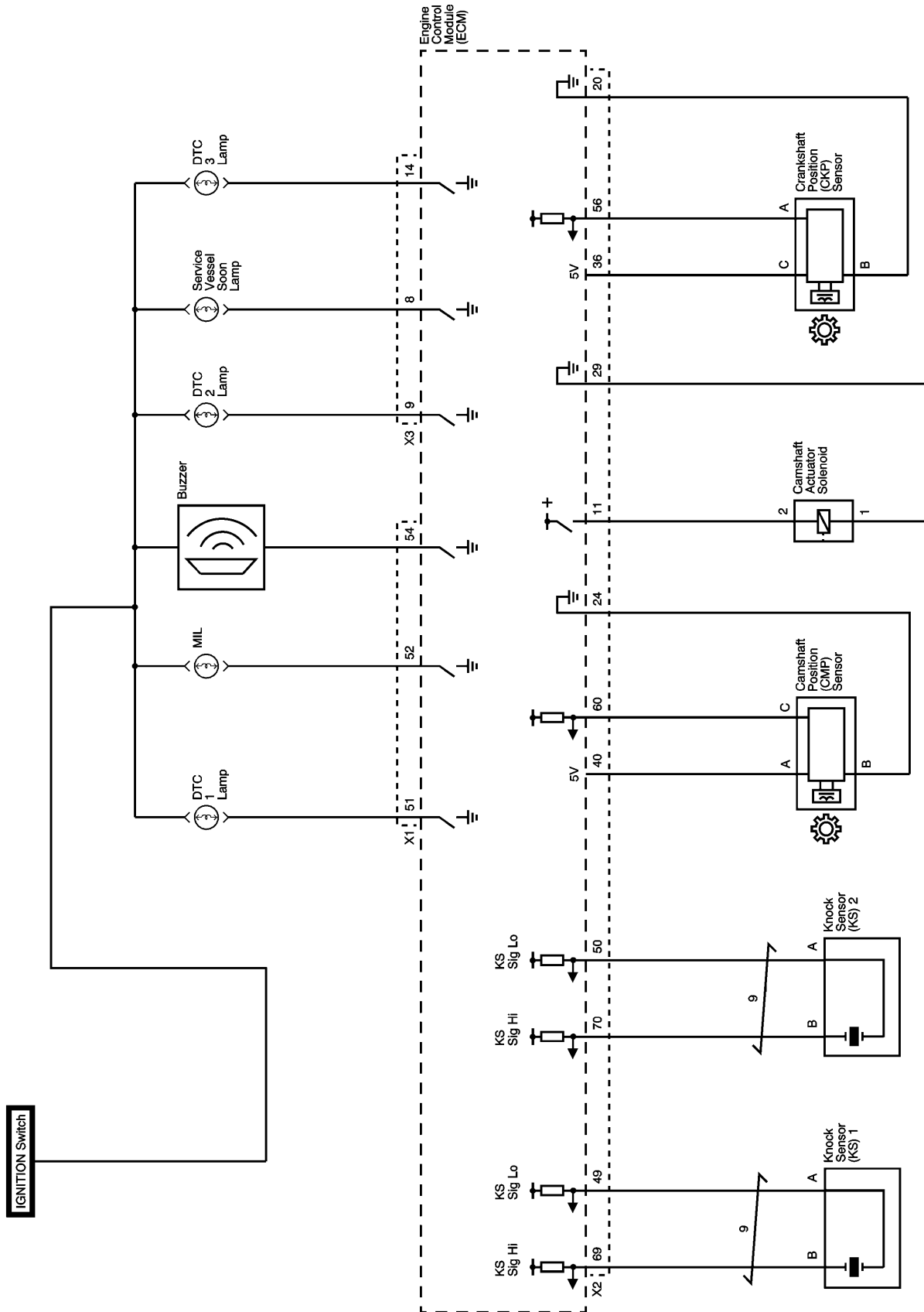


2444349

Engine Controls Schematics (Ignition Controls – Camshaft, Crankshaft, and Knock Sensors with 3.0/4.3/5.0/5.7L)

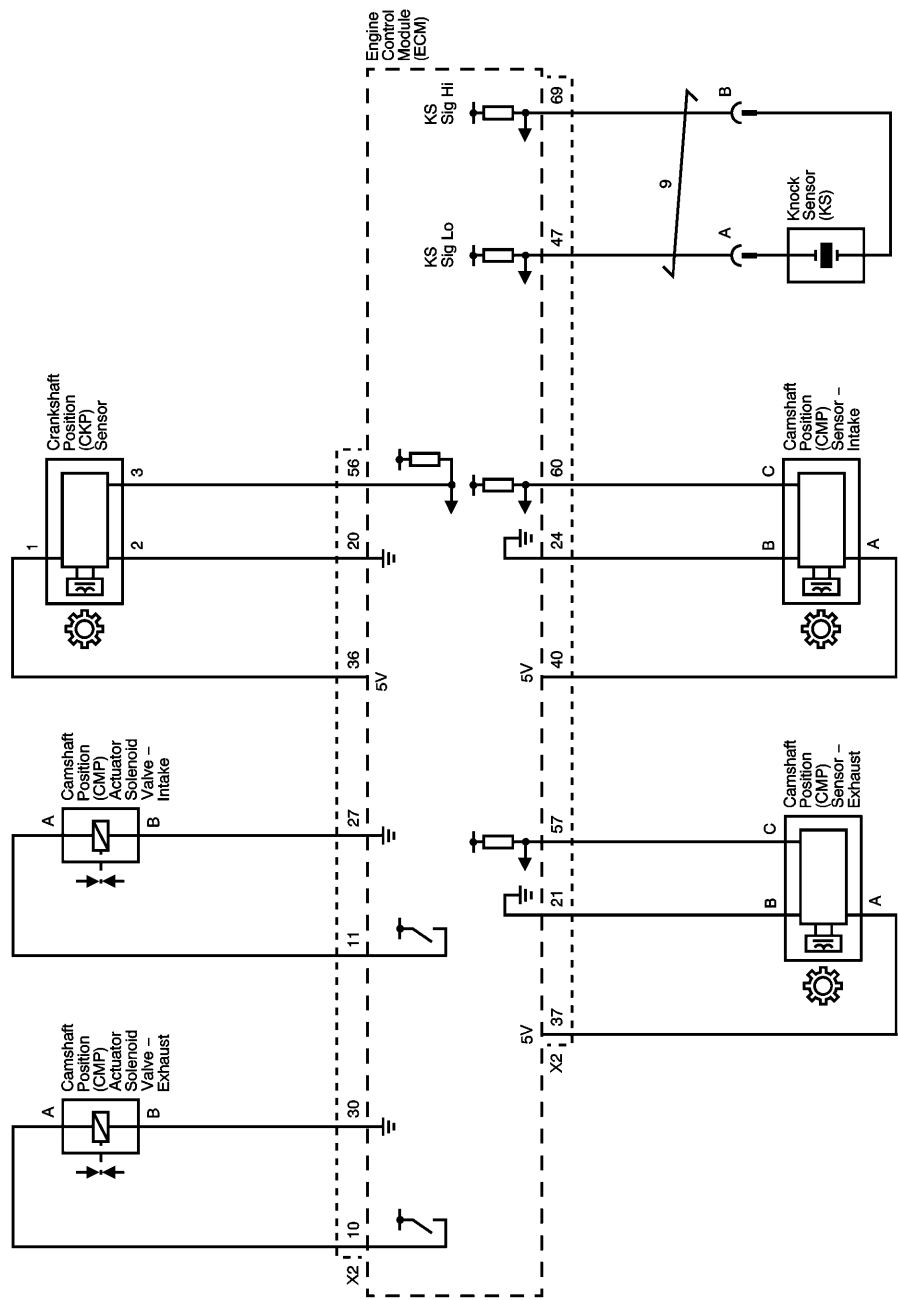


Engine Controls Schematics (Ignition Controls – Camshaft, Crankshaft, and Knock Sensors with 6.0/6.2L)

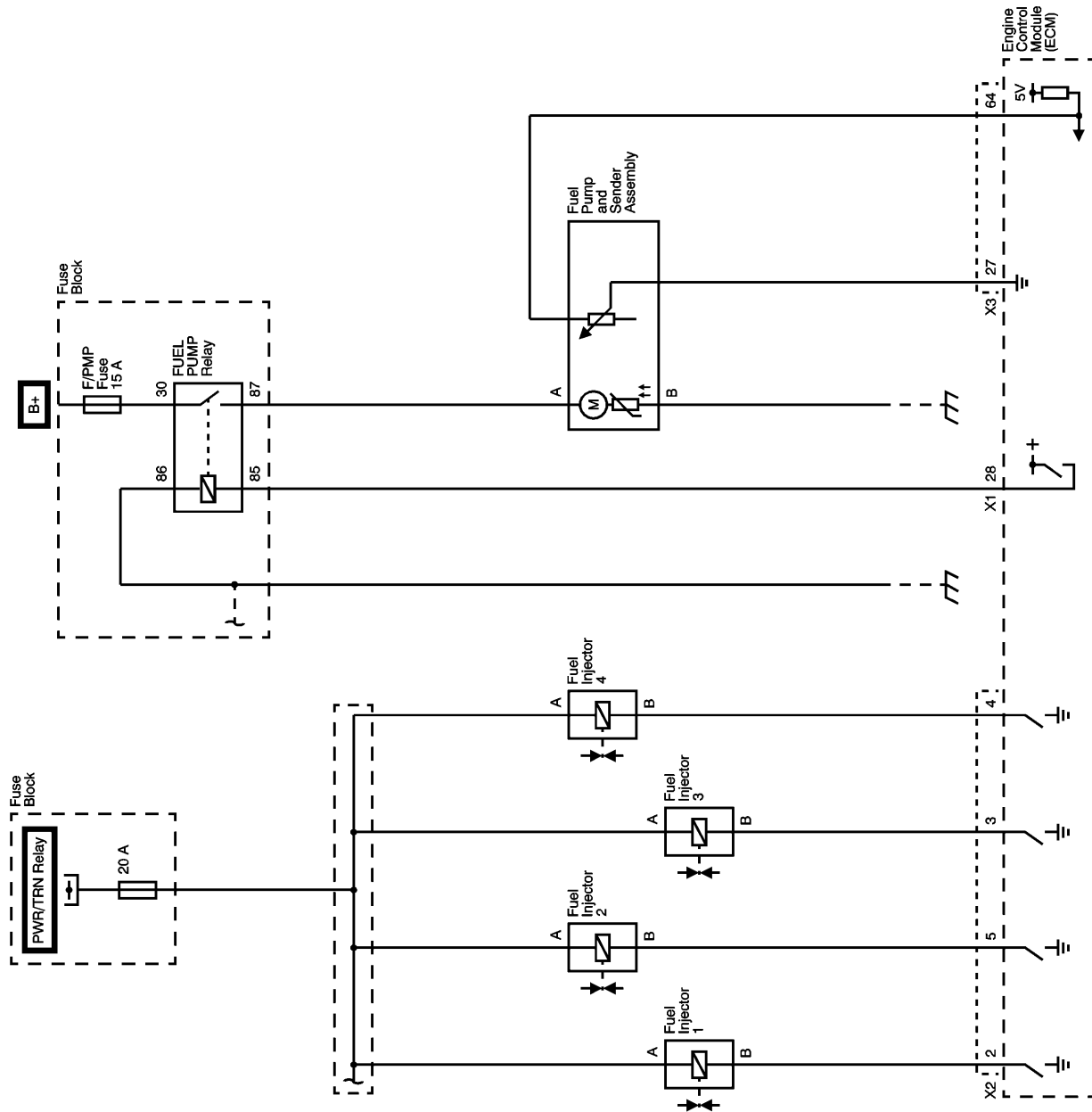


2444354

Engine Controls Schematics (Ignition Controls – Sensors)

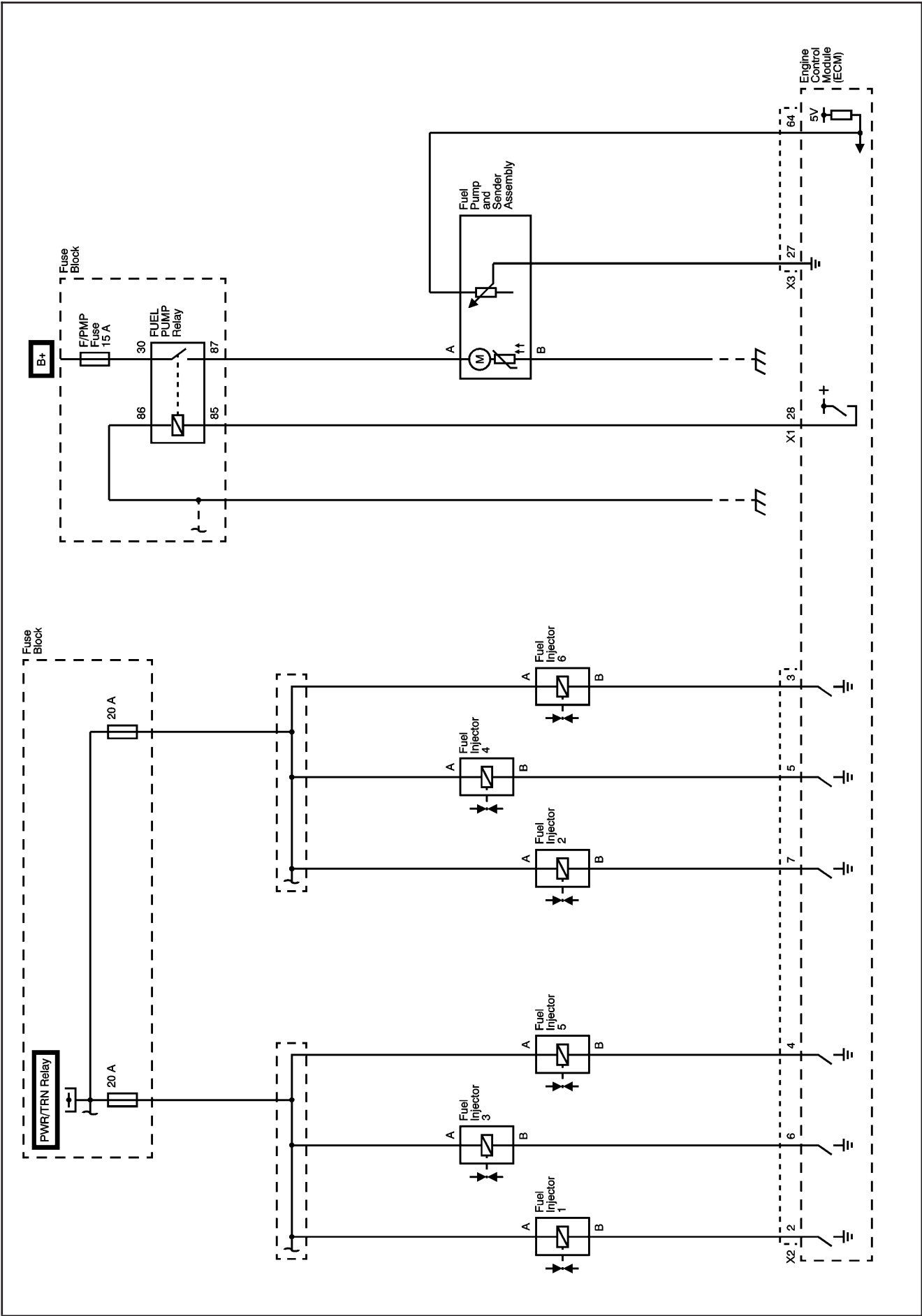


Engine Controls Schematics (Fuel Controls – Fuel Injectors and Fuel Pump with 2.4/3.0L)

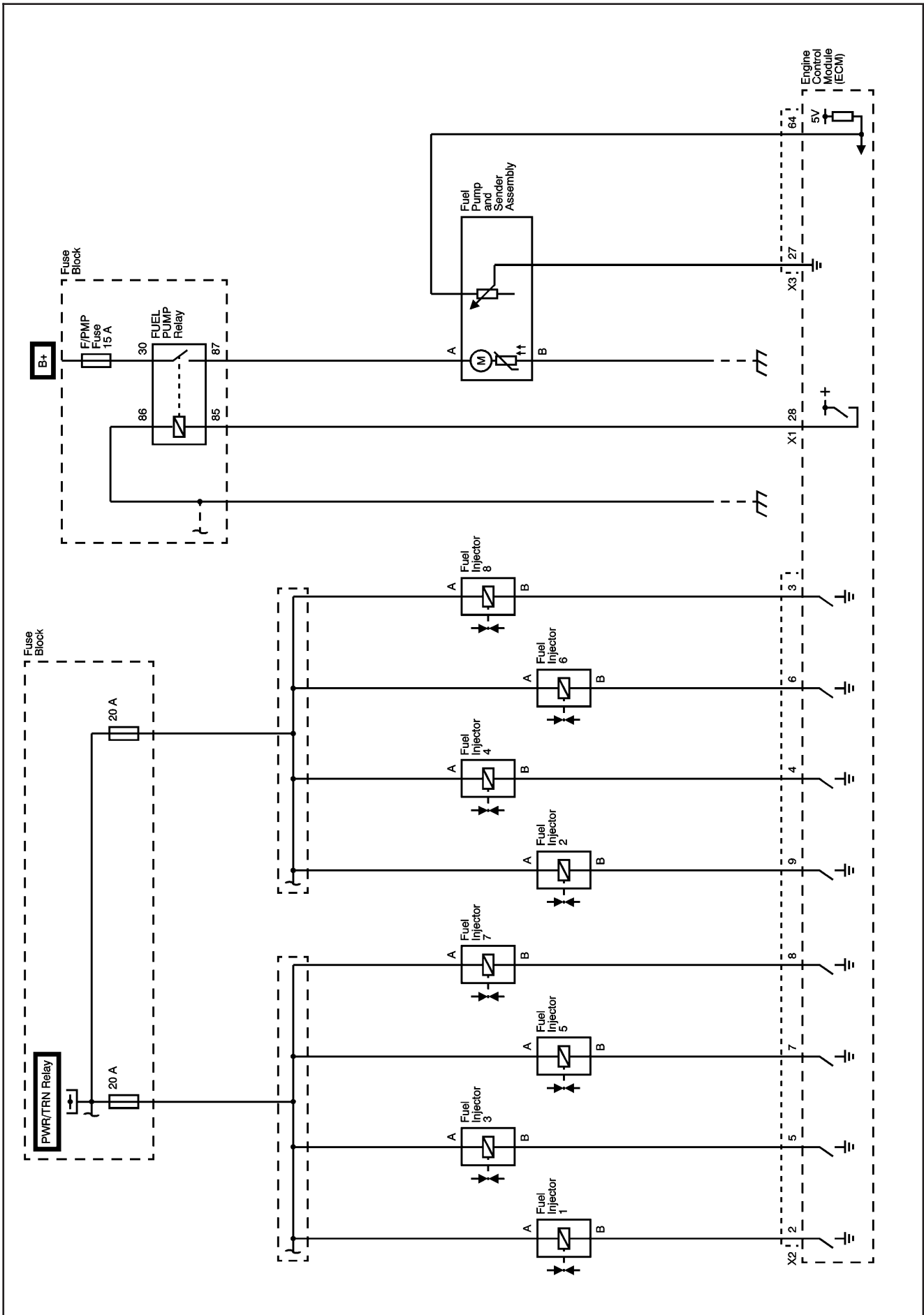


2546167

Engine Controls Schematics (Fuel Controls – Fuel Injectors and Fuel Pump with 4.3L)

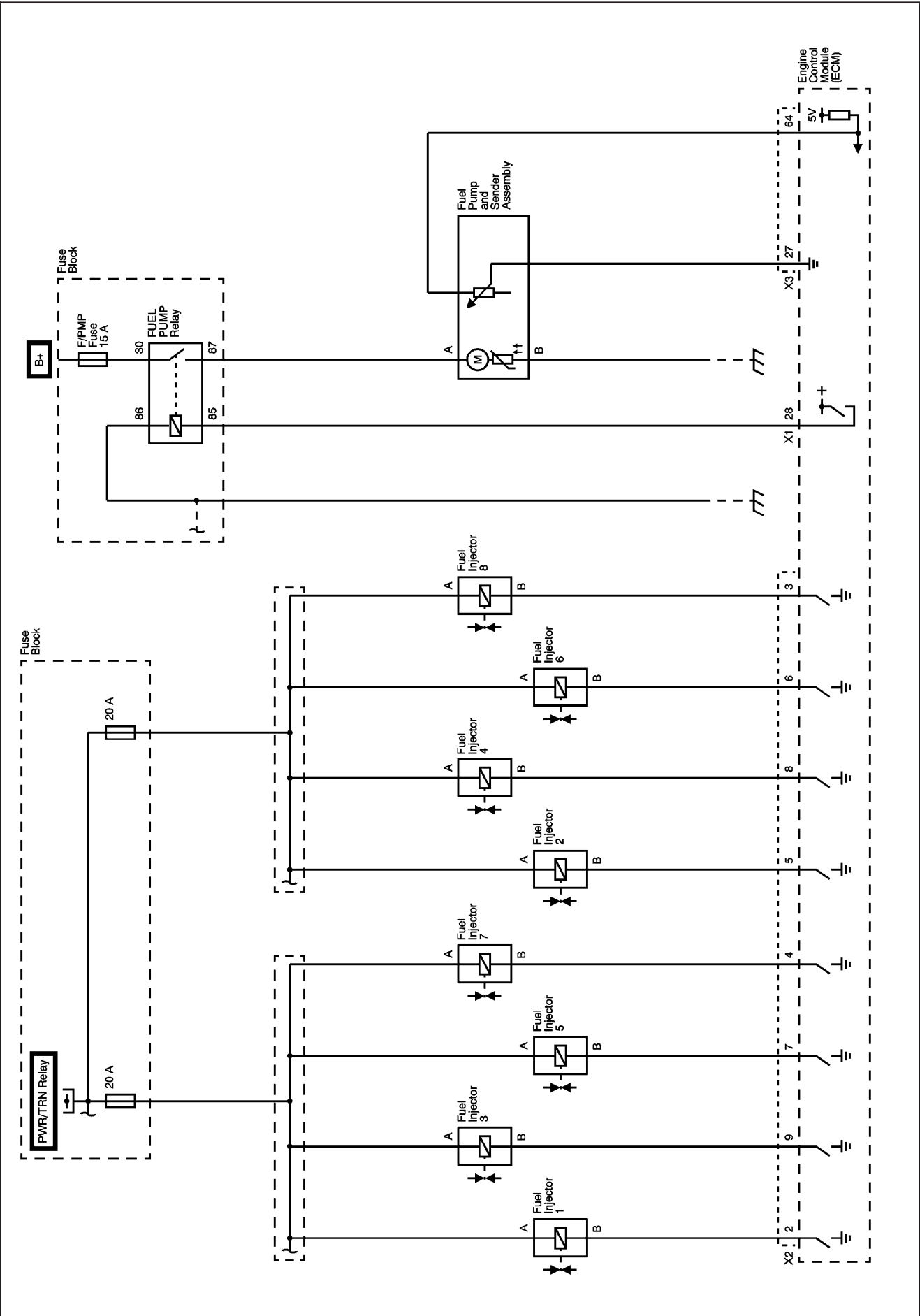


Engine Controls Schematics (Fuel Controls – Fuel Injectors and Fuel Pump with 5.0/5.7L)

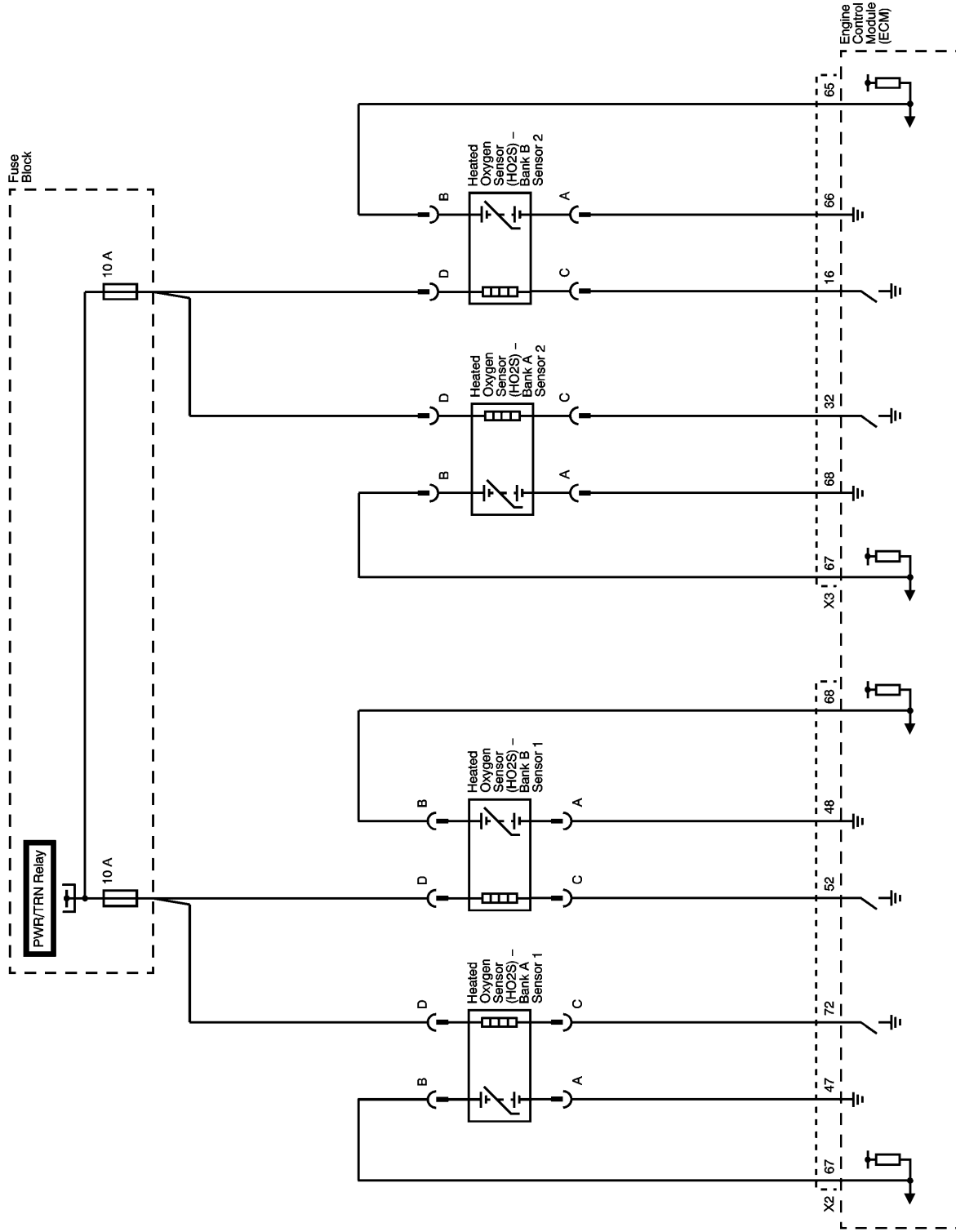


2546170

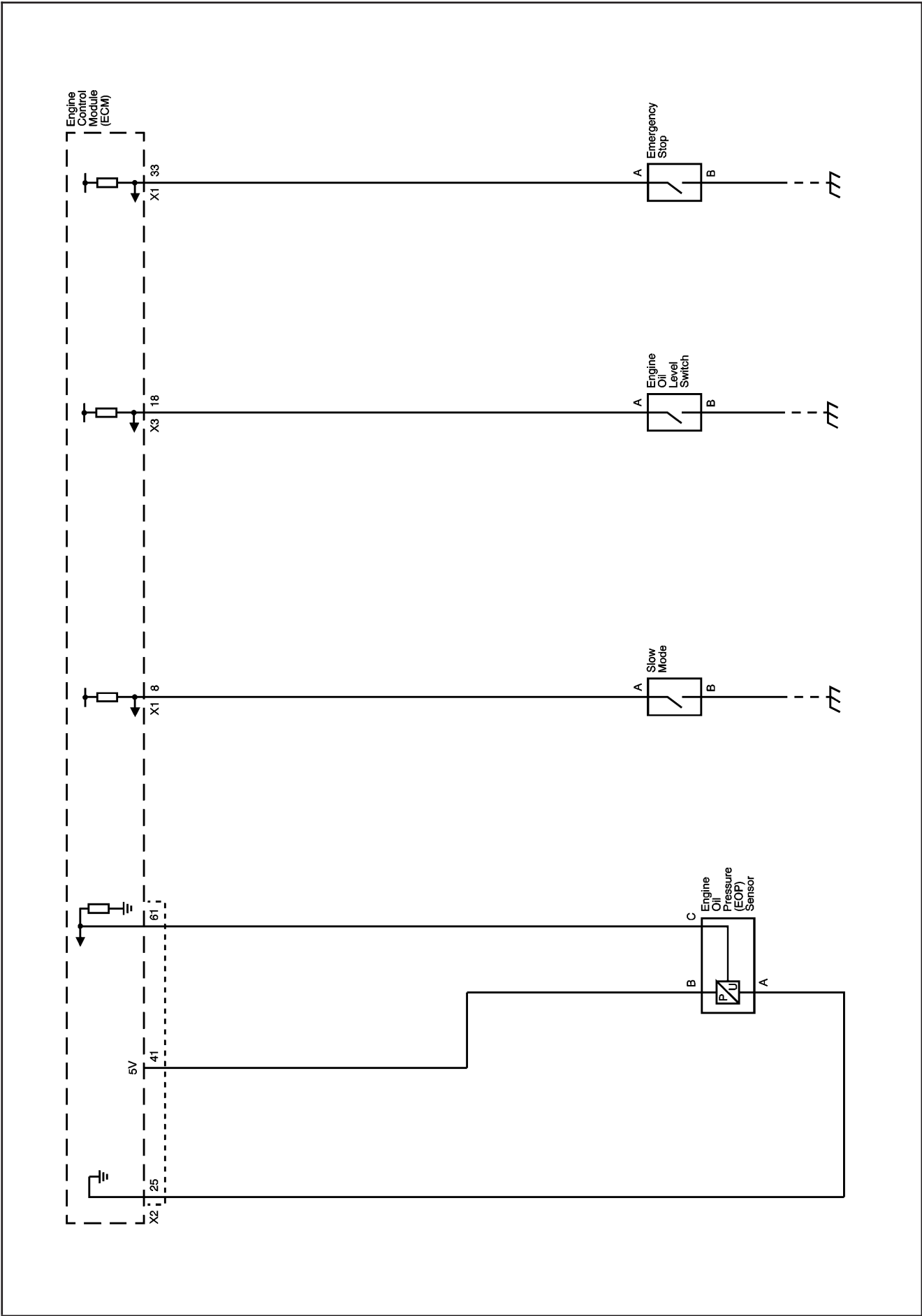
Engine Controls Schematics (Fuel Controls – Fuel Injectors and Fuel Pump with 6.0/6.2L)



Engine Controls Schematics (Engine Data Sensors – HO2S)

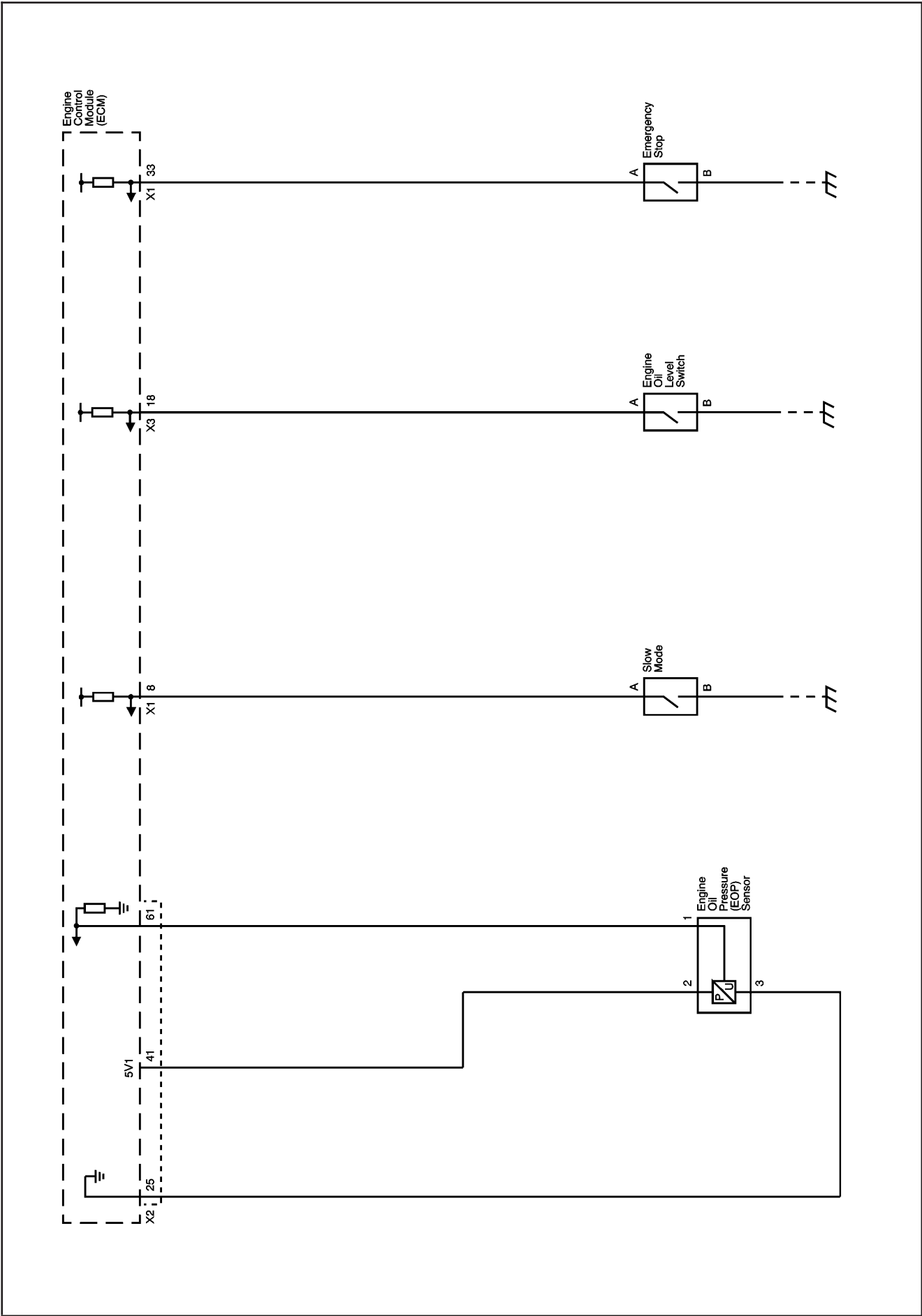


Engine Controls Schematics (Engine Data Sensors – Engine Oil Pressure with 3.0/4.3/5.0/5.7L)



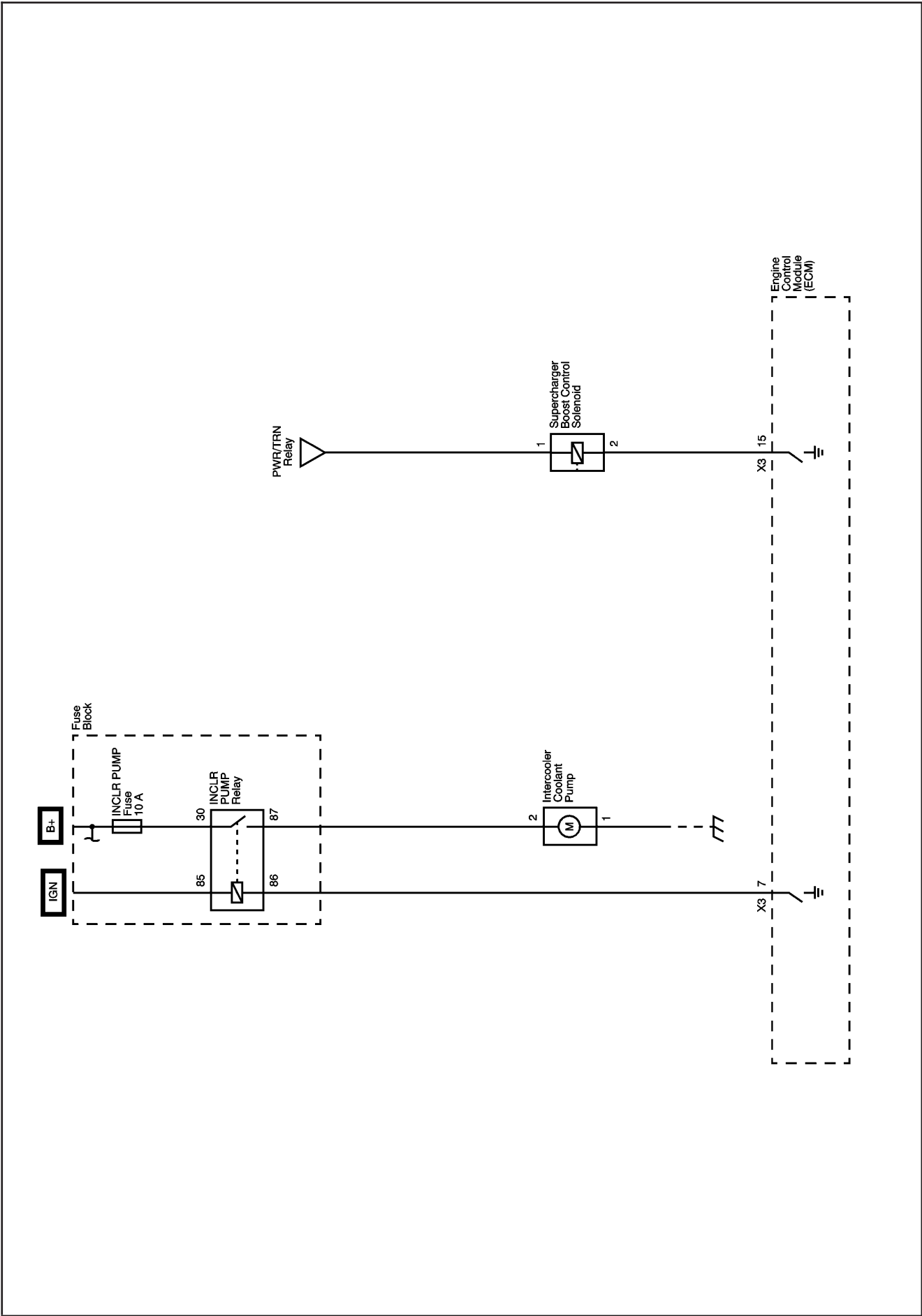
2444363

Engine Controls Schematics (Engine Data Sensors – Engine Oil Pressure)

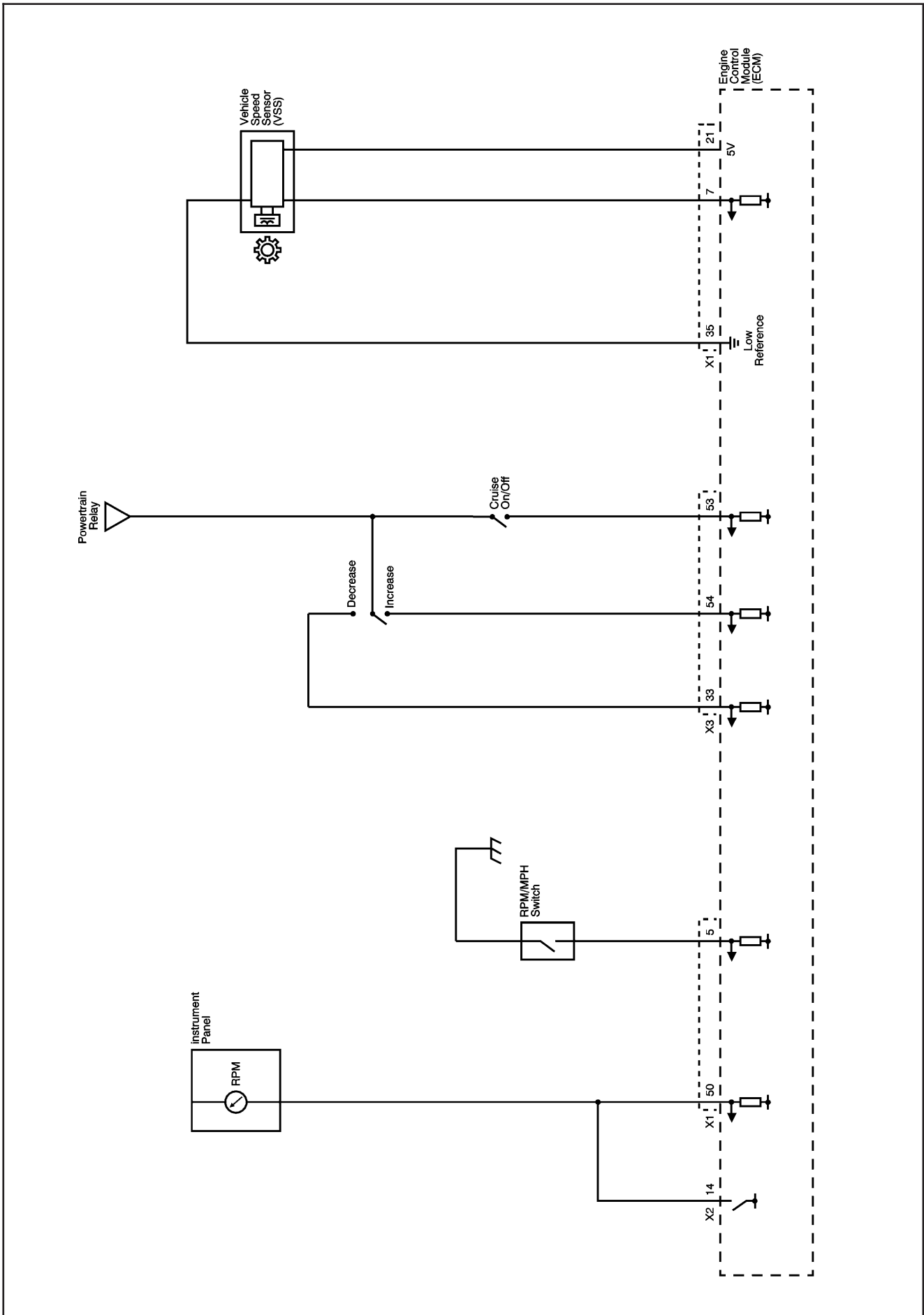


2444366

Engine Controls Schematics (Engine Data Sensors – Supercharger Boost Control and Intercooler Relay)

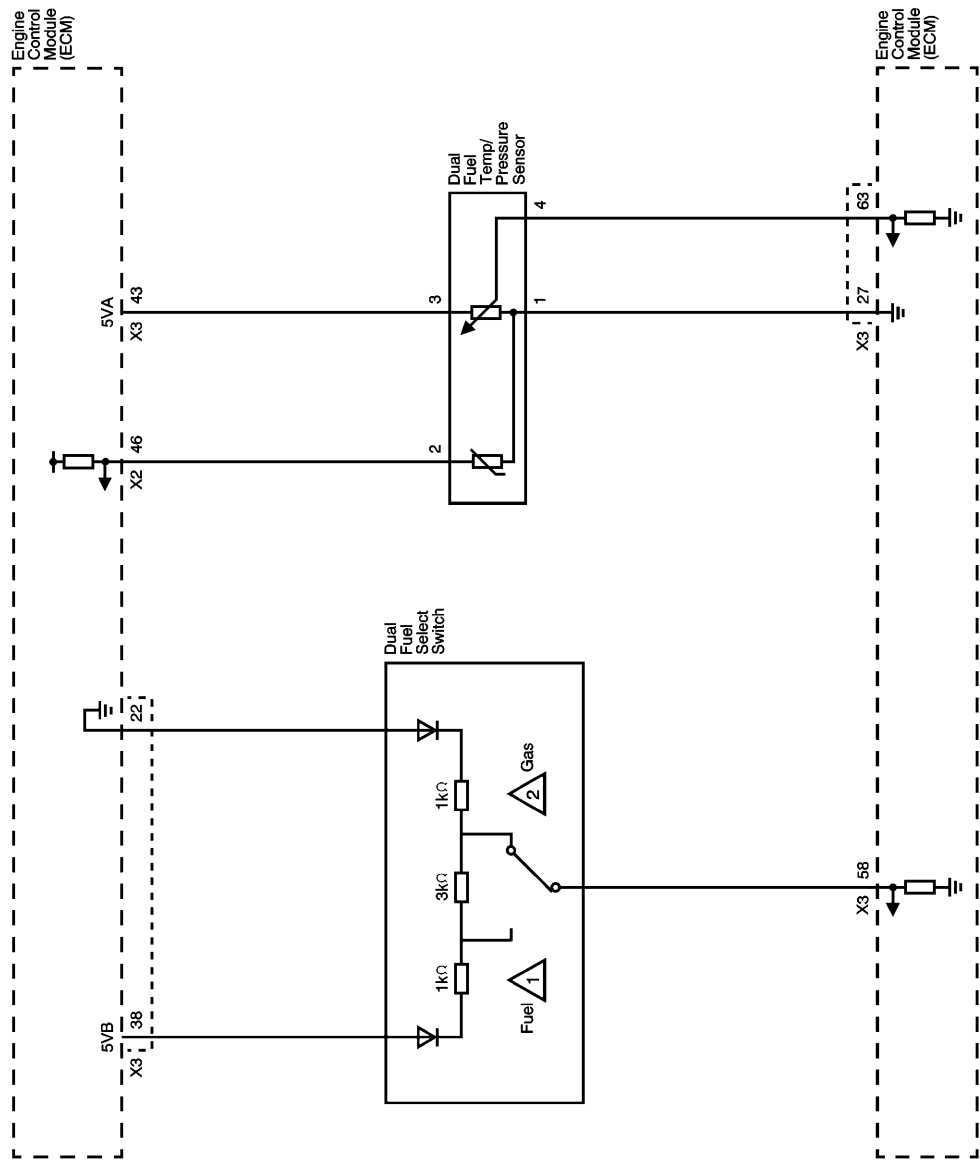


Engine Controls Schematics (Cruise Control, Tachometer, and Vehicle Speed Sensor)

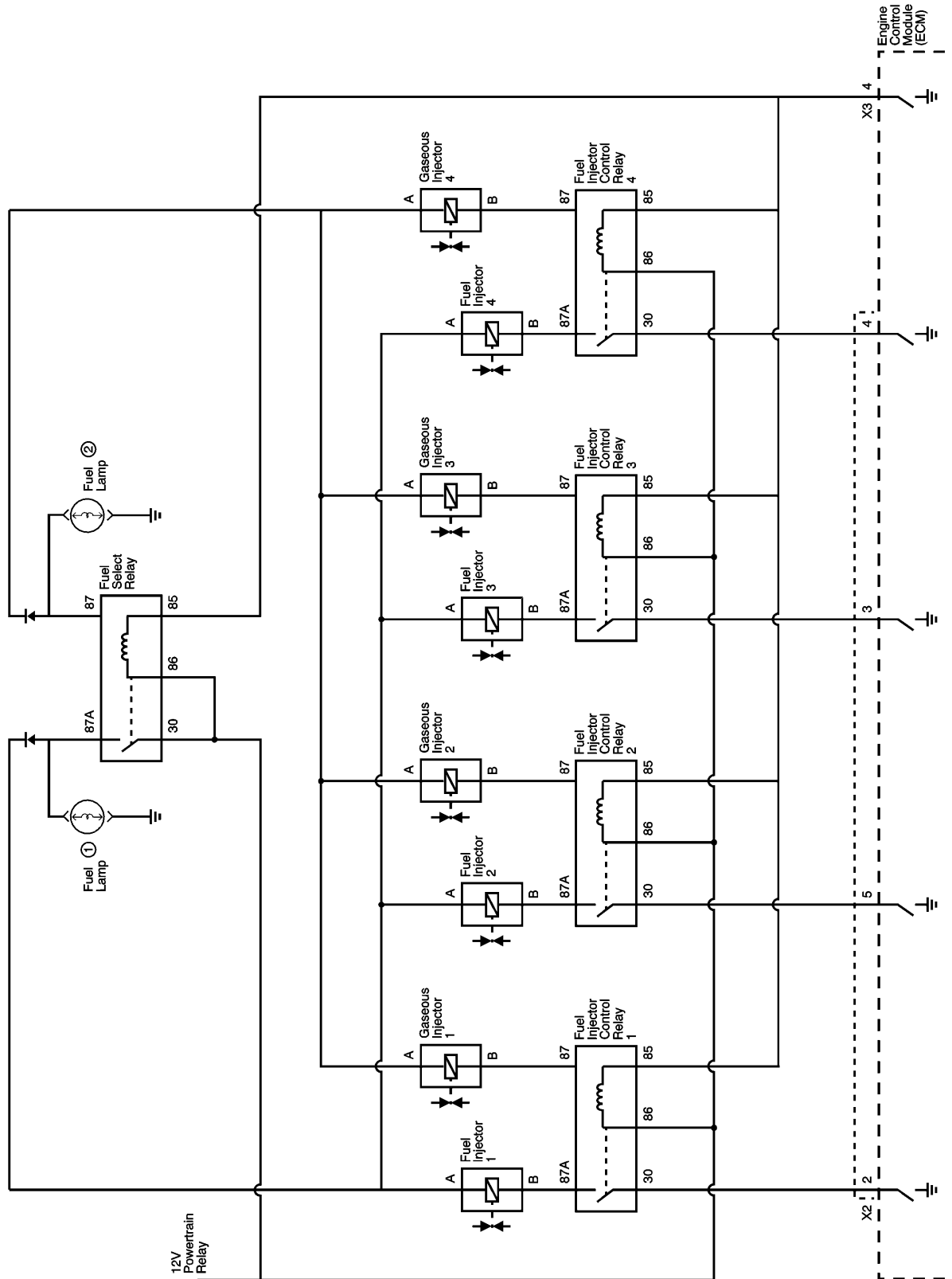


2444372

Engine Controls Schematics (Dual Fuel Controls – Fuel Pressure Sensor and Fuel Select Switch)



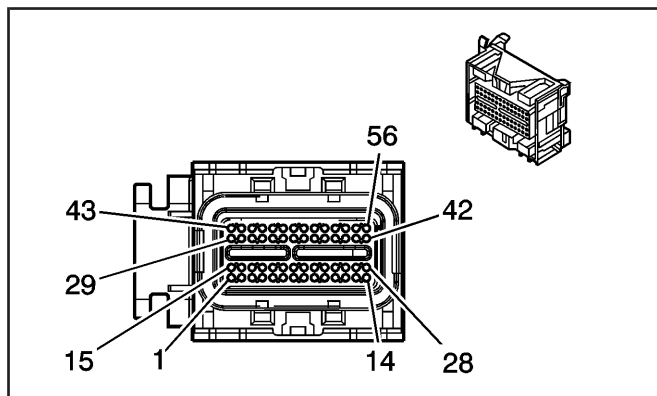
Engine Controls Schematics (Dual Fuel Controls – Fuel Injection Control)



Visual Identification

Engine Control Module Connector End Views

Engine Control Module (ECM) X1



784851

Connector Part Information

Harness: Engine

OEM: 13510837

Service: 88988373

Description: 56-Way F MX123 Series (BK)

Terminal Part Information

Pins: 2, 10, 12–14, 16, 24, 26, 28, 30, 34, 38, 40, 50, 52

Terminal/Tray: 33467-0003/23

Core/Insulation Crimp: H/H

Release Tool/Test Probe:

J-38125-213/J-35616-64B (L-BU)

Pins: 3–5, 11, 18–20, 25, 27, 29, 31, 33, 39, 43, 45, 47, 53, 56

Terminal/Tray: 33467-0005/23

Core/Insulation Crimp: Pins: 3–5, 11, 18–20, 25, 27, 29, 31, 33, 39, 43, 45, 47, 56 – J/J

Core/Insulation Crimp: Pins: 53 – K/K

Release Tool/Test Probe:

J-38125-213/J-35616-64B (L-BU)

Engine Control Module (ECM) X1

Pin	Wire	Circuit	Function
1	—	—	High Speed CAN Serial Data Bus 2 (+)
2	—	—	Pedal Position Sensor 2 Signal
3	—	—	MAF Sensor Signal
4	—	—	Slave Engine Select
5	—	—	Governor Mode
6	—	—	Load Anticipate 1
7	—	—	Vehicle Speed Sensor Signal

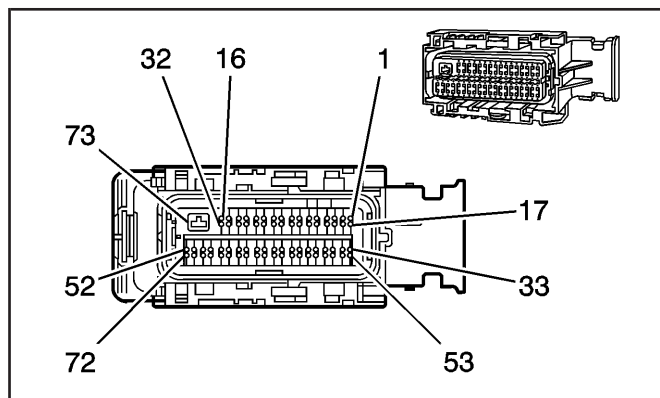
Engine Control Module (ECM) X1 (cont'd)

Pin	Wire	Circuit	Function
8	—	—	Slow Mode Signal
9	—	—	Supercharger Inlet Pressure Sensor Signal
10	—	—	Pedal Position Sensor 1 Signal
11	—	—	Barometric Pressure Sensor Signal
12	—	—	Variable Governor Signal
13	—	—	Variable Governor Low Reference
14	—	—	Fuel Pump Relay Control - Secondary
15	—	—	High Speed CAN Serial Data Bus 2 (-)
16	—	—	5-Volt Reference 1
17	—	—	Not Available
18	—	—	Boot Mode
19	—	—	Ignition 1 Voltage
20	—	—	Battery Positive Voltage
21	—	—	Vehicle Speed Sensor 5-Volt Reference
22–25	—	—	5-Volt Reference 2
26	—	—	5-Volt Reference 1
27	—	—	Starter Relay Control High Side Driver
28	—	—	Fuel Pump Relay Control - Primary
29	—	—	High Speed CAN Serial Data Bus (+)
30–32	—	—	Low Reference
33	—	—	Emergency Stop Signal
34	—	—	Shift Interrupt Switch Signal
35–39	—	—	Low Reference
40	—	—	Powertrain Relay Coil Control
41–42	—	—	Not Available
43	—	—	High Speed CAN Serial Data Bus (-)
44	—	—	Not Available
45	—	—	IAT/MAT Sensor Signal
46	—	—	Exhaust Gas Temperature (EGT) Sensor Bank B
47–49	—	—	Not Available
50	—	—	TACH–Pull Up
51	—	—	DTC 1 Lamp Control
52	—	—	MIL Control
53	—	—	Speed Based Output

Engine Control Module (ECM) X1 (cont'd)

Pin	Wire	Circuit	Function
54	—	—	Buzzer Control
55	—	—	Not Used
56	—	—	Governor Status Lamp Control

Engine Control Module (ECM) X2



1590596

Connector Part Information

Harness: Engine

OEM: 15466079

Service: 88988931

Description: 73-Way F MX123 Series, Sealed (BK)

Terminal Part Information

Pins: 11, 24, 29, 40, 43–44, 60, 63, 65

Terminal/Tray: 33467-0003/23

Core/Insulation Crimp: H/H

Release Tool/Test Probe:

J-38125-213/J-35616-64B (L-BU)

Pins: 3–5, 11, 18–20, 25, 27, 29, 31, 33, 39, 43, 45, 47, 53, 56

Terminal/Tray: 33467-0005/23

Core/Insulation Crimp: Pins: 1–9, 15–20, 25, 28, 33–36, 41, 47–50, 52–56, 61, 67–70, 72 – J/J

Core/Insulation Crimp: Pins: 49–50, 69–70 – K/K

Release Tool/Test Probe:

J-38125-213/J-35616-64B (L-BU)

Pins: 73

Terminal/Tray: 7116-4152-02/9

Core/Insulation Crimp: A/5

Release Tool/Test Probe: J-38125-11A/J-35616-35 (VT)

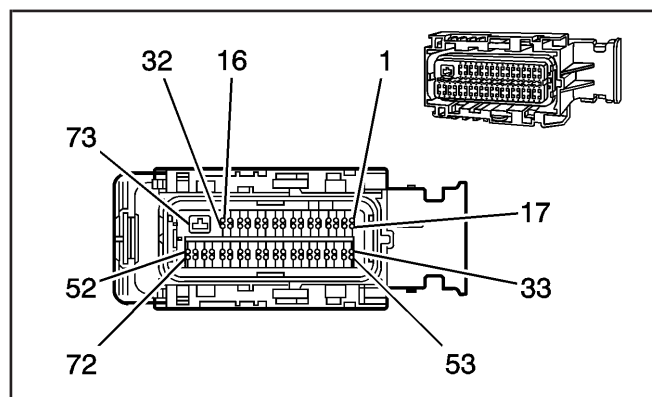
Engine Control Module (ECM) X2

Pin	Wire	Circuit	Function
1	—	—	Ignition Control (IC) 1
2	—	—	Fuel Injector 1 Control
3	—	—	Fuel Injector 8 Control
4	—	—	Fuel Injector 7 Control
5	—	—	Fuel Injector 2 Control
6	—	—	Fuel Injector 6 Control
7	—	—	Fuel Injector 5 Control
8	—	—	Fuel Injector 4 Control
9	—	—	Fuel Injector 3 Control
10	—	—	Not Used
11	—	—	Camshaft Actuator Solenoid Control
12	—	—	Not Used
13	—	—	Ignition 2 Voltage
14	—	—	Tach Driver
15	—	—	ETC/IAC Motor Control–Open
16	—	—	ETC/IAC Motor Control–Close
17	—	—	IC 8
18	—	—	IC 4
19	—	—	Electronic Spark Timing (EST) Return 2
20	—	—	Crank Sensor Low Reference
21–25	—	—	Low Reference
26	—	—	Not Used
27	—	—	Oil Temperature Sensor Low Reference
28	—	—	Ignition 1 Voltage
29	—	—	Camshaft Actuator Solenoid Low Reference
30	—	—	Low Reference
31	—	—	Engine Oil Pressure Switch Signal
32	—	—	Exhaust Gas Recirculation (EGR) Solenoid Valve or Fuel Valve High Control
33	—	—	IC 7
34	—	—	IC 5
35	—	—	EST Return
36	—	—	5-Volt Reference 2
37–41	—	—	5-Volt Reference 1
42	—	—	Not Used

Engine Control Module (ECM) X2 (cont'd)

Pin	Wire	Circuit	Function
43	—	—	5-Volt Reference 2
44	—	—	TP Sensor 1 and 2 Low Reference
45	—	—	Not Used
46	—	—	Fuel Temperature Sensor Signal
47	—	—	Heated Oxygen Sensor (HO2S) Signal - Low Bank A Sensor 1
48	—	—	HO2S Signal - Low Bank B Sensor 1
49	—	—	Knock Sensor (KS) 1 Signal - Low
50	—	—	KS 2 Signal - Low
51	—	—	Low Reference
52	—	—	HO2S Heater Control - Bank B Sensor 1
53	—	—	IC 2
54	—	—	IC 6
55	—	—	IC 3
56	—	—	CKP Sensor Signal
57–59	—	—	Not Used
60	—	—	CMP Sensor Signal
61	—	—	Oil Pressure Sensor Signal
62	—	—	Not Used
63	—	—	TP Sensor 1 Signal
64	—	—	EGR Solenoid Valve Position or Fuel Level Sensor Signal
65	—	—	TP Sensor 2 Signal
66	—	—	Engine Oil Temperature Sensor Signal
67	—	—	HO2S Signal - High Bank A Sensor 1
68	—	—	HO2S Signal - High Bank B Sensor 1
69	—	—	KS 1 Signal–High
70	—	—	KS 2 Signal–High
71	—	—	Not Used
72	—	—	HO2S Heater Control - Bank A Sensor 1
73	—	—	ECM Ground

Engine Control Module (ECM) X3



1590596

Connector Part Information

Harness: Engine

OEM: 15482787

Service: 88988372

Description: 73-Way F 64/2.8 Series, Sealed (BK)

Terminal Part Information

Pins: 27, 43–44, 55, 63–64

Terminal/Tray: 33467-0003/23

Core/Insulation Crimp: H/H

Release Tool/Test Probe:

J-38125-213/J-35616-64B (L-BU)

Pins: 10, 16–17, 28–30, 32, 45–46, 48–49, 65–68

Terminal/Tray: 33467-0005/23

Core/Insulation Crimp: J/J

Release Tool/Test Probe:

J-38125-213/J-35616-64B (L-BU)

Engine Control Module (ECM) X3

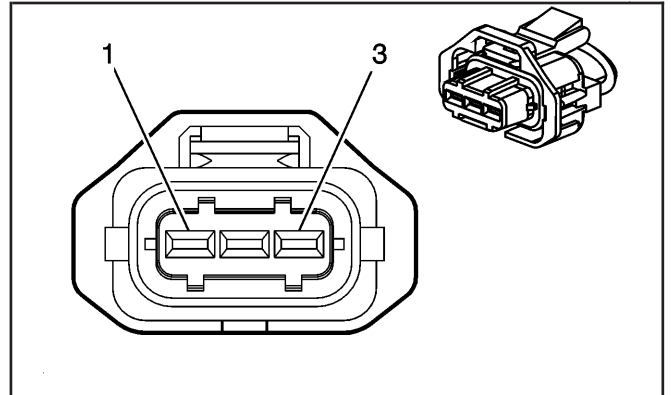
Pin	Wire	Circuit	Function
1	—	—	Load Anticipate Signal 2
2	—	—	Crank Request Signal
3–6	—	—	Not Used
7	—	—	Intercooler Relay Control
8	—	—	Service Vessel Soon Lamp Control
9	—	—	DTC 2 Lamp Control
10	—	—	Evaporative Emission (EVAP) Canister Purge Solenoid or Fuel Valve Control
11	—	—	Not Used
12	—	—	Slow Mode Lamp Control
13	—	—	Not Used
14	—	—	DTC 3 Lamp Control
15	—	—	Supercharger Boost Solenoid Valve Control
16	—	—	HO2S Heater Control Bank B Sensor 2

Engine Control Module (ECM) X3 (cont'd)

Pin	Wire	Circuit	Function
17	—	—	Not Used
18	—	—	Engine Oil Level Sensor Signal
19	—	—	Not Used
20–21	—	—	Low Reference
23–25	—	—	Not Used
26–27	—	—	Low Reference
28	—	—	5-Volt Reference 1
29	—	—	MAP Sensor Low Reference
30	—	—	ETC Sensor Low Reference
31	—	—	EGT Sensor A Low Reference
32	—	—	HO2S Heater Control Bank A Sensor 2
33	—	—	Cruise Set/Decrease Signal
34–35	—	—	Not Used
36	—	—	5-Volt Reference General Warning 2
37	—	—	5-Volt Reference General Warning 1
38–42	—	—	Not Used
43	—	—	5-Volt Reference 1
44	—	—	Fuel Level Sensor 2 or Variable Governor Signal
45	—	—	MAP Sensor Signal
46	—	—	ETC Sensor Signal
47	—	—	EGT Sensor Bank A
48	—	—	VSS Signal–High
49	—	—	VSS Signal–Low
50–52	—	—	Not Used
53	—	—	Cruise Control ON/OFF Signal
54	—	—	Cruise Increase Signal
55	—	—	Not Used
56	—	—	General Warning Sensor 1 Signal
57	—	—	General Warning Sensor 2 Signal
58–62	—	—	Not Used
63	—	—	Fuel Tank Pressure Sensor Signal
64	—	—	Fuel Level Sensor Signal - Primary
65	—	—	HO2S Signal–High Bank B Sensor 2
66	—	—	HO2S Signal–Low Bank B Sensor 2
67	—	—	HO2S Signal–High Bank A Sensor 2
68	—	—	HO2S Signal–Low Bank A Sensor 2
69–73	—	—	Not Available

Engine Controls Connector End Views

Barometric Pressure (BARO) Sensor



1331443

Connector Part Information

Harness Type: Engine

OEM Connector: 15365614

Service Connector: 88988583

Description: 3-Way F Kompakt 2.8 Series, Sealed (BK)

Terminal Part Information

Terminated Lead: Pending

Release Tool: J-38125-561

Diagnostic Test Probe: J-35616-35 (VT)

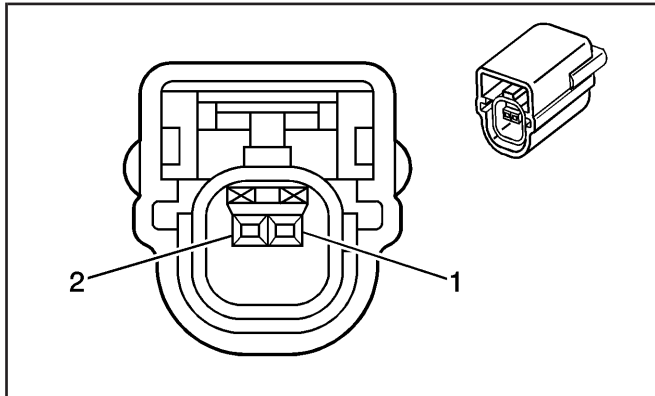
Terminal/Tray: 1928498056/8

Core/Insulation Crimp: E/1

Barometric Pressure (BARO) Sensor

Pin	Wire Color	Circuit No.	Function
1	—	—	5-Volt Reference
2	—	—	Low Reference
3	—	—	BARO Sensor Signal

Camshaft Actuator Solenoid (6.0/6.2L)



1673477

Connector Part Information

OEM: 15472554

Service: 88988610

Description: 2-Way F 0.64 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 1393364-2/7

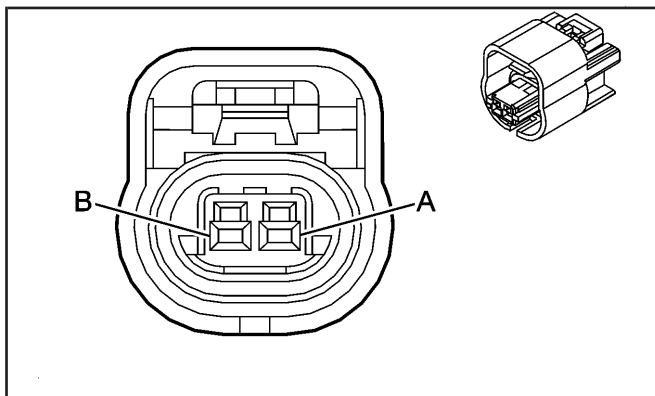
Core/Insulation Crimp: K/K

Release Tool/Test Probe: 15315247/J-35616-64B (L-BU)

Camshaft Actuator Solenoid (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
1	—	—	Camshaft Actuator Solenoid Control
2	—	—	Low Reference

Camshaft Actuator Solenoid - Exhaust (2.4L)



646406

Connector Part Information

OEM: 15336004

Service: 15306187

Description: 2-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

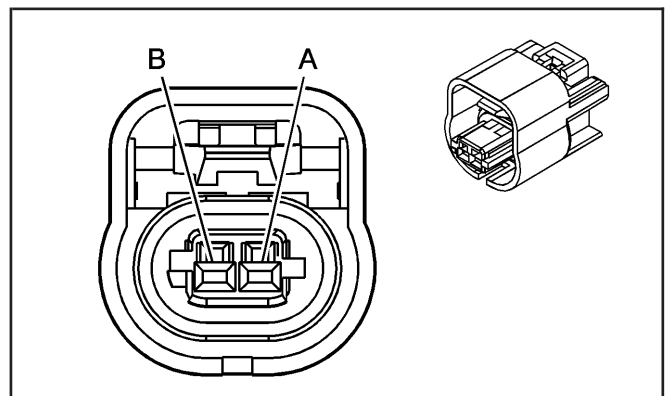
Core/Insulation Crimp: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Camshaft Actuator Solenoid - Exhaust (2.4L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Camshaft Actuator Solenoid Control
B	—	—	Low Reference

Camshaft Actuator Solenoid - Intake (2.4L)



646403

Connector Part Information

OEM: 15335987

Service: 15306430

Description: 2-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

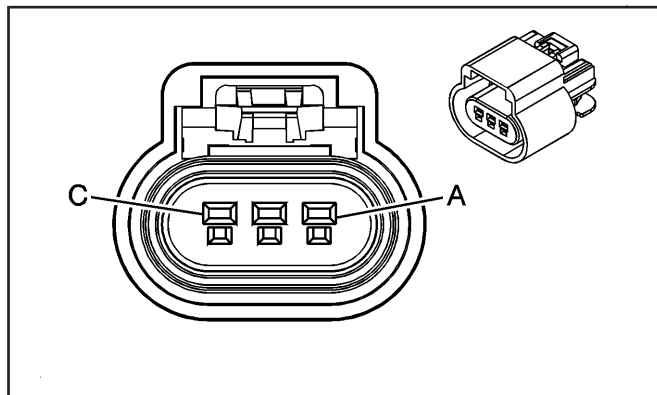
Core/Insulation Crimp: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Camshaft Actuator Solenoid - Intake (2.4L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Camshaft Actuator Solenoid Control
B	—	—	Low Reference

Camshaft Position (CMP) Sensor - Exhaust (2.4L)



646415

Connector Part Information

OEM: 15326808

Service: 15306388

Description: 3-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12191819/8

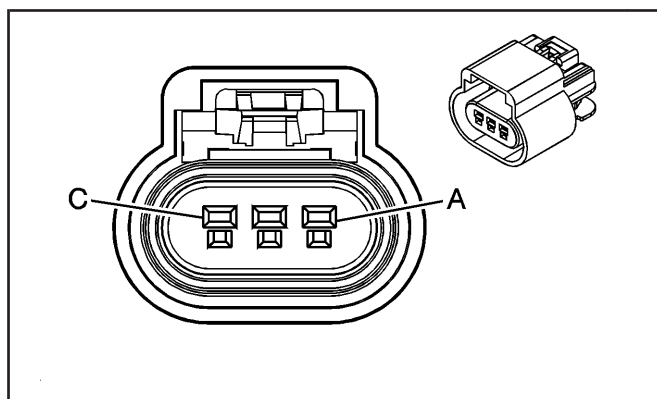
Core/Insulation Crimp: E/A

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Camshaft Position (CMP) Sensor - Exhaust (2.4L)

Pin	Wire Color	Circuit No.	Function
A	—	—	5-Volt Reference
B	—	—	Low Reference
C	—	—	CMP Sensor Signal

Camshaft Position (CMP) Sensor - Intake (2.4L)



646415

Connector Part Information

OEM: 15326808

Service: 15306388

Description: 3-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12191819/8

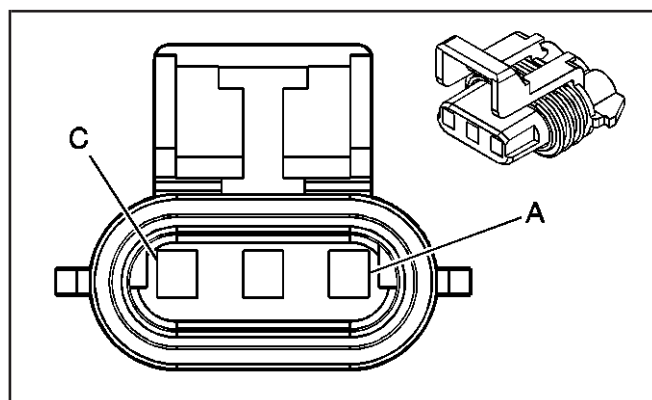
Core/Insulation Crimp: E/A

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Camshaft Position (CMP) Sensor - Intake (2.4L)

Pin	Wire Color	Circuit No.	Function
A	—	—	5-Volt Reference
B	—	—	Low Reference
C	—	—	CMP Sensor Signal

Camshaft Position (CMP) Sensor W (3.0/4.3/5.0/5.7L)



684807

Connector Part Information

OEM: 12110293

Service: 12117025

Description: 3-Way F Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12048074/2

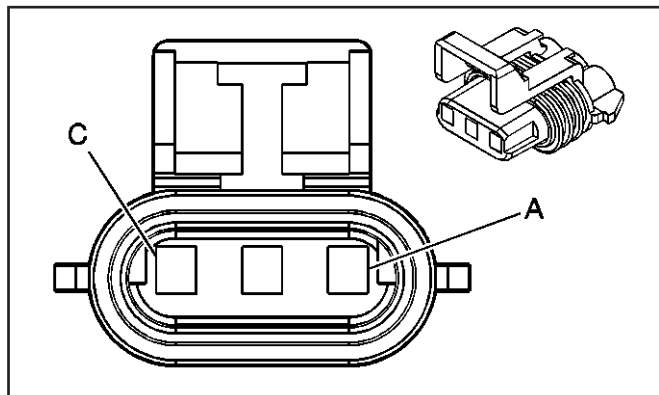
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Camshaft Position (CMP) Sensor W (3.0/4.3/5.0/5.7L)

Pin	Wire Color	Circuit No.	Function
A	—	—	5-Volt Reference
B	—	—	CMP Sensor Signal
C	—	—	Low Reference

Camshaft Position (CMP) Sensor W (6.0/6.2L)



684807

Connector Part Information

OEM: 12110293

Service: 12117025

Description: 3-Way F Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12048074/2

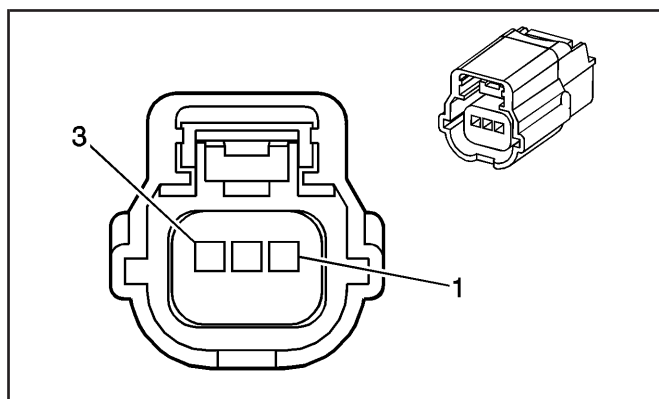
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Camshaft Position (CMP) Sensor W (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	5-Volt Reference
B	—	—	Low Reference
C	—	—	CMP Sensor Signal

Crankshaft Position (CKP) Sensor (2.4L)



1664596

Connector Part Information

OEM: 31403-3710

Service: 88988337

Description: 3-Way F Mixed 64 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 33467-0003/23

Core/Insulation Crimp: H/H

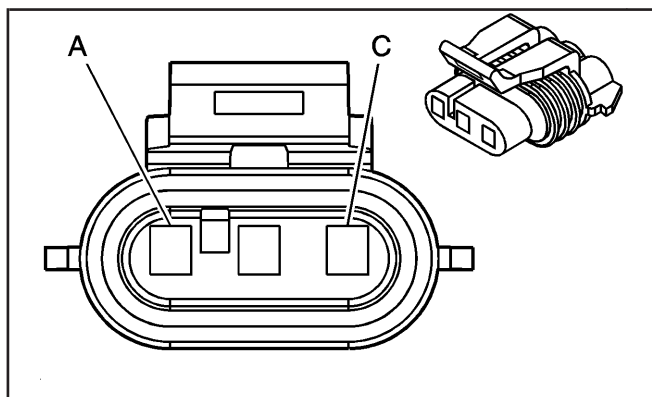
Release Tool/Test Probe:

J-38125-213/J-35616-64B (L-BU)

Crankshaft Position (CKP) Sensor (2.4L)

Pin	Wire Color	Circuit No.	Function
1	—	—	5-Volt Reference
2	—	—	Low Reference
3	—	—	CKP Sensor Signal

Crankshaft Position (CKP) Sensor (3.0/4.3/5.0/5.7L)



516611

Connector Part Information

OEM: 12059595

Service: 88986451

Description: 3-Way F Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12048074/2

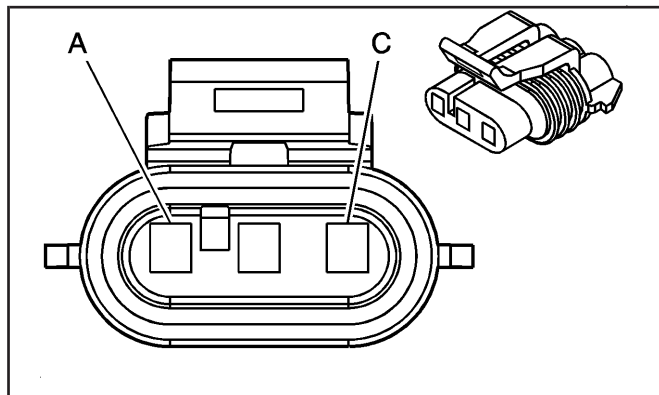
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Crankshaft Position (CKP) Sensor (3.0/4.3/5.0/5.7L)

Pin	Wire Color	Circuit No.	Function
A	—	—	5-Volt Reference
B	—	—	Low Reference
C	—	—	CKP Sensor Signal

Crankshaft Position (CKP) Sensor (6.0/6.2L)



516611

Connector Part Information

OEM: 12059595

Service: 88986451

Description: 3-Way F Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12048074/2

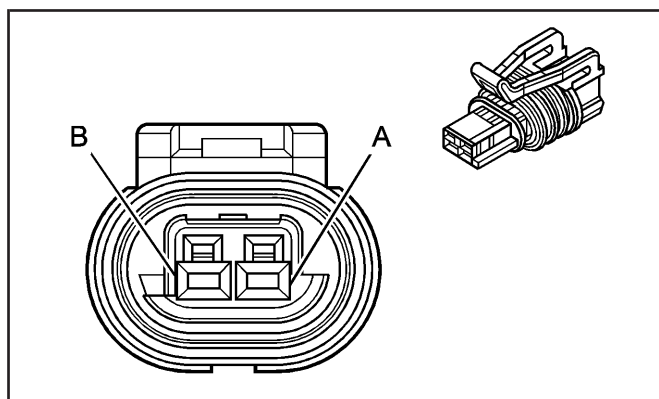
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Crankshaft Position (CKP) Sensor (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	CKP Sensor Signal
B	—	—	Low Reference
C	—	—	5-Volt Reference

Engine Coolant Temperature (ECT) Sensor



1538760

Connector Part Information

OEM: 15449028

Service: 88987993

Description: 2-Way F 150 GT Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

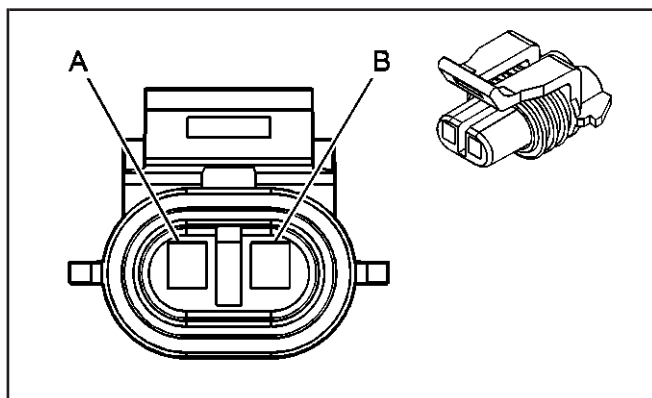
Core/Insulation Crimp: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Engine Coolant Temperature (ECT) Sensor

Pin	Wire Color	Circuit No.	Function
A	—	—	Low Reference
B	—	—	ECT Sensor Signal

Engine Oil Level Switch



635009

Connector Part Information

OEM: 12052641

Service: 12102747

Description: 2-Way F Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12048074/2

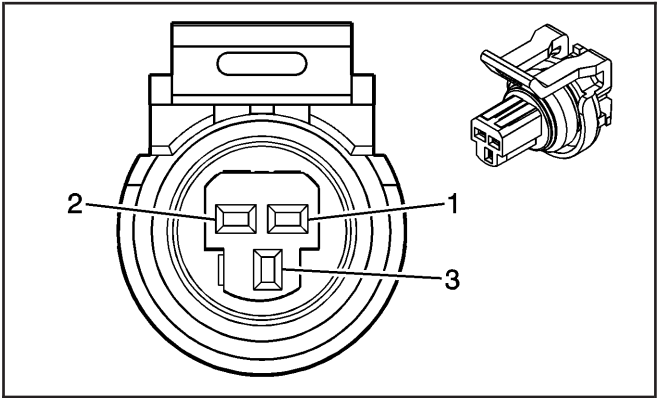
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Engine Oil Level Switch

Pin	Wire Color	Circuit No.	Function
A	—	—	Engine Oil Level Switch Signal
B	—	—	Ground

**Engine Oil Pressure (EOP)
Sensor (3.0/4.3/5.0/5.7L)**



1519475

Connector Part Information

OEM: 15477863
Service: 88988301
Description: 3-Way F GT 150 Series Sealed (BK)

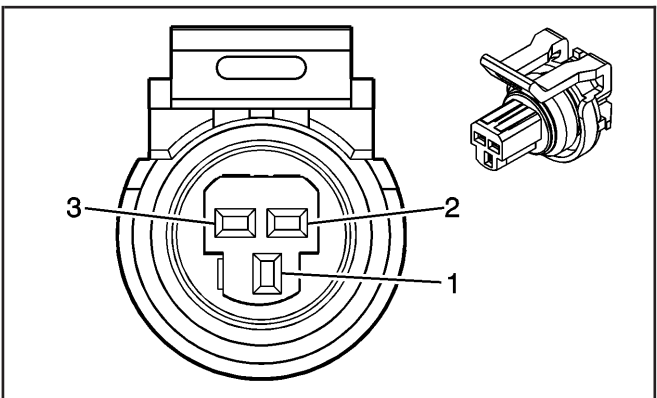
Terminal Part Information

Terminal/Tray: 15326267/19
Core/Insulation Crimp: E/4
Release Tool/Test Probe: 15315247/J-35616-2A (GY)

**Engine Oil Pressure (EOP)
Sensor (4.3/5.0/5.7L)**

Pin	Wire Color	Circuit No.	Function
A/1	—	—	Low Reference
B/2	—	—	5-Volt Reference
C/3	—	—	Engine Oil Pressure Sensor Signal

**Engine Oil Pressure (EOP)
Sensor (6.0/6.2L)**



2212053

Connector Part Information

OEM: 15477863
Service: 88988301
Description: 3-Way F GT 150 Series Sealed (BK)

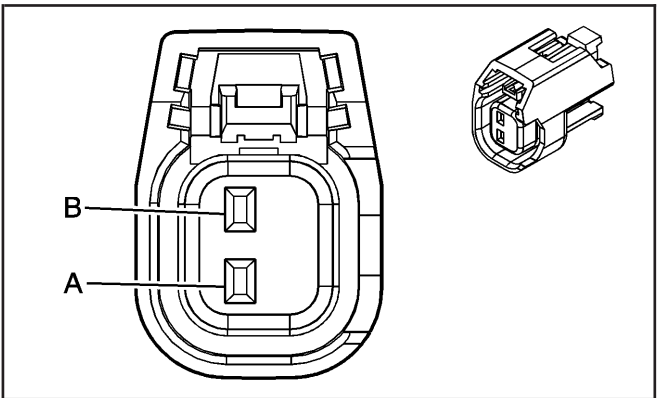
Terminal Part Information

Terminal/Tray: 15326267/19
Core/Insulation Crimp: E/4
Release Tool/Test Probe: 15315247/J-35616-2A (GY)

**Engine Oil Pressure (EOP)
Sensor (6.0/6.2L)**

Pin	Wire Color	Circuit No.	Function
1	—	—	Engine Oil Pressure Sensor Signal
2	—	—	5-Volt Reference
3	—	—	Low Reference

Fuel Injector 1 (2.4/6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480
Service: 88988313
Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

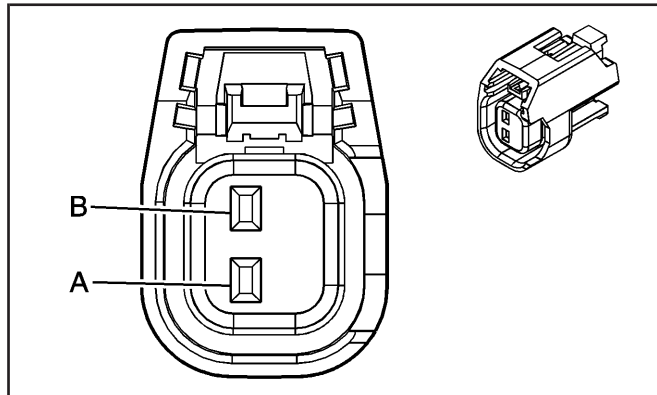
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 1 (2.4/6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 1 Control

Fuel Injector 2 (2.4/6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480

Service: 88988313

Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

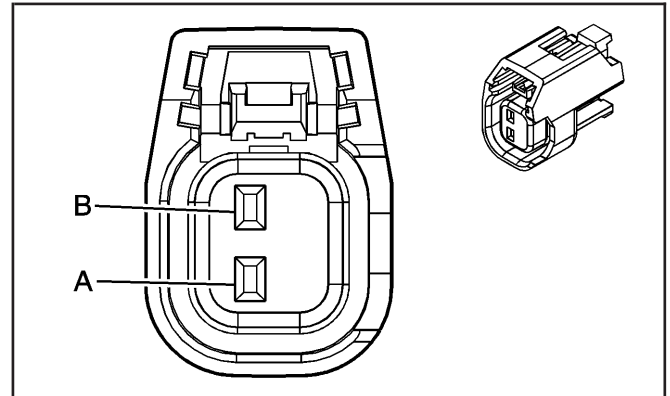
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 2 (2.4/6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 2 Control

Fuel Injector 3 (2.4/6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480

Service: 88988313

Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

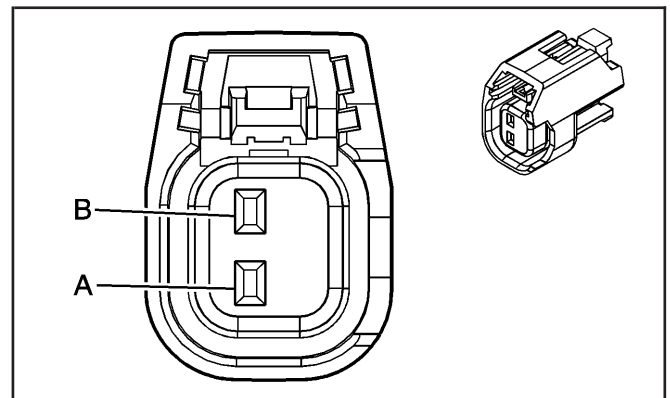
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 3 (2.4/6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 3 Control

Fuel Injector 4 (2.4/6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480

Service: 88988313

Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

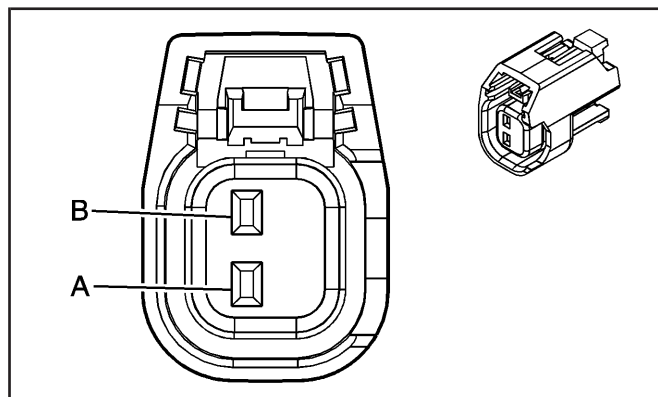
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 4 (2.4/6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 4 Control

Fuel Injector 5 (6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480

Service: 88988313

Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

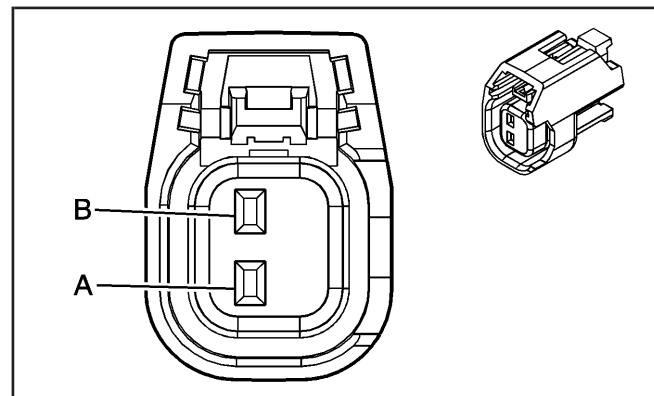
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 5 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 5 Control

Fuel Injector 6 (6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480

Service: 88988313

Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

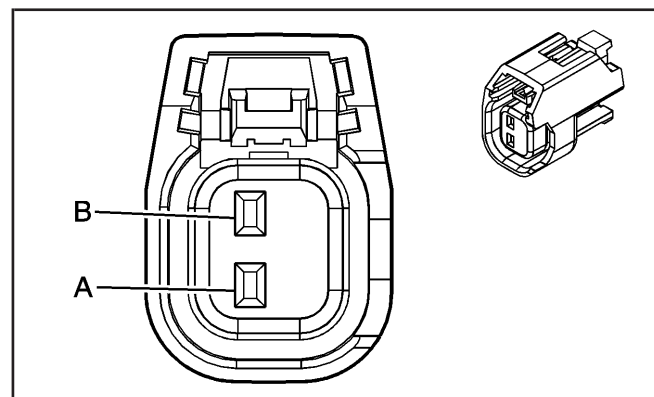
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 6 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 6 Control

Fuel Injector 7 (6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480

Service: 88988313

Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

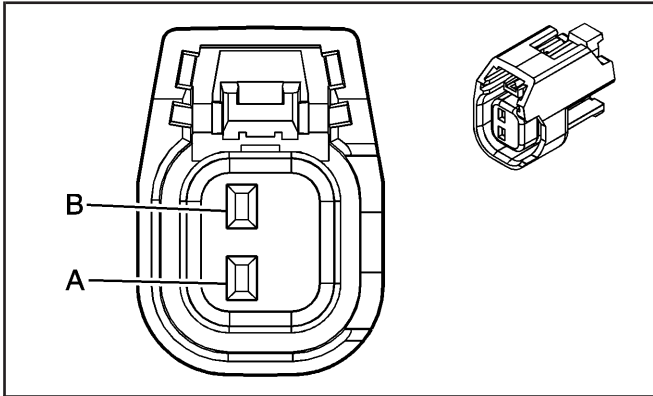
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 7 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 7 Control

Fuel Injector 8 (6.0/6.2L)



1527729

Connector Part Information

OEM: 12602480

Service: 88988313

Description: 2-Way F GT 150 Series, Sealed (GY)

Terminal Part Information

Terminal/Tray: 12191819/8

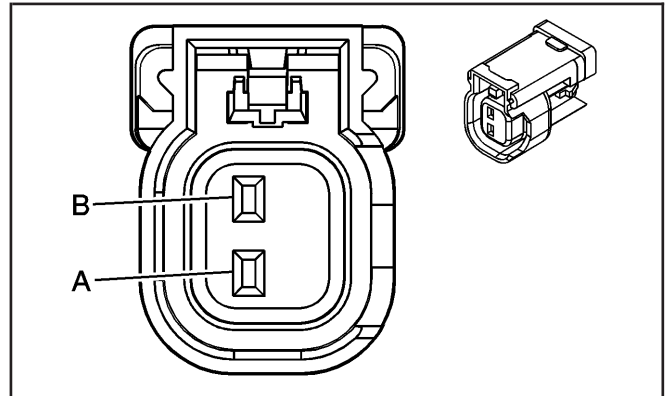
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Fuel Injector 8 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 8 Control

Fuel Injector 1 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

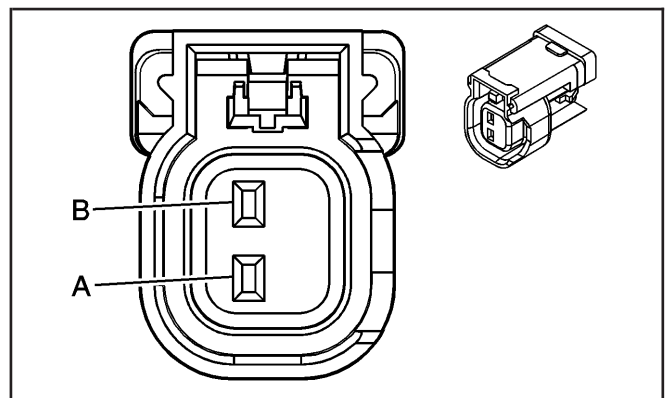
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 1

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 1 Control

Fuel Injector 2 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

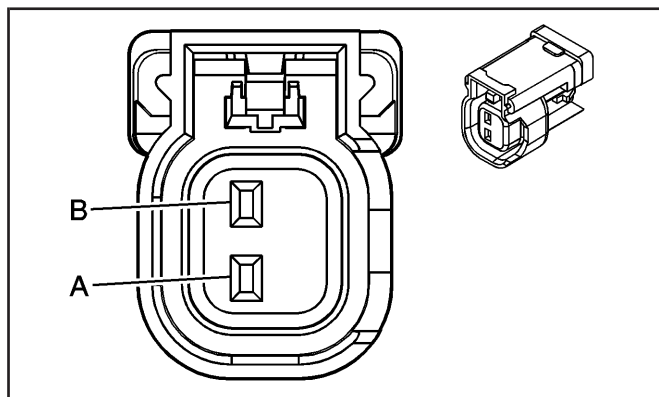
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 2

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 2 Control

Fuel Injector 3 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

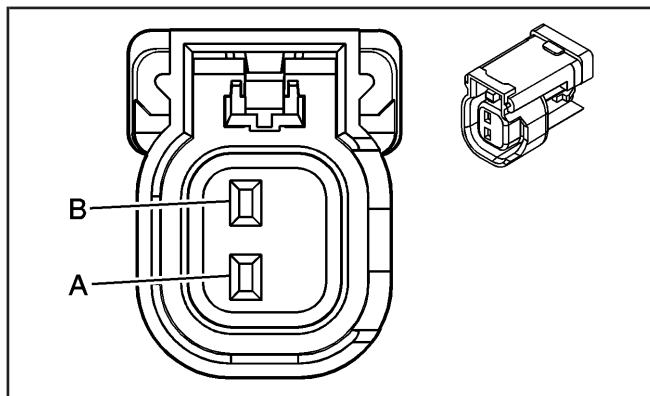
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 3

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 3 Control

Fuel Injector 4 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

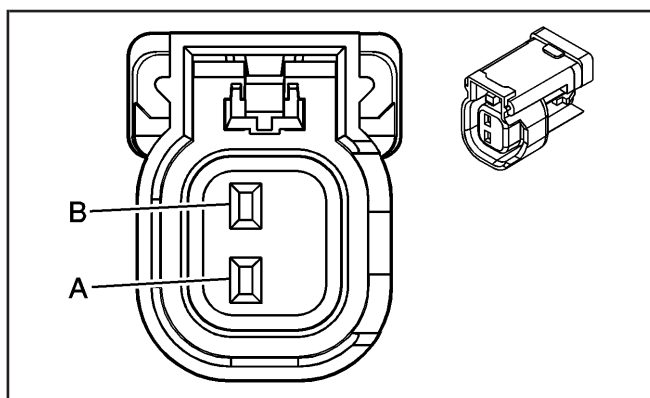
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 4

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 4 Control

Fuel Injector 5 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

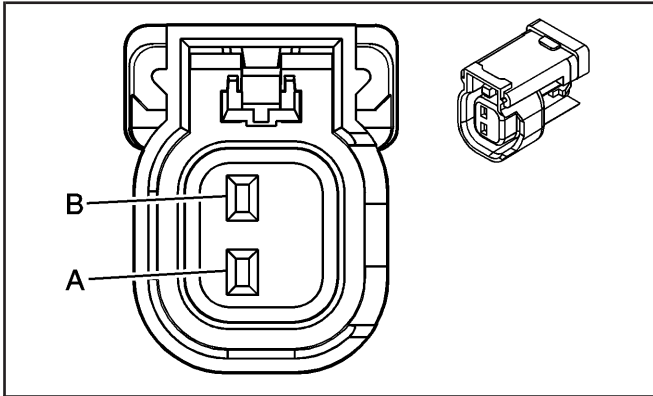
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 5

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 5 Control

Fuel Injector 6 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

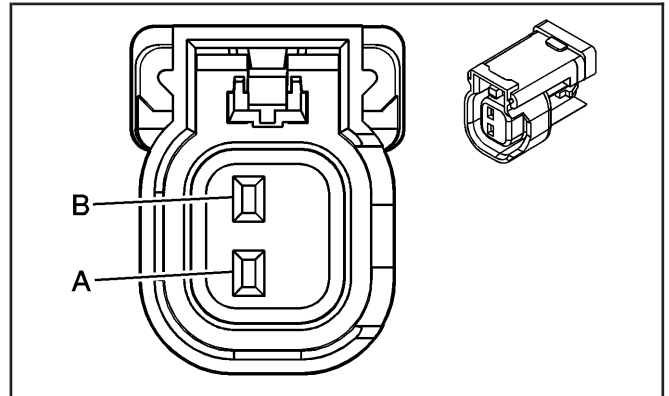
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 6

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 6 Control

Fuel Injector 7 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

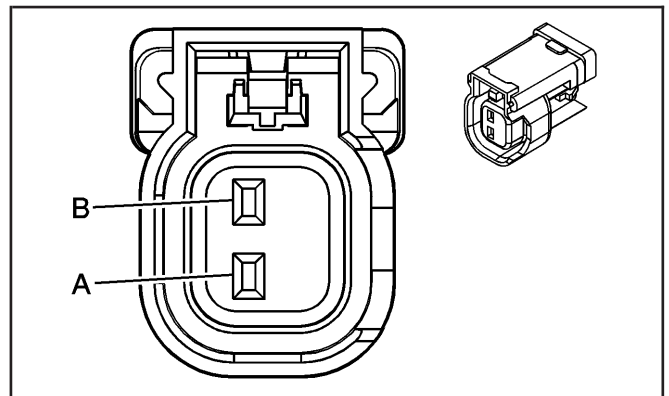
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 7

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 7 Control

Fuel Injector 8 (4.3/5.0/5.7L)



1273820

Connector Part Information

OEM: 15355226

Service: 89046636

Description: 2-Way F Metri-Pack 150 Tangless Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12176636/19

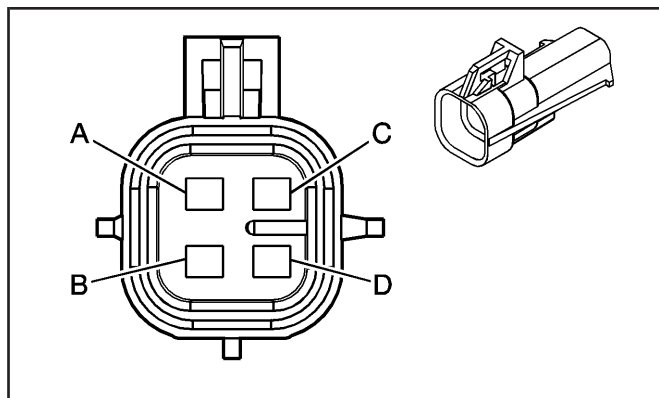
Core/Insulation Crimp: C/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Fuel Injector 8

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	Fuel Injector 8 Control

Heated Oxygen Sensor (HO2S) Bank A Sensor 1



280761

Connector Part Information

OEM: 12160825

Service: 15305801

Description: 4-Way M Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12045773/2

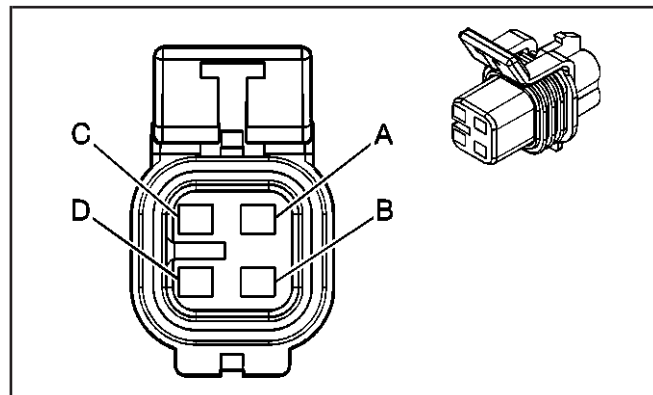
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-3 (GY)

Heated Oxygen Sensor (HO2S) Bank A Sensor 1

Pin	Wire Color	Circuit No.	Function
A	—	—	HO2S Low Signal – Bank A Sensor 1
B	—	—	HO2S High Signal – Bank A Sensor 1
C	—	—	HO2S Heater Low Control – Bank A Sensor 1
D	—	—	Ignition 1 Voltage

Heated Oxygen Sensor (HO2S) Bank A Sensor 2



456551

Connector Part Information

OEM: 12160482

Service: 88988598

Description: 4-Way F Metri-Pack 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12048074/2

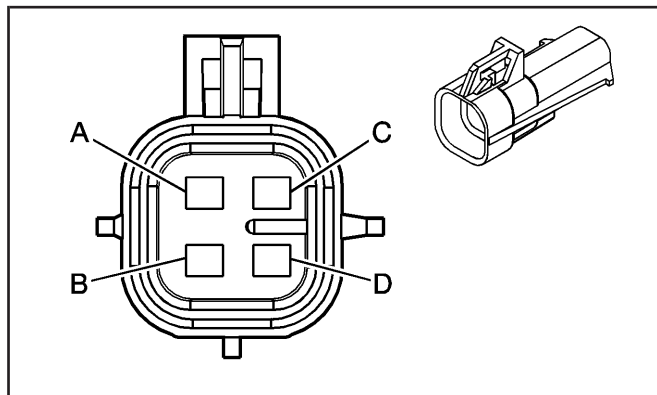
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-2A (GY)

Heated Oxygen Sensor (HO2S) Bank A Sensor 2

Pin	Wire Color	Circuit No.	Function
A	—	—	HO2S Low Signal – Bank A Sensor 2
B	—	—	HO2S High Signal – Bank A Sensor 2
C	—	—	HO2S Heater Low Control – Bank A Sensor 2
D	—	—	Ignition 1 Voltage

Heated Oxygen Sensor (HO2S) Bank B Sensor 1



280761

Connector Part Information

OEM: 12160825

Service: 15305801

Description: 4-Way M Metri-Pack 150 Series (BK)

Terminal Part Information

Terminal/Tray: 12045773/2

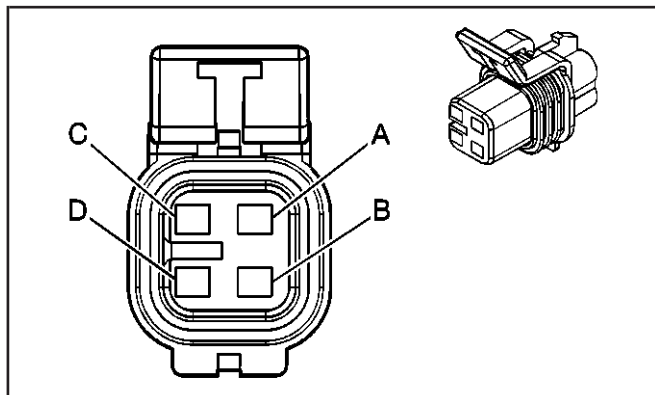
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-3 (GY)

Heated Oxygen Sensor (HO2S) Bank B Sensor 1

Pin	Wire Color	Circuit No.	Function
A	—	—	HO2S Low Signal – Bank B Sensor 1
B	—	—	HO2S High Signal – Bank B Sensor 1
C	—	—	HO2S Heater Low Control – Bank B Sensor 1
D	—	—	Ignition 1 Voltage

Heated Oxygen Sensor (HO2S) Bank B Sensor 2



456551

Connector Part Information

OEM: 12160825

Service: 15305801

Description: 4-Way M Metri-Pack 150 Series (BK)

Terminal Part Information

Terminal/Tray: 12045773/2

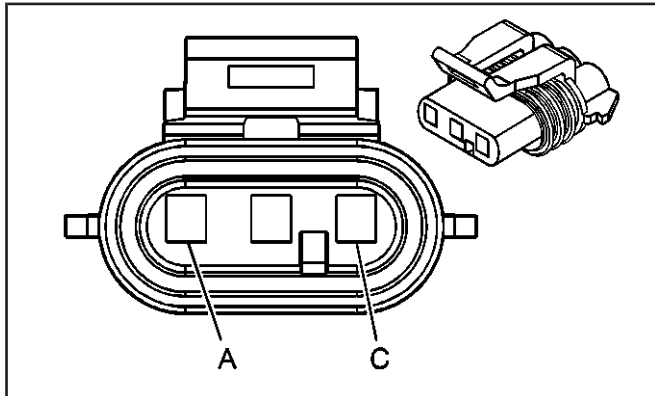
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094429/J-35616-3 (GY)

Heated Oxygen Sensor (HO2S) Bank B Sensor 2

Pin	Wire Color	Circuit No.	Function
A	—	—	HO2S Low Signal – Bank B Sensor 2
B	—	—	HO2S High Signal – Bank B Sensor 2
C	—	—	HO2S Heater Low Control – Bank B Sensor 2
D	—	—	Ignition 1 Voltage

Ignition Coil (Distributor Ignition)



68743

Connector Part Information

OEM: 12146121

Service: 88987992

Description: 3-Way F Metri-Pack 150 Series (BN)

Terminal Part Information

Terminal/Tray: See Terminal Repair Kit

Core/Insulation Crimp: See Terminal Repair Kit

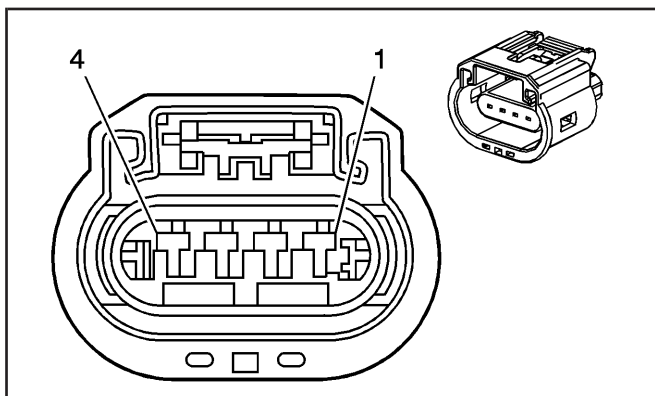
Core/Insulation Crimp: See Terminal Repair Kit

Release Tool/Test Probe: See Terminal Repair Kit

Ignition Coil (Distributor Ignition)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition 1 Voltage
B	—	—	Not Used
C	—	—	Ignition Coil Control

Ignition Coil 1 (2.4L)



1590069

Connector Part Information

OEM: 7283-3392-30

Service: 88988338

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

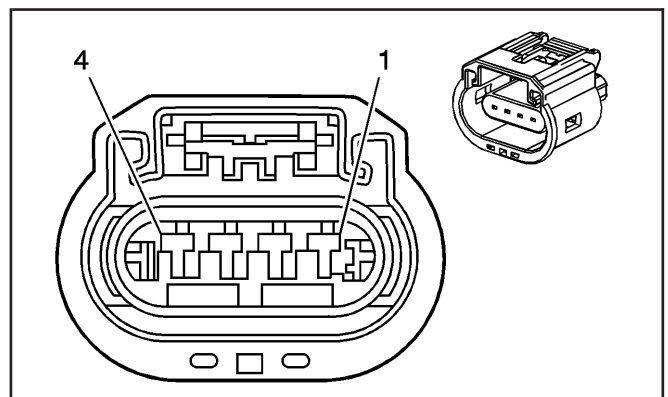
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Ignition Coil 1 (2.4L)

Pin	Wire Color	Circuit No.	Function
1	—	—	Ground
2	—	—	Low Reference
3	—	—	IC 1 Control
4	—	—	Ignition Voltage

Ignition Coil 2 (2.4L)



1590069

Connector Part Information

OEM: 7283-3392-30

Service: 88988338

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

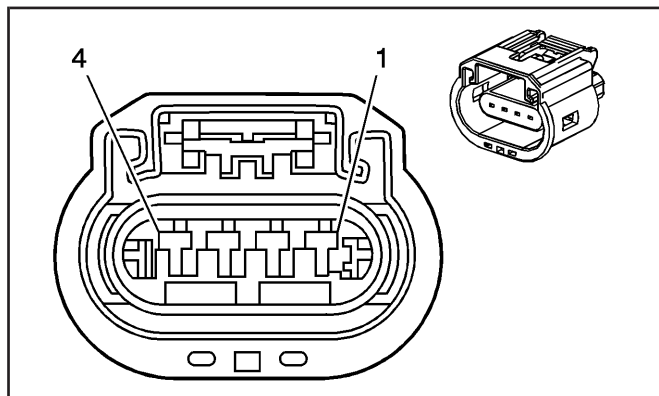
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Ignition Coil 21 (2.4L)

Pin	Wire Color	Circuit No.	Function
1	—	—	Ground
2	—	—	Low Reference
3	—	—	IC 2 Control
4	—	—	Ignition Voltage

Ignition Coil 3 (2.4L)



1590069

Connector Part Information

OEM: 7283-3392-30

Service: 88988338

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

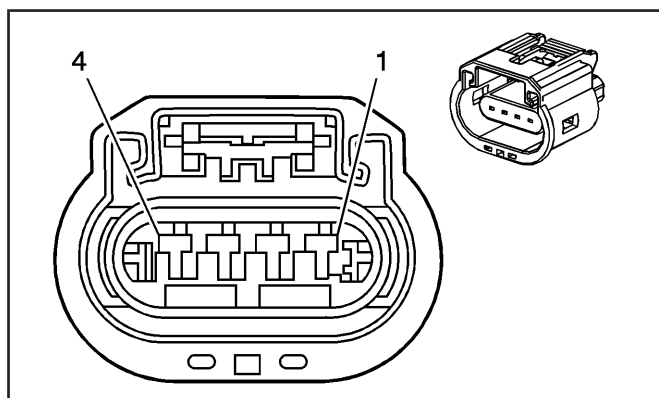
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Ignition Coil 3 (2.4L)

Pin	Wire Color	Circuit No.	Function
1	—	—	Ground
2	—	—	Low Reference
3	—	—	IC 3 Control
4	—	—	Ignition Voltage

Ignition Coil 4 (2.4L)



1590069

Connector Part Information

OEM: 7283-3392-30

Service: 88988338

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

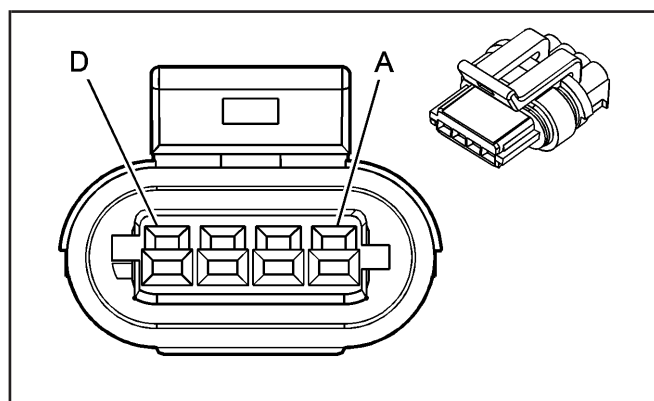
Core/Insulation Crimp: E/1

Release Tool/Test Probe: 12094430/J-35616-2A (GY)

Ignition Coil 4 (2.4L)

Pin	Wire Color	Circuit No.	Function
1	—	—	Ground
2	—	—	Low Reference
3	—	—	IC 4 Control
4	—	—	Ignition Voltage

Ignition Coil 1 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

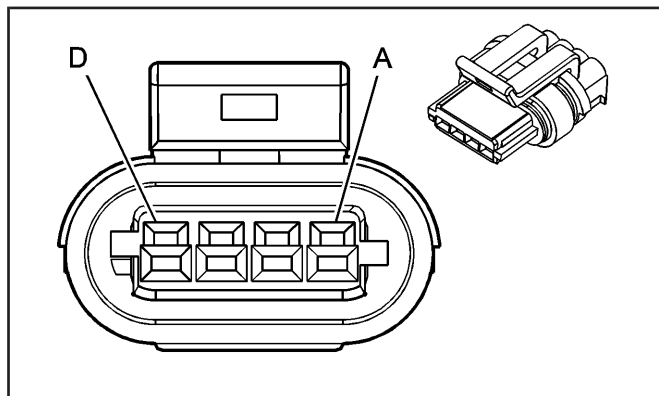
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 1 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 1 Control
D	—	—	Ignition Voltage

Ignition Coil 2 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

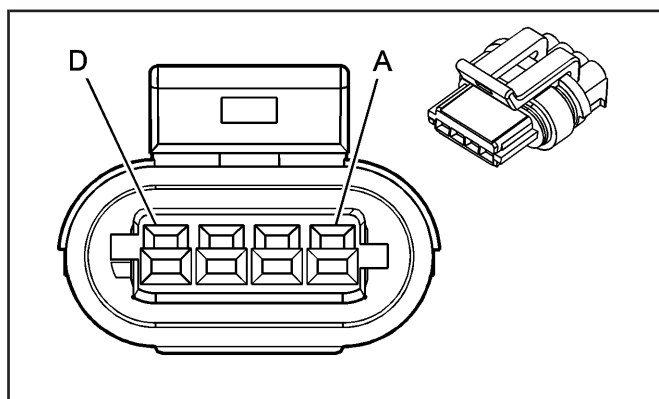
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 2 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 2 Control
D	—	—	Ignition Voltage

Ignition Coil 3 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

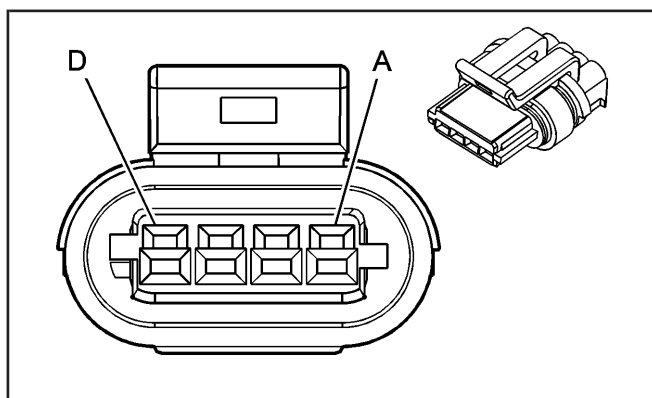
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 3 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 3 Control
D	—	—	Ignition Voltage

Ignition Coil 4 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

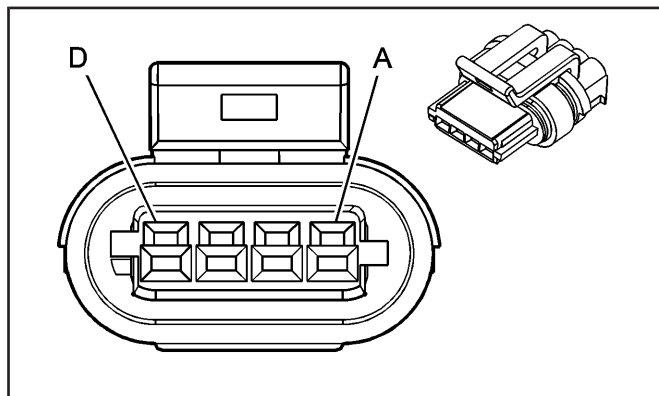
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 4 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 4 Control
D	—	—	Ignition Voltage

Ignition Coil 5 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

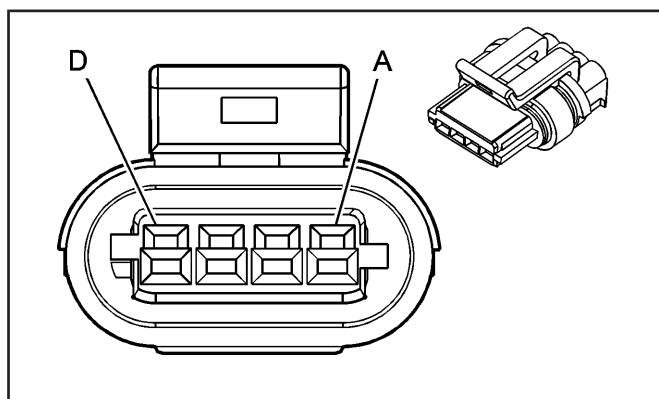
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 5 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 5 Control
D	—	—	Ignition Voltage

Ignition Coil 6 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

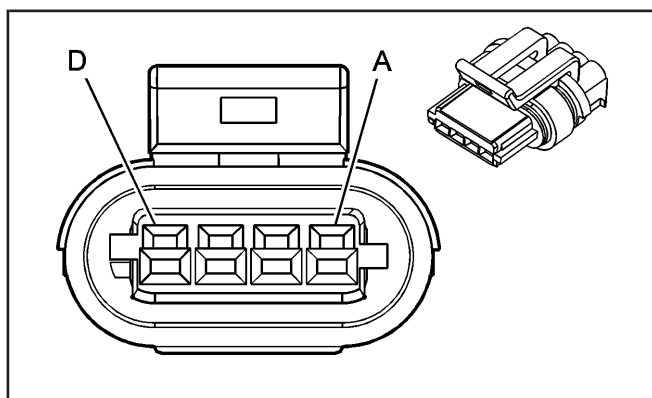
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 6 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 6 Control
D	—	—	Ignition Voltage

Ignition Coil 7 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

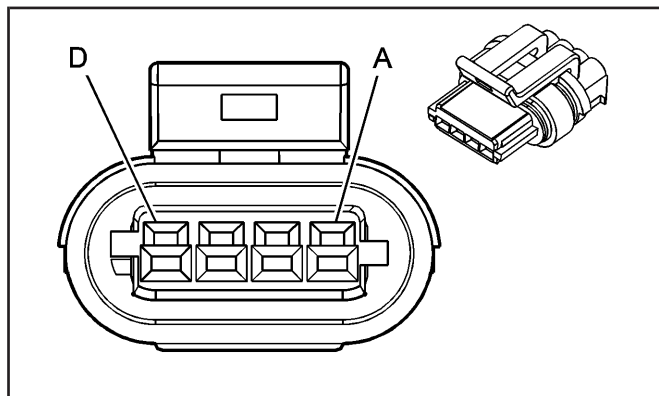
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 7 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 7 Control
D	—	—	Ignition Voltage

Ignition Coil 8 (6.0/6.2L)



1581641

Connector Part Information

OEM: 15439568

Service: 88987184

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

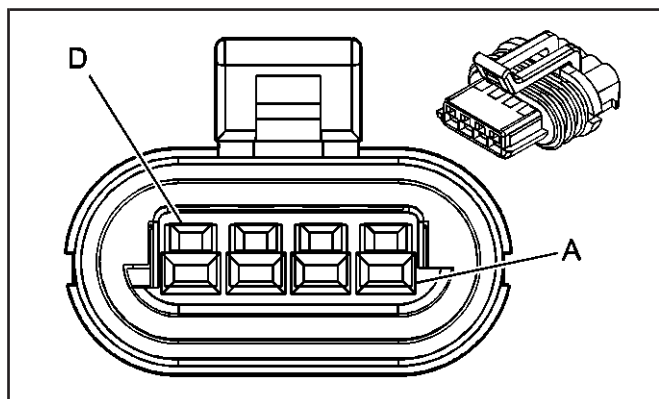
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Coil 8 (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ground
B	—	—	Low Reference
C	—	—	IC 8 Control
D	—	—	Ignition Voltage

Ignition Control Module (Distributor Ignition)



684948

Connector Part Information

OEM: 15354716

Service: 15306397

Description: 4-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

Core/Insulation Crimp: Pins A, D: E/1

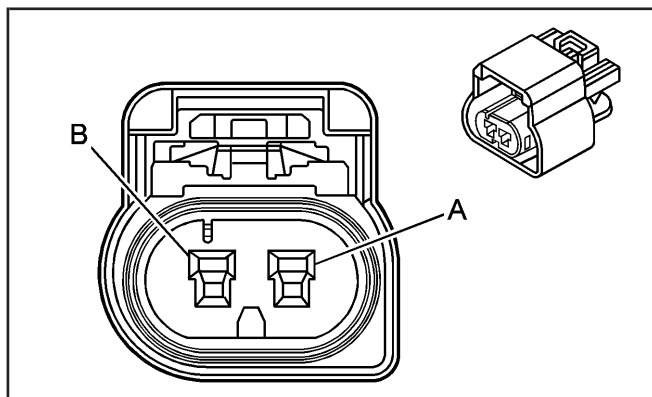
Core/Insulation Crimp: Pins B, C: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Ignition Control Module (Distributor Ignition)

Pin	Wire Color	Circuit No.	Function
A	—	—	Ignition Voltage
B	—	—	IC Timing Control
C	—	—	Ground
D	—	—	Ignition Coil Control

Knock Sensor (KS) – 1



1232999

Connector Part Information

OEM: 15374222

Service: 88953268

Description: 2-Way F GT 150 Sealed (WH)

Terminal Part Information

Terminal/Tray: 12191819/8

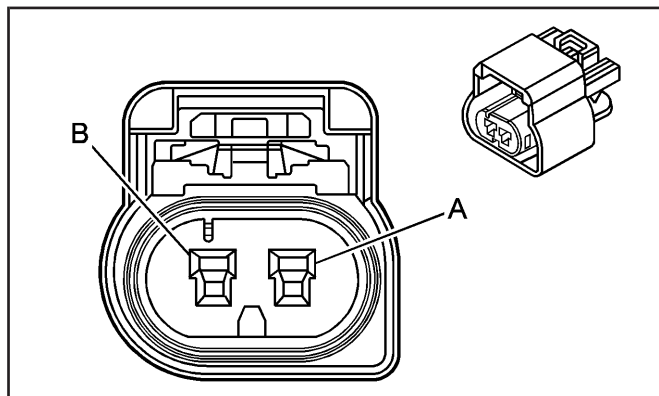
Core/Insulation Crimp: 2/A

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Knock Sensor (KS) – 1

Pin	Wire Color	Circuit No.	Function
A	—	—	KS 1 Low Signal
B	—	—	KS 1 High Signal

Knock Sensor (KS) – 2



1232999

Connector Part Information

OEM: 15374222

Service: 88953268

Description: 2-Way F GT 150 Sealed (WH)

Terminal Part Information

Terminal/Tray: 12191819/8

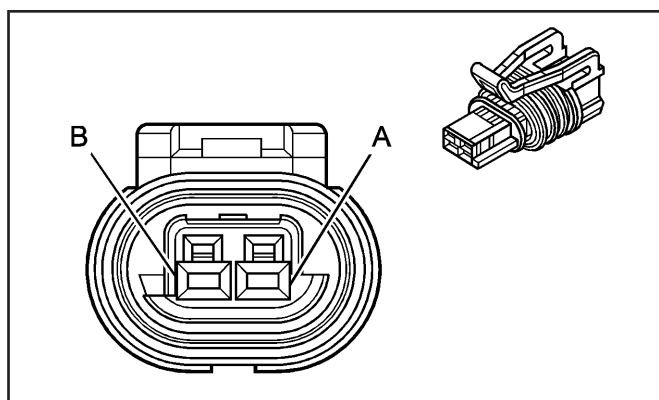
Core/Insulation Crimp: E/A

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Knock Sensor (KS) – 2

Pin	Wire Color	Circuit No.	Function
A	—	—	KS 2 Low Signal
B	—	—	KS 2 High Signal

Manifold Air Temperature (MAT) Sensor (6.0/6.2L)



1538760

Connector Part Information

OEM: 15449028

Service: 88987993

Description: 2-Way F 150 GT Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 15326267/19

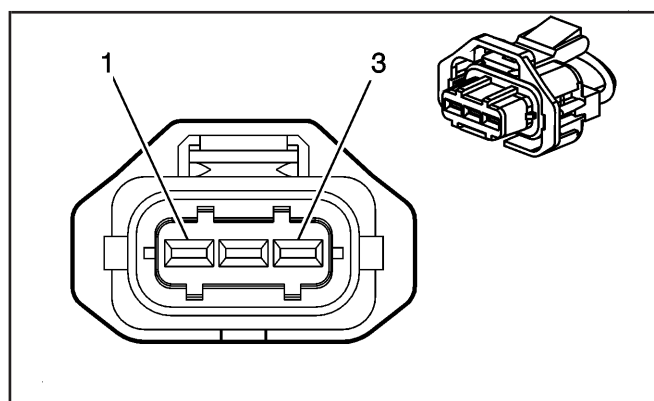
Core/Insulation Crimp: E/4

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Manifold Air Temperature (MAT) Sensor (6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
A	—	—	MAT Sensor Signal
B	—	—	Low Reference

Manifold Absolute Pressure (MAP) Sensor (2.4/6.0/6.2L)



1331443

Connector Part Information

Harness Type: Engine

OEM Connector: 15365614

Service Connector: 88988583

Description: 3-Way F Kompakt 2.8 Series, Sealed (BK)

Terminal Part Information

Terminated Lead: Pending

Release Tool: J-38125-561

Diagnostic Test Probe: J-35616-35 (VT)

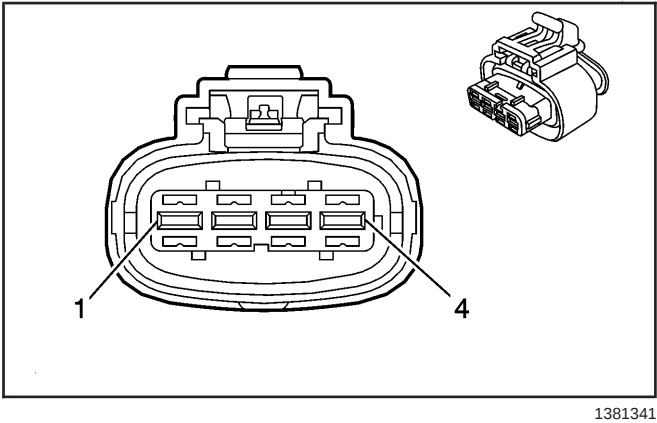
Terminal/Tray: 1928498056/8

Core/Insulation Crimp: E/1

Manifold Absolute Pressure (MAP) Sensor (2.4/6.0/6.2L)

Pin	Wire Color	Circuit No.	Function
1	—	—	5-Volt Reference
2	—	—	Low Reference
3	—	—	MAP Sensor Signal

**Manifold Absolute Pressure
Sensor/Manifold Air Temperature
(MAP/MAT) Sensor (3.0/4.3/5.0/5.7L)**



Connector Part Information

Harness Type: Engine
OEM Connector: 10763258
Service Connector: 88988320
Description: 4-Way F Kompakt 280 Series Sealed (BK)

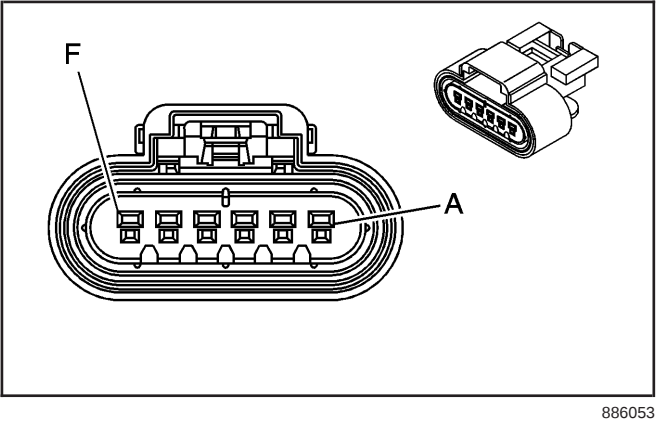
Terminal Part Information

Terminated Lead: Pending
Release Tool: J-38125-561
Diagnostic Test Probe: J-35616-35 (VT)
Terminal/Tray: 1928498056/8
Core/Insulation Crimp: E/1

**Manifold Absolute Pressure
Sensor/Manifold Air Temperature
(MAP/MAT) Sensor (3.0/4.3/5.0/5.7L)**

Pin	Wire Color	Circuit No.	Function
1	—	—	Low Reference
2	—	—	MAT Sensor Signal
3	—	—	5-Volt Reference
4	—	—	MAP Sensor Signal

Pedal Position Sensor



Connector Part Information

OEM: 15326830
Service: 88953153
Description: 6-Way F GT 150 Series Sealed (BK)

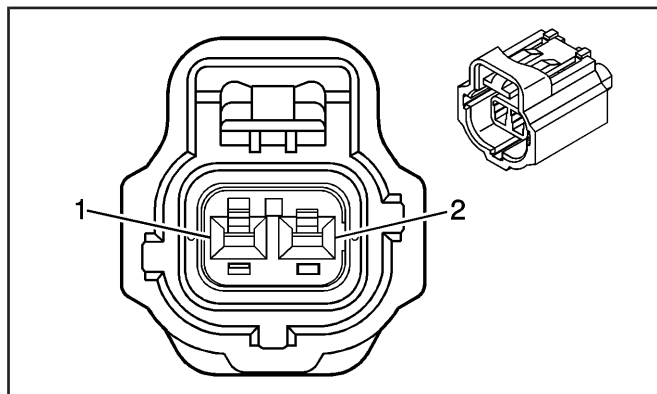
Terminal Part Information

Terminal/Tray: 12191819/8
Core/Insulation Crimp: E/A
Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Pedal Position Sensor

Pin	Wire Color	Circuit No.	Function
A	—	—	5-Volt Reference
B	—	—	Pedal Position Sensor 1 Signal
C	—	—	Low Reference
D	—	—	Low Reference Pedal Position Sensor 2 Signal
E	—	—	Pedal Position Sensor 2 Signal
F	—	—	5-Volt Reference

Supercharger Bypass Valve Solenoid



1701981

Connector Part Information

OEM: 184006-2

Service: 88988501

Description: 2-Way M Asm Key D-C3 Sealed (GY)

Terminal Part Information

Terminal/Tray: See Terminal Repair Kit

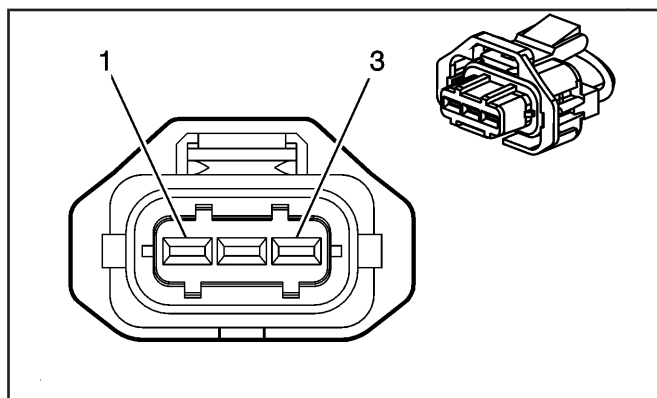
Core/Insulation Crimp: See Terminal Repair Kit

Release Tool/Test Probe: See Terminal Repair Kit

Supercharger Bypass Valve Solenoid

Pin	Wire Color	Circuit No.	Function
1	—	—	Ignition 1 Voltage
2	—	—	Supercharger Vacuum Bypass Valve Control

Supercharger Inlet Pressure (SCIP) Sensor



1331443

Connector Part Information

Harness Type: Engine

OEM Connector: 15365614

Service Connector: 88988583

Description: 3-Way F Kompakt 2.8 Series, Sealed (BK)

Terminal Part Information

Terminated Lead: Pending

Release Tool: J-38125-561

Diagnostic Test Probe: J-35616-35 (VT)

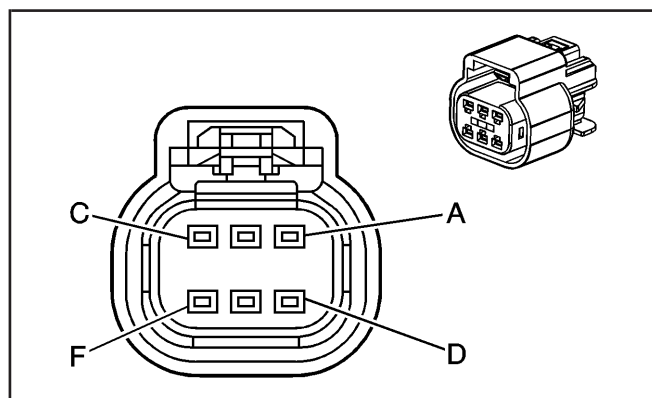
Terminal/Tray: 1928498056/8

Core/Insulation Crimp: E/1

Supercharger Inlet Pressure (SCIP) Sensor

Pin	Wire Color	Circuit No.	Function
1	—	—	5-Volt Reference
2	—	—	Low Reference
3	—	—	SCIP Sensor Signal

Throttle Body



1664617

Connector Part Information

OEM: 15355297

Service: 88988106

Description: 6-Way F GT 150 Series Sealed (BK)

Terminal Part Information

Terminal/Tray: 12191819/8

Core/Insulation Crimp: E/A

Release Tool/Test Probe: 15315247/J-35616-2A (GY)

Throttle Body

Pin	Wire Color	Circuit No.	Function
A	—	—	TAC Motor Close
B	—	—	TAC Motor Open
C	—	—	Low Reference
D	—	—	TP Sensor 2 Signal
E	—	—	5-Volt Reference
F	—	—	TP Sensor 1 Signal

Diagnostic Information and Procedures

Diagnostic Starting Point - Engine Controls

Begin the system diagnosis with the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64. The Powertrain On-Board Diagnostic (OBD) System Check will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and the code status

The use of the Powertrain On-Board Diagnostic (OBD) System Check will identify the correct procedure for diagnosing the system and where the procedure is located.

Engine Control Module Scan Tool Information

The Engine Control Module Scan Tool Data List contains all engine-related parameters that are available on the scan tool. This is a master list arranged in alphabetical order.

Use the Engine Scan Tool Data List only after the following is determined:

- The *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 is completed.
- No suspect parameter numbers (SPNs)
- On-board diagnostics are functioning properly

The scan tool values from a properly running engine may be used for comparison with the engine you are diagnosing. The Engine Scan Tool Data List represents values that would be seen on a normally running engine.

Note: A scan tool that displays faulty data should not be used. The scan tool concern should be reported to the manufacturer. Use of a faulty scan tool can result in misdiagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service manual for use in diagnosis.

Engine Control Module Scan Tool Data

Parameter	System State	Expected Value	Description
Base Operating Conditions: Engine Idling/Normal Operating Temperature/Neutral/Closed Loop			
A DTC has set this ignition cycle	—	NO	This parameter displays if a DTC has set during this ignition cycle.
Actual Boost	—	0.0 kPa	This parameter displays amount of boost being supplied by the supercharger as calculated by the control module.
Air Flow	—	Varies	This parameter displays the amount and speed of the air flow entering the engine as determined by the control module, based on inputs from the TP and MAP sensors.
BARO Pressure	—	65–104 kPa (8–16 psi) - Varies with altitude	This parameter displays the barometric pressure. The control module uses the barometric pressure sensor input for fuel control to compensate for altitude differences.
Battery Voltage	—	B+	This parameter displays B+ when the control module detects a voltage at the ignition 1 input terminal.
Boost Control Duty Cycle	—	0.0 %	This parameter displays the boost control solenoid on time, or duty cycle being commanded by the control module.
Boost System Present	—	YES/NO	This parameter displays YES when the control module detects the presence of certain boost system components.
CAM Angle	—	0.0°	This parameters displays the actual amount, in camshaft degrees, of camshaft actuation as measured by the control module.
CAM W Angle	—	0.0°	This parameters displays the actual amount, in camshaft degrees, of camshaft actuation as measured by the control module.
CAM W Phaser Duty Cycle	—	0.0 %	This parameters displays the CAM Phaser duty cycle as commanded by the control module.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
CAM W Phaser Ref Angle	—	Varies	This parameters displays the CAM Phaser reference angle as determined by the control module, based on inputs from the CMP and CKP sensors.
CAM X Angle	—	0.0°	This parameters displays the actual amount, in camshaft degrees, of camshaft actuation as measured by the control module.
CAM X Phaser Duty Cycle	—	0.0 %	This parameters displays the CAM Phaser duty cycle as commanded by the control module.
CAM X Phaser Ref Angle	—	Varies	This parameters displays the CAM Phaser reference angle as determined by the control module, based on inputs from the CMP and CKP sensors.
Cause For Power Reduction	—	NO	This parameter displays YES when the control module is operating in reduced power mode.
Check Engine Lamp Output	—	OFF	This parameter displays the control module commanded state of the MIL control circuit.
Check Gauges Lamp Output	—	OFF	This parameter displays the control module commanded state of the check gauges control circuit.
Closed Throttle Idle Control Mode	—	YES	This parameter displays YES when the throttle actuator control (TAC) motor is being used to control the idle speed.
Coolant Sensor Resistance	—	Varies	This parameter displays the resistance of the engine coolant sensor based on input to the control module from the engine coolant temperature (ECT) sensor.
Coolant Temperature—Filtered	—	–39 to +140°C (–38 to +284°F)	This parameter displays a defaulted coolant temperature value being used by the control module when the ECM has detected a condition with the engine coolant temperature (ECT) sensor.
Coolant Temperature—Raw	—	–39 to +140°C (–38 to +284°F)	This parameter displays the temperature of the engine coolant based on the input to the control module from the ECT sensor.
Crank Request Input	—	NO	This parameter displays YES when the control module detects a voltage at the crank request input terminal.
Cruise	Cruise Control ON	ON	This parameter displays the state of the cruise control ON/OFF switch input to the control module.
Cruise Resume/Accelerate	—	OFF	This parameter displays the state of the cruise control decrease/increase switch input to the control module.
	Cruise Decrease/Increase switch set to Increase	ON	
Cruise Set/Coast	—	OFF	This parameter displays the state of the cruise control decrease/increase switch input to the control module.
	Cruise Decrease/Increase switch set to Decrease	ON	
Current RPM Rated Torque	—	Varies	This parameter displays the torque being delivered by the engine, based on engine speed.
Desired EGR Position	—	0%	This parameter displays the desired EGR position as commanded by the control module.
Desired Idle Speed	—	500–700 RPM	This parameter displays the desired engine idle speed as commanded by the control module.
Desired Throttle Position	—	7.0–11.0 %	This parameter displays the desired throttle position as commanded by the control module.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
Discrete Low Oil Pressure Input Active	—	YES/NO	This parameter displays YES if the control module detects the presence of a low oil pressure switch.
Dual Fuel Mode	—	Fuel 1 or Fuel 2	This parameter displays the position of the fuel select switch as determined by the operator, on vehicles equipped with dual fuel capability.
ECM Hardware I.D. Version	—	Varies	This parameter displays the ECM hardware version installed in the vehicle.
ECM Embedded Software Release Number	—	Varies	This parameter displays the ECM software release that is programmed in the control module.
ECM Embedded Software Revision Number	—	Varies	This parameter displays the ECM software revision that is programmed in the control module.
Emergency Stop Input	—	OFF	This parameter displays the status of the emergency stop input terminal to the control module.
Engine Displacement	—	5.7/6.0L	This parameter displays the engine displacement programmed in the control module.
Engine Hours	—	Varies	This parameter displays the total hours the engine has been operating.
Engine Speed	Engine Cranking	Greater than 60 RPM	This parameter displays the speed of the engine crankshaft rotation from information received from the crankshaft position (CKP) sensor.
	Engine Idling	Approximately 600 RPM	
Estimated Torque	—	Varies	This parameter displays the available torque the engine is delivering to the out-drive.
ETC Idle Stop/Idle Valve Duty Cycle	—	Varies	This parameter displays the duty cycle (on time) of the ETC motor while the engine is operating in idle mode.
ETC or Governor Motor PWM	—	8.0–30.0 %	This parameter displays the over-all duty cycle (on time) of the ETC motor regardless of pedal position.
ETC System Present	—	YES	This parameter displays whether or not the vehicle is equipped with Electronic Throttle Control.
Fuel Flow Rate	—	Varies	This parameter displays in liters or gallons per hour, the fuel consumption as calculated by the control module.
Fuel Level	—	0–100%	This parameter displays the amount of fuel remaining in percent of range, as calculated by the control module.
Fuel Level 1 Percent	—	0–100%	This parameter displays the amount of fuel in the fuel tank 1 in percent of range, as calculated by the control module.
Fuel Level 2 Percent	—	0–100%	This parameter displays the amount of fuel in the fuel tank 2 in percent of range, as calculated by the control module.
Fuel Level 1 Volts	—	0–5 Volts	This parameter displays the voltage signal received by the control module from the fuel level sensor 1.
Fuel Level 2 Volts	—	0–5 Volts	This parameter displays the voltage signal received by the control module from the fuel level sensor 2.
Fuel Pressure	—	380-427 kPa (55-62 psi)	This parameter displays the pressure of the fuel system based on input to the control module from the Fuel Pressure sensor.
Fuel Pressure Sensor Present	—	YES/NO	This parameter displays YES if the control module detects the presence of a fuel pressure sensor.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
Fuel Pressure Sensor Voltage	—	0–5 Volts	This parameter displays the voltage signal received by the control module from the fuel pressure sensor.
Fuel Pump Relay Output Active	—	YES	This parameter displays the commanded state of the control module fuel pump relay control circuit.
Fuel Pump 2 Relay Output Active	—	NO	This parameter displays the commanded state of the control module fuel pump relay control circuit.
Fuel Select Output 1 Active	—	NO	This parameter displays YES when the engine is being operated by an alternate fuel source, if equipped.
Fuel Select Output 2 Active	—	NO	This parameter displays YES when the engine is being operated by an alternate fuel source, if equipped.
Fuel Temperature Sensor Present	—	NO	This parameter displays YES if the control module detects the presence of a fuel temperature sensor.
Fuel Temperature Sensor Resolution	—	Coarse/Fine	This parameter displays the type of scale the fuel temperature is being displayed on.
Fuel Temp Sensor Volts	—	0–5 Volts	This parameter displays the voltage signal received by the control module from the fuel temperature sensor.
General Warning Lamp 1 Output	—	OFF	This parameter displays the commanded state of the control module general warning lamp 1 control circuit.
General Warning Lamp 2 Output	—	OFF	This parameter displays the commanded state of the control module general warning lamp 2 control circuit.
Gov Mode Input	Cruise ON/OFF switch ON	ON	This parameter displays the status of the cruise control system as determined by the control module.
Governed Vehicle Speed	Cruise MPH/RPM switch set to MPH	Varies	This parameter displays the governed vehicle speed limit in miles per hour that is set by the throttle control.
Governor Present	—	YES	This parameter displays whether or not the vehicle is equipped with governor control.
Governor RPM Speed	Cruise MPH/RPM switch set to RPM	Varies	This parameter displays the governed vehicle speed limit in engine RPM that is set by the throttle control.
Governor Status Lamp	—	OFF	This parameter displays the commanded state of the control module governor status lamp control circuit.
History Data Has Been Corrupted	—	NO	This parameter displays YES if the control module detects an ECM reset.
IAC in Control of RPM	—	YES	This parameter displays YES when the control module is regulating the engine speed with the ETC motor.
IAC Position	—	40–50 %	This parameter displays a percentage in a range of 0–100 percent relative to the position of throttle plate when the engine is considered to be at idle, pedal position (PP) is 0 percent. The percentage indicates only the throttle opening necessary to maintain the desired idle speed and is not a function of the throttle plates total travel from closed to wide open.
Intercooler Output Active	—	YES	This parameter displays YES if the vehicle is equipped with an intercooler and the engine is operating.
In Fuel Detonation Control Mode	—	NO	This parameter displays YES when the control module is compensating for an engine detonation spark knock.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
Injector Bank A Pulse Width	—	2.5–3.5 ms	This parameter displays the average pulse width modulation in milliseconds of the fuel injectors on cylinder bank A.
Injector Bank B Pulse Width	—	2.5–3.5 ms	This parameter displays the average pulse width modulation in milliseconds of the fuel injectors on cylinder bank B.
Knock Present in Last Second	—	NO	This parameter displays YES when the control module detects a spark knock condition.
Knock Retard	—	0°	This parameter displays in degrees the amount of timing compensation the control module is commanding to compensate for spark knock.
Load Anticipate 1 or 2 Enable	—	NO	This parameter displays YES if an OEM system or component has been installed that places an additional load on the engine when activated.
Load Anticipate 1 or 2 Input	—	NO	This parameter displays YES if an OEM installed system or component has been activated.
Load Anticipate 1 or 2	—	0.0 %	This parameter displays the percentage of load compensation needed to offset the engine drag caused by the activation of an OEM installed system or component.
Low Oil Level Input	—	ON	This parameter displays the status of the low oil switch circuit to the control module.
Low Oil Level Lamp Output	—	OFF	This parameter displays the control module commanded state of the low oil level lamp control circuit.
Manifold Absolute Pressure	—	32–50 kPa (9–15 in Hg)	This parameter displays the pressure from the MAP sensor to the control module.
MAP Sensor Voltage	—	0–5 Volts	This parameter displays the signal voltage from the MAP sensor to the control module.
Manifold Air Temperature	—	–39° to +140°C (–38° to +284°F)	This parameter displays the temperature of the air entering the air induction system based on input to the control module from the MAT sensor.
MAT Sensor Present	—	YES	This parameter displays whether or not the vehicle is equipped with a manifold air temperature (MAT) sensor.
MAT Sensor Resistance	—	Varies	This parameter displays the resistance of the manifold air temperature (MAT) sensor based on input to the control module from the MAT sensor.
MAT Sensor Voltage	—	0–5 Volts	This parameter displays the voltage of the manifold air temperature (MAT) sensor based on input to the control module from the MAT sensor.
Max Knock Retard Cylinder	—	0 #	This parameter displays the number of a cylinder if a knock condition has been detected related to that cylinder's combustion event. The scan tool will display 0 if there is no knock condition detected related to a specific cylinder combustion event.
Min Position Learn Pending	—	NO	This parameter will display YES if the control module has not learned the minimum throttle position.
Misc Status Flags	—	0.0 #	This parameter displays the number of the current failure mode indicator (FMI) if an SPN is set.
Monitoring For Knock	—	YES	This parameter displays if the control module is monitoring for knock.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
O2 A1 or B1 BLM Cell I.D.	—	0 #	This parameter displays the block learn memory (BLM) or fuel trim cell number as calculated by the control module based on engine speed and load inputs. The scan tool will display a lower number as conditions are nearer to idle, and a higher value as conditions approach maximum engine speed and maximum load.
O2 A1 or B1 BLM Cell Value	Closed Loop ON	0.90–1.10 #, Varies	This parameter displays the short term correction to fuel delivery for bank 1 or bank 2 in response to the amount of time the oxygen sensor voltage spends above or below the 450 mV threshold. The scan tool will display a value of 1.00 which is equal to stoich 14.7–1, if no adjustments are required. The scan tool will display a value greater than 1.00 if fuel has to be added, and a value less than 1.00 if fuel has to be subtracted.
O2 A1 Cross Counts Per Second	—	Varies	This parameter displays the oxygen sensor rich/lean and lean/rich switches. A switch is when the oxygen sensor voltage goes above 450 mV and below 450 mV.
O2 B1 Cross Counts Per Second	—	Varies	This parameter displays the oxygen sensor rich/lean and lean/rich switches. A switch is when the oxygen sensor voltage goes above 450 mV and below 450 mV.
O2 A1 or B1 Fuel Multiplier	Closed Loop ON	0.90–1.10 #	A change made to the fuel delivery will be indicated by the Fuel Multiplier and the BLM Cell Value. The BLM Cell Values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The Fuel Multiplier values change in response to the trends in the BLM Cell Values. The Fuel Multiplier makes coarse adjustments to the fueling in order to re-center and restore control to the BLM Cell Value. The scan tool will display a value less than 1.00 when the engine is running too rich and fuel is being subtracted from the combustion event. The scan tool will display a value greater than 1.00 if the engine is running too lean and fuel is being added to the combustion event.
O2 A1 or B1 Heater Current	—	0.5–5 Amps	This parameter displays the amperage of the HO2S heater commanded by the control module.
O2 A2 or B2 Heater Current	Catalyst Monitoring Enabled	0–5 Amps	This parameter displays the amperage of the HO2S heater commanded by the control module. The control module will not command any current until the conditions for running the catalyst monitoring have been met.
O2 A1, A2, B1, or B2 Percent	—	–22 to +22 Percent	This parameter displays the oxygen content of the exhaust stream at the respective O2 sensor. A negative value indicates rich exhaust, and a positive value indicates lean exhaust.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
O2 Sensor A1 or B1 Closed Loop	—	ON	This parameter displays the state of the fuel control system as commanded by the control module. ON indicates that the control module is controlling the fuel delivery based on the oxygen sensors input signal. OFF indicates Open Loop operation. The control module ignores the oxygen sensor input signal in Open Loop and bases the amount of fuel to be delivered on other sensor inputs.
O2 Sensor A1, A2, B1 or B2 Present	—	YES	This parameter displays whether or not the vehicle is equipped with an oxygen sensor.
O2 Sensor A1 or B1 Ready	—	YES	This parameter displays that the HO2S 1 is at operating temperature.
O2 Sensor A1 or B1 Rich/Lean	Closed Loop ON	Varies	This parameter displays the oxygen sensor rich/lean and lean/rich status. A switch is when the oxygen sensor voltage goes above 450 mV and below 450 mV.
O2 A1, A2, B1, or B2 Volts	—	100–900 mV	This parameter displays the voltage output from the HO2S to the control module. A lower voltage indicates a lean exhaust, while a higher voltage indicates a rich exhaust.
Octane Adapt Enable	—	OFF	This parameter displays ON when the control module is calibrated to allow the ECM learn the octane rating of the fuel being consumed. This feature, when enabled increases the ignition timing advance curve to raise the performance of an engine operating on higher octane fuels. Used primarily in racing applications.
Octane Rating Adapt	—	0.0 %	This parameter displays a range of 0–100 percent, and indicates amount of an increase in the ignition timing advance curve based on the learned octane rating.
Octane Update in Progress	—	NO	This parameter displays YES when the control module is in the process of learning the octane rating.
OEM Input 1–4 Active	—	YES/NO	These parameters display YES if an input is supplied to the control module on the respective OEM circuit.
OEM Output 1–4 Active	—	YES/NO	These parameters display YES if the control module is using the respective output control circuit to operate an OEM component or system.
Oil Pressure	—	41–414 kPa (6–60 psi)	This parameter displays the oil pressure based on input to the control module from the engine oil pressure sensor.
Oil Pressure Sensor Voltage	—	0–5 Volts	This parameter displays the oil pressure sensor voltage based on input to the control module from the engine oil pressure sensor.
Oil Sensor Resistance	—	Varies	This parameter displays the resistance of the oil pressure sensor based on input to the control module from the sensor.
Oil Temperature	—	Varies	This parameter displays the temperature of the engine oil as determined by the control module.
Oil Temperature Flag	—	NO	This parameter displays YES if the control detects that the oil temperature was greater than a calibrated value during the ignition cycle.
Paired Firing Mode	—	OFF	This parameter displays YES when the engine RPM is synchronized by the control module on a twin engine vehicle.
Pedal Position	—	0%	This parameter displays the pedal Position angle as calculated by the control module using the signals from the PP sensors.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
Pedal Position Sensor 1 Voltage	—	PP 1 0.7–1.2 Volts	This parameter displays the actual voltage of the PP 1 sensor signal circuit as measured by the control module.
Pedal Position Sensor 2 Voltage	—	PP 2 0.3–0.6 Volts	This parameter displays the actual voltage of the PP 2 sensor signal circuit as measured by the control module.
Powertrain Relay Output	—	ON	This parameter displays the control modules commanded state of the powertrain relay control circuit.
Reflects ETC H-Bridge Direction	—	Varies	This parameter will display OPEN or CLOSE depending which direction the control module is commanding the throttle plate.
Required Fuel Flow Rate	—	Varies	This parameter displays the desired fuel pressure as determined by the control module, if applicable.
Rev Limit Threshold	—	Varies with engine application	This parameter display the engine revolution limit calibration in RPM.
Rev Limit Within Last Second	—	NO	This parameter displays YES if the engine speed was limited by the rev limit threshold within the last second.
RPM Based Output Active	—	NO	This parameter displays YES if the control module detects OEM installed cruise control system has been switched ON.
Shift Interrupt Input	—	OFF	This parameter displays the shift interrupt switch circuit status to the control module.
Spark Advance	—	–20 to +40 Degrees	This parameter displays the amount of spark advance the control module is commanding on the ignition control circuits. The control module determines the desired advance.
Starter Relay Output	—	OFF	This parameter displays the control modules commanded state of the starter relay control circuit.
Supercharger Inlet Pressure Sensor Present	—	YES/NO	This parameter displays YES if the control module detects a SCIP sensor signal.
Supercharger Inlet Pressure Sensor	—	Varies	This parameter indicates the pressure at the supercharger inlet as calculated by the control module based on the signal from the supercharger inlet pressure (SCIP) sensor. The scan tool will display a higher value wide open throttle, and a lower value at idle.
Supercharger Inlet Pressure Sensor Volts	—	0–5 Volts	This parameter indicates the voltage signal received by the control module from the SCIP sensor. The scan tool displays a low voltage at idle, and a high voltage at wide open throttle. Barometric pressure and altitude can effect these values.
Throttle Position	—	7–11 %	This parameter displays the percent of throttle opening as calculated by the control module using information from the two TP sensors.
Throttle Position Sensor 1 Voltage	—	0.95–1.25 Volts	This parameter displays the actual voltage on the TP sensor 1 signal circuit as measured by the control module.
Throttle Position Sensor 2 Voltage	—	3.75–4.25 Volts	This parameter displays the actual voltage on the TP sensor 2 signal circuit as measured by the control module.
Total Fuel Used	—	Varies Gal/Ltr	This parameter displays the total amount of fuel consumed over the life of the engine.
Total Hours	—	Varies	This parameter displays the total number of hours that the engine has been operating.

Engine Control Module Scan Tool Data (cont'd)

Parameter	System State	Expected Value	Description
Total Operating Time	—	Varies	This parameter displays the total number of crankshaft revolutions since the very first engine start-up.
Trans Shift Output	—	OFF	This parameter displays if the control module is limiting trans shift operation.
Troll Mode	—	OFF	This parameter displays if the control module is commanding troll mode operation.
Troll Mode Enabled	—	OFF	This parameter displays if troll mode operation is enabled.
Troll Mode Input	—	OFF	This parameter displays the state of the troll mode switch input to the control module.
Variable Governor Input Voltage	—	0–5 Volts	This parameter displays signal voltage of an OEM installed speed or RPM control system.
Vehicle Speed	—	0 mph/kph	This parameter displays the vehicle speed signal to the control module.
Warm Up Cycles Since Last DTC	—	Varies	This parameter indicates the number of warm up cycles that have occurred without a fault present. The scan tool will display a 0 if a fault has occurred. The scan tool will display a higher count if a number of warm up cycles have occurred without a fault.
Warning Buzzer Output	—	OFF	This parameter displays the commanded state of the warning buzzer control circuit by the control module.

Engine Control Module (ECM) Scan Tool Output Controls

Output Control	Description
Boost Override	This function controls the boost solenoid from the none to ON or OFF.
Buzzer Override	This function controls the buzzer. The normal commanded state is None. When commanded ON, the ECM will command the buzzer ON and OFF.
Cam Phaser Cleaning	This function controls the camshaft actuator solenoid. The normal commanded state is NONE. The system will command the camshaft solenoid valve ON to 90 percent for approximately 2 seconds. This causes the camshaft actuator to travel to the maximum advance or retard position, approximately 40 degrees camshaft, depending on the actual engine speed. The scan tool initiates the test when the following conditions are met: • The vehicle speed is 0 km/h (0 mph). • The engine speed is between 2,000-2,500 RPM. • The transmission is in neutral.
Check Gauges Lamp Override	This function controls the check gauges lamp. The normal commanded state is None. When commanded ON, the ECM will blink the check gauges lamp ON and OFF.
Fuel Pump 1 Relay Override	This function controls the fuel pump relay. When commanded ON/OFF, the ECM turns the fuel pump relay ON/OFF. If the engine is running and the fuel pump relay is commanded OFF, the engine will stall. This output can also be monitored on the scan tool data parameter Fuel Pump Relay Command. The system remains in the commanded state until cancelled by the scan tool or the ECM.

Engine Control Module (ECM) Scan Tool Output Controls (cont'd)

Output Control	Description
Fuel Pump 2 Relay Override	This function controls the fuel pump 2 relay. When commanded ON/OFF, the ECM turns the fuel pump relay ON/OFF. If the engine is running and the fuel pump relay is commanded OFF, the engine will stall. This output can also be monitored on the scan tool data parameter Fuel Pump Relay Command. The system remains in the commanded state until cancelled by the scan tool or the ECM.
Fuel Select Output 1 or 2	This function controls the respective fuel control circuit, if used. The normal commanded state is None. When commanded ON, the ECM will command the control circuit ON and OFF.
DTC Lamp 1–3 Override	This function controls the respective DTC lamp. The normal commanded state is None. When commanded ON, the ECM will blink the DTC lamp ON and OFF.
Governor Status Lamp Override	This function controls the governor status lamp. The normal commanded state is None. When commanded ON, the ECM will blink the governed status lamp ON and OFF.
Idle Speed Override	This function controls the idle speed override from the base idle speed. The scan tool initiates the test when the following conditions are met: • The transmission is in neutral. • The engine speed is less than 1,000 RPM. The engine speed will remain in the commanded state until cancelled by the scan tool.
Intercooler Cooler Override	This function activates the intercooler coolant pump relay. The normal commanded state is NONE. When commanded ON, the ECM turns the relay ON for approximately 2 seconds.
MIL Lamp Override	This function controls the malfunction indicator lamp (MIL). The normal commanded state is None. When commanded ON, the ECM will blink the malfunction indicator lamp (MIL) ON and OFF.
O2 Heater Test	This function commands the selected O2 heater control circuit ON and OFF.
Oil Life Monitor Reset	This output control contains the engine oil remaining life determined from an algorithm based upon the effective engine revolutions and the hours of operation since the last oil change. This output control may be used to reset the engine oil remaining life to 100% after an oil change or to any other value when replacing a control module.
Power Balance Test	This function will disable a fuel injector for a cylinder one at a time. The engine speed can be monitored and used for comparing each cylinders RPM decrease.
Reset Block Learn Values	Activates the reset of Fuel Multiplier data in all BLM Cell I.Ds.
Slow Mode Lamp Override	This function controls the troll lamp lamp. The normal commanded state is None. When commanded ON, the ECM will blink the troll lamp ON and OFF.
Speed Based Output Override	This function allows the scan tool to override the speed based system for testing.
SVS Lamp Override	This function controls the service vehicle soon (SVS) lamp. The normal commanded state is None. When commanded ON, the ECM will blink the oil level lamp ON and OFF.
Trans Shift Override	This function activates the shift interlock solenoid, if equipped. The normal commanded state is NONE. When commanded ON, the control module turns the solenoid ON for approximately 2 seconds.

Powertrain On Board Diagnostic (OBD) System Check

1. Verify that none of the following preliminary inspections/tests reveal the cause of the vehicle concern before beginning diagnosis:
 - Ensure that the battery is fully charged.
 - Ensure that the battery cables are clean and tight.
 - Inspect for any open fuses. Refer to *Engine Controls Schematics on page 9-6*.
 - Ensure that the grounds are clean, tight, and in the correct location.
 - Inspect the easily accessible systems or the visible system components for obvious damage or conditions that could cause the concern. This would include checking to ensure that all connections/connectors are fully seated and secured.
 - Inspect for aftermarket devices that could affect the operation of the system. Refer to *Checking Aftermarket Accessories on page 11-6*.
 - Search for applicable service bulletins.

⇒ If the preceding inspections/tests resolve the concern, go to *Diagnostic Repair Verification on page 6-22*.
 2. Install a scan tool. Verify that the scan tool powers up.

⇒ If the scan tool does not power up, refer to *Scan Tool Does Not Power Up on page 11-3*.
 3. Ignition ON, Engine OFF, verify communication with all of the control modules on the vehicle.

⇒ If the scan tool does not communicate with one or more of the expected control modules, refer to *Scan Tool Does Not Communicate with CAN Device on page 11-4*.
 4. Verify that SPN 65558 or 65559 is not set.

⇒ If either SPN is set, refer to *SPN 65558 or 65559 on page 9-118*.
 5. Attempt to start the engine. Verify that the engine cranks.

⇒ If the engine does not crank, refer to *SPN 66002 on page 9-162* (if equipped). If the vehicle is not equipped with an ECM controlled starter relay, repair the starting system.
 6. Attempt to start the engine. Verify the engine starts and idles.

⇒ If the engine does not start and idle, refer to *Engine Cranks But Does Not Run on page 9-201*.
- Note:** Do not clear any SPNs unless instructed to do so by a diagnostic procedure.
7. Use the appropriate scan tool selections to obtain any SPNs from each of the vehicle control modules. Verify there are no SPNs reported from any module.

⇒ If any SPNs are present, refer to *Diagnostic Trouble Code (DTC) List on page 6-11* and diagnose any current SPNs in the following order:

 - 7.1. Any of the following: 630, 65580, 65581, or 65582.
 - 7.2. SPN 627.
 - 7.3. Component level SPNs.
 - 7.4. System level SPNs.
 - 7.5. Any remaining SPNs.

⇒ If none of the previous tests or inspections addresses the concern, refer to *Symptoms - Engine Controls on page 9-199*.

SPN 38 or 96

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provide an overview of each diagnostic category.

SPN Descriptor

SPN 38 FMI 3: Fuel Level Sensor 2 Circuit Voltage Above Normal or Shorted High

SPN 38 FMI 4: Fuel Level Sensor 2 Circuit Voltage Below Normal or Shorted Low

SPN 96 FMI 3: Fuel Level Sensor 1 Circuit Voltage Above Normal or Shorted High

SPN 96 FMI 4: Fuel Level Sensor 1 Circuit Voltage Below Normal or Shorted Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Level Sensor 1 Low Reference Circuit	—	96–3	96–3	—
Fuel Level Sensor 1 Signal Circuit	96–4	96–3	96–3	—
Fuel Level Sensor 2 Low Reference Circuit	—	38–3	38–3	—
Fuel Level Sensor 2 Signal Circuit	38–4	38–3	38–3	—

Circuit/System Description

The fuel level sensor changes resistance in response to the fuel level. The engine control module (ECM) monitors the signal circuit of the fuel level sensor in order to determine the fuel level. When the fuel tank is full, the sensor resistance is low and the ECM detects a low signal voltage. When the fuel tank is empty, the sensor resistance is high and the ECM detects a high signal voltage. The ECM uses the signal circuit of the fuel level sensor in order to calculate the percentage of remaining fuel in the tank.

Conditions for Running the SPN

- SPN 630, 65580, 65620, or 65621 is not set.
- The ignition is ON for a predetermined time.
- SPNs 38 and 96 run continuously when the conditions above exist.

Conditions for Setting the SPN

38–3 and 96–3

- The ECM detects the fuel sensor voltage is greater than 2.9 volts.
- The above condition is present for greater than 30 seconds.

38–4 and 96–4

- The ECM detects the fuel sensor voltage is less than 0.39 volts.
- The above condition is present for greater than 30 seconds.

Action Taken When the SPN Sets

- SPNs 38 and 96 are type C SPNs.
- The fuel gauge defaults to empty (if equipped).
- The low fuel indicator illuminates (if equipped).

Conditions for Clearing the SPN

SPNs 38 and 96 are type C SPNs.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Description and Operation

Fuel System Description on page 9-284

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. SPN 38 or 96 should not be set.
2. Observe the scan tool Fuel Level 1 or 2 Percent parameter. The parameter should be between 4 percent and 98 percent.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate fuel level sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify that the appropriate scan tool Fuel Level Volts parameter is greater than 4.97 V.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.

Note: If the fuse in the jumper wire opens the signal circuit is shorted to a voltage, and the fuel level sensor may be damaged.

4. Install a 3 A fused jumper between the signal circuit terminal and the low reference circuit terminal. Verify the appropriate scan tool Fuel Level Volts parameter is less than 0.10 V.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the fuel level sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate fuel level sensor.
2. Remove the fuel level sensor.
3. Connect a DMM between the terminals of the fuel level sensor.
4. While sweeping the fuel level sensor through its full range of motion, test for a minimum value less than 41 Ω and a maximum value greater than 119 Ω .
 - ⇒ If not within the specified range, replace the fuel level sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure. *Engine Control Module Replacement* on page 9-217 for engine control module replacement, setup, and programming

SPN 51

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

DTC Descriptors

SPN 51 FMI 0: Throttle Position (TP) Sensor Circuit Voltage Data Valid but Above Normal

SPN 51 FMI 3: Throttle Position (TP) Sensor Circuit Voltage Above Normal or Shorted High

SPN 51 FMI 4: Throttle Position (TP) Sensor Circuit Voltage Below Normal or Shorted Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	65623-4	51-4	51-3, 65605-2	—
TP Sensor Signal	51-4	51-4	51-3	51-0
Low Reference	—	51-3	—	51-0

Typical Scan Tool Data

TP Sensor 1 and 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON and the engine is OFF.			
Parameter Normal Range: TP Sensor 0.5 volts			
5-Volt Reference	0.00 V	0.00 V	3.75 V
TP Sensor Signal	0.00 V	0.00 V	5.02 V
Low Reference	0.00 V	4.96 V	—

Circuit/System Description

The throttle body assembly contains a throttle position (TP) sensor. The TP sensor is mounted externally on the throttle body assembly. The TP sensor is a potentiometer which provides a signal voltage that changes relative to the throttle blade angle. The engine control module (ECM) supplies the TP sensor with a 5-volt reference circuit, a low reference circuit, and a signal circuit. The TP sensor signal voltage increases from less than 1 volt at idle to greater than 4 volts at wide open throttle (WOT).

Conditions for Running the SPN

- Before the ECM can report that SPN 51-0 failed, SPN 106-0 and 106-1 must run and pass.
- SPN 106, 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine speed is less than a predetermined value.
- The MAP signal is less than a predetermined value.

51-3 and 51-4

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The SPN runs continuously when the conditions above are met.

Conditions for Setting the SPN

51-0

The ECM detects that the TP sensor voltage is greater than a calibrated value for greater than 1 second.

51-3

The ECM detects that the TP sensor voltage is greater than 4.49 volts.

51-4

The ECM detects that the TP sensor voltage is less than 0.29 volt.

Action Taken When the SPN Sets

SPN 51 is a Type B SPN.

Conditions for Clearing the SPN

SPN 51 is a Type B SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. SPN 65623-4 should not be set. Refer to *SPN 65620-65623 on page 9-149* if the SPN is set.
2. Engine operating, observe the SPN information with a scan tool. SPN 51 should not set.
3. Ignition ON, engine OFF, slowly depress the accelerator pedal from the rest position to wide open throttle and observe the scan tool TP Sensor voltage parameter. The voltage should increase from less than 1 volt with the throttle closed to greater than 4 volts at WOT with no drop-outs or jumps in voltage.

4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the TP sensor.
2. Ignition OFF for 30 S, test for less than 5 Ω between the low reference circuit terminal 3 and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 volts between the 5-volt reference circuit terminal 2 and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool TP Sensor voltage parameter is less than 0.10 volt.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 2. Verify the scan tool TP sensor voltage parameter is greater than 4.80 volts.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, test or replace the TP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

- *Throttle Position Sensor Replacement (Non ETC) on page 9-227*
- *Engine Control Module Replacement on page 9-217* for ECM replacement, setup, and programming

SPN 84

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provide an overview of each diagnostic category.

SPN Descriptor

SPN 84 FMI 1: Vehicle Speed Sensor (VSS) Data Valid but Below Normal

SPN 84 FMI 2: Vehicle Speed Sensor (VSS) Data Erratic, Intermittent or Incorrect

SPN 84 FMI 3: Vehicle Speed Sensor (VSS) Voltage Above Normal or Shorted High

SPN 84 FMI 4: Vehicle Speed Sensor (VSS) Voltage Below Normal or Shorted Low

Circuit/System Description

The vessel speed is provided to the engine control module (ECM) by the vehicle speed sensor (VSS). The sensor is a paddle wheel permanent magnet generator that is usually located through hull, or attached to the transom of the vessel. The VSS produces a signal whenever the vessel is moving. The number of pulses increases with the speed of the vessel. The ECM converts this signal into miles per hour (MPH), which can be monitored with a scan tool. The vehicle speed information is used by the ECM for governing the vessels speed during cruise control operation.

Conditions for Running the SPN

84-1

- Before the ECM can report that SPN-84-1 failed, SPN 84-3 and 84-4 must run and pass.
- SPN 106, 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is operating for greater than a calibrated time.
- The engine speed is greater than a calibrated value.
- The MAP signal is less than a calibrated value.
- The pedal position is less than a calibrated value.
- The SPN runs continuously when the conditions above exist.

84-2

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is operating for greater than a calibrated time.
- The SPN runs continuously when the conditions above exist.

84-3 and 84-4

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is operating for greater than a predetermined time.
- The pedal position is less than a predetermined value.
- The SPNs run continuously when the conditions above are met.

Conditions for Setting the SPN

84-1

The ECM detects that the VSS signal is greater than a calculated value.

84-2

The ECM detects the VSS signal is erratic for greater than pre-determined time.

84-3 and 84-4

The ECM detects a short to ground, an open, or a short to voltage in the VSS circuits or sensor.

Action Taken When the SPN Sets

- SPN 84 is a Type C SPN.
- The cruise control system will be disabled.

Conditions for Clearing the SPN

SPN 84 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify SPN 65620, 65621 65622, or 65623 is not set.
⇒ If an SPN is set, refer to *SPN 65620-65623 on page 9-149* for further diagnosis.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the VSS.
2. Test for less than 5 Ω between the low reference circuit terminal and ground.
⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal and ground.
⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, test for 4.8–5.2 V between the signal circuit terminal and ground.
⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, replace the VSS.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

- *Vehicle Speed Sensor Replacement*
- *Engine Control Module Replacement on page 9-217* for ECM replacement, setup, and programming

SPN 94

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 94 FMI 3: Fuel Pressure Sensor Voltage Above Normal or Shorted High

SPN 94 FMI 4: Fuel Pressure Sensor Voltage Below Normal or Shorted Low

SPN 94 FMI 15: Fuel Pressure Data Valid But Above Normal Range-Least Severe Level

SPN 94 FMI 17: Fuel Pressure Data Valid But Below Normal Range-Least Severe Level

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	94-3	94-4	94-3	94-17
FP Sensor Signal	94-4	94-4	94-3	94-15, 94-17
Low Reference	—	94-3	—	94-15

Typical Scan Tool Data

Fuel Pressure Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at Normal Operating Temperature			
Parameter Normal Range: 379–427 kPa (55–62 psi)			
5-Volt Reference	0 kPa (0 psi)	0 kPa (0 psi)	689 kPa (100 psi)
FP Sensor Signal	0 kPa (0 psi)	689 kPa (100 psi)	689 kPa (100 psi)
Low Reference	—	689 kPa (100 psi)	*
* Internal ECM damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The fuel pressure (FP) sensor changes resistance based on fuel system pressure. The engine control module (ECM) monitors the signal circuit from the FP sensor. The ECM supplies 5-volts to the FP sensor on the 5-volt reference circuit. The ECM also provides a ground on the low reference circuit. The FP sensor provides a signal to the ECM on the FP sensor signal circuit which is relative to the pressure changes in the fuel system pressure. When the fuel pressure is high, the sensor resistance is high, and the ECM senses a high voltage. When the fuel pressure is low, the sensor voltage is low, and the ECM senses a low signal voltage. A FP sensor fault code may cause an engine speed reduction to occur on vessels with certain engine applications.

Conditions for Running the SPN

94-3 and 94-4

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is operating for greater than 10 seconds.
- SPN 94 runs continuously when the above conditions are met.

94-15 and 94-17

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or engine is operating.
- The fuel pump is commanded ON.
- The desired fuel pressure is stable within ± 5 kPa (0.7 PSI).
- SPN 94 runs continuously when the above conditions are met for greater than 10 seconds.

Conditions for Setting the SPN

94-3

The ECM detects that the FP sensor voltage is greater than 4.8 volts for greater than 1.3 seconds.

94-4

The ECM detects that the FP sensor voltage is less than 0.25 volt for greater than 1.3 seconds.

94-15, 17

The ECM detects that the actual fuel pressure is ± 40 kPa (6 PSI) of the desired fuel pressure for greater than 10 seconds.

Action Taken When the SPN Sets

SPN 94 is a Type B SPN.

Conditions for Clearing the SPN

SPN 94 is a Type B SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

J 34730-1A Fuel Pressure Gauge

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65620, 65621, 65622, or 65623 is not set.
⇒ If either SPN is set, refer to *SPN 65620-65623 on page 9-149*.
2. Engine idling, observe the scan tool FP Sensor parameter. The reading should be between 379–427 kPa (55–62 psi).
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the FP sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal and ground.
⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal and ground.
⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool FP sensor pressure parameter is 0 kPa (0 psi).
⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal and the 5-volt reference circuit terminal. Verify the scan tool FP sensor parameter is greater than 655 kPa (95 psi).
⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, refer to *Fuel System Diagnosis (with Returnless Fuel System) on page 9-208* or *Fuel System Diagnosis (without Returnless Fuel System) on page 9-210*. If the fuel system tests normal, replace the FP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure. *Engine Control Module Replacement on page 9-217* for engine control module replacement, setup, and programming

SPN 98

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provide an overview of each diagnostic category.

SPN Descriptor

SPN 98 FMI 17: Oil Level Switch Signal Data Valid But Below Normal Range-Least Severe Level

Circuit/System Description

The oil level switch is a normally open switch that is closed when the oil is at the proper level. The engine control module (ECM) monitors the signal circuit of the oil level switch in order to determine if there is a low oil level condition. When the oil is full, the switch contacts are closed, and the ECM detects a low signal voltage. When the oil level is low, the switch contacts open and the ECM detects a high signal voltage.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON.
- The ECM determines that the oil has had time to drain back into the oil pan.
- The SPN runs at ignition ON depending on coolant temperature.

Conditions for Setting the SPN

The ECM detects a low oil level condition for greater than 30 seconds.

Action Taken When the SPN Sets

SPN 98 is a type C SPN.

Conditions for Clearing the SPN

SPN 98 is a type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Description and Operation

Data Link Communications Description and Operation on page 11-5

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition OFF, verify the engine crankcase is filled to the correct level with engine oil.
2. Ignition ON, observe the scan tool Low Oil Level Input parameter. The parameter should display OFF.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
3. Ignition ON, install a 3 A fused jumper wire between the signal circuit terminal A and the ground circuit terminal B. Observe the scan tool Oil Level parameter. The parameter should display OFF.
 - ⇒ If the parameter does not display OFF, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, replace the oil level switch.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the oil level switch.
2. Ignition OFF, test for less than 5 Ω between the ground circuit terminal B and ground.
 - ⇒ If greater than the specified range, repair the ground circuit for a short to voltage or an open/high resistance.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for engine control module replacement, setup, and programming

SPN 100 (3.0L, 4.3L, 5.0L, 5.7L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 100 FMI 3: Engine Oil Pressure (EOP) Sensor Circuit Voltage Above Normal or Shorted High

SPN 100 FMI 4: Engine Oil Pressure (EOP) Sensor Circuit Voltage Below Normal or Shorted Low

SPN 100 FMI 17: Engine Oil Pressure (EOP) Sensor Data Valid But Below Normal Range-Least Severe Level

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	65620-4	100-4	100-4	—
EOP Sensor Signal	100-4	100-4	100-3	100-17
Low Reference	—	—	—	—

Typical Scan Tool Data

EOP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at Normal Operating Temperature Parameter Normal Range: 41–414 kPa (6–60 psi)			
5-Volt Reference	0 kPa (0 psi)	0 kPa (0 psi)	0 kPa (0 psi)
EOP Sensor Signal	0 kPa (0 psi)	0 kPa (0 psi)	910 kPa (132 psi)
Low Reference	—	118 psi (813 kPa)	*
* Internal ECM damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The engine oil pressure (EOP) sensor changes voltage based on the engine oil pressure. The EOP sensor is a 3-wire sensor comprising of the signal circuit, the low reference circuit and the 5-volt reference circuit. The engine control module (ECM) supplies 5 volts to the EOP sensor via the 5-volt reference circuit and provides ground via the EOP low reference circuit. The ECM monitors the signal circuit of the EOP sensor to determine the EOP sensor voltage is within the normal operating range of approximately 1-4 volts. When the engine oil pressure is high, the EOP sensor voltage is high and the ECM senses a high signal voltage. When the engine oil pressure is low, the EOP sensor voltage is low and the ECM senses a low signal voltage. An EOP fault code will cause RPM reduction to occur on some engine applications.

Conditions for Running the SPN

100-3 and 100-4

- SPNs 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or engine is operating.
- The SPNs run continuously when the above conditions are met for greater than 10 seconds.

100-17

- SPNs 100-3, 100-4, 630, 65580, 65620, or 65621, 65622, or 65623 is not set.
- The engine speed is equal to or greater than 500 RPM.
- The SPN runs continuously when the above conditions are met for greater than 10 seconds.

Conditions for Setting the SPN

100-3

The ECM detects that the EOP sensor voltage is greater than 4.49 volts for greater than 3 seconds.

100-4

The ECM detects that the EOP sensor voltage is less than 0.39 volts for greater than 3 seconds.

100-17

The ECM detects that the engine oil pressure is less than a calibrated range, based on engine speed, for greater than 5 seconds.

Action Taken When the SPN Sets

- SPN 100-3 and 100-4 are Type B SPNs.
- SPN 100-17 is a Type C SPN.
- Cam phaser not enabled.

Conditions for Clearing the SPN

- SPN 100-3 and 100-4 are Type B SPNs.
- SPN 100-17 is a Type C SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65620, 65621, 65622, or 65623 is not set.
⇒ If either SPN is set, refer to *SPN 65620-65623 on page 9-149*.

2. Engine operating, observe the SPN information with a scan tool. Verify SPN 100-3, 100-4 or 100-17 is not set.
3. Engine idling, observe the scan tool EOP Sensor parameter. The reading should be between 41-414 kPa (6-60 psi).
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EOP sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal A and ground.
⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal B and ground.
⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool Oil Pressure Sensor Voltage parameter is less than 0.10 V.
⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Connect a 3 A fused jumper wire between the signal circuit terminal C and the 5-volt reference circuit terminal B. Verify the scan tool Oil Pressure Sensor Voltage parameter is greater than 4.9 V.
⇒ If less than the specified range, test the signal circuit for a short to ground or for an open/high resistance. If the circuit tests normal, replace the ECM.
6. Ignition OFF, install a mechanical engine oil pressure gauge.
7. Engine idling, verify the oil pressure is within 41-414 kPa (6-60 psi).
⇒ If not within the specified range, repair the engine mechanical condition.
8. If all circuits test normal, replace the EOP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Engine Oil Pressure Sensor Replacement on page 9-225*
- *Engine Control Module Replacement on page 9-217 for engine control module replacement, setup, and programming.*

SPN 100 (6.0L, 6.2L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 100 FMI 3: Engine Oil Pressure (EOP) Sensor Circuit Voltage Above Normal or Shorted High

SPN 100 FMI 4: Engine Oil Pressure (EOP) Sensor Circuit Voltage Below Normal or Shorted Low

SPN 100 FMI 17: Engine Oil Pressure (EOP) Sensor Data Valid But Below Normal Range-Least Severe Level

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	65620-4	100-4	100-4	—
EOP Sensor Signal	100-4	100-4	100-3	100-17
Low Reference	—	—	—	—

Typical Scan Tool Data

EOP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine idling at Normal Operating Temperature			
Parameter Normal Range: 41–414 kPa (6–60 psi)			
5-Volt Reference	0 kPa (0 psi)	0 kPa (0 psi)	0 kPa (0 psi)
EOP Sensor Signal	0 kPa (0 psi)	0 kPa (0 psi)	910 kPa (132 psi)
Low Reference	—	118 psi (813 kPa)	*
* Internal ECM damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The engine oil pressure (EOP) sensor changes resistance based on engine oil pressure. The engine control module (ECM) monitors the signal circuit from the EOP sensor. The ECM supplies 5-volts to the EOP sensor on the 5-volt reference circuit. The ECM also provides a ground on the low reference circuit. The EOP sensor provides a signal to the ECM on the EOP sensor signal circuit which is relative to the pressure changes in the engine oil pressure. When the oil pressure is high, the sensor resistance is high, and the ECM senses a high voltage. When the oil pressure is low, the sensor voltage is low, and the ECM senses a low signal voltage. An EOP fault code may cause an engine speed reduction to occur on vessels with certain engine applications.

Conditions for Running the SPN

100-3 and 100-4

- SPNs 630, 65580, 65620, or 65621, 65622, or 65623 is not set.
- The ignition is ON, or engine is operating.
- The SPNs run continuously when the above conditions are met for greater than 10 seconds.

100-17

- SPNs 100-3, 100-4, 630, 65580, 65620, or 65621, 65622, or 65623 is not set.
- The engine speed is equal to or greater than 500 RPM.
- The SPN runs continuously when the above conditions are met for greater than 10 seconds.

Conditions for Setting the SPN

100-3

The ECM detects that the EOP sensor voltage is greater than 4.49 volts for greater than 3 seconds.

100-4

The ECM detects that the EOP sensor voltage is less than 0.39 volts for greater than 3 seconds.

100-17

The ECM detects that the engine oil pressure is less than a calibrated range, based on engine speed, for greater than 5 seconds.

Action Taken When the SPN Sets

- SPN 100-3 and 100-4 are Type B SPNs.
- SPN 100-17 is a Type C SPN.
- Cam phaser not enabled.

Conditions for Clearing the SPN

- SPN 100-3 and 100-4 are Type B SPNs.
- SPN 100-17 is a Type C SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65620, 65621, 65622, or 65623 is not set.
⇒ If an SPN is set, refer to *SPN 65620-65623 on page 9-149*.

2. Engine operating, observe the SPN information with a scan tool. Verify SPN 100-3, 100-4 or 100-17 is not set.
3. Engine idling, observe the scan tool EOP Sensor parameter. The reading should be between 41-414 kPa (6-60 psi).
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EOP sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal 3 and ground.
⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8-5.2 V between the 5-volt reference circuit terminal 2 and ground.
⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the scan tool Oil Pressure Sensor Voltage parameter is less than 0.10 V.
⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Connect a 3 A fused jumper wire between the signal circuit terminal 1 and the 5-volt reference circuit terminal 2. Verify the scan tool Oil Pressure Sensor Voltage parameter is greater than 4.9 V.
⇒ If less than the specified range, test the signal circuit for a short to ground or for an open/high resistance. If the circuit tests normal, replace the ECM.
6. Ignition OFF, install a mechanical engine oil pressure gauge.
7. Engine idling, verify the oil pressure is within 41-414 kPa (6-60 psi).
⇒ If not within the specified range, repair the engine mechanical condition.
8. If all circuits test normal, replace the EOP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Engine Oil Pressure Sensor Replacement on page 9-225*
- *Engine Control Module Replacement on page 9-217 for engine control module replacement, setup, and programming*

SPN 105 (3.0L, 4.3L, 5.0L, 5.7L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 105 FMI 3: Manifold Air Temperature (MAT) Sensor Circuit Voltage Above Normal or Shorted High

SPN 105 FMI 4: Manifold Air Temperature (MAT) Sensor Circuit Voltage Below Normal or Shorted Low

SPN 105 FMI 15: Manifold Air Temperature (MAT) Sensor Circuit Voltage Data Valid But Above Normal Range-Least Severe Level

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MAT Sensor Signal	105-4	105-3	105-3*	105-15
MAP/MAT Low Reference	—	105-3, 106-3	—	105-15

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

MAT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: Varies with ambient temperature			
MAT Sensor Signal	130°C (266°F)	-40°C (-40°F)	-40°C (-40°F)*
MAP/MAT Low Reference	—	-40°C (-40°F)	-40°C (-40°F)*

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit Description

The manifold air temperature (MAT) sensor is a part of the manifold absolute pressure (MAP) sensor. The MAT is a variable resistor that measures the temperature of the air entering the engine. The MAT sensor has a signal circuit and shares a low reference circuit with the MAP sensor. The engine control module (ECM) supplies 5 volts to the MAT signal circuit and a ground for the MAP/MAT low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

MAT	MAT Resistance	MAT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the SPN

- SPN 110, 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is operating for greater than 10 seconds.
- The SPN 105 runs continuously once the above conditions are met.

Conditions for Setting the SPN

105-3

The ECM detects that the MAT sensor parameter is colder than -38°C (-36°F).

105-4

The ECM detects that the MAT sensor is warmer than 129°C (264°F).

105-15

The ECM detects that the manifold air temperature is within the range of the MAT sensor, but warmer than a predicted value.

Action Taken When the SPN Sets

SPN 105 is a Type B SPN.

Conditions for Clearing the SPN

SPN 105 is a Type B SPN.

Diagnostic Aids

If the vehicle has set overnight, the MAT sensor and the ECT sensor values should display within 3°C (5°F).

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine running for 1 minute, observe the SPN information with a scan tool. SPNs 105–3, 105–4, or 105–15 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the MAP/MAT sensor.
2. Test for less than 5 Ω between the low reference circuit terminal 1 and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool MAT sensor parameter is at –40°C (–40°F).
 - ⇒ If warmer than the specified range, test the signal circuit terminal 2 for a short to ground. If the circuit tests normal, replace the ECM.

Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Connect a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool MAT sensor parameter is warmer than 129°C (264°F).
 - ⇒ If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the MAP/MAT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the MAP/MAT sensor.

Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the MAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the *Temperature Versus Resistance on page 9-3* table and verify that the resistance is within 5 percent of the specification.
 - ⇒ If not within the specified range, replace the MAP/MAT sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

- *Manifold Absolute Pressure Sensor Replacement (without Supercharger) on page 9-220*
- *Engine Control Module Replacement on page 9-217* for engine control module replacement, setup, and programming

SPN 105 (2.4L, 6.0L, 6.2L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 105 FMI 3: Manifold Air Temperature (MAT) Sensor Circuit Voltage Above Normal or Shorted High

SPN 105 FMI 4: Manifold Air Temperature (MAT) Sensor Circuit Voltage Below Normal or Shorted Low

SPN 105 FMI 15: Manifold Air Temperature (MAT) Sensor Circuit Voltage Data Valid But Above Normal Range-Least Severe Level

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MAT Sensor Signal	105-4	105-3	105-3*	105-15
MAP/MAT Low Reference	—	105-3	—	105-15

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

MAT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: Varies with ambient temperature			
MAT Sensor Signal	130°C (266°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	—	-40°C (-40°F)	-40°C (-40°F)*

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit Description

The manifold air temperature (MAT) sensor is a variable resistor that measures the temperature of the air entering the engine. The MAT sensor has a signal circuit and a low reference circuit. The engine control module (ECM) supplies 5 volts to the MAT signal circuit and a ground for the MAT low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

MAT	MAT Resistance	MAT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the SPN

- SPN 110, 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is operating for greater than 10 seconds.
- The SPN 105 runs continuously once the above conditions are met.

Conditions for Setting the SPN

105-3

The ECM detects that the MAT is colder than -38°C (-36°F).

105-4

The ECM detects that the MAT sensor is warmer than 129°C (264°F).

105-15

The ECM detects that the manifold air temperature is within the range of the MAT sensor, but warmer than a predicted value.

Action Taken When the SPN Sets

SPN 105 is a Type B SPN.

Conditions for Clearing the SPN

SPN 105 is a Type B SPN.

Diagnostic Aids

If the vehicle has set overnight, the MAT sensor and the ECT sensor values should display within 3°C (5°F).

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine running for 1 minute, observe the SPN information with a scan tool. SPNs 105–3, 105–4, or 105–15 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the MAT sensor.
2. Test for less than 5 Ω between the low reference circuit terminal B and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

3. Ignition ON, verify the scan tool MAT sensor parameter is at -40°C (-40°F).
 - ⇒ If warmer than the specified range, test the signal circuit terminal A for a short to ground. If the circuit tests normal, replace the ECM.

Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Connect a 3 A fused jumper wire between the signal circuit terminal A and ground. Verify the scan tool MAT sensor parameter is warmer than 129°C (264°F).
 - ⇒ If colder than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the MAT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the MAT sensor.

Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the MAT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the *Temperature Versus Resistance on page 9-3* table and verify that the resistance is within 5 percent of the specification.
 - ⇒ If not within the specified range, replace the MAT sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

- *Manifold Air Temperature Sensor Replacement on page 9-218*
- *Engine Control Module Replacement on page 9-217* for engine control module replacement, setup, and programming

SPN 106 (3.0L, 4.3L, 5.0L, 5.7L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 106 FMI 0: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Data Valid But Above Normal

SPN 106 FMI 1: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Data Valid But Below Normal

SPN 106 FMI 3: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Above Normal or Shorted High

SPN 106 FMI 4: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Below Normal or Shorted Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	65622-4	106-4	106-3, 65604-2, 65613-2	106-0, 106-1
MAP Sensor Signal	106-4	106-4	106-3	106-0, 106-1
MAP/MAT Low Reference	—	105-3, 106-3	*	106-0, 106-1
* Internal ECM damage may occur if the circuit is shorted to B+.				

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: 30-48 kPa			
5-Volt Reference	0 volts	0 volts	4.9 volts
MAP Sensor Signal	0 volts	0 volts	4.9 volts
Low MAP/MAT Low Reference	—	4.9 volts	*
* Internal ECM damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The manifold absolute pressure (MAP) sensor responds to pressure changes in the intake manifold. The pressure changes occur based on the engine load. The engine control module (ECM) supplies 5 volts to the MAP sensor on the 5-volt reference circuit. The ECM provides a ground on the low reference circuit that is shared with the manifold air temperature (MAT) sensor, which is a part of the MAP sensor. The MAP sensor provides a signal to the ECM on the MAP sensor signal circuit which is relative to the pressure changes

in the manifold. The ECM detects a low signal voltage at a low MAP, such as during an idle or a deceleration. The ECM detects a high signal voltage at a high MAP, such as the ignition is ON, with the engine OFF, or at a wide open throttle (WOT). On some engine applications the MAP sensor is also used to determine the barometric pressure (BARO). This occurs when the ignition switch is turned ON, with the engine OFF. The BARO reading may also be updated whenever the throttle position (TP) sensor is greater than 28 percent.

Conditions for Running the SPN

106-0

- Before the ECM can report that SPN 106-0, or 106-1 failed, SPNs 100-3, 100-4, 65604, 65605, 65610, 65613, 65615, 65616, and 65618 must run and pass.
- SPN 105, 110, 630, 65580, 65621, or 65622 is not set.
- The engine speed is greater than 800 RPM.
- The throttle angle is less than 30 percent.
- The ECM is not commanding reduced power, or fuel cut-off.
- The SPN runs continuously once the above conditions are met.

106-1

- Before the ECM can report that SPN 106-0, or 106-1 failed, SPNs 100-3, 100-4, 65604, 65605, 65610, 65613, 65615, 65616, and 65618 must run and pass.
- SPN 105, 110, 630, 65580, 65621, or 65622 is not set.
- The engine speed is less than 150 RPM.
OR
- The throttle angle is greater than 75 percent.
- The ECM is not commanding reduced power, or fuel cut-off.
- The SPN runs continuously once the above conditions are met.

106-3 and 106-4

- SPN 105, 110, 630, 65580, 65621, or 65622 is not set.
- The ignition is ON.
- The SPN runs continuously when the above conditions are met.

Conditions for Setting the SPN

106-0

The ECM detects that the MAP sensor signal is greater than 90 kPa for greater than 2 seconds.

106-1

The ECM detects that the MAP sensor signal is less than 20 kPa for greater than 2 seconds.

106-3

The ECM detects that the MAP sensor voltage is greater than 4.8 V.

106-4

The ECM detects that the MAP sensor voltage is less than 0.25 V.

Action Taken When the SPN Sets

- SPN 106 is a Type B SPN.
- The BARO will not be updated.
- The ECM operates with a default MAP reading, which varies based on throttle angle.

Conditions for Clearing the SPN

SPN 106 is a Type B SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tool Required

J-23738-A Vacuum Pump

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65622 is not set.
⇒ If SPN 65622 is set, refer to *SPN 65620-65623 on page 9-149* for further diagnosis.
2. Turn all accessories OFF.

Note: In extreme cold weather conditions ice may form in the vacuum source to the MAP sensor and may set a SPN. Inspect the MAP sensor and the vacuum source for ice, moisture, or other restrictions.

3. Engine operating, observe the scan tool MAP Sensor parameter. The reading should be between 31-68 kPa (9-20 in Hg).
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the vacuum hose at the MAP/MAT sensor, or remove the MAP/MAT sensor from the intake manifold. Connect the J-23738-A to the vacuum source.
2. Engine operating, verify that 31–68 kPa (9–20 in Hg) of vacuum is available to the MAP/MAT sensor.
 - ⇒ If not within the specified range, repair the restriction in the vacuum supply to the MAP/MAT sensor.
3. Ignition OFF, connect the vacuum hose to the MAP/MAT sensor, or install the MAP/MAT sensor to the intake manifold. Disconnect the harness connector at the MAP sensor.
4. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal 1 and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
5. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal 3 and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

6. Verify the scan tool MAP sensor voltage parameter is less than 0.25 V.
 - ⇒ If greater than the specified range, test the signal circuit terminal 4 for a short to voltage. If the circuit tests normal, replace the ECM.
7. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the 5-volt reference circuit terminal 3. Verify the scan tool MAP sensor parameter is greater than 4.8 V.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
8. If all circuits test normal, test or replace the MAP/MAT sensor.

Component Testing

The ignition ON, engine OFF MAP sensor scan tool value should decrease within +/- 4 kPa by the amount of vacuum applied with the J-23738-A. For example, at 92 kPa, the MAP sensor scan tool reading should be between 71–79 kPa with 5 in Hg (17 kPa) of vacuum applied to the sensor.

SPN 106 (3.0L, 4.3L, 5.0L, 5.7L)

Ignition ON, engine OFF, MAP Sensor parameter	MAP Sensor parameter with 5 inches of vacuum applied	MAP Sensor parameter with 10 inches of vacuum applied
100 kPa	79–87 kPa	62–70 kPa
95 kPa	74–82 kPa	57–65 kPa
90 kPa	69–77 kPa	52–60 kPa
80 kPa	59–67 kPa	42–50 kPa
70 kPa	49–57 kPa	32–40 kPa
60 kPa	39–47 kPa	22–30 kPa

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Manifold Absolute Pressure Sensor Replacement (without Supercharger)* on page 9-220
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 106 (2.4L, 6.0L, 6.2L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 106 FMI 0: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Data Valid But Above Normal

SPN 106 FMI 1: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Data Valid But Below Normal

SPN 106 FMI 2: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Data Erratic, Intermittent or Incorrect

SPN 106 FMI 3: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Above Normal or Shorted High

SPN 106 FMI 4: Manifold Absolute Pressure (MAP) Sensor Circuit Voltage Below Normal or Shorted Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	65622-4	106-4	106-3, 65604-2, 65613-2	106-0, 106-1
MAP Sensor Signal	106-4	106-4	106-3	106-0, 106-1
Low Reference	—	105-3	*	106-0, 106-1

* Internal ECM damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

MAP Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: 30–48 kPa			
5-Volt Reference	0 volts	0 volts	4.9 volts
MAP Sensor Signal	0 volts	0 volts	4.9 volts
Low Reference	—	4.9 volts	*

* Internal ECM damage may occur if the circuit is shorted to B+.

Circuit/System Description

The manifold absolute pressure (MAP) sensor responds to pressure changes in the intake manifold. The pressure changes occur based on the engine load. The engine control module (ECM) supplies 5 volts to the MAP sensor on the 5-volt reference circuit. The ECM provides a ground on the low reference circuit. The MAP sensor provides a signal to the ECM on the MAP sensor signal circuit which is relative to the pressure changes in the manifold. The ECM detects a low signal voltage at a low MAP, such as during an idle or a deceleration. The ECM detects a high signal voltage at a high MAP, such as the ignition is ON, with the engine OFF, or at a wide open throttle (WOT). The MAP sensor is also used to determine the barometric pressure (BARO). This occurs when the ignition switch is turned ON, with the engine OFF. The BARO reading may also be updated whenever the throttle position (TP) sensor is greater than 28 percent.

Conditions for Running the SPN

106-0

- Before the ECM can report that SPN 106-0, or 106-1 failed, SPNs 100-3, 100-4, 65604, 65605, 65610, 65613, 65615, 65616, and 65618 must run and pass.
- SPN 105, 110, 630, 65580, 65621, or 65622 is not set.
- The engine speed is greater than 800 RPM.
- The ECM is not commanding reduced power, or fuel cut-off.
- The throttle angle is less than 30 percent.
- The SPN runs continuously once the above conditions are met.

106-1

- Before the ECM can report that SPN 106-0, or 106-1 failed, SPNs 100-3, 100-4, 65604, 65605, 65610, 65613, 65615, 65616, and 65618 must run and pass.
- SPN 105, 110, 630, 65580, 65621, or 65622 is not set.
- The engine speed is less than 150 RPM.
OR
- The throttle angle is greater than 75 percent.
- The ECM is not commanding reduced power, or fuel cut-off.
- The SPN runs continuously once the above conditions are met.

106-2

- Before the ECM can report that SPN 106-2 failed, SPNs 106-0, 106-1, 106-3, 106-4, and 3563 must run and pass,
- SPN 105, 110, 630, 65580, 65621, or 65622 is not set.
- The ignition is ON.
- The engine speed is 0 RPM.
- The ECM detects the BARO sensor, and SCIP sensor.
- The SPN runs at ignition ON once the above conditions are met.

106-3 and 106-4

- SPN 105, 110, 630, 65580, 65621, or 65622 is not set.
- The ignition is ON.
- The SPNs run continuously when the above conditions are met.

Conditions for Setting the SPN

106-0

The ECM detects that the MAP sensor signal is greater than 90 kPa for greater than 2 seconds.

106-1

The ECM detects that the MAP sensor signal is less than 20 kPa for greater than 2 seconds.

106-2

The ECM detects that the MAP sensor does not correlate with the BARO sensor and the SCIP sensor, at ignition ON for greater than 2 seconds.

106-3

The ECM detects that the MAP sensor voltage is greater than 4.8 V for greater than 4 seconds.

106-4

The ECM detects that the MAP sensor voltage is less than 0.25 V for greater than 4 seconds.

Action Taken When the SPN Sets

- SPN 106 is a Type B SPN.
- The ECM operates with a default MAP reading, which varies based on throttle angle.
- Super charger boost is disabled.
- Camshaft actuator not enabled.

Conditions for Clearing the SPN

SPN 106 is a Type B SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tool Required

J-23738-A Vacuum Pump

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65621 or 65622 is not set.
⇒ If SPN 65621 or 65622 is set, refer to *SPN 65620-65623 on page 9-149* for further diagnosis.
2. Turn all accessories OFF.
3. Engine operating, observe the scan tool MAP Sensor parameter. The reading should be between 31-68 kPa (9-20 in Hg).
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the vacuum hose at the MAP sensor, or remove the MAP sensor from the intake manifold. Connect the J-23738-A to the vacuum source.
2. Engine operating, verify that 31–68 kPa (9–20 in Hg) of vacuum is available to the MAP sensor.
 - ⇒ If not within the specified range, repair the restriction in the vacuum supply to the MAP sensor.
3. Ignition OFF, connect the vacuum hose to the MAP sensor, or install the MAP sensor to the intake manifold. Disconnect the harness connector at the MAP sensor.
4. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal 2 and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
5. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal 1 and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
6. Verify the scan tool MAP sensor pressure parameter is less than 0.25 V.
 - ⇒ If greater than the specified range, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the ECM.
7. Install a 3A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 1. Verify the scan tool MAP sensor parameter is greater than 4.8 V.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
8. If all circuits test normal, test or replace the MAP sensor.

Component Testing

The ignition ON, engine OFF MAP sensor scan tool value should decrease within +/- 4 kPa by the amount of vacuum applied with the J-23738-A. For example, at 92 kPa, the MAP sensor scan tool reading should be between 71–79 kPa with 5 in Hg (17 kPa) of vacuum applied to the sensor.

SPN 106 (2.4L, 6.0L, 6.2L)

Ignition ON, engine OFF, MAP Sensor parameter	MAP Sensor parameter with 5 inches of vacuum applied	MAP Sensor parameter with 10 inches of vacuum applied
100 kPa	79–87 kPa	62–70 kPa
95 kPa	74–82 kPa	57–65 kPa
90 kPa	69–77 kPa	52–60 kPa
80 kPa	59–67 kPa	42–50 kPa
70 kPa	49–57 kPa	32–40 kPa
60 kPa	39–47 kPa	22–30 kPa

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Manifold Absolute Pressure Sensor Replacement (without Supercharger)* on page 9-220
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 108

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 108 FMI 2: Barometric Pressure (BARO) Sensor Voltage Data Erratic, Intermittent or Incorrect

SPN 108 FMI 3: Barometric Pressure (BARO) Sensor Voltage Above Normal or Shorted High

SPN 108 FMI 4: Barometric Pressure (BARO) Sensor Voltage Below Normal or Shorted Low

SPN 108 FMI 10: Barometric Pressure (BARO) Sensor Abnormal Rate of Change

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5-Volt Reference	65620-4	108-4	108-4	108-3	108-10
BARO Sensor Signal	108-4	108-4	108-4	108-3	108-10
Low Reference	—	108-3	108-3	—	108-10

Circuit/System Description

The engine control module (ECM) supplies 5 volts to the BARO sensor on a 5-volt reference circuit, and provides a ground on a low reference circuit. The BARO sensor provides a voltage signal to the ECM on a signal circuit relative to the changes in atmospheric pressure.

- The ignition is ON, or the engine is operating.
- SPN 108-10 runs continuously when the above conditions are met.

Conditions for Running the SPN

108-2

- Before the ECM can report that SPN 108-2 failed, SPNs 106, 108-3, 108-4, 108-10, and 3563 must run and pass.
- SPN 630, 65580 65620, 65621, 65622, or 65623 is not set.
- The engine speed is less than 150 RPM.
- The ignition is ON.
- The MAP and SCIP sensor correlation is within 5 kPa.
- SPN 108-2 runs continuously when the conditions above exist.

108-3 and 108-4

- SPN 630, 65580 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- SPNs 108-3 and 108-4 run continuously when the above conditions are met.

108-10

- Before the ECM can report that SPN 108-10 failed, SPNs 108-3, and 108-4 must run and pass.
- SPN 630, 65580 65620, 65621, 65622, or 65623 is not set.

Conditions for Setting the SPN

108-2

The ECM detects a difference of greater than 15 kPa between the BARO signal and the MAP or SCIP signals.

108-3

The ECM detects the BARO sensor voltage is greater than 4.9 volts for greater than 5 seconds.

108-4

The ECM detects the BARO sensor voltage is less than 0.20 volt for greater than 5 seconds.

108-10

The ECM detects the BARO signal +/-10 kPa of the expected value for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 108 is Type B SPN.

Conditions for Clearing the MIL/SPN

SPN 108 is Type B SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54 for scan tool information

Special Tools

J-23738-A Mityvac

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPNs 65620, 65621, 65622, or 65623 is not set.
⇒ If an SPN is set, refer to *SPN 65620-65623 on page 9-149*.
2. Compare the scan tool BARO sensor pressure parameter, MAP sensor pressure parameter, and the SCIP sensor pressure parameter. All three parameter readings should be within 3 kPa.
3. Observe the BARO sensor parameter with a scan tool. The BARO parameter should be within the range specified in the Altitude vs. Barometric Pressure table. Refer to *Altitude Versus Barometric Pressure on page 9-3*.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the BARO sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal 2 and ground.
⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal 1 and ground.
⇒ If less than the specified range, test the 5-volt reference circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Observe the scan tool BARO Pressure parameter. Verify the parameter is at 0.1 kPa (0.0 inHg).
⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Ignition OFF, connect a 3 A fused jumper wire between the signal circuit terminal 3 and the 5-volt reference circuit terminal 1.

Note: The SPN should set when the circuits are connected together with a jumper wire.

6. Ignition ON, observe the scan tool BARO Pressure parameter. Verify the parameter is at 122.6 kPa (36.2 inHg).
⇒ If less than the specified range, test the sensor signal circuit for an open/high resistance or a short to ground.
7. If all circuits test normal, test or replace the BARO sensor.

Component Testing

The ignition ON, engine OFF BARO sensor scan tool value should decrease within +/- 4 kPa by the amount of vacuum applied with the J-23738-A. For example, at 92 kPa, the BARO sensor scan tool reading should be between 71–79 kPa with 5 in Hg (17 kPa) of vacuum applied to the sensor.

SPN 108

Ignition ON, Engine OFF, BARO Sensor Parameter	BARO Sensor Parameter With 5 Inches of Vacuum Applied	BARO Sensor Parameter With 10 Inches of Vacuum Applied
100	79–87	62–70
90	69–77	52–60
80	59–67	42–50
70	49–57	32–40
60	39–47	22–30

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Barometric Pressure Sensor Replacement on page 9-221*
- *Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming*

SPN 110

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 110 FMI 3: Engine Coolant Temperature (ECT) Sensor Circuit Voltage Above Normal or Shorted High

SPN 110 FMI 4: Engine Coolant Temperature (ECT) Sensor Circuit Voltage Below Normal or Shorted Low

SPN 110 FMI 15: Engine Coolant Temperature (ECT) Sensor Circuit Voltage Data Valid But Above Normal Range-Least Severe Level

SPN 110 FMI 16: Engine Coolant Temperature (ECT) Sensor Circuit Voltage Data Valid But Above Normal Range-Moderate Severe Level

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
ECT Sensor Signal	110-4	110-3	110-3*	110-15
Low Reference	—	110-3	*	—

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

ECT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: Varies with ambient temperature			
ECT Sensor Signal	151°C (304°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	—	-40°C (-40°F)	-40°C (-40°F)*

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit/System 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 supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

ECT	ECT Resistance	ECT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the SPNs

110-3 and 110-4

- SPN 630, 65580 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- SPN 110-3 and 110-4 run continuously when the above conditions are met.

110-15 and 110-16

- Before the ECM can report that 110-15 or 110-16 failed, SPNs 110-3 and 110-4 must run and pass.
- SPN 630, 65580 65620, 65621, 65622, or 65623 is not set.
- The engine is operating for greater than 10 seconds.
- SPN 110-15 runs continuously when the above conditions are met.

Conditions for Setting the SPNs

110-3

The ECM detects that the ECT is warmer than 302°F (150°C) for greater than 1 second.

110-4

The ECM detects that the ECT is colder than -23°F (-31°C) for greater than 1 second.

110-15

The ECM detects the ECT is warmer than 220°F (104°C) for greater than 1 second.

110-16

The ECM detects the ECT is warmer than 239°F (115°C) for greater than 1 second.

Action Taken When the SPN Sets

- SPN 11-3 and 110-4 are Type B SPNs.
- Cam phaser not enabled.
- Boost not enabled.
- The engine operates based on a default (filtered) coolant temp.
- SPN 110-15 is a type C SPN

Conditions for Clearing the MIL/SPN

- SPN 11-3 and 110-4 are Type B SPNs.
- SPN 110-15 is a type C SPN

Diagnostic Aids

- After starting the engine, the ECT sensor temperature should rise steadily, then stabilize after the thermostat opens.
- Test the ECT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a driveability condition.
- If the vehicle has set overnight, the ECT sensor and the MAT/IAT sensor values should display within 3°C (5°F).

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. SPNs 110-3, 110-4 should not set.
2. Engine operating, observe the scan tool SPN information. Verify that SPN 110-15 or 110-16 is not set.
 - ⇒ If SPN 110-15 or 110-16 is set, inspect for an engine overheating condition. If a condition is found, repair the cooling system as necessary.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.
2. Test for less than 5 Ω between the low reference circuit terminal A and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, verify the scan tool ECT sensor parameter is at -40°C (-40°F).
 - ⇒ If warmer than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.

Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the ECT sensor parameter is warmer than 150°C (303°F).
 - ⇒ If less than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the ECT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the ECT sensor.

Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the ECT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the *Temperature Versus Resistance* on page 9-3 table and verify that the resistance is within 5 percent of the specification.
 - ⇒ If not within the specified range, replace the ECT sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Engine Coolant Temperature Sensor Replacement* on page 9-218
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 174

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 174 FMI 0: Fuel Temperature (FT) Sensor Data Valid but Above Normal

SPN 174 FMI 1: Fuel Temperature (FT) Sensor Data Valid but Below Normal

SPN 174 FMI 3: Fuel Temperature (FT) Sensor Circuit Voltage Above Normal or Shorted High

SPN 174 FMI 4: Fuel Temperature (FT) Sensor Circuit Voltage Below Normal or Shorted Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
FT Sensor Signal	174-4	174-3	174-3*	174-1
Low Reference	—	174-3	*	174-0

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit/System Description

The fuel temperature (FT) sensor is a variable resistor that measures the temperature of the fuel. The engine control module (ECM) supplies 5 volts to the FT signal circuit and supplies a ground to the low reference circuit.

The following table illustrates the difference between temperature, resistance, and voltage:

FT	FT Resistance	FT Signal Voltage
Cold	High	High
Warm	Low	Low

Conditions for Running the SPN

174 FMI 0 or 1

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- Before the ECM can report that SPN 174-0 or 174-1 failed, SPN 110, 174-3, and 174-4 must run and pass.
- The engine is operating for greater than 10 seconds.
- The SPNs run continuously when the above condition is met.

174 FMI 3 or 4

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating for greater than 10 seconds.
- The SPNs run continuously when the above condition is met.

Conditions for Setting the SPN

174-0 or 174-1

The ECM detects that the FT is greater or less than a calibrated value of the expected value determined by the control module.

174-3

The ECM detects that the FT sensor voltage is greater than a calibrated value.

174-4

The ECM detects that the FT sensor voltage is less than a calibrated value.

Action Taken When the SPN Sets

SPN 174 is a Type B SPN.

Conditions for Clearing the SPN

SPN 174 is a Type B SPN.

Diagnostic Aids

- Test the FT sensor at various temperature levels in order to evaluate the possibility of a skewed sensor. A skewed sensor can result in a driveability condition.
- If the vehicle has set overnight, the FT sensor, ECT sensor, and the MAT sensor values should display within 3°C (5°F).

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine running, observe the SPN information with a scan tool. SPN 174–3 or 174–4 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the FT sensor.
2. Test for less than 5 Ω between the low reference circuit terminal A and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

3. Ignition ON, verify the scan tool FT sensor voltage parameter is greater than 4.5 V.

⇒ If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.

Note: If the fuse in the jumper wire opens, the signal circuit is shorted to a voltage and the sensor may be damaged.

4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Verify the FT sensor voltage parameter is less than 0.5 V.

⇒ If greater than the specified range, test the signal circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

5. If all circuits test normal, test or replace the FT sensor.

Component Testing

1. Ignition OFF, disconnect the harness connector at the FT sensor.

Note: A thermometer can be used to test the sensor off the vehicle.

2. Test the FT sensor by varying the sensor temperature while monitoring the sensor resistance. Compare the readings with the *Temperature Versus Resistance on page 9-3* table and verify that the resistance is within 5 percent of the specification.

⇒ If not within the specified range, replace the FT sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 175

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 175 FMI 3: Engine Oil Temperature (EOT) Sensor Circuit Voltage Above Normal or Shorted High

SPN 175 FMI 4: Engine Oil Temperature (EOT) Sensor Circuit Voltage Below Normal or Shorted Low

SPN 175 FMI 15: Engine Oil Temperature (EOT) Sensor Circuit Voltage Data Valid But Above Normal Range-Least Severe Level

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
EOT Sensor Signal	175-4	175-3	175-3	175-15
EOT Low Reference	—	175-3	*	—

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Typical Scan Tool Data

EOT Sensor

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: Varies with ambient temperature			
EOT Sensor Signal	152°C (305°F)	-40°C (-40°F)	-40°C (-40°F)*
Low Reference	—	-40°C (-40°F)	-40°C (-40°F)*

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit/System Description

The engine oil temperature (EOT) sensor is a variable resistor that measures the temperature of the engine oil. The engine control module (ECM) supplies 5 V on the EOT signal circuit, and a ground to the low reference circuit.

Monitoring the engine oil temperature is necessary for optimal control of the cam actuators. The oil temperature is monitored from the dual function oil level switch and temperature sensor located in the oil pan.

Conditions for Running the SPNs

175-3 and 175-4

- The ignition is ON, or the engine is operating.
- The SPNs run continuously when the above enable condition is met for greater than 2 s.

175-15

- Before the ECM can report that 175-15 failed, SPNs 175-3 and 175-4 must run and pass.
- SPN 630, 65580, 65620, or 65621 is not set.
- The engine run time is greater than a calibrated value.
- SPN 175-15 runs continuously when the above conditions are met.

Conditions for Setting the SPNs

175-3

The ECM detects the EOT is colder than -35°C (-31°F).

175-4

The ECM detects the EOT is warmer than 170°C (331°F).

175-15

The ECM detects the EOT is warmer than a calibrated temperature for greater than 3 seconds.

Action Taken When the SPN Sets

- SPN 175–3 and 175–4 are Type B SPNs.
- SPN 175–15 is a type C SPN

Conditions for Clearing the MIL/SPN

- SPN 175–3 and 175–4 are Type B SPNs.
- SPN 175–15 is a type C SPN

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine operating, observe the SPN information with a scan tool. SPN 175–3, 175–4, or 175–15 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the EOT sensor.
2. Test for less than 5 Ω between the low reference circuit terminal and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5 V reference circuit terminal and ground.
 - ⇒ If less than the specified range, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, replace the engine oil level and temperature sensor.

Component Testing

1. Connect a DMM between the signal and low reference circuit terminals.
2. Verify the engine oil level and temperature sensor resistance is between 400–500 Ω at 21°C (70° F).
 - ⇒ If the resistance is outside the specified range, replace the engine oil level and temperature sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming.

SPN 627

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 627 FMI 15: System Voltage Data Valid But Above Normal Range-Least Severe Level

SPN 627 FMI 17: System Voltage Data Valid But Below Normal Range-Least Severe Level

Circuit/System Description

The engine control module (ECM) monitors the ignition voltage to ensure that the voltage stays within the proper range. Damage to components, and incorrect data may occur when the voltage is out of range.

Conditions for Running the SPN

- SPNs 630 or 65580 are not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.

Conditions for Setting the SPN

627–15

The ECM detects the ignition voltage is greater than 16 volts.

627–17

The ECM detects the ignition voltage is less than 10 volts.

Action Taken When the SPN Sets

SPN 627 is a Type C SPN.

Conditions for Clearing the SPN

SPN 627 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, test for 11–15 V between the terminals of each battery.
⇒ If not within the specified range, charge and test the battery, replace if necessary.
2. Engine idling, the battery voltage tested in step 1 should increase.
⇒ If the battery voltage does not increase, repair the charging system condition.
3. Observe the scan tool Battery Voltage parameter. Compare the scan tool voltage parameter to the battery voltage displayed on the DMM. The scan tool parameter and the DMM should display within 1 volt of each other.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF. Disconnect the ECM harness connectors X1 and X2. Test for less than 1 Ω between the ground circuit terminal X2–73 and ground.
⇒ If greater than the specified range, test the ground circuit for an open/high resistance.
2. Load test for battery voltage between the battery positive voltage circuit terminal X1–20 and ground.
⇒ If not within the specified range, test the battery positive voltage circuit for a short to ground or an open/high resistance.
3. If all circuits test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure. *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming.

SPN 630, 65580, 65581, or 65582

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 630 FMI 13: Cal Memory Out of Calibration

SPN 65580 FMI 12: CPU Bad Intelligent Device or Component

SPN 65581 FMI 12: MHC Failure Bad Intelligent Device or Component

SPN 65582 FMI 2: NV RAM Failure Data Erratic, Intermittent or Incorrect

Circuit/System Description

This diagnostic applies to the integrity of the engine control module's (ECM) internal microprocessor and the throttle actuator control (TAC) system. This diagnostic also addresses "ECM is Not Programmed" conditions.

Conditions for Running the SPNs

- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 10 volts.
- SPNs 630, 65580–65582 run continuously once the above conditions are met.

Conditions for Setting the SPNs

The ECM detects an internal failure, or incomplete programming for greater than 14 seconds.

Action Taken When the SPN Sets

- SPN 630, 65580, and 65581 are type A SPNs.
- SPN 65582 is a type B SPN
- The ECM will disable engine operation or command the TAC system to operate in a Reduced Engine Power mode.

Conditions for Clearing the SPNs

- SPN 630, 65580, and 65581 are type A SPNs.
- SPN 65582 is a type B SPN

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Description and Operation

Engine Control Module Description on page 9-279

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Testing

1. Ignition ON, clear the SPN information with a scan tool. Observe the scan tool SPN information. Verify that SPN 630–13 does not fail this ignition cycle.
 - ⇒ If the SPN fails this ignition cycle, reprogram the ECM. Refer to *Engine Control Module Programming and Setup* on page 6-3. If SPN 630–13 resets, replace the ECM.
2. Observe the SPN information with a scan tool. Verify that SPNs 65580–12, 65581–12, or 65582–2 do not fail this ignition cycle.
 - ⇒ If any of the SPNs set this ignition cycle, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure. *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 636 (3.0L, 4.3L, 5.0L, 5.7L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 636 FMI 2: Crankshaft Position (CKP) Sensor Circuit Data Erratic, Intermittent or Incorrect

SPN 636 FMI 8: Crankshaft Position (CKP) Sensor Signal Abnormal Frequency or Pulse Width

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	65621-4	636-8	636-8,	—
CKP Sensor Signal	636-8	636-8	636-8,	636-2
Low Reference	—	636-8	—	—

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses crankshaft position sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the camshaft position actuator, if equipped.

Conditions for Running the SPNs

- SPNs 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is cranking or operating.
- The SPN 636 runs continuously once the above conditions are met.

Conditions for Setting the SPN

636-2

The ECM detects an incorrect number of CKP reference pulses for greater than 125 mS.

636-8

The ECM does not detect a signal from the CKP sensor for greater than 125 mS.

Action Taken When the SPN Sets

- SPN 636 is a Type A SPN.
- The engine will crank but not start.

Conditions for Clearing the SPN

SPN 636 is a Type A SPN.

Diagnostic Aids

The following conditions may also set SPN 636:

- Physical damage to the CKP sensor or the reluctor wheel
- Excessive play or looseness of the CKP sensor or the reluctor wheel
- Improper installation of the CKP sensor or the reluctor wheel
- Foreign material passing between the CKP sensor and the reluctor wheel
- Excessive air gap between the CKP sensor and the reluctor wheel
- An intermittent condition with the CMP sensor or circuits

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: If you were sent here from Engine Cranks but Does Not Run, proceed to Circuit/System Testing.

1. Attempt to start the engine, observe the SPN information with a scan tool. SPN 636–2 or 636–8 should not set.
2. Engine cranking, observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.
3. Move related harnesses/connectors of the CKP sensor and verify the engine does not stumble, stall, or change engine speed.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the CKP sensor.
2. Test for less than 5 Ω between the low reference circuit terminal B/2 and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal A/1 and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Test for 4.8–5.2 V between the signal circuit terminal C/3 and ground.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the CKP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Crankshaft Position Sensor Replacement (3.0L) on page 9-256 or Crankshaft Position Sensor Replacement (4.3/5.0/5.7L) on page 9-257 or Crankshaft Position Sensor Replacement (6.0/6.2L) on page 9-258 or Crankshaft Position Sensor Replacement (2.4L) on page 9-261*
- *Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming*

SPN 636 (6.0L, 6.2L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 636 FMI 2: Crankshaft Position (CKP) Sensor Circuit Data Erratic, Intermittent or Incorrect

SPN 636 FMI 8: Crankshaft Position (CKP) Sensor Signal Abnormal Frequency or Pulse Width

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	65621-4	636-8	636-8, 3563-2, 3563-4	—
CKP Sensor Signal	636-8	636-8	636-8	636-2
Low Reference	—	636-8	—	—

Circuit/System Description

The crankshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V circuit, low reference circuit and an output signal circuit. The crankshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 58-tooth reluctor wheel on the crankshaft. Each tooth on the reluctor wheel is spaced at 60-tooth spacing, with 2 missing teeth for the reference gap. The crankshaft position sensor produces an ON/OFF DC voltage of varying frequency, with 58 output pulses per crankshaft revolution. The frequency of the crankshaft position sensor output depends on the velocity of the crankshaft. The crankshaft position sensor sends a digital signal, which represents an image of the crankshaft reluctor wheel, to the ECM as each tooth on the wheel rotates past the crankshaft position sensor. The ECM uses each crankshaft position signal pulse to determine crankshaft speed and decodes the crankshaft reluctor wheel reference gap to identify crankshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses crankshaft position sensor output information to determine the crankshaft relative position to the camshaft, to detect cylinder misfire, and to control the camshaft position actuator, if equipped.

Conditions for Running the SPNs

- SPNs 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The engine is cranking or operating.
- SPN 636 runs continuously once the above conditions are met.

Conditions for Setting the SPN

636 2

The ECM detects an incorrect number of CKP reference pulses for greater than 125 mS.

636 8

The ECM does not detect a signal from the CKP sensor for greater than 125 mS.

Action Taken When the SPN Sets

- SPN 636 is a Type A SPN.
- The engine will crank but not start.

Conditions for Clearing the SPN

SPN 636 is a Type A SPN.

Diagnostic Aids

The following conditions could also set the SPNs:

- Physical damage to the CKP sensor or the reluctor wheel
- Excessive play or looseness of the CKP sensor or the reluctor wheel
- Improper installation of the CKP sensor or the reluctor wheel
- Foreign material passing between the CKP sensor and the reluctor wheel
- Excessive air gap between the CKP sensor and the reluctor wheel
- An intermittent condition with the CMP sensor or circuits

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: If you were sent here from Engine Cranks but Does Not Run, proceed to Circuit/System Testing.

1. Attempt to start the engine, observe the SPN information with a scan tool. SPNs 636–2 or 636–8 should not set.
2. Engine cranking, observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.
3. Move related harnesses/connectors of the CKP sensor and verify the engine does not stumble, stall, or change engine speed.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the CKP sensor.
2. Test for less than 5 Ω between the low reference circuit terminal B and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal C and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Test for 4.8–5.2 V between the signal circuit terminal A and ground.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the CKP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Crankshaft Position Sensor Replacement (3.0L) on page 9-256 or Crankshaft Position Sensor Replacement (4.3/5.0/5.7L) on page 9-257 or Crankshaft Position Sensor Replacement (6.0/6.2L) on page 9-258 or Crankshaft Position Sensor Replacement (2.4L) on page 9-261*
- *Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming*

SPN 651, 652, 653, 654, 655, 656, 657, or 658

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 651 FMI 3: Fuel Injector 1 Voltage Above Normal or Shorted High
SPN 651 FMI 5: Fuel Injector 1 Current Below Normal or Open Circuit
SPN 652 FMI 3: Fuel Injector 2 Voltage Above Normal or Shorted High
SPN 652 FMI 5: Fuel Injector 2 Current Below Normal or Open Circuit
SPN 653 FMI 3: Fuel Injector 3 Voltage Above Normal or Shorted High
SPN 653 FMI 5: Fuel Injector 3 Current Below Normal or Open Circuit
SPN 654 FMI 3: Fuel Injector 4 Voltage Above Normal or Shorted High
SPN 654 FMI 5: Fuel Injector 4 Current Below Normal or Open Circuit
SPN 655 FMI 3: Fuel Injector 5 Voltage Above Normal or Shorted High
SPN 655 FMI 5: Fuel Injector 5 Current Below Normal or Open Circuit
SPN 656 FMI 3: Fuel Injector 6 Voltage Above Normal or Shorted High
SPN 656 FMI 5: Fuel Injector 6 Current Below Normal or Open Circuit
SPN 657 FMI 3: Fuel Injector 7 Voltage Above Normal or Shorted High
SPN 657 FMI 5: Fuel Injector 7 Current Below Normal or Open Circuit
SPN 658 FMI 3: Fuel Injector 8 Voltage Above Normal or Shorted High
SPN 658 FMI 5: Fuel Injector 8 Current Below Normal or Open Circuit

Circuit/System Description

The engine control module (ECM) enables the appropriate fuel injector pulse for each cylinder. Ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition voltage is equal to or greater than 9 volts.
- The SPNs 651–658 runs continuously once the above conditions are met for greater than 6 seconds.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

- SPN 651, 652, 653, 654, 655, 656, 657, and 658 are Type B SPNs.
- Closed loop not enabled.

SPN 651, 652, 653, 654, 655, 656, 657, and 658 are Type B SPNs.

Conditions for Clearing the SPN

SPN 651, 652, 653, 654, 655, 656, 657, and 658 are Type B SPNs.

Diagnostic Aids

If the ECM detects a short to ground the ECM enters hydro-lock protection mode. The engine will stop, and engine cranking will be disabled if the vessel is equipped with smart start.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*
- *Diagnostic Starting Point - Engine Controls on page 9-54*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools Required

J 34730-405 Injector Test Lamp

Circuit/System Verification

1. Engine operating, observe the SPN information with a scan tool. SPNs 651, 652, 653, 654, 655, 656, 657, or 658 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate fuel injector.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal A/1 and ground.
 - ⇒ If the test lamp does not illuminate, repair the ignition voltage circuit for a short to ground or an open/high resistance. Replace the fuse if necessary.
3. Ignition OFF, connect the J 34730-405 between the control circuit terminal B/2 and the ignition voltage circuit terminal A/1 of the appropriate fuel injector.
4. Engine idling, the test lamp should flash.
 - ⇒ If the test lamp is always ON, test the control circuit for a short to ground. If the circuit tests normal, replace the engine control module (ECM).
 - ⇒ If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the fuel injector.

Component Testing

Refer to *Fuel Injector Diagnosis on page 9-211* for component testing.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

- *Fuel Injector Replacement (Except 2.4L) on page 9-238 or Fuel Injector Replacement (2.4L) on page 9-240*
- *Engine Control Module Replacement on page 9-217* for engine control module replacement, setup, and programming

SPN 1765 (High-Side Driver)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 1765 FMI 4: Fuel Valve High Side Driver Voltage below normal or shorted low

SPN 1765 FMI 5: Fuel Valve High Side Driver Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Solenoid Valve Control	1765-4	1765-5	1765-5	—
Fuel Solenoid Valve Low Reference	—	1765-5	*	—

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit/System Description

The fuel solenoid valve allows the engine control module (ECM) to control the amount of gaseous fuel entering the throttle body while the engine is cranking or operating. The fuel solenoid valve signal from the ECM is pulse width modulated (PWM). The ECM controls the fuel solenoid valve duty cycle by controlling the amount of solenoid valve ON time. The fuel solenoid valve increases or decreases the amount of gaseous fuel entering the engine based on inputs to the ECM from the HO2S, TPS, and MAP sensors. The ECM controls the fuel solenoid valve by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the SPN

1765-4

- SPN 630 65580, 65620, 65621, 65622 or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The fuel valve is commanded ON.
- SPN 1765 runs continuously once the above conditions are met.

1765-5

- SPN 630 65580, 65620, 65621, 65622 or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The fuel valve is commanded OFF.
- SPN 1765 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 1765 is a Type B SPN.

Conditions for Clearing the SPN

SPN 1765 is a Type B SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the fuel solenoid valve ON and OFF with a scan tool. An audible click should be heard when changing between the commanded states.
2. Observe the SPN information with a scan tool. SPN 1765-4 or 1765-5 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the fuel solenoid valve.
2. Test for less than 5 Ω between the low reference circuit terminal and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.

3. Ignition ON, connect a test lamp between the control circuit terminal and ground. The test lamp should not illuminate.
 - ⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
4. Command the fuel solenoid valve ON and OFF with a scan tool. The test lamp should illuminate and turn OFF as commanded.
 - ⇒ If the test lamp is always OFF, test the control circuit for an open/high resistance or a short to ground. If the circuit/connections test normal, replace the ECM.
5. If all the circuit/connections test normal, test or replace the fuel solenoid valve.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure. *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 1765 (Low-Side Driver)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 1765 FMI 3: Fuel Valve Low Side Driver Voltage Above Normal or Shorted High

SPN 1765 FMI 5: Fuel Valve Low Side Driver Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Solenoid Valve Voltage Supply	*	1765-5	—	—
Fuel Solenoid Valve Voltage Control	1765-5	1765-5	1765-3	—

* The fuse that supplies voltage to the device opens.

Circuit/System Description

The fuel solenoid valve allows the engine control module (ECM) to control the amount of gaseous fuel entering the throttle body while the engine is cranking or operating. The fuel solenoid valve is pulse width modulated (PWM). The ECM controls the fuel solenoid valve duty cycle by controlling the amount of solenoid valve ON time. The fuel solenoid valve increases or decreases the amount of gaseous fuel entering the engine based on inputs to the ECM from the HO2S, TPS, and MAP sensors. Ignition voltage is supplied directly to the fuel solenoid valve through a fuse. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

1765-3

- SPN 630 65580, 65620, 65621, 65622 or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The fuel valve is commanded ON.
- SPN 1765 runs continuously once the above conditions are met.

1765-5

- SPN 630 65580, 65620, 65621, 65622 or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The fuel valve is commanded OFF.
- SPN 1765 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 1765 is a Type B SPN.

Conditions for Clearing the SPN

SPN 1765 is a Type B SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the fuel solenoid valve ON and OFF with a scan tool. An audible click should be heard when changing between the commanded states.
2. Observe the SPN information with a scan tool. SPN 1765-3 or 1765-5 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the fuel solenoid valve.
2. Ignition ON, verify a test lamp illuminates between the ignition voltage supply circuit terminal and ground.
 - ⇒ If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Connect a test lamp between the control circuit terminal and B+. The test lamp should not illuminate.
 - ⇒ If the test lamp is always ON, test the control circuit for a short to ground. If the circuit/connections test normal, replace the ECM.
4. Command the fuel solenoid valve ON and OFF with a scan tool. The test lamp should illuminate and turn OFF as commanded.
 - ⇒ If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Test for 3.0-4.0 V between the control circuit terminal and ground.
 - ⇒ If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. If all the circuit/connections test normal, test or replace the fuel solenoid valve.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure. *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 3563

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 3563 FMI 0: Supercharger Inlet Pressure (SCIP) Sensor Circuit Data Valid but Above Normal

SPN 3563 FMI 1: Supercharger Inlet Pressure (SCIP) Sensor Circuit Data Valid but Below Normal

SPN 3563 FMI 2: Supercharger Inlet Pressure (SCIP) Sensor Circuit Data Erratic, Intermittent, or Incorrect

SPN 3563 FMI 3: Supercharger Inlet Pressure (SCIP) Sensor Circuit Voltage Above Normal or Shorted High

SPN 3563 FMI 4: Supercharger Inlet Pressure (SCIP) Sensor Circuit Voltage Below Normal or Shorted Low

Diagnostic Fault Information

SC Inlet Pressure Sensor

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5-Volt Reference	65621-4*	3563-4	3563-4	636-8, 3563-2, 3563-3*	—
SC Inlet Pressure Sensor Signal	3563-4	3563-4	3563-4	3563-3	3563-0, 3563-2
Low Reference	—	3563-3	3563-3	3563-3	3563-2

* Engine cranks but does not run.

Circuit Description

The supercharger inlet pressure (SCIP) sensor measures the pressure after the throttle body, but before the supercharger. Pressure in this area is affected by engine speed, throttle opening, air temperature, and barometric pressure (BARO). A diaphragm within the SCIP sensor is displaced by the pressure changes that occur from the varying load and operating conditions of the engine. The engine control module (ECM) supplies a regulated 5 volts to the sensor on a 5-volt reference circuit, and a ground on a low reference circuit. The SCIP sensor provides a signal to the ECM on the SCIP sensor signal circuit, relative to pressure changes. The ECM converts the signal voltage input to a pressure value.

Under normal operation the highest pressure that can exist in the supercharge intake manifold is equal to BARO. This occurs when the vehicle is operated at wide-open throttle (WOT) or when the ignition is ON while the engine is OFF. The lowest manifold pressures occur when the vehicle is idling or decelerating. The SCIP can range from 20–30 kPa, when pressures are low, to as much as BARO when pressures are high. The ECM monitors the SCIP sensor signal for pressure outside of the normal range.

Conditions for Running the SPN

3563-0

- Before the ECM can report that SPN 3563-0 failed, SPNs 3563-3, 3563-4, 65601, 65602, and 65610 must run and pass.
- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The throttle angle is less than 25 percent.
- The engine speed is greater than 800 RPM.
- The engine is not operating in reduced power mode or fuel cut-off mode.
- SPN 3563-0 runs continuously when the above conditions are met.

3563-1

- Before the ECM can report that SPN 3563-1 failed, SPNs 3563-3, 3563-4, 65601, 65602, and 65610 must run and pass.
- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The throttle angle is greater than 75 percent.
OR
- The engine speed less than 150 RPM.
- SPN 3563-1 runs continuously when the above conditions are met.

3563-2

- Before the ECM can report that SPN 3563-2 failed, SPNs 106, 108, 3563-0, 3563-1, 3563-3, and 3563-4 must run and pass.
- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON.
- The engine speed is less than 150 RPM.
- The MAP and BARO sensor correlation is within 5 kPa.
- SPN 3563-2 runs continuously when the above conditions are met.

3563-3 and 3563-4

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON.
- This SPNs 3563-3 and 3563-4 run continuously when the above conditions are met.

Conditions for Setting the SPN**3563-0**

The ECM detects that the SCIP sensor signal is greater than 95 kPa for greater than 2 seconds.

3563-1

The ECM detects that the SCIP sensor signal is less than 30 kPa for greater than 250 mS.

3563-2

The ECM detects the SCIP sensor signal is not within 15 kPa of the MAP and BARO sensors for greater than 156 mS.

3563-3

The ECM detects that the SCIP sensor voltage is greater than 4.8 volts for greater than 625 mS.

3563-4

The ECM detects that the SCIP sensor voltage is less than 0.2 volt for greater than 625 mS.

Action Taken When the SPN Sets

SPN 3563 is Type B SPN.

Conditions for Clearing the MIL/SPN

SPN 3563 is Type B SPN.

Reference Information**Schematic Reference**

Engine Controls Schematics on page 9-6

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54 for scan tool information

Special Tools

J-23738-A Mityvac

Circuit/System Verification

1. Ignition ON, observe SPN information with a scan tool. Verify that SPN 65620, 65621 or 65622 is not set.
⇒ If any SPN is set, refer to *SPN 65620-65623 on page 9-149*.
2. Observe the scan tool SCIP Sensor parameter. The reading should be within 5 kPa of the BARO parameter. Refer to *Altitude Versus Barometric Pressure on page 9-3*.
3. Engine idling, observe the scan tool SCIP sensor parameter. The reading should closely match the MAP sensor parameter value.
4. Observe the scan tool SPN information. SPN 3563 should not be set.
5. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Inspect the SCIP sensor system for the following conditions:
 - Any damage to the SCIP sensor housing.
 - A loose or improperly installed SCIP sensor.
 ⇒ If a condition is found, repair as necessary.
2. Ignition OFF, disconnect the harness connector at the SCIP sensor.
3. Test for less than 5 Ω between the low reference circuit terminal 2 and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal 1 and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.

5. Verify the scan tool SC Inlet Pressure Sensor parameter is less than 20 kPa.
 - ⇒ If the greater than the specified parameter, test the signal circuit terminal 3 for a short to voltage. If the circuit tests normal, replace the ECM.
6. Install a 3 A fused jumper wire between the 5-volt reference circuit terminal 1 and the signal circuit terminal 3. Verify the scan tool SC Inlet Pressure Sensor parameter is greater than 100 kPa.
 - ⇒ If less than the specified parameter, test the signal circuit for a short to ground, open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the SCIP sensor.

Component Testing

The ignition ON, engine OFF SCIP sensor scan tool value should decrease within +/- 4 kPa by the amount of vacuum applied with the J-23738-A. For example, at 92 kPa, the SCIP sensor scan tool reading should be between 71–79 kPa with 5 in Hg (17 kPa) of vacuum applied to the sensor.

SPN 3563

Ignition ON, Engine OFF, SCIP Sensor Parameter	SCIP Sensor Parameter With 5 Inches of Vacuum Applied	SCIP Sensor Parameter With 10 Inches of Vacuum Applied
100	79–87	62–70
90	69–77	52–60
80	59–67	42–50
70	49–57	32–40
60	39–47	22–30

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Supercharger Air Inlet Pressure Sensor Replacement* on page 9-222
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65541 FMI 4:	Ignition Coil 1 Voltage Below Normal or Shorted Low
SPN 65541 FMI 5:	Ignition Coil 1 Current Below Normal or Open Circuit
SPN 65542 FMI 4:	Ignition Coil 2 Voltage Below Normal or Shorted Low
SPN 65542 FMI 5:	Ignition Coil 2 Current Below Normal or Open Circuit
SPN 65543 FMI 4:	Ignition Coil 3 Voltage Below Normal or Shorted Low
SPN 65543 FMI 5:	Ignition Coil 3 Current Below Normal or Open Circuit
SPN 65544 FMI 4:	Ignition Coil 4 Voltage Below Normal or Shorted Low
SPN 65544 FMI 5:	Ignition Coil 4 Current Below Normal or Open Circuit
SPN 65545 FMI 4:	Ignition Coil 5 Voltage Below Normal or Shorted Low
SPN 65545 FMI 5:	Ignition Coil 5 Current Below Normal or Open Circuit
SPN 65546 FMI 4:	Ignition Coil 6 Voltage Below Normal or Shorted Low
SPN 65546 FMI 5:	Ignition Coil 6 Current Below Normal or Open Circuit
SPN 65547 FMI 4:	Ignition Coil 7 Voltage Below Normal or Shorted Low
SPN 65547 FMI 5:	Ignition Coil 7 Current Below Normal or Open Circuit
SPN 65548 FMI 4:	Ignition Coil 8 Voltage Below Normal or Shorted Low
SPN 65548 FMI 5:	Ignition Coil 8 Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition Voltage	1	2	—	—
Ignition Coil 1 Control Circuit	65541-4	65541-5	65541-5	—
Ignition Coil 2 Control Circuit	65542-4	65542-5	65542-5	—
Ignition Coil 3 Control Circuit	65543-4	65543-5	65543-5	—
Ignition Coil 4 Control Circuit	65544-4	65544-5	65544-5	—
Ignition Coil 5 Control Circuit	65545-4	65545-5	65545-5	—
Ignition Coil 6 Control Circuit	65546-4	65546-5	65546-5	—
Ignition Coil 7 Control Circuit	65547-4	65547-5	65547-5	—
Ignition Coil 8 Control Circuit	65548-4	65548-5	65548-5	—
1. The Engine Cranks but Does Not Run and/or the fuse opens that supplies voltage to the bank specific ignition coils. 2. The Engine Cranks but Does Not Run.				

Circuit/System Description

Ignition voltage is supplied to the ignition coil (module). The engine control module (ECM) provides a ground for the ignition coil (IC) control circuits. When the ECM removes the ground path of the ignition primary coil, the magnetic field produced by the coil collapses. The collapsing magnetic field produces a voltage in the secondary coil which ignites the spark plugs. The sequencing and timing are controlled by the ECM.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition voltage is equal to or greater than 9 volts.
- The engine is cranking, or operating.
- The SPNs 65541–65548 run continuously once the above condition is met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 500 mS.

Action Taken When the SPN Sets

- SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, and 65548 are Type B SPNs.
- Closed loop not enabled.
- The injector to the corresponding EST fault is disabled.

Conditions for Clearing the SPN

SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, and 65548 are Type B SPNs.

Diagnostic Aids

The SPN must be cleared after the condition is repaired to enable the injector(s).

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

Description and Operation

- *Electronic Ignition System Description on page 9-286*
- *Distributor Ignition (DI) System Description on page 9-287*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine running or cranking, observe the scan tool SPN information. SPN 65541, 65542, 65543, 65544, 65545, 65546, 65547, or 65548 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the ignition control module (ICM), or the appropriate ignition coil.
 - ICM Terminal C (3.0/4.3/5.0/5.7L)
 - Coil Terminals A/1 and B/2 (2.4/6.0/6.2L)⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
- ⇒ (2.4/6.0/6.2L), If the EST return circuit terminal B/2 is greater than the specified range, test for an open/high resistance, if the circuit tests normal, replace the ECM.
3. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal listed below and ground.
 - ICM Terminal A (3.0/4.3/5.0/5.7L)
 - Coil Terminal D/4 (2.4/6.0/6.2L)⇒ If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.

Note: Set the DMM to the DC 4 volt scale for this test.

4. Connect a DMM between the appropriate ignition control circuit terminal listed below and ground.
 - ICM Terminal B (3.0/4.3/5.0/5.7L)
 - Coil Terminal C/3 (2.4/6.0/6.2L)
5. Ignition ON, verify the voltage is less than 0.050 V.
 - ⇒ If greater than the specified range, test the circuit for a short to voltage.
6. Engine cranking or operating, verify the voltage is greater than 100 mV.
 - ⇒ If less than the specified range, test the ignition control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, replace the ignition coil or IC module.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Ignition Coil Replacement (3.0L) on page 9-241 or Ignition Coil Replacement (6.0L and 6.2L) on page 9-242 or Ignition Coil Replacement (4.3L, 5.0L, and 5.7L) on page 9-243 or Ignition Coil Replacement (2.4L) on page 9-244*
- *Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming*

SPN 65550, 65551, or 65552

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

- SPN 65551 FMI 1:** Knock Sensor (KS) Bank 1 Data Valid, but Below Normal
- SPN 65551 FMI 3:** Knock Sensor (KS) Bank 1 Voltage Above Normal or Shorted High
- SPN 65551 FMI 4:** Knock Sensor (KS) Bank 1 Voltage Below Normal or Shorted Low
- SPN 65551 FMI 5:** Knock Sensor (KS) Bank 1 Current Below Normal or Open Circuit
- SPN 65552 FMI 1:** Knock Sensor (KS) Bank 2 Data Valid, but Below Normal
- SPN 65552 FMI 3:** Knock Sensor (KS) Bank 2 Voltage Above Normal or Shorted High
- SPN 65552 FMI 4:** Knock Sensor (KS) Bank 2 Voltage Below Normal or Shorted Low
- SPN 65552 FMI 5:** Knock Sensor (KS) Bank 2 Current Below Normal or Open Circuit

Circuit/System Description

The knock sensor (KS) enables the engine control module (ECM) to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation. The KS produces an AC voltage signal that varies depending on the vibration level during engine operation. The ECM adjusts the spark timing based on the amplitude and the frequency of the KS signal. The ECM receives the KS signal through a signal circuit. The ECM supplies a ground circuit to the KS through a low reference circuit. The ECM also supplies a shielded ground circuit to the KS. The ECM learns the normal KS noise level at idle and uses the normal noise level as a base to predict the normal values for the rest of the engine speed range. The ECM monitors the KS signal for detonation levels that exceed the predicted value of the normal noise channel.

- The engine speed is less than 2,000 RPM for greater than 5 seconds to establish base-line knock activity.
- The engine speed is greater than 3,500 RPM for greater than 5 seconds to obtain a test sample.
- The SPN runs once every 250 cylinder events when the conditions above are met.

65551 and 65552 FMI 3 and 4

- SPN 630 or 65580 is not set.
- The ignition is ON or the engine is operating.
- The SPNs run continuously once the conditions above are met.

65551 and 65552 FMI 5

- Before the ECM can report that SPN 65551–5 or 65552–5 failed, SPN 65551–3, 65551–4, 65552–3, and 65552–4 must run and pass.
- SPN 630 or 65580 is not set.
- The engine coolant temperature is warmer than 50°C (122°F).
- The Fuel Detonation Control Mode is enabled.
- The engine speed is greater than 1,500 RPM.
- The engine speed is steady within 500 RPM for greater than 10 seconds.
- The MAP signal is steady within 20 kPa for greater than 10 seconds.
- Knock retard activity is less than 0.5 degrees since the last test.
- The SPN runs once every 300 seconds when the conditions above are met.

Conditions for Running the SPN

65551 or 65552 FMI 1

- Before the ECM can report that SPN 65551–1 or 65552–1 failed, SPN 65551–3, 65551–4, 65552–3, and 65552–4 must run and pass.
- SPN 630 or 65580 is not set.
- The engine coolant temperature is warmer than 50°C (122°F).
- The Fuel Detonation Control Mode is enabled.
- The ECM is not performing the KS intrusive open test.

Conditions for Setting the SPN

65551 or 65552 FMI 1

The ECM detects that the knock sensor activity did not increase with the engine speed for greater than 2 seconds.

65551 or 65552 FMI 3

The ECM detects that the KS voltage is greater than 2.5 volts for greater than 2 seconds.

65551 or 65552 FMI 4

The ECM detects that the KS voltage is less than 0.29 volt for greater than 2 seconds.

65551 or 65552 FMI 5

The ECM detects that an open KS circuit for greater than 2 seconds.

Action Taken When the SPN Sets

SPN 65551 and 65552 are Type B SPNs.

Conditions for Clearing the SPN

SPN 65551 and 65552 are Type B SPNs.

Diagnostic Aids

The following conditions may also set the SPNs:

- Inspect the KS for physical damage. A KS that is dropped or damaged may cause an SPN to set.
- Inspect the KS for proper installation. A KS that is loose or over torqued may cause an SPN to set. The KS should be free of thread sealant. The KS mounting surface should be free of burrs, casting flash, and foreign material.
- The KS must be clear of hoses, brackets, and engine electrical wiring.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine operating, observe the SPN information with a scan tool. SPN 65551 or 65552 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate KS.
2. Ignition ON, test for 1–2 V between the low signal circuit terminal A and ground.
 - ⇒ If less than the specified range, test the low signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the low signal circuit for a short to voltage, or for a wire to wire short between the KS circuits. If the circuit tests normal, replace the ECM.
3. Test for 3–4 V between the high signal circuit terminal B and ground.
 - ⇒ If less than the specified range, test the high signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, replace the KS sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Knock Sensor Replacement (Except 2.4L) on page 9-277 or Knock Sensor Replacement (2.4L) on page 9-278*
- *Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming*

SPN 65555

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64. Powertrain On Board Diagnostic (OBD) System Check prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

DTC Descriptor

SPN 65555 FMI 1: Oil Life Monitor Data Valid But Below Normal

SPN 65555 FMI 18: Oil Life Monitor Data Valid But Below Normal Range - Moderate Severe Level

Circuit/System Description

The engine control module (ECM) monitors the condition or life of the engine oil and indicates when to change the engine oil and filter. This is based on engine revolutions and engine temperature, and not on mileage. The mileage at which the ECM indicates an oil change is necessary can vary considerably depending on operating conditions. The oil life monitor must be reset every time the oil is changed for the oil life system to work properly. When the ECM determines the oil life has diminished the ECM will illuminate and/or flash an original equipment manufacturer (OEM) specified lamp to indicate an oil change is necessary. The ECM may send oil life data via a CAN message to a monitored sub-system that may display an oil life value and/or a message to indicate an oil change is necessary.

Conditions for Running the DTC

The engine is operating.

Conditions for Setting the DTC

65555-1

The ECM detects that the remaining oil life is less than 6 percent.

65555-18

The ECM detects that the remaining oil life is less than 20 percent.

Action Taken When the DTC Sets

- SPN 65555 is a Type A SPN.
- An OEM specified lamp illuminates or flashes.
OR
- A OEM specified sub-system displays a Change Oil Soon, or a Change Oil Now message.

Conditions for Clearing the DTC

SPN 65555 is a Type A SPN.

Reference Information

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. SPN 65555-1 or 65555-18 should not be set.
⇒ If the SPN is set, change the engine oil and oil filter per the OEM specific instructions.

Note: Some applications may not be equipped with a pedal position sensor (PPS). Follow the OEM specific instructions to reset the oil life monitor when a PPS is not present.

2. Reset the Oil Life monitor as follows:
 - 2.1. Ignition ON, engine OFF.
 - 2.2. Press the accelerator pedal or actuate the throttle lever from the closed throttle position to the wide open throttle (WOT) position 3 times within 15 S.
3. The Oil Life monitor is reset when the OEM specified lamp is OFF.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

SPN 65558 or 65559

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65558 FMI 11: CAN 2 Bus Hardware Fault Root Cause Unknown

SPN 65559 FMI 11: CAN 1 Bus Hardware Fault Root Cause Unknown

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CAN HI Circuit	1	1	—	—
CAN LO Circuit	1	1	—	—
1. Scan Tool Does Communicate				

Circuit/System Description

The controller area network (CAN) HI and CAN LO circuits transmit information between the engine control module (ECM) and the scan tool. Some vehicles are equipped with multiple engines that require a control module for each engine. Information is transmitted between the ECMs via the CAN communication circuits.

The data link connector (DLC) is a 6 cavity connector. The connector provides the following:

- Scan tool power battery positive voltage at terminal A
- Scan tool ground circuit at terminal B
- Controller area network (CAN) HI communication circuit at terminal C
- CAN LO communication circuit at terminal D

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 9–16 volts
- SPNs 65558 and 65559 run continuously when the above conditions are met.

Conditions for Setting the SPN

- The ECM does not receive a valid message from 1 or more of the controllers on the CAN communication circuit.
- The ECM detects the CAN communication circuit is shorted to a voltage or ground.

Action Taken When the SPN Sets

SPNs 65558 and 65559 are Type B SPNs.

Conditions for Clearing the SPN

SPNs 65558 and 65559 are Type B SPNs.

Diagnostic Aids

- The scan tool will power up with the ignition OFF.
- The ECM will not communicate unless the ignition is ON.
- It may be necessary to disconnect each module connected to the CAN communication circuits in order to isolate the condition.
- On vehicles equipped with multiple engine/controllers, the scan tool can only communicate with one ECM at a time. Attempt to establish communication with each ECM. Communication with only one ECM can be caused by the following:
 - An open CAN communication circuit between the splice and the ECM
 - An ECM that is not powered up. Test the B+, ignition feed, and ground circuits for an open/high resistance or short to ground

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Description and Operation

Data Link Communications Description and Operation on page 11-5

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: If the vehicle is equipped with multiple engines, the scan tool can only communicate with one ECM at a time. Attempt to establish communication with each ECM. The scan tool should display ECM information for each engine.

1. Ignition ON, attempt to establish communication with the ECM. The scan tool should display ECM information.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, verify a test lamp does not illuminate between the following CAN circuit terminals and B+.
 - CAN HI Terminal C
 - CAN LO Terminal D

⇒ If the test lamp illuminates, disconnect each module connected to the CAN circuit one at a time while observing the test lamp. If the test lamp does not illuminate when a module is disconnected replace the module. If the test lamp remains illuminated, repair the appropriate circuit for a short to ground.
2. Ignition ON, test for 2–3 V between the following CAN circuit terminals and ground.
 - CAN HI Terminal C
 - CAN LO Terminal D

⇒ If less than the specified range, repair the appropriate circuit for an open. If the circuit tests normal replace the ECM.

⇒ If greater than the specified range, test the appropriate circuit for a short to voltage. If the circuit tests normal replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the repair.

Engine Control Module Replacement on page 9-217 for engine control module replacement, setup, and programming

SPN 65560

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65560 FMI 9: CAN Bus Governor Command Abnormal Update Rate

Circuit/System Description

The controller area network (CAN) HI and CAN LO circuits transmit information between the engine control module (ECM), vessel specific control modules such as a helm control module, and the scan tool. Some vehicles are equipped with multiple engines that require a control module for each engine. Information is transmitted between the ECMs via the CAN communication circuits. The ECM monitors the CAN communication circuits for messages from control modules that are connected to the CAN Communication circuits.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating for greater than 6 seconds.
- The ECM is not operating in CAN bus override mode.
- SPN 65560 runs continuously when the above conditions are met.

Conditions for Setting the SPN

The ECM does not receive a valid message from a OEM specific controller on the CAN communication circuit for greater than 10 seconds.

Action Taken When the SPN Sets

- SPN 65560 is a Type C SPN.
- The ECM may command the throttle actuator control (TAC) system to operate in reduced power.

Conditions for Clearing the SPN

SPN 65560 is a Type C SPN.

Diagnostic Aids

- The scan tool will power up with the ignition OFF.
- The ECM will not communicate unless the ignition is ON.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Description and Operation

Data Link Communications Description and Operation on page 11-5

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65658–11 or 65559–11 is not set.
⇒ If an is set, refer to *SPN 65558 or 65559 on page 9-118* for further diagnosis.
2. Ignition ON, observe the SPN information with a scan tool. SPN 65560–9 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the OEM specific control module.
2. Ignition ON, test for 2–3 V between the following CAN circuit terminals and ground.
 - CAN HI Terminal
 - CAN LO Terminal
 ⇒ If less than the specified range, test the appropriate circuit for an open. If the circuit tests normal replace the ECM.
 ⇒ If greater than the specified range, test the appropriate circuit for a short to voltage. If the circuit tests normal replace the ECM.
3. If all circuits test normal, replace the vehicle specific control module.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the repair.

Engine Control Module Programming and Setup on page 6-3 for engine control module replacement, setup, and programming

SPN 65561, 65562, 65563, or 65564

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65561 FMI 0:	Oxygen Sensor Bank A Sensor 1 Data Valid But Above Normal
SPN 65561 FMI 1:	Oxygen Sensor Bank A Sensor 1 Data Valid But Below Normal
SPN 65561 FMI 3:	Oxygen Sensor Bank A Sensor 1 Voltage Above Normal or Shorted High
SPN 65561 FMI 4:	Oxygen Sensor Bank A Sensor 1 Voltage Below Normal or Shorted Low
SPN 65561 FMI 5:	Oxygen Sensor Bank A Sensor 1 Current Below Normal or Open Circuit
SPN 65562 FMI 0:	Oxygen Sensor Bank A Sensor 2 Data Valid But Above Normal
SPN 65562 FMI 1:	Oxygen Sensor Bank A Sensor 2 Data Valid But Below Normal
SPN 65562 FMI 3:	Oxygen Sensor Bank A Sensor 2 Voltage Above Normal or Shorted High
SPN 65562 FMI 4:	Oxygen Sensor Bank A Sensor 2 Voltage Below Normal or Shorted Low
SPN 65562 FMI 5:	Oxygen Sensor Bank A Sensor 2 Current Below Normal or Open Circuit
SPN 65563 FMI 0:	Oxygen Sensor Bank B Sensor 1 Data Valid But Above Normal
SPN 65563 FMI 1:	Oxygen Sensor Bank B Sensor 1 Data Valid But Below Normal
SPN 65563 FMI 3:	Oxygen Sensor Bank B Sensor 1 Voltage Above Normal or Shorted High
SPN 65563 FMI 4:	Oxygen Sensor Bank B Sensor 1 Voltage Below Normal or Shorted Low
SPN 65563 FMI 5:	Oxygen Sensor Bank B Sensor 1 Current Below Normal or Open Circuit
SPN 65564 FMI 0:	Oxygen Sensor Bank B Sensor 2 Data Valid But Above Normal
SPN 65564 FMI 1:	Oxygen Sensor Bank B Sensor 2 Data Valid But Below Normal
SPN 65564 FMI 3:	Oxygen Sensor Bank 2 Sensor 2 Voltage Above Normal or Shorted High
SPN 65564 FMI 4:	Oxygen Sensor Bank B Sensor 2 Voltage Below Normal or Shorted Low
SPN 65564 FMI 5:	Oxygen Sensor Bank B Sensor 2 Current Below Normal or Open Circuit

Typical Scan Tool Data

HO2S 1 and 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop			
Parameter Normal Range: Fluctuates above and below 200–800 mV			
HO2S 1 and 2 Signal	0 mV	947 mV	1,245 mV
Low Reference	—	947 mV	—

Circuit Description

The heated oxygen sensor (HO2S) is used for fuel control and catalyst monitoring. The HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. The HO2S samples the oxygen content of the exhaust stream as it passes the sensor. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 1,900 mV. When the engine is operating, the exhaust stream warms the HO2S which affects the resistance of the sensing element. During normal operation, the temperature of the exhaust stream fluctuates according to oxygen content of the stream, which causes the bias voltage to increase or decrease in a range of 0-1,000 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S signal voltage to determine and vary the delivered air-to-fuel ratio based in part, on the oxygen content of the exhaust. An HO2S voltage that increases toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heats the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner, which reduces fuel consumption and improves the vessels exhaust emissions performance.

Conditions for Running the SPN

65561, 65563

- SPN 94, 106, 630 or 65580 is not set.
- The ignition voltage is greater than 10 volts.
- The engine is operating for greater than 60 seconds.
- The engine coolant temperature is warmer than 60°C (140°F).
- The engine is operating in Closed Loop for greater than 50 seconds.
- SPNs 65561 and 65563 run continuously when the above conditions are met.

65562, 65564

- SPN 94, 106, 630 or 65580 is not set.
- The ignition voltage is greater than 10 volts.

- The engine is operating for greater than 60 seconds.
- The engine coolant temperature is warmer than 60°C (140°F).
- The engine is operating in Closed Loop for greater than 50 seconds.
- The enable conditions for catalyst monitoring have been met.
- The ECM is not performing an intrusive catalyst test.
- SPNs 65562 and 65564 run continuously when the above conditions are met.

Conditions for Setting the SPN

65561-0, 65562-0, 65563-0, and 65564-0

The engine control module (ECM) detects that the HO2S voltage is greater than 800 mV during Decel Fuel Cut-Off.

65561-1, 65562-1, 65563-1, and 65564-1

The ECM detects that the HO2S voltage is less than 302 mV during Power Enrichment.

65561-3, 65562-3, 65563-3, and 65564-3

The engine control module (ECM) detects that the HO2S voltage is greater than 1,240 mV.

65561-4, 65562-4, 65563-4, and 65564-4

The engine control module (ECM) detects that the HO2S voltage is less than 48 mV for greater than 30 seconds.

65561-5, 65562-5, 65563-5, and 65564-5

The ECM detects that the HO2S signal circuit is open for greater than 30 seconds.

Action Taken when the SPN Sets

- SPN 65561, 65562, 65563, and 65564 are Type B SPNs
- The ECM commands open loop fuel control

Conditions for Clearing the SPN

SPN 65561, 65562, 65563, and 65564 are Type B SPNs

Diagnostic Aids

This ECM uses a bias voltage on the high signal circuit of the HO2S. The voltage measured between the high and low signal HO2S terminals is approximately 1,900 mV.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: The rear heated oxygen sensor (HO2S) must be in closed loop for the rear HO2S diagnostics to run. A load condition is necessary to obtain closed loop.

1. Engine operating, observe the scan tool heated oxygen sensor voltage parameters. The parameter should fluctuate above and below the range of 200–800 mV.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition OFF, test for less than 5 Ω of between the low reference circuit terminal A and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

3. Ignition ON, verify the HO2S scan tool voltage parameter is between 900–1,000 mV.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Ignition ON, verify the scan tool HO2S voltage parameter is less than 48 mV.
 - ⇒ If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
5. Verify none of the following conditions exist:
 - Lean or rich fuel injectors—Refer to *Fuel Injector Diagnosis on page 9-211*.
 - Water intrusion in the HO2S harness connector
 - Low or high fuel system pressure—Refer to *Fuel System Diagnosis (with Returnless Fuel System) on page 9-208* or *Fuel System Diagnosis (without Returnless Fuel System) on page 9-210*.
 - Fuel that is contaminated—Refer to *Alcohol/Contaminants-in-Fuel Diagnosis on page 9-213*.
 - Exhaust leaks near the HO2S.
 - Engine vacuum leaks.
 - ⇒ If you find any of the above conditions, repair as necessary.
6. If all circuits test normal, test or replace the appropriate HO2S.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

- *Heated Oxygen Sensor Replacement on page 9-226*
- *Engine Control Module Replacement on page 9-217* for ECM replacement, setup, and programming

SPN 65565 or 65566

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65565 FMI 0: Fuel Trim Bank 1 Data Valid But Above Normal

SPN 65565 FMI 1: Fuel Trim Bank 1 Data Valid But Below Normal

SPN 65566 FMI 0: Fuel Trim Bank 2 Data Valid But Above Normal

SPN 65566 FMI 1: Fuel Trim Bank 2 Data Valid But Below Normal

Circuit Description

The engine control module (ECM) controls a Closed Loop air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage and adjusts the fuel delivery based on the signal voltage while in Closed Loop. A change made to the fuel delivery changes the long and short term fuel trim values. The short term fuel trim or O2-Fuel Multiplier values change rapidly in response to the HO2S signal voltages. These changes fine tune the engine fueling. The long term fuel trim or O2-BLM Cell Values change in response to trends in the O2-Fuel Multiplier. The O2-BLM Cell Value makes coarse adjustments to fueling in order to re-center and restore control to the O2-Fuel Multiplier. The ideal O2-BLM Cell Values are around 1.00. A value greater than 1.00 indicates that the ECM is adding fuel in order to compensate for a lean condition. A value less than 1.00 indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition. The BLM Cell ID numbers are based on the engine speed and load.

Conditions for Running the SPN

- SPN 94, 105, 106, 630, 651–658, 65541–65548, 65580, or 65591–65599 is not set.
- The engine is operating in Closed Loop.
- The ECT is warmer than 140°F (60°C).
- The engine speed is less than 4,100 RPM.
- SPNs 65565 and 65566 run continuously when the above conditions are met.

Conditions for Setting the SPN

65565–0 and 65566–0

The O2-BLM Cell value is greater than 1.24 for greater than 1 second.

65565–1 and 65566–1

The O2-BLM Cell value is less than 0.74 for greater than 1 second.

Action Taken When the SPN Sets

SPNs 65565 and 65566 are Type B SPNs.

Conditions for Clearing the SPN

SPNs 65565 and 65566 are Type B SPNs.

Diagnostic Aids

- The system will become lean if a fuel injector is not supplying enough fuel.
- A lean condition could be present during high fuel demand due to a fuel pump that does not deliver enough fuel, a plugged fuel filter, or a restricted fuel pipe.
- The system will become rich if a fuel injector is supplying too much fuel.
- Review the Freeze Frame/Failure Records with a scan tool.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. SPN 106, 65601, 65602, 65561–65564, 65567, or 65568 should not be set.
⇒ If any of the above SPNs are set, refer to *Diagnostic Trouble Code (DTC) List* on page 6-11
2. Engine operating, observe the SPN information with a scan tool. SPN 65565 or 65566 should not set.
3. Observe the scan tool O2A1-BLM Cell Value and O2B1-BLM Cell Value. Verify both parameters are between 0.75 and 1.25.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Verify none of the following conditions exist:

65565–0 or 65566–0

- Splits, kinks, or improper connections at the vacuum hoses
- Vacuum leaks at the intake manifold, throttle body, and injector O-rings
- Leaking crankcase ventilation system
- Fuel contamination—Refer to *Alcohol/Contaminants-in-Fuel Diagnosis* on page 9-213.
- The fuel system is operating lean. Refer to *Fuel System Diagnosis (with Returnless Fuel System)* on page 9-208 or *Fuel System Diagnosis (without Returnless Fuel System)* on page 9-210.
- The fuel injectors are operating lean. Refer to *Fuel Injector Diagnosis* on page 9-211.

65565–1 or 65566–1

- Fuel contamination—Refer to *Alcohol/Contaminants-in-Fuel Diagnosis* on page 9-213.
 - The fuel system is operating rich. Refer to *Fuel System Diagnosis (with Returnless Fuel System)* on page 9-208 or *Fuel System Diagnosis (without Returnless Fuel System)* on page 9-210.
 - The fuel injectors are operating rich. Refer to *Fuel Injector Diagnosis* on page 9-211.
 - The air intake duct for being collapsed or restricted, or a restricted air filter
 - Leaking fuel pressure regulator—Inspect for evidence of fuel in the vacuum line. Refer to *Fuel System Diagnosis (with Returnless Fuel System)* on page 9-208 or *Fuel System Diagnosis (without Returnless Fuel System)* on page 9-210.
 - Excessive fuel in the crankcase.
2. If all conditions test normal, test the engine for a mechanical condition.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Fuel Injector Replacement (Except 2.4L) on page 9-238 or *Fuel Injector Replacement (2.4L)* on page 9-240

SPN 65567 or 65568

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65567 FMI 8: Oxygen Sensor Bank 1 Sensor 1 Abnormal Frequency or Pulse Width

SPN 65567 FMI 10: Oxygen Sensor Bank 1 Sensor 1 Abnormal Rate of Change

SPN 65568 FMI 8: Oxygen Sensor Bank 2 Sensor 1 Abnormal Frequency or Pulse Width

SPN 65568 FMI 10: Oxygen Sensor Bank 2 Sensor 1 Abnormal Rate of Change

Typical Scan Tool Data

HO2S 1 and 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Engine operating in Closed Loop.			
Parameter Normal Range: Fluctuates above and below 350–500 mV.			
Sensor Signal	0 mV	947 mV	1,245 mV
Low Reference	—	947 mV	—

Circuit Description

The heated oxygen sensor (HO2S) is used for fuel control and catalyst monitoring. The HO2S compares the oxygen content of the surrounding air with the oxygen content of the exhaust stream. The HO2S samples the oxygen content of the exhaust stream as it passes the sensor. When the engine is started, the control module operates in an Open Loop mode, ignoring the HO2S signal voltage while calculating the air-to-fuel ratio. The control module supplies the HO2S with a reference, or bias voltage of about 450 mV. When the engine is operating, the exhaust stream warms the HO2S which affects the resistance of the sensing element. During normal operation, the temperature of the exhaust stream fluctuates according to oxygen content of the stream, which causes the bias voltage to increase or decrease in a range of 0–1,000 mV. Once sufficient HO2S voltage fluctuation is observed by the control module, Closed Loop is entered. The control module uses the HO2S signal voltage to determine and vary the delivered air-to-fuel ratio based in part, on the oxygen content of the exhaust. An HO2S voltage that increases above bias voltage toward 1,000 mV indicates a rich fuel mixture. An HO2S voltage that decreases below the bias voltage toward 0 mV indicates a lean fuel mixture.

The heating elements inside each HO2S heats the sensor to bring the sensor up to operating conditions faster. This allows the system to enter Closed Loop earlier and the control module to calculate the air-to-fuel ratio sooner, which reduces fuel consumption and improves the vessels exhaust emissions performance.

Conditions for Running the SPN

- Before the ECM can report that SPN 65567 or 65568 failed, SPNs 106, 110, and 65561, 65562, 65563, and 65564 must run and pass.
- SPN 94, 105, 630, 651–658, 65541–65548, 65580, or 65590–65599, is not set.
- The engine is operating for greater than 60 seconds.
- The coolant temperature is warmer than a 60°C (140°F).
- The engine speed is between 2,000–4,500 RPM.
- The MAP is between 35–80 kPa.
- The engine is operating in Closed Loop.
- The ECM is not performing an intrusive catalyst test.
- SPNs 65567 and 65568 run continuously once the above conditions are met for greater than 20 seconds.

Conditions for Setting the SPN

- The engine control module (ECM) detects that the HO2S rich-to-lean average response time is greater than 309 mS.
- The engine control module (ECM) detects that the HO2S lean-to-rich average response time is greater than a 281 mS.
- Either condition exists for greater than 20 seconds.

Action Taken when the SPN Sets

SPNs 65567 and 65568 are Type B SPNs.

Conditions for Clearing the SPN

SPNs 65567 and 65568 are Type B SPNs.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine operating, observe the appropriate scan tool HO2S voltage parameter. The reading should fluctuate above and below 351–654 mV.
2. Observe the SPN information with a scan tool. Verify SPN 65567 or 65568 is not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Test for less than 5 Ω between the low reference circuit terminal A and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.

3. Ignition ON, verify the HO2S scan tool voltage parameter is between 900–1,000 mV.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Install a 3 A fused jumper wire between the signal circuit terminal B and the low reference circuit terminal A. Ignition ON, verify the scan tool HO2S voltage parameter is less than 48 mV.
 - ⇒ If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
5. Verify none of the following conditions exist:
 - The HO2S is loose.
 - Lean or rich fuel injectors—Refer to *Fuel Injector Diagnosis on page 9-211*.
 - Water intrusion in the HO2S harness connector
 - Low or high fuel system pressure—Refer to *Fuel System Diagnosis (with Returnless Fuel System) on page 9-208* or *Fuel System Diagnosis (without Returnless Fuel System) on page 9-210*.
 - Fuel that is contaminated—Refer to *Alcohol/Contaminants-in-Fuel Diagnosis on page 9-213*.
 - Exhaust leaks near the HO2S
 - Engine vacuum leaks
 - ⇒ If you find any of the above conditions, repair as necessary.
6. If all circuits test normal, test or replace the applicable HO2S.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Heated Oxygen Sensor Replacement on page 9-226*
- *Engine Control Module Replacement on page 9-217* for engine control module replacement, setup, and programming

SPN 65570 (6.0/6.2L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65570 FMI 2: Cam Phaser W Data Erratic, Intermittent, or Incorrect

SPN 65570 FMI 4: Cam Phaser W Voltage Below Normal or Shorted Low

SPN 65570 FMI 5: Cam Phaser W Short High or Open

SPN 65570 FMI 7: Cam Phaser W Accuracy Mechanical System Not Responding or Out of Adjustment

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cam Phaser Control	65570-4	65570-5	65570-5	—
Low Reference	—	65570-5	*	—

* Internal ECM or sensor damage may occur if the circuit is shorted to B+.

Circuit/System Description

The camshaft position (CMP) actuator system enables the engine control module (ECM) to change the timing of the camshaft while the engine is operating. The ECM controls the Camshaft Position Actuator Magnet duty cycle by controlling the amount of ON time. The magnet controls the amount of engine oil flow to the CMP actuator by extending a pintle within the solenoid. The pintle acts against a spool valve in the CMP actuator mechanism which is attached to the front of the camshaft. As the spool valve is moved, oil is directed to the CMP actuator, which rotates the camshaft. The ECM can only command the camshaft position actuator to retard the valve timing from the camshaft park position, or advance the valve timing back to the park position. The total range of valve timing command is 26 degree as measured at the camshaft or 52 degree as measured at the crankshaft.

The ECM controls the Camshaft Position Actuator Magnet by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the SPN

65570-2

- Before the ECM can report that SPN 65570-2 failed, SPNs 65570-3, 65570-4, and 65723 must run and pass.
- SPN 630 or 65580 is not set.
- The ignition is ON.
- The cam reference angle is learned.
- SPN 65570-2 runs continuously once the above conditions are met.

65570-4 and 65570-5

- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10-16 volts.
- SPNs 65570-4 and 65570-5 run continuously once the above conditions are met.

65570-7

- Before the ECM can report that SPN 65570-7 failed, SPNs 65570-2, 65570-3, 65570-4, and 65723 must run and pass.
- SPN 630 or 65580 is not set.
- The ignition is ON.
- The cam reference angle is learned.
- The cam phaser cleaning pulse is not enabled.
- The SPN 65570-7 runs continuously once the above conditions are met.

Conditions for Setting the SPN

65570-2

The ECM detects a deviation in the relationship between a camshaft and the crankshaft.

65570-4 and 65570-5

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

65570-7

The ECM detects the difference between the desired camshaft position angle and the actual camshaft position angle.

Action Taken When the SPN Sets

- SPN 65570 is a Type B SPN.
- Cam phaser not enabled.

Conditions for Clearing the SPN

SPN 65570 is a Type B SPN.

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this SPN. The engine may require an oil change. Inquire with the customer when the last oil change was performed.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain may cause SPN 65570–2, or 65570–7 to set.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: The engine oil level and the oil pressure are critical to the correct operation of the camshaft position (CMP) actuator system. Verify that the engine has the correct oil level and the correct oil pressure before continuing with this diagnostic.

1. Ignition ON, observe the scan tool SPN information. Verify that none of the following SPNs are set. SPN 98, 100, 636, 65615, 65616, 65618, or 65723.
⇒ If any of the SPNs are set, refer to *Diagnostic Trouble Code (DTC) List on page 6-11*
2. Engine idling, observe the scan tool SPN information. SPN 65570-2, or 65570-7 should not set.

Note: It may be necessary to perform the procedure a few times in order to clean the cam phaser actuator.

⇒ If either SPN is set, perform the cam phaser actuator cleaning procedure with a scan tool. Verify SPNs 65570-2, or 65570-7 do not reset.

3. Engine idling, observe the scan tool SPN information. SPN 65570-4, or 65570-5 should not be set.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the Camshaft Position Sensor and Actuator Magnet jumper harness connector. Refer to *Engine Controls Connector End Views on page 9-33* for connector identification.

Note: Testing for steps 2–4 is performed on the ECM side of the jumper harness connector.

2. Ignition OFF for 1 minute, test for less than 5 Ω between the low reference circuit terminal E and ground.
⇒ If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, engine OFF, verify that a test lamp does not illuminate between the control circuit terminal D and ground.
⇒ If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Connect the DMM black lead to the control circuit terminal D. Connect the DMM red lead to B+. Set the DMM on the diode setting.
5. Engine operating 2,000–2,500 RPM, pulse the CMP actuator solenoid ON with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
⇒ If the circuit voltage does not correspond to the specified values, test the control circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the ECM.

Note: Testing for steps 5 and 6 is performed on the engine side of the jumper harness connector.

6. Ignition OFF, test for infinite resistance between the control circuit terminal D and ground.
⇒ If not the specified value, repair the control circuit for a short to ground.

7. Test for 5.0–9.0 Ω between the control circuit terminal D and the low reference circuit terminal E.
 - ⇒ If less than the specified range, test for a short between the control circuit and the low reference circuit. If the circuits/connections test normal, test or replace the Camshaft Position Actuator Magnet.
 - ⇒ If greater than the specified range, test the control circuit and the low reference for an open/high resistance. If the circuits/connections test normal, test or replace the Camshaft Position Actuator Magnet.
8. Remove the Camshaft Position Actuator Magnet. Perform the *Camshaft Position Actuator Magnet Cleaning and Inspection* on page 9-275. The Camshaft Position Actuator Magnet should pass the inspection.
 - ⇒ If the inspection fails, replace the Camshaft Position Actuator Magnet.
9. Perform the *Camshaft Position Actuator Solenoid Valve Inspection* on page 9-276. The Camshaft Position Actuator Solenoid Valve should pass the inspection.
 - ⇒ If the inspection fails, replace the Camshaft Position Actuator Solenoid Valve.
10. If all circuits and components test normal, replace the mechanical Camshaft Position Actuator.

Component Testing

Static Test

1. Ignition OFF, remove the Camshaft Position Actuator Magnet.
2. Test for 5.0–9.0 Ω between the solenoid control terminal 2 and the low reference terminal 1 at the Camshaft Position Actuator Magnet.
 - ⇒ If not within the specified range, replace the Camshaft Position Actuator Magnet.
3. Test for infinite resistance between each terminal of the magnet and the magnet housing.
 - ⇒ If not the specified value, replace the Camshaft Position Actuator Magnet.

Dynamic Test

1. Remove the Camshaft Position Actuator Magnet.

Note:

- The Camshaft Position Actuator Magnet pintle should be facing downward for this test.
 - Do not allow electrical current to flow through the Camshaft Position Actuator Magnet for greater than 1–2 s.
2. Install a 20 A fused jumper wire between the control circuit terminal 2 and 12 V. Momentarily install a jumper wire between the low reference terminal 1 and ground. The pintle should extend.
 - ⇒ If the function does not perform as specified, replace the Camshaft Position Actuator Magnet.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Camshaft Position Actuator Magnet Replacement* on page 9-271
- *Camshaft Position Actuator Solenoid Valve Replacement (6.0/6.2L)* on page 9-272 or *Camshaft Position Actuator Solenoid Valve Replacement (2.4L)* on page 9-274
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 65570, 65571, 65572, or 65573 (2.4L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65570 FMI 2:	Cam Phaser W Data Erratic, Intermittent, or Incorrect
SPN 65570 FMI 4:	Cam Phaser W Voltage Below Normal or Shorted Low
SPN 65570 FMI 5:	Cam Phaser W Short High or Open
SPN 65570 FMI 7:	Cam Phaser W Accuracy Mechanical System Not Responding or Out of Adjustment
SPN 65571 FMI 2:	Cam Phaser X Data Erratic, Intermittent, or Incorrect
SPN 65571 FMI 4:	Cam Phaser X Voltage Below Normal or Shorted Low
SPN 65571 FMI 5:	Cam Phaser X Short High or Open
SPN 65571 FMI 7:	Cam Phaser X Accuracy Mechanical System Not Responding or Out of Adjustment
SPN 65572 FMI 2:	Cam Phaser Y Data Erratic, Intermittent, or Incorrect
SPN 65572 FMI 4:	Cam Phaser Y Voltage Below Normal or Shorted Low
SPN 65572 FMI 5:	Cam Phaser Y Short High or Open
SPN 65572 FMI 7:	Cam Phaser Y Accuracy Mechanical System Not Responding or Out of Adjustment
SPN 65573 FMI 2:	Cam Phaser Z Data Erratic, Intermittent, or Incorrect
SPN 65573 FMI 4:	Cam Phaser Z Voltage Below Normal or Shorted Low
SPN 65573 FMI 5:	Cam Phaser Z Short High or Open
SPN 65573 FMI 7:	Cam Phaser Z Accuracy Mechanical System Not Responding or Out of Adjustment

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Cam Phaser Control	65570-4, 65571-4	65570-5, 65571-5	65570-5, 65571-5	—
Low Reference	—	65570-5, 65571-5	*	—
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.				

Circuit/System Description

The camshaft position actuator system enables the Engine Control Module (ECM) to change the timing of the camshafts while the engine is operating. The Camshaft Position Actuator Solenoid Valve signal from the ECM is pulse width modulated (PWM). The ECM controls the Camshaft Position Actuator Solenoid Valve duty cycle by controlling the amount of solenoid valve ON time. The Camshaft Position Actuator Solenoid

Valve controls the advance or the retard of each camshaft. The Camshaft Position Actuator Solenoid Valve controls the oil flow that applies the pressure to advance or retard the camshafts.

The ECM controls the Camshaft Position Actuator Solenoid Valve by supplying a 12 V pulse width modulated (PWM) signal. The ECM supplies a ground to the low reference circuit.

Conditions for Running the SPN

65570, 65571, 65572, 65573 FMI 2

- Before the ECM can report that SPN 65570–2, 65571–2, 65572–2, or 65573–2 failed, SPNs 65570–4, 65570–5, 65571–4, 65571–5, 65572–4, 65572–5, 65573–4, 65573–5, 65723, 65724, 65725, or 65726 must run and pass.
- SPN 630 or 65580 is not set.
- The ignition is ON.
- The cam reference angle is learned.
- The SPN runs continuously once the above conditions are met.

65570, 65571, 65572, 65573 FMI 4 and 5

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The SPNs run continuously once the above conditions are met.

65570, 65571, 65572, 65573 FMI 7

- Before the ECM can report that SPN 65570–2, 65571–2, 65572–2, or 65573–2 failed, SPNs 65570–4, 65570–5, 65571–4, 65571–5, 65572–4, 65572–5, 65573–4, 65573–5, 65723, 65724, 65725, or 65726 must run and pass.
- SPN 630 or 65580 is not set.
- The ignition is ON.
- The cam reference angle is learned.
- The cam phaser cleaning pulse is not enabled.
- The SPN 65570–7 runs continuously once the above conditions are met.

Conditions for Setting the SPN

65570, 65571, 65572, and 65573 FMI 2

The ECM detects a deviation in the relationship between a camshaft and the crankshaft.

65570, 65571, 65572, and 65573 FMI 4 and 5

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

65570, 65571, 65572, and 65573 FMI 7

The ECM detects that the actual cam angle is $\pm 40^\circ$ of the desired cam angle as measured in degrees of crank rotation.

Action Taken When the DTC Sets

- SPNs 65570, 65571, 65572, and 65573 are type B DTCs.
- Cam phasers not enabled.

Conditions for Clearing the DTC

SPNs 65570, 65571, 65572, and 65573 are type B DTCs.

Diagnostic Aids

- The engine oil condition has a major impact on the camshaft actuator system.
- A low oil level condition may set this SPN. The engine may require an oil change. Inquire with the customer when the last oil change was performed. You may also monitor the scan tool Engine Oil Life parameter. Advise the customer an oil change may be required.
- Inspect the engine for any recent engine mechanical repairs. An incorrectly installed camshaft, camshaft actuator, or timing chain may cause SPN 65570–2, 65570–7, 65571–2, 65571–7, 65572–2, 65572–7, 65573–2, or 65573–7 to set.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: If a crankshaft or camshaft position sensor SPN is set, the Cam Phaser Cleaning test may not function.

1. Ignition ON, observe the scan tool SPN information. Verify that none of the following SPNs are set. SPN 98, 100, 636, 65615, 65616, 65618, 65723, or 65724, 65725, or 65726.
⇒ If any of the SPNs are set, refer to *Diagnostic Trouble Code (DTC) List on page 6-11* for further diagnosis.
2. Engine idling, observe the scan tool SPN information. SPN 65570-2, 65570-7, 65571-2, 65571-7, 65572-2, 65572-7, 65573-2, or 65573-7 should not set.

Note: It may be necessary to perform the procedure a few times in order to clean the cam phaser actuator.

- ⇒ If any of the SPNs are set, perform the Cam Phaser Cleaning procedure with a scan tool. Verify SPN 65570-2, 65570-7, 65571-2, 65571-7, 65572-2, 65572-7, 65573-2, or 65573-7 does not reset.
3. Engine idling, observe the scan tool SPN information. SPN 65570-4, 65570-5, 65571-4, 65571-5, 65572-4, 65572-5, 65573-4, or 65573-5 should not be set.
4. Operate the vehicle within the Conditions for Running the DTC to verify the DTC does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Camshaft Position Actuator Solenoid Valve.
2. Test for less than 5 Ω between the low reference circuit terminal B and ground.
⇒ If greater than the specified value, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, Engine OFF, verify that a test lamp does not illuminate between the control circuit terminal A and ground.
⇒ If the test lamp illuminates, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Test for B+ between the control circuit terminal A and ground with a DMM.
⇒ If less than the specified range, test the control circuit for a short to ground or for an open/high resistance.
5. Connect the DMM black lead to the control circuit terminal A. Connect the DMM red lead to B+. Set the DMM on the diode setting.
6. Engine operating 2,000–2,500 RPM, pulse the CMP actuator solenoid ON with a scan tool. The DMM should transition from OL when commanded OFF to less than 1 V when commanded ON.
⇒ If the circuit voltage does not correspond to the specified values, replace the ECM.

7. Ignition OFF, remove the Camshaft Position Actuator Solenoid Valve. Verify the following conditions do not exist with the Camshaft Position Actuator Solenoid Valve:
 - Torn, restricted, mis-positioned, or missing screens at the CMP actuator solenoid.
 - Engine oil leak between the oil sealing lands of the CMP actuator solenoid. Inspect the lands of the CMP actuator solenoid for nicks.
 - Oil seepage at the CMP actuator solenoid connector.⇒ If a condition is found, replace Camshaft Position Actuator Solenoid Valve.
8. Ignition OFF, swap the appropriate Camshaft Position Actuator Solenoid Valve with a Camshaft Position Actuator Solenoid Valve that is operating correctly.
9. Engine operating, perform the Cam Phaser Cleaning procedure with a scan tool. Verify SPN 65570-2, 65570-7, 65571-2, 65571-7, 65572-2, 65572-7, 65573-2, or 65573-7 does not reset.
⇒ If an SPN resets, replace the mechanical camshaft position actuator.
10. If all circuits/connections test normal, test or replace the appropriate Camshaft Position Actuator Solenoid Valve.

Component Testing

1. Ignition OFF, disconnect the harness connector at the appropriate Camshaft Position Actuator Solenoid Valve.
2. Test for 8–15 Ω between the control terminal A and the low reference circuit terminal B of the Camshaft Position Actuator Solenoid Valve.
⇒ If not within the specified range, replace the Camshaft Position Actuator Solenoid Valve.
3. Test for infinite resistance between each terminal and the Camshaft Position Actuator Solenoid Valve housing.
⇒ If not the specified value, replace the Camshaft Position Actuator Solenoid Valve.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Camshaft Position Actuator Solenoid Valve Replacement (6.0/6.2L)* on page 9-272 or *Camshaft Position Actuator Solenoid Valve Replacement (2.4L)* on page 9-274
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 65585

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 65685 FMI 2: Fuel Select Input Data Erratic, Intermittent or Incorrect

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	65621-4	65685-2	65685-2	—
Fuel Select Input Signal	65621-4	65685-2	65685-2	65685-2
Low Reference	—	65685-2	—	—

Circuit/System Description

The fuel select input (FSI) sensor changes voltage based on the position of the sensor switch. The fuel select input sensor is a three wire sensor comprising of the signal circuit, the low reference circuit and the 5-volt reference circuit. The engine control module (ECM) supplies 5 volts to the sensor via the 5-volt reference circuit and provides ground via the FSI low reference circuit. The ECM monitors the voltage signal of the FSI sensor to determine which fuel type to use for engine operation. The FSI sensor voltage is within the normal operating range at approximately 1 or 4 volts.

Conditions for Running the SPN

- SPNs 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or engine is operating.
- The SPNs run continuously when the above conditions are met.

Conditions for Setting the SPN

- The ECM detects that the FSI signal is greater or less than 0.25–1.5 volts.
OR
- The ECM detects that the FSI signal is greater or less than 3.5–4.5 volts.

Action Taken When the DTC Sets

SPN 65585-2 is a Type B SPN.

Conditions for Clearing the DTC

SPN 65585-2 is a Type B SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54 for scan tool information

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65620, 65621, 65622, or 65623 is not set.
⇒ If either SPN is set, refer to *SPN 65620-65623* on page 9-149.
2. Move the fuel select input switch between the fuel select 1 and 2 positions. Verify SPN 65585-2 does not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the fuel select input sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Test for 0.050–1 volt between the signal circuit terminal and ground.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
 - ⇒ If less than the specified range, test the signal circuit for an open/high resistance or a short to ground.
5. If all circuits test normal, replace the FSI sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for engine control module replacement, setup, and programming.

SPN 65586 or 65587

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 65586 FMI 3: Fuel Select Output 1 Voltage Above Normal or Shorted High

SPN 65586 FMI 5: Fuel Select Output 1 Current Below Normal or Open Circuit

SPN 65587 FMI 3: Fuel Select Output 2 Voltage Above Normal or Shorted High

SPN 65587 FMI 5: Fuel Select Output 2 Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Select Output Voltage Supply	*	65586-5, 65587-5	—	—
Fuel Select Output Control	65586-5, 65587-5	65586-5, 65587-5	65586-3, 65587-3	—

* The fuse that supplies voltage to the device opens.

Circuit/System Description

The fuel select output 1 or 2 circuit is used to enable a relay, or series of relays which are wired in parallel. The fuel select relay(s) allow the engine to be operated with an alternate fuel system. Ignition voltage is supplied to the relay(s) through a fuse. The engine control module (ECM) turns the relay(s) ON by grounding the control circuit when the ECM receives the appropriate fuel select input. The ECM controls the solenoid by grounding the control circuit with a solid state device known as a low-side driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

65586 and 65587 FMI 3

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The fuel select output is commanded ON.
- The SPNs run continuously once the above conditions are met.

65586 and 65587 FMI 5

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The fuel select output is commanded OFF.
- The SPNs run continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPNs 65586 and 65587 are Type B SPNs.

Conditions for Clearing the SPN

SPNs 65586 and 65587 are Type B SPNs.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the appropriate fuel select output ON and OFF with a scan tool. An audible click should be heard when changing between the commanded states.
2. Observe the SPN information with a scan tool. SPN 65586–3, 65586–5, 65587–3, or 65587–5 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note:

1. Ignition OFF, disconnect all of the fuel control relays.
2. Ignition ON, verify a test lamp illuminates between the ignition voltage supply circuit terminal 86 and ground, at each relay connector.
 - ⇒ If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.

3. Connect a test lamp between a fuel control relay control circuit terminal 85 and B+. The test lamp should not illuminate.
 - ⇒ If the test lamp is always ON, test the control circuit for a short to ground. If the circuit/connections test normal, replace the ECM.

Note: Perform this test at terminal 85 of each relay, if applicable.

4. Command the appropriate fuel select output ON and OFF with a scan tool. The test lamp should illuminate and turn OFF as commanded.
 - ⇒ If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Test for 3.0-4.0 V between the control circuit terminal and ground.
 - ⇒ If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. If all the circuit/connections test normal, test or replace the fuel solenoid valve.

Component Testing

1. Ignition OFF, disconnect the dual fuel control relay with the J 43244.
2. Test for 70–110 Ω between terminals 85 and 86.
 - ⇒ If not within the specified range, replace the fuel pump relay 1.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - ⇒ If not within the specified range, replace the fuel pump relay 1.
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
 - ⇒ If greater than the specified range, replace the relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure. *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, or 65599**Diagnostic Instructions**

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65590 FMI 7: Misfire Mechanical System Not Responding or Out of Adjustment

SPN 65591 FMI 7: Misfire Cylinder 1 Mechanical System Not Responding or Out of Adjustment

SPN 65592 FMI 7: Misfire Cylinder 2 Mechanical System Not Responding or Out of Adjustment

SPN 65593 FMI 7: Misfire Cylinder 3 Mechanical System Not Responding or Out of Adjustment

SPN 65594 FMI 7: Misfire Cylinder 4 Mechanical System Not Responding or Out of Adjustment

SPN 65595 FMI 7: Misfire Cylinder 5 Mechanical System Not Responding or Out of Adjustment

SPN 65596 FMI 7: Misfire Cylinder 6 Mechanical System Not Responding or Out of Adjustment

SPN 65597 FMI 7: Misfire Cylinder 7 Mechanical System Not Responding or Out of Adjustment

SPN 65598 FMI 7: Misfire Cylinder 8 Mechanical System Not Responding or Out of Adjustment

SPN 65599 FMI 7: Misfire Random Mechanical System Not Responding or Out of Adjustment

Circuit/System Description

The engine control module (ECM) uses information from the crankshaft position (CKP) sensor and the camshaft position (CMP) sensor in order to determine when an engine misfire is occurring. By monitoring variations in the crankshaft rotation speed for each cylinder, the ECM is able to detect individual misfire events. A misfire rate that is high enough can cause 3-way catalytic converter damage. The malfunction indicator lamp (MIL) will flash ON and OFF when the conditions for catalytic converter damage are present.

Conditions for Running the SPN

- SPN 94, 105, 106, 110, 630, 636, 65570, 65571, or 65580 is not set
- The engine is operating for greater than 10 seconds.
- Engine speed is between 1,500–6,000 RPM.
- The ignition voltage is between 8-18 volts.
- The engine coolant temperature (ECT) is between 108–221°F (42–105°C).
- The ECM is not in fuel cut-off or decel fuel cut-off (DFCO) mode.
- The throttle angle is greater than 10 percent and steady within +/-5 percent.
- The manifold absolute pressure is greater than 35 kPa.
- SPNs 65590–65599 run continuously when the above conditions are met.

Conditions for Setting the SPN

- The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause emissions levels to exceed a predetermined value.
- The ECM detects a crankshaft rotation speed variation indicating a misfire rate sufficient to cause catalyst damage (MIL flashing).

Action Taken When the SPN Sets

SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, and 65599 are Type A (MIL flashing) or Type B SPNs.

Conditions for Clearing the SPN

SPN 65590, 65591, 65592, 65593, 65594, 65595, 65596, 65597, 65598, and 65599 are Type A (MIL flashing) or Type B SPNs.

Diagnostic Aids

- On an engine equipped with a distributor ignition system a misfire SPN may be caused by a cam sensor, or distributor, that is out of adjustment.
- A misfire SPN may be caused by an excessive vibration from sources other than the engine.

Reference Information**Schematic Reference**

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools Required

J 26792 Spark Tester

Circuit/System Verification

1. Engine idling, verify there is no abnormal engine noise.
⇒ If there is an abnormal engine noise, refer to Engine Mechanical for further diagnosis.
2. Observe the scan tool SPN information. Verify that SPN 636, 651–658, 65541–65548, or 65723–7 65724–7 is not set.
⇒ If any of the SPNs are set, refer to *Diagnostic Trouble Code (DTC) List on page 6-11* for further diagnosis.

Note: A misfire may occur only when the engine is under a load. An engine load may be necessary to verify the condition.

3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Verify the following conditions do not exist:
 - Vacuum hose splits, kinks, and incorrect connections
 - Engine vacuum leaks
 - Crankcase ventilation system for vacuum leaks
 - Fuel pressure that is too low or too high—Refer to *Fuel System Diagnosis (with Returnless Fuel System) on page 9-208* or *Fuel System Diagnosis (without Returnless Fuel System) on page 9-210*.
 - Contaminated fuel—Refer to *Alcohol/Contaminants-in-Fuel Diagnosis on page 9-213*.⇒ If you find any of the above conditions, repair as necessary.
2. Ignition OFF, disconnect the spark plug wire from the misfiring cylinder.
3. Install the J 26792 to the boot of a spark plug wire and ground.

Note: An erratic or weak spark is considered a no spark condition.

4. Attempt to start the engine and observe the J 26792. The spark tester should spark.
⇒ If there is no spark, test the spark plug wire for the correct resistance. Refer to *Spark Plug Wire Inspection on page 9-245*. Replace the spark plug wire if necessary. If the spark plug wire tests normal, refer to *Distributor Ignition (DI) System Diagnosis on page 9-214* or *Electronic Ignition System Diagnosis on page 9-215* for diagnosis of the ignition coil.
5. Ignition OFF, remove the spark plug from the misfiring cylinder. Verify the following conditions do not exist:
 - A spark plug that is Gas, coolant, or oil fouled—Refer to *Spark Plug Inspection on page 9-245*.
 - Cracked, worn, incorrectly gapped spark plug.⇒ If there is a condition with the spark plug, replace the spark plug.
6. Exchange the suspected spark plug with another cylinder that is operating correctly.
7. Clear the SPN information with a scan tool. Operate the vehicle within the Conditions for Running the SPN. Observe the scan tool SPN information. The misfire should not follow the spark plug exchange.
⇒ If the misfire follows the spark plug, replace the spark plug.
8. If all conditions test normal, test or inspect for the following:
 - A lean or rich fuel injector—Refer to *Fuel Injector Diagnosis on page 9-211*
 - An engine mechanical condition—Refer to Engine Mechanical.

Repair Instructions

- *Spark Plug Wire Replacement on page 9-245*
- *Spark Plug Replacement on page 9-247*

Repair Verification

1. If the customer concern was a flashing MIL, operate the vehicle within the Conditions for Running SPN 65675 or 65676. Refer to *SPN 65675 or 65676 on page 9-151*.
2. Clear the SPNs 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 SPN. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records.
6. If the SPN fails this ignition, a misfire still exists.

SPN 65601, 65602, or 65610

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65601 FMI 2: Throttle Position (TP) Sensor 2 Data Erratic, Intermittent or Incorrect

SPN 65602 FMI 2: Throttle Position (TP) Sensor 1 Data Erratic, Intermittent or Incorrect

SPN 65610 FMI 2: Throttle Position (TP) Sensor 1 and 2 Data Erratic, Intermittent or Incorrect

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
5-Volt Reference	65623-4	65610-2	65601-2, 65602-2, 65610-2	65601-2, 65602-2, 65605-2, 65610-2, 65613-2	65610-2
TP Sensor 1 Signal	65623-4	65610-2	65602-2, 65610-2	65602-2, 65610-2	65610-2
TP Sensor 2 Signal	65623-4	65610-2	65601-2, 65610-2	65601-2, 65610-2	65610-2
Low Reference	—	65610-2	65601-2, 65602-2, 65610-2	—	65610-2

Typical Scan Tool Data

TP Sensor 1 and 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON and the engine is OFF.			
Parameter Normal Range: TP Sensor 1 1.5 volts, TP sensor 2 3.5 volts			
5-Volt Reference	TP 1 0 volts, TP 2 0.06 volts	TP 1 0 volts, TP 2 0 volts	—
TP Sensor 1 Signal	0 volts	0 volts	4.9 volts
TP Sensor 2 Signal	0 volts	4.9 volts	4.9 volts
Low Reference	0 volts	4.9 volts	4.9 volts

Circuit/System Description

The throttle body assembly contains 2 throttle position (TP) sensors. The TP sensors are mounted to the throttle body assembly and are not serviceable. The TP sensors provide a signal voltage that changes relative to throttle blade angle. The engine control module (ECM) supplies the TP sensors with a common 5-volt reference circuit, a common low reference circuit, and 2 independent signal circuits.

The TP sensors have opposite functionality. TP sensor 1 signal voltage increases from approximately 1.5 volts at idle to above 4 volts at wide open throttle (WOT). TP sensor 2 signal voltage decreases from approximately 3.5 volts at idle to below 1 volt at WOT.

Conditions for Running the SPN

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is running.
- SPNs 65601, 65602, and 65610 run continuously when the conditions above are met.

Conditions for Setting the SPN

65601–2

The ECM detects that the TP sensor 2 voltage is less than 0.25 V or greater than 4.75 V for greater than 247 mS.

65602–2

The ECM detects that the TP sensor 1 voltage is less than 0.25 V or greater than 4.75 V for greater than 247 mS.

65610–2

The ECM detects that the actual TP sensor 1 and TP sensor 2 values disagree by greater than 5 % for greater than 247 mS.

Action Taken When the SPN Sets

- SPN 65601, 65602, and 65610 are type A SPNs.
- The ECM will operate the engine in reduced power mode.
- An indicator may display Reduced Engine Power.

Conditions for Clearing the SPN

SPN 65601, 65602, and 65610 are type A SPNs

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify SPNs 65615, 65620, 65621, 65622, or 65623 is not set.
⇒ If any of the listed SPNs are set, refer to *SPN 65615, 65616, or 65618 on page 9-147* or *SPN 65620-65623 on page 9-149*.
2. Observe both TP Sensor percentage parameters while pressing the accelerator pedal from a closed throttle to WOT. Both TP Sensor percentage parameters should change.
3. Rapidly depress the accelerator pedal from the rest position to the WOT position and release pedal. Repeat the procedure several times. SPNs 65601, 65602, or 65610 should not set.
4. Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed throttle. Repeat the procedure several times. SPNs 65601, 65602, or 65610 should not set.
5. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the throttle body assembly.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal C and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal E and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Verify the following scan tool parameters:
 - TP sensor 1; 0.0 V
 - TP sensor 2; 4.9 V
 - ⇒ If less than the specified range, test the appropriate signal circuit for a short to ground. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the appropriate signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Connect a 3 A fused jumper wire between TP sensor 1 signal circuit terminal F and the 5-volt reference circuit terminal E. Verify the scan tool TP sensor 1 voltage parameter is greater than 4.5 V.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. Connect a 3 A fused jumper wire between TP sensor 2 signal circuit terminal D and ground. Verify the scan tool TP sensor 2 voltage parameter is less than 0.5 V.
 - ⇒ If greater than the specified range, test the signal circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the throttle body assembly.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Throttle Body Assembly Replacement* on page 9-228
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 65604, 65605, or 65613

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65604 FMI 2: Pedal Position (PP) Sensor 2 Data Erratic, Intermittent or Incorrect

SPN 65605 FMI 2: Pedal Position (PP) Sensor 1 Data Erratic, Intermittent or Incorrect

SPN 65613 FMI 2: Pedal Position (PP) Sensor 1 and 2 Data Erratic, Intermittent or Incorrect

Diagnostic Fault Information

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
PP Sensor 1 5-Volt Reference	65623-4	65613-2	65605-2	65601-2, 65602-2, 65605-2, 65610-2, 65613-2	65613-2
PP Sensor 1 Signal	65623-4	65613-2	65605-2, 65613-2	65605-2, 65613-2	65613-2
PP Sensor 1 Low Reference	—	65613-2	65605-2, 65613-2	—	65613-2

Circuit	Short to Ground	High Resistance	Open	Short to Voltage	Signal Performance
PP Sensor 2 5-Volt Reference	65622-4	65613-2	65604-2, 65613-2	106-2, 106-3, 65604-2, 65613-2	65613-2
PP Sensor 2 Signal	65622-4	65613-2	65604-2, 65613-2	65604-2, 65613-2	65613-2
PP Sensor 2 Low Reference	—	65613-2	65604-2	—	65613-2

Typical Scan Tool Data

PP Sensor 1 and 2

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: The ignition is ON and the engine is OFF.			
Parameter Normal Range: PP Sensor 1; 1.0 volts, PP sensor 2; 0.49 volts			
PP 1 5-Volt Reference	0.00 volts	0.00 volts	1.92 volts
PP Sensor 1 Signal	0.00 volts	0.00 volts	4.98 volts
PP 1 Low Reference	—	4.96 volts	*
PP 2 5-Volt Reference	0.00 volts	0.00 volts	1.22 volts
PP Sensor 2 Signal	0.00 volts	0.00 volts	4.98 volts
PP 2 Low Reference	—	4.92 volts	*
* Internal ECM or sensor damage may occur if the circuit is shorted to B+.			

Circuit/System Description

The pedal position sensor assembly contains 2 pedal position (PP) sensors. The PP sensors provide a signal voltage that changes relative to the pedal angle. The engine control module (ECM) supplies each PP sensor with a 5-volt reference circuit, a low reference circuit, and signal circuits.

Both of the PP sensors have positive functionality. The PP sensor 1 signal voltage increases from approximately 1.0 volt at idle to greater than 4 volts at wide open throttle (WOT). While the PP sensor 2 signal voltage increases from approximately 0.5 volts at idle to greater than 2 volts at WOT.

Conditions for Running the SPN

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 10 volts.
- SPNs 65604, 65605, and 65613 run continuously when the conditions above are met.

Conditions for Setting the SPN

65604-2

The ECM detects that the PP sensor 2 voltage is less than 0.5 V or greater than 4.5 V for greater than 247 mS.

65605-2

The ECM detects that the PP sensor 1 voltage is less than 0.5 V or greater than 4.5 V for greater than 247 mS.

65613-2

The ECM detects that the PP sensor 1 and PP sensor 2 values disagree by greater than 8 % for greater than 247 mS.

Action Taken When the SPN Sets

- SPN 65604, 65605, and 65613 are type A SPNs
- The ECM will operate the engine in reduced power mode.
- An indicator may display Reduced Engine Power.

Conditions for Clearing the SPN

SPN 65604, 65605, and 65613 are type A SPNs

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify SPN 65620 or 65621 is not set.
⇒ If either SPN is set, refer to *SPN 65620-65623 on page 9-149*.
2. Observe the PP Sensor percentage parameters with a scan tool. Verify the scan tool PP sensors parameters are at 0 percent.
3. Observe both PP Sensor percentage parameters while pressing the accelerator pedal from a closed pedal to WOT. Both PP Sensor percentage parameters should change.
4. Rapidly depress the accelerator pedal from the rest position to the WOT position and release pedal. Repeat the procedure several times. SPNs 65604, 65605, or 65613 should not set.
5. Slowly depress the accelerator pedal to WOT and then slowly return the pedal to closed pedal. Repeat the procedure several times. SPN 65604, 65605, or 65613 should not set.
6. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the pedal position sensor assembly.
2. Test for less than 5 Ω between the following low reference circuit terminals and ground.
 - PP sensor 1 terminal C
 - PP sensor 2 terminal D

⇒ If greater than the specified range, test the appropriate low reference circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the appropriate 5-volt reference circuit terminal and ground.
 - PP sensor 1 terminal A
 - PP sensor 2 terminal F

⇒ If less than the specified range, test the appropriate 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.

⇒ If greater than the specified range, test the appropriate 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Observe the scan tool PP sensor 1 and PP sensor 2 voltage parameters. Both parameters should display less than 1 volt.

⇒ If greater than the specified range, test the appropriate signal circuit listed below, for a short to voltage. If the circuit tests normal, replace the ECM.

 - PP sensor 1, signal circuit terminal B
 - PP sensor 2, signal circuit terminal E
5. Connect a 3 A fused jumper wire between PP sensor 1 signal circuit terminal B and the 5-volt reference circuit terminal A. Verify the scan tool PP sensor 1 voltage parameter is greater than 4.89 V.

⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. Connect a 3 A fused jumper wire between PP sensor 2 signal circuit terminal E and the 5-volt reference circuit terminal F. Verify the scan tool PP sensor 2 voltage parameter is greater than 4.89 V.

⇒ If less than the specified range, test the signal circuit for an open/high resistance or for a short to ground. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the pedal position sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 65615, 65616, or 65618

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65615 FMI 7: Electronic Throttle Control (ETC) Actuation Fault Mechanical System Not Responding or Out of Adjustment

SPN 65616 FMI 12: Electronic Throttle Control (ETC) Process Fault Bad Intelligent Device or Component

SPN 65618 FMI 7: Electronic Throttle Control (ETC) Return Fault Mechanical System Not Responding or Out of Adjustment

Circuit/System Description

The engine control module (ECM) controls the throttle valve by applying a varying voltage to the control circuits of the throttle actuator control (TAC) motor. The ECM monitors the duty cycle that is required to actuate the throttle valve. The ECM monitors the throttle position (TP) sensors 1 and 2 to determine the actual throttle valve position.

Conditions for Running the SPN

65615–7

- Before the ECM can report that SPN 65615–7 failed, SPNs 65601, 65602, 65610, and 65618–7 must run and pass.
- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The minimum throttle position is learned.
- The ignition voltage is greater than 9 volts.
- SPN 65615 runs continuously when the above conditions are met.

65616–12

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- SPN 65616 runs continuously when the above conditions are met.

65618–7

- Before the ECM can report that SPN 65618–7 failed, SPNs 65601, 65602, and 65610 must run and pass.
- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- SPN 65618 runs continuously when the above conditions are met.

Conditions for Setting the SPN

65615–7

The difference between the commanded and the actual throttle position is greater than 10 percent for greater than 276 mS.

65616–12

The predicted throttle position calculations in the main processor differ from the motor control processor.

65618–7

The ECM detects that the throttle blade did not return to the default position, during power up.

Action Taken When the SPN Sets

- SPN 65615, 65616, and 65618 are Type A SPNs.
- The ECM commands the TAC system to operate in a Reduced Engine Power mode.

Conditions for Clearing the SPN

SPN 65615, 65616, and 65618 are Type A SPNs.

Diagnostic Aids

- Inspect for a condition in which the throttle valve may have been held open. For example, ice may have formed in the throttle bore causing the throttle valve not to close.
- A high resistance condition on the throttle position and throttle actuator control circuits could cause a DTC to set.
- A low battery condition may cause a DTC to set.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify SPN 65601, 65602, 65604, 65605, 65610, or 65613 is not set.
⇒ If any of the SPNs are set refer to *SPN 65601, 65602, or 65610 on page 9-141* or *SPN 65604, 65605, or 65613 on page 9-144* for further diagnosis.
2. Clear the DTCs with a scan tool. Ignition OFF and all vehicle systems OFF.

Note: If there is a condition with the throttle body, the ETC or Governor Motor PWM parameter will display 0.0 % when an SPN sets.

3. Ignition ON, rapidly move the accelerator from the closed throttle position to the wide open throttle (WOT) position and return to the closed throttle. Repeat the procedure several times.
4. Slowly move the accelerator to WOT and then slowly return to closed throttle. Repeat the procedure several times.
5. Observe the DTC information with a scan tool. Verify SPN 65615, 65616, or 65618 is not set.
6. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Warning: Turn OFF the ignition before inserting fingers into the throttle bore. Unexpected movement of the throttle blade could cause personal injury.

1. Ignition OFF, inspect the throttle body for the following conditions:
 - A throttle blade that is not in the rest position
 - A throttle valve that is binding open or closed
 - A throttle valve that opens or closes without spring pressure⇒ If any condition is found, replace the throttle body assembly.

Note: Disconnecting the throttle body harness connector may cause additional SPNs to set.

2. Ignition OFF, disconnect the harness connector at the throttle body assembly.
3. Connect a test lamp between the ETC Motor Control Closed circuit terminal A and ground.
4. Ignition ON, verify that the test lamp flashes once then remains illuminated.
⇒ If the test lamp is always OFF, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If the test lamp illuminates without flashing test the circuit for a short to voltage.
5. Ignition ON, verify that a test lamp illuminates between the ETC Motor Control Open circuit terminal B and ground.
⇒ If the test lamp is always OFF, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. Ignition OFF, disconnect the ECM harness connector X2.
7. Ignition ON, test the ETC Motor Control Open circuit terminal B for a short to voltage or a short to the ETC Motor Control Closed circuit terminal A.
⇒ If a condition exists, repair the circuit as necessary.
8. If all the circuits and connections test normal, replace the throttle body assembly.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Throttle Body Assembly Replacement on page 9-228*
- *Engine Control Module Replacement on page 9-217* for ECM replacement, setup, and programming

SPN 65620-65623

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65620 FMI 4: 5 Volt Reference A Circuit Voltage Below Normal or Shorted Low

SPN 65621 FMI 4: 5 Volt Reference B Circuit Voltage Below Normal or Shorted Low

SPN 65622 FMI 4: 5 Volt Reference C Circuit Voltage Below Normal or Shorted Low

SPN 65523 FMI 4: 5 Volt Reference D Circuit Voltage Below Normal or Shorted Low

Circuit/System Description

The engine control module (ECM) uses two internal 5-volt reference circuits. Each internal reference circuit provides a bussed 5-volts via the external circuits that supply several sensors on each 5 V buss. A short to ground or short to voltage on one of the external 5 V reference circuits may affect the other components connected to the same internal 5 V reference buss. The ECM monitors the 5-volt reference circuits for conditions that pull the 5 V buss above or below a predetermined voltage.

Conditions for Running the SPN

- SPNs 630 or 65580 are not set.
- The ignition is ON, or the engine is running.
- SPNs 65620, 65621, 65622, and 65623 run continuously when the above condition is met.

Conditions for Setting the SPN

The control module detects less than 4.5 volts, on a 5-volt reference circuit for greater than 5 mS.

Action Taken When the SPN Sets

- SPN 65620, 65621, 65622, and 65623 are Type A SPNs.
- The ECM commands the TAC system to operate in a reduced engine power mode.

Conditions for Clearing the SPN

SPN 65620, 65621, 65622, and 65623 are Type A SPNs.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

65620-4

The 5-volt reference A circuit provides 5 volts to the following sensors:

- The barometric pressure (BARO) sensor
- The camshaft position (CMP) sensor(s)
- The engine oil pressure (EOP) sensor
- The variable governor control sensor

65621-4

The 5-volt reference B circuit provides 5 volts to the following sensors:

- The crankshaft position (CKP) sensor
- The supercharger inlet pressure (SCIP) sensor
- The vehicle speed (VSS) sensor
- The general warning sensor 1
- The general warning sensor 2

65622-4

The 5-volt reference C circuit provides 5 volts to the following sensors:

- The manifold absolute pressure (MAP) sensor
- The accelerator pedal position (APP) sensor 2

65623-4

The 5-volt reference D circuit provides 5 volts to the following sensors:

- The throttle position (TP) sensor 1
- The throttle position (TP) sensor 2
- The accelerator pedal position (APP) sensor 1

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. SPNs 65620, 65621, 65622, or 65623 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note: Additional SPNs will set when disconnecting the components.

1. Ignition OFF, disconnect the harness connector at all appropriate sensors for the applicable SPN. Refer to Diagnostic Aids.
2. Ignition ON, test for greater than 4.4 V between one of the 5-volt reference circuits and ground.
 - ⇒ If less than the specified range, test for a short to ground on all the 5-volt reference circuits for each component associated with the appropriate 5-volt reference circuit. If all circuits test normal, replace the control module.

3. Connect each component associated with the 5-volt reference circuit one at a time while monitoring the appropriate scan tool 5 volt reference parameter. The voltage should not change greater than 0.5 volt.

⇒ If less than the specified range when a component is connected, replace the component.

4. If all circuits test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Throttle Body Assembly Replacement on page 9-228*
- *Manifold Absolute Pressure Sensor Replacement (without Supercharger) on page 9-220*
- *Barometric Pressure Sensor Replacement on page 9-221*
- *Crankshaft Position Sensor Replacement (3.0L) on page 9-256 or Crankshaft Position Sensor Replacement (4.3/5.0/5.7L) on page 9-257 or Crankshaft Position Sensor Replacement (6.0/6.2L) on page 9-258 or Crankshaft Position Sensor Replacement (2.4L) on page 9-261*
- *Camshaft Position Sensor Replacement (4.3/5.0/5.7L) on page 9-262 or Camshaft Position Sensor Replacement (with CMP Actuator) on page 9-268 or Camshaft Position Sensor Replacement (without CMP Actuator) on page 9-269 or Camshaft Position Sensor Replacement (2.4L Intake) on page 9-270 or Camshaft Position Sensor Replacement (2.4L Exhaust) on page 9-270*
- *Engine Oil Pressure Sensor Replacement on page 9-225*
- *Supercharger Air Inlet Pressure Sensor Replacement on page 9-222*
- *Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming*

SPN 65675 or 65676

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 65675 FMI 11: Catalytic Converter A Efficiency Root Cause Unknown

SPN 65676 FMI 11: Catalytic Converter B Efficiency Root Cause Unknown

Circuit/System Description

A 3-way catalytic converter (TWC) controls emissions of hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx). The catalyst within the converter promotes a chemical reaction, which oxidizes the HC and the CO that are present in the exhaust gas. This process converts the HC and the CO into water vapor and carbon dioxide (CO₂), and reduces the NOx, converting the NOx into nitrogen. The catalytic converter also stores oxygen. The engine control module (ECM) monitors this process by using a heated oxygen sensor (HO₂S) that is in the exhaust stream after the TWC. The HO₂S 2 produces an output signal that the ECM uses to calculate the oxygen storage capacity of the catalyst. This indicates the ability of the catalyst to convert the exhaust emissions efficiently. The ECM monitors the efficiency of the catalyst by allowing the catalyst to heat, then wait for a stabilization period while the engine is idling. The ECM then adds and removes fuel while monitoring the HO₂S 2. When the catalyst is functioning properly, the HO₂S 2 response to the extra fuel is slow compared to the response of the HO₂S 1, which is located before the TWC. When the HO₂S 2 response is near that of the HO₂S 1, the oxygen storage capability and efficiency of the catalyst may be degraded below an acceptable threshold.

Conditions for Running the SPN

- Before the ECM can report that SPN 65675 or 65676 has failed, SPN 65561, 65562, 65563, 65564, 65567, 65568 and 66019–66022 must run and pass.
- SPN 51, 94, 105, 106, 110, 630, 636, 651–658, 65541–65548, 65561–65568, 65565, 65566, 65580, 65590–65599, 65601, 65602, 65610, 65620, 65621, 65622, 65623, or 65723–65726, is not set.

- The engine has been operating for greater than a calibrated time.
- The long term fuel trim is learned.
- The engine coolant temperature (ECT) is between a calibrated value.
- The manifold air temperature (MAT) is between a calibrated value
- The engine is operating in Closed Loop.
- The engine MAP and RPM is steady within a calibrated value.
- The vessel is operating under a load.
- SPNs 65675 and 65676 attempts one test per ignition cycle when the conditions above have been met.

Conditions for Setting the SPN

The ECM determines that the efficiency of the catalyst has degraded below a calibrated threshold.

Action Taken When the SPN Sets

SPN 65675 and 65676 are Type B SPNs.

Conditions for Clearing the SPN

SPN 65675 and 65676 are Type B SPNs.

Diagnostic Aids

Inspect for the following conditions, which may cause a catalytic converter to degrade:

- An engine misfire
- High engine oil or high coolant consumption
- Retarded spark timing
- A weak or poor spark
- A lean fuel mixture
- A damaged oxygen sensor or wiring harness

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Testing

1. Engine operating, observe the scan tool SPN information. Verify there are no HO2S or misfire SPNs set.
 - ⇒ If any of the SPNs are set, refer to *Diagnostic Trouble Code (DTC) List on page 6-11* to diagnosis the applicable SPN, before proceeding with this diagnostic procedure.
2. Verify the following conditions do not exist with the catalytic converter:
 - Dents
 - A severe discoloration caused by excessive temperatures
 - An internal rattle caused by damaged catalyst substrate
 - Restrictions
 - ⇒ If a condition is found, replace the catalytic converter.

3. Verify the following conditions do not exist with the exhaust system:
 - Leaks
 - Physical damage
 - Loose or missing hardware
 - Water intrusion or terminal corrosion within the HO2S harness connectors
 - Properly torqued HO2S
 - ⇒ If a condition is found, repair the exhaust system.
4. Verify the following conditions do not exist with the HO2S 2:
 - A grounded wiring harness
 - Damage
 - ⇒ If a condition is found, replace the HO2S 2.
5. If no physical condition is detected perform the following:
 - 5.1. Operate the engine at 2,000 RPM for 5 minutes under a load
 - 5.2. Allow the engine to return to a stabilized idle.
 - 5.3. Verify that the HO2S 2 is not as active as the HO2S 1.
 - ⇒ If the HO2S 2 is as active as the HO2S 1, then replace the catalytic converter.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

SPN 65690

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65690 FMI 3: Variable Governor Control Voltage Above Normal or Shorted High

SPN 65690 FMI 4: Variable Governor Control Voltage Below Normal or Shorted Low

Circuit/System Description

The variable governor control switch is used on vessels equipped with cruise control to adjust the cruise speed. The ECM supplies the variable governor control switch with a 5-volt reference circuit and a low reference circuit. The variable governor control switch supplies a signal voltage to the ECM that varies dependent upon switch rotation. As The variable governed control switch is rotated, the signal voltage increases, or decreases depending on the cruise control speed that is desired. The ECM controls the cruise speed with the throttle actuator control (TAC) system.

Conditions for Running the SPN

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- SPN 65690 runs continuously when the conditions above are met for greater than 5 seconds.

Conditions for Setting the SPN

65690-3

The ECM detects the variable governor control signal voltage is greater than a calibrated value for greater than 5 seconds.

65690-4

The ECM detects the variable governor control signal voltage is less than a calibrated value for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 65690 is a Type C SPN.

Conditions for Clearing the SPN

SPN 65690 is a Type C SPN.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65620, 65621, 65622, or 65623 is not set.
⇒ If either SPN is set, refer to *SPN 65620-65623 on page 9-149*.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the variable governor control sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal C and ground.
⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal A and ground.
⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

4. Verify the scan tool variable governor control sensor voltage parameter is less than 0.5 V.
⇒ If greater than the specified range, test the signal circuit terminal B for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal B and the 5-volt reference circuit terminal A. Verify the scan tool variable governor control sensor voltage parameter is greater than 4.8 V.
⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, replace the variable governor control sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.
Engine Control Module Replacement on page 9-217 for engine control module replacement, setup, and programming

SPN 65701 or 65702

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65701 FMI 31: General Warning Sensor 1 Not Available

SPN 65702 FMI 31: General Warning Sensor 2 Not Available

Circuit/System Description

The general warning sensor changes resistance based on position. The engine control module (ECM) monitors the signal circuit from the general warning sensor. The ECM supplies 5-volts to the general warning sensor on the 5-volt reference circuit. The ECM also provides a ground on the low reference circuit. The general warning sensor provides a signal to the ECM on the signal circuit which is relative to changes in position. The component that the general warning sensor monitors may vary between manufacturers.

Conditions for Running the SPN

- SPN 630, 65580, 65620, 65621, 65622, or 65623 is not set.
- The ignition is ON, or the engine is operating.
- The SPNs 65701 and 65702 run continuously when the above conditions are met for greater than 5 seconds.

Conditions for Setting the SPN

The ECM detects the general warning sensor voltage is less than, or greater than, a calibrated value for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 65701 and 65702 are Type C SPNs.

Conditions for Clearing the SPN

SPN 65701 and 65702 are Type C SPNs.

Diagnostic Aids

If a shared 5-volt reference circuit is shorted to ground or shorted to a voltage, other 5-volt reference circuits may be affected.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. Verify that SPN 65620, 65621, 65622, or 65623 is not set.
⇒ If either SPN is set, refer to *SPN 65620-65623 on page 9-149*.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the general warning sensor.
2. Ignition OFF, test for less than 5 Ω between the low reference circuit terminal and ground.
⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal and ground.
⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or open/high resistance. If the circuit tests normal, replace the ECM.
⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.

4. Test for less than 0.5 V between the signal circuit terminal and ground.
⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal and the 5-volt reference circuit terminal. Verify the scan tool general warning sensor voltage parameter is greater than 4.8 V.
⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, replace the general warning sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification on page 6-22* after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for engine control module replacement, setup, and programming

SPN 65710

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65710 FMI 31: Emergency Stop Warning Not Available

Circuit/System Description

The engine control module (ECM) applies a voltage to the emergency stop switch circuit. The ECM monitors the status of the emergency stop switch circuit. When the emergency stop switch is removed, the ECM detects a high signal voltage and will limit the engine speed output or stop the engine.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The engine is operating.
- SPN 65710 runs continuously when the above condition is met for greater than 5 seconds.

Conditions for Setting the SPN

The ECM detects the emergency stop voltage is greater than a calibrated value for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 65710 is a Type C SPN.

Conditions for Clearing the SPN

SPN 65710 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, observe the scan tool emergency stop parameter. The parameter should display ON.
2. Observe the scan tool SPN information. SPN 65710 should not be set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the emergency stop switch harness connector.
2. Test for less than 5 Ω between the emergency stop switch ground circuit terminal B and ground.
⇒ If greater than the specified range, test the emergency stop switch ground circuit for an open/high resistance.
3. Ignition ON, test for greater than 4 V between the emergency stop switch signal circuit terminal A and ground.
⇒ If less than the specified range, test the emergency stop switch signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, replace the emergency stop switch.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.
Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 65723, 65724, 65725, or 65726 (3.0/4.3/5.0/5.7L)**Diagnostic Instructions**

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 65723 FMI 2: Camshaft Position (CMP) Sensor Circuit Data Erratic, Intermittent or Incorrect

SPN 65723 FMI 7: Camshaft Position (CMP) Sensor Mechanical System Not Responding or Out of Adjustment

SPN 65723 FMI 8: Camshaft Position (CMP) Sensor Signal Abnormal Frequency or Pulse Width

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	65620-4	636-8	100-17	—
CMP Sensor Signal	65723-8	65723-8	65723-8	636-2, 65723-2, 65723-7
Low Reference	—	65723-8	—	—

Circuit/System Description

The 4X camshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with 2 narrow, and 2 wide output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control the camshaft position actuator if equipped, and for limp-home operation.

Conditions for Running the SPN**65723-2 and 65723-8**

- SPN 630, 65580, 65620, or 65621, 65622, or 65623 is not set.
- The engine is cranking or running.
- SPN 65723 runs continuously once the above conditions are met.

65723-7

- SPN 630, 65580, 65620, or 65621, 65622, or 65623 is not set.
- The engine speed is greater than 1,000 RPM.
- SPN 65723-7 runs continuously once the above conditions are met.

Conditions for Setting the SPN**65723-2**

The ECM detects an incorrect number of CMP reference pulses for greater than 49 engine revolutions.

65723-7

The ECM detects the CMP sensor signal is out of range compared to the CKP sensor signal for greater than 49 engine revolutions.

65723-8

The ECM does not detect a signal from the CMP sensor for greater than 49 engine revolutions.

Action Taken When the SPN Sets

SPN 65723 is a Type B SPN.

Closed Loop not enabled

Conditions for Clearing the SPN

SPN 65723 is a Type B SPN.

Diagnostic Aids

The following conditions may also set the SPNs:

- Physical damage to the CMP sensor or the reluctor wheel
- Excessive play or looseness of the CMP sensor or the reluctor wheel
- A distributor that is installed improperly
- Improper installation of the CMP sensor or the reluctor wheel
- Foreign material passing between the CMP sensor and the reluctor wheel
- Excessive air gap between the CMP sensor and the reluctor wheel

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: If you were sent here from Engine Cranks but Does Not Run, proceed to Circuit/System Testing.

1. Attempt to start the engine, observe the SPN information with a scan tool. SPN 65723–2 and 65723–8 should not set.
2. Engine speed greater 1,000 RPM, observe the SPN information with a scan tool. SPN 65723–7 should not set.
 - ⇒ If SPN 65723–7 is set, perform the camshaft retard offset procedure—Refer to *Camshaft Retard Offset Adjustment (3.0L and 4.3L) on page 9-255* or *Camshaft Retard Offset Adjustment (5.0L and 5.7L) on page 9-255*.

3. Move related harnesses/connectors of the CMP sensor and verify the engine does not stumble, stall, or change engine speed.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the CMP sensor.
2. Test for less than 5 Ω between the low reference circuit terminal A and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal C and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, test for 4.8–5.2 V between the signal circuit terminal B and ground.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, replace the CMP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Camshaft Position Sensor Replacement (4.3/5.0/5.7L) on page 9-262* or *Camshaft Position Sensor Replacement (with CMP Actuator) on page 9-268* or *Camshaft Position Sensor Replacement (without CMP Actuator) on page 9-269* or *Camshaft Position Sensor Replacement (2.4L Intake) on page 9-270* or *Camshaft Position Sensor Replacement (2.4L Exhaust) on page 9-270*
- *Engine Control Module Replacement on page 9-217* for ECM replacement, setup, and programming

SPN 65723, 65724, 65725, or 65726 (2.4/6.0/6.2L)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

- SPN 65723 FMI 2:** Camshaft Position (CMP) Sensor Circuit Data Erratic, Intermittent or Incorrect
- SPN 65723 FMI 7:** Camshaft Position (CMP) Sensor Mechanical System Not Responding or Out of Adjustment
- SPN 65723 FMI 8:** Camshaft Position (CMP) Sensor Signal Abnormal Frequency or Pulse Width
- SPN 65724 FMI 2:** Camshaft Position (CMP) Sensor Circuit Data Erratic, Intermittent or Incorrect
- SPN 65724 FMI 7:** Camshaft Position (CMP) Sensor Mechanical System Not Responding or Out of Adjustment
- SPN 65724 FMI 8:** Camshaft Position (CMP) Sensor Signal Abnormal Frequency or Pulse Width

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference Circuit	65620-4	65723-8, 65724-8	100-17, 108-3	—
CMP Sensor Signal	65723-8, 65724-8	65723-8, 65724-8	65723-8, 65724-8	636-2, 65723-2, 65723-7, 65724-2, 65724-7
Low Reference	—	65723-8, 65724-8	—	—

Circuit/System Description

The 4X camshaft position sensor circuits consist of an engine control module (ECM) supplied 5 V reference circuit, low reference circuit, and an output signal circuit. The camshaft position sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes between the peaks and valleys of a 4-tooth reluctor wheel attached to the camshaft. As each reluctor wheel tooth rotates past the camshaft position sensor, the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The sensor returns a digital ON/OFF DC voltage pulse of varying frequency, with 2 narrow, and 2 wide output pulses per camshaft revolution that represent an image of the camshaft reluctor wheel. The frequency of the camshaft position sensor output depends on the velocity of the camshaft. The ECM decodes the narrow and wide tooth pattern to identify camshaft position. This information is then used to sequence the ignition timing and fuel injection events for the engine. The ECM also uses camshaft position sensor output information to determine the camshaft relative position to the crankshaft, to control the camshaft position actuator if equipped, and for limp-home operation.

Conditions for Running the SPN

65723-2, 65723-8 65724-2, and 65724-8

- SPN 630, 65580, 65620, or 65621, 65622, or 65623 is not set.
- The engine is cranking or running.
- SPN 65723 runs continuously once the above conditions are met.

65723-7 and 65724-7

- SPN 630, 65580, 65620, or 65621, 65622, or 65623 is not set.
- The engine speed is greater than 1,000 RPM.
- SPN 65723-7 runs continuously once the above conditions are met.

Conditions for Setting the SPN

65723-2 and 65714-2

The ECM detects an incorrect number of CMP reference pulses for greater than 49 engine revolutions.

65723-7 and 65724-7

The ECM detects the CMP sensor signal is out of range compared to the CKP sensor signal for greater than 49 engine revolutions.

65723–8 and 65724–8

The ECM does not detect a signal from the CMP sensor for greater than 49 engine revolutions.

Action Taken When the SPN Sets

SPN 65723 and 65724 are Type B SPNs.

- Closed Loop not enabled
- Cam phaser not enabled

Conditions for Clearing the SPN

SPN 65723 and 65724 are Type B SPNs.

Diagnostic Aids

The following conditions may also set the SPNs:

- Physical damage to the CMP sensor or the reluctor wheel
- Excessive play or looseness of the CMP sensor or the reluctor wheel
- A distributor that is installed improperly
- Improper installation of the CMP sensor or the reluctor wheel
- Foreign material passing between the CMP sensor and the reluctor wheel
- Excessive air gap between the CMP sensor and the reluctor wheel

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: If you were sent here from Engine Cranks but Does Not Run, proceed to Circuit/System Testing.

1. Attempt to start the engine, observe the SPN information with a scan tool. SPN 65723–2, 65723–8, 65724–2, or 65724–8 should not set.

2. Engine speed greater 1,000 RPM, observe the SPN information with a scan tool. SPN 65723–7 or 65724–7 should not set.
3. Move related harnesses/connectors of the CMP sensor and verify the engine does not stumble, stall, or change engine speed.
4. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the CMP sensor.
2. Test for less than 5 Ω between the low reference circuit terminal B and ground.
 - ⇒ If greater than the specified range, test the low reference circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
3. Ignition ON, test for 4.8–5.2 V between the 5-volt reference circuit terminal A and ground.
 - ⇒ If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Ignition ON, test for 4.8–5.2 V between the signal circuit terminal C and ground.
 - ⇒ If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, replace the CMP sensor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Camshaft Position Sensor Replacement (4.3/5.0/5.7L) on page 9-262 or Camshaft Position Sensor Replacement (with CMP Actuator) on page 9-268 or Camshaft Position Sensor Replacement (without CMP Actuator) on page 9-269 or Camshaft Position Sensor Replacement (2.4L Intake) on page 9-270 or Camshaft Position Sensor Replacement (2.4L Exhaust) on page 9-270*
- *Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming*

SPN 66002

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66002 FMI 4: Starter Relay High Side Driver Voltage Below Normal or Shorted Low

SPN 66002 FMI 5: Starter Relay High Side Driver Current Below Normal or Open Circuit

Circuit/System Description

The Starter Relay, is controlled by the engine control module (ECM) depending upon input from the ignition switch. When the ignition switch is rotated to the crank position, a voltage is applied to the neutral start switch. With the neutral switch in the closed position the ECM will receive a crank signal. The ECM will then supply a voltage to the control circuit of the crank relay. When this occurs, battery voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid. The starter relay control circuit is equipped with a feedback circuit that is pulled up to 2.5 volts within the ECM. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater 9 volts.
- The relay has been commanded ON and OFF at least once during the ignition cycle.
- SPN 66002 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 seconds.

Action Taken When the SPN Sets

SPN 66002 is a Type C SPN.

Conditions for Clearing the SPN

SPN 66002 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

J 43244 Relay Puller Pliers

Circuit/System Verification

1. Ignition ON, observe the SPN information with a scan tool. SPN 66002–4, or 66002–5 should not set.
2. Cycle the ignition from RUN to CRANK. The engine should crank, or you should hear and feel an audible click from the starter relay. Repeat as necessary in order to verify starter relay operation.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the starter relay with the *J 43244*.
2. Test for less than 5 Ω between the ground circuit terminal 86 and ground.
 - ⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
3. Connect a test lamp between the starter relay control circuit terminal 85 and ground.
4. Ignition ON, cycle the ignition from RUN to CRANK. verify a test lamp illuminates when the ignition is cycled to CRANK.
 - ⇒ If the test lamp does not illuminate, test the relay control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If the test lamp is always ON, test the relay coil control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the starter relay.

Component Testing

1. Ignition OFF, disconnect the starter relay with the *J 43244*.
2. Test for 70–110 Ω between terminals 85 and 86.
 - ⇒ If not within the specified range, replace the starter relay.

3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - ⇒ If not the specified value, replace the starter relay.
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
 - ⇒ If greater than the specified range, replace the starter relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66003

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66003 FMI 3: Malfunction Indicator Lamp (MIL) Driver Voltage Above Normal or Shorted High

SPN 66003 FMI 5: Malfunction Indicator Lamp (MIL) Driver Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
MIL Voltage Supply	*	66003-5	—	—
MIL Control	66003-5	66003-5	66003-3	—

* The fuse that supplies voltage to the IPC/Bulb opens.

Circuit/System Description

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). Ignition voltage is supplied to the MIL through a fuse. The engine control module (ECM) turns the MIL ON by grounding the MIL control circuit. There should be a steady MIL with the ignition ON and the engine OFF.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The MIL has been commanded ON and OFF at least once during the ignition cycle.
- SPN 66003 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66003 is a Type B SPN.

Conditions for Clearing the SPN

SPN 66003 is a Type B SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the MIL ON and OFF with a scan tool. The MIL should turn ON and OFF.
2. Observe the SPN information with a scan tool. SPN 66003 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition ON, verify that no other indicators are inoperative.
⇒ If any other indicators are inoperative, repair the ignition supply voltage circuit.
2. Ignition OFF, disconnect the ECM harness connector X1.

3. Ignition ON, the MIL should not illuminate.
⇒ If the MIL illuminates, repair the MIL control circuit for a short to ground.
4. Ignition ON, connect a 3 A fused jumper wire between the MIL control circuit terminal X1-52 and ground. The MIL should illuminate.
⇒ If the MIL does not illuminate, test the MIL control circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the IPC/Bulb.
5. If all of the circuits/connections test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.
Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66004

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66004 FMI 3: Service Vehicle Soon Lamp (SVS) Voltage Above Normal or Shorted High

SPN 66004 FMI 5: Service Vehicle Soon Lamp (SVS) Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
SVS Voltage Supply	*	66004-5	—	—
SVS Control	66004-5	66004-5	66004-3	—

* The fuse that supplies voltage to the IPC/Bulb opens.

Circuit/System Description

The Service Vehicle Soon (SVS) Lamp is located on the instrument panel cluster (IPC). Ignition voltage is supplied to the SVS lamp through a fuse. The engine control module (ECM) turns the SVS lamp ON by grounding the control circuit. There should be a steady SVS lamp with the ignition ON and the engine OFF.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The SVS lamp has been commanded ON and OFF at least once during the ignition cycle.
- SPN 66004 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66004 is a Type C SPN.

Conditions for Clearing the SPN

SPN 66004 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the SVS lamp ON and OFF with a scan tool. The SVS lamp should turn ON and OFF.
2. Observe the SPN information with a scan tool. SPN 66004 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition ON, verify that no other indicators are inoperative.
⇒ If any other indicators are inoperative, repair the ignition supply voltage circuit.
2. Ignition OFF, disconnect the ECM harness connector X3.

3. Ignition ON, the SVS lamp should not illuminate.
⇒ If the SVS illuminates, test the SVS control circuit for a short to ground.
4. Ignition ON, connect a 3 A fused jumper wire between the SVS lamp control circuit terminal X3-8 and ground. The SVS should illuminate.
⇒ If the SVS lamp does not illuminate, test the SVS control circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the IPC/Bulb.
5. If all the circuit/connections test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.
Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66005

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66005 FMI 3: Governor Status Lamp (GSL) Voltage Above Normal or Shorted High

SPN 66005 FMI 5: Governor Status Lamp (GSL) Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
GSL Voltage Supply	*	66005-5	—	—
GSL Control	66005-5	66005-5	66005-3	—

* The fuse that supplies voltage to the IPC/Bulb opens.

Circuit/System Description

The Governor Status Lamp (GSL) is located on the instrument panel cluster (IPC). Ignition voltage is supplied to the GSL through a fuse. The engine control module (ECM) turns the GSL ON by grounding the control circuit. There should be a steady GSL with the ignition ON and the engine OFF.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The GSL has been commanded ON and OFF at least once during the ignition cycle.
- SPN 66005 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66005 is a Type C SPN.

Conditions for Clearing the SPN

SPN 66005 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the GSL ON and OFF with a scan tool. The GSL should turn ON and OFF.
2. Observe the SPN information with a scan tool. SPN 66005 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition ON, verify that no other indicators are inoperative.
⇒ If any other indicators are inoperative, repair the ignition supply voltage circuit.
2. Ignition OFF, disconnect the ECM harness connector X1.

3. Ignition ON, the GSL should not illuminate.
⇒ If the GSL illuminates, repair the GSL control circuit for a short to ground.
4. Ignition ON, connect a 3 A fused jumper wire between the GSL control circuit terminal X1-56 and ground. The GSL should illuminate.
⇒ If the GSL does not illuminate, test the GSL control circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the IPC/Bulb.
5. If all the circuit/connections test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.
Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66007

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66007 FMI 3: Buzzer Driver Short Voltage Above Normal or Shorted High

SPN 66007 FMI 5: Buzzer Driver Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Buzzer Voltage Supply	*	66007-5	—	—
Buzzer Control	66007-5	66007-5	66007-3	—

* The fuse that supplies voltage to the IPC/Bulb opens.

Circuit/System Description

The Buzzer is located on the driver information center (DIC). Ignition voltage is supplied directly to the Buzzer. The engine control module (ECM) turns the Buzzer ON by grounding the control circuit.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The Buzzer has been commanded ON and OFF at least once during the ignition cycle.
- The SPNs run continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66007 is a Type C SPN.

Conditions for Clearing the SPN

SPN 66007 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the buzzer ON and OFF with a scan tool. The buzzer should turn ON and OFF.
2. Observe the SPN information with a scan tool. SPN 66007 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition ON, verify that no other indicators are inoperative.
⇒ If any other indicators are inoperative, repair the ignition supply voltage circuit.
2. Ignition OFF, disconnect the ECM harness connector X1.

3. Ignition ON, the buzzer should not sound.
⇒ If the buzzer sounds, test the buzzer control circuit for a short to ground.
4. Ignition ON, connect a 3 A fused jumper wire between the buzzer control circuit terminal X1-54 and ground. The buzzer should sound.
⇒ If the buzzer does not sound, test the buzzer control circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the buzzer.
5. If all the circuit/connections test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.
Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66006, 66008, or 6609

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66006 FMI 3: DTC Lamp 3 Voltage Above Normal or Shorted High

SPN 66006 FMI 5: DTC Lamp 3 Current Below Normal or Open Circuit

SPN 66008 FMI 3: DTC Lamp 1 Voltage Above Normal or Shorted High

SPN 66008 FMI 5: DTC Lamp 1 Current Below Normal or Open Circuit

SPN 66009 FMI 3: DTC Lamp 2 Voltage Above Normal or Shorted High

SPN 66009 FMI 5: DTC Lamp 2 Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
DTC 1 Lamp Voltage Supply	*	66008-5	—	—
DTC 2 Lamp Voltage Supply	*	66009-5	—	—
DTC 3 Lamp Voltage Supply	*	66006-5	—	—
DTC 1 Lamp Control	66008-5	66008-5	66008-3	—
DTC 2 Lamp Control	66009-5	66009-5	66009-3	—
DTC 3 Lamp Control	66006-5	66006-5	66006-3	—
* The fuse that supplies voltage to the IPC/Bulb opens.				

Circuit/System Description

The DTC 1, 2, and 3 lamps are located in the instrument panel cluster (IPC). Ignition voltage is supplied to the DTC lamps through a fuse. The engine control module (ECM) turns the DTC lamps ON by grounding a dedicated control circuit for each lamp.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The DTC lamp has been commanded ON and OFF at least once during the ignition cycle.
- SPNs 66006, 66008, and 66009 run continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPNs 66006, 66008, and 66009 are Type C SPNs.

Conditions for Clearing the SPN

SPNs 66006, 66008, and 66009 are Type C SPNs.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the appropriate DTC lamp ON and OFF with a scan tool. The DTC lamp should turn ON and OFF as commanded.
2. Observe the SPN information with a scan tool. SPN 66006, 66008, or 66009 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition ON, verify that no other indicators are inoperative.
⇒ If any other indicators are inoperative, repair the ignition supply voltage circuit.
2. Ignition OFF, disconnect the ECM harness connectors.
3. Ignition ON, the DTC lamps should not illuminate.
⇒ If a DTC lamp illuminates, test the appropriate DTC lamp control circuit for a short to ground.

4. Ignition ON, connect a 3 A fused jumper wire between ground and a DTC lamp control circuit terminal listed below:
 - DTC 1 lamp control circuit terminal X1-51
 - DTC 2 lamp control circuit terminal X3-9
 - DTC 3 lamp control circuit terminal X3-14The DTC lamp should illuminate.
⇒ If the DTC lamp does not illuminate, test the appropriate DTC lamp control circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the IPC/Bulb.
5. If all the circuit/connections test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66010

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66010 FMI 3: Slow Mode Lamp Voltage Above Normal or Shorted High

SPN 66010 FMI 5: Slow Mode Lamp Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Slow Mode Lamp Voltage Supply	*	66010-5	—	—
Slow Mode Lamp Control	66010-5	66010-5	66010-3	—

* The fuse that supplies voltage to the IPC/Bulb opens.

Circuit/System Description

The slow mode lamp is located on the instrument panel cluster (IPC). Ignition voltage is supplied to the slow mode lamp through a fuse. The engine control module (ECM) turns the slow mode lamp ON by grounding the control circuit.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The Slow Mode lamp has been commanded ON and OFF at least once during the ignition cycle.
- SPN 66010 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66010 is a Type C SPN.

Conditions for Clearing the SPN

SPN 66010 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the Slow Mode lamp ON and OFF with a scan tool. The Slow Mode lamp should turn ON and OFF.
2. Observe the SPN information with a scan tool. SPN 66010 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition ON, verify that no other indicators are inoperative.
 - ⇒ If any other indicators are inoperative, repair the ignition supply voltage circuit.
2. Ignition OFF, disconnect the ECM harness connector X3.
3. Ignition ON, the slow mode lamp should not illuminate.
 - ⇒ If the slow mode lamp illuminates, repair the slow mode lamp control circuit for a short to ground.

4. Ignition ON, connect a 3 A fused jumper wire between the slow mode lamp control circuit terminal X3-12 and ground. The slow mode lamp should illuminate.
 - ⇒ If the slow mode lamp does not illuminate, test the slow mode lamp control circuit for a short to voltage or an open/high resistance. If the circuit test normal, replace the IPC/Bulb.
5. If all the circuit/connections test normal, replace the ECM.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66011

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66011 FMI 3: Speed Based Output Voltage Above Normal or Shorted High

SPN 66011 FMI 5: Speed Based Output Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Voltage Supply	*	66011-5	—	—
Control	66011-5	66011-5	66011-3	—

* The fuse that supplies voltage to the device opens.

Circuit/System Description

This SPN diagnosis the control circuit of an OEM specified speed based component. Ignition voltage is supplied to the component through a fuse. The engine control module (ECM) turns the component ON or OFF by grounding and ungrounding the control circuit based on engine or vehicle speed. The ECM controls the component by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The component has been commanded ON and OFF during the ignition cycle.
- SPN 66011 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66011 is a Type C SPN.

Conditions for Clearing the SPN

SPN 66011 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the speed based component ON and OFF with a scan tool. The component should turn ON and OFF.
2. Observe the SPN information with a scan tool. SPN 66011-3 or 66011-5 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector to the speed based component.
2. Ignition ON, verify a test lamp illuminates between the ignition voltage supply circuit terminal and ground.
 - ⇒ If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Connect a test lamp between the control circuit terminal and B+. The test lamp should not illuminate.
 - ⇒ If the test lamp is always ON, test the control circuit for a short to ground. If the circuit/connections test normal, replace the ECM.

4. Command the speed based component ON and OFF with a scan tool. The test lamp should illuminate and turn OFF as commanded.
 - ⇒ If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Test for 3.0-4.0 V between the control circuit terminal and ground.
 - ⇒ If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. If all the circuit/connections test normal, test or replace the speed based component.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66012

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66012 FMI 3: Trans UpShift Output Voltage Above Normal or Shorted High

SPN 66012 FMI 5: Trans UpShift Output Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Trans Upshift Output Voltage Supply	*	66012-5	—	—
Trans Upshift Output Control	66012-5	66012-5	66012-3	—

* The fuse that supplies voltage to the device opens.

Circuit/System Description

Ignition voltage is supplied to the transmission shift lock-out solenoid through a fuse. The engine control module (ECM) turns the solenoid ON or OFF by grounding and ungrounding the control circuit based on engine speed and load. The ECM controls the solenoid by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is between 10–16 volts.
- The component has been commanded ON and OFF during the ignition cycle.
- SPN 66012 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66012 is a Type C SPN.

Conditions for Clearing the SPN

SPN 66012 is a Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the transmission shift lock-out solenoid ON and OFF with a scan tool. The solenoid should turn ON and OFF as commanded.
2. Observe the SPN information with a scan tool. SPN 66012-3 or 66012-5 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the trans shift solenoid.
2. Ignition ON, verify a test lamp illuminates between the ignition voltage supply circuit terminal and ground.
 - ⇒ If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition circuit fuse is open, test all the components connected to the ignition circuit and replace as necessary.
3. Connect a test lamp between the control circuit terminal and B+. The test lamp should not illuminate.
 - ⇒ If the test lamp is always ON, test the control circuit for a short to ground. If the circuit/connections test normal, replace the ECM.

4. Command the trans shift solenoid ON and OFF with a scan tool. The test lamp should illuminate and turn OFF as commanded.
 - ⇒ If the test lamp is always OFF, test the control circuit for an open/high resistance. If the circuit/connections test normal, replace the ECM.
5. Test for 3.0-4.0 V between the control circuit terminal and ground.
 - ⇒ If not within the specified range, test the control circuit for a short to voltage. If the circuit/connections test normal, replace the ECM.
6. If all the circuit/connections test normal, test or replace the trans shift solenoid.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66013 or 66014

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66013 FMI 3: Powertrain Relay Voltage Above Normal or Shorted High

SPN 66013 FMI 5: Powertrain Relay Current Below Normal or Open Circuit

SPN 66014 FMI 4: Powertrain Relay Contact Voltage Below Normal or Shorted Low

Circuit/System Description

The Powertrain (PT) Relay, or MEFI relay, is controlled by the engine control module (ECM) depending upon input from the ignition switch. Battery positive voltage is supplied to the relay coil and switch. When the ignition switch is turned to the ON position, the ECM will provide ground on the control circuit of the relay with a low side driver. This will allow voltage through the relay switch contacts to the MEFI components. The ECM monitors the voltage level on the control circuit of the relay.

Conditions for Running the SPN

66013-3 and 66013-5

- SPN 630 and 65580 are not set.
- The relay has been commanded ON and OFF at least once during the ignition cycle.
- The ignition voltage is greater than 9 volts.
- SPN 66013 runs continuously once the above conditions are met.

66014-4

- SPN 630 and 65580 are not set.
- The ignition is ON, or the engine is operating.
- SPN 66014 runs continuously once the above conditions are met for greater than 1 second.

Conditions for Setting the SPN

66013-3 and 66013-5

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

66014-4

- The ECM detects greater than 3 volts on the PT relay output circuit when the relay has been commanded OFF.
OR
- The ECM detects 5 volts or less on the PT relay output circuit when the relay has been commanded ON.

Action Taken When the SPN Sets

SPNs 66013 and 66014 are Type B SPNs.

Conditions for Clearing the SPN

SPNs 66013 and 66014 are Type B SPNs.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

J 43244 Relay Puller Pliers

Circuit/System Verification

Note: If you were sent here from Engine Cranks But Does Not Run proceed to Circuit/System Testing.

1. Ignition ON, observe the SPN information with a scan tool. SPN 66013, or 66014 should not set.
2. Cycle the ignition from OFF to ON. You should hear and feel an audible click from the powertrain (MEFI) relay. Repeat as necessary in order to verify powertrain relay operation.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the powertrain (MEFI) relay with the J 43244.
2. Ignition ON, verify a test lamp illuminates between the relay coil ignition circuit terminal 86 and ground.
 - ⇒ If the test lamp does not illuminate, test the relay coil ignition circuit for a short to ground or an open/high resistance.
3. Ignition OFF, connect a test lamp between the relay coil control circuit terminal 85 and the relay coil ignition circuit terminal 86.
 - ⇒ If the test lamp is always ON, test the relay coil control circuit for a short to ground. If the circuit tests normal, replace the ECM.
4. Ignition ON, the test lamp should illuminate.
 - ⇒ If the test lamp is always OFF, test the relay coil control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. Connect a 20 A fused jumper wire between the relay switch B+ circuit terminal 30 and the relay switch ignition voltage circuit terminal 87.
6. Attempt to start the engine. The engine should start.
 - ⇒ If the engine does not start, test the relay switched ignition voltage circuit between the MEFI relay and the ECM for a short to ground or for an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the powertrain (MEFI) relay.

Component Testing

1. Ignition OFF, disconnect the powertrain (MEFI) relay with the J 43244.
2. Test for 70–110 Ω between terminals 85 and 86.
 - ⇒ If not within the specified range, replace the powertrain relay.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - ⇒ If not the specified value, replace the relay.
4. Install a 20 A fused jumper wire between relay terminal 85 and B+. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
 - ⇒ If greater than the specified range, replace the powertrain relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Relay Replacement (Fuse Block)* on page 11-28 or *Relay Replacement (Harness)* on page 11-29
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 66017

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 66017 FMI 4: Fuel Pump Relay 1 Voltage Below Normal or Shorted Low

SPN 66017 FMI 5: Fuel Pump Relay 1 Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Voltage – Relay Switch	1	2	—	—
Fuel Pump Supply Voltage	1	2	3	—
Fuel Pump Relay 1 Control	66017–4	66017–5	3	—
Fuel Pump Ground	—	2	—	—

1. The fuel pump fuse opens and the engine cranks but does not run.
2. The engine cranks but does not run.
3. The fuel pump operates continuously and the battery will discharge.

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the coil side of the fuel pump relay whenever the engine is cranking or running. The control module enables the fuel pump relay as long as the engine is cranking or running, and ignition system reference pulses are received. If no ignition system reference pulses are received, the control module turns OFF the fuel pump. The fuel pump relay control circuit is equipped with a feedback circuit that is pulled up to a voltage within the ECM. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The ECM has commanded the fuel pump relay ON and OFF at least once during the ignition cycle.
- SPN 66017 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 seconds.

Action Taken When the SPN Sets

SPN 66017 is a Type B SPN.

Conditions for Clearing the SPN

SPN 66017 is a Type B SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

J 43244 Relay Puller Pliers

Circuit/System Verification

1. Cycle the ignition from OFF to ON. You should hear and feel an audible click from the fuel pump relay. Repeat as necessary in order to verify fuel pump relay operation.
2. Ignition ON, command the fuel pump relay ON and OFF with a scan tool. Verify SPN 66017 is not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the fuel pump relay 1 with the *J 43244*.
2. Test for less than 5 Ω between the ground circuit terminal 86 and ground.
⇒ If greater than the specified range, test the ground circuit for an open/high resistance.
3. Connect a test lamp between the relay coil control circuit terminal 85 and ground.
4. Ignition ON, command the fuel pump ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
⇒ If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the fuel pump relay 1.

Component Testing

1. Ignition OFF, disconnect the fuel pump relay 1 with the *J 43244*.
2. Test for 70–110 Ω between terminals 85 and 86.
⇒ If not within the specified range, replace the fuel pump relay 1.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 ⇒ If not within the specified range, replace the fuel pump relay 1.
4. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
⇒ If greater than the specified range, replace the relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Relay Replacement (Fuse Block)* on page 11-28 or *Relay Replacement (Harness)* on page 11-29
- *Engine Control Module Replacement* on page 9-217 for engine control module replacement, setup, and programming

SPN 66018

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66018 FMI 3: Tachometer Voltage Above Normal or Shorted High

SPN 66018 FMI 5: Tachometer Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Tachometer Driver Circuit	66018-5	66018-5	66018-4	—
Tachometer Pull-up Circuit	66018-5	66018-5	66018-4	—

Circuit/System Description

The engine control module (ECM) creates the tachometer signal by pulsing the engine speed signal circuit to ground at a rate of 2 pulses per engine revolution. The instrument panel cluster (IPC) converts the 2 pulses per engine revolution signal to a tachometer position indicating the engine speed. The engine speed is sent to the IPC over a discreet wire from the ECM.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition voltage is greater than 9 volts.
- The component has been commanded ON and OFF at least once during the ignition cycle.
- SPN 66018 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66018 is Type C SPN.

Conditions for Clearing the SPN

SPN 66018 is Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine idling, the tachometer should display engine speed.
2. Engine operating, observe the scan tool SPN information. SPN 66018 should not be set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the tachometer.
2. Ignition ON, test for greater than 11 V from the tachometer circuit.
⇒ If less than the specified range, test the tachometer driver circuit, and tachometer pull-up circuit for an open, or a short to ground. If the circuits test normal, replace the ECM.

3. Engine idling, test for 4–7 V from the tachometer circuit.
⇒ If greater than the specified range, test the tachometer driver circuit, and tachometer pull-up circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, replace the tachometer.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming.

SPN 66019, 66020, 66021, or 66022

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 66019 FMI 3: Oxygen Sensor Bank A Sensor 1 Heater Voltage Above Normal or Shorted High

SPN 66019 FMI 5: Oxygen Sensor Bank A Sensor 1 Heater Current Below Normal or Open Circuit

SPN 66019 FMI 8: Oxygen Sensor Bank A Sensor 1 Heater Abnormal Frequency or Pulse Width

SPN 66020 FMI 3: Oxygen Sensor Bank B Sensor 1 Heater Voltage Above Normal or Shorted High

SPN 66020 FMI 5: Oxygen Sensor Bank B Sensor 1 Heater Current Below Normal or Open Circuit

SPN 66020 FMI 8: Oxygen Sensor Bank B Sensor 1 Heater Abnormal Frequency or Pulse Width

SPN 66021 FMI 3: Oxygen Sensor Bank A Sensor 2 Heater Voltage Above Normal or Shorted High

SPN 66021 FMI 5: Oxygen Sensor Bank A Sensor 2 Heater Current Below Normal or Open Circuit

SPN 66021 FMI 8: Oxygen Sensor Bank A Sensor 2 Heater Abnormal Frequency or Pulse Width

SPN 66022 FMI 3: Oxygen Sensor Bank B Sensor 2 Heater Voltage Above Normal or Shorted High

SPN 66022 FMI 5: Oxygen Sensor Bank B Sensor 2 Heater Current Below Normal or Open Circuit

SPN 66022 FMI 8: Oxygen Sensor Bank B Sensor 2 Heater Abnormal Frequency or Pulse Width

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
HO2S A Sensor 1 Ignition Voltage	*	65561-1, 66019-5	—	—
HO2S A Sensor 1 Heater Control	66019-5	65561-1, 66019-5	65561-0, 66019-3	66019-8
HO2S B Sensor 1 Ignition Voltage	*	65563-1, 66020-5	—	—
HO2S B Sensor 1 Heater Control	66020-5	65563-1, 66020-5	65563-0, 66020-3	66020-8
HO2S A Sensor 2 Ignition Voltage	*	65562-1, 66021-5	—	—
HO2S A Sensor 2 Heater Control	66021-5	65562-1, 66021-5	65562-0, 66021-3	66021-8
HO2S B Sensor 2 Ignition Voltage	*	65564-1, 66022-5	—	—
HO2S B Sensor 2 Heater Control	66022-5	65564-1, 66022-5	65564-0, 66022-3	66022-8

* Engine cranks but does not run and the fuse for the ignition circuit opens.

Circuit Description

The heated oxygen sensors (HO2S) are used for fuel control and post catalyst monitoring. Each HO2S compares the oxygen content of the surrounding air with the oxygen content in the exhaust stream. The HO2S must reach operating temperature to provide an accurate voltage signal. A heating element inside the HO2S minimizes the time required for the sensor

to reach operating temperature. Voltage is provided to the heater by the ignition voltage circuit through a fuse. Ground is provided to the heater on the heater control circuit by a solid-state device called a low side driver. The driver is pulled up to a voltage within the controller which enables the ECM to determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feed back voltage.

Conditions for Running the SPN

66019, 66020, 66021, 66022 FMI 3 and 5

- SPN 110, 630, or 65580 is not set.
- The ignition is ON or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The heater control circuit has been commanded ON and OFF at least once during the ignition cycle.
- The SPNs run continuously when the above conditions are met.

66019, 66020, 66021, 66022 FMI 8

- SPN 110, 630, or 65580 is not set.
- The ignition voltage is greater than 10 volts.
- The engine is operating.
- The ECM is not commanding decel fuel cut-off (DFCO).
- The calculated airflow is greater than 10 grams/second (36 kg/hour).
- The SPN runs continuously when the above conditions are met.

Conditions for Setting the SPN

66019, 66020, 66021, 66022 FMI 3 and 5

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

66019 and 66020 FMI 8

The ECM detects that the heater control duty cycle is greater than 90 percent for greater than 160 seconds.

66021 and 66022 FMI 8

The ECM detects that the heater control duty cycle is greater than 0 percent.

Action Taken When the SPN Sets

SPN 66019, 66020, 66021, and 66022 are Type B SPNs.

Conditions for Clearing the SPN

SPN 66019, 66020, 66021, and 66022 are Type B SPNs.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Engine idling at normal operating temperature, observe the SPN information with a scan tool. SPN 66019, 66020, 66021, or 66022 should not set.
2. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the appropriate HO2S.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal D and ground.
 - ⇒ If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.
3. Ignition ON, connect a test lamp between the heater control circuit terminal C and B+. Verify the test lamp does not illuminate.
 - ⇒ If the test lamp illuminates, test the control circuit for a short to ground. If the circuit tests normal, replace the ECM.

Note: The heater control circuit is pulled-up to a voltage within the controller. 3–4 volts measured on this circuit is normal.

4. Command the heater control circuit ON for the appropriate HO2S with a scan tool. Verify the test lamp illuminates, and turns OFF, as commanded.
 - ⇒ If the test lamp is always OFF, test the control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the HO2S.

Component Testing

1. Ignition OFF, disconnect the harness connector at the HO2S.
2. Test for 4–8 Ω between the ignition voltage circuit terminal D and the control circuit terminal C.
 - ⇒ If not within the specified range, replace the HO2S.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Heated Oxygen Sensor Replacement* on page 9-226
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 66025

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 66025 FMI 4: Fuel Pump Relay 2 Voltage Below Normal or Shorted Low

SPN 66025 FMI 5: Fuel Pump Relay 2 Current Below Normal or Open Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Voltage – Relay Switch	1	2	—	—
Fuel Pump Supply Voltage	1	2	3	—
Fuel Pump Relay Control	66025–4	66025–5	3	—
Fuel Pump Ground	—	2	—	—

1. The fuel pump fuse opens and the engine cranks but does not run.
2. The engine cranks but does not run.
3. The fuel pump operates continuously and the battery will discharge.

Circuit/System Description

The engine control module (ECM) provides ignition voltage to the coil side of the fuel pump relay 2 whenever the engine is cranking or running. The control module enables the fuel pump relay as long as the engine is cranking or running, and ignition system reference pulses are received. If no ignition system reference pulses are received, the control module turns OFF the fuel pump. The fuel pump relay control circuit is equipped with a feedback circuit that is pulled up to a voltage within the ECM. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The ECM has commanded the fuel pump relay ON and OFF at least once during the ignition cycle.
- SPN 66025 runs continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 2 seconds.

Action Taken When the SPN Sets

SPN 66025 is a Type B SPN.

Conditions for Clearing the SPN

SPN 66025 is a Type B SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

J 43244 Relay Puller Pliers

Circuit/System Verification

1. Ignition ON, command the fuel pump relay 2 ON and OFF with a scan tool. You should hear and feel an audible click.
2. Observe the scan tool SPN information. SPN 66025 should not be set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the fuel pump relay 2 with the *J 43244*.
2. Test for less than 5 Ω between the ground circuit terminal 86 and ground.
⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
3. Connect a test lamp between the relay coil control circuit terminal 85 and ground.
4. Ignition ON, command the fuel pump relay 2 ON and OFF with a scan tool. The test lamp should turn ON and OFF when changing between the commanded states.
⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
⇒ If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the fuel pump relay 2.

Component Testing

1. Ignition OFF, disconnect the fuel pump relay 2 with the *J 43244*.
2. Test for 70–110 Ω between terminals 85 and 86.
⇒ If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87⇒ If not within the specified range, replace the relay.
4. Install a 20 A fused jumper wire between relay terminal 85 and B+. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
⇒ If greater than the specified range, replace the relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Relay Replacement (Fuse Block)* on page 11-28 or *Relay Replacement (Harness)* on page 11-29
- *Engine Control Module Replacement* on page 9-217 for engine control module replacement, setup, and programming

SPN 66026

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptors

SPN 66026 FMI 7: Shift Interrupt Switch Mechanical System Not Responding or Out of Adjustment

Circuit/System Description

The shift interrupt switch is used to reduce the torque applied to the lower unit while shifting in and out of gear. This makes it easier to shift, and reduces gear noise. The engine control module (ECM) supplies B+ to the shift interrupt switch signal circuit. When the throttle control is in the neutral position, the ECM detects a high signal voltage. When the throttle control is shifted out of neutral, the contacts on the shift interrupt switch close and the ECM detects a low shift interrupt signal. The ECM will momentarily reduced the engine RPM when the signal circuit is grounded.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The pedal position is less than 5 percent.
- SPN 66026 runs continuously when the above conditions are met.

Conditions for Setting the SPN

The ECM detects the shift interrupt switch signal circuit is open, shorted to ground, or shorted to a voltage for greater than a calibrated amount of time.

Action Taken When the SPN Sets

SPN 66026 is Type C SPN.

Conditions for Clearing the MIL/SPN

SPN 66026 is Type C SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54 for scan tool information

Circuit/System Verification

1. Ignition ON, observe the shift interrupt switch parameter with a scan tool while shifting in and out of gear. The parameter should display OFF in neutral and ON in gear.
2. Observe the SPN information with a scan tool. SPN 66026 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

Note: Verify the shift interrupt switch is properly adjusted before proceeding with this diagnostic procedure.

1. Ignition OFF, disconnect the harness connector at the shift interrupt switch.
2. Test for less than 5 Ω between the ground circuit terminal 2 and ground.
⇒ If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for greater than 10 V between the shift interrupt switch signal circuit terminal 1 and ground.
⇒ If less than the specified range, test the signal circuit for an open/high resistance or a short to ground. If the circuit tests normal, replace the ECM.
4. Ignition OFF, install a 3 A fused jumper wire between the between the shift interrupt switch signal circuit terminal 1 and ground.
5. Ignition ON, observe the scan tool shift interrupt switch parameter. The parameter should display ON.
⇒ If the parameter does not display ON, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, test or replace the shift interrupt switch.

Component Testing

1. Ignition OFF, disconnect the harness connector at the shift interrupt switch.
2. Measure the resistance between the shift interrupt switch signal circuit terminal 1 and the shift interrupt switch ground circuit terminal 2. The DMM should display OL.
⇒ If less than the specified value, replace the shift interrupt switch.
3. Test for less than 5 Ω while depressing the shift interrupt switch.
⇒ If greater than the specified range, replace the shift interrupt switch.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66030

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66030 FMI 3: Intercooler Relay Voltage Above Normal or Shorted High

SPN 66030 FMI 5: Intercooler Relay Voltage Below Normal or Shorted Low

Circuit Description

The supercharger intercooler relay is a normally open relay. The relay switch is held in the open position by spring tension. Ignition voltage is supplied directly to the relay coil. Battery voltage is supplied to the switch side of the relay. The engine control module (ECM) provides ground to the control circuit of the relay with a low side driver. When the ECM commands the relay ON, the relay contacts will close allowing current to flow from the battery to the supercharger intercooler pump. The fuel pump relay control circuit is equipped with a feedback circuit that is pulled up to 2.5 volts within the ECM. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The ECM has commanded the intercooler relay ON and OFF at least once during the ignition cycle.
- SPN 66030 run continuously when the above condition is met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66030 is a Type B SPN.

Conditions for Clearing the MIL/SPN

SPN 66030 is a Type B SPN.

Diagnostic Aids

- A resistance on the intercooler pump control circuit or the relay coil ignition voltage circuit may cause this SPN to set.
- When disconnecting electrical connectors or removing fuses and relays from a fuse block, always inspect the component electrical terminals for corrosion and the mating electrical terminals for correct tension.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54 for scan tool information

Special Tools

J 43244 Relay Puller Pliers

Circuit/System Verification

1. Ignition ON, command the intercooler coolant pump relay ON and OFF several times with a scan tool. Listen and feel for the intercooler coolant pump relay to click with each command.
2. Observe the SPN information with a scan tool. SPN 66030 should not set.
3. Operate the vehicle within the Conditions for Running the SPN. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the intercooler coolant pump relay with the *J 43244*.
2. Ignition ON, verify a test lamp illuminates between the relay coil ignition voltage circuit terminal 85 and ground.
 - ⇒ If the test lamp does not illuminate, test the relay coil ignition voltage circuit for a short to ground or an open/high resistance.
3. Ignition ON, command the intercooler pump relay ON and OFF with a scan tool. The test lamp turn ON and OFF as commanded.
 - ⇒ If the test lamp is always ON, test the relay coil control circuit for a short to ground. If the circuit tests normal, replace the ECM.
 - ⇒ If the test lamp is always OFF, test the relay coil control circuit for a short to voltage or an open/high resistance. If the circuit tests normal, replace the ECM.
4. Connect a 20 A fused jumper wire between the relay switch B+ circuit terminal 30 and the relay switch ignition voltage circuit terminal 87. The intercooler pump should operate.
 - ⇒ If the intercooler pump does not operate, refer to *Supercharger Intercooler Relay Diagnosis* on page 9-204.
5. If all circuits test normal, test or replace the intercooler pump relay.

Component Testing

1. Ignition OFF, disconnect the intercooler pump relay with the *J 43244*.
2. Test for 70–110 Ω between terminals 85 and 86.
 - ⇒ If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87
 - ⇒ If not the specified value, replace the relay.
4. Install a 10 A fused jumper wire between relay terminal 85 and B+.
5. Install a jumper wire between relay terminal 86 and ground.
6. Test for less than 2 Ω between terminals 30 and 87.
 - ⇒ If greater than the specified range, replace the relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the repair.

- *Relay Replacement (Fuse Block)* on page 11-28 or *Relay Replacement (Harness)* on page 11-29
- *Engine Control Module Replacement* on page 9-217 for ECM replacement, setup, and programming

SPN 66035

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66035 FMI 0: Supercharger Boost Control Solenoid Data Valid but Above Normal

SPN 66035 FMI 3: Supercharger Boost Control Solenoid Data Valid but Below Normal

SPN 66035 FMI 5: Supercharger Boost Control Solenoid Current Below Normal or Open Circuit

SPN 66035 FMI 7: Supercharger Boost Control Solenoid Mechanical System Not Responding or Out of Adjustment

Circuit Description

Supercharger (SC) boost pressure is regulated to prevent engine damage. When the engine is operating under high boost conditions, the engine control module (ECM) limits boost pressure to a calibrated value. The ECM disables boost under the following conditions:

- When an electronic throttle control (ETC) fault is detected.
- When an intercooler pump failure is detected
- When the ECM detects an over-temperature condition.

The ECM controls boost pressure by pulse width modulation (PWM) of the boost control solenoid. The boost control solenoid is a normally open valve. Under most conditions, the ECM commands the boost control solenoid to operate at a 99–100 percent duty cycle. This keeps the boost control solenoid valve closed and allows only inlet vacuum from the supercharger plenum to the bypass valve actuator to control the position of the bypass valve. At idle, engine vacuum is applied to the upper side of the bypass valve actuator, counteracting spring tension to hold the bypass valve open. When the engine load is increased, the engine vacuum is decreased, causing the spring in the bypass valve actuator to overcome the diminishing applied vacuum, closing the bypass valve and allowing the boost pressure to increase. When reduced boost pressure is desired, the ECM commands the boost control solenoid to operate at a 0–98 percent duty cycle. This opens the solenoid valve and allows boost pressure to enter the bypass valve actuator at the lower side to counteract the spring tension, opening the bypass valve and recirculating excess boost pressure back into the supercharger inlet. The ECM controls the valve by grounding the control circuit with a solid state device called a driver. The driver is equipped with a feedback circuit that is pulled-up to a voltage. The ECM can determine if the control circuit is open, shorted to ground, or shorted to a voltage by monitoring the feedback voltage.

Conditions for Running the SPN

66035–0

- Before the ECM can report that SPN 66035–0 failed, SPNs 66035–3, and 66035–5 must run and pass.
- SPN 106, 108, 630, 3563, or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- SPN 66035–0 runs continuously when the above conditions are met.

66035–3

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The boost control solenoid is commanded ON.
- SPN 66035–3 runs continuously when the above conditions are met.

66035–5

- SPN 630 or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The boost control solenoid is commanded OFF.
- SPN 66035–5 runs continuously when the above conditions are met.

66035–7

- Before the ECM can report that SPN 66035–7 failed, SPNs 66035–3, and 66035–5 must run and pass.
- SPN 106, 108, 630, 3563, or 65580 is not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The desired boost is stable within 5 percent.
- SPN 66035–7 runs continuously when the above conditions are met.

Conditions for Setting the SPN

66035-0

The ECM detects the SC boost exceeds 75 kPa for greater than 2 seconds.

66035-3 and 66035-5

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

66035-7

- The Actual SC boost is 99.6 percent less than the desired boost for greater than 2 seconds.
- OR
- The SC boost is 30 percent greater than the desired boost for greater than 2 seconds.

Action Taken When the SPN Sets

SPN 66035 is a Type B SPN.

Conditions for Clearing the MIL/SPN

SPN 66035 is a Type B SPN.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Description and Operation

Supercharger Description and Operation on page 9-282

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54 for scan tool information

Circuit/System Verification

1. Ignition ON, compare the scan tool BARO sensor pressure parameter, MAP sensor pressure parameter, and the SCIP sensor pressure parameter. All three parameter readings should be within 5 kPa of each other.
 - ⇒ If greater than the specified range, refer to *Altitude Versus Barometric Pressure on page 9-3* and *Diagnostic Trouble Code (DTC) List on page 6-11* for diagnosis of an out of range sensor.
2. Engine operating, verify the intercooler pump is operating.
 - ⇒ If the intercooler pump is not operating, refer to *Supercharger Intercooler Relay Diagnosis on page 9-204*.
3. Verify proper operation of the boost control system. Refer to *Boost Control System Diagnosis on page 9-205*
4. Observe the SPN information with a scan tool. SPN 66035 should not set.
5. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the SCB solenoid.
2. Ignition ON, verify that a test lamp illuminates between the ignition voltage supply circuit terminal 1 and ground.
 - ⇒ If the test lamp does not illuminate, test the ignition circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.
3. Test for 2.6-4.6 V between the control circuit terminal 2 and ground.
 - ⇒ If less than the specified range, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
 - ⇒ If greater than the specified range, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
4. Connect a test lamp between the ignition voltage supply circuit terminal 1 and the control circuit terminal 2.

5. Command the SCB solenoid on with a scan tool. Verify the test lamp should illuminate.
 - ⇒ If the test lamp does not illuminate, replace the ECM.
6. If all circuits test normal, test or replace the SCB solenoid.

Component Testing

1. Ignition OFF, disconnect the harness connector at the SCB solenoid.
2. Test for 30–55 Ω between the control terminal and the voltage supply terminal of the SCB solenoid.
 - ⇒ If the resistance is not within the specified range, replace the SCB solenoid.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

SPN 66040-66043

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

SPN Descriptor

SPN 66040 FMI 3: OEM Output Driver 1 Voltage Above Normal or Shorted High

SPN 66040 FMI 5: OEM Output Driver 1 Current Below Normal or Open Circuit

SPN 66041 FMI 3: OEM Output Driver 2 Voltage Above Normal or Shorted High

SPN 66041 FMI 5: OEM Output Driver 2 Current Below Normal or Open Circuit

SPN 66042 FMI 3: OEM Output Driver 3 Voltage Above Normal or Shorted High

SPN 66042 FMI 5: OEM Output Driver 3 Current Below Normal or Open Circuit

SPN 66043 FMI 3: OEM Output Driver 4 Voltage Above Normal or Shorted High

SPN 66043 FMI 5: OEM Output Driver 4 Current Below Normal or Open Circuit

Circuit/System Description

Ignition voltage is supplied to the OEM device through a fuse. The engine control module (ECM) turns the OEM device ON by grounding the OEM output control circuit.

Conditions for Running the SPN

- SPN 630 or 65580 are not set.
- The ignition is ON, or the engine is operating.
- The ignition voltage is greater than 9 volts.
- The ECM has commanded the OEM output ON and OFF at least once during the ignition cycle.
- The SPNs 66040–66043 run continuously once the above conditions are met.

Conditions for Setting the SPN

The ECM detects that the commanded state of the driver and the actual state of the control circuit do not match for greater than 5 seconds.

Action Taken When the SPN Sets

SPN 66040, 66041, 66042, and 66043 are Type C SPNs.

Conditions for Clearing the SPN

SPN 66040, 66041, 66042, and 66043 are Type C SPNs.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

SPN Type Reference

Suspect Parameter Number (SPN) Type Definitions on page 6-9

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

1. Ignition ON, command the OEM device ON and OFF with a scan tool. The OEM device should turn ON and OFF.
2. Observe the SPN information with a scan tool. SPN 66040, 66041, 66042, or 66043 should not set.
3. Operate the vehicle within the Conditions for Running the SPN to verify the SPN does not reset. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the OEM device.
2. Ignition ON, verify a test lamp illuminates between the ignition voltage circuit terminal and ground.
 - ⇒ If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground, or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.
3. Ignition OFF, connect a test lamp between the control circuit terminal and B+.
4. Ignition ON, command the OEM device ON and OFF with a scan tool. The test lamp should turn ON and OFF with each command.
 - ⇒ If the test lamp is ON all of the time, test the control circuit for a short to ground. If the circuit test normal, replace the ECM.
 - ⇒ If the test lamp is OFF all of the time, test the control circuit for a short to voltage, or an open/high resistance. If the circuit test normal, replace the ECM.
5. If all circuits test normal, test or replace the OEM device.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.
Engine Control Module Replacement on page 9-217 for ECM replacement, setup, and programming

Symptoms - Engine Controls

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Symptoms Description

Symptoms covers conditions that are not covered by DTCs. Certain conditions can cause multiple symptoms. These conditions are listed together under Symptoms Testing. Conditions that may only cause specific symptoms are listed separately under Additional Symptoms Testing. Perform the Symptoms Testing before using the Additional Symptoms Testing.

Symptoms Definition

Backfire: Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Cuts Out, Misses: A steady pulsation or jerking that follows engine speed, which is usually more pronounced as the engine load increases. This condition is not normally felt above 1,500 RPM or 48 km/h (30 mph). The exhaust has a steady spitting sound at idle or at low speed.

Detonation/Spark Knock: A mild to severe ping which usually occurs worse while under acceleration. The engine makes sharp metallic knocks that change with throttle opening.

Dieseling, Run-On: Fuel ignites in the intake manifold or in the exhaust system, making a loud popping noise.

Hard Start: Engine cranks OK, but does not start for a long time. The vehicle does eventually run, or may start but immediately stalls.

Hesitation, Sag, Stumble: Momentary lack of response as the accelerator is pushed down. This condition can occur at any vehicle speed. This condition is usually more pronounced when first trying to make the vehicle move, as from a stop. This condition may cause the engine to stall in severe conditions.

Lack of Power, Sluggishness, or

Sponginess: The engine delivers less than expected power. Little or no increase in speed when the accelerator pedal is pushed down part way.

Poor Fuel Economy: Fuel economy is noticeably lower than expected. Also, the fuel economy is noticeably lower than it was on this vehicle at one time.

Poor Fuel Fill Quality: Difficulty when refueling the vehicle.

Rough, Unstable, or Incorrect Idle and

Stalling: The engine runs unevenly at idle. If severe, the engine or the vehicle may shake. Engine idle may vary in speed. Either condition may be severe enough to stall the engine.

Surges/Chuggles: Engine power variation under steady throttle or cruise. Feels like the vehicle speeds up and slows down with no change in the accelerator pedal position.

Symptoms Verification

Verify all of the following conditions are true:

- The engine control module (ECM) and the malfunction indicator lamp (MIL) are operating correctly
- There are no suspect parameter numbers (SPNs) stored
- The scan tool data is within the normal operating range
- Bulletins are not available for the current symptom
- The ECM grounds are clean, tight, and in the correct locations
- The air filter element is not restricted

Symptoms Testing

Backfire, Cuts Out/Misses, Detonation/Spark Knock, Dieseling/Run-On, Hard Start, Hesitation/Sag/Stumble, Lack of Power/Sluggishness/Sponginess, Poor Fuel Economy, Rough, Unstable, or Incorrect Idle and Stalling, or Surges/Chuggles

1. Test for the following conditions:

- The fuel system for the following:
 - Correct fuel pressure—Refer to *Fuel System Diagnosis (with Returnless Fuel System)* on page 9-208 or *Fuel System Diagnosis (without Returnless Fuel System)* on page 9-210
 - Fuel injectors that are leaking or improper operation—Refer to *Fuel Injector Diagnosis* on page 9-211
 - Contaminated or a poor fuel quality condition—Refer to *Alcohol/Contaminants-in-Fuel Diagnosis* on page 9-213
- The ignition system for the following:
 - Spark plugs for incorrect heat range or an abnormal condition—Refer to *Spark Plug Inspection* on page 9-245
 - Wet down the secondary ignition system with water from a spray bottle—Wetting down the secondary ignition system may help locate damaged or deteriorated components. Look/listen for arcing or misfiring as the water is applied
 - Weak spark using the J 26792 Spark Tester—Refer to *Distributor Ignition (DI) System Diagnosis* on page 9-214 or *Electronic Ignition System Diagnosis* on page 9-215
- Items that can cause an engine to run lean or rich—Refer to *SPN 65565 or 65566* on page 9-125
- The crankshaft position (CKP) sensor for the correct resistance—The CKP sensor resistance may be out of range after a hot soak. The resistance should be between 460–620 Ω
- The engine for the following mechanical failures:
 - Excessive oil in the combustion chamber or leaking valve seals
 - Incorrect cylinder compression
 - Sticking or leaking valves
 - Worn camshaft lobes
 - Incorrect valve timing
 - Worn rocker arms
 - Broken valve springs
 - Excessive carbon buildup in the combustion chambers—Clean the chambers with top engine cleaner. Follow the instructions on the can
 - Incorrect engine parts

- Vacuum hoses for splits or kinks—Verify that the routing and connections are correct
 - Knock sensor (KS) system for excessive spark retard activity—Refer to *SPN 65550, 65551, or 65552* on page 9-115
 - The exhaust system components for the following:
 - Physical damage or possible internal failure
 - The three-way catalytic converters for a restriction
 - Electromagnetic interference (EMI) on the reference circuit can cause a misfire condition. You can usually detect EMI with a scan tool by monitoring the engine speed parameter. A sudden increase in the engine speed parameter with little change in actual engine speed indicates that EMI is present. Inspect the high voltage components near the ignition control circuit if a condition exists
 - Inspect the positive crankcase ventilation (PCV) system and all connections for leaks or restrictions
 - The engine cooling system for the following conditions:
 - The thermostat is the correct heat range
 - Proper engine coolant level
 - The supercharger intercooler pump operation—Refer to *Supercharger Intercooler Relay Diagnosis* on page 9-204
 - The supercharger boost control system for proper operation—Refer to *Boost Control System Diagnosis* on page 9-205
2. If the above conditions do not address the symptom, refer to the additional symptoms tests.

Additional Symptoms Tests

Detonation/Spark Knock

Test the engine for an overheating condition.

Lack of Power, Hesitation, or Cut Out

Test for the correct operation of the ignition system. Refer to *Distributor Ignition (DI) System Diagnosis* on page 9-214 or *Electronic Ignition System Diagnosis* on page 9-215.

Rough, Unstable, or Incorrect Idle and Stalling

Inspect the engine mounts.

Surges/Chuggles

Test the heated oxygen sensors (HO2S). The HO2S should respond quickly to a change in throttle position. If the HO2S do not respond to different throttle positions, inspect for contamination from fuel, silicon, or the incorrect use of RTV sealant. The sensors may have a white powdery coating and result in a high, but false, signal voltage, which gives a rich exhaust indication. The ECM reduces the amount of fuel delivered to the engine, causing a driveability condition.

Hard Start

- Test the engine coolant temperature (ECT) sensor. Compare the ECT sensor value to the manifold air temperature (MAT) sensor value on a cold engine. The ECT and MAT sensor values should be within $\pm 3^{\circ}\text{C}$ (5°F). If the ECT sensor is out of range with the MAT sensor, test the resistance of the ECT sensor. Refer to *Temperature Versus Resistance on page 9-3* for resistance specifications. Replace the ECT sensor if the resistance is not within specification. Refer to *Engine Coolant Temperature Sensor Replacement on page 9-218*. If the sensor is within the specification, test the ECT circuits for a high resistance.
- Test the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when the ignition is turned ON. Refer to *Fuel Pump Electrical Circuit Diagnosis on page 9-207*.

Hesitation, Sag, Stumble

- Test the manifold absolute pressure (MAP) sensor. Refer to *SPN 106 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-83* or *SPN 106 (2.4L, 6.0L, 6.2L) on page 9-86*.
- Test the generator. Repair the charging system if the generator output voltage is less than 10 V or greater than 16 V.

Poor Fuel Economy

- Heavy loads being carried or towed.
- Acceleration rate too much or too often.
- Inspect for foreign material accumulation in the throttle bore, and for carbon deposits on the throttle plate and shaft. Also inspect for throttle body tampering.

Poor Fuel Fill Quality

Test for the following conditions that are applicable to the current symptom:

Difficult to fill

- Restricted fill lines.
- Restricted vent lines.
- High fuel temperature.
- A condition with the internal components of the fuel tank assembly.

Fuel Odor

- A leak in the fuel supply or return lines—Refer to *Fuel System Diagnosis (with Returnless Fuel System) on page 9-208* or *Fuel System Diagnosis (without Returnless Fuel System) on page 9-210*.
- A condition with the internal components of the fuel tank assembly.

Engine Cranks But Does Not Run

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check on page 9-64* prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis on page 6-4* for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions on page 6-5* provides an overview of each diagnostic category.

Circuit/System Description

This Engine Cranks but Does Not Run diagnostic is an organized approach to identify a condition which causes the engine to crank but not start. This diagnostic directs the technician to the appropriate system diagnosis.

Diagnostic Aids

Inspect for any of the following conditions:

- Insufficient fuel can cause a no start condition. Thoroughly inspect the fuel delivery system for sufficient fuel volume to the fuel injectors. Inspect the fuel supply components for partial blockage or restrictions.
- Fuel injectors with partially blocked and restricted nozzles, or a malfunctioning solenoid, can cause a no start condition. Refer to *Fuel Injector Diagnosis on page 9-211*.
- There may be fuel spray at the fuel injectors and the indicated fuel pressure may be correct, yet there may not be enough fuel to start the engine. If the fuel injectors and the injector circuit are OK, and fuel spray is detected, the fuel injector ON time may be inadequate. If the engine control module (ECM) receives incorrect inputs from the various information sensors, the fuel delivered by the fuel injectors may be inadequate to start the engine. Check all the engine data parameters with a scan tool and compare the values indicated with the expected values.
- Check the crankshaft position (CKP) sensor engine reference signal with a scan tool. Observe the Engine Speed parameter while cranking the engine. The scan tool should indicate a steady 200–300 RPM while cranking. If erratic values, such as sudden spikes in the engine speed are displayed, the engine reference signal is not stable enough for the engine to start and run properly.
- Inspect the engine for good secure electrical grounds.
- If the engine almost starts and then stalls, check for an open in the ground circuits of the CKP sensor and the camshaft position (CMP) sensor.

9-202 Engine Controls and Fuel - Marine

- Water or foreign material in the fuel can cause a no start or engine will not stay running condition. During freezing weather water can freeze inside the fuel system. Extreme weather conditions can cause contaminated fuel to prevent the vehicle from starting.
- A vehicle that starts and runs after being brought to the repair shop for a no start condition, may have an ignition system that is susceptible to moisture. Spray water on the ignition system components and the wiring in order to check for an engine starting or will not stay running concern.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

- J 34730-1A Fuel Pressure Gauge
- J 26792 Spark Tester
- J 34730-405 Injector Test Lamp

Circuit/System Verification

Note: This diagnostic assumes the following:

- The battery is completely charged.
 - The engine cranking speed is acceptable.
 - There is adequate fuel in the fuel tank.
1. Engine cranking for 15 seconds, observe the scan tool SPN information. Verify that SPN 110, 627, 630, 636, 651–658, 65541–65548, 65580, 65581, 65615, 65616, 65620, 65621, 65622, 65623, 66013, 66014, or 66017 is not set.
 - ⇒ If any DTCs are set, refer to *Diagnostic Trouble Code (DTC) List on page 6-11*.

2. Engine cranking, observe the scan tool Engine Speed parameter. The scan tool should indicate an engine speed greater than 0 RPM.
 - ⇒ If the engine speed is 0 RPM, refer to *SPN 636 (3.0L, 4.3L, 5.0L, 5.7L) on page 9-100* or *SPN 636 (6.0L, 6.2L) on page 9-102* for further diagnosis.
3. Cycle the ignition from OFF to ON. You should hear and feel an audible click from the powertrain relay. Repeat as necessary in order to verify powertrain relay operation.
 - ⇒ If the powertrain relay does not click, refer to *SPN 66013 or 66014 on page 9-180* for further diagnosis.
4. Connect a J 26792 to the boot of a spark plug wire of a cylinder and ground.

Note: An erratic or weak spark is considered a no spark condition.

5. Engine cranking, verify the spark tester sparks.
 - ⇒ If there is no spark, refer to *Distributor Ignition (DI) System Diagnosis on page 9-214* or *Electronic Ignition System Diagnosis on page 9-215*.
6. Ignition ON, command the fuel pump ON with a scan tool. You should hear the fuel pump turn ON.
 - ⇒ If the fuel pump does not turn ON, refer to *Fuel Pump Electrical Circuit Diagnosis on page 9-207*.
7. Ignition OFF, disconnect the harness connector at a fuel injector.
8. Connect a J 34730-405 between the control circuit and the ignition 1 voltage circuit. Engine cranking, the injector test lamp should flash.
 - ⇒ If the injector test lamp does not flash, refer to *SPN 651, 652, 653, 654, 655, 656, 657, or 658 on page 9-104*.
9. Ignition OFF, install the J 34730-1A. Refer to *Fuel Pressure Gauge Installation and Removal on page 9-229*.

Note:

- The fuel pump may need to be commanded ON a few times, in order to obtain the highest possible fuel pressure.
 - Do NOT start the engine for this test.
10. Ignition ON, command the fuel pump ON with a scan tool. The fuel pressure should be between 380–427 kPa (55–62 psi).
 - ⇒ If not within the specified range, refer to *Fuel System Diagnosis (with Returnless Fuel System) on page 9-208* or *Fuel System Diagnosis (without Returnless Fuel System) on page 9-210*.

11. Verify the following conditions do not exist:
- Collapsed air intake duct to the throttle body
 - Restricted air filter element
 - Spark plugs for being gas or coolant fouled
 - A skewed manifold absolute pressure (MAP) sensor—Refer to *SPN 106 (3.0L, 4.3L, 5.0L, 5.7L)* on page 9-83 or *SPN 106 (2.4L, 6.0L, 6.2L)* on page 9-86
 - A skewed engine coolant temperature (ECT) sensor—Refer to *SPN 110* on page 9-91
 - Exhaust system restricted

- Fuel contamination—Refer to *Alcohol/Contaminants-in-Fuel Diagnosis* on page 9-213
 - Engine mechanical condition, for example, worn valve-train components, or low compression
- ⇒ If you find any of the above conditions, repair as necessary.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Run/Crank Relay Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Voltage – Relay Switch	1	2	—	—
Battery Voltage – Relay Coil	1	2	—	—
Run/Crank Relay Signal	1	2	—	—
Run/Crank Ground	—	2	—	—
1. The fuse opens and the scan tool does communicate with the ECM.				
2. The scan tool does communicate with the ECM.				

Circuit/System Description

The Run/Crank Relay is controlled by the ignition switch. When the ignition switch in the run, or crank position, ignition voltage is supplied to the relay coil which allows voltage through the relay switch contacts to the engine control module (ECM). When the ignition switch is rotated to the crank position, a voltage is applied to the neutral start switch. With the neutral switch in the closed position the ECM will receive a crank signal. If the vessel is equipped with ECM starter control, the ECM will then supply 12 volts, or a ground, to the control circuit of the starter control relay dependent upon option. When this occurs, battery voltage is supplied through the switch of the crank relay to S terminal of the starter solenoid.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools Required

J 43244 Relay Puller Pliers

Circuit/System Verification

Cycle the ignition from OFF to ON. You should hear and feel an audible click from the run/crank relay. Repeat as necessary in order to verify run/crank relay operation.

Circuit/System Testing

1. Ignition OFF, disconnect the run/crank relay with the J 43244.
2. Test for less than 5 Ω between the ground circuit terminal 86 and ground.
⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
3. Connect a test lamp between the relay coil control circuit terminal 85 and ground.
4. Cycle the ignition ON and OFF. The test lamp should turn ON and OFF when changing between the commanded states.
⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ignition switch.
⇒ If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ignition switch.
5. Test for B+ between the relay switch voltage circuit terminal 30 and ground.
⇒ If less than the specified range, repair the relay switch voltage circuit for an open/high resistance.
6. Install a 20 A fused jumper wire between the relay switch voltage circuit terminal 30, and the relay switch supply circuit terminal 87. Attempt to start the engine. The engine should start and idle.
⇒ If the engine does not start and idle, test the run/crank relay signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
7. If all circuits test normal, test or replace the run/crank relay.

Component Testing

1. Ignition OFF, disconnect the run/crank relay with the J 43244.
2. Test for 70–110 Ω between terminals 85 and 86.
⇒ If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87⇒ If not within the specified range, replace the relay.

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω between terminals 30 and 87.
⇒ If greater than the specified range, replace the relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Relay Replacement (Fuse Block)* on page 11-28 or *Relay Replacement (Harness)* on page 11-29
- *Engine Control Module Programming and Setup* on page 6-3 for engine control module replacement, setup, and programming

Supercharger Intercooler Relay Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit/System Description

The supercharger intercooler relay is a normally open relay. Ignition voltage is supplied to the relay coil when the ignition is ON or the engine is operating, and B+ is supplied directly to the switch side contact through a fuse. The engine control module (ECM) supplies the ground path to the relay coil control circuit with a low side driver. When the engine is operating, the ECM commands the relay ON, which allows B+ through the relay switch contacts to the supercharger intercooler pump.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools Required

J 43244 Relay Puller Pliers

Circuit/System Verification

1. Cycle the ignition from OFF to ON. You should hear and feel an audible click from the supercharger intercooler coolant pump relay. Repeat as necessary in order to verify supercharger intercooler relay operation.
2. Cycle the ignition from OFF to ON. You should hear and feel the supercharger intercooler coolant pump operate.

Circuit/System Testing

1. Ignition OFF, disconnect the supercharger intercooler coolant pump relay with the J 43244.
2. Ignition ON, verify a test lamp illuminates between the voltage supply circuit terminals 30 and 85.
 - ⇒ If the test lamp is not illuminated, test the appropriate voltage circuit for a short to ground or an open/high resistance.
3. Connect a test lamp between the relay coil control circuit terminal 86 and ground.
4. Cycle the ignition ON and OFF. The test lamp should turn ON and OFF when changing between the commanded states.
 - ⇒ If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
 - ⇒ If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
5. Install a 20 A fused jumper wire between the relay switch voltage circuit terminal 30, and the relay controlled output circuit terminal 87. Ignition ON, the supercharger intercooler coolant pump should operate.
 - ⇒ If the supercharger intercooler coolant pump does not operate, test for the following:
 - The relay controlled output circuit for a short to ground or an open/high resistance
 - The supercharger intercooler coolant pump ground circuit for an open/high resistance
 - ⇒ If the circuits test normal, replace the supercharger intercooler coolant pump.
6. If all circuits test normal, test or replace the supercharger intercooler coolant pump relay.

Component Testing

1. Ignition OFF, disconnect the supercharger intercooler coolant pump relay with the J 43244.
2. Test for 70–110 Ω between terminals 85 and 86.
 - ⇒ If not within the specified range, replace the relay.

3. Test for infinite resistance between the following terminals:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

⇒ If not within the specified range, replace the relay.

4. Install a 20 A fused jumper wire between relay terminal 85 and B+. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω ; between terminals 30 and 87.

⇒ If greater than the specified range, replace the relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Relay Replacement (Fuse Block)* on page 11-28 or *Relay Replacement (Harness)* on page 11-29
- *Engine Control Module Programming and Setup* on page 6-3 for engine control module replacement, setup, and programming

Boost Control System Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit Description

Supercharger boost pressure is regulated under certain conditions to prevent engine and drive train damage. The ECM controls boost pressure by a pulse-width modulated ground signal to the boost control solenoid. The boost control solenoid is a normally open valve. Under most conditions, the ECM commands the boost control solenoid to 99–100 percent. This keeps the boost control solenoid valve closed and allows only inlet vacuum from the supercharger plenum to the bypass valve actuator to control the position of the bypass valve. At idle, engine vacuum is applied to the upper side of the bypass valve actuator, counteracting spring tension to hold the bypass valve open. When the engine load increases, the engine vacuum decreases, allowing the spring in the bypass valve actuator to overcome the applied vacuum. This closes the bypass valve and allows the boost pressure to increase. When reduced boost pressure is desired, the ECM decreases the boost control solenoid duty cycle. This opens the boost control solenoid and allows boost pressure to enter the bypass valve actuator at the lower side to counteract the spring tension. When the bypass valve opens, excess boost pressure is re-circulated back into the supercharger inlet.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Description and Operation

Supercharger Description and Operation on page 9-282

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54 for scan tool information

Special Tools

J-23738-A Mityvac

Circuit/System Verification

1. Ignition OFF, inspect the supercharger vacuum lines for any of the following conditions:
 - Cracking
 - Loose fit
 - Improper connections
 - Improper routing
 - Restrictions
2. Inspect the following components for damage, and for improper connections, improper adjustments, and improper installation:
 - The bypass valve actuator
 - The boost control solenoid
 - The bypass valve lever
 - The bypass valve cable
3. Verify that the supercharger coolant pump coolant level is full.
4. Ignition ON, command the supercharger coolant pump ON with a scan tool. Listen for the supercharger coolant pump to turn ON for 2 seconds and then OFF.
 - ⇒ If the supercharger coolant pump does not turn ON and OFF refer to *Supercharger Intercooler Relay Diagnosis on page 9-204*.
5. Verify there are no vacuum leaks at the supercharger manifold gaskets and supercharger intake plenum.

Circuit/System Testing

1. Ignition OFF, disconnect the boost source hose from the boost control solenoid. Connect the J-23738-A to the boost source hose.
2. Engine idling, verify that greater than 15 inch Hg is displayed on the gauge.
 - ⇒ If less than the specified range, repair the boost source hose or the intake manifold port for a restriction or blockage.
3. Ignition OFF, connect the boost source hose to the boost solenoid.
4. Disconnect the boost signal hose from the bottom port of the bypass valve actuator.
5. Connect the J-23738-A to the boost signal hose.
6. Engine idling, verify that less than 1 inch Hg is displayed on the gauge.
 - ⇒ If greater than the specified range, replace the boost control solenoid.

Note: SPNs will set when disconnecting components.

7. Ignition OFF, disconnect the harness connector at the boost control solenoid.
8. Engine idling, verify greater than 15 inch Hg is displayed on the gauge.
 - ⇒ If less than the specified range, test the boost signal hose for a restriction or blockage. If the boost signal hose tests normal, replace the boost control solenoid.
9. Disconnect the inlet vacuum signal hose from the top of the bypass valve actuator, and connect the J-23738-A to the inlet vacuum signal hose.
10. Engine running, observe the gauge on the J-23738-A. The gauge should display greater than 15 inch Hg.
 - ⇒ If less than the specified range, repair the inlet vacuum signal hose or the intake manifold port for a restriction or blockage.

Component Testing

1. Ignition OFF, disconnect the inlet vacuum signal hose from the top of the bypass valve actuator.
2. Connect the J-23738-A to the inlet vacuum signal port at the bypass valve actuator. Slowly apply 15 inch Hg of vacuum while observing the bypass valve actuator. The bypass valve actuator and cable should retract.
 - ⇒ If the bypass valve actuator and cable do not retract, inspect the bypass valve and bypass valve actuator linkage for binding, sticking, or damage. If the bypass valve, cable, and linkage operate normally, replace the bypass valve actuator.
3. Connect the inlet vacuum signal hose to the top of the bypass valve actuator.
4. Disconnect the boost signal hose from the bottom of the bypass valve actuator.
5. Connect the J-23738-A to the boost signal port on the bypass valve actuator.

6. Engine idling, slowly apply 20 inch Hg of vacuum, while observing the bypass valve actuator. The bypass valve actuator should extend.

⇒ If the bypass valve actuator does not extend, inspect the bypass valve and linkage for binding, sticking, or damage. If the bypass valve and linkage operate normally, replace the bypass valve actuator.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the repair.

- *Charge Air Bypass Regulator Solenoid Valve Replacement* on page 9-223
- *Supercharger Bypass Valve Actuator Replacement* on page 9-224

Fuel Pump Electrical Circuit Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Fuel Pump Relay Ignition 1 Voltage	1	2	—	—
Fuel Pump Motor Supply Voltage	1	2	3	—
Fuel Pump Relay Control	66017-4	66017-5	3	—
Fuel Pump Relay Ground	—	2	—	—
Fuel Pump Ground	—	2	—	—
1. The fuel pump fuse opens and the engine cranks but does not run. 2. The engine cranks but does not run. 3. The fuel pump operates continuously and the battery will discharge.				

Circuit/System Description

When the ignition switch is turned ON, the engine control module (ECM) energizes the fuel pump relay which powers the fuel pump ON. The fuel pump remains ON as long as the engine is cranking or running and the ECM receives ignition reference pulses. If there are no ignition reference pulses, the ECM shuts the fuel pump OFF within 2 seconds after the ignition was switched to the ON position or if the engine stops.

Diagnostic Aids

The following conditions may cause the fuel pump fuse to open:

- The fuse is faulty.
- There is an intermittent short to ground in the supply voltage circuit of the fuel pump.
- The fuel pump has an intermittent internal condition.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools Required

J 43244 Relay Puller Pliers

Circuit/System Verification

1. Cycle the ignition ON, you should hear and feel a click from the fuel pump relay when you turn the ignition ON.
2. Ignition ON, command the fuel pump relay ON and OFF with a scan tool. You should hear and feel a click when you command the fuel pump relay ON and OFF.

Circuit/System Testing

1. Ignition OFF, the fuel pump should not be running.
⇒ If the fuel pump runs continuously, test the relay switch supply circuit terminal 87 for a short to voltage. If the circuit tests normal, replace the fuel pump relay.
2. Ignition OFF, remove the fuel pump relay with the *J 43244*.
3. Test for less than 5 Ω ; between the relay coil ground circuit terminal 86 and ground.
⇒ If greater than the specified range, repair the relay coil ground circuit for an open/high resistance.
4. Ignition ON, verify a test lamp illuminates between the relay switch B+ voltage circuit terminal 30 and ground.
⇒ If the test lamp does not illuminate, repair the relay switch B+ voltage circuit for a short to ground or an open/high resistance.
5. Install a 15A fused jumper wire between the relay switch B+ voltage circuit terminal 30 and the relay switch supply circuit terminal 87. The fuel pump should turn ON.
⇒ If the fuel pump does not turn ON, test for the following conditions:
 - An open/high resistance in the relay switch supply circuit
 - An open/high resistance in the fuel pump ground circuit⇒ If the above circuits test normal, replace the fuel pump.
6. Ignition OFF, connect a test lamp between the relay coil control circuit terminal 85 and ground.
7. Ignition ON. The test lamp should turn ON for approximately 3 seconds and then OFF.
⇒ If the test lamp is always ON, test the relay coil control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
⇒ If the test lamp is always OFF, test the relay coil control circuit for a short to ground or an open/high resistance. If circuit tests normal, replace the ECM.
8. If all circuits test normal, test or replace the fuel pump relay.

Component Testing

1. Ignition OFF, remove the fuel pump relay from the electrical center with the *J 43244*.
2. Test for 70–110 Ω ; between terminals 85 and 86.
⇒ If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
 - 30 and 86
 - 30 and 87
 - 30 and 85
 - 85 and 87⇒ If not the specified value, replace the relay.
4. Install a 20A fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 Ω ; between terminals 30 and 87.
⇒ If greater than the specified range, replace the relay.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Relay Replacement (Fuse Block)* on page 11-28 or *Relay Replacement (Harness)* on page 11-29
- *Engine Control Module Programming and Setup* on page 6-3 for engine control module replacement, setup, and programming

Fuel System Diagnosis (with Returnless Fuel System)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit/System Description

When the ignition switch is turned ON, the engine control module (ECM) supplies power to the fuel pump(s), by energizing the fuel pump relay. The fuel pump remains ON as long as the engine is cranking or running and the ECM receives crankshaft reference pulses. If there are no reference pulses, the ECM turns the fuel pump OFF, 2 seconds after the ignition switch is turned ON or 2 seconds after the engine stops running. The fuel pump supplies fuel through a fuel filter, through the fuel feed pipes, to the fuel rail assembly. The fuel pump provides fuel at a pressure above the pressure needed by the fuel injectors. The fuel pressure regulator, located in the modular fuel pump and sender assembly, keeps the fuel available to the fuel injectors at a regulated pressure.

When the fuel pressure rises above the pressure regulator calibration, the pressure is relieved, with excess fuel returned to the fuel tank.

Reference Information

Description and Operation

Fuel System Description on page 9-284

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

- J 34730-1A Fuel Pressure Gauge
- J 37287 Fuel Line Shut-Off Adapters

Circuit/System Verification

Note:

- Inspect the fuel system for damage or external leaks before proceeding.
 - Verify that adequate fuel is in the fuel tank before proceeding.
 - Verify that the low pressure fuel pump is operating (if equipped). A low pressure pump that is not functioning will cause low fuel pressure.
 - The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
1. Ignition ON, command the fuel pump relay ON with a scan tool. You should hear the fuel pump turn ON and OFF.
⇒ If the fuel pump does not turn ON, refer to *Fuel Pump Electrical Circuit Diagnosis on page 9-207*.
 2. Ignition OFF, install the J 34730-1A. Refer to *Fuel Pressure Gauge Installation and Removal on page 9-229*.
 3. Ignition ON, command the fuel pump relay ON with a scan tool. Verify the fuel pressure is between 380–427 kPa (55–62 psi) and remains steady for 5 minutes.

Circuit/System Testing

Note:

- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
 - DO NOT start the engine.
1. Ignition ON, command the fuel pump relay ON with a scan tool and observe the fuel pressure gauge while the fuel pump is operating. Verify the fuel pressure is between 380–427 kPa (55–62 psi).

Note: It may be necessary to remove the fuel tank.

- ⇒ If less than the specified range, test, inspect, and repair the items listed below. If all items test normal, replace the fuel pump.
 - Restricted fuel feed pipe
 - Restricted or plugged fuel filter
 - Restricted or plugged strainer
 - Stuck or binding fuel level float
 - Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.
- ⇒ If greater than the specified range, replace the fuel pump.

Note: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

2. Verify the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.
⇒ If greater than the specified range, perform the following procedure:
 - 2.1. Ignition OFF, relieve the fuel pressure. Refer to *Fuel Pressure Relief on page 9-230*.
 - 2.2. Install the J 37287 between the fuel feed pipe and the fuel rail.
 - 2.3. Open the valve on the J 37287.
 - 2.4. Ignition ON, command the fuel pump relay ON with a scan tool and bleed the air from the fuel pressure gauge.
 - 2.5. Close the valve on the J 37287.
 - 2.6. Verify the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.
⇒ If the fuel pressure drops, locate and replace the leaking fuel injector.
 - 2.7. If the fuel system test normal, replace the fuel pump.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify the fuel pressure does not decrease greater than 14 kPa (2 psi) in 5 minutes.
⇒ If greater than the specified range, replace the fuel pump.
4. Remove the J 37287 and J 34730-1A. Refer to *Fuel Pressure Gauge Installation and Removal on page 9-229*.
5. Operate the vehicle within the conditions of the customers concern while monitoring fuel related parameters with a scan tool. The scan tool parameters should not indicate a lean condition.
⇒ If the scan tool parameters indicate a lean condition, test for a restricted fuel feed pipe, restricted fuel filter, or poor connections at the harness connectors and ground circuits of the fuel pump. If all test normal, replace the fuel pump.
6. If the fuel system components test normal, refer to *Symptoms - Engine Controls on page 9-199*.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Fuel Injection Fuel Rail Assembly Replacement (3.0L)* on page 9-230 or *Fuel Injection Fuel Rail Assembly Replacement (4.3L 5.0L and 5.7L)* on page 9-231 or *Fuel Injection Fuel Rail Assembly Replacement (6.0L and 6.2L)* on page 9-234 or *Fuel Injection Fuel Rail Assembly Replacement (2.4L)* on page 9-235
- *Fuel Injector Replacement (Except 2.4L)* on page 9-238 or *Fuel Injector Replacement (2.4L)* on page 9-240

Fuel System Diagnosis (without Returnless Fuel System)

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit/System Description

When the ignition switch is turned ON, the engine control module (ECM) supplies power to the fuel pump(s), by energizing the fuel pump relay. The fuel pump remains ON as long as the engine is cranking or running and the ECM receives crankshaft reference pulses. If there are no reference pulses, the ECM turns the fuel pump OFF, 2 seconds after the ignition switch is turned ON or 2 seconds after the engine stops running. The fuel pump supplies fuel through a fuel filter, through the fuel feed pipes, to the fuel rail assembly. The fuel pump provides fuel at a pressure above the pressure needed by the fuel injectors. The fuel pressure regulator, located in the modular fuel pump and sender assembly, keeps the fuel available to the fuel injectors at a regulated pressure. When the fuel pressure rises above the pressure regulator calibration, the pressure is relieved, with excess fuel returned to the fuel tank.

Reference Information

Description and Operation

Fuel System Description on page 9-284

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

- J 34730-1A Fuel Pressure Gauge
- J 37287 Fuel Line Shut-Off Adapters

Circuit/System Verification

Note:

- Inspect the fuel system for damage or external leaks before proceeding.
- Verify that adequate fuel is in the fuel tank before proceeding.
- Verify that the low pressure fuel pump is operating (if equipped). A low pressure pump that is not functioning will cause low fuel pressure.
- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.

1. Ignition ON, command the fuel pump relay ON with a scan tool. You should hear the fuel pump turn ON and OFF.
⇒ If the fuel pump does not turn ON, refer to *Fuel Pump Electrical Circuit Diagnosis* on page 9-207.
2. Ignition OFF, install the J 34730-1A. Refer to *Fuel Pressure Gauge Installation and Removal* on page 9-229.
3. Ignition ON, command the fuel pump relay ON with a scan tool. Verify the fuel pressure is between 380–427 kPa (55–62 psi) and remains steady for 5 minutes.

Circuit/System Testing

Note:

- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
 - DO NOT start the engine.
1. Ignition ON, command the fuel pump relay ON with a scan tool and observe the fuel pressure gauge while the fuel pump is operating. Verify the fuel pressure is between 380–427 kPa (55–62 psi).

Note: It may be necessary to remove the fuel tank.

⇒ If less than the specified range, test, inspect, and repair the items listed below. If all items test normal, replace the fuel pump.

- Restricted fuel feed pipe
- Restricted or plugged fuel filter
- Restricted or plugged strainer
- Stuck or binding fuel level float
- Inspect the harness connectors and the ground circuits of the fuel pump for poor connections.

⇒ If greater than the specified range, replace the fuel pump.

Note: The fuel pressure may vary slightly when the fuel pump stops operating. After the fuel pump stops operating, the fuel pressure should stabilize and remain constant.

2. Verify the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.
 - ⇒ If greater than the specified range, perform the following procedure:
 - 2.1. Ignition OFF, relieve the fuel pressure. Refer to *Fuel Pressure Relief* on page 9-230.
 - 2.2. Install the J 37287 between the fuel feed pipe and the fuel rail.
 - 2.3. Open the valve on the J 37287.
 - 2.4. Ignition ON, command the fuel pump relay ON with a scan tool and bleed the air from the fuel pressure gauge.
 - 2.5. Close the valve on the J 37287.
 - 2.6. Verify the fuel pressure does not decrease greater than 34 kPa (5 psi) in 1 minute.
 - ⇒ If the fuel pressure drops, locate and replace the leaking fuel injector.
 - 2.7. If the fuel system test normal, replace the fuel pump.
3. Relieve the fuel pressure to 69 kPa (10 psi). Verify the fuel pressure does not decrease greater than 14 kPa (2 psi) in 5 minutes.
 - ⇒ If greater than the specified range, replace the fuel pump.
4. Remove the J 37287 and J 34730-1A. Refer to *Fuel Pressure Gauge Installation and Removal* on page 9-229.
5. Operate the vehicle within the conditions of the customers concern while monitoring fuel related parameters with a scan tool. The scan tool parameters should not indicate a lean condition.
 - ⇒ If the scan tool parameters indicate a lean condition, test for a restricted fuel feed pipe, restricted fuel filter, or poor connections at the harness connectors and ground circuits of the fuel pump. If all test normal, replace the fuel pump.
6. If the fuel system components test normal, refer to *Symptoms - Engine Controls* on page 9-199.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Fuel Injection Fuel Rail Assembly Replacement (3.0L)* on page 9-230 or *Fuel Injection Fuel Rail Assembly Replacement (4.3L 5.0L and 5.7L)* on page 9-231 or *Fuel Injection Fuel Rail Assembly Replacement (6.0L and 6.2L)* on page 9-234 or *Fuel Injection Fuel Rail Assembly Replacement (2.4L)* on page 9-235
- *Fuel Injector Replacement (Except 2.4L)* on page 9-238 or *Fuel Injector Replacement (2.4L)* on page 9-240

Fuel Injector Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit/System Description

The control module enables the appropriate fuel injector pulse for each cylinder. The ignition voltage is supplied directly to the fuel injectors. The control module controls each fuel injector by grounding the control circuit via a solid state device called a driver. A fuel injector coil winding resistance that is too high or too low will affect the engine driveability. A fuel injector control circuit DTC may not set, but a misfire may be apparent. The fuel injector coil windings are affected by temperature. The resistance of the fuel injector coil windings will increase as the temperature of the fuel injector increases.

When performing the fuel injector balance test, the scan tool is first used to energize the fuel pump relay. The fuel injector tester or the scan tool is then used to pulse each injector for a precise amount of time, allowing a measured amount of the fuel to be injected. This causes a drop in the system fuel pressure that can be recorded and used to compare each injector.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Description and Operation

Data Link Communications Description and Operation on page 11-5

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

- CH-48027 Digital Fuel Pressure Gauge
- J 34730-1A Fuel Pressure Gauge
- J 39021 Fuel Injector Coil and Balance Tester
- J 44602 Injector Test Adapter

Component Testing

Fuel Injector Coil Test

Verify the resistance of each fuel injector with one of the following methods:

- If the engine coolant temperature (ECT) sensor is between 10–32°C (50–90°F), the resistance of each fuel injector should be 11–14 Ω.
 - ⇒ If the injectors test OK, perform the Fuel Injector Balance Test – Fuel Pressure Test.
 - ⇒ If not within the specified range, replace the fuel injector.
- If the ECT sensor is not between 10–32°C (50–90°F), measure and record the resistance of each fuel injector with a DMM. Subtract the lowest resistance value from the highest resistance value. The difference between the lowest value and the highest value should be equal to or less than 3 Ω.
 - ⇒ If the difference is equal to or less than 3 Ω, refer to Fuel Injector Balance Test – Fuel Pressure Test for further diagnosis of the fuel injectors.
 - ⇒ If the difference is greater than 3 Ω, add all of the fuel injector resistance values to obtain a total resistance value. Divide the total resistance value by the number of fuel injectors to obtain an average resistance value. Subtract the lowest individual fuel injector resistance value from the average resistance value. Compute the difference between the highest individual fuel injector resistance value and the average resistance value. Replace the fuel injector that displays the greatest difference above or below the average.

Fuel Injector Balance Test-Fuel Pressure Test

Note:

- DO NOT perform this test if the engine coolant temperature (ECT) is above 94°C (201°F). Irregular fuel pressure readings may result due to hot soak fuel boiling.
 - Verify that adequate fuel is in the fuel tank before proceeding with this diagnostic.
1. Install a J 34730-1A, refer to *Fuel Pressure Gauge Installation and Removal* on page 9-229.
 2. Ignition ON, engine OFF.

Note:

- The fuel pump relay may need to be commanded ON a few times in order to obtain the highest possible fuel pressure.
 - DO NOT start the engine.
3. Command the fuel pump relay ON with a scan tool.
 4. Observe the fuel pressure gauge with the fuel pump commanded ON. The fuel pressure should be 380–427 kPa (55–62 psi).
 - ⇒ If less than the specified range, refer to *Fuel System Diagnosis (with Returnless Fuel System)* on page 9-208 or *Fuel System Diagnosis (without Returnless Fuel System)* on page 9-210.

5. Monitor the J 34730-1A for one minute. The fuel pressure should not decrease more than 34 kPa (5 psi).
 - ⇒ If the fuel pressure decreases greater than 34 kPa (5 psi), refer to *Fuel System Diagnosis (with Returnless Fuel System)* on page 9-208 or *Fuel System Diagnosis (without Returnless Fuel System)* on page 9-210
 - ⇓ If the fuel system tests OK, perform the Fuel Injector Balance Test with Special Tool or the Fuel Injector Balance Test with Scan Tool.

Fuel Injector Balance Test with Special Tool

1. Install a J 34730-1A, refer to *Fuel System Diagnosis (with Returnless Fuel System)* on page 9-208 or *Fuel System Diagnosis (without Returnless Fuel System)* on page 9-210.
2. Set the amperage supply selector switch on the fuel injector tester to the Balance Test 0.5–2.5 amp position.
3. Connect the J 39021 to a fuel injector with a J 44602.
4. Command the fuel pump relay ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.

Caution: Refer to *Fuel Injector Balance Test Caution* on page 0-5.

5. Command the fuel pump relay ON and energize the fuel injector by depressing the Push to Start Test button on the J 39021 at the previously selected pressure.

Note: The fuel pressure may rise after the fuel injector stops pulsing. Record the fuel pressure value immediately after the fuel injector stops pulsing. DO NOT record the higher fuel pressure value.

6. After the injector stops pulsing, record the minimum pressure displayed on the J 34730-1A.
7. Repeat steps 5 and 6 for each fuel injector.
 - ⇓ Perform the Pressure Drop Calculation.

Fuel Injector Balance Test with Scan Tool and CH 48027-5

Note: Before proceeding with this test review the User Manual CH 48027-5 for Safety Information and Instructions.

1. Command the fuel pump relay ON and then OFF three times with a scan tool. On the last command, as the fuel pressure begins to slowly degrade and stabilize, select a fuel pressure within 34 kPa (5 psi) of the maximum pump pressure. Record this fuel pressure. This is the starting pressure at which you will pulse each injector.
2. Select the Fuel Injector Balance Test function within the Control Functions menu of a scan tool.
3. Select an injector to be tested.
4. Press Enter to prime the fuel system.

5. Energize the fuel injector by depressing the Pulse Injector button on the scan tool at the previously selected pressure.
6. After the injector stops pulsing, select Min from the Display Mode on the *CH-48027* and record the minimum pressure.

Note: New test results will not be recorded if the Min/Max results are not cleared after each injector is tested.

7. Clear the Min/Max results on the *CH-48027*.
8. Select Normal from the Display Mode on the *CH-48027*.
9. Press Enter on the scan tool to bring you back to the Select Injector screen.
10. Repeat steps 3 through 9 for each fuel injector.
 ↓ Perform the Pressure Drop Calculation.

Pressure Drop Calculation

1. Subtract the minimum pressure from the starting pressure for one fuel injector. The result is the pressure drop value.
2. Obtain a pressure drop value for each fuel injector.
3. Add all of the individual pressure drop values except for the injector suspected of being faulty. This is the total pressure drop.
4. Divide the total pressure drop by the number of fuel injectors that were added together. This is the average pressure drop. The difference between any individual pressure drop and the average pressure drop should not be more than 20 kPa (3 psi).
 ⇒ If the difference between any individual pressure drop and the average pressure drop is more than 20 kPa (3 psi), replace the fuel injector.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.
Fuel Injector Replacement (Except 2.4L) on page 9-238 or *Fuel Injector Replacement (2.4L)* on page 9-240

Alcohol/Contaminants-in-Fuel Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provide an overview of each diagnostic category.

Test Description

Water contamination in the fuel system may cause driveability conditions such as hesitation, stalling, no start, or misfires in one or more cylinders. Water may collect near a single fuel injector at the lowest point in the fuel injection system and cause a misfire in that cylinder. If the fuel system is contaminated with water, inspect the fuel system components for rust or deterioration.

Alcohol concentrations of 10 percent or greater in fuel can be detrimental to fuel system components. Alcohol contamination may cause fuel system corrosion, deterioration of rubber components, and subsequent fuel filter restriction. Some types of alcohol are more detrimental to fuel system components than others. Ethanol is commonly used in gasoline, but in concentrations of no more than 10 percent. Some fuels, such as E85, contain a very high percentage of ethanol. Fuel with more than 10 percent ethanol may cause driveability conditions such as hesitation, lack of power, stalling, or no start.

System Verification

The fuel sample should be drawn from the bottom of the tank so that any water present in the tank will be detected. The sample should be bright and clear.

System Testing

1. Using a 100 ml (3.38 oz) specified cylinder with 1 ml (0.034 oz) graduation marks, fill the cylinder with fuel to the 90 ml (3.04 oz) mark.
2. Add 10 ml (0.34 oz) of water in order to bring the total fluid volume to 100 ml (3.38 oz) and install a stopper.
3. Shake the cylinder vigorously for 10–15 seconds.
4. Carefully loosen the stopper in order to release the pressure.
5. Install the stopper and shake the cylinder vigorously again for 10–15 seconds.
6. Place the cylinder on a level surface for approximately 5 minutes in order to allow adequate liquid separation. If alcohol is present in the fuel, the volume of the lower layer, which would now contain both alcohol and water, will be greater than 10 ml (0.34 oz). For example, if the volume of the lower layer is increased to 15 ml (0.51 oz), this indicates at least 5 percent alcohol in the fuel. The actual amount of alcohol may be somewhat greater because this procedure does not extract all of the alcohol from the fuel.

Particulate Contaminants in Fuel Testing Procedure

1. Using an approved fuel container, draw approximately 0.5 liter (0.53 qt) of fuel.
2. Place the container on a level surface for approximately 5 minutes in order to allow settling of the particulate contamination. Particulate contamination will show up in various shapes and colors. Sand will typically be identified by a white or light brown crystals. Rubber will appear as black and irregular particles.
3. Observe the fuel sample. If any physical contaminants or water are present, clean the fuel system.

Distributor Ignition (DI) System Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit/System Description

The distributor ignition (DI) system uses the crankshaft position (CKP) sensor in order to provide a timing input to the engine control module (ECM). Ignition control (IC) spark timing for each cylinder is based on this input. The ECM provides the ignition timing signal to the ignition control module (ICM) to control the ignition coil. Each timing pulse detected by the ICM allows it to energize the ignition coil. A large secondary ignition voltage is induced in the secondary coil by the primary coil. This high voltage is switched to the correct spark plug by the distributor.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Special Tools

J 26792 Spark Tester

Circuit/System Verification

Note:

- Do not perform this diagnostic procedure if you were not sent here from a misfire DTC or the Engine Cranks but Does Not Run diagnostic.
- It may be necessary to perform step 1 on a few of the spark plug wires.

1. Ignition OFF, connect the J 26792 to the boot of a spark plug wire of a cylinder and ground.

Note: An erratic or weak spark is considered a no spark condition.

2. Engine cranking, the spark tester should spark.

Circuit/System Testing

1. Ignition OFF, inspect the spark plug wires, and coil wire for the following:
 - Mis-routed wires
 - Cracks in the insulation
 - Improper connection at the spark plugs and distributor cap

⇒ If a condition is found, repair as necessary.
2. Disconnect the harness connector at the ICM.
3. Test for less than 5 Ω between the ground circuit terminal C and ground.

⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
4. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal A and ground.

⇒ If the test lamp does not illuminate, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.

Note: Set the DMM to the DC 4 volt scale for this test.

5. Connect a DMM between the ignition control circuit terminal B and ground.
6. Ignition ON, verify the voltage is less than 0.050 V.

⇒ If greater than the specified range, test the circuit for a short to voltage.
7. Engine cranking, verify the voltage is greater than 100 mV.

⇒ If less than the specified range, test the ignition control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
8. Ignition OFF, connect the ICM harness connector. Disconnect the harness connector at the ignition coil.

9. Ignition ON, verify that a test lamp illuminates between the ignition voltage circuit terminal A and ground.
 - ⇒ If less than the specified range, repair the ignition voltage circuit for an open/high resistance.
10. Connect a test lamp between the coil driver circuit terminal C and B+.
11. Engine cranking, the test lamp should blink.
 - ⇒ If the test lamp remains ON all the time, test the ignition control circuit for a short to ground. If the circuit tests normal, replace the ICM.
 - ⇒ If the test lamp remains OFF all the time, test the ignition control circuit for a short to voltage, or an open/high resistance. If the circuit tests normal, replace the ICM.
12. Ignition OFF, connect the ignition coil harness connector. Disconnect the ignition coil wire from the distributor cap. Connect the J 26792 between the boot of the coil wire and ground.
13. Engine cranking, the spark tester should spark.
 - ⇒ If the spark tester does not spark, test the coil wire for an open/high resistance. If the coil wire tests normal, replace the ignition coil.
14. Ignition OFF, remove the distributor cap.
15. Engine cranking, verify the distributor rotor is rotating.
 - ⇒ If the distributor rotor does not rotate, repair the engine mechanical condition.
16. If all circuits test normal, inspect and replace the distributor cap and rotor.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Ignition Coil Replacement (3.0L) on page 9-241 or Ignition Coil Replacement (6.0L and 6.2L) on page 9-242 or Ignition Coil Replacement (4.3L, 5.0L, and 5.7L) on page 9-243 or Ignition Coil Replacement (2.4L) on page 9-244*
- *Spark Plug Wire Inspection on page 9-245*
- *Engine Control Module Programming and Setup on page 6-3 for ECM replacement, setup, and programming*

Electronic Ignition System Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit/System Description

Ignition 1 voltage is supplied to the ignition coil. The engine control module (ECM) provides a ground for the ignition coil (IC) control circuits. When the ECM removes the ground path of the ignition primary coil, the magnetic field produced by the coil collapses. The collapsing magnetic field produces a voltage in the secondary coil which ignites the spark plugs. The sequencing and timing are controlled by the ECM.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views on page 9-30*
- *Engine Controls Connector End Views on page 9-33*

Electrical Information Reference

- *Circuit Testing on page 11-6*
- *Connector Repairs on page 11-22*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Wiring Repairs on page 11-16*

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Testing

Note: Do not perform this diagnostic procedure if you were not sent here from a misfire DTC or the Engine Cranks but Does Not Run diagnostic.

1. Ignition OFF, disconnect the harness connector at the ignition coil.
2. Test for less than 2 Ω between the ground circuit terminal A/1 and ground.
 - ⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
3. Test for less than 2 Ω between the EST return circuit terminal B/2 and ground.
 - ⇒ If greater than the specified range, test the EST return circuit for an open/high resistance. If the circuit tests normal, replace the ECM.
4. Ignition ON, load test for B+ between the ignition voltage circuit terminal D/4 and ground.
 - ⇒ If less than the specified range, test the ignition voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal and the ignition voltage circuit fuse is open, test all components connected to the ignition voltage circuit and replace as necessary.
5. If all circuits test normal, replace the ignition coil.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

- *Ignition Coil Replacement (3.0L) on page 9-241 or Ignition Coil Replacement (6.0L and 6.2L) on page 9-242 or Ignition Coil Replacement (4.3L, 5.0L, and 5.7L) on page 9-243 or Ignition Coil Replacement (2.4L) on page 9-244*
- *Engine Control Module Programming and Setup on page 6-3 for ECM replacement, setup, and programming*

Slow Mode Switch Diagnosis

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Circuit/System Description

The slow mode switch allows the operator to change the throttle control percentage in order to maintain a more accurate control of the engine speed at low vehicle speeds. The engine control module (ECM) applies a voltage to the slow mode circuit. The ECM monitors the status of the slow mode circuit. When the slow mode switch is depressed, the ECM detects a low signal voltage and will limit the engine speed output. Normal throttle control will return when the slow mode switch is OFF, and the throttle has been placed in neutral.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: Verify the throttle is in neutral for this procedure.

Engine idling, depress the slow mode switch. With the throttle control in neutral, raise the engine speed. The engine should operate at a reduced RPM.

Circuit/System Testing

1. Ignition OFF, disconnect the slow mode switch harness connector.
2. Test for less than 5 Ω between the slow mode switch ground circuit and ground
⇒ If greater than the specified range, repair the slow mode switch ground circuit for an open/high resistance.
3. Ignition ON, test for greater than 4 V between the slow mode switch signal circuit and ground.
⇒ If less than the specified range, test the slow mode switch signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, replace the slow mode switch.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the diagnostic procedure.

Engine Control Module Programming and Setup on page 6-3 for ECM replacement, setup, and programming

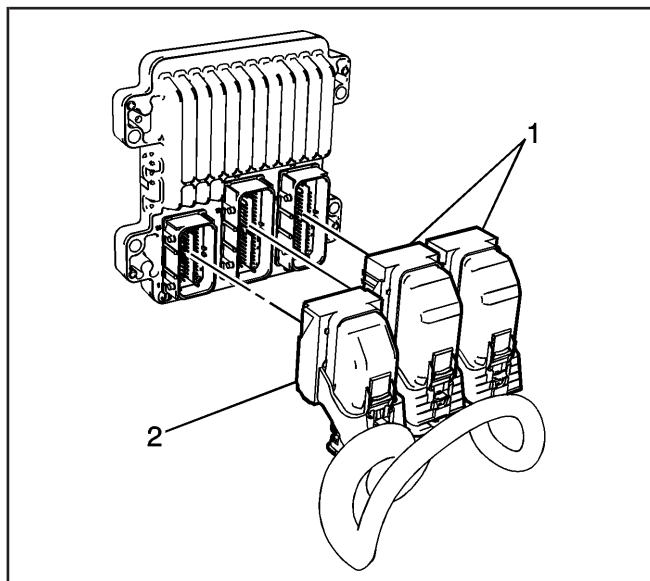
Repair Instructions

Engine Control Module Replacement

Removal Procedure

Note:

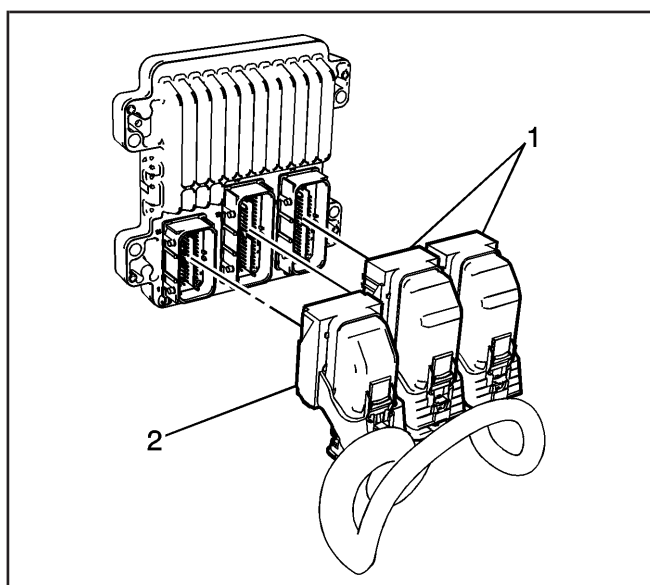
- Turn the ignition OFF when installing or removing the control module connectors and disconnecting or reconnecting the power to the control module in order to prevent internal control module damage.
 - Control module damage may result when the metal case contacts battery voltage. DO NOT contact the control module metal case with battery voltage when servicing a control module, using battery booster cables, or when charging the vehicle battery.
 - In order to prevent any possible electrostatic discharge damage to the control module, do not touch the connector pins or the soldered components on the circuit board.
 - Remove any debris from around the control module connector surfaces before servicing the control module. Inspect the control module connector gaskets when diagnosing or replacing the control module. Ensure that the gaskets are installed correctly. The gaskets prevent contaminant intrusion into the control module.
1. Ignition OFF.
 2. Disconnect the negative battery cable.
 3. Disconnect the engine wiring harness electrical connectors (1) and (2) from the ECM.



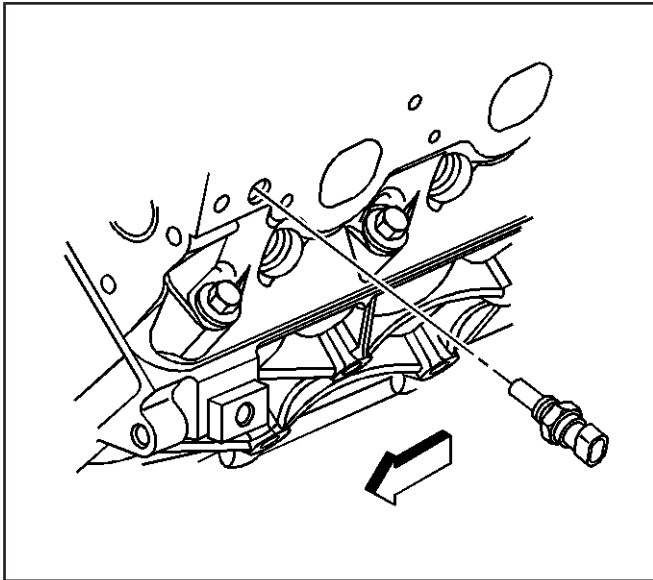
1838648

Installation Procedure

1. Connect the engine wiring harness electrical connectors (1) and (2) to the ECM.
2. Connect the negative battery cable.
3. If a NEW ECM was installed, the ECM may need to be programmed. Refer to *Engine Control Module Programming and Setup* on page 6-3.



1838648



855737

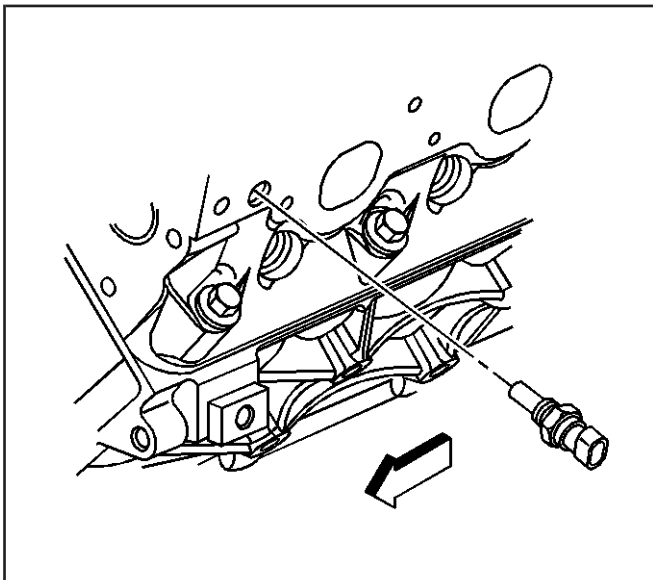
Engine Coolant Temperature Sensor Replacement

Removal Procedure

1. Drain the cooling system to a level below the engine cooling temperature (ECT) sensor.

Note: Use care when handling the coolant sensor. Damage to the coolant sensor will affect the operation of the fuel control system.

2. Disconnect the engine wiring harness electrical connector from the ECT sensor.
3. Remove the ECT sensor.



855737

Installation Procedure

Caution: Refer to *Component Fastener Tightening Caution* on page 0-5.

1. If installing the old sensor, coat the threads with sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent.

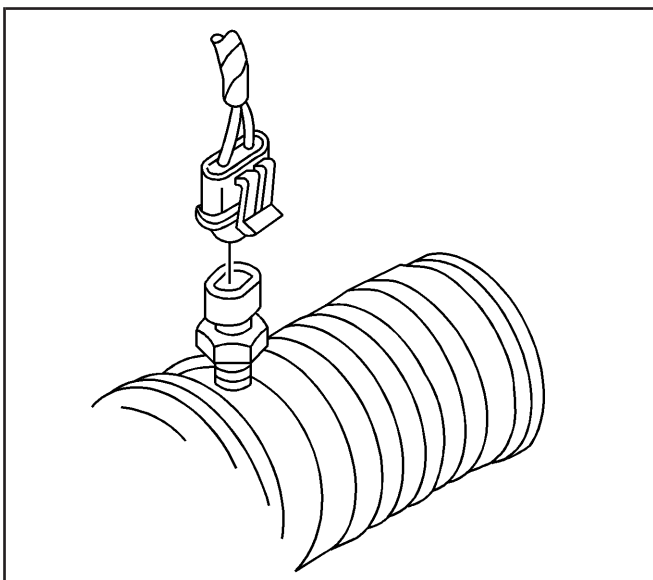
Caution: Refer to *Fastener Caution* on page 0-5.

2. Install the ECT sensor.

Tighten

Tighten the sensor to 20 N·m (15 lb ft).

3. Connect the engine wiring harness electrical connector to the ECT sensor.
4. Refill the cooling.



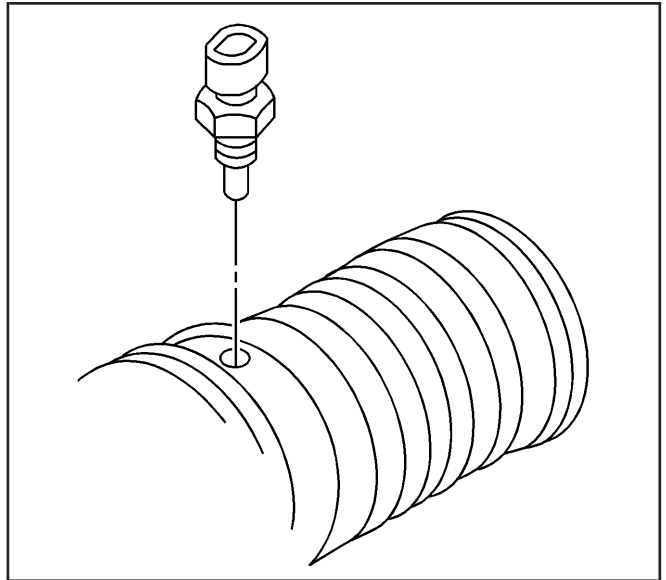
2004809

Manifold Air Temperature Sensor Replacement

Removal Procedure

1. Disconnect the negative battery cable.
2. Disconnect the manifold air temperature (MAT) sensor harness connector.

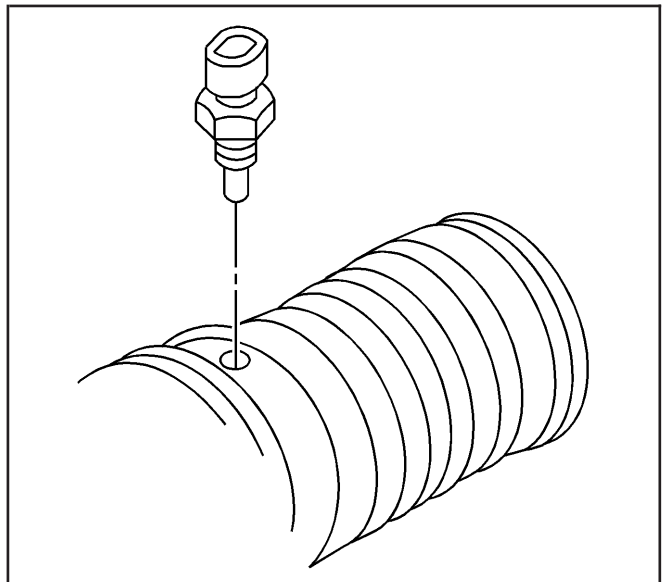
3. Remove the MAT sensor from the air cleaner outlet duct by pulling the sensor upward.



2004821

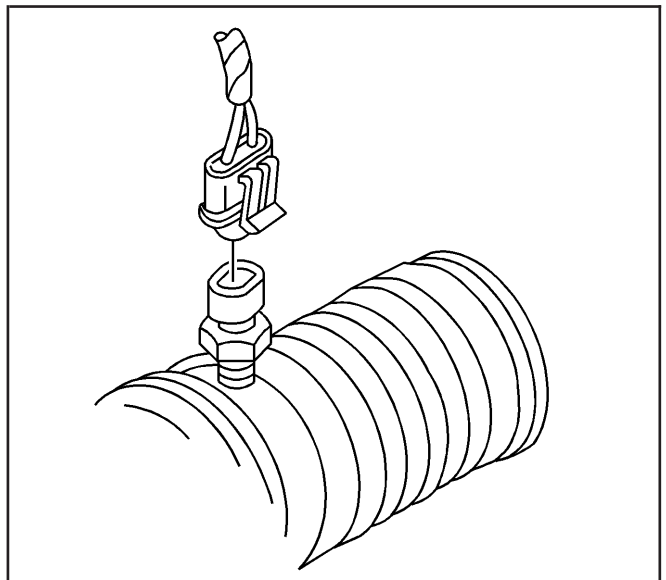
Installation Procedure

1. Install the MAT sensor in the air cleaner outlet duct.

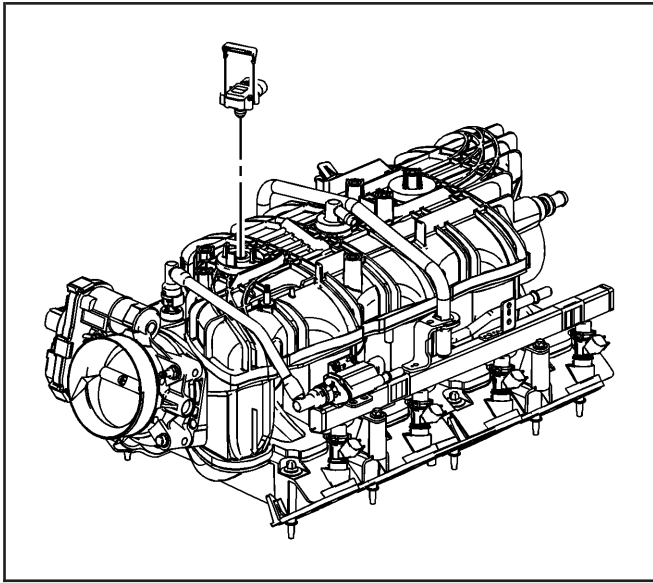


2004821

2. Connect the MAT sensor harness connector.
3. Connect the negative battery cable.



2004809

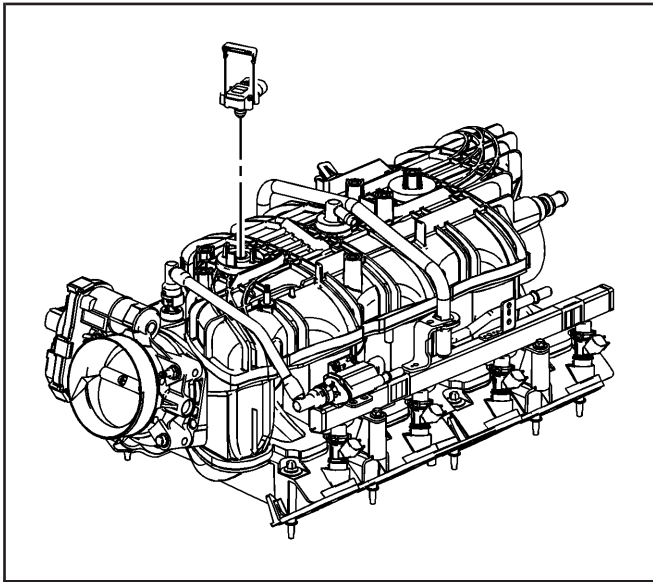


1697060

Manifold Absolute Pressure Sensor Replacement (without Supercharger)

Removal Procedure

1. Disconnect the engine wiring harness electrical connector from the manifold absolute pressure (MAP) sensor.
2. Remove the MAP sensor retainer.
3. Remove the MAP sensor.



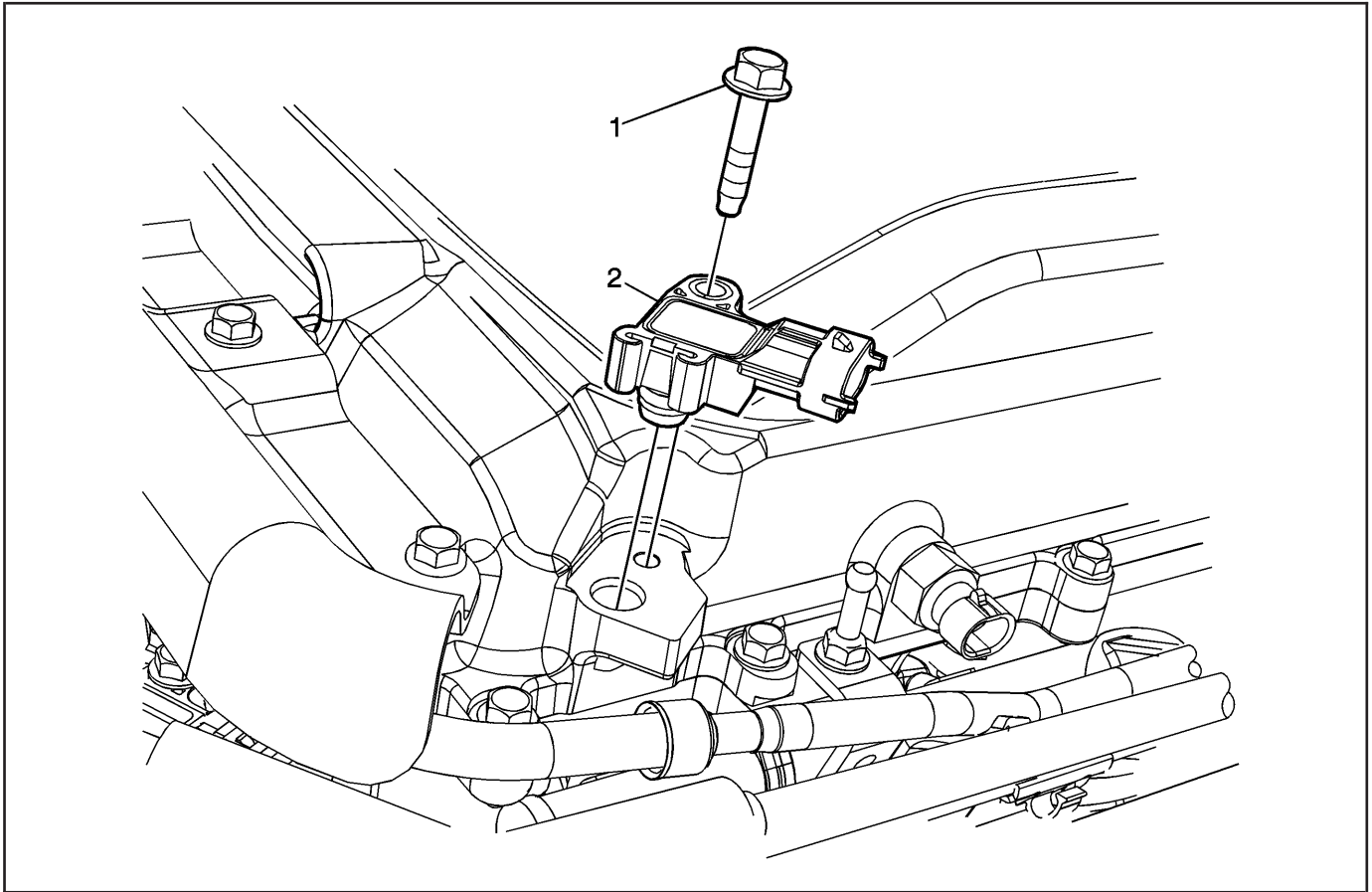
1697060

Installation Procedure

Note: Lightly coat the MAP sensor seal with clean engine oil before installing the sensor.

1. Install the MAP sensor.
2. Install the MAP sensor retainer.
3. Connect the engine harness wiring electrical connector to the MAP sensor.

Barometric Pressure Sensor Replacement

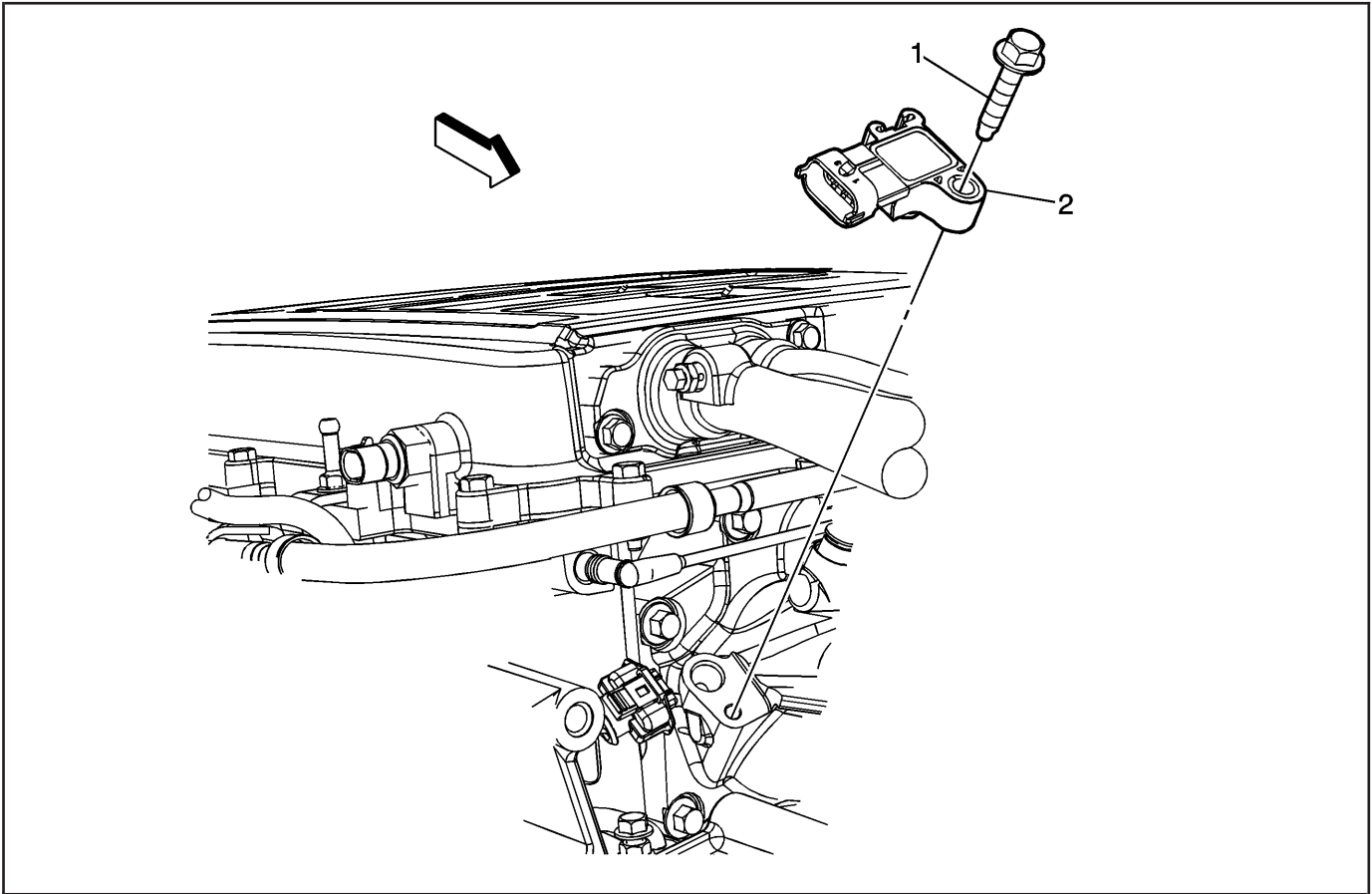


2164114

Barometric Pressure Sensor Replacement

Callout	Component Name
1	Barometric Pressure Sensor Bolt Caution: Refer to <i>Component Fastener Tightening Caution</i> on page 0-5. Tighten 10 N·m (89 lb in)
2	Barometric Pressure Sensor Procedure Disconnect the Baro sensor harness connector. Tip: Always install the NEW O-ring provided with the BARO sensor.

Supercharger Air Inlet Pressure Sensor Replacement

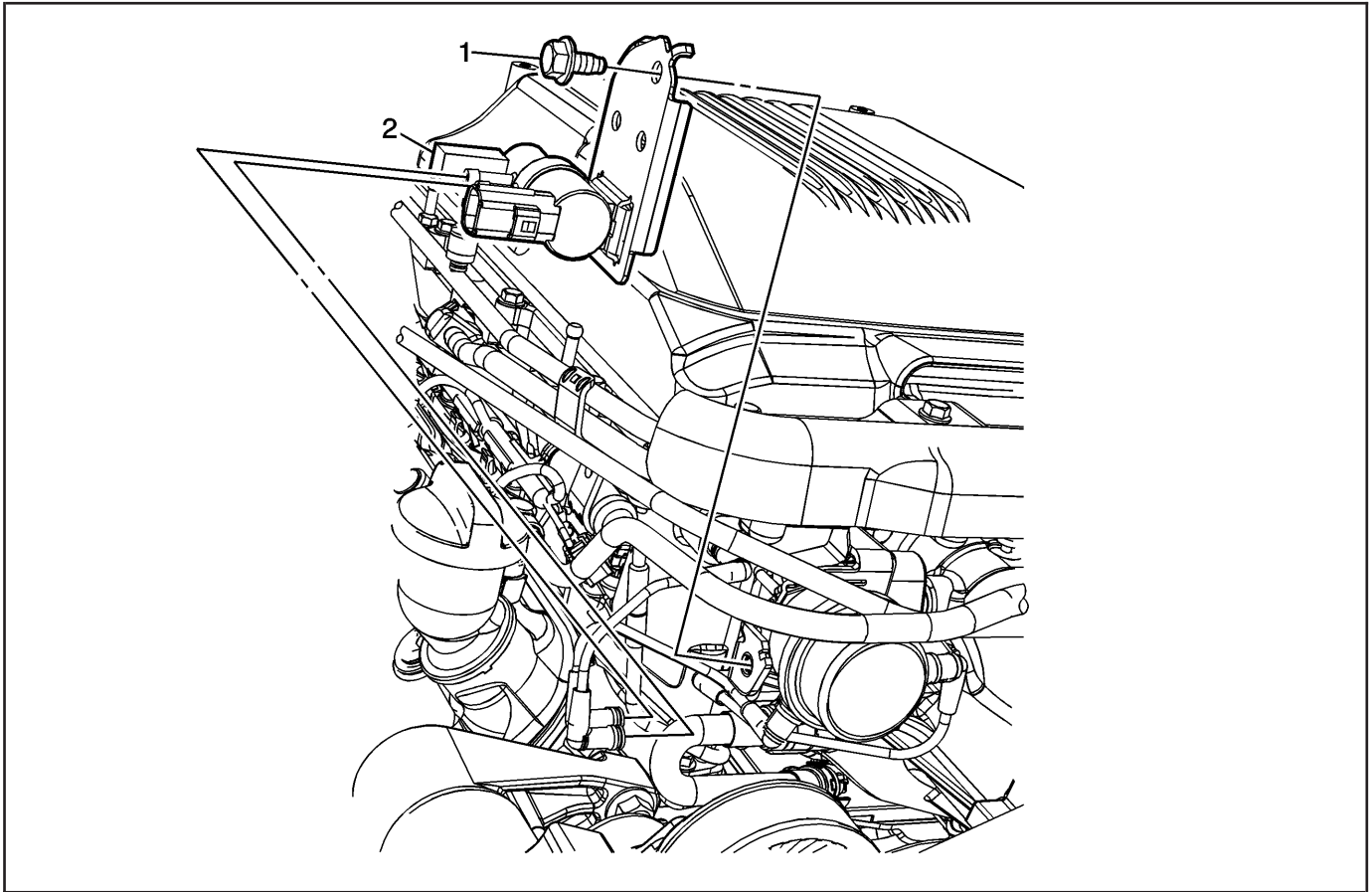


2157401

Supercharger Air Inlet Pressure Sensor Replacement

Callout	Component Name
1	Super Charger Inlet Pressure Sensor Bolt Caution: Refer to <i>Component Fastener Tightening Caution</i> on page 0-5. Tighten 10 N·m (89 lb in)
2	Super Charger Inlet Pressure Sensor Procedure Disconnect the super charger pressure sensor harness connector. Tip: Always install the NEW O-ring provided with the super charger pressure sensor.

Charge Air Bypass Regulator Solenoid Valve Replacement

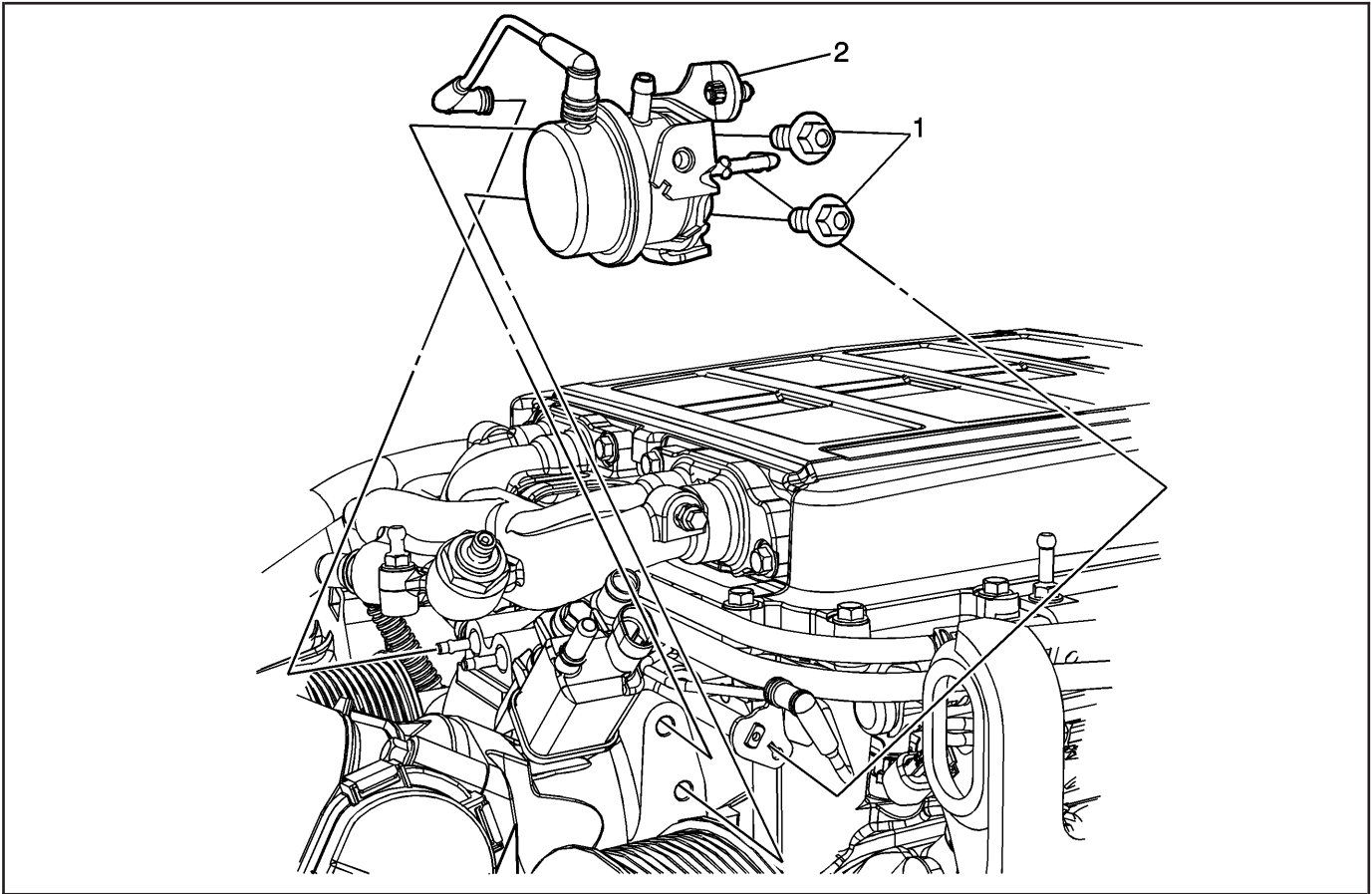


2164115

Charge Air Bypass Regulator Solenoid Valve Replacement

Callout	Component Name
1	Charge Air Bypass Regulator Solenoid Fastener Caution: Refer to <i>Component Fastener Tightening Caution</i> on page 0-5. Tighten 10 N·m (89 lb in)
2	Charge Air Bypass Regulator Solenoid Procedure • Disconnect the harness connector. • Disconnect the vacuum tubes from the charge air bypass regulator solenoid.

Supercharger Bypass Valve Actuator Replacement



2159710

Supercharger Bypass Valve Actuator Replacement

Callout	Component Name
1	Supercharger Air Bypass Regulator Actuator Fastener Caution: Refer to <i>Component Fastener Tightening Caution</i> on page 0-5. Tighten 10 N·m (89 lb in)
2	Supercharger Air Bypass Regulator Actuator Procedure 1. Disconnect the Vacuum Tube from the supercharger. 2. Disconnect the vacuum tubes from the supercharger air bypass regulator actuator.

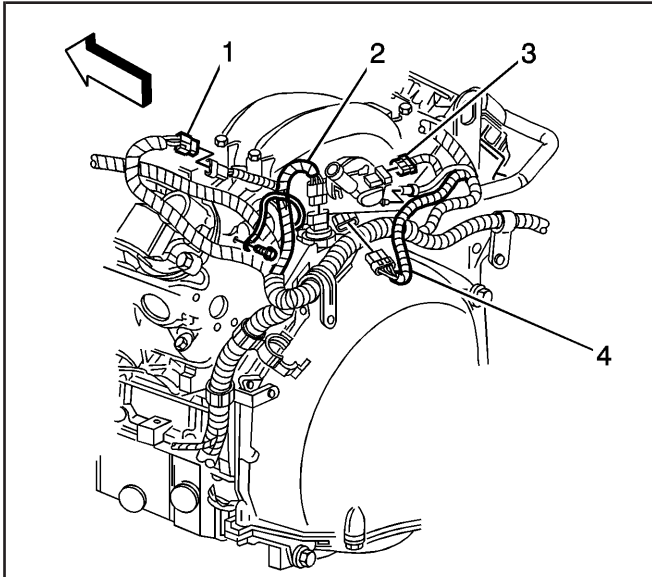
Engine Oil Pressure Sensor Replacement

Special Tools

J 41712 Oil Pressure Sensor Socket

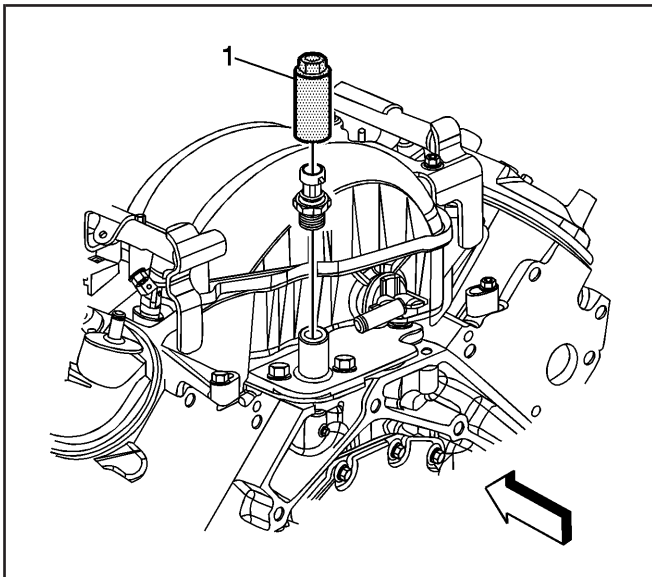
Removal Procedure

1. Clean area around the oil sensor/switch before removing it.



1656451

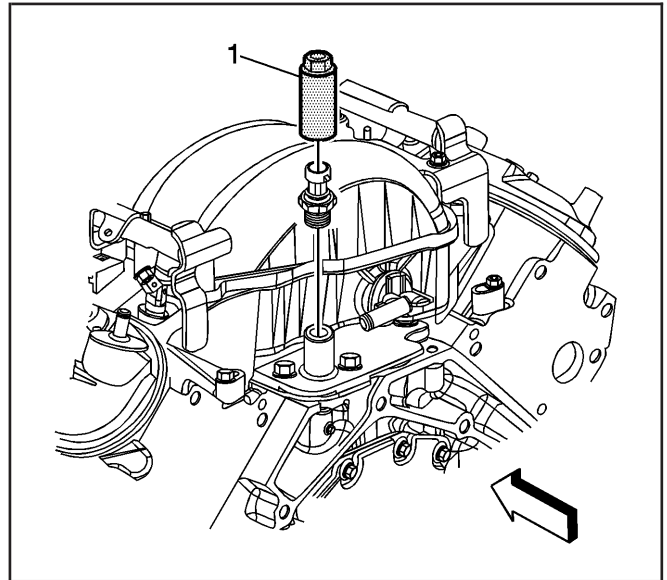
2. Disconnect the electrical connector for the oil pressure sensor/switch (2).



1658870

3. Remove the oil pressure sensor/switch with the J 41712 (1).

Installation Procedure



1658870

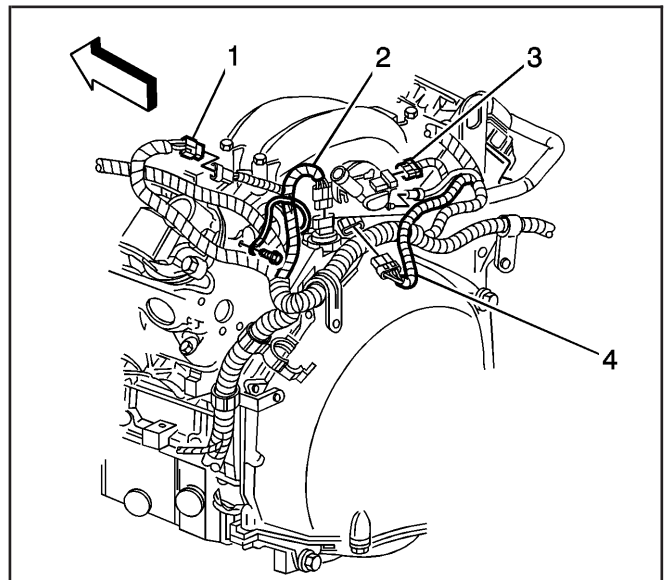
1. If installing the old sensor, coat the threads with sealant GM P/N 12346004 (Canadian P/N 10953480) or equivalent.

Caution: Refer to *Fastener Caution* on page 0-5.

2. Install the oil pressure sensor/switch with the J 41712 (1).

Tighten

Tighten the engine oil pressure sensor to 35 N·m (26 lb ft).



1656451

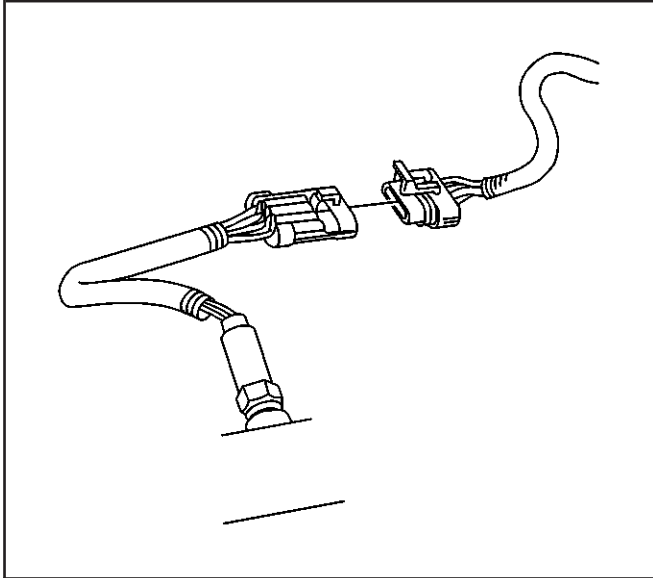
3. Reconnect the oil pressure sensor/switch electrical connector (2).

Heated Oxygen Sensor Replacement

Removal Procedure

Caution: Refer to *Heated Oxygen and Oxygen Sensor Caution* on page 0-6.

1. Remove the connector position assurance (CPA) retainer.



313264

2. Disconnect the HO2S harness connector from the engine wiring harness connector.

Caution: Refer to *Excessive Force and Oxygen Sensor Caution* on page 0-5.

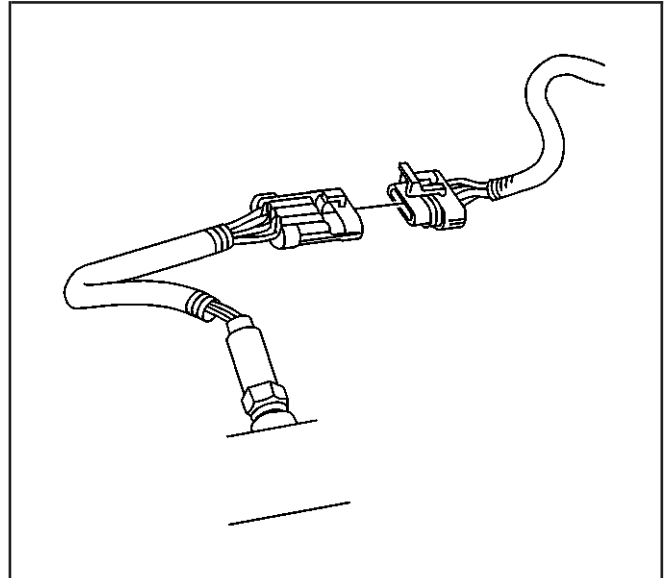
3. Remove the HO2S.

Installation Procedure

Note: A special anti-seize compound is used on the HO2S threads. The compound consists of liquid graphite and glass beads. The graphite tends to burn away, but the glass beads remain, making the sensor easier to remove. New, or service replacement sensors already have the compound applied to the threads. If the sensor is removed from an exhaust component and if for any reason the sensor is to be reinstalled, the threads must have anti-seize compound applied before the reinstallation.

Caution: Replacement components must be the correct part number for the application. Components requiring the use of the thread locking compound, lubricants, corrosion inhibitors, or sealants are identified in the service procedure. Some replacement components may come with these coatings already applied. Do not use these coatings on components unless specified. These coatings can affect the final torque, which may affect the operation of the component. Use the correct torque specification when installing components in order to avoid damage.

1. If reinstalling the old sensor, coat the threads with anti-seize compound GM P/N 12377953, or equivalent.



313264

2. Install the HO2S.

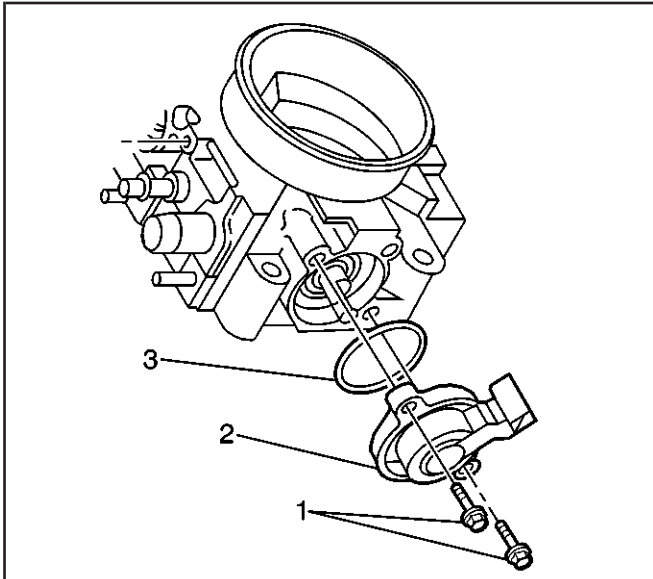
Tighten

Tighten the sensor to 42 N·m (31 lb ft).

3. Connect the HO2S harness connector to the engine wiring harness connector.
4. Install the CPA retainer.

Throttle Position Sensor Replacement (Non ETC)

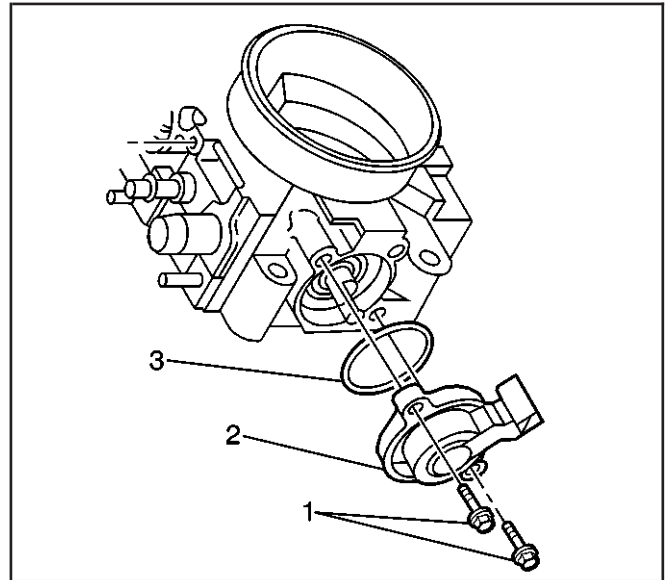
Removal Procedure



13315

1. Disconnect the throttle position (TP) sensor electric connection.
2. Remove the TP sensor attaching screws (1).
3. Remove the TP sensor (2) and seal (3).

Installation Procedure



13315

1. With the throttle valve in the normal closed (idle) position, install the TP sensor (2) and the seal (3) on the throttle body assembly.

Caution: Refer to *Fastener Caution* on page 0-5.

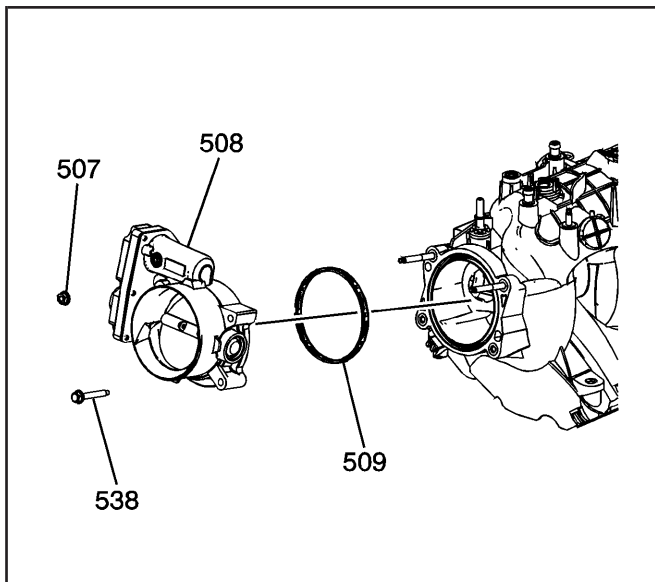
Note: Install the new TP sensor attaching screws when replacing the TP sensor.

2. Install 2 TP sensor screws (1).

Tighten

Tighten the screws to 3 N·m (27 lb in).

3. Connect the TP sensor electric connection.



1401966

Throttle Body Assembly Replacement

Removal Procedure

Caution: Handle the electronic throttle control components carefully. Use cleanliness in order to prevent damage. Do not drop the electronic throttle control components. Do not roughly handle the electronic throttle control components. Do not immerse the electronic throttle control components in cleaning solvents of any type.

Caution: DO NOT for any reason, insert a screwdriver or other small hand tools into the throttle body to hold open the throttle plate, as the wedge inside the throttle body could be damaged.

1. Remove the air cleaner outlet duct.
2. Disconnect the engine wiring harness electrical connector from the electronic throttle control.
3. Remove the throttle body nuts (507) and bolts (538).
4. Remove the throttle body (508).
5. Remove and discard the throttle body gasket (509).

Installation Procedure

1. Install a NEW throttle body gasket to the intake manifold. Align the tab of the gasket with the notch in the manifold.

Caution: Refer to *Fastener Caution on page 0-5*.

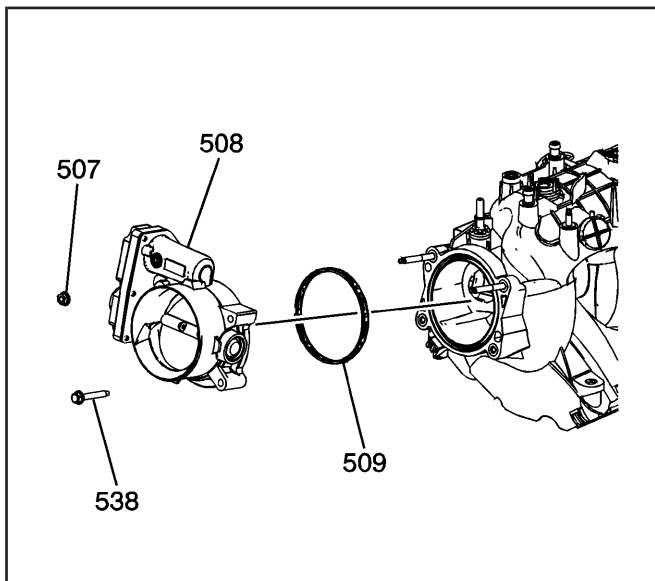
2. Install the throttle body (508), bolts (538), and nuts (507).

Tighten

Tighten the bolts/nuts to 10 N·m (89 lb in).

Note: Verify that the engine wiring harness electrical connector seal for the electronic throttle control is properly installed and not damaged.

3. Connect the engine wiring harness electrical connector to the electronic throttle control.
4. Install the air cleaner outlet duct.
5. Connect a scan tool in order to test for proper throttle-opening and throttle-closing range.
6. Operate the accelerator pedal and monitor the throttle angles. The accelerator pedal should operate freely, without binding, between a closed throttle, and a wide open throttle (WOT).
7. Verify that the vehicle meets the following conditions:
 - The vehicle is not in a reduced engine power mode.
 - The ignition is ON.
 - The engine is OFF.
8. Start the engine.
9. Inspect for coolant leaks.



1401966

Fuel Pressure Gauge Installation and Removal

Installation Procedure

Tools Required

- J 34730-1A Fuel Pressure Gauge
- J-34730-FF Fuel Pressure Gauge

Warning: Wrap a shop towel around the fuel pressure connection in order to reduce the risk of fire and personal injury. The towel will absorb any fuel leakage that occurs during the connection of the fuel pressure gauge. Place the towel in an approved container when the connection of the fuel pressure gauge is complete.

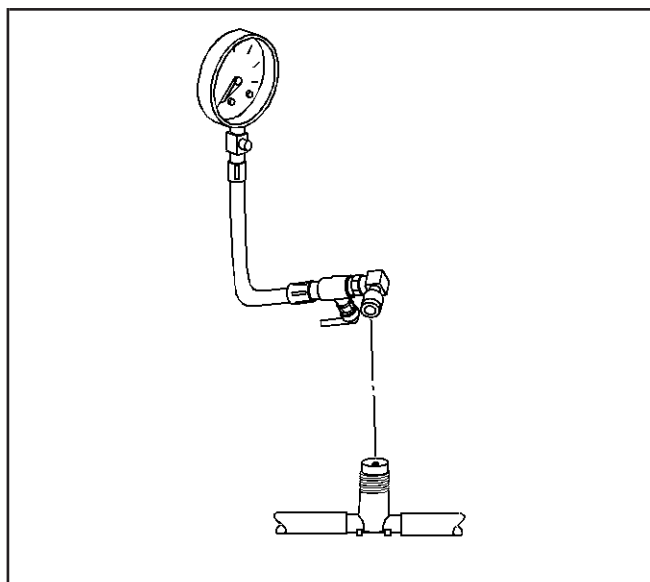
Warning: Fuel Vapors can collect while servicing fuel system components in enclosed areas such as the vessels cabin or engine compartment. To reduce the risk of fire and increased exposure to vapors:

- Use forced air ventilation such as a fan set outside of the vessels engine compartment.
- Plug or cap any fuel system openings in order to reduce fuel vapor formation.
- Clean up any spilled fuel immediately.
- Avoid sparks and any source of ignition.
- Use signs to alert others in the work area that fuel system work is in process.

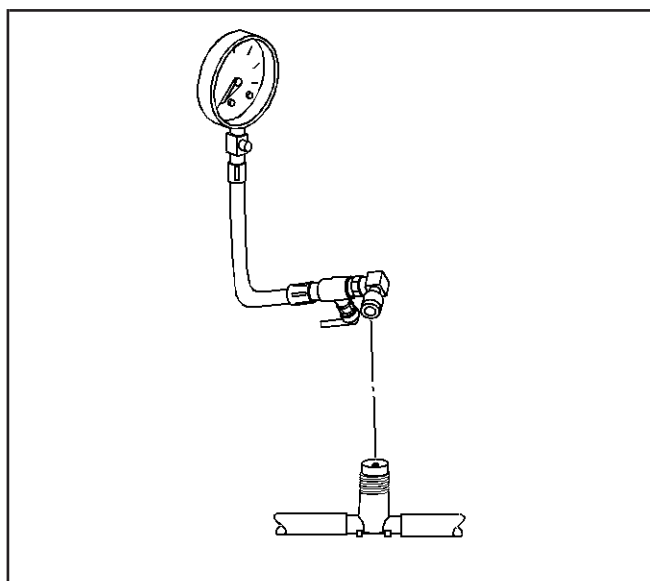
1. Remove the fuel rail pressure fitting cap.
2. Connect the J 34730-1A or the J-34730-FF to the fuel pressure valve. Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
3. Install the bleed hose on the J 34730-1A or the J-34730-FF into an approved container.

Removal Procedure

1. Remove the bleed hose on the J 34730-1A or the J-34730-FF from the approved container.
2. Remove the shop towel from around the fitting and discard into an approved container.
3. Disconnect the J 34730-1A or the J-34730-FF from the fuel pressure valve.
4. Install the fuel rail pressure fitting cap.



180378



180378

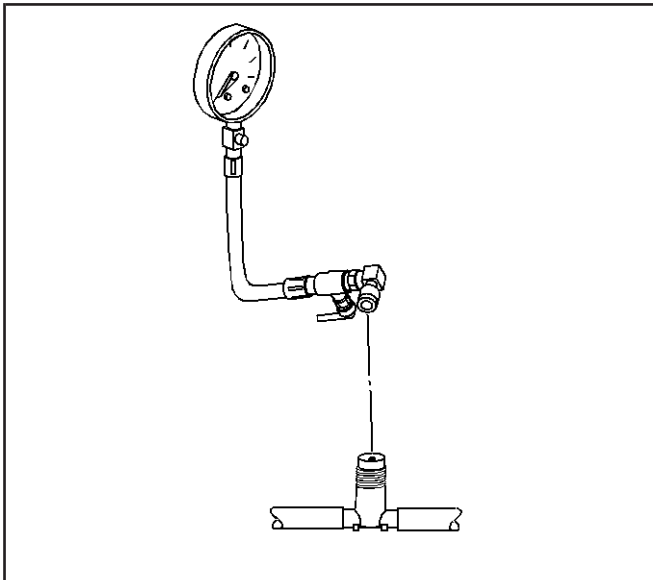
Fuel Pressure Relief

Special Tools

J 34730-1A Fuel Pressure Gauge

Warning: Refer to *Actions to Take When Working with Fuel Warning* on page 0-3.

Warning: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.



180378

1. Disconnect the negative battery cable.
2. Install the J 34730-1A. Refer to *Fuel Pressure Gauge Installation and Removal* on page 9-229.
3. Open the valve on the J 34730-1A in order to bleed the system pressure. The fuel connections are now safe for servicing.
4. Drain any fuel remaining in the gauge into an approved container.
5. Once the system pressure is completely relieved, remove the J 34730-1A.

Fuel Injection Fuel Rail Assembly Replacement (3.0L)

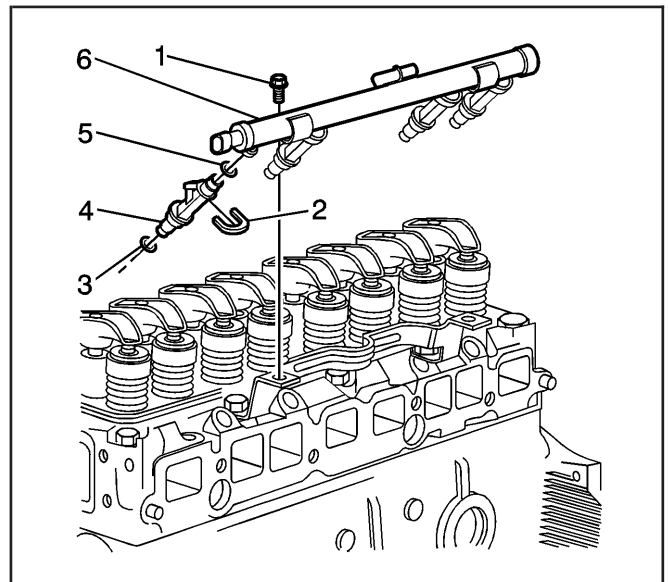
Removal Procedure

1. Relieve the fuel system pressure. Refer to the *Fuel Pressure Relief* on page 9-230.
2. Before removal, clean the fuel rail assembly with a spray type engine cleaner, GM X-30A or equivalent, if necessary. Follow the package instructions. Do not soak fuel rails in liquid cleaning solvent.

Caution:

- Use care when servicing the fuel system components, especially the fuel injector electrical connectors, the fuel injector tips, and the injector O-rings. Plug the inlet and the outlet ports of the fuel rail in order to prevent contamination.
- Do not use compressed air to clean the fuel rail assembly as this may damage the fuel rail components.
- Do not immerse the fuel rail assembly in a solvent bath in order to prevent damage to the fuel rail assembly.

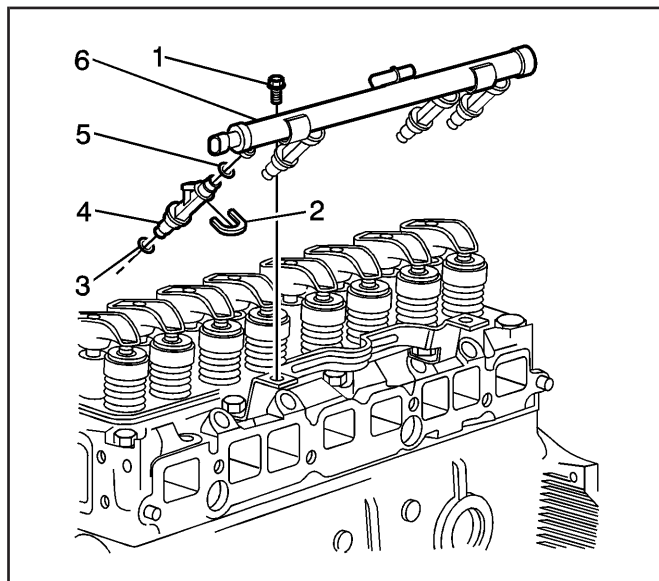
3. Disconnect the fuel feed hose from the fuel rail.



2211680

4. Disconnect the electrical connectors from the fuel injectors. Identify the connectors to their corresponding injectors to ensure correct sequential injector firing order after reassembly.
5. Remove the fuel rail attaching bolts (1).
6. Lift evenly on both sides of the fuel rail, and remove the fuel rail assembly.
7. Remove the injector lower O-ring seal (3) from the spray tip end of each injector.
8. Discard the O-ring seals.

Installation Procedure



2211680

1. Lubricate the new lower injector O-ring seals with clean engine oil.
2. Install the new O-ring seals on the spray tip end of each injector.
3. Install the fuel rail assembly to the cylinder head.
4. Apply a 0.5 mm (0.020 in) band of GM P/N 12345382 (Canadian P/N 10953489) threadlock or equivalent to the threads of the fuel rail bolts.

Caution: Refer to *Fastener Caution* on page 0-5.

5. Install the fuel rail attaching bolts.

Tighten

Tighten the fuel rail attaching bolts to 10 N·m (89 lb in).

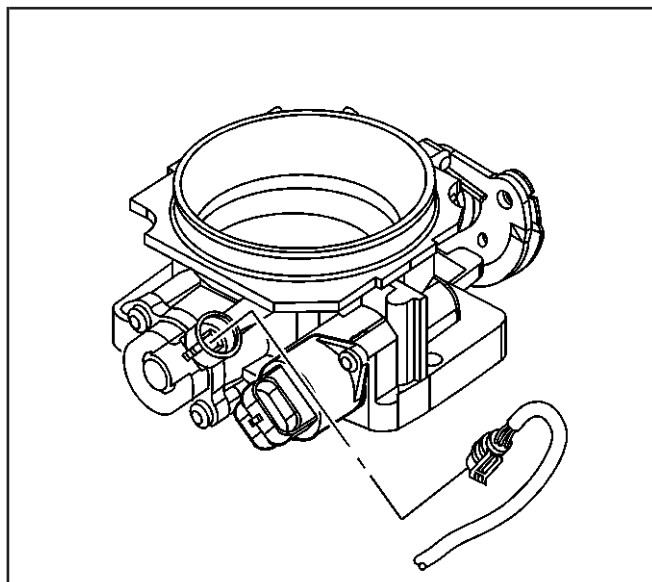
6. Connect the injector electrical connectors.
 - Install each connector on the proper injector in order to ensure correct sequential injector firing order.
 - Rotate the injectors as required in order to avoid stretching the wire harness.
7. Connect the fuel feed hose to the fuel rail fuel pipe.
8. Connect the negative battery cable.
9. Inspect for leaks:
 - 9.1. Turn ON the ignition for 2 seconds.
 - 9.2. Turn OFF the ignition for 10 seconds.
 - 9.3. Turn ON the ignition.
 - 9.4. Inspect for fuel leaks.

Fuel Injection Fuel Rail Assembly Replacement (4.3L 5.0L and 5.7L)

Removal Procedure

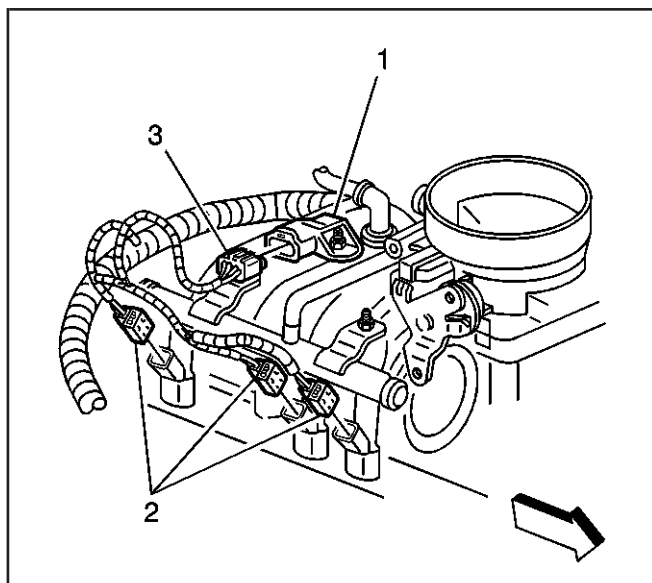
Caution: Refer to *Fuel Rail Caution* on page 0-5.

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief* on page 9-230.
2. Remove the air cleaner outlet resonator.
3. Remove the accelerator controls cable.
4. Remove the radiator inlet hose.



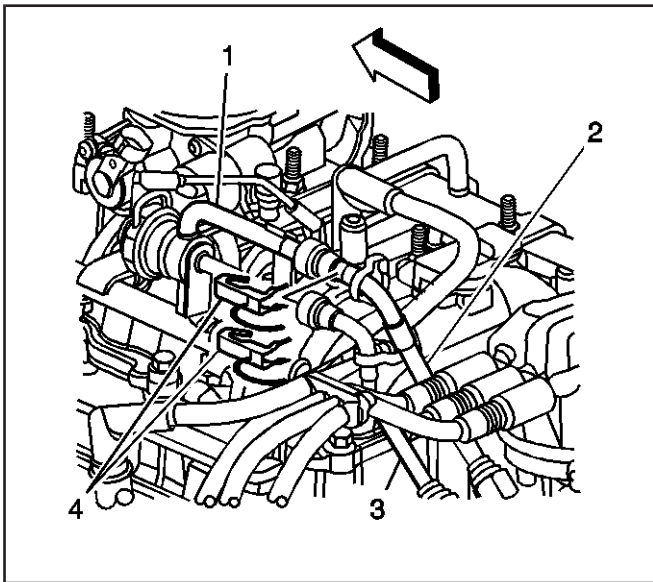
12885

5. Disconnect the electrical connector from the throttle body assembly.



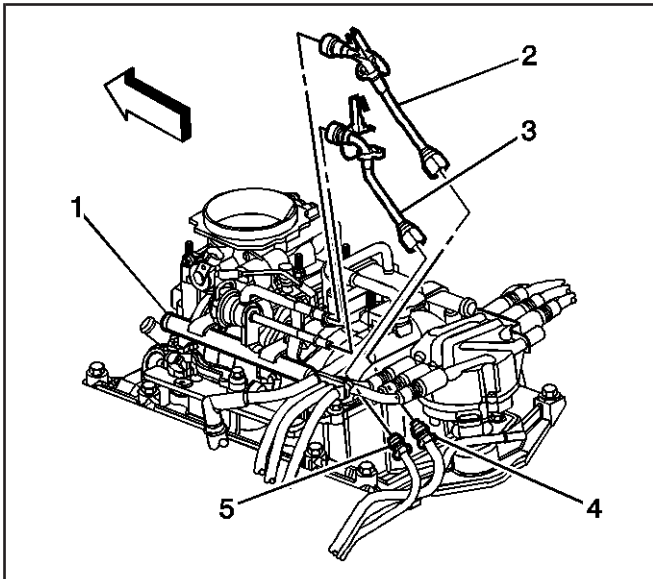
735711

6. Disconnect the electrical connectors (2) from the fuel injectors using the following procedure:
 - 6.1. Pull upwards on the CPA retainer.
 - 6.2. Pinch the connector to unlock.
 - 6.3. Disconnect the connector from the fuel injector.



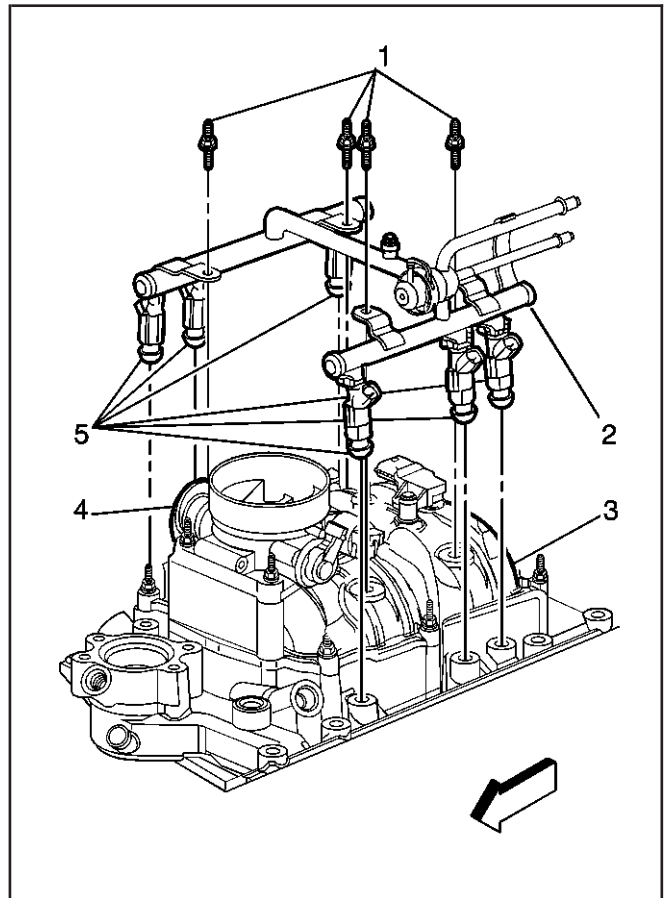
785740

7. Remove the secondary retainers (4) from the fuel feed and fuel return pipes (2, 3).



740874

8. Disconnect the fuel feed pipe (2) and the fuel return pipe (3) from the fuel rail assembly (1).



738694

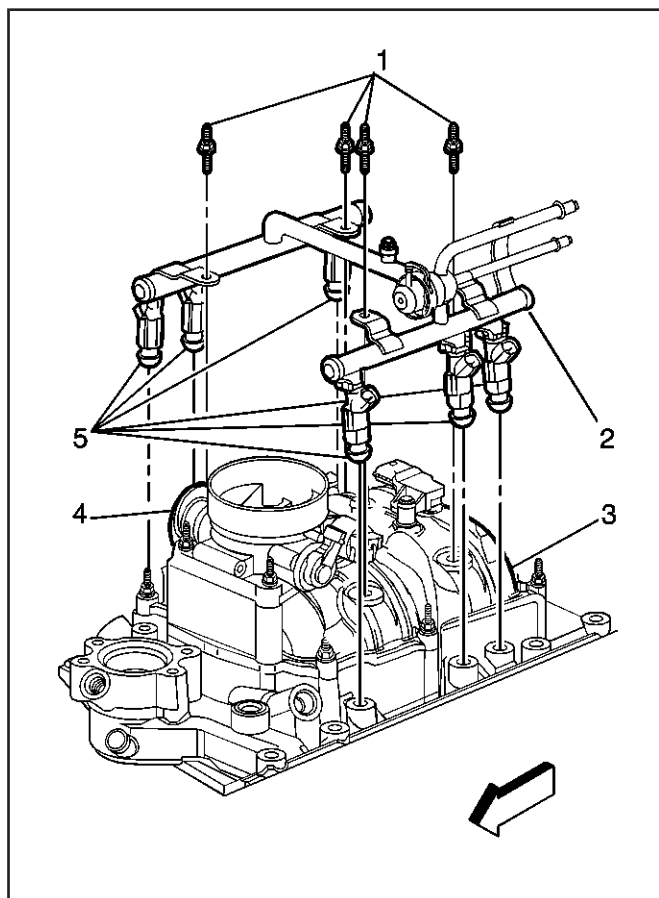
9. Remove the fasteners (1) from the fuel rail assembly.

Notice: Mask off the intake ports. Accidental entry of foreign objects can cause severe engine damage.

10. Remove the fuel rail assembly (2) from the intake manifold (3).

Installation Procedure

1. Inspect the fuel injector O-ring seals for damage and replace if necessary.
2. Lubricate the fuel injector O-rings with clean engine oil before installation.



738694

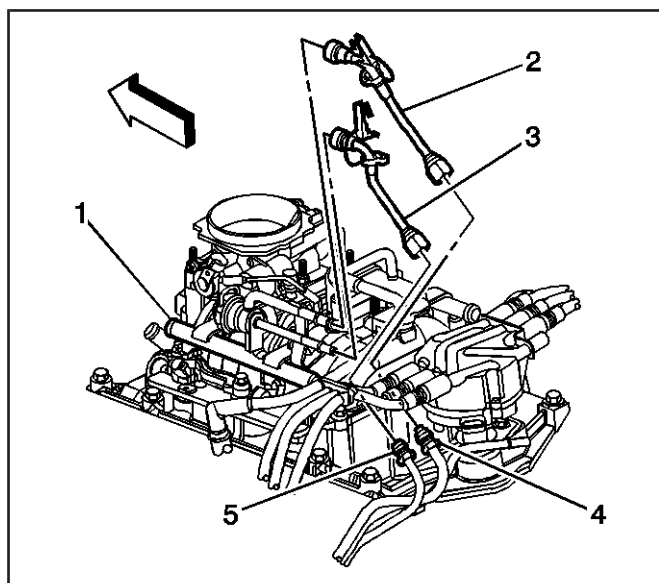
3. Install the fuel rail assembly (2) to the intake manifold (3).

Caution: Refer to *Fastener Caution* on page 0-5.

4. Install the fasteners (1) to the fuel rail assembly.

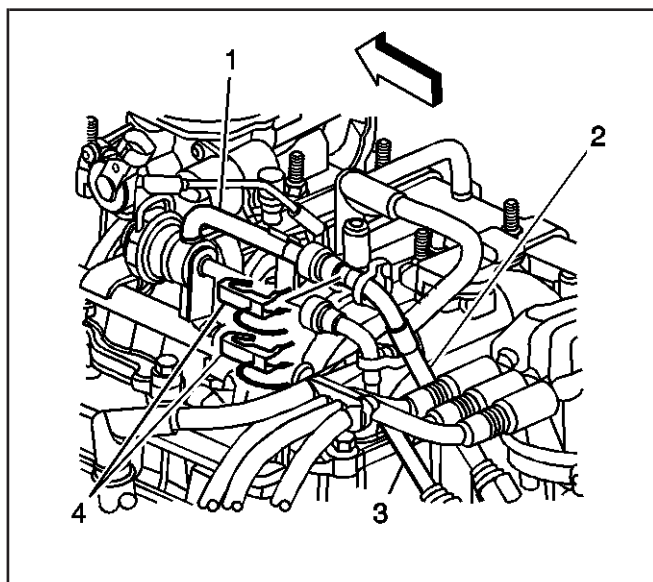
Tighten

Tighten the fasteners to 10 N·m (88 lb in).



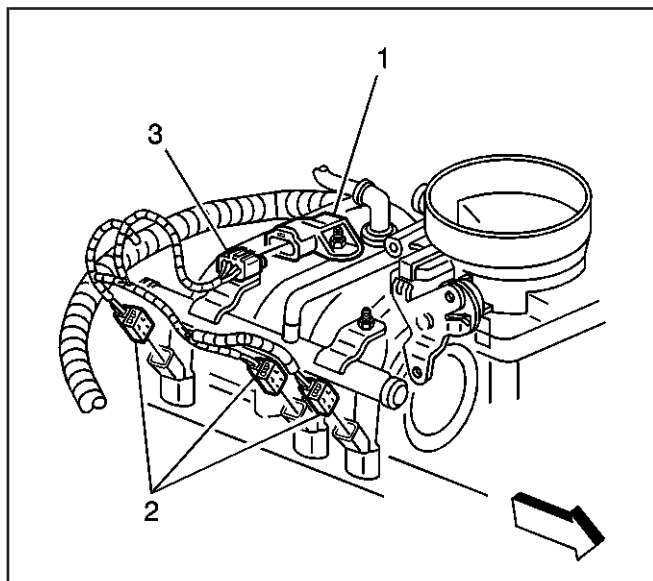
740874

5. Connect the fuel feed pipe (2) and the fuel return pipe (3) to the fuel rail assembly (1).



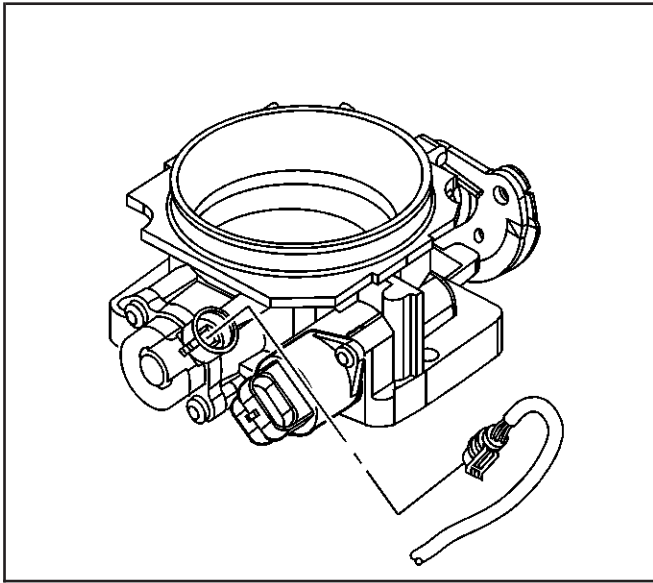
785740

6. Install the secondary retainers (4) to the fuel feed and fuel return pipes (2, 3).



735711

7. Connect the electrical connectors (2) to the fuel injectors.

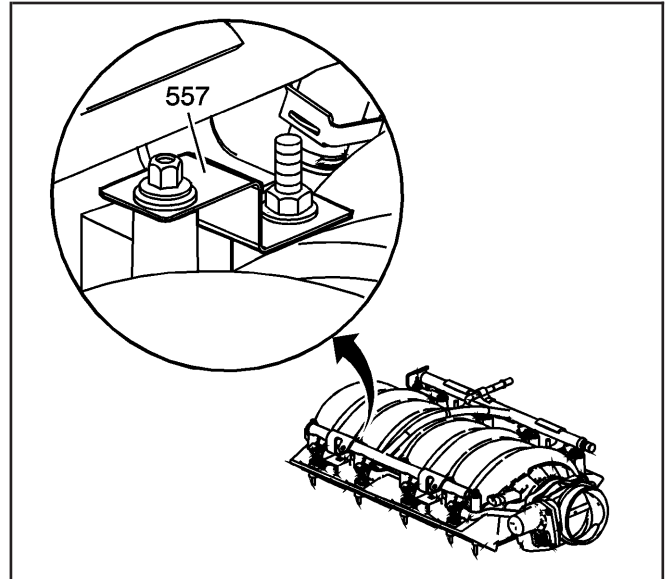


12885

8. Connect the electrical connector to the throttle body assembly.
9. Connect the vacuum hose to the fuel pressure regulator.
10. Install the radiator inlet hose.
11. Install the air cleaner outlet resonator.
12. Connect the negative battery cable.
13. Inspect for fuel leaks using the following procedure:
 - 13.1. Ignition ON for 2 seconds.
 - 13.2. Ignition OFF for 10 seconds.
 - 13.3. Ignition ON.
 - 13.4. Inspect for fuel leaks.

Fuel Injection Fuel Rail Assembly Replacement (6.0L and 6.2L)

Removal Procedure



1408855

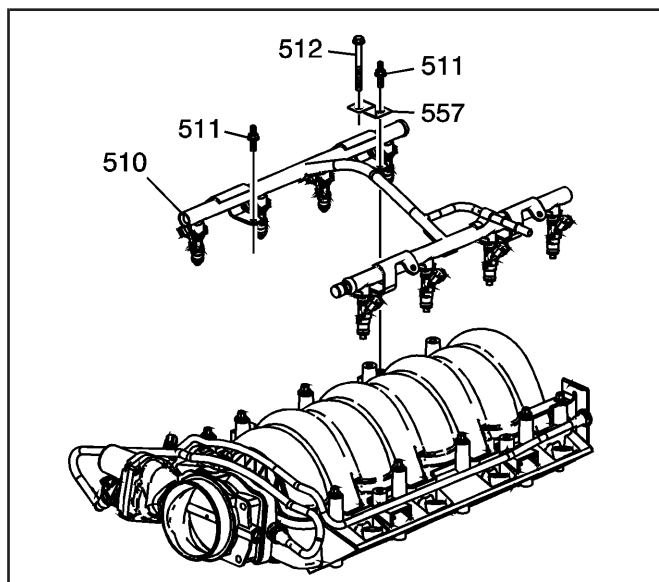
Note: Observe the location of the fuel rail ground strap (557).

1. Relieve the fuel system pressure. Refer to the *Fuel Pressure Relief* on page 9-230.
2. Before removal, clean the fuel rail assembly with a spray type engine cleaner, GM X-30A or equivalent, if necessary. Follow the package instructions. Do not soak fuel rails in liquid cleaning solvent.

Caution: Refer to *Fuel Rail Caution* on page 0-5.

Caution: Cap the fittings and plug the holes when servicing the fuel system in order to prevent dirt and other contaminants from entering the open pipes and passages.

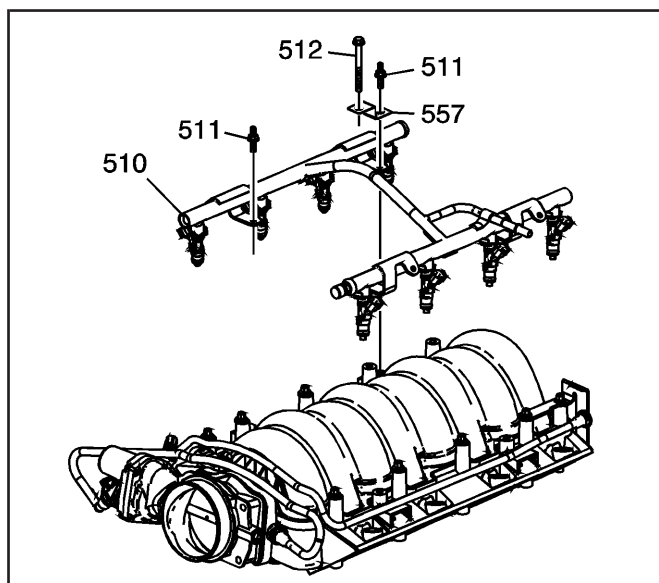
3. Disconnect the fuel feed hose from the fuel rail.



1408856

4. Disconnect the electrical connectors from the fuel injectors. Identify the connectors to their corresponding injectors to ensure correct sequential injector firing order after reassembly.
5. Disconnect the electrical harness from the fuel rail brackets.
6. Remove the fuel rail attaching bolts (511, 512), ground strap (557).
7. Lift evenly on both sides of the fuel rail, and remove the fuel rail assembly.
8. Remove the injector lower O-ring seal from the spray tip end of each injector.
9. Discard the O-ring seals.

Installation Procedure



1408856

1. Lubricate the new lower injector O-ring seals with clean engine oil.
2. Install the new O-ring seals on the spray tip end of each injector.

3. Install the fuel rail assembly to the intake manifold.
4. Apply a 0.5 mm (0.020 in) band of GM P/N 12345382 (Canadian P/N 10953489) threadlock or equivalent to the threads of the fuel rail bolts.

Caution: Refer to *Fastener Caution* on page 0-5.

5. Install the fuel rail attaching bolts (511, 512), ground strap (557).

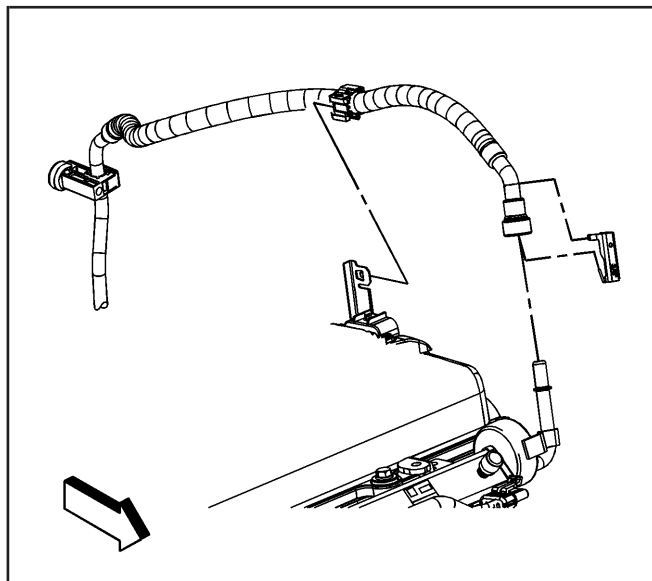
Tighten

Tighten the fuel rail attaching bolts to 10 N·m (89 lb in).

6. Connect the injector electrical connectors.
 - Install each connector on the proper injector in order to ensure correct sequential injector firing order.
 - Rotate the injectors as required in order to avoid stretching the wire harness.
7. Connect the electrical harness to the fuel rail brackets.
8. Connect the fuel feed hose to the fuel rail fuel pipe.
9. Connect the negative battery cable.
10. Inspect for leaks.
 - 10.1. Ignition ON for 2 seconds.
 - 10.2. Ignition OFF for 10 seconds.
 - 10.3. Ignition ON.
 - 10.4. Inspect for fuel leaks.

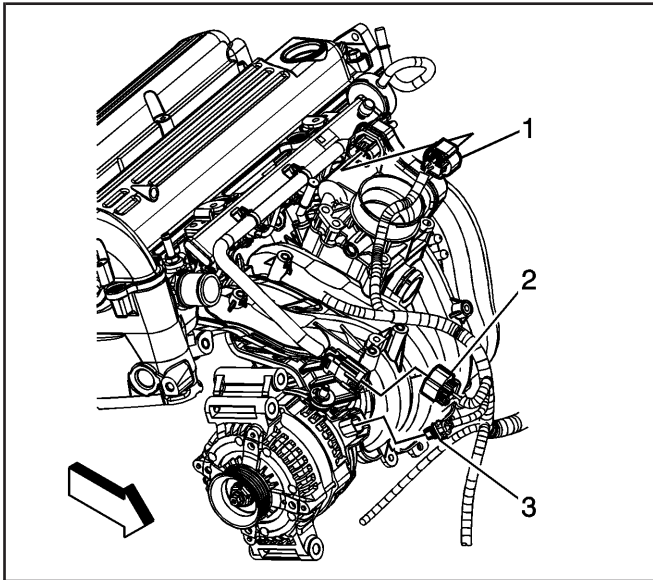
Fuel Injection Fuel Rail Assembly Replacement (2.4L)

Removal Procedure



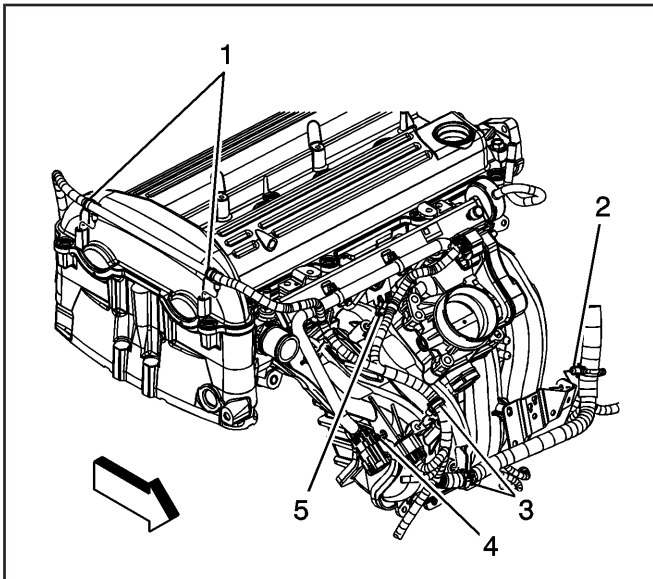
1625417

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief* on page 9-230.
2. Disconnect the fuel feed line quick connect fitting from the fuel rail.



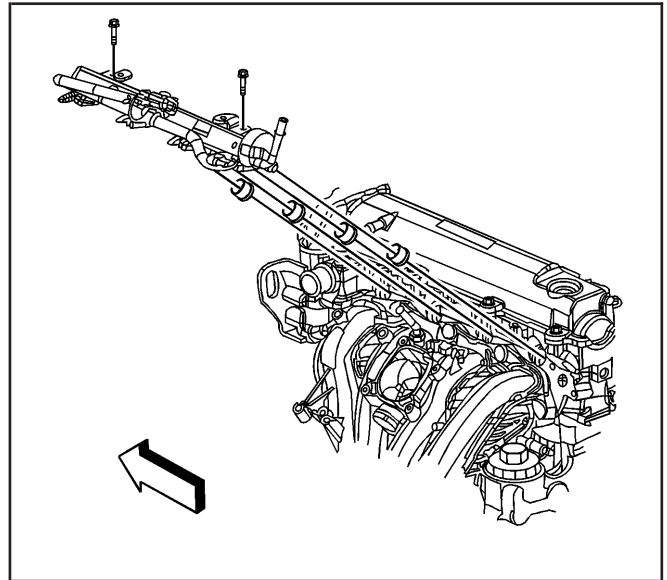
1623764

3. Disconnect the fuel injector harness electrical connector (2).
4. Disconnect the manifold absolute pressure (MAP) sensor electrical connector.



1623549

5. Remove the fuel injector harness electrical connector clips (4 and 5) from the intake manifold.



1578472

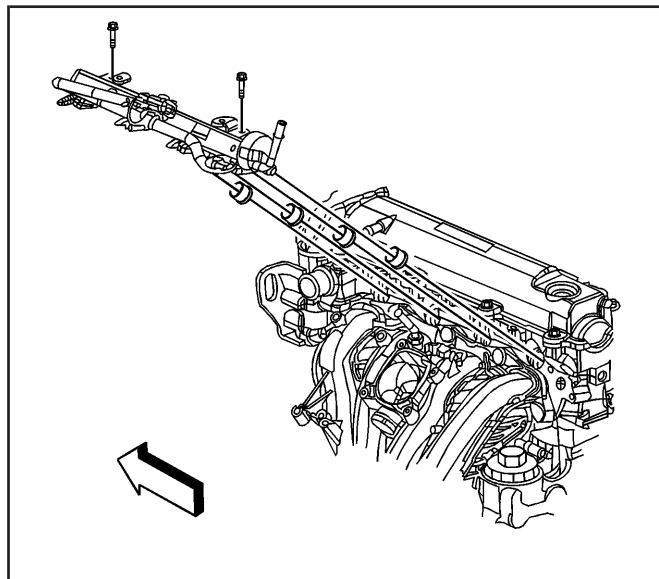
6. Remove the fuel rail studs.

Note: Use care when removing the fuel rail assembly in order to prevent damage to the fuel injectors electrical connector terminals and spray tips.

7. Pull the fuel rail back and upward in order to release the fuel injectors from the cylinder head ports.
8. Remove the fuel rail.
9. Remove the fuel injectors, if necessary. Refer to *Fuel Injector Replacement (Except 2.4L)* on page 9-238 or *Fuel Injector Replacement (2.4L)* on page 9-240.

Installation Procedure

Note: Install new lower O-rings when reusing fuel injectors. Lubricate the injector tip O-rings prior to installing the injectors into the intake manifold.



1578472

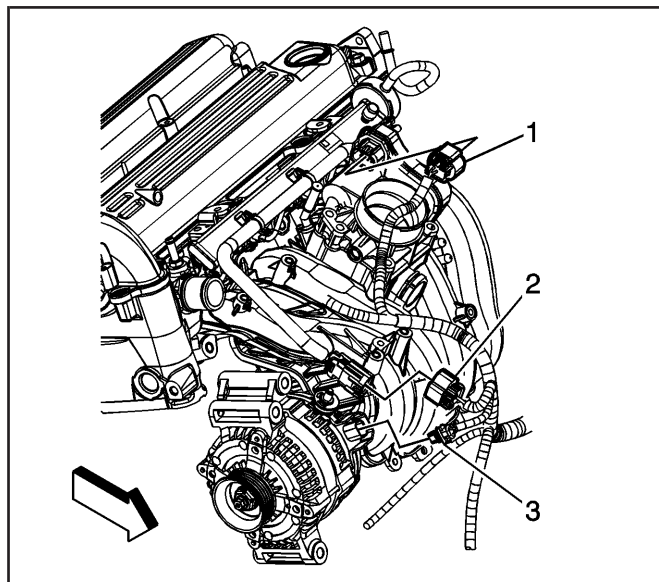
1. Install the fuel injectors, if necessary. Refer to *Fuel Injector Replacement (Except 2.4L)* on page 9-238 or *Fuel Injector Replacement (2.4L)* on page 9-240.
2. With the fuel injectors positioned downward, lower the fuel injectors into the cylinder head ports.
3. Carefully push the fuel injectors into the cylinder head ports.

Caution: Refer to *Fastener Caution* on page 0-5.

4. Install the fuel rail bolts.

Tighten

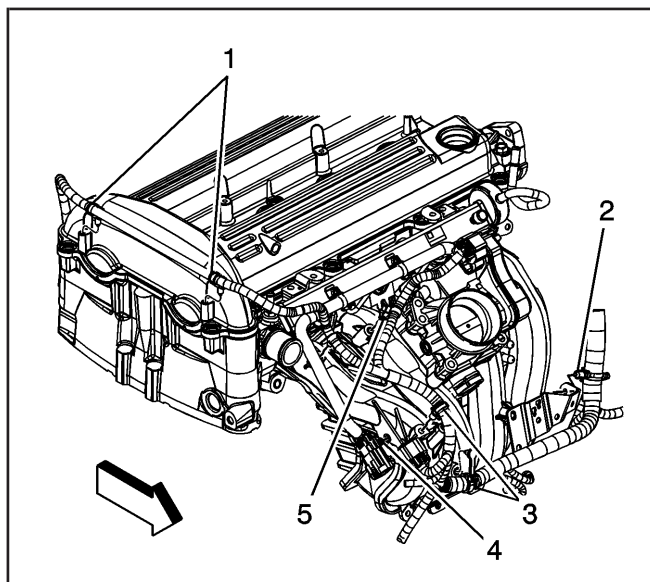
Tighten the bolts to 10 N·m (89 lb in).



1623764

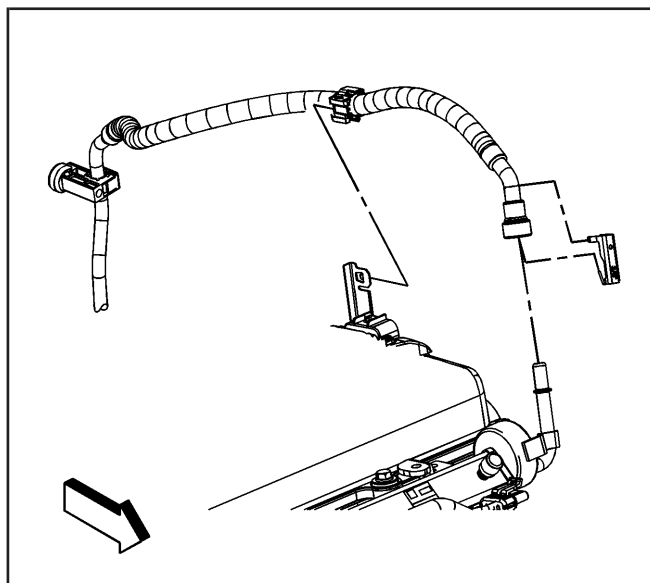
5. Connect the fuel injector harness electrical connector (2).

6. Connect the MAP sensor electrical connector.



1623549

7. Install the fuel injector harness electrical connector clips (4 and 5) to the intake manifold.



1625417

8. Connect the fuel feed line quick connect fitting to the fuel rail.
9. Connect the negative battery cable
10. Inspect for fuel leaks using the following procedure:
 - 10.1. Turn ON the ignition, with the engine OFF for 2 seconds.
 - 10.2. Turn OFF the ignition for 10 seconds.
 - 10.3. Turn ON the ignition.
 - 10.4. Inspect for fuel leaks.

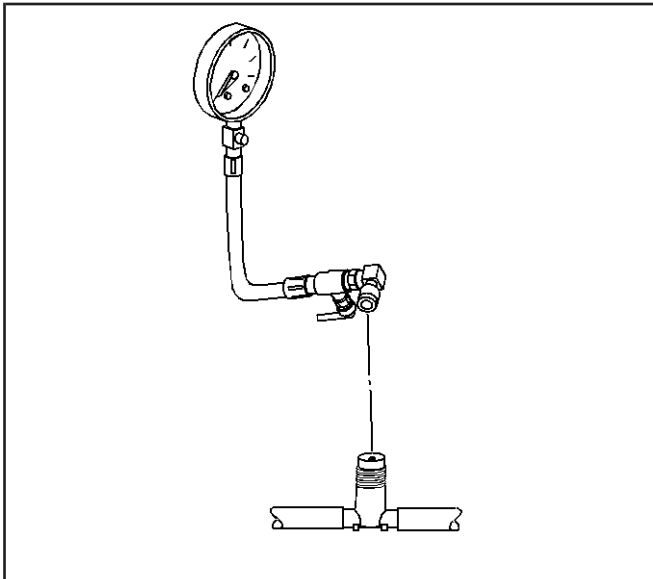
Fuel Pressure Regulator Replacement

Special Tools

J 34730-1A Fuel Pressure Gauge

Warning: Refer to *Actions to Take When Working with Fuel Warning* on page 0-3.

Warning: Remove the fuel tank cap and relieve the fuel system pressure before servicing the fuel system in order to reduce the risk of personal injury. After you relieve the fuel system pressure, a small amount of fuel may be released when servicing the fuel lines, the fuel injection pump, or the connections. In order to reduce the risk of personal injury, cover the fuel system components with a shop towel before disconnection. This will catch any fuel that may leak out. Place the towel in an approved container when the disconnection is complete.



180378

1. Disconnect the negative battery cable.
2. Install the J 34730-1A. Refer to *Fuel Pressure Gauge Installation and Removal* on page 9-229.
3. Open the valve on the J 34730-1A in order to bleed the system pressure. The fuel connections are now safe for servicing.
4. Drain any fuel remaining in the gauge into an approved container.
5. Once the system pressure is completely relieved, remove the J 34730-1A.

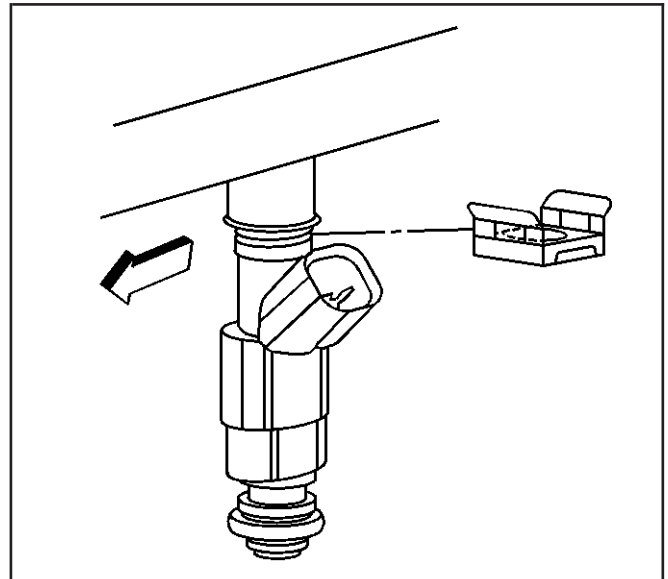
Fuel Injector Replacement (Except 2.4L)

Removal Procedure

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief* on page 9-230.
2. Disconnect the negative battery cable.

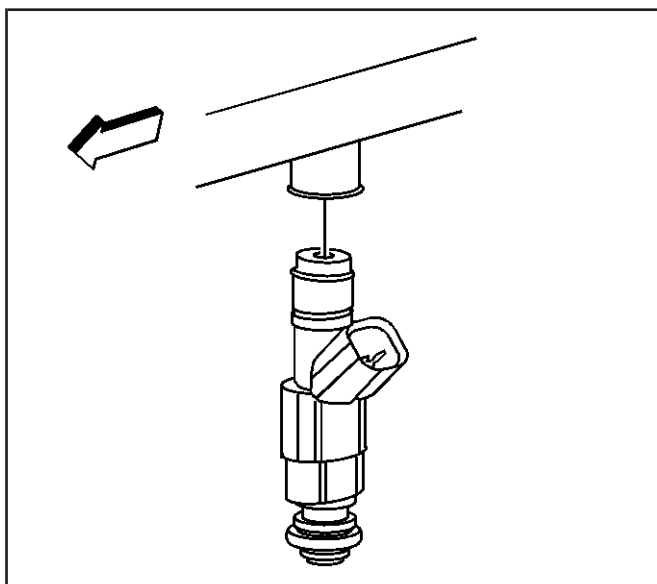
Note: Mask off the intake ports. Accidental entry of foreign objects can cause severe engine damage.

3. Remove the fuel rail assembly. Refer to *Fuel Injection Fuel Rail Assembly Replacement (3.0L)* on page 9-230 or *Fuel Injection Fuel Rail Assembly Replacement (4.3L 5.0L and 5.7L)* on page 9-231 or *Fuel Injection Fuel Rail Assembly Replacement (6.0L and 6.2L)* on page 9-234 or *Fuel Injection Fuel Rail Assembly Replacement (2.4L)* on page 9-235.



738617

4. Remove the retaining clip from the fuel injector.

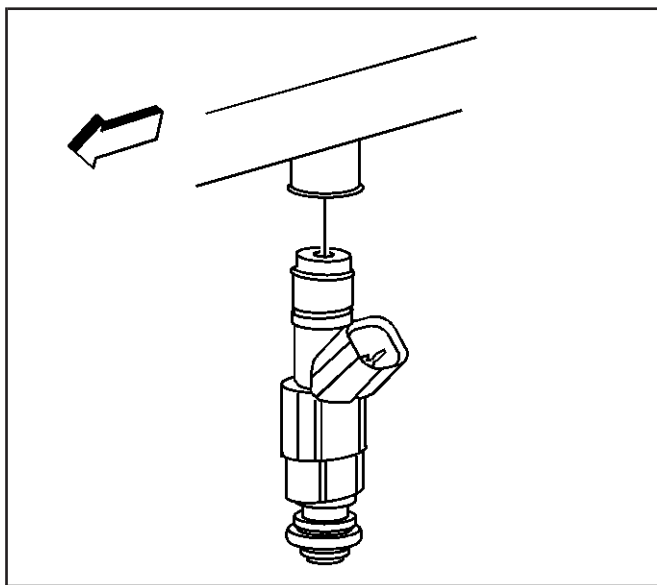


738607

5. Remove the fuel injector and the injector O-ring from the fuel rail assembly.

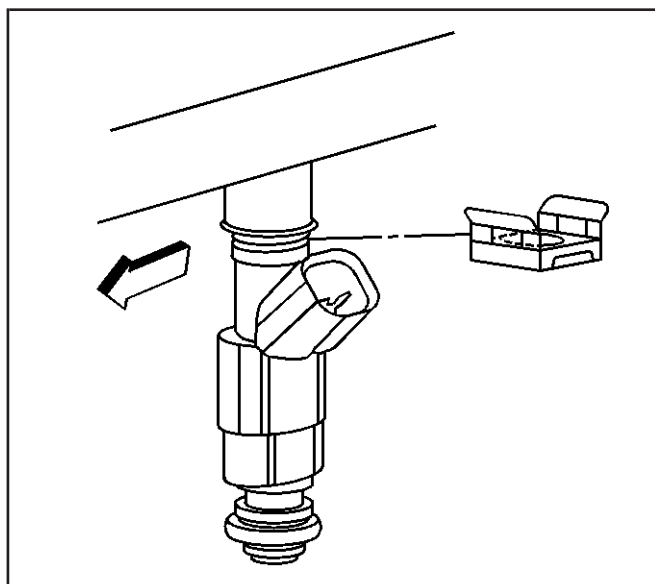
Installation Procedure

1. Inspect the fuel injector O-ring seals for damage and replace if necessary.
2. Lubricate the fuel injector O-rings with clean engine oil.



738607

3. Install the fuel injector to the fuel rail assembly.



738617

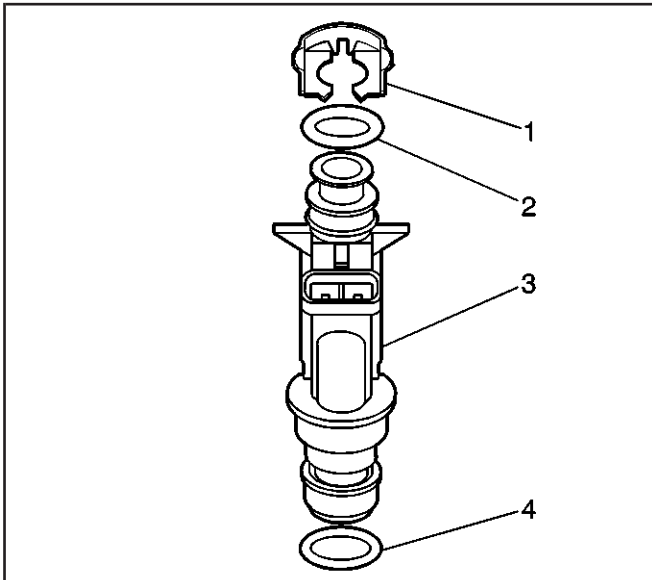
4. Install the retaining clip onto the fuel injector.
5. Install the fuel rail assembly. Refer to *Fuel Injection Fuel Rail Assembly Replacement (3.0L)* on page 9-230 or *Fuel Injection Fuel Rail Assembly Replacement (4.3L 5.0L and 5.7L)* on page 9-231 or *Fuel Injection Fuel Rail Assembly Replacement (6.0L and 6.2L)* on page 9-234 or *Fuel Injection Fuel Rail Assembly Replacement (2.4L)* on page 9-235.
6. Connect the negative battery cable.
7. Inspect for fuel leaks using the following procedure:
 - 7.1. Ignition ON for 2 seconds.
 - 7.2. Ignition OFF for 10 seconds.
 - 7.3. Ignition ON.
 - 7.4. Inspect for fuel leaks.

Fuel Injector Replacement (2.4L)

Removal Procedure

Caution: Use care in removing the fuel injectors in order to prevent damage to the fuel injector electrical connector pins or the fuel injector nozzles. Do not immerse the fuel injector in any type of cleaner. The fuel injector is an electrical component and may be damaged by this cleaning method.

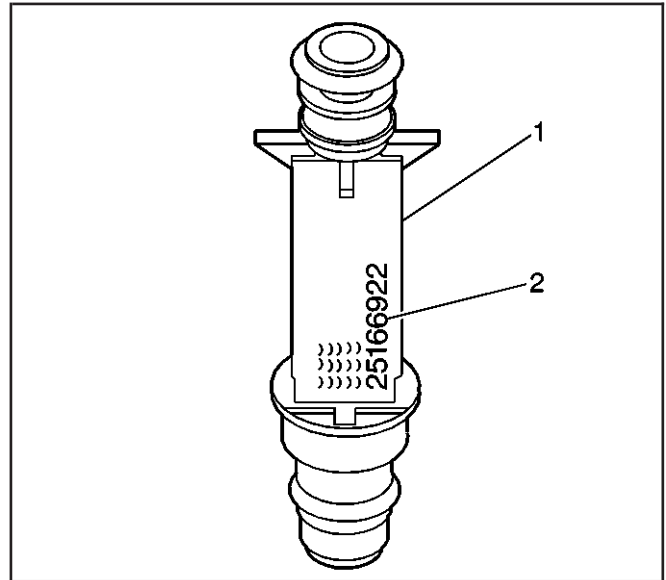
Note: If the fuel injectors are found to be leaking, the engine oil may be contaminated with fuel.



537311

1. Remove the fuel rail. Refer to *Fuel Injection Fuel Rail Assembly Replacement (3.0L)* on page 9-230 or *Fuel Injection Fuel Rail Assembly Replacement (4.3L 5.0L and 5.7L)* on page 9-231 or *Fuel Injection Fuel Rail Assembly Replacement (6.0L and 6.2L)* on page 9-234 or *Fuel Injection Fuel Rail Assembly Replacement (2.4L)* on page 9-235.
2. Remove the fuel injector retaining clip (1).
3. Remove the fuel injector (3) from the fuel rail.
4. Remove and discard the fuel injector lower O-ring (4).
5. Remove and discard the fuel injector upper O-ring (2).

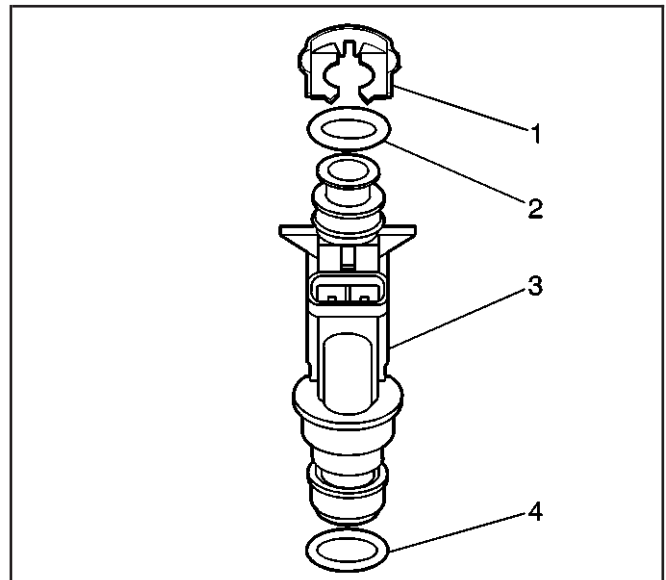
Installation Procedure



537308

Note: Be sure to use the correct part number when ordering replacement fuel injectors.

1. The fuel injector assembly (1) is stamped with a part number identification (2).



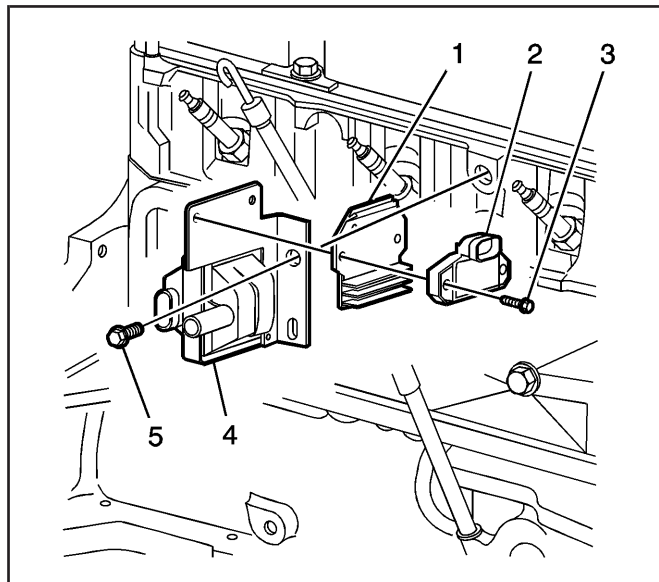
537311

2. Lubricate the NEW injector O-rings with clean engine oil.
3. Install the fuel injector upper O-ring (2).
4. Install the fuel injector lower O-ring (4).
5. Install the fuel injector (3) to the fuel rail.
6. Install the fuel injector retaining clip (1).
7. Install the fuel rail. Refer to *Fuel Injection Fuel Rail Assembly Replacement (3.0L)* on page 9-230 or *Fuel Injection Fuel Rail Assembly Replacement (4.3L 5.0L and 5.7L)* on page 9-231 or *Fuel Injection Fuel Rail Assembly Replacement (6.0L and 6.2L)* on page 9-234 or *Fuel Injection Fuel Rail Assembly Replacement (2.4L)* on page 9-235.

Ignition Coil Replacement (3.0L)

Removal Procedure

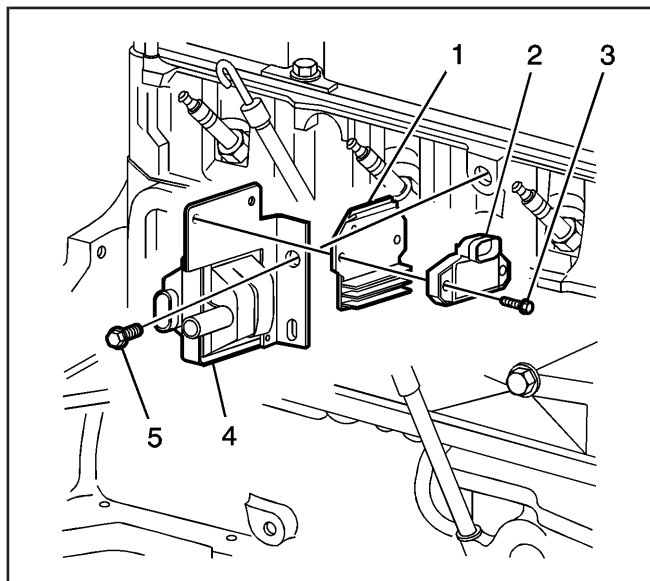
1. Disconnect the negative battery terminal.
2. Disconnect the harness connectors at the ignition coil module.
3. Remove the ignition coil wire to the distributor.



2211676

4. Remove the bolts (5) holding the bracket and the ignition coil module assembly to the engine.
5. Remove the bracket and the ignition coil module assembly.
6. Remove the two rivets that connect the ignition coil to the ignition coil bracket by drilling them out.
7. Remove the ignition coil from the bracket.
8. Remove the two bolts (3) that connect the ignition coil module (2) and heat sink (1) to the ignition coil bracket.
9. Remove the ignition coil module and heat sink.

Installation Procedure



2211676

Caution: Refer to *Component Fastener Tightening Caution* on page 0-5.

1. Install the ignition control module and heat sink to the ignition coil bracket.

Tighten

Tighten the bolts to 2 N·m (18 lb in).

Note: A replacement ignition coil kit comes with 2 screws in order to attach the ignition coil to the bracket.

2. Install the ignition coil to the bracket with the 2 screws.
3. Install the ignition coil and the bracket to the engine with bolts.

Tighten

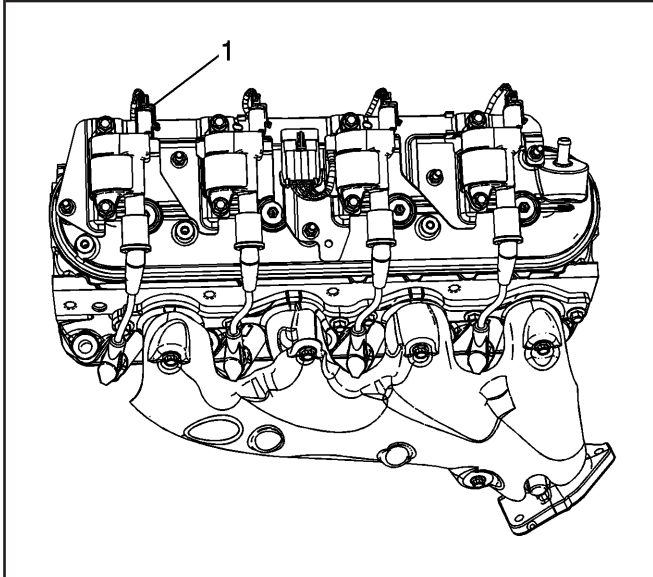
Tighten the bolts to 25 N·m (18 lb ft).

Note: Verify the coil wire does not contact any metal objects. Rubbing will cause a short after time of use.

4. Install the ignition coil wire.
5. Install the harness connectors at the ignition coil module.
6. Install the negative battery terminal.

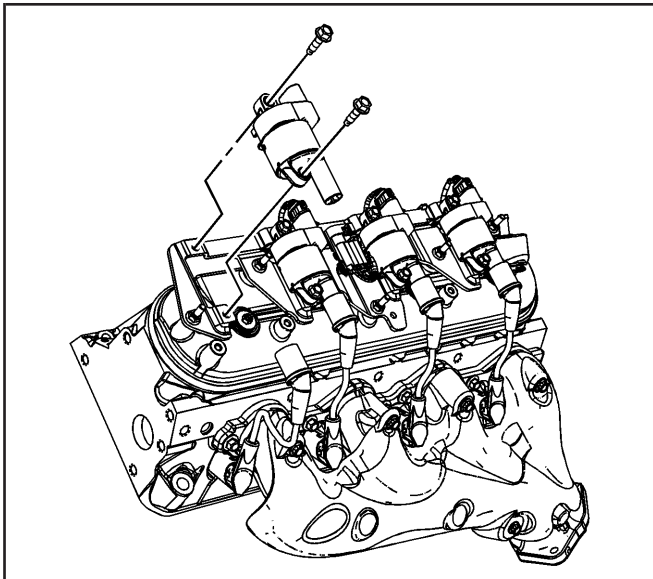
Ignition Coil Replacement (6.0L and 6.2L)

Removal Procedure



1707122

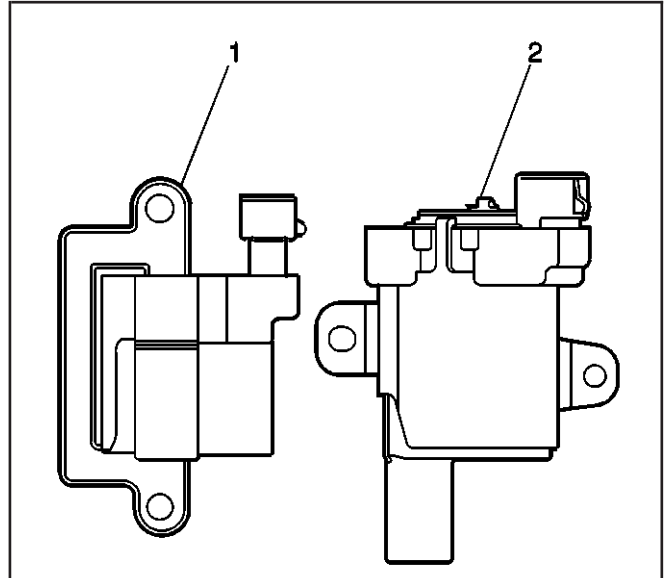
1. Remove the intake manifold sight shield, if equipped.
2. Disconnect the ignition coil wiring harness electrical connector (1) from the ignition coil.



1707124

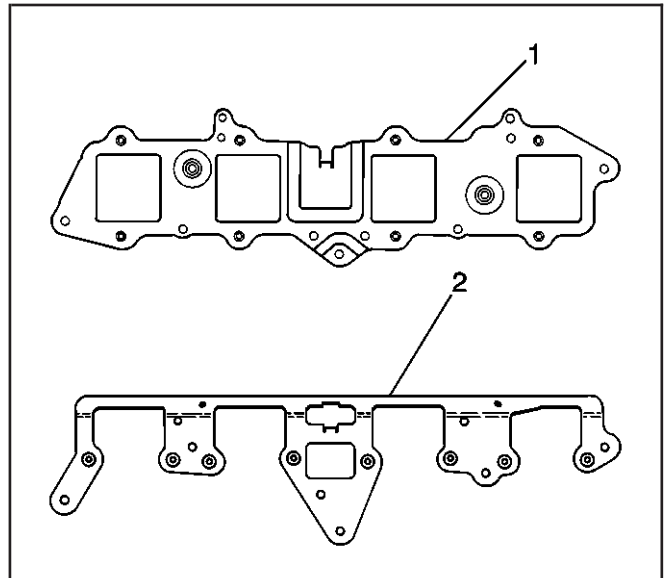
3. Remove the spark plug wire from the ignition coil.
 - Twist the spark plug wire boot a 1/2 turn.
 - Pull only on the boot in order to remove the wire from the ignition coil.
4. Remove the ignition coil bolts.
5. Remove the ignition coil from the bracket.
(left side shown, right side similar).

6. There are 2 different manufacturers for the ignition coils and coil brackets. They are as follows:



260177

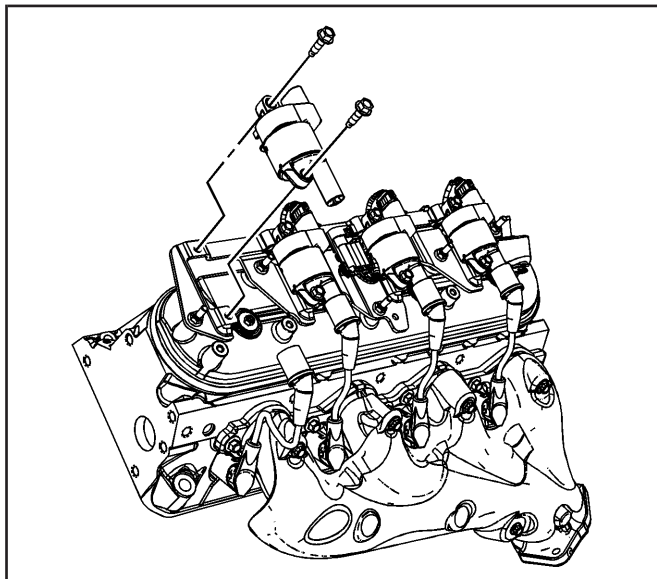
7. The Melco® (1) ignition coil is a square design.
8. The Delphi® (2) ignition coil is a round design.



260077

9. The Melco® ignition coil bracket (1) is a square design.
10. The Delphi® ignition coil bracket (2) is a round design.

Installation Procedure



1707124

1. Position the ignition coil to the ignition coil bracket. (left side shown, right side similar).

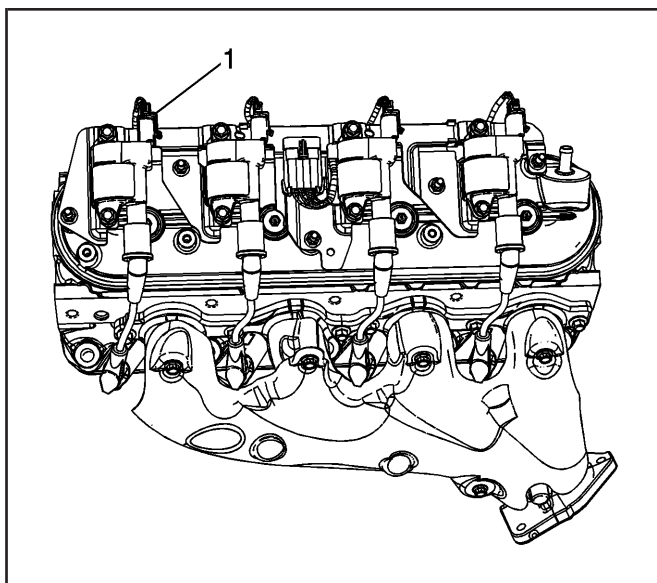
Caution: Refer to *Fastener Caution* on page 0-5.

2. Install the ignition coil bolts.

Tighten

Tighten the bolts to 10 N·m (89 lb in).

3. Install the spark plug wire to the ignition coil.
4. Inspect the spark plug wire for proper installation:
 - Push sideways on each boot in order the inspect the seating.
 - Reinstall any loose boot.



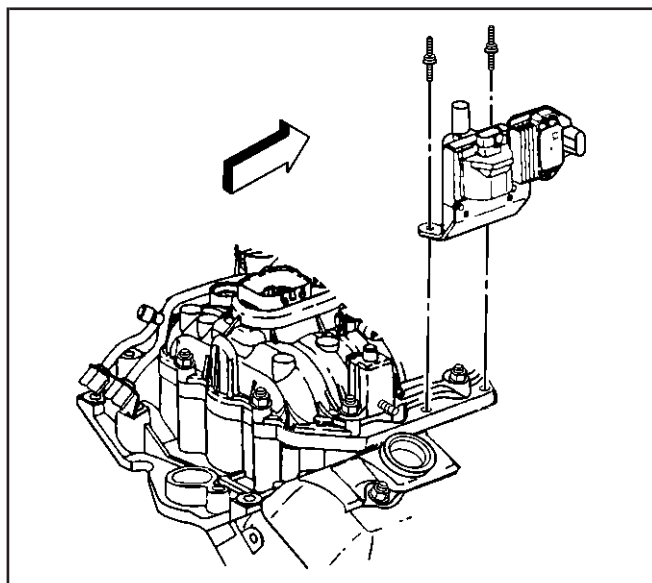
1707122

5. Connect the ignition coil wiring harness electrical connector (1) to the ignition coil.
6. Install the intake manifold sight shield.

Ignition Coil Replacement (4.3L, 5.0L, and 5.7L)

Removal Procedure

1. Disconnect the negative battery terminal.
2. Disconnect the electrical connectors.
3. Remove the ignition coil wire to the distributor.



31466

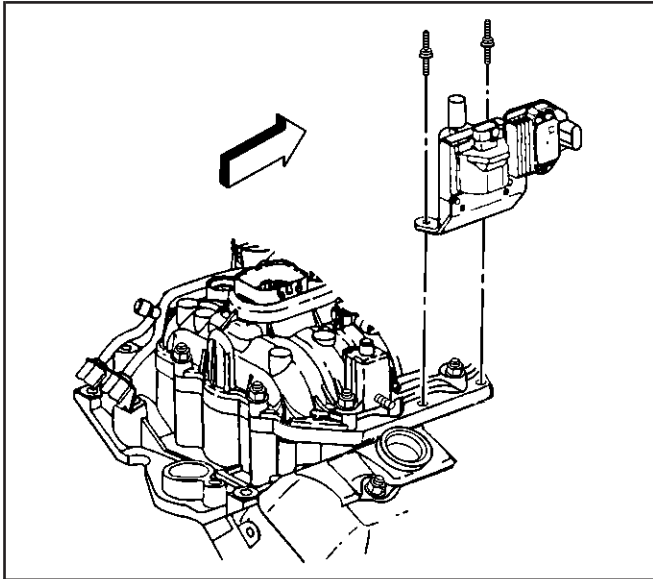
4. Remove the studs holding the bracket and the ignition coil to the intake manifold.
5. Remove the bracket and the ignition coil.
6. Remove the two rivets that connect the ignition coil to the ignition coil bracket by drilling and them out.
7. Remove the ignition coil from the bracket.

Installation Procedure

Note: A replacement ignition coil kit comes with 2 screws in order to attach the ignition coil to the bracket.

1. Install the ignition coil to the bracket with the 2 screws.

Caution: Refer to *Component Fastener Tightening Caution* on page 0-5.



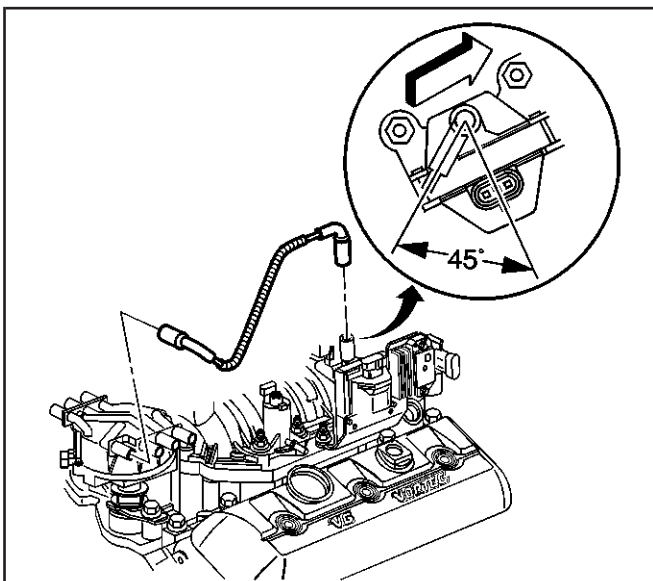
31466

2. Install the ignition coil and the bracket to the intake manifold with studs.

Tighten

Tighten the studs to 11 N·m (97 lb in).

Note: Verify the coil wire does not contact any metal objects. Rubbing will make a ground or short after time of use.



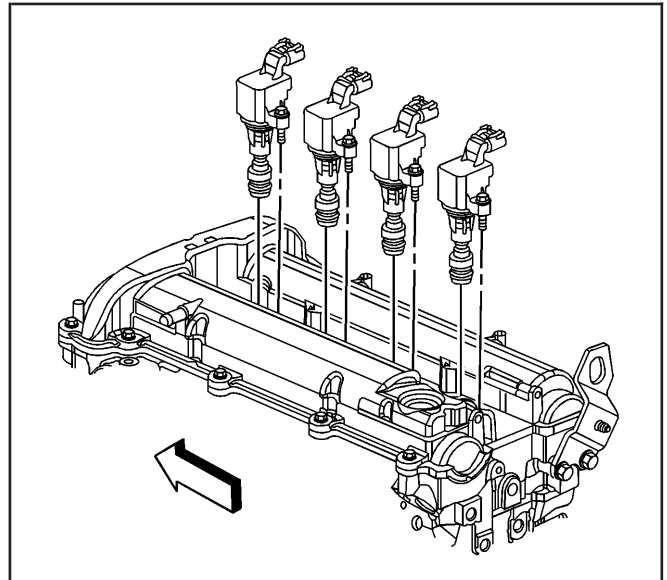
387772

3. Install the ignition coil wire.
4. Install the electrical connectors.
5. Install the negative battery terminal.

Ignition Coil Replacement (2.4L)

Removal Procedure

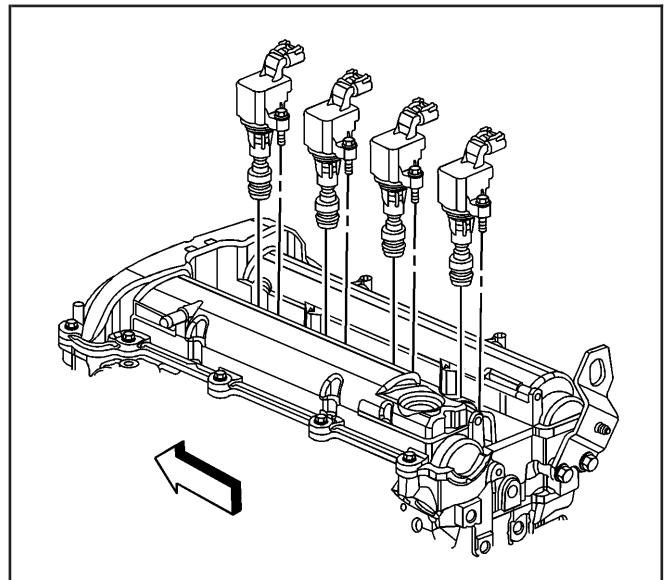
1. Disconnect the ignition coil electrical connector(s) (3).



1578474

2. Remove the ignition coil bolt(s).
3. Remove the ignition coil(s).

Installation Procedure



1578474

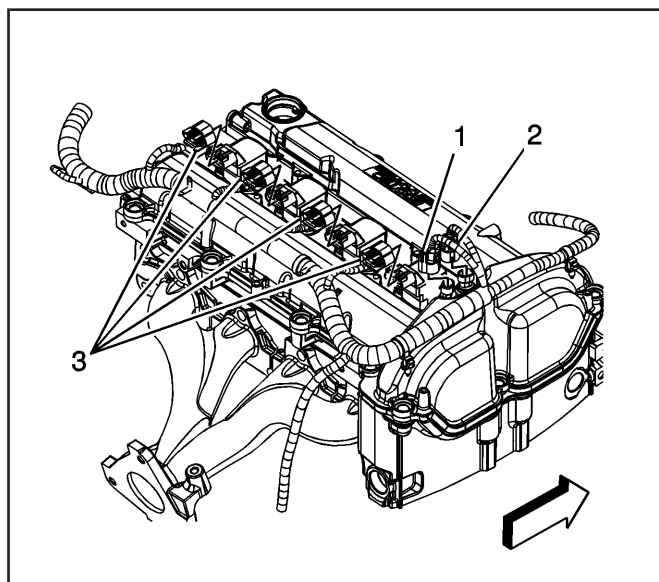
1. Install the ignition coil(s).

Caution: Refer to *Fastener Caution* on page 0-5.

2. Install the ignition coil bolt(s).

Tighten

Tighten the bolt(s) to 10 N·m (89 lb in).



1628020

3. Connect the ignition coil electrical connector(s) (3).

Spark Plug Wire Inspection

Spark plug wire integrity is vital for proper engine operation. A thorough inspection is necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

1. Correct routing of the spark plug wires, Incorrect routing may cause cross firing.
2. Any signs of cracks or splits in the wires.
3. Inspect each boot for any of the following conditions:
 - Tearing
 - Piercing
 - Arcing
 - Carbon tracking
 - Corroded terminal

If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or terminal, replace the wire and the component connected to the wire.

Spark Plug Wire Replacement

Removal Procedure

1. Disconnect the spark plug wire at each spark plug.
 - Twist each spark plug 1/2 turn.
 - Pull only on the boot in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from the ignition coil.
 - Twist each spark plug boot 1/2 turn.
 - Pull only on the boot in order to remove the wires from the ignition coil.

Installation Procedure

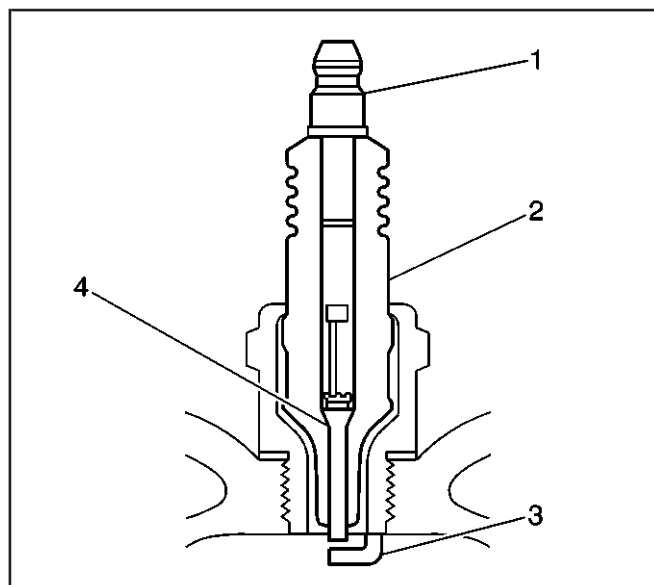
1. Install the spark plug wires at the ignition coil.
2. Install the spark plug wire to each spark plug.
3. Inspect the wires for proper installation:
 - Push sideways on each boot in order to inspect the seating.
 - Reinstall any loose boot.

Spark Plug Inspection

Spark Plug Usage

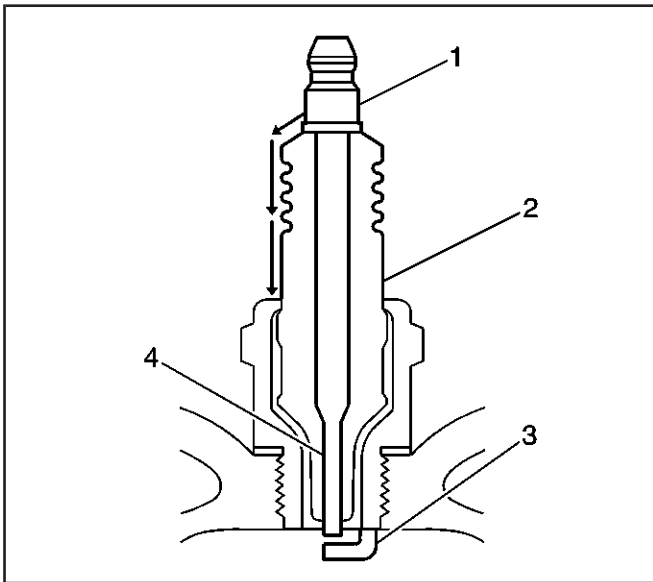
- Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions.
- Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - Spark plug fouling—Colder plug
 - Pre-ignition causing spark plug and/or engine damage—Hotter plug

Spark Plug Inspection



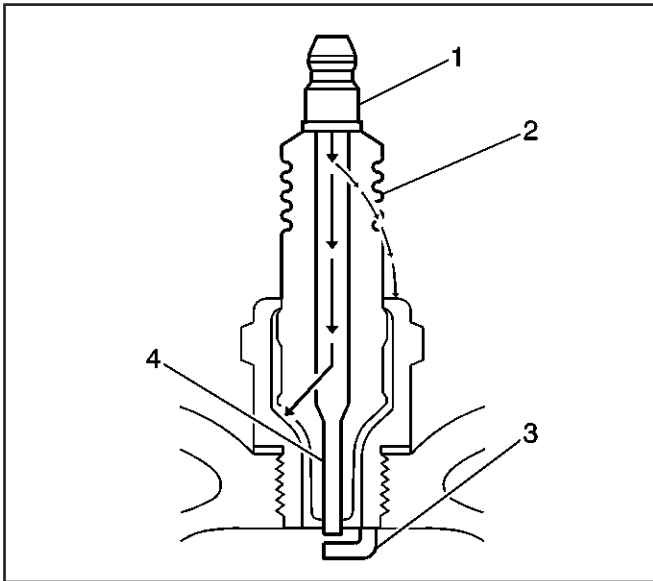
622530

1. Inspect the terminal post (1) for damage.
 - Inspect for a bent or broken terminal post (1).
 - Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.



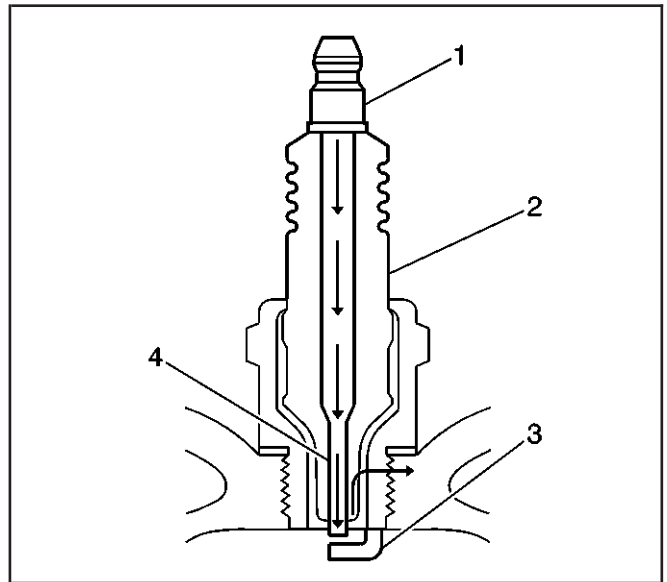
622529

2. Inspect the insulator (2) for flashover or carbon tracking, soot. This is caused by the electrical charge traveling across the insulator (2) between the terminal post (1) and ground. Inspect for the following conditions:
 - Inspect the spark plug boot for damage.
 - Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant, or water. A spark plug boot that is saturated causes arcing to ground.



622528

3. Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).



622527

4. Inspect (3) for evidence of improper arcing.
 - Measure the gap between the center electrode (4) and the side electrode (3) terminals. An excessively wide electrode gap can prevent correct spark plug operation.
 - Inspect for the correct spark plug torque. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
 - Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - Inspect for a broken or worn side electrode (3).
 - Inspect for a broken, worn, or loose center electrode (4) by shaking the spark plug.
 - A rattling sound indicates internal damage.
 - A loose center electrode (4) reduces the spark intensity.
 - Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
 - Inspect for excessive fouling.
5. Inspect the spark plug recess area of the cylinder head for debris. Dirty or damaged threads can cause the spark plug not to seat correctly during installation.

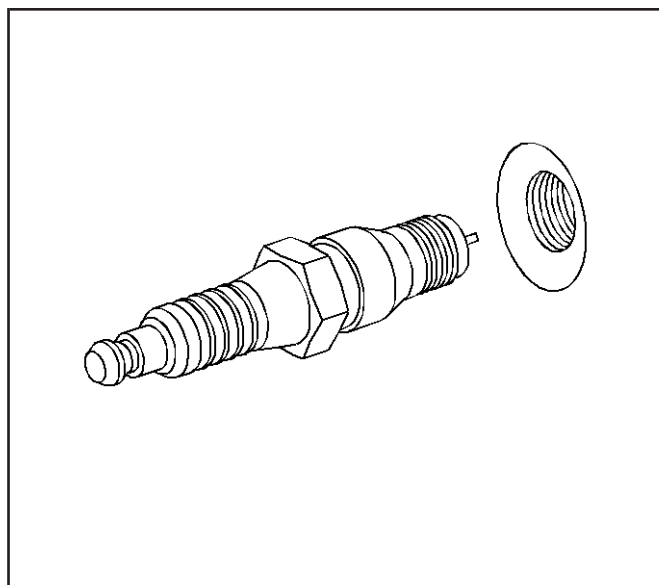
Spark Plug Visual Inspection

- Normal operation—Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
- Carbon fouled—Dry, fluffy black carbon, or soot caused by the following conditions:
 - Rich fuel mixtures
 - Leaking fuel injectors
 - Excessive fuel pressure
 - Restricted air filter element
 - Incorrect combustion
 - Reduced ignition system voltage output
 - Weak coils
 - Worn ignition wires
 - Incorrect spark plug gap
 - Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
- Deposit fouling—Oil, coolant, or additives that include substances such as silicone, very white coating, reduces the spark intensity. Most powdery deposits will not effect spark intensity unless they form into a glazing over the electrode.

Spark Plug Replacement

Removal Procedure

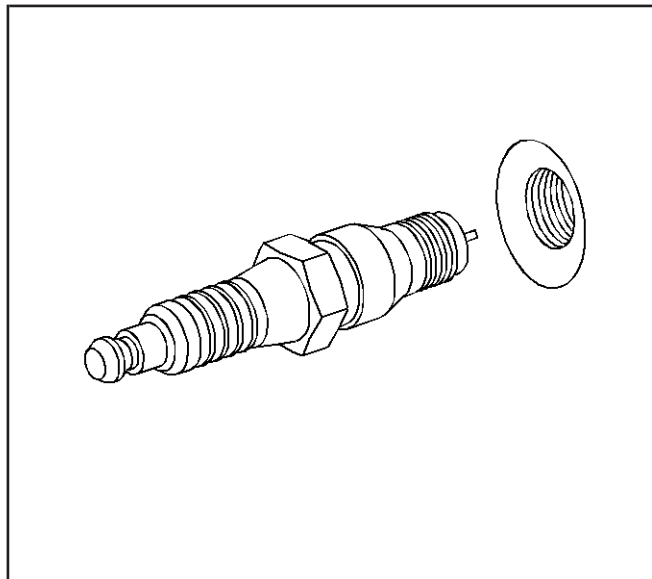
1. Remove the spark plug wire from the spark plug.
 - 1.1. Twist the spark plug wire boot a 1/2 turn.
 - 1.2. Pull only on the boot in order to remove the wire from the spark plug.



14824

2. Brush or using compressed air, blow away any dirt from around the spark plug.
3. Remove the spark plug.
If removing more than one plug, place each plug in a tray marked with the corresponding cylinder number.

Installation Procedure



14824

1. Inspect the spark plug gap. Adjust the gap as needed. Refer to *Ignition System Specifications (2.4L)* on page 9-4 or *Ignition System Specifications (3.0L)* on page 9-4 or *Ignition System Specifications (4.3L, 5.0L, or 5.7L)* on page 9-4 or *Ignition System Specifications (6.0L or 6.2L)* on page 9-4.
 2. Hand start the spark plug in the corresponding cylinder.
- Caution:** Refer to *Fastener Caution* on page 0-5.
3. Tighten the spark plug to **15 N·m (11 lb ft)**.
 4. Install the spark plug wire to the spark plug.
 5. Inspect the spark plug wire for proper installation:
 - 5.1. Push sideways on each boot in order to inspect the seating.
 - 5.2. Reinstall any loose boot.

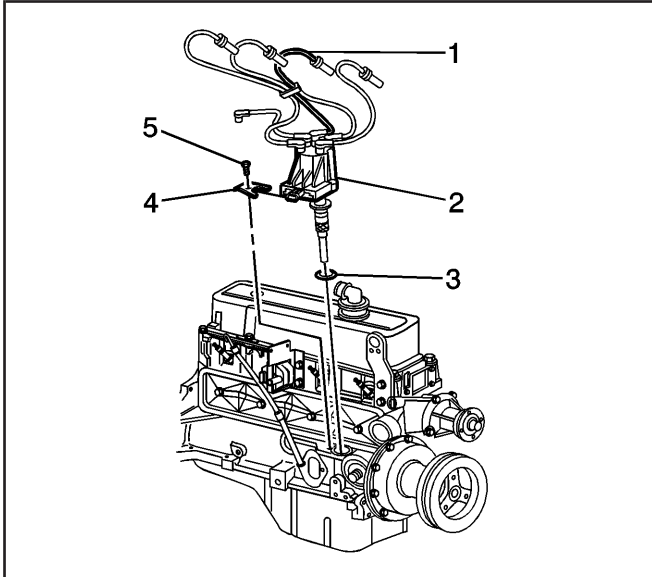
Distributor Replacement (3.0L)

Removal Procedure

Note: There are two procedures available to install the distributor. Use Installation Procedure 1 when the crankshaft has not been rotated from the original position. Use Installation Procedure 2 when any of the following components are removed:

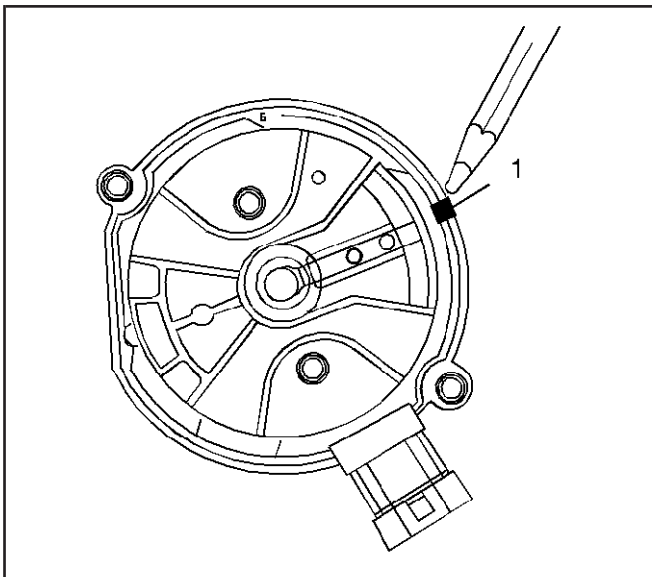
- The camshaft
- The complete engine

1. Ignition OFF.



2211673

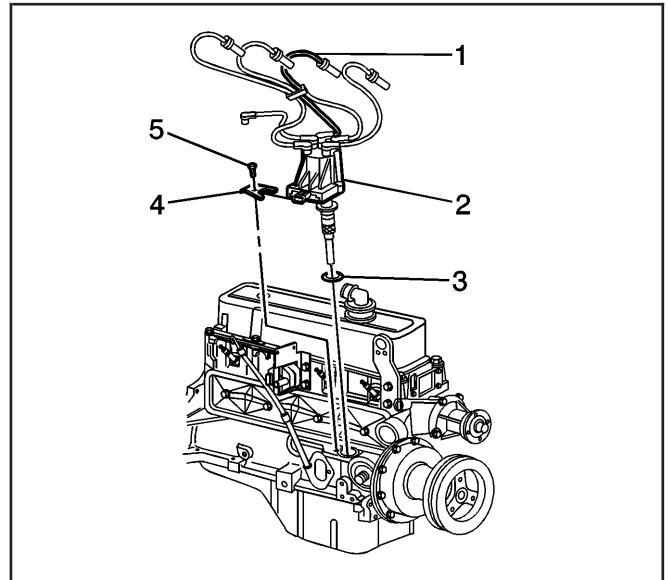
2. Disconnect the spark plug wires (1) from the distributor cap.
3. Disconnect the harness connector from the distributor.
4. Remove the distributor cap from the distributor housing.



4373

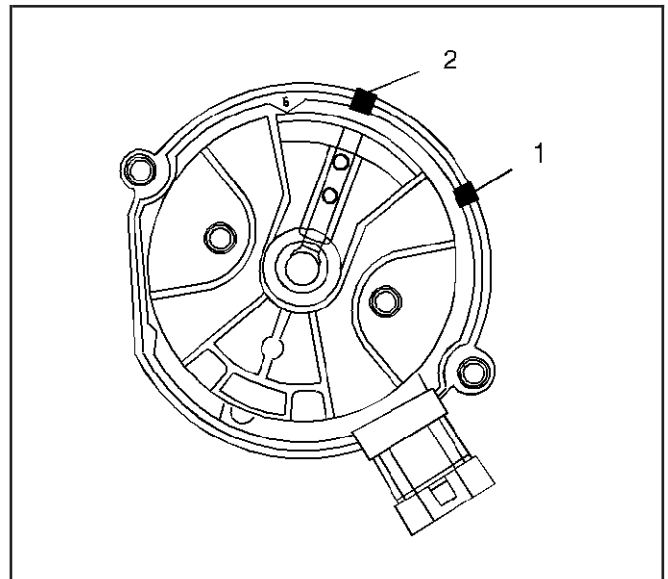
5. Mark the position of the rotor in relation to the distributor housing (1) with a grease pencil.

6. Mark the distributor housing to engine block position with a grease pencil.



2211673

7. Remove the distributor hold down bolt (5) and hold down (4).
8. Remove the distributor and gasket (3).



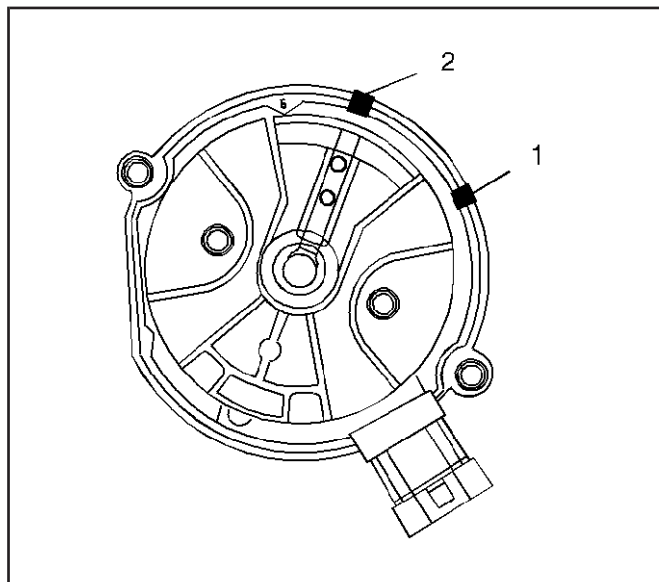
4376

9. As the distributor is being removed from the engine, the rotor will move in a counter-clockwise direction.
10. Place a second mark (2) on the base of the distributor housing in order to ensure proper rotor alignment during the distributor installation.

Installation Procedure 1

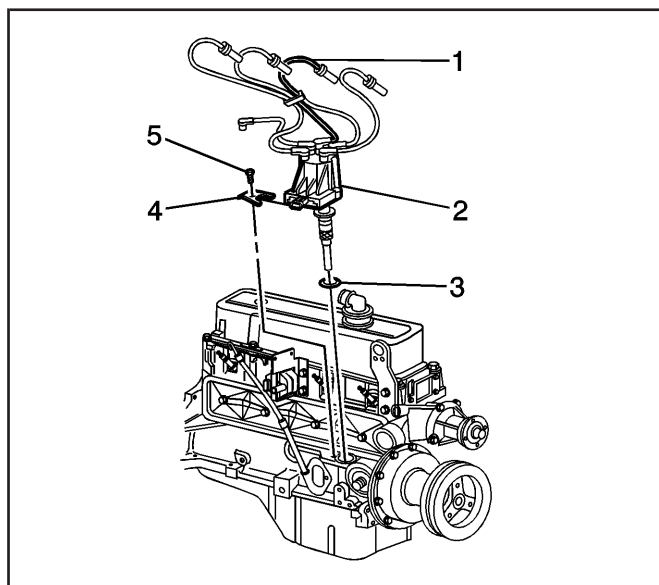
Note: If installing a new distributor assembly, transfer the two marks from the original housing to the new distributor housing in the same location.

1. Install a new gasket on the distributor.



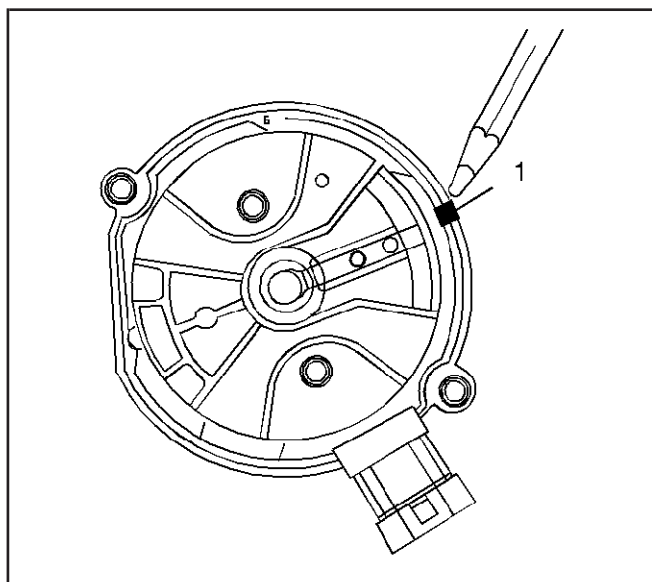
4376

2. Align the distributor rotor with mark made at location 2.



2211673

3. Guide the distributor into the engine.



4373

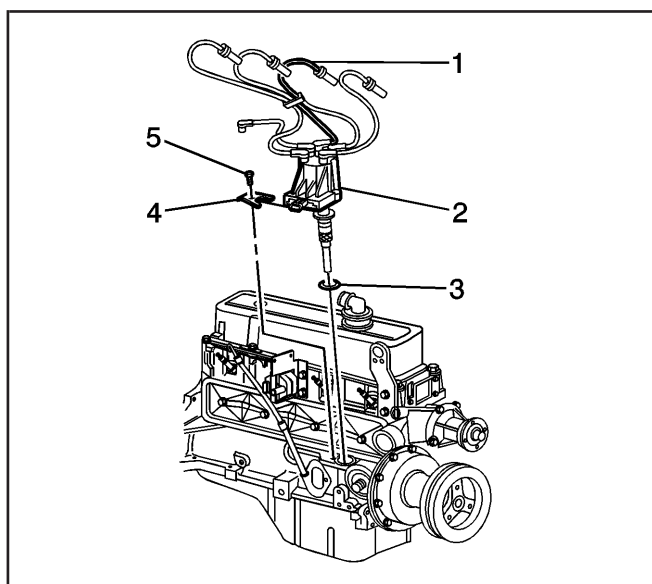
4. While the distributor is being installed, observe the rotor moving in a clockwise direction.
5. With the distributor fully seated, verify the rotor segment is aligned with the mark on the distributor base in location 1.
⇒ If the rotor segment is not aligned with the number 1 mark, the driven gear teeth and the camshaft have meshed one or more teeth out of alignment. In order to correct this condition, remove the distributor and reinstall it.

Caution: Refer to *Component Fastener Tightening Caution* on page 0-5.

6. Install the distributor hold down bolt.

Tighten

Tighten the distributor clamp bolt to 27 N·m (20 lb ft).



2211673

Install the distributor cap.

7. Install new distributor cap screws.

Tighten

Tighten the screws to 2.4 N·m (21 lb in).

8. Install the harness connector to the distributor.
9. Install the spark plug wires to the distributor cap.
10. Perform the Cam Retard Offset procedure.
Refer to *Camshaft Retard Offset Adjustment (3.0L and 4.3L)* on page 9-255 or *Camshaft Retard Offset Adjustment (5.0L and 5.7L)* on page 9-255.

Installation Procedure 2

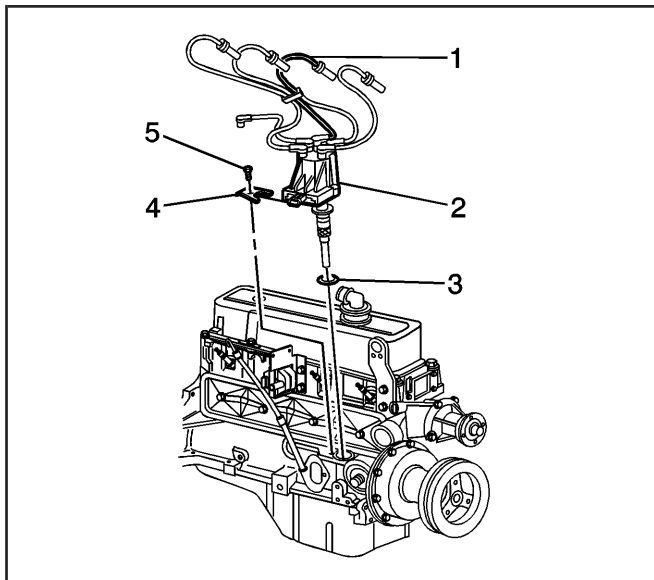
1. Rotate the engine to number 1 cylinder Top Dead Center (TDC) of the compression stroke.
2. Align the rotor segment with the number 1 tower on the distributor cap.
3. With a long screw driver, align the oil pump drive shaft to the drive tab of the distributor.

Notice: The ignition system distributor driven gear and rotor may be installed in multiple positions. In order to avoid mistakes, mark the distributor on the following components in order to ensure the same mounting position upon reassembly:

- The distributor driven gear
- The distributor shaft
- The rotor holes

Installing the driven gear 180 degrees out of alignment, or locating the rotor in the wrong holes, will cause a no-start condition. Premature engine wear or damage may result.

4. Rotate the rotor segment approximately 30 degrees counter-clockwise.



5. Guide the distributor into the engine.

6. While the distributor is being installed, observe the rotor moving in a clockwise direction.
7. With the distributor fully seated, the rotor segment should be aligned with the number 1 tower on the distributor cap.

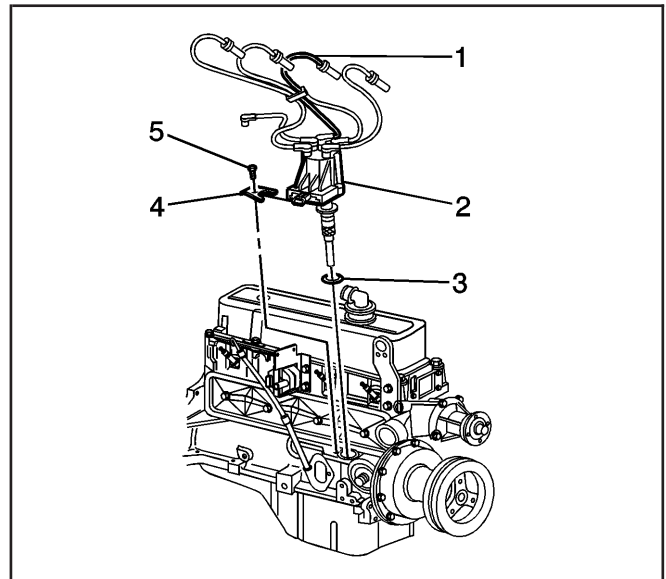
⇒ If the rotor segment does not come within a few degrees of the tower, the gear mesh between the distributor and the camshaft may be off one tooth or more. Repeat the procedure again in order to achieve proper alignment.

Caution: Refer to *Component Fastener Tightening Caution* on page 0-5.

8. Install the distributor hold down and hold down bolt.

Tighten

Tighten the distributor clamp bolt to 27 N·m (20 lb ft).



9. Install the distributor cap.

Tighten

Tighten the screws to 2.4 N·m (21 lb in).

10. Install the harness connector to the distributor.
11. Install the spark plug wires to the distributor cap.
12. Perform the Cam Retard Offset Procedure.
Refer to *Camshaft Retard Offset Adjustment (3.0L and 4.3L)* on page 9-255 or *Camshaft Retard Offset Adjustment (5.0L and 5.7L)* on page 9-255.

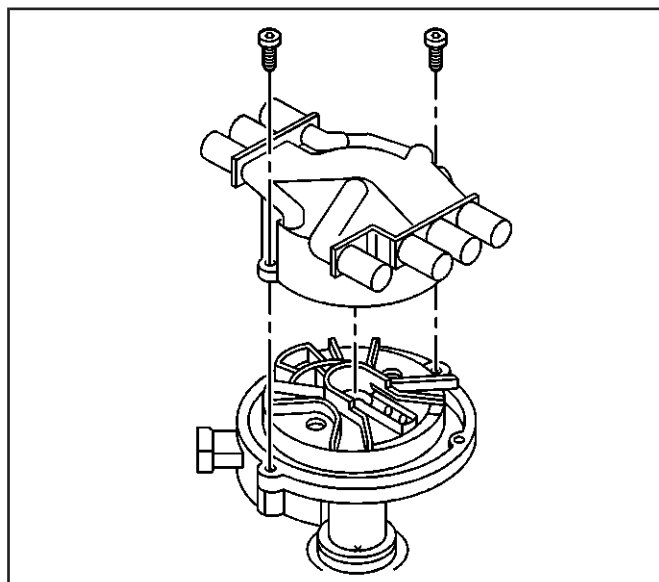
Distributor Replacement (4.3L, 5.0L, 5.8L)

Removal Procedure

Note: There are two procedures available to install the distributor. Use Installation Procedure 1 when the crankshaft has not been rotated from the original position. Use Installation Procedure 2 when any of the following components are removed:

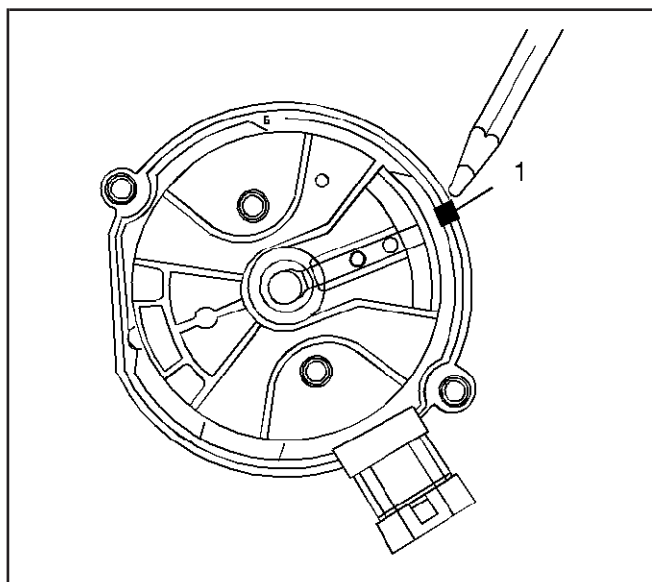
- The intake manifold
- The cylinder head
- The camshaft
- The timing chain or sprockets
- The complete engine

1. Ignition OFF.
2. Disconnect the spark plug wires from the distributor cap.
3. Disconnect the harness connector from the distributor.



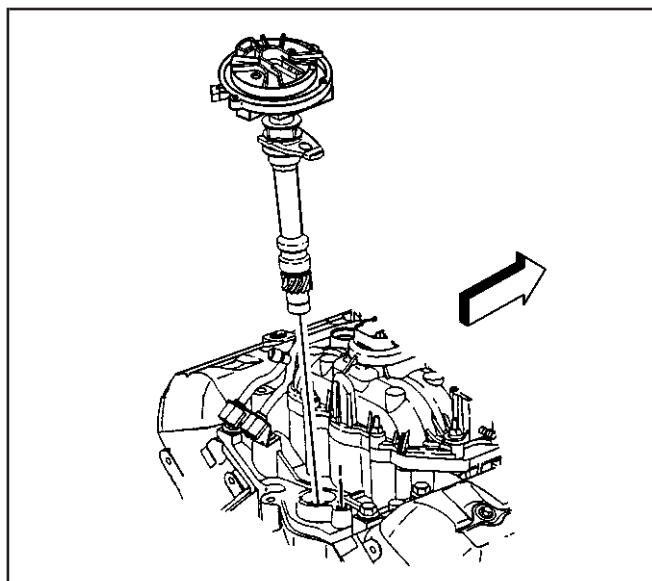
301393

4. Remove the distributor cap screws and discard.
5. Remove the distributor cap from the distributor housing.



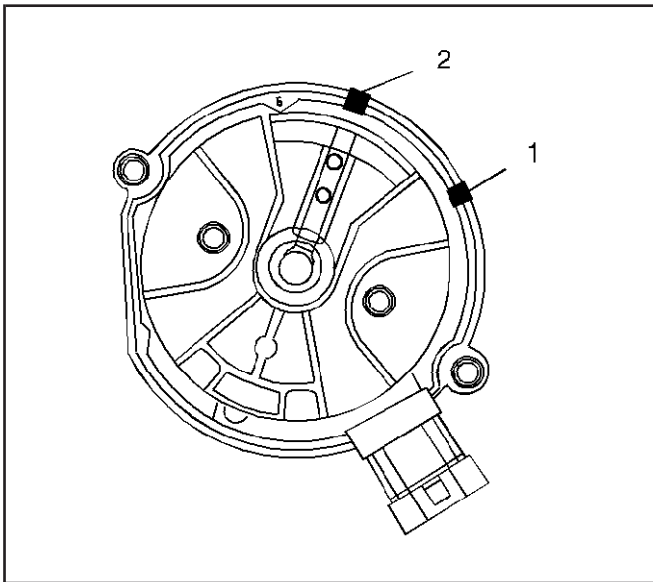
4373

6. Mark the position of the rotor in relation to the distributor housing (1) with a grease pencil.
7. Mark the distributor housing to intake manifold position with a grease pencil.



34397

8. Remove the distributor hold down bolt.
9. Remove the distributor.

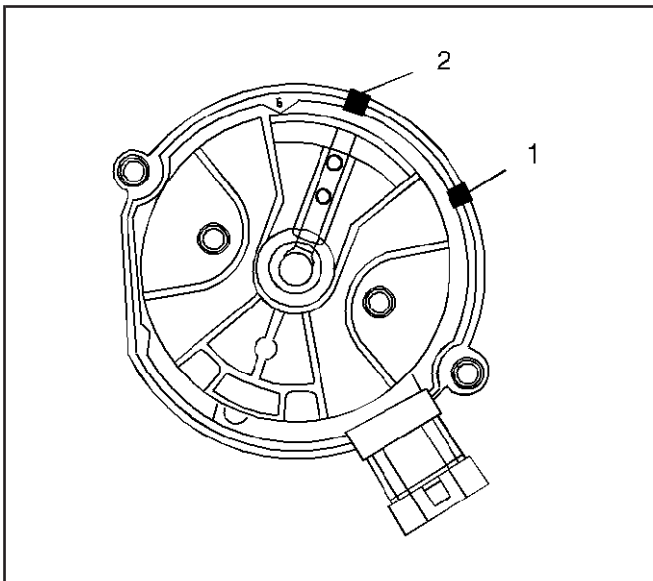


4376

10. As the distributor is being removed from the engine, the rotor will move in a counter-clockwise direction about 42 degrees.
11. Place a second mark (2) on the base of the distributor housing in order to ensure proper rotor alignment during the distributor installation.

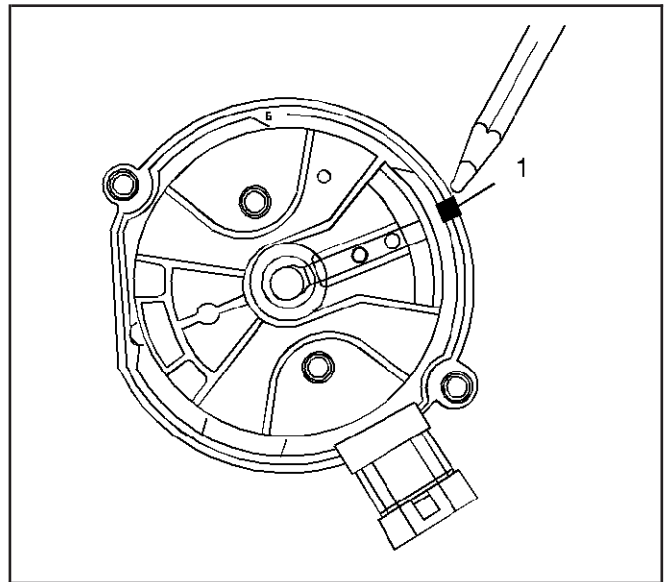
Installation Procedure 1

Note: If installing a new distributor assembly, transfer the two marks from the original housing to the new distributor housing in the same location.



4376

1. Align the distributor rotor with mark made at location 2.



4373

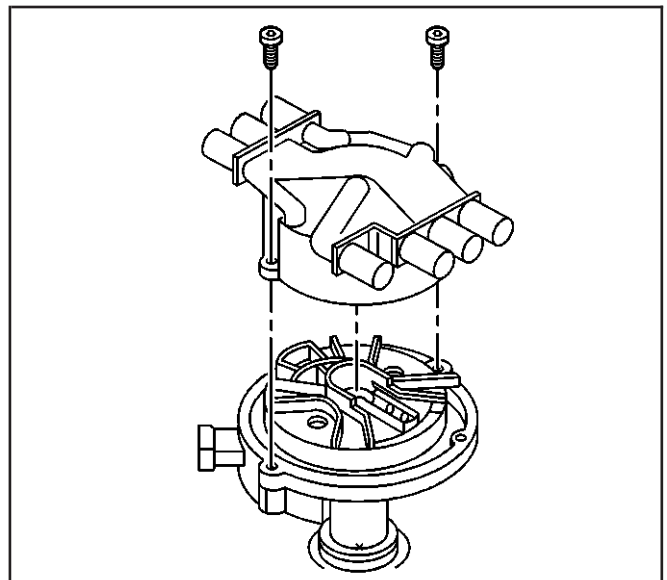
2. While the distributor is being installed, observe the rotor moving in a clockwise direction about 42 degrees.
3. With the distributor completely seated, verify the rotor segment is aligned with the mark on the distributor base in location 1.
 - ⇒ If the rotor segment is not aligned with the number 1 mark, the driven gear teeth and the camshaft have meshed one or more teeth out of alignment. In order to correct this condition, remove the distributor and reinstall it.

Caution: Refer to *Component Fastener Tightening Caution* on page 0-5.

4. Install the distributor hold down bolt.

Tighten

Tighten the distributor clamp bolt to 27 N·m (20 lb ft).



301393

Install the distributor cap.

5. Install new distributor cap screws.

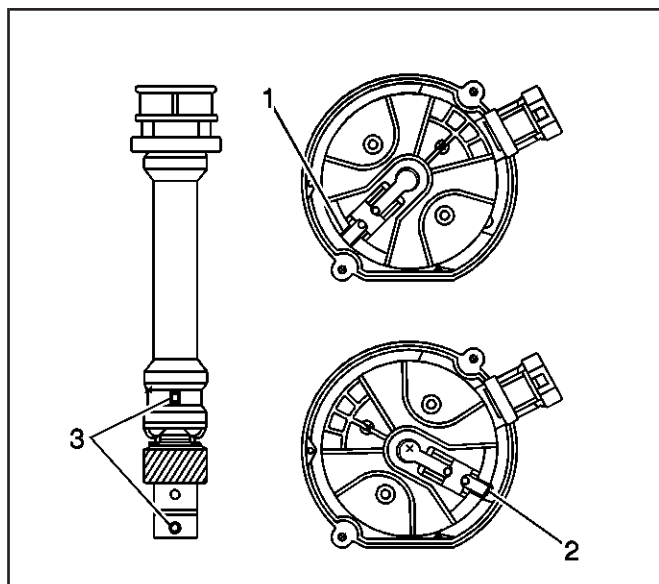
Tighten

Tighten the screws to 2.4 N·m (21 lb in).

6. Install the harness connector to the distributor.
7. Install the spark plug wires to the distributor cap.
8. Perform the Cam Retard Offset Procedure.
Refer to *Camshaft Retard Offset Adjustment (3.0L and 4.3L)* on page 9-255 or *Camshaft Retard Offset Adjustment (5.0L and 5.7L)* on page 9-255.

Installation Procedure 2

1. Rotate the number 1 cylinder to Top Dead Center (TDC) of the compression stroke.



301395

2. Align white paint mark on the bottom stem of the distributor, and the pre-drilled indent hole in the bottom of the gear (3).

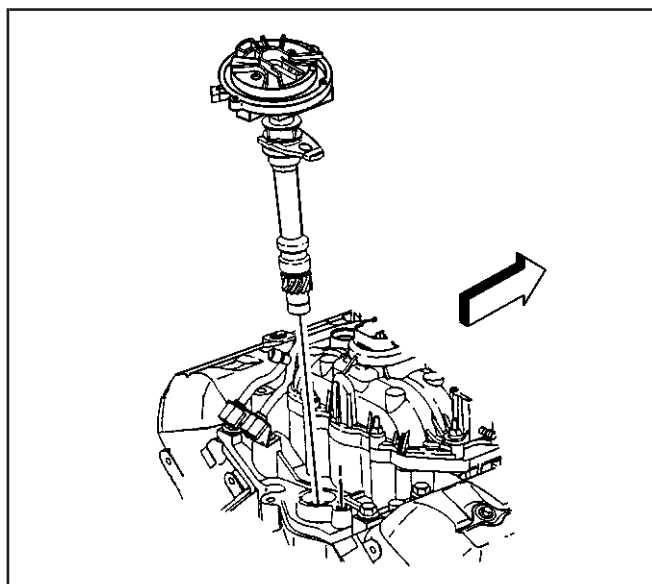
Caution: The ignition system distributor driven gear and rotor may be installed in multiple positions. In order to avoid mistakes, mark the distributor on the following components in order to ensure the same mounting position upon reassembly:

- The distributor driven gear
- The distributor shaft
- The rotor holes

Installing the driven gear 180 degrees out of alignment, or locating the rotor in the wrong holes, will cause a no-start condition. Premature engine wear or damage may result.

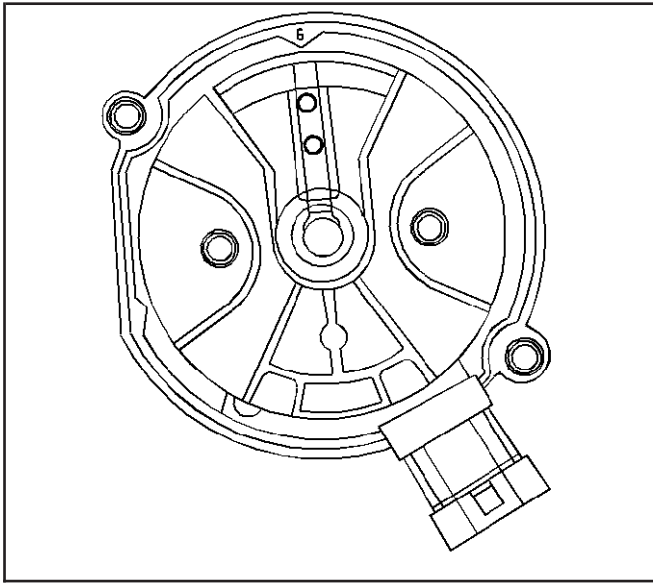
Caution: Installing the driven gear 180 degrees out of alignment, or locating the distributor rotor in the wrong holes, may cause a no-start condition. Premature engine wear and damage may result.

3. With the gear in this position, the rotor segment should be positioned as shown for a V6 engine (1) or V8 engine (2).
 - The alignment will not be exact.
 - If the driven gear is installed incorrectly, the dimple will be approximately 180 degrees opposite of the rotor segment when it is installed in the distributor.



34397

4. With a long screw driver, align the oil pump drive shaft to the drive tab of the distributor.
5. Guide the distributor into the engine.
Ensure that the spark plug towers are perpendicular to the centerline of the engine.



4350

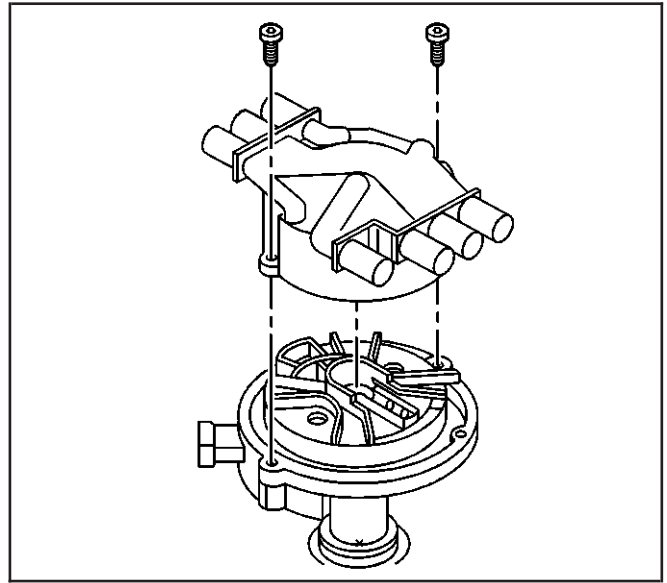
6. Once the distributor is fully seated, the rotor segment should be aligned with the pointer cast into the distributor base.
 - This pointer may have a 6 cast into it, indicating that the distributor is to be used on a 6 cylinder engine or a 8 cast into it, indicating that the distributor is to be used on a 8 cylinder engine.
 - If the rotor segment does not come within a few degrees of the pointer, the gear mesh between the distributor and the camshaft may be off one tooth or more. Repeat the procedure again in order to achieve proper alignment.

Caution: Refer to *Component Fastener Tightening Caution* on page 0-5.

7. Install the distributor hold down bolt.

Tighten

Tighten the distributor clamp bolt to 27 N·m (20 lb ft).



301393

8. Install the distributor cap.
9. Install new distributor cap screws.

Tighten

Tighten the screws to 2.4 N·m (21 lb in).

10. Install the harness connector to the distributor.
11. Install the spark plug wires to the distributor cap.
12. Perform the Cam Retard Offset Procedure. Refer to *Camshaft Retard Offset Adjustment (3.0L and 4.3L)* on page 9-255 or *Camshaft Retard Offset Adjustment (5.0L and 5.7L)* on page 9-255.

Camshaft Retard Offset Adjustment (3.0L and 4.3L)

The distributor and ignition timing are not adjustable. The distributor will need to be removed in order to reposition the rotor in order to prevent ignition crossfire. To verify proper alignment of the distributor, perform the following:

Note: The scan tool Cam Angle reading will not be accurate below 1,200 RPM.

1. Engine idling at operating temperature. Observe the scan tool Cam Angle parameter.
2. Increase the engine speed to 1,200 RPM. Verify the scan tool Cam Angle parameter is within 700–740 degrees.
 - ⇒ If within the specified range, the distributor is properly adjusted.
 - ⇒ If not within the specified range, remove the distributor in order to adjust the rotor. Refer to Installation Procedure 2 in *Distributor Replacement (3.0L)* on page 9-248 or *Distributor Replacement (4.3L, 5.0L, 5.8L)* on page 9-251.

Camshaft Retard Offset Adjustment (5.0L and 5.7L)

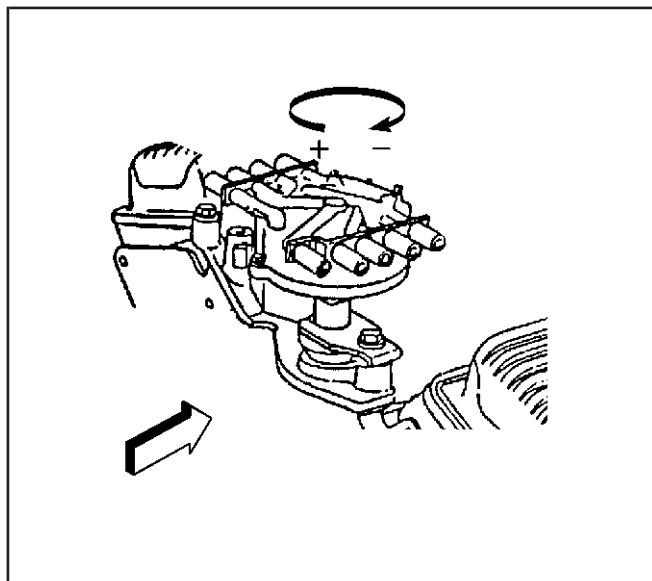
Test Procedure

The ignition timing is not adjustable. The distributor may need to be adjusted in order to prevent ignition crossfire. To insure proper alignment of the distributor, perform the following:

Note: The scan tool Cam Angle reading will not be accurate below 1,200 RPM.

1. Engine idling at operating temperature. Observe the scan tool Cam Angle parameter.
2. Increase the engine speed to 1,200 RPM. Verify the scan tool Cam Angle parameter is within 685–725 degrees.
 - ⇒ If within the specified value, the distributor is properly adjusted.
 - ⇒ If not within the specified value, adjust the distributor.

Adjustment Procedure



18446

1. Ignition OFF, slightly loosen the distributor hold down bolt.

Note: The Cam Angle reading will not be accurate below 1,200 RPM.

2. Engine operating, raise the engine speed to 1,200 RPM. Observe the scan tool Cam Angle parameter.
 - ⇒ If the Cam Angle parameter is less than 685 degrees, rotate the distributor in a counterclockwise direction to adjust.
 - ⇒ If the Cam Angle parameter is greater than 725 degrees, rotate the distributor in a clockwise direction to adjust.
3. Repeat step 2 until 705 degrees is obtained.
4. Ignition OFF.

Caution: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Do not use paints, lubricants, or corrosion inhibitors on fasteners, or fastener joint surfaces, unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems. When using fasteners that are threaded directly into plastic, use extreme care not to strip the mating plastic part(s). Use hand tools only, and do not use any kind of impact or power tools. Fastener should be hand tightened, fully seated, and not stripped.

5. Tighten the distributor hold-down bolt.

Tighten

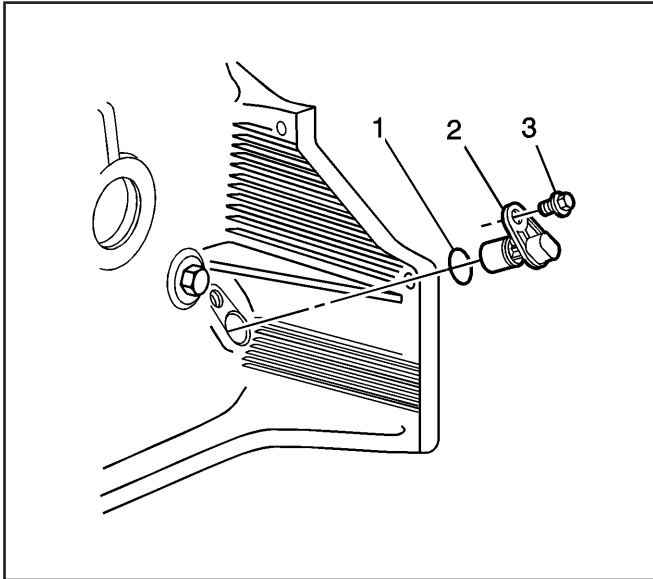
Tighten the bolt to 27 N·m (20 lb ft).

Crankshaft Position Sensor Replacement (3.0L)

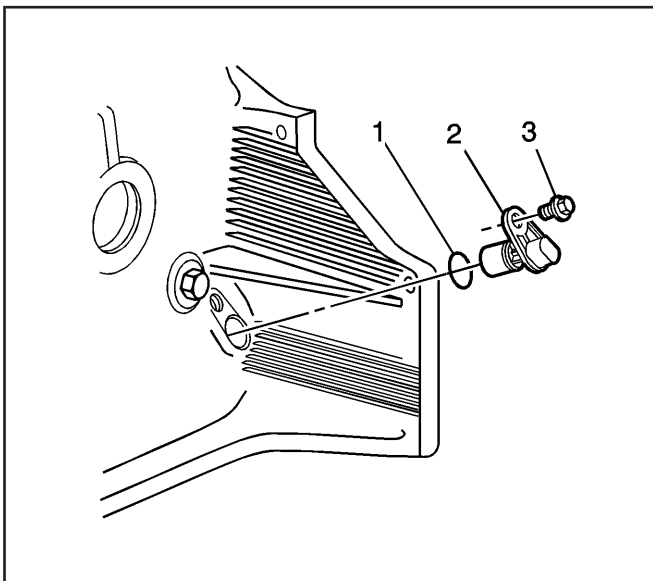
Removal Procedure

Warning: Refer to *Battery Disconnect Warning* on page 0-4.

1. Disconnect the negative battery cable.
2. Remove the crankshaft position sensor (CKP) sensor harness connector.
3. Remove the CKP sensor hold down bolt (3).
4. Remove the CKP sensor (2) from the engine block.
5. Inspect the sensor O-ring (1) for wear, cracks, or leakage.
6. Replace if necessary. Lubricate the new O-ring with clean engine oil before installing.



2211668



2211668

Installation Procedure

1. Lubricate the CKP sensor O-ring with clean engine oil.

Note:

- Verify the crankshaft position (CKP) sensor mounting surfaces are clean and free of burrs before installing the CKP sensor.
- When installing the CKP sensor, ensure the sensor is fully seated and held stationary in the engine block before torquing the hold down bolt. A sensor which is not seated may cause erratic operation and false codes to set.

2. Install the CKP sensor into the engine block.

Caution: Refer to *Fastener Caution* on page 0-5.

3. Install the sensor hold down bolt.

Tighten

Tighten the hold down bolt to 10 N·m (88 lb in).

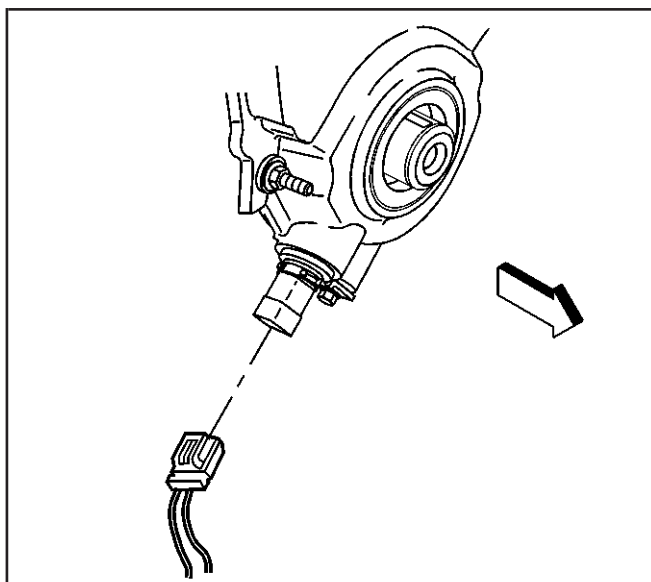
4. Install the CKP sensor harness connector.
5. Connect the negative battery cable.

Crankshaft Position Sensor Replacement (4.3/5.0/5.7L)

Removal Procedure

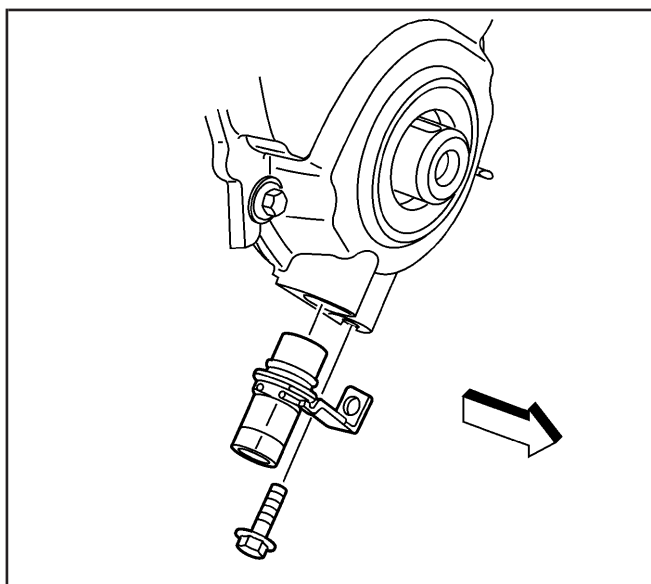
Warning: Refer to *Battery Disconnect Warning* on page 0-4.

1. Disconnect the negative battery cable.
2. Remove the CKP sensor harness connector.



10937

3. Remove the sensor hold down bolt.
4. Remove the sensor from the timing cover.
5. Inspect the sensor O-ring for wear, cracks, or leakage.
6. Replace if necessary. Lube the new O-ring with clean engine oil before installing.



11485

Installation Procedure

1. Lube the CKP sensor O-ring with clean engine oil.

Note:

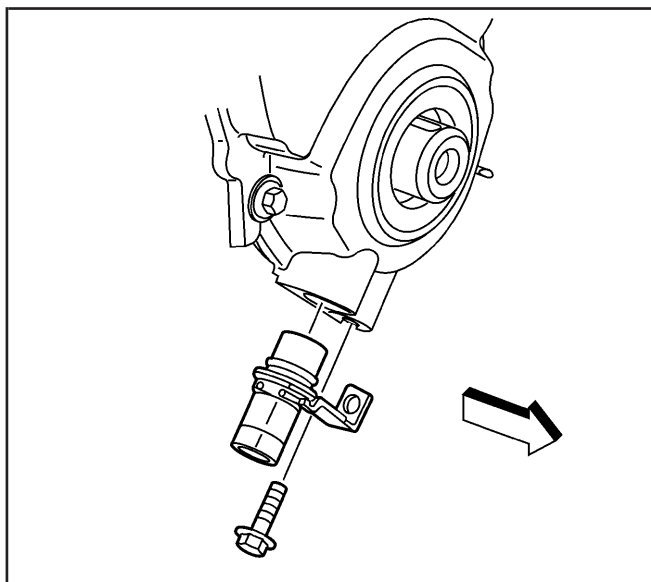
- Verify the crankshaft position (CKP) sensor mounting surfaces are clean and free of burrs before installing the CKP sensor.
 - When installing the CKP sensor, ensure the sensor is fully seated and held stationary in the front cover before torquing the hold down bolt. A sensor which is not seated may cause erratic operation and false codes to set.
2. Install the CKP sensor into the timing cover.

Caution: Refer to *Fastener Caution* on page 0-5.

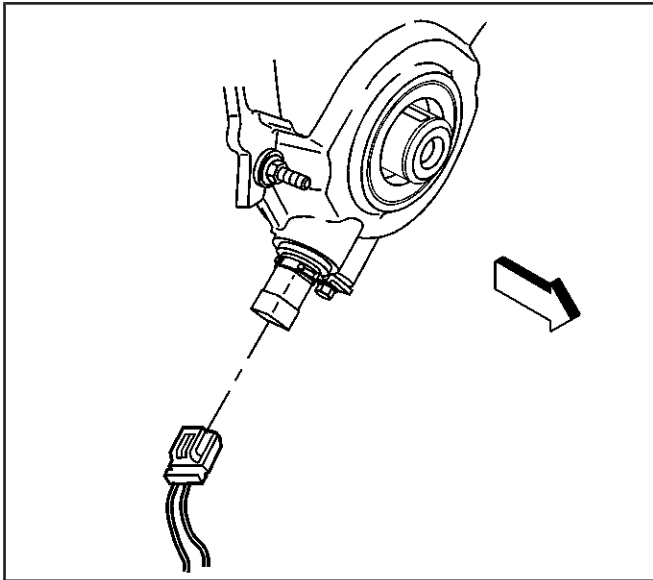
3. Install the sensor hold down bolt.

Tighten

Tighten the hold down bolt to 8 N·m (71 lb in.).

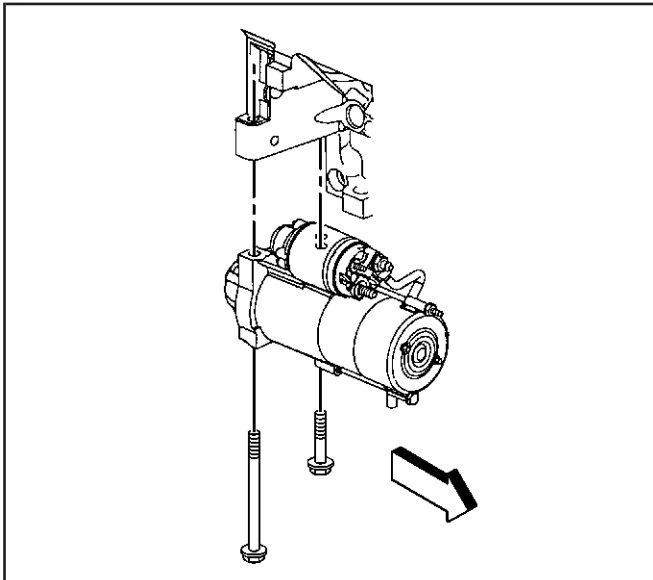


11485



10937

4. Install the CKP sensor harness connector.
5. Connect the negative battery cable.



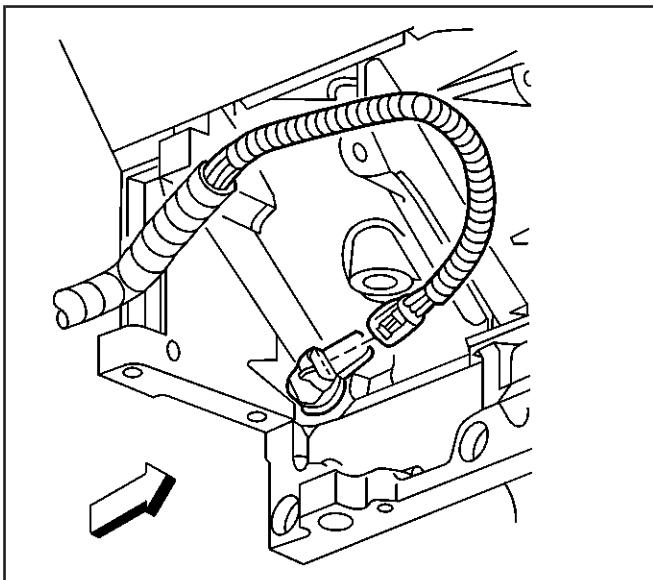
211621

Crankshaft Position Sensor Replacement (6.0/6.2L)

Removal Procedure

Warning: Refer to Battery Disconnect Warning on page 0-4.

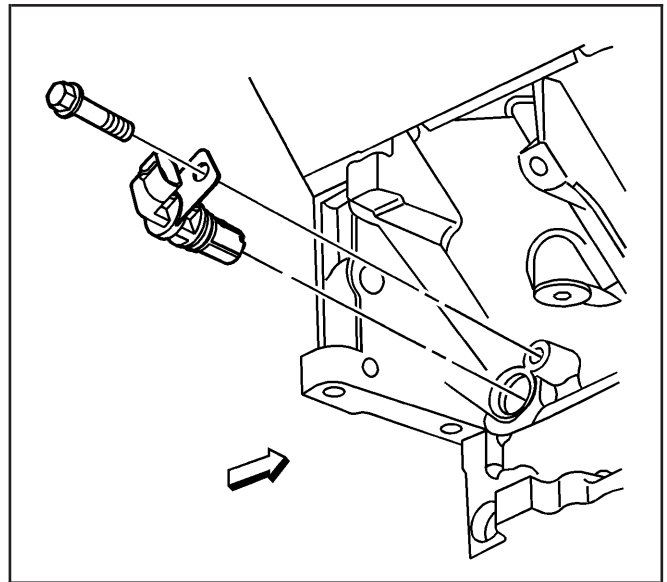
1. Disconnect the negative battery cable.
2. Remove the starter.



56592

3. Disconnect the crankshaft position (CKP) sensor electrical connector.

4. Remove the CKP sensor retaining bolt.
5. Remove the CKP sensor.



55322

Installation Procedure

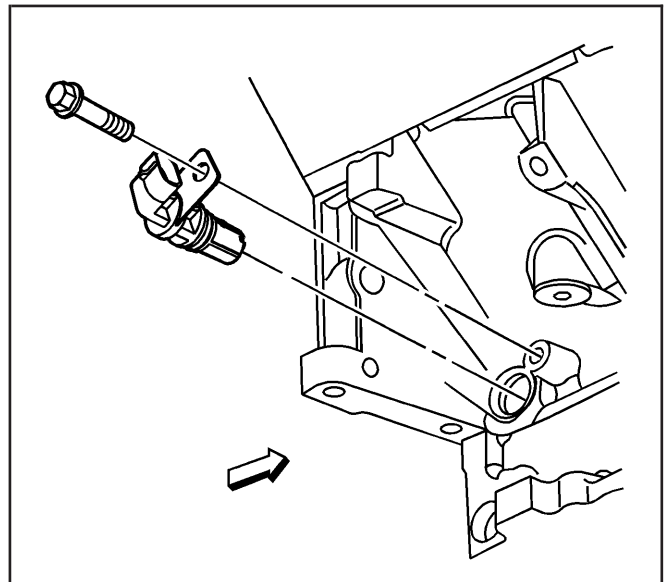
1. Install the CKP sensor.

Caution: Refer to *Fastener Caution* on page 0-5.

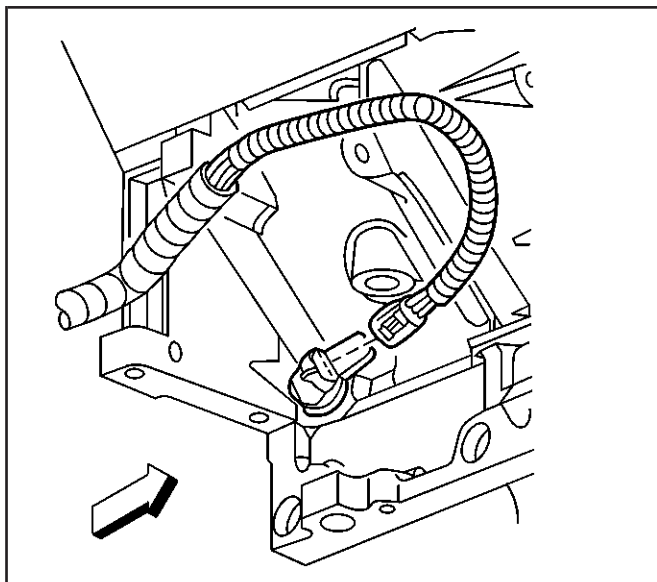
2. Install the CKP sensor retaining bolt.

Tighten

Tighten the CKP sensor to 25 N·m (18 lb ft).

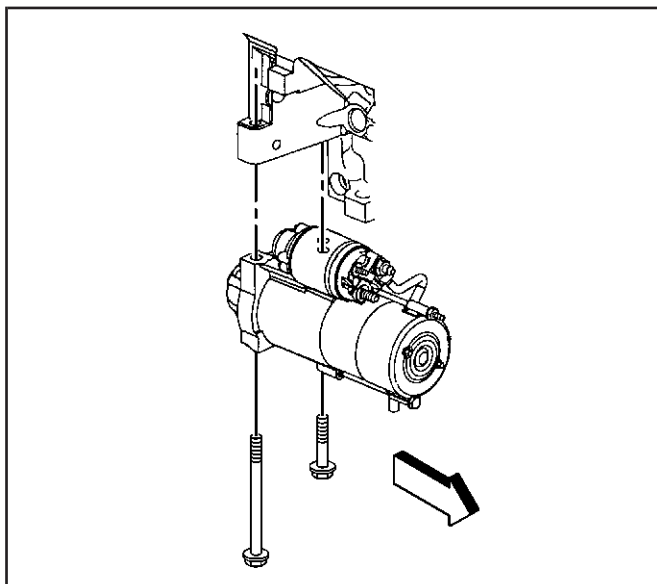


55322



56592

3. Connect the CKP sensor electrical connector.

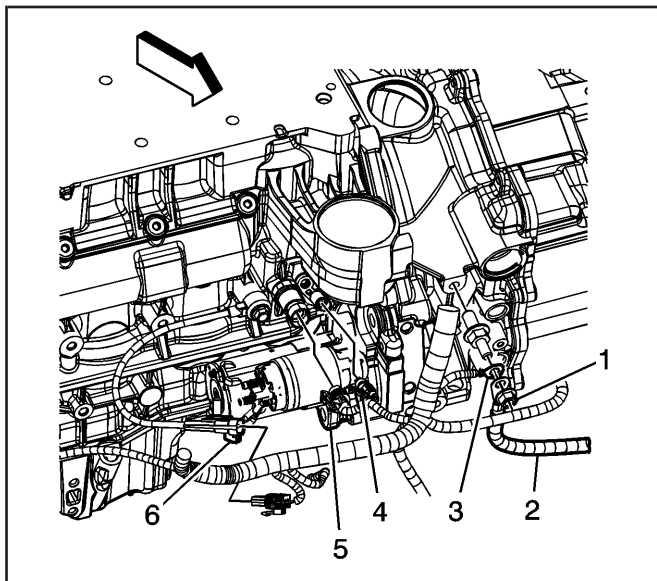


211621

4. Install the starter.

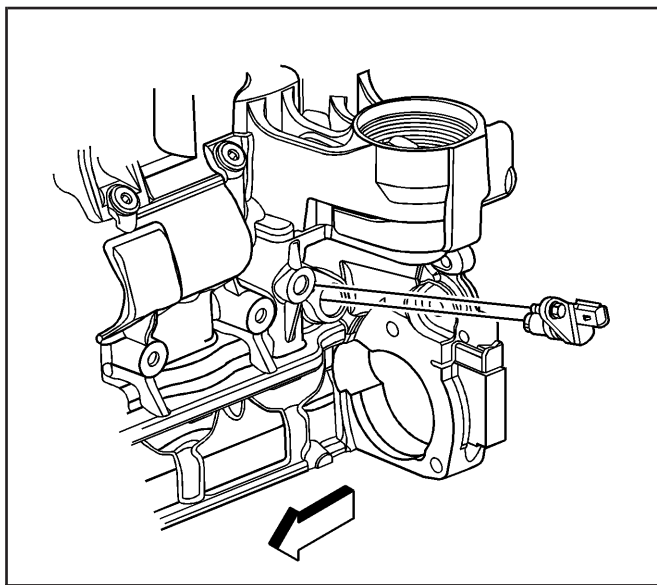
Crankshaft Position Sensor Replacement (2.4L)

Removal Procedure



1622787

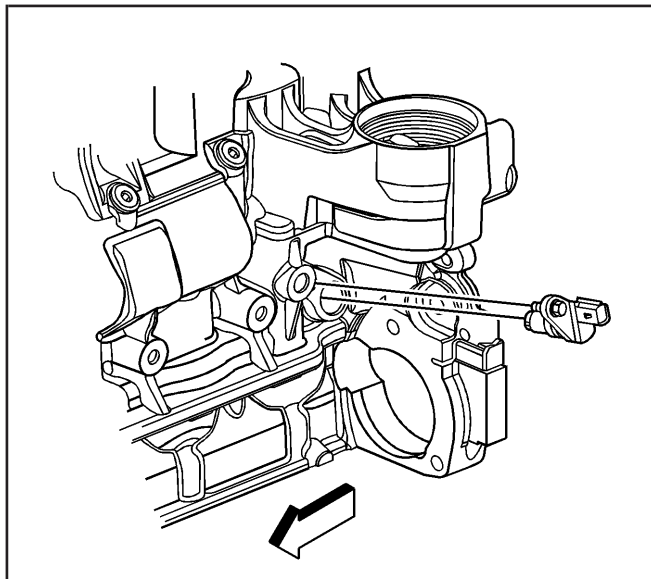
1. Remove the starter motor assembly.
2. Disconnect the crankshaft position (CKP) sensor electrical connector (4).



1578475

3. Remove the CKP sensor bolt.
4. Remove the CKP sensor.

Installation Procedure



1578475

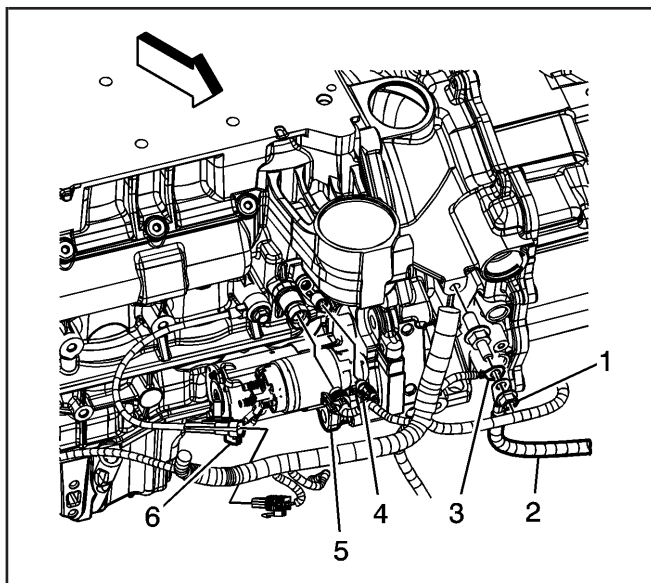
1. Lubricate the CKP sensor O-ring seal with clean engine oil.
2. Install the CKP sensor.

Caution: Refer to *Fastener Caution* on page 0-5.

3. Install the CKP sensor bolt.

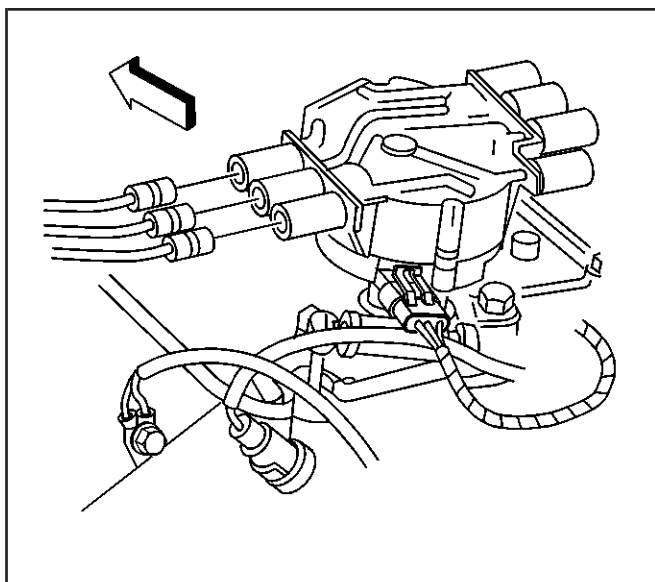
Tighten

Tighten the sensor bolt to 10 N·m (89 lb in).



1622787

4. Connect the CKP sensor electrical connector (4).
5. Install the starter motor assembly.

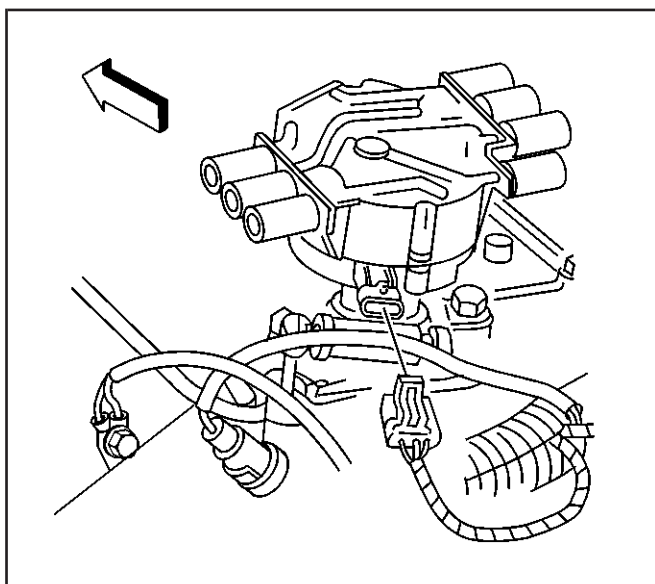


302854

Camshaft Position Sensor Replacement (4.3/5.0/5.7L)

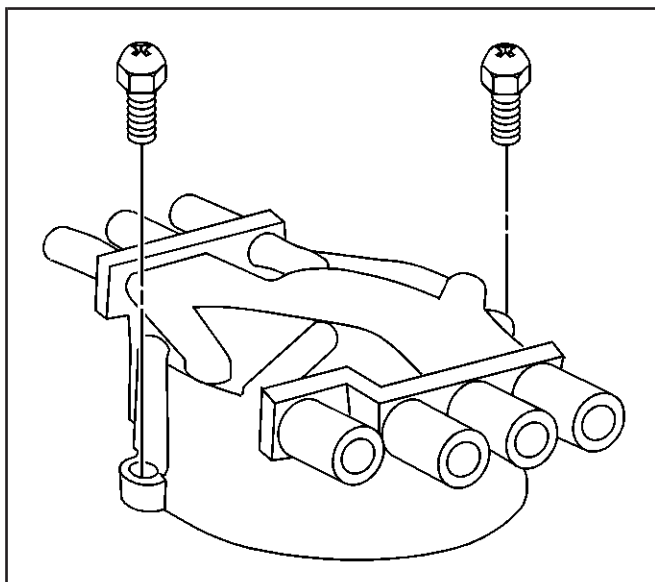
Removal Procedure

1. Disconnect the spark plug wires and ignition coil wire from the distributor. Refer to *Spark Plug Wire Replacement* on page 9-245.



302829

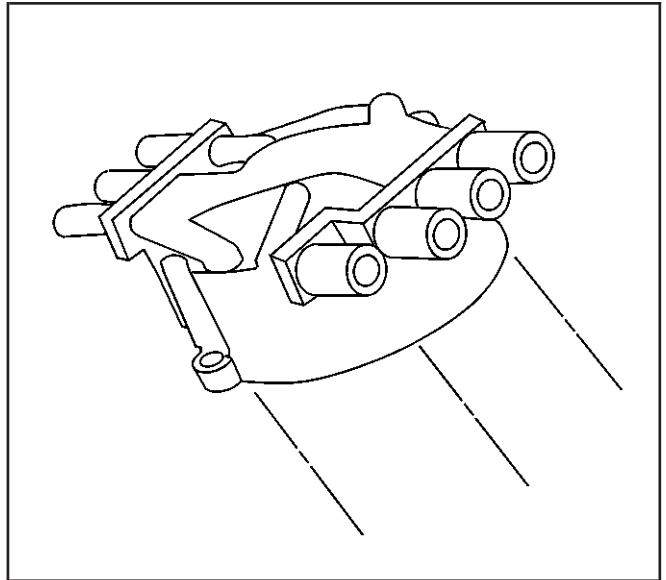
2. Disconnect the camshaft position (CMP) sensor harness connector from the distributor.



157984

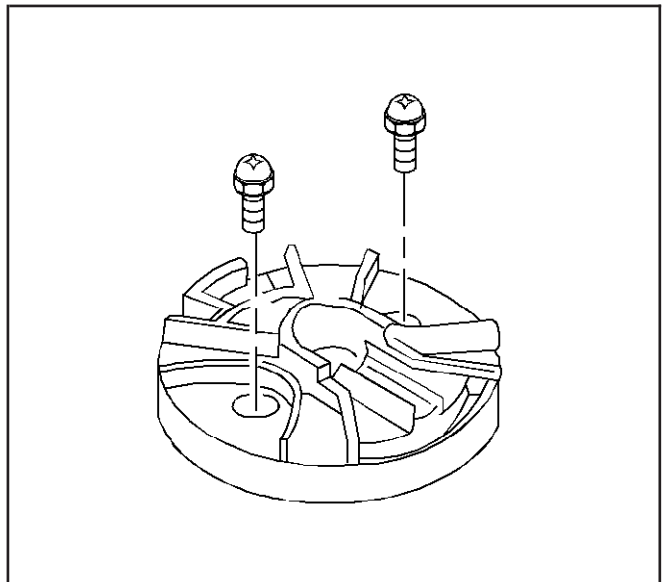
3. Remove the distributor cap screws.

4. Remove the distributor cap.



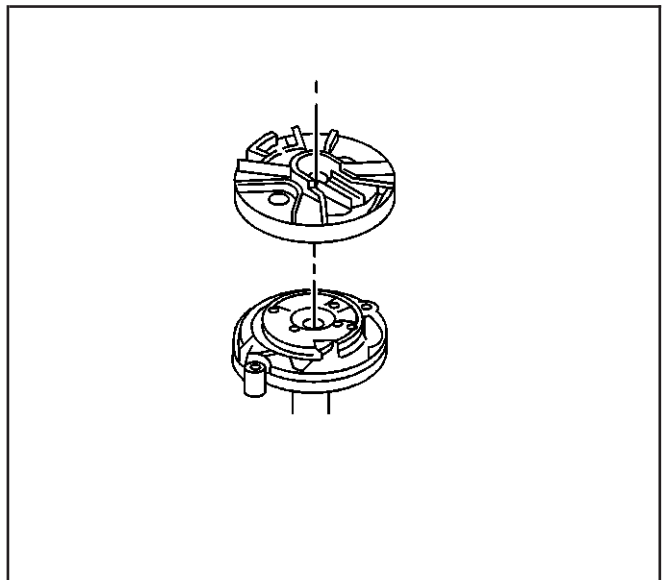
157986

5. Remove the rotor screws.

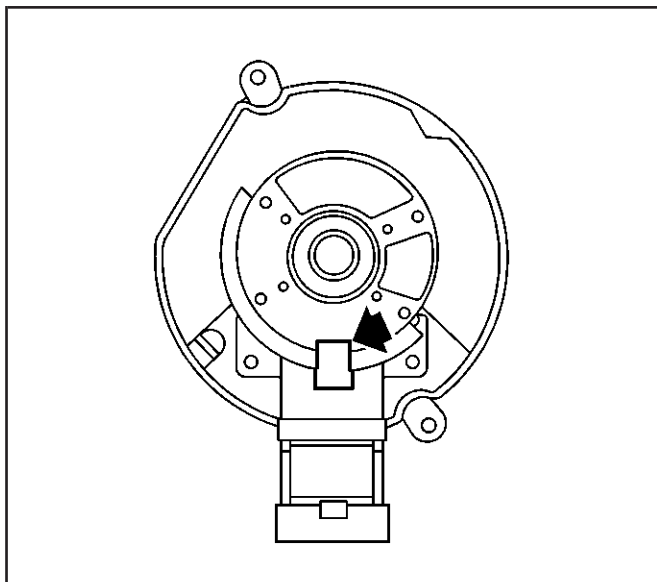


4354

6. Remove the rotor.

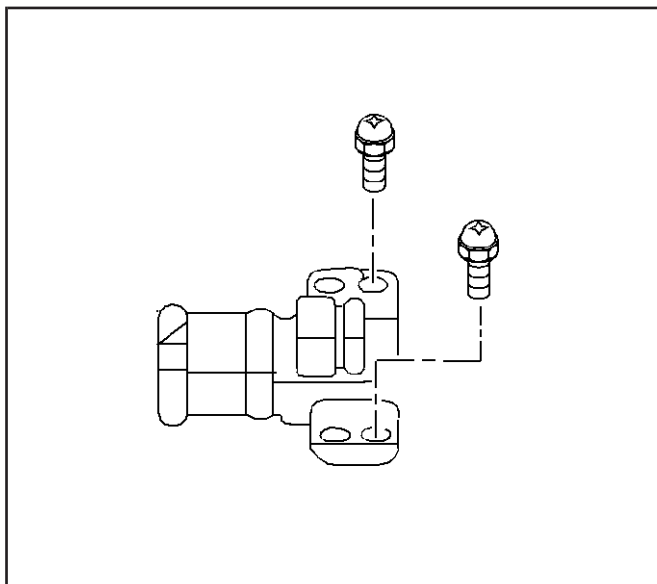


156748



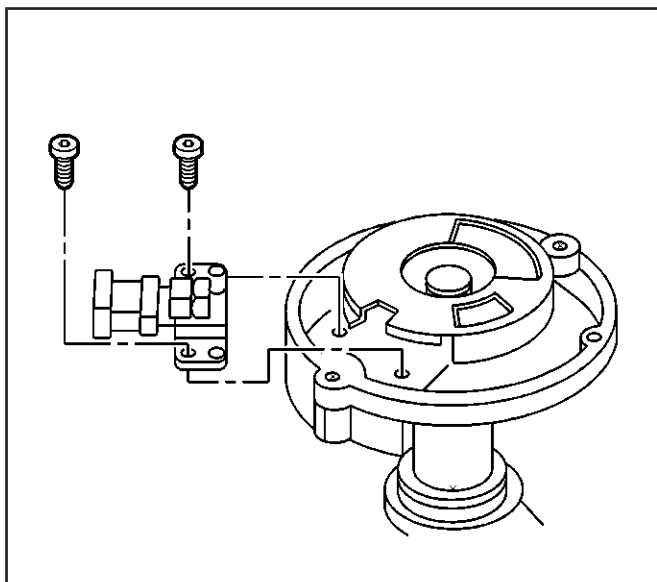
156754

7. Align the square slot in the reluctor wheel with the CMP sensor.



4341

8. Remove the CMP screws.



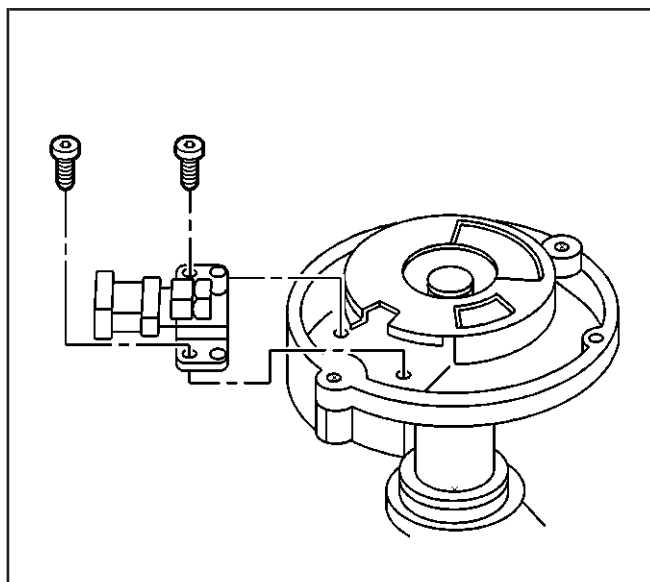
301398

9. Remove the CMP sensor.

Installation Procedure

Note: Do not use the old cap, CMP sensor, and rotor screws. Use the replacement screws that have been coated with a thread locking compound.

1. Insert the CMP sensor through the reluctor wheel slot.



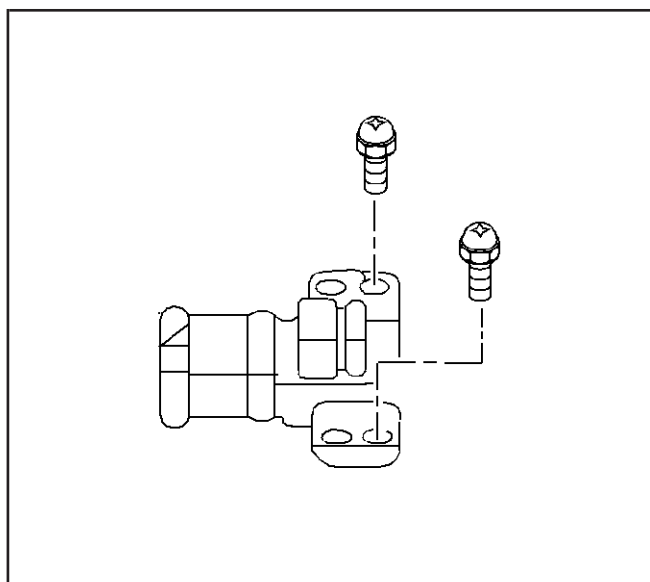
301398

Caution: Use the correct fastener in the correct location. Replacement fasteners must be the correct part number for that application. Do not use paints, lubricants, or corrosion inhibitors on fasteners, or fastener joint surfaces, unless specified. These coatings affect fastener torque and joint clamping force and may damage the fastener. Use the correct tightening sequence and specifications when installing fasteners in order to avoid damage to parts and systems. When using fasteners that are threaded directly into plastic, use extreme care not to strip the mating plastic part(s). Use hand tools only, and do not use any kind of impact or power tools. Fastener should be hand tightened, fully seated, and not stripped.

2. Install new CMP mounting screws.

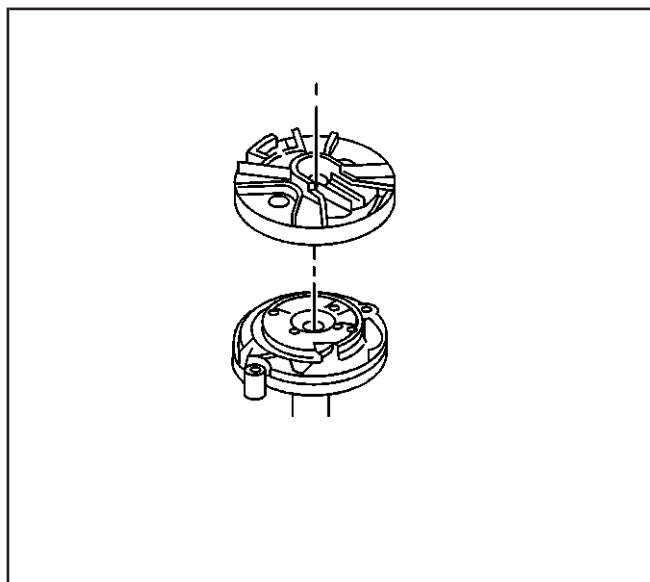
Tighten

Tighten the bolts to 2.2 N·m (19 lb in).

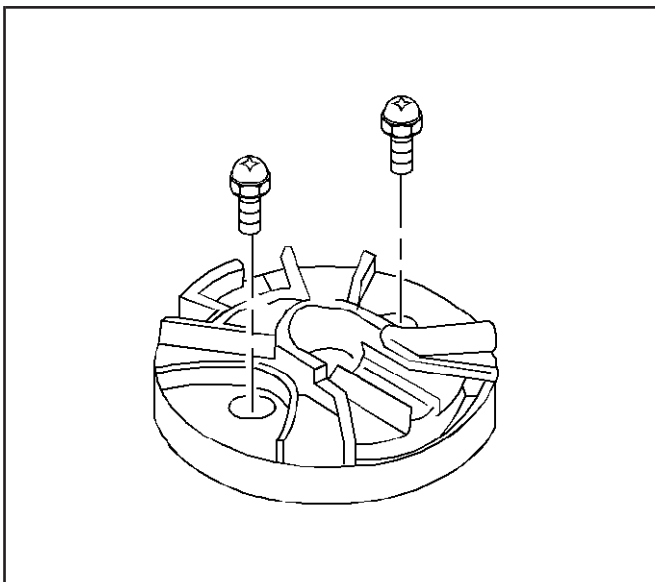


4341

3. Install the rotor onto the reluctor wheel.



156748

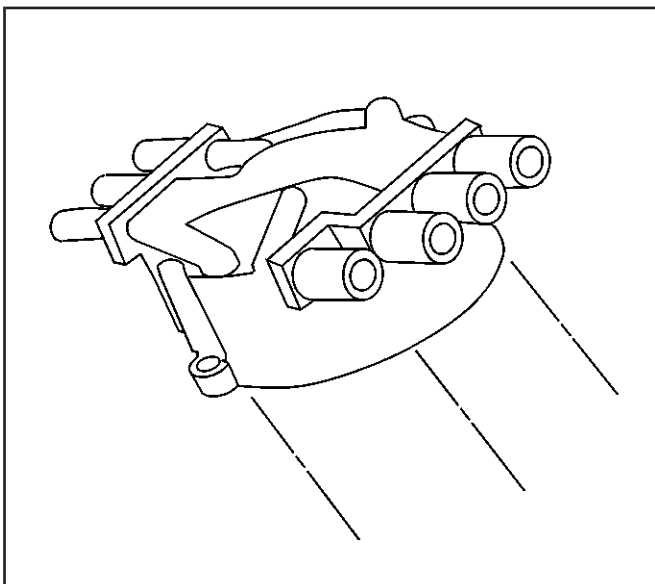


4354

4. Install new rotor screws.

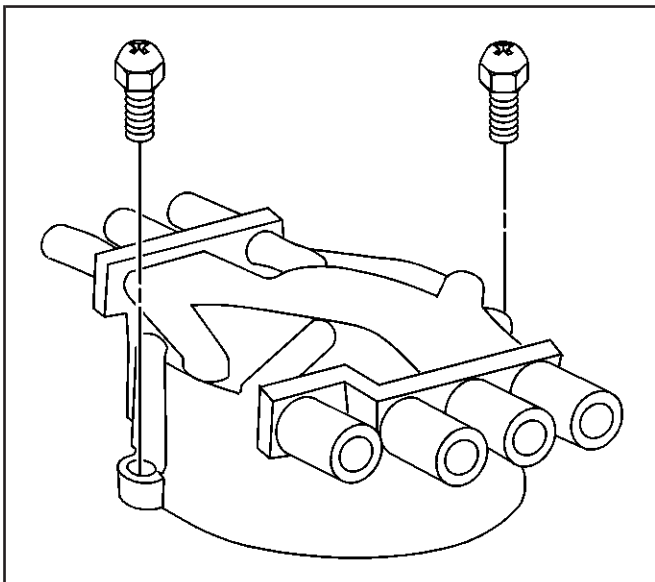
Tighten

Tighten the screws to 1.9 N·m (17 lb in).



157986

5. Install the distributor cap.



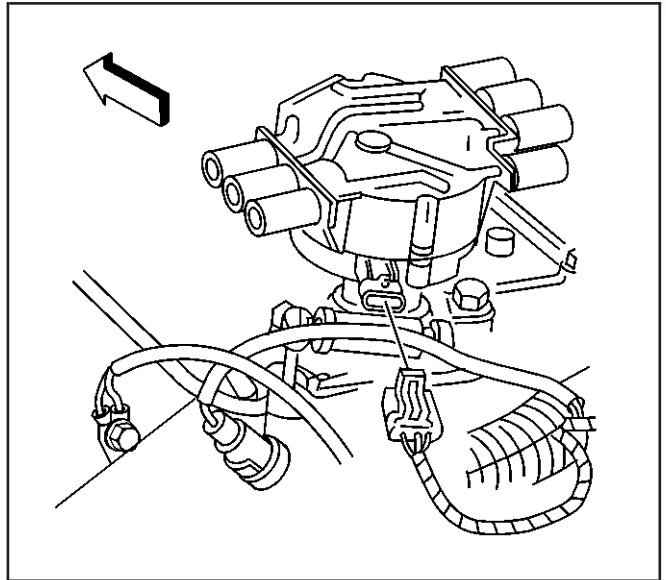
157984

6. Install new distributor cap screws.

Tighten

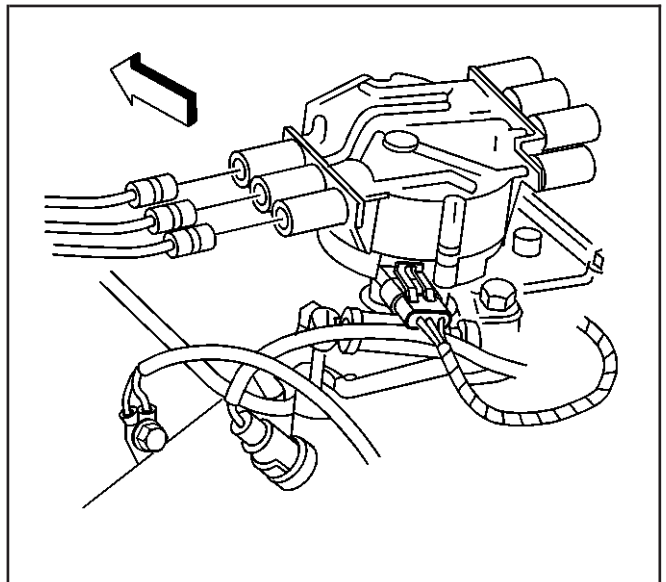
Tighten the screws to 2.4 N·m (21 lb in).

7. Connect the CMP sensor harness connector.



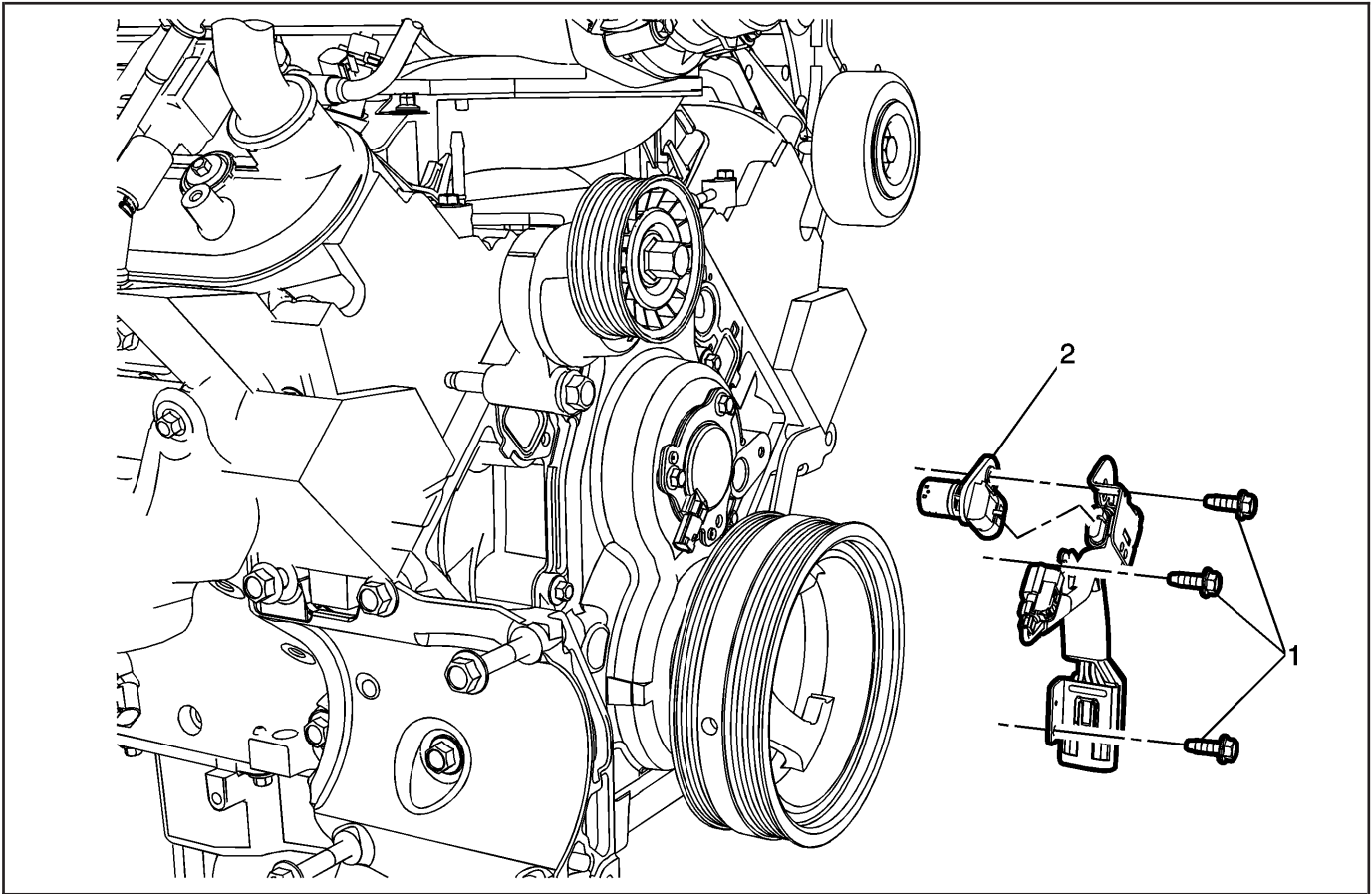
302829

8. Connect the spark plug wires and ignition coil wire. Refer to *Spark Plug Wire Replacement* on page 9-245.



302854

Camshaft Position Sensor Replacement (with CMP Actuator)

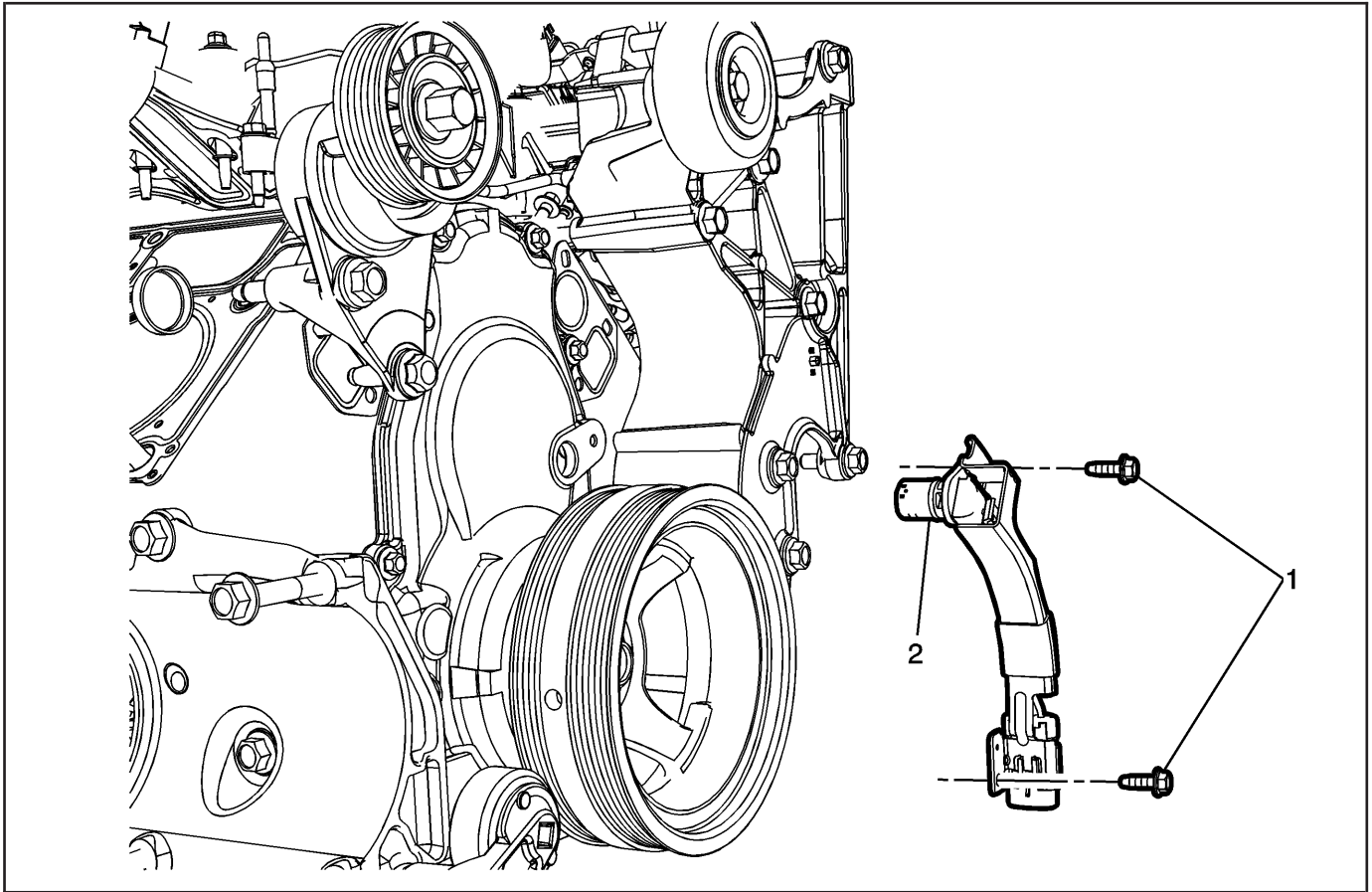


2491396

Camshaft Position Sensor Replacement (with CMP Actuator)

Callout	Component Name
1	Camshaft Position Sensor Fastener (Qty: 3) Caution: Refer to <i>Fastener Caution</i> on page 0-5. Tighten 12 N·m (106 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical connectors.

Camshaft Position Sensor Replacement (without CMP Actuator)



2491402

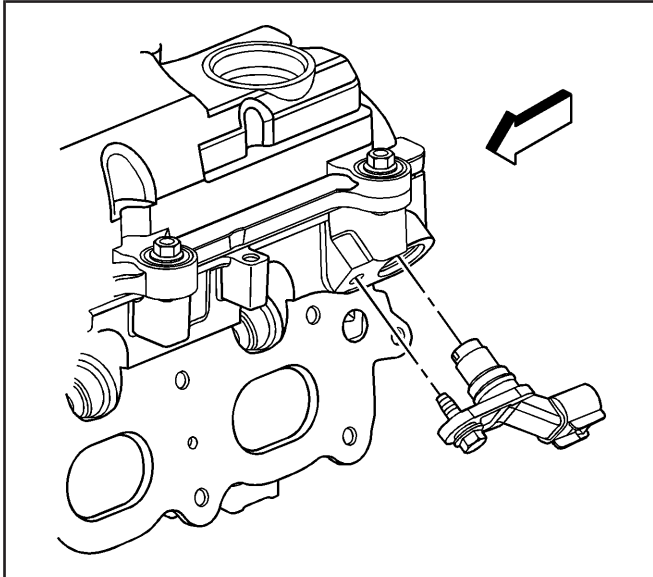
Camshaft Position Sensor Replacement (without CMP Actuator)

Callout	Component Name
1	Camshaft Position Sensor Fastener (Qty: 2) Caution: Refer to <i>Fastener Caution</i> on page 0-5. Tighten 12 N·m (106 lb in)
2	Camshaft Position Sensor Procedure Disconnect the electrical connectors.

Camshaft Position Sensor Replacement (2.4L Intake)

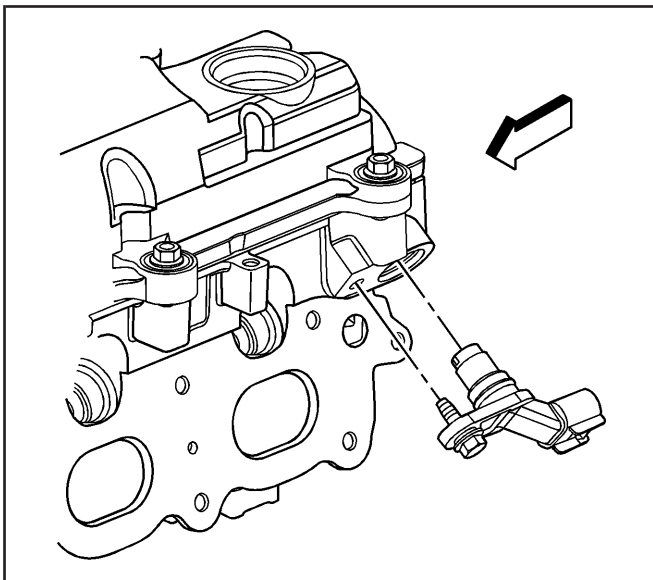
Removal Procedure

1. Disconnect the intake camshaft position (CMP) sensor electrical connector (2).



2. Remove the CMP sensor bolt.
3. Remove the CMP sensor.

Installation Procedure



Note: Inspect the CMP sensor for damage. Replace as necessary.

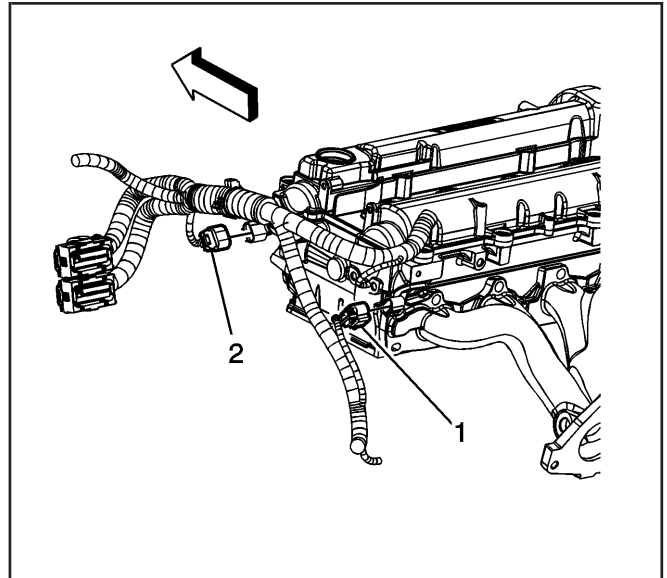
1. Lubricate the CMP sensor O-ring seal with clean engine oil.
2. Install the CMP sensor.

Caution: Refer to *Fastener Caution* on page 0-5.

3. Install the CMP sensor bolt.

Tighten

Tighten the bolt to 10 N·m (89 lb in).

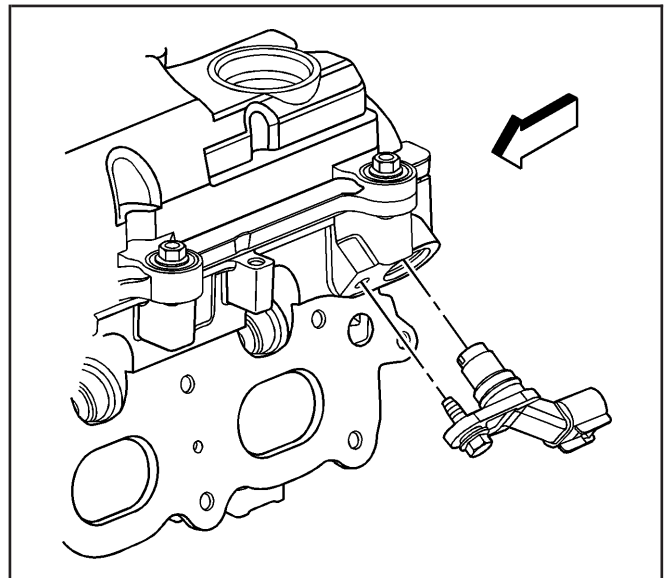


4. Connect the intake CMP sensor electrical connector (2).

Camshaft Position Sensor Replacement (2.4L Exhaust)

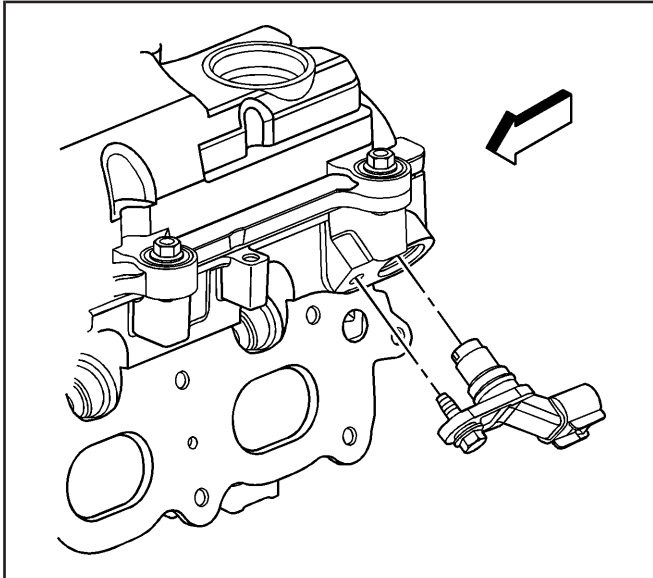
Removal Procedure

1. Disconnect the exhaust camshaft position (CMP) sensor electrical connector (1).



2. Remove the CMP sensor bolt. Intake CMP shown, exhaust CMP similar.
3. Remove the CMP sensor.

Installation Procedure



1578483

Note: Inspect the CMP sensor for damage, replace as necessary.

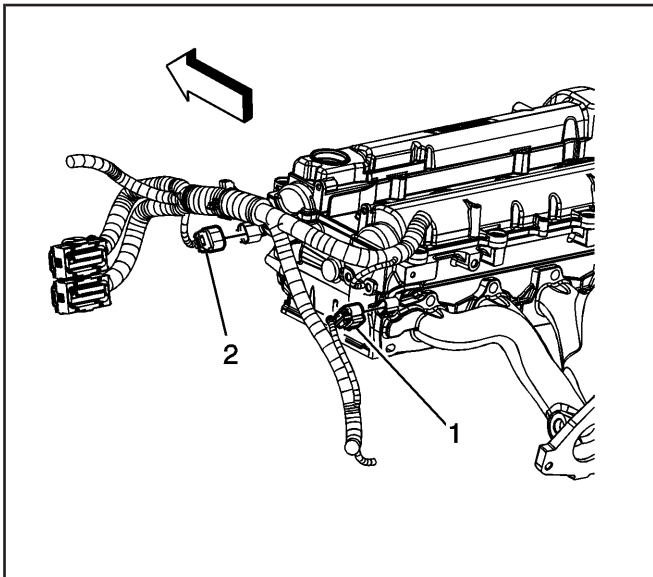
1. Lubricate the CMP sensor O-ring seal with clean engine oil.
2. Install the CMP sensor. Intake CMP shown, exhaust CMP similar.

Caution: Refer to *Fastener Caution* on page 0-5.

3. Install the CMP sensor bolt.

Tighten

Tighten the bolt to 10 N·m (89 lb in).

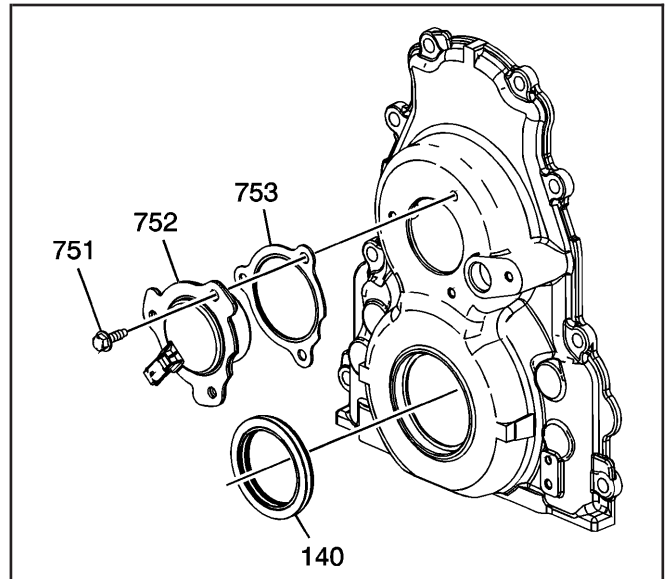


1639712

4. Connect the exhaust CMP sensor electrical connector (1).

Camshaft Position Actuator Magnet Replacement

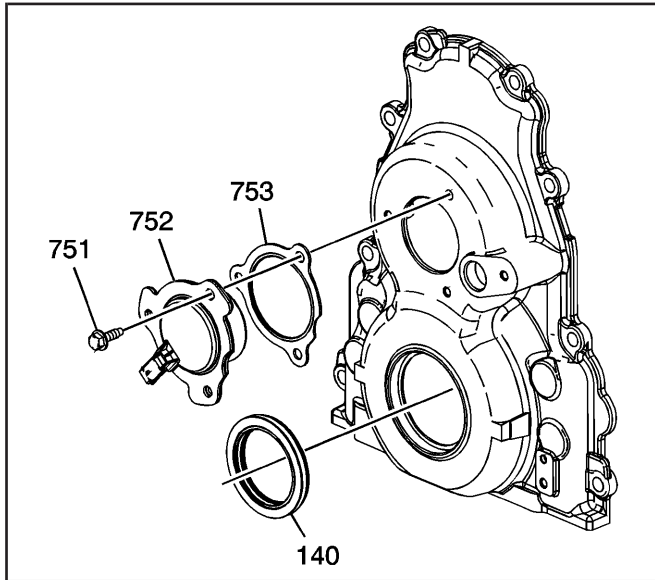
Removal Procedure



1658168

1. Remove the water pump.
2. Disconnect the engine harness electrical connector from the camshaft position (CMP) actuator magnet.
3. Remove the CMP actuator magnet bolts (751) and magnet (752).
4. Remove and discard the CMP actuator magnet gasket (753).

Installation Procedure



1658168

Note: The gasket surface should be free of oil or other foreign material during assembly.

1. Install a NEW CMP actuator magnet gasket (753) onto the CMP actuator magnet.
2. Install the CMP actuator magnet (752) to the front cover.

Caution: Refer to *Fastener Caution* on page 0-5.

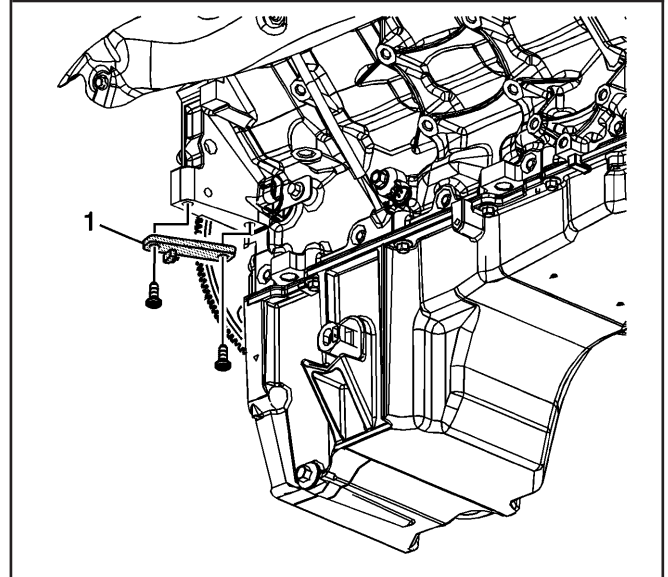
3. Install the CMP actuator magnet bolts (751) and tighten to **12 N·m (106 lb in)**.
4. Connect the engine harness electrical connector to the CMP actuator magnet.
5. Install the water pump.

Camshaft Position Actuator Solenoid Valve Replacement (6.0/6.2L)

Special Tools

- J 42386-A Flywheel Holding Tool
- J 45059 Angle Meter

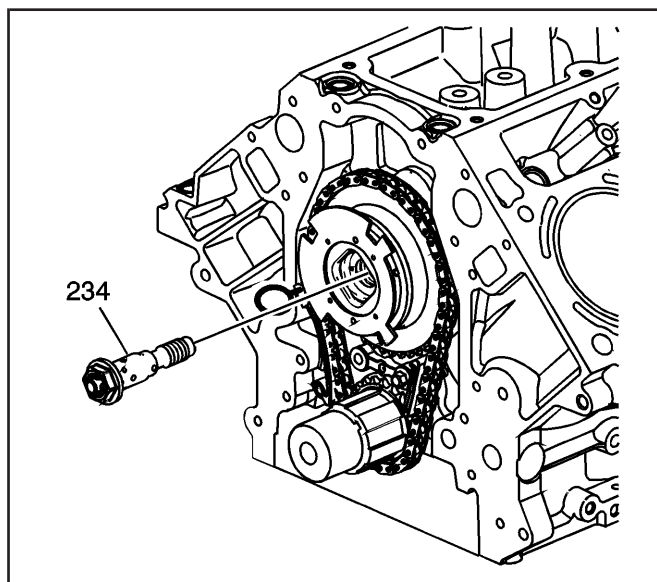
Removal Procedure



1658136

Caution: Refer to *Fastener Caution* on page 0-5.

1. Install the J 42386-A (1) and bolts. Use 1 M10 – 1.5 x 120 mm and 1 M10 – 1.5 x 45 mm bolt for proper tool operation. Tighten the J 42386-A bolts to **50 N·m (37 lb ft)**.
2. Remove the camshaft position (CMP) actuator magnet. Refer to *Camshaft Position Actuator Magnet Replacement* on page 9-271.

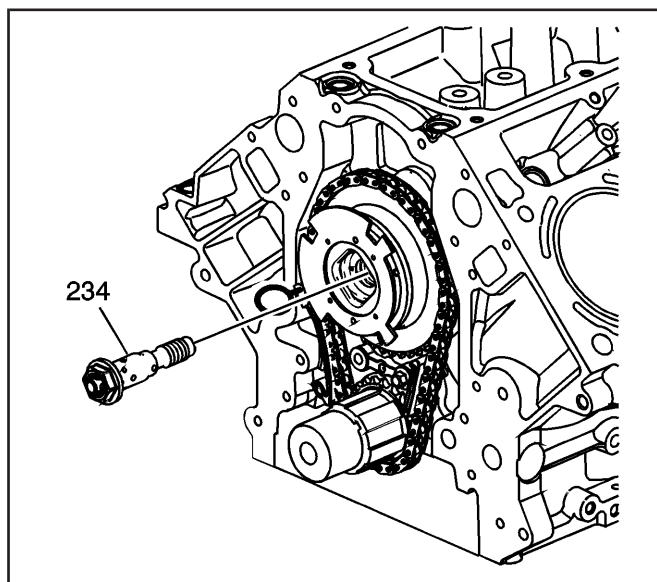


1670622

Warning: Refer to *Camshaft Position Actuator Removal and Installation Warning* on page 0-4.

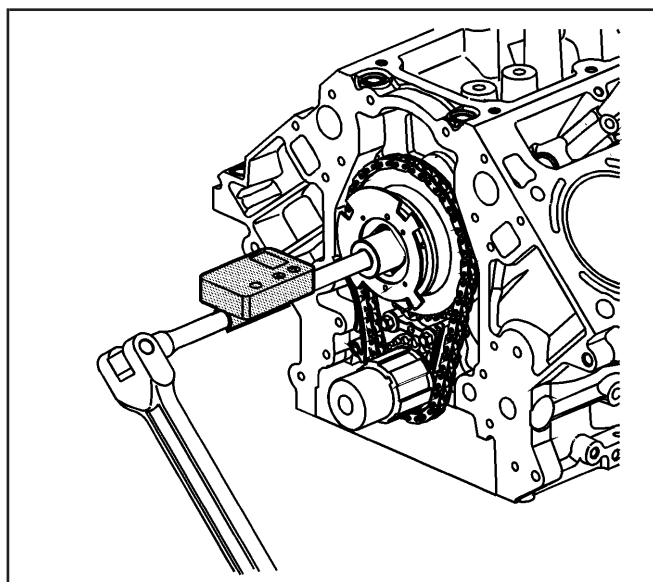
3. Remove the CMP actuator solenoid valve (234).
4. Discard the solenoid valve.

Installation Procedure



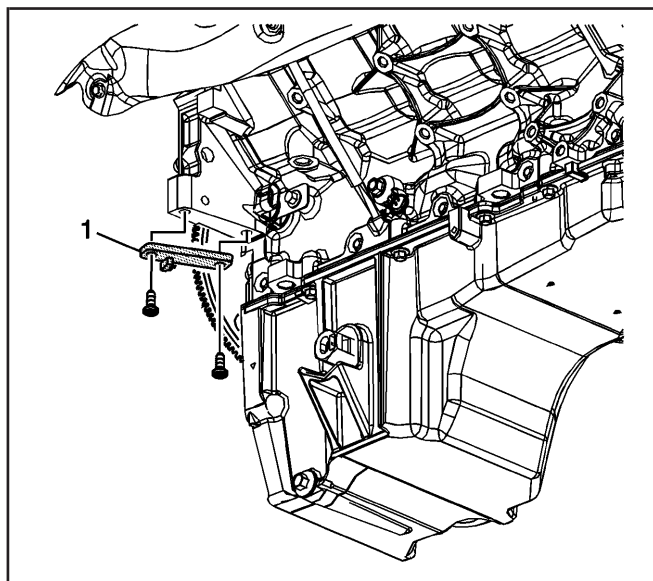
1670622

1. Install a NEW CMP actuator solenoid valve (234).
With the CMP actuator properly positioned onto the camshaft, the CMP actuator solenoid valve can be threaded completely into the camshaft using light hand pressure. Tighten by hand until snug.



1658245

2. Tighten the CMP actuator solenoid valve.
 - 2.1. Tighten the CMP actuator solenoid valve a first pass to **65 N·m (48 lb ft)**.
 - 2.2. Tighten the CMP actuator solenoid valve a final pass an additional 90 degrees using the *J 45059*.



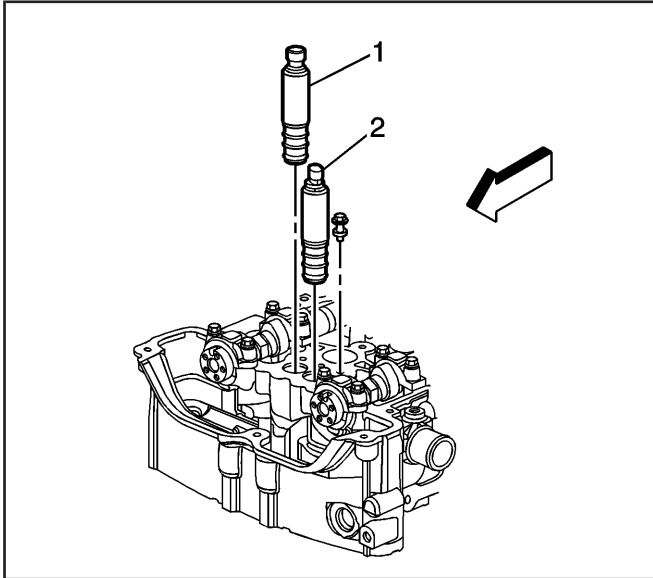
1658136

3. Remove the *J 42386-A* (1).
4. Install the CMP actuator magnet. Refer to *Camshaft Position Actuator Magnet Replacement* on page 9-271.

Camshaft Position Actuator Solenoid Valve Replacement (2.4L)

Removal Procedure

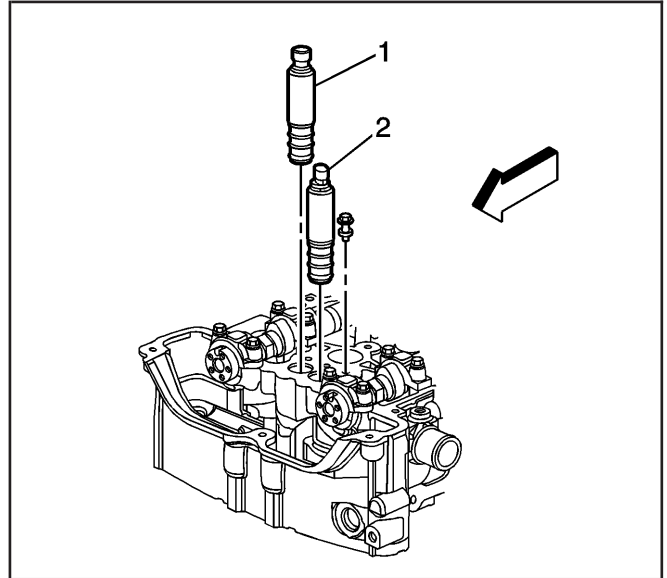
1. Disconnect the intake (3) or exhaust (2) camshaft position actuator solenoid valve electrical connector, as required.



1578482

2. Remove the exhaust (1) camshaft position (CMP) actuator solenoid valve bolt and valve, as required.
3. Remove the intake (2) CMP actuator solenoid valve bolt and valve, as required.
4. Inspect the solenoid valve O-ring seals from damage, replace as necessary.

Installation Procedure



1578482

1. Lubricate the solenoid valve O-ring seals with clean engine oil.

Caution: Refer to *Fastener Caution* on page 0-5.

2. Install the intake (2) CMP actuator solenoid valve and bolt, as required.

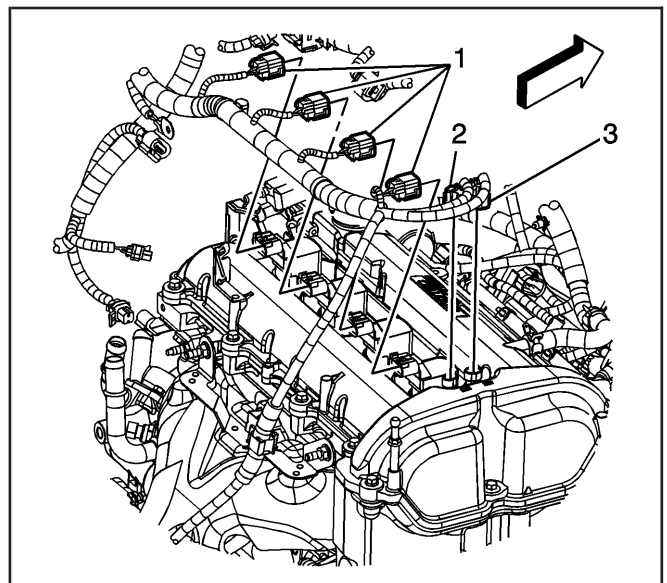
Tighten

Tighten the bolt to 10 N·m (89 lb in).

3. Install the exhaust (1) CMP actuator solenoid valve and bolt, as required.

Tighten

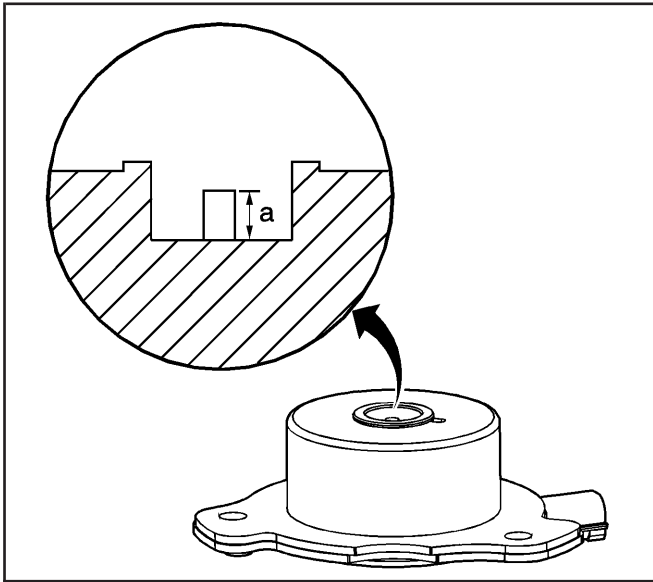
Tighten the bolt to 10 N·m (89 lb in).



1647538

4. Connect the intake (3) or exhaust (2) camshaft position actuator solenoid valve electrical connector, as required.

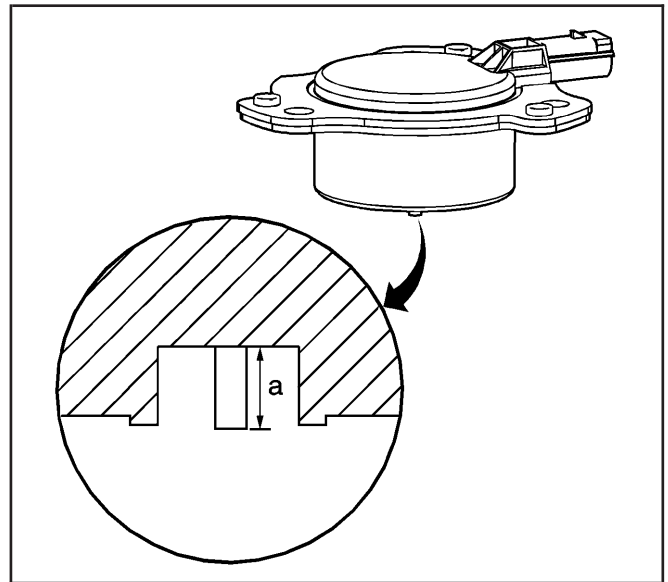
Camshaft Position Actuator Magnet Cleaning and Inspection



1721004

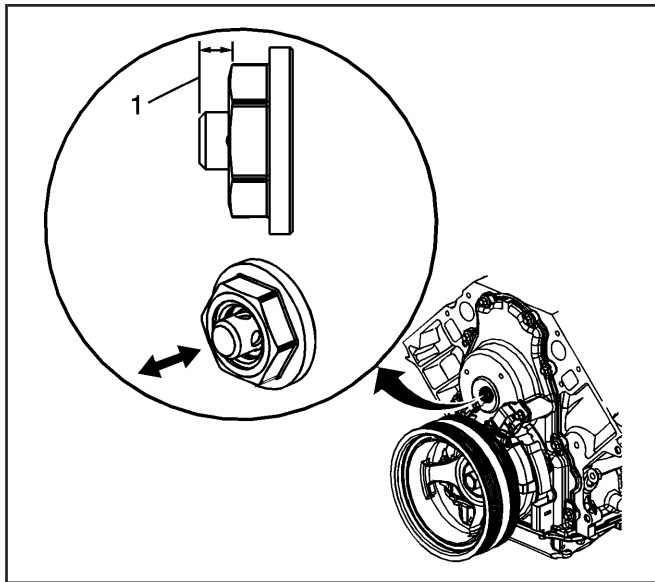
Note: Do not energize the camshaft position (CMP) magnet using a 12-volt power supply.

1. Inspect the CMP magnet for the following conditions:
 - A damaged electrical connector
 - An accumulation of dirt or debris in the recessed area around the pintle
 - A build-up of burnt engine oil on the shaft of the pintle which may cause the pintle to stick and not move freely within the proper range of travel
2. Holding the CMP magnet with the pintle facing upward, measure the pintle retracted position (a). Record the dimension.



1721006

3. Holding the CMP magnet with the pintle facing downward, measure the pintle extended position (a). Record the dimension.
4. Subtract the retracted dimension from the extended dimension to determine pintle travel. A properly moving pintle will travel 3.0–5.5 mm (0.12–0.22 in).
5. If the pintle of the CMP magnet is binding or does not move within the proper range of travel, replace the CMP magnet as an assembly.



1714950

Camshaft Position Actuator Solenoid Valve Inspection

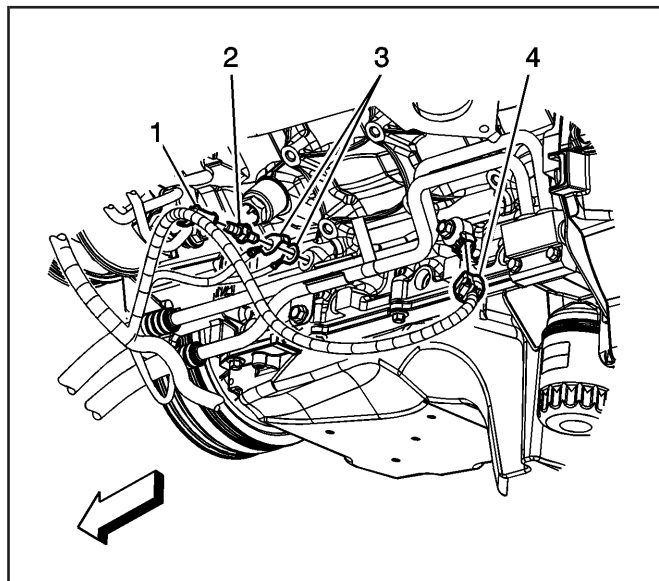
Note: Do not use the camshaft position (CMP) actuator solenoid valve again. Install a NEW valve during assembly. The inspection procedure below is provided for on-vehicle diagnostic purposes only.

1. With the CMP magnet removed, inspect for a sticking valve spool or broken valve spool spring.
2. Depress the valve spool into the housing. The valve should move freely with no binding or sticking and minimal resistance inward. When released, the valve spring should return the spool to the proper extended position (1) of 6.08–6.12 mm (0.239–0.241 in).

Knock Sensor Replacement (Except 2.4L)

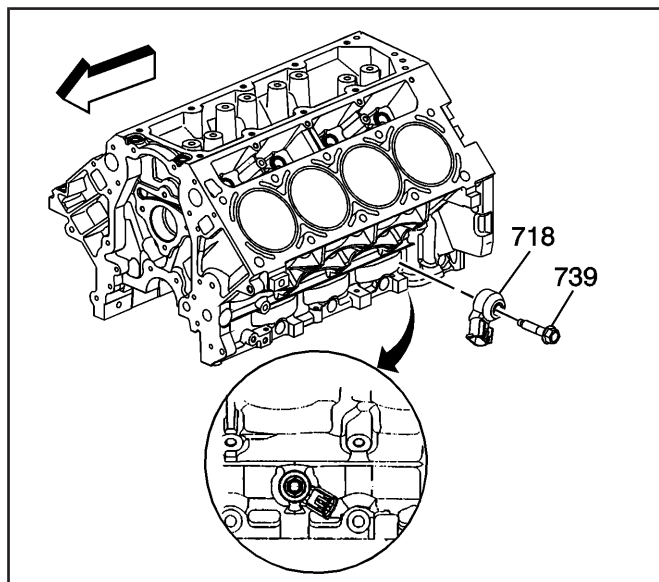
Removal Procedure

1. Disconnect the negative battery cable.



1699536

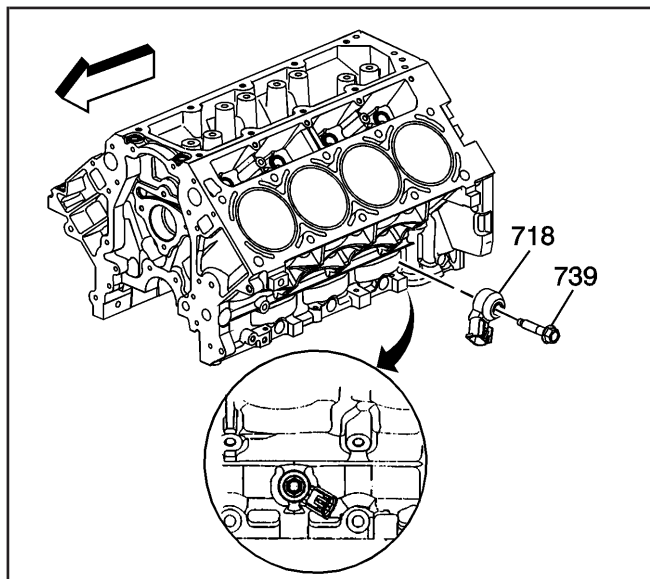
2. Disconnect the harness connector (4) at the knock sensor (KS).
3. Remove the mounting bolt (739) from the KS (718).



1402136

4. Remove the KS (718) from the engine block.

Installation Procedure



1402136

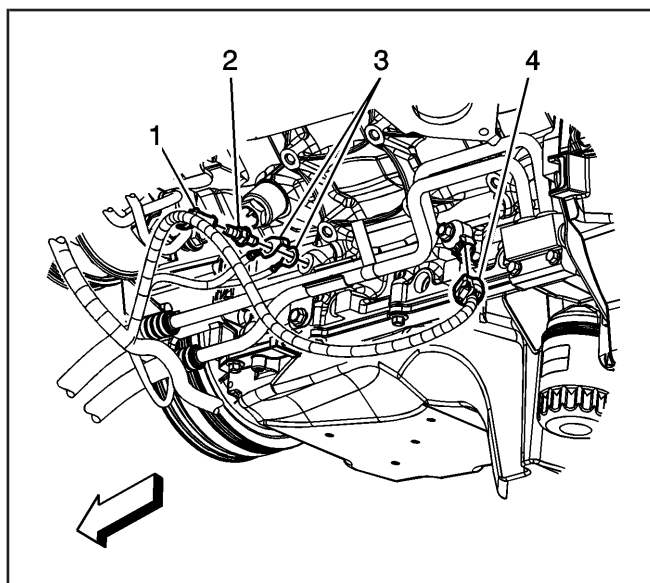
1. Position the KS (718) on the engine block.
2. Install the mounting bolt (739) for the KS.

Caution: Refer to *Fastener Caution* on page 0-5.

3. Tighten the KS mounting bolt.

Tighten

Tighten the KS mounting bolt to 25 N·m (18 lb ft).

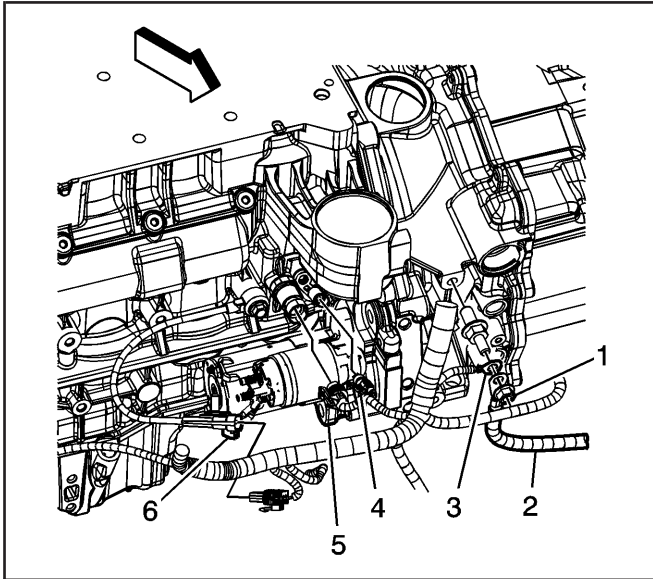


1699536

4. Reconnect the harness connector (4) at the KS.
5. Connect the negative battery cable.

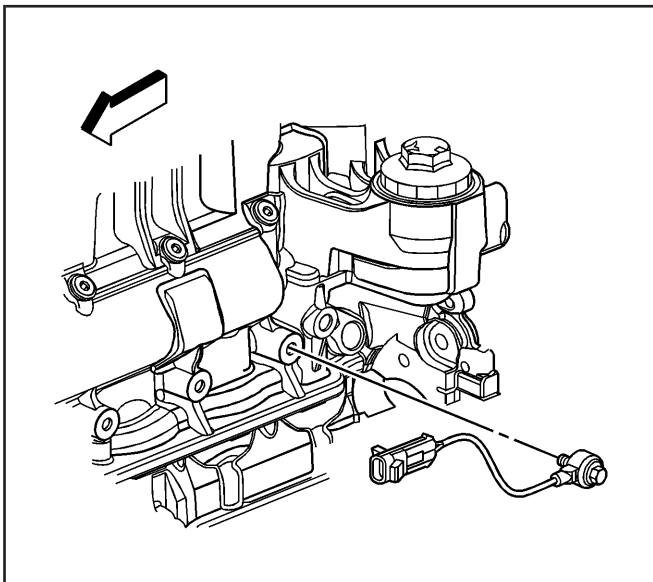
Knock Sensor Replacement (2.4L)

Removal Procedure



1622787

1. Disconnect the knock sensor (KS) electrical connector (6).

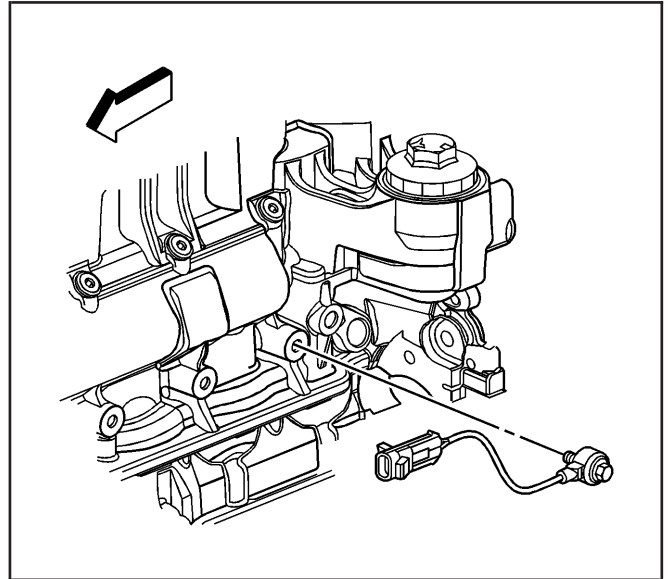


1578476

2. Remove the KS bolt.
3. Remove the KS.

Installation Procedure

Note: Rotate the pigtail 90 degrees from vertical before securing the fastener.



1578476

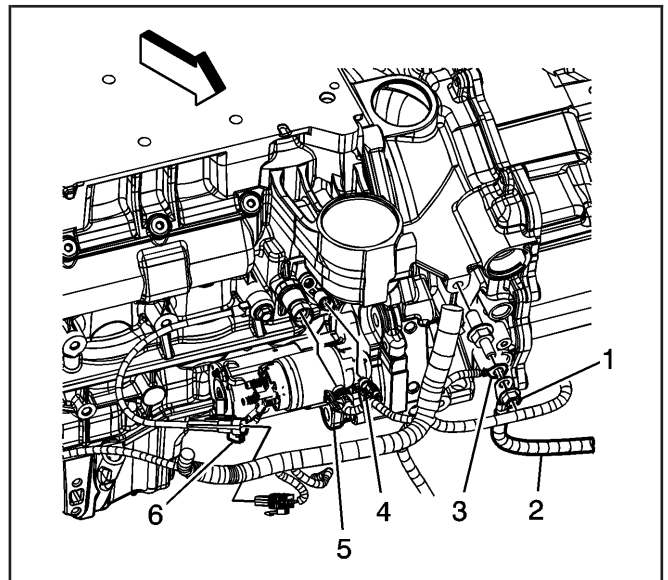
1. Install the KS.

Caution: Refer to *Fastener Caution* on page 0-5.

2. Install the KS bolt.

Tighten

Tighten the bolt to 25 N·m (18 lb ft).



1622787

3. Connect the KS electrical connector (6).

Description and Operation

Engine Control Module Description

The engine control module (ECM) interacts with many emission related components and systems. The ECM also monitors emission related components, and systems, for deterioration. The on-board diagnostics monitor the system performance and a suspect parameter number (SPN) sets if the system performance degrades.

The malfunction indicator lamp (MIL) operation and SPN storage are dictated by the SPN type. SPNs are ranked as a Type A, B, C, or E. Types A, B and E SPNs are emissions related. Type C SPNs are non-emissions related.

The ECM is the control center of the engine controls system. The ECM controls the following components:

- The fuel injection system
- The ignition system
- The emission control systems
- The on-board diagnostics
- The throttle control (TAC) system

The ECM constantly monitors the information from various sensors and other inputs, and controls the systems that affect the vehicle performance and emissions. The ECM also performs diagnostic tests on various parts of the system. The ECM can recognize operational problems and alert the driver via the MIL. When the ECM detects a malfunction, the ECM stores a SPN. The condition area is identified by the particular SPN that is set. This aids the technician in making repairs.

ECM Function

The engine control module (ECM) can supply 5 volts, 12 volts, or ground to various sensors or switches. Voltage is supplied through pull-up resistors to the regulated power supplies within the ECM. In some cases an ordinary shop voltmeter will not give an accurate reading due to low input resistance. A DMM with at least 10 megaohms input impedance is required in order to ensure accurate voltage readings.

The ECM controls the output circuits by controlling the ground or the power feed circuit through the transistors or a device called an output driver module.

EEPROM

The electronically erasable programmable read only memory (EEPROM) is a permanent memory that is physically part of the engine control module (ECM). The EEPROM contains program and calibration information that the ECM needs in order to control the powertrain operation.

Special equipment, as well as the correct program and calibration for the vehicle, are required in order to reprogram the ECM.

ECM Default Actions

When a malfunction occurs within the engine control system, the engine control module (ECM) maintains control of the system with Default Actions. Default Actions are calculated values, and/or calibrated default values, that are stored within the ECM. A certain level of engine performance is possible when a malfunction occurs dependant on the Default Actions taken. The ECM Default Actions prevent a complete loss of engine performance.

ECM Output Controls

The scan tool can control certain solenoids, valves, motors, and relays. The Output Controls can be found under the Special Functions selection of the scan tool. Some Output Controls may be disabled by the engine control module (ECM) during certain types of vehicle operation.

Data Link Connector (DLC)

The data link connector (DLC) provides the technician a means of accessing serial data for aid in diagnosis. This connector allows the technician to use a scan tool in order to monitor the various serial data parameters, and to display SPN information.

Malfunction Indicator Lamp (MIL)

The malfunction indicator lamp (MIL) is located on the instrument panel cluster (IPC). The MIL is controlled by the engine control module (ECM) and illuminates when the ECM detects a condition that affects the vehicle emissions.

ECM Service Precautions

The engine control module (ECM) is designed to withstand the normal current draws that are associated with vehicle operation. Care must be used in order to avoid overloading any circuits during testing. Do not ground, or apply voltage, to any ECM circuits unless a diagnostic procedure instructs you to do so. Circuits should only be tested with a DMM.

Throttle Actuator Control (TAC) System Description

Purpose

The throttle actuator control (TAC) system delivers improved throttle response and greater reliability and eliminates the need for mechanical cable. The TAC system performs the following functions:

- Pedal position sensing
- Throttle positioning to meet driver and engine demands
- Throttle position sensing
- Internal diagnostics
- Cruise control functions
- Manage TAC electrical power consumption

The TAC system includes the following components:

- The pedal position sensors
- The throttle body assembly
- The engine control module (ECM)

Pedal Position Sensor

The pedal position sensor contains 2 individual sensors within the assembly. The Pedal Position sensors 1 and 2 are potentiometer type sensors each with 3 circuits:

- A 5-volt reference circuit
- A low reference circuit
- A signal circuit

The pedal position sensors are used to determine the throttle angle. The engine control module (ECM) provides each pedal position sensor a 5-volt reference circuit and a low reference circuit. The pedal position sensors provide the ECM with signal voltage proportional to the throttle movement. The pedal position sensor 1 signal voltage at rest position is less than 1 volt and increases to above 4 volts as the pedal is actuated. The APP sensor 2 signal voltage at rest position is greater than 4 volts and decreases to less than 1 volt as the throttle is actuated.

Throttle Body Assembly

The throttle assembly contains the following components:

- The throttle blade
- The throttle actuator motor
- The throttle position (TP) sensor 1 and 2

The throttle body functions similar to a conventional throttle body with the following exceptions:

- An electric motor opens and closes the throttle valve.
- The throttle blade is spring loaded in both directions and the default position is slightly open.
- There are 2 individual TP sensors within the throttle body assembly.

The TP sensors are used to determine the throttle plate angle. The TP sensors provide the engine control module (ECM) with a signal voltage proportional to throttle plate movement. The TP sensor 1 signal voltage at closed throttle is approximately 1.5 volts and increases to greater than 4 volts as the throttle plate is opened. The TP sensor 2 signal voltage at closed throttle is approximately 3.5 volts and decreases to less than 1 volt as the throttle plate is opened.

Engine Control Module

The engine control module (ECM) is the control center for the throttle actuator control (TAC) system. The ECM determines the drivers intent and then calculates the appropriate throttle response. The ECM achieves throttle positioning by providing a pulse width modulated voltage to the TAC motor.

Modes of Operation

Normal Mode

During the operation of the throttle actuator control (TAC) system, several modes or functions are considered normal. The following modes may be entered during normal operation:

- Minimum pedal value—At key-up the engine control module (ECM) updates the learned minimum pedal value.
- Minimum throttle position (TP) values—At key-up the ECM updates the learned minimum TP value. In order to learn the minimum TP value, the throttle blade is moved to the closed position.
- Ice break mode—If the throttle is not able to reach a predetermined minimum throttle position, the ice break mode is entered. During the ice break mode, the ECM commands the maximum pulse width several times to the throttle actuator motor in the closing direction.
- Battery saver mode—After a predetermined time without engine RPM, the ECM commands the battery saver mode. During the battery saver mode, the TAC module removes the voltage from the motor control circuits, which removes the current draw used to maintain the idle position and allows the throttle to return to the spring loaded default position.

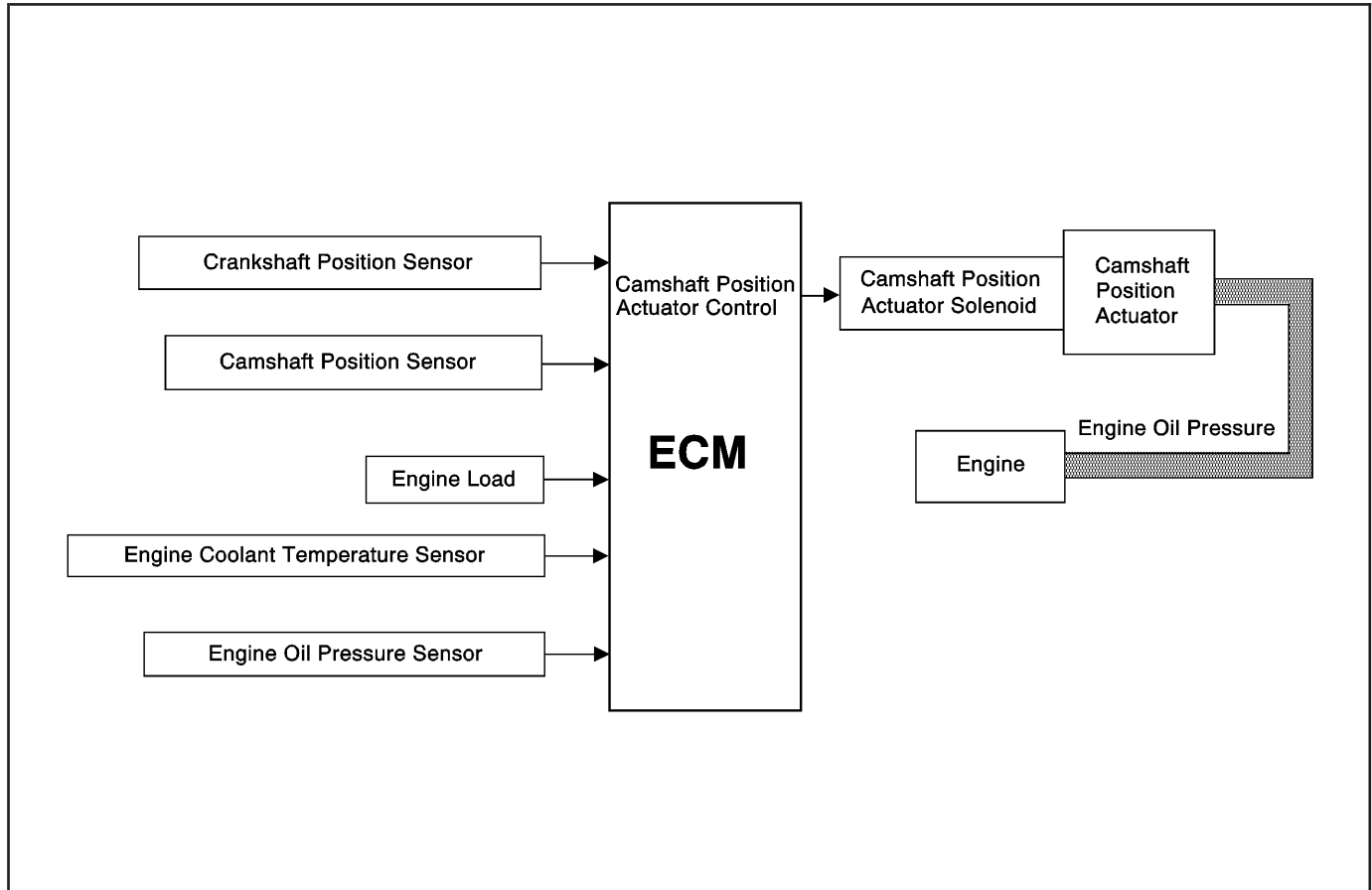
Reduced Engine Power Mode

When the ECM detects a condition with the TAC system, the ECM may enter a reduced engine power mode. Reduced engine power may cause one or more of the following conditions:

- Acceleration limiting—The ECM will continue to use the accelerator pedal for throttle control; however, the vehicle acceleration is limited.
- Limited throttle mode—The ECM will continue to use the accelerator pedal for throttle control; however, the maximum throttle opening is limited.
- Throttle default mode—The ECM will turn off the throttle actuator motor and the throttle will return to the spring loaded default position.
- Forced idle mode—The ECM will perform the following actions:
 - Limit engine speed to idle by positioning the throttle position, or by controlling the fuel and spark if the throttle is turned off.
 - Ignore the accelerator pedal input.
- Engine shutdown mode—The ECM will disable fuel and de-energize the throttle actuator.

Camshaft Actuator System Description

Camshaft Position (CMP) Actuator System



1916848

The camshaft position (CMP) actuator system is used for a variety of engine performance enhancements. These enhancements include lower emission output, a wider engine torque range, improved gas mileage, and improved engine idle stability. The park position for the CMP actuator and camshaft is 7 crankshaft degrees BTDC. The engine control module (ECM) can only command the CMP actuator to retard the valve timing from the park position or return the valve timing back to the park position. The total range of valve timing authority is 52 degrees of crankshaft rotation. The control range is from the park position of 7 degrees crankshaft BTDC, to 45 degrees crankshaft after top dead center (ATDC).

CMP Actuator System Operation

The camshaft position (CMP) actuator system is controlled by the engine control module (ECM). The ECM sends a pulse width modulated 12-volt signal to a CMP actuator solenoid in order to control the amount of engine oil flow to a camshaft actuator passage. There are 2 different passages for oil to flow through, a passage for cam advance and a passage for cam retard. The camshaft actuator is attached to the

front of the camshaft and is hydraulically operated in order to change the angle of the camshaft relative to crankshaft position (CKP). Incorrect engine oil pressure (EOP), viscosity, temperature, engine oil level, or aftermarket engine oil additives can have an adverse affect on camshaft phaser performance.

CMP Actuator Solenoid Circuit Diagnostics

The engine control module (ECM) monitors the control circuit of the camshaft position (CMP) actuator solenoid for electrical faults. The control module has the ability to determine if a control circuit is open, shorted high, or shorted low.

CMP Actuator System Performance Diagnostic

The engine control module (ECM) monitors the performance of the camshaft position (CMP) actuator system by monitoring the calibrated desired position and the actual position of the camshaft through the 4X signal of the CMP sensor.

Supercharger Description and Operation

Supercharger Description

The marine supercharger is a positive displacement pump that consists of 2 counter-rotating rotors, an inlet port and an outlet port, and an air bypass valve that is built into a housing. The rotors are designed with 3 lobes and a helical twist. An air bypass valve is built into the housing. The rotors in the supercharger are designed to run at a minimal clearance, not in contact with each other or the housing and are timed to each other by a pair of precision spur gears which are pressed onto the rotor shafts. The front ends of the rotors are held in position by deep-groove ball bearings, while the rear ends of the rotors are supported by sealed roller bearings.

The gears and ball bearings are lubricated by a synthetic oil. The oil reservoir is self-contained in the supercharger, isolated from the engine oil, sealed for the life of the unit and is not serviceable.

The cover on the supercharger contains the input shaft which is supported by 2 deep-groove ball bearings, and is coupled to the rotor drive gears. The pulley is pressed onto the input shaft and is not serviceable. The bearings are lubricated by the synthetic oil contained in the same reservoir.

Operation

The supercharger is designed to increase the air pressure and density in the intake manifold. When this air is mixed with the correct amount of fuel the result is more power from the engine. This excess air creates a boost pressure in the intake manifold. Because the supercharger is a positive displacement pump and is directly driven from the engine drive belt system, boost pressure is available at all driving conditions.

When boost is not required, such as during idle or light throttle cruising, the excess air is routed through the bypass passage between the intake manifold and the supercharger inlet. This bypass circuit is regulated by a bypass valve which is similar to a throttle plate. The bypass valve is controlled by a vacuum actuator which is connected to the vacuum signal between the throttle and the supercharger inlet. Spring force from the actuator holds the valve in a normally closed position to create boost, and vacuum pulls the valve open when the throttle closes to decrease boost.

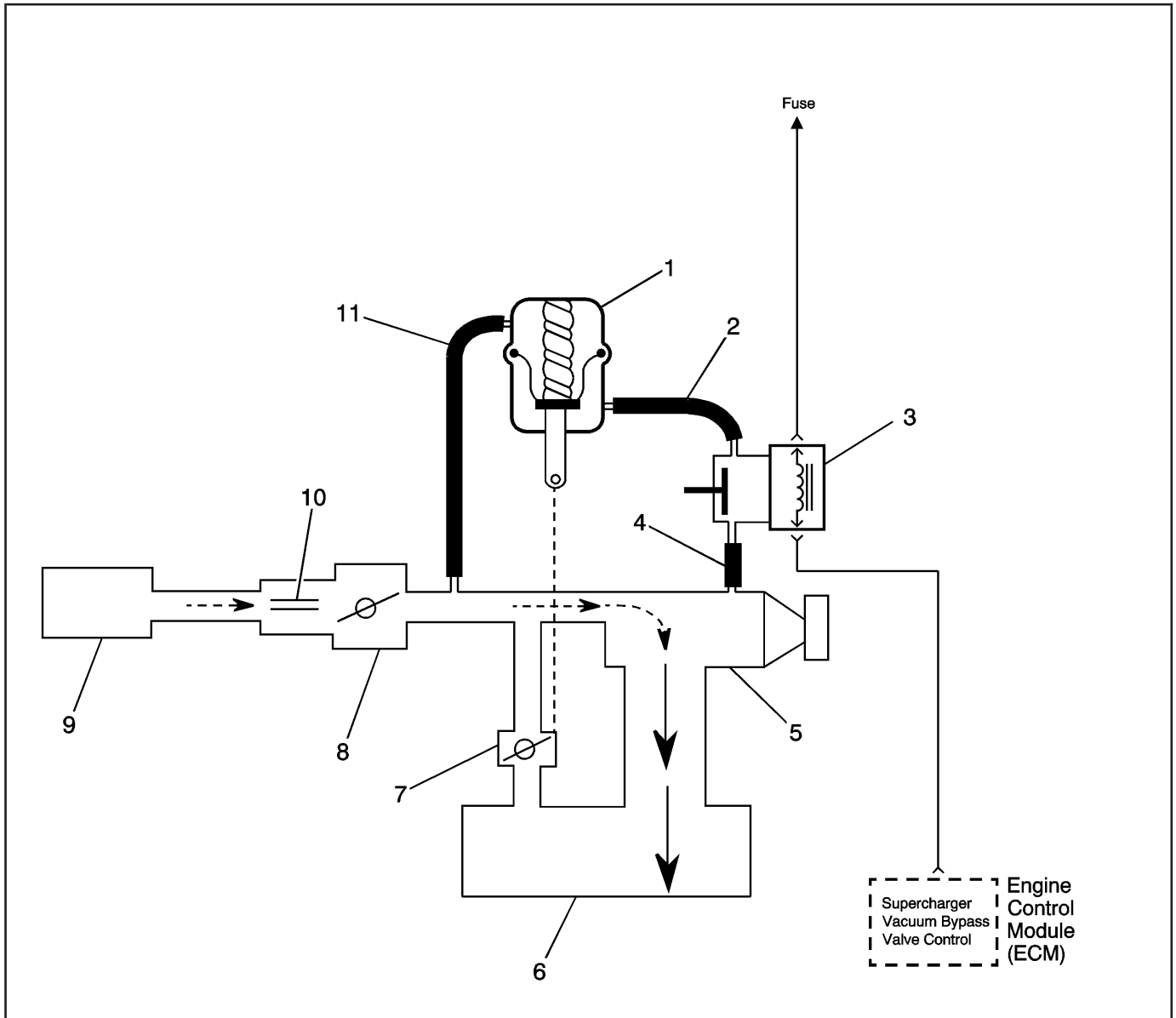
A solenoid valve is attached to the supercharger housing. This three-way valve, controlled by the engine control module (ECM), determines whether pressure from the manifold is routed to the bypass actuator or closed off. This valve allows pressure from the manifold to open the bypass valve and lower boost pressure during specific driving conditions. The open bypass valve reduces the pumping effort of the supercharger, thereby increasing the fuel efficiency in light load operations.

Intercooler

The supercharger has an intercooler. Cooling the supercharger boost air enhances the effectiveness of the supercharger. The intercooler uses conventional coolant in a separate sealed system from the engine cooling system. The intercooler system has a radiator, a back fill port at the rear of the supercharger, attaching hoses, and a coolant pump. The coolant pump is supplied power through the coolant pump relay. The coolant pump relay operation is controlled by the ECM. Ignition voltage is supplied to the coolant pump relay coil, and the coolant pump relay switch. The ECM controls the coolant pump relay with a low side driver. When the ECM commands the coolant pump relay ON, the relay contacts close, supplying power to the supercharger intercooler coolant pump.

Boost Control System Operation

Bypass Valve Closed



1671645

Legend

- | | |
|----------------------------|-------------------------------------|
| (1) By-pass Valve Actuator | (7) By-pass Valve (normally closed) |
| (2) Boost Signal | (8) Throttle Body |
| (3) Boost Control Solenoid | (9) Air Cleaner |
| (4) Boost Vacuum Source | (10) MAF Sensor |
| (5) Supercharger | (11) Inlet Vacuum Signal |
| (6) Intake Plenum | |

Operation

The ECM controls boost pressure by using the boost control solenoid. The boost control solenoid is normally an open valve. Under most conditions, the ECM commands the boost control solenoid to operate at a 99–100 percent duty cycle. This keeps the solenoid valve closed and allows only inlet vacuum to control the position of the bypass valve. At idle, engine vacuum is applied to the upper side of the bypass valve actuator, counteracting spring tension to hold the bypass valve open. As engine load is increased, engine vacuum is decreased, causing the spring in the bypass valve actuator to overcome the applied vacuum, closing the bypass valve and allowing the boost pressure to increase. When reduced boost pressure is desired, the ECM decreases the boost control solenoid duty cycle. This opens the solenoid valve and allows boost pressure to enter the bypass valve actuator at the lower side to counteract the spring tension, opening the bypass valve and re-circulating excess boost pressure back into the supercharger inlet.

Results of Incorrect Operation

The following conditions will result in reduced engine power, especially during a wide open throttle (WOT) operation:

- An open boost control solenoid control circuit.
- An open control solenoid ignition 1 voltage circuit.
- An open control solenoid control circuit.
- A boost control solenoid valve that is stuck open.

The following conditions will result in full boost to be commanded at all times. These conditions can also result in over-boost conditions during high engine load situations.

- A boost control solenoid control circuit shorted to ground.
- A boost control solenoid valve is stuck closed.
- A restriction in the boost source or signal vacuum hoses.
- A restriction in the exhaust system may cause an over-boost condition and reduced fuel economy.

A restriction in the vacuum signal hose to the bypass valve actuator or stuck closed bypass valve will cause a noisy idle and reduced fuel economy.

Fuel System Description

Fuel System Overview

Low Pressure Fuel Pump

The low pressure fuel pump supplies low pressure, high volume fuel flow to the high pressure fuel pump. The low pressure fuel pressure pump maintains a constant flow of fuel to the high pressure fuel pump in order to prevent long cranking times.

High Pressure Fuel Pump

The fuel pump supplies high pressure fuel through the fuel filter and the fuel feed pipe to the fuel injection system. The fuel pump provides fuel at a higher rate of flow than is needed by the fuel injection system. The fuel pressure regulator maintains the correct fuel pressure to the fuel injection system. The fuel pump and sender assembly contains a reverse flow check valve. The check valve and the fuel pressure regulator maintain fuel pressure in the fuel feed pipe and the fuel rail in order to prevent long cranking times.

Fuel Level Sensor

The fuel level sensor consists of a float, a wire float arm, and a ceramic resistor cord. The position of the float arm indicates the fuel level. The fuel level sensor contains a variable resistor, which changes resistance in correspondence to the amount of fuel in the fuel tank. The engine control module (ECM) sends the fuel level information via the class 2 circuit to the instrument panel (I/P) cluster. This information is used for the I/P fuel gauge and the low fuel warning indicator, if applicable. The ECM also monitors the fuel level input for various diagnostics.

Fuel Pump

The fuel pump is an electric high pressure pump. Fuel is pumped to the fuel rail at a specified flow and pressure. The fuel pump delivers a constant flow of fuel to the engine during low fuel conditions and aggressive vehicle maneuvers. The engine control module (ECM) controls the electric fuel pump operation through a fuel pump relay.

Fuel Filter

The fuel filter is contained in the fuel sender assembly inside the fuel tank. The paper filter element of the fuel filter traps particles in the fuel that may damage the fuel injection system. The fuel filter housing is made to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature.

Nylon Fuel Pipes

Warning: Refer to Fuel Pipe Fitting Warning on page 0-4.

Nylon pipes are constructed to withstand maximum fuel system pressure, exposure to fuel additives, and changes in temperature. There are 3 sizes of nylon pipes used: 9.5 mm (3/8 in) ID for the fuel supply, 7.6 mm (5/16 in) ID for the fuel return, and 12.7 mm (1/2 in) ID for the vent. Heat resistant rubber hose or corrugated plastic conduit protects the sections of the pipes that are exposed to chafing, to high temperatures, or to vibration.

Nylon fuel pipes are somewhat flexible and can be formed around gradual turns under the vehicle. However, if nylon fuel pipes are forced into sharp bends, the pipes kink and restrict the fuel flow. Also, once exposed to fuel, nylon pipes may become stiffer and are more likely to kink if bent too far. Take special care when working on a vehicle with nylon fuel pipes.

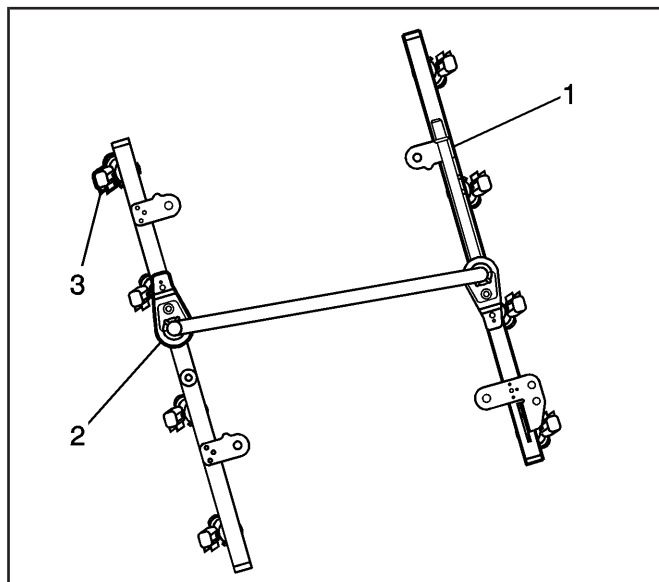
Quick-Connect Fittings

Quick-connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consist of a unique female connector and a compatible male pipe end. O-rings, located inside the female connector, provide the fuel seal. Integral locking tabs inside the female connector hold the fittings together.

Fuel Pipe O-Rings

O-rings seal the threaded connections in the fuel system. Fuel system O-ring seals are made of special material. Service the O-ring seals with the correct service part.

Fuel Rail Assembly



1542826

The fuel rail assembly attaches to the engine intake manifold. The fuel rail assembly performs the following functions:

- Positions the injectors (3) in the intake manifold
- Distributes fuel evenly to the injectors (2)
- Fuel rail feed pipe (1)

Fuel Injectors

The fuel injector assembly is a solenoid device controlled by the engine control module (ECM) that meters pressurized fuel to a single engine cylinder. The ECM energizes the injector solenoid to open a normally closed ball valve. This allows the fuel to flow into the top of the injector, past the ball valve, and through a director plate at the injector outlet. The director plate has machined holes that control the fuel flow, generating a spray of finely atomized fuel at

the injector tip. Fuel from the injector tip is directed at the intake valve, causing the fuel to become further atomized and vaporized before entering the combustion chamber. This fine atomization improves fuel economy and emissions.

Fuel Pressure Regulator

The type of fuel system, return or returnless, will vary depending on year, and engine. Returnless fuel systems are not regulated at the fuel rail. Fuel pressure regulation is controlled at the module outlet filter, therefore the type of fuel system can be determined by the number of fuel lines to the fuel rail.

The fuel pressure regulator controls the fuel pressure that is delivered to the fuel injectors.

Fuel Metering Modes of Operation

The engine control module (ECM) monitors voltages from several sensors in order to determine how much fuel to give the engine. The ECM controls the amount of fuel delivered to the engine by changing the fuel injector pulse width. The fuel is delivered under one of several modes.

Starting Mode

When the ignition is first turned ON, the ECM energizes the fuel pump relay for 2 seconds. This allows the fuel pump to build pressure in the fuel system. The ECM calculates the air/fuel ratio based on inputs from the engine coolant temperature (ECT), manifold absolute pressure (MAP), and throttle position (TP) sensors. The system stays in starting mode until the engine speed reaches a predetermined RPM.

Clear Flood Mode

If the engine floods, clear the engine by pressing the accelerator pedal down to the floor and then crank the engine. When the TP sensor is at wide open throttle (WOT), the ECM reduces the fuel injector pulse width in order to increase the air to fuel ratio. The ECM holds this injector rate as long as the throttle stays wide open and the engine speed is below a predetermined RPM. If the throttle is not held wide open, the ECM returns to the starting mode.

Run Mode without Heated Oxygen Sensors (HO2S)

On vehicles that are not equipped with heated oxygen sensors (HO2S) the run mode is called Open Loop. When the engine is first started and the engine speed is above a predetermined RPM, the system begins Open Loop operation. The ECM calculates the air/fuel ratio based on inputs from the ECT, MAP, and TP sensors.

Run Mode with Heated Oxygen Sensors (HO2S)

On vehicles that are equipped with heated oxygen sensors (HO2S) the run mode has 2 conditions called Open Loop and Closed Loop. When the engine is first started and the engine speed is above a predetermined RPM, the system begins Open Loop operation. The ECM ignores the signal from the heated oxygen sensors HO2S. The ECM calculates the air/fuel ratio based on inputs from the ECT, MAP, and TP sensors. The system stays in Open Loop until meeting the following conditions:

- Both front HO2S have varying voltage output, showing that both HO2S are hot enough to operate properly.
- The ECT sensor is above a specified temperature.
- A specific amount of time has elapsed after starting the engine.

Specific values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM). The system begins Closed Loop operation after reaching these values. In Closed Loop, the ECM calculates the air/fuel ratio, injector ON time, based upon the signal from various sensors, but mainly from the HO2S. This allows the air/fuel ratio to stay very close to 14.7:1.

Acceleration Mode

When the driver pushes on the accelerator pedal, air flow into the cylinders increases rapidly. To prevent possible hesitation, the ECM increases the pulse width to the injectors to provide extra fuel during acceleration. This is also known as power enrichment. The ECM determines the amount of fuel required based upon the TP, the ECT, the MAP, and the engine speed.

Deceleration Mode

When the driver releases the throttle, air flow into the engine is reduced. The ECM monitors the corresponding changes in the TP, and the MAP. The ECM shuts OFF fuel completely if the deceleration is very rapid. The fuel shuts OFF in order to prevent damage to the catalytic converters.

Battery Voltage Correction Mode

When the battery voltage is low, the ECM compensates for the weak spark delivered by the ignition system in the following ways:

- Increasing the amount of fuel delivered
- Increasing the idle RPM
- Increasing the ignition dwell time

Fuel Cutoff Mode

The ECM cuts OFF fuel from the fuel injectors when the following conditions are met in order to protect the powertrain from damage and improve driveability:

- The ignition is OFF. This prevents engine run-on.
- The ignition is ON but there is no ignition reference signal. This prevents flooding or backfiring.
- The engine speed is too high, above red line.
- During rapid deceleration, in order to prevent damage to the catalytic converters

Fuel Trim

The engine control module (ECM) controls the air/fuel metering system in order to provide the best possible combination of driveability, fuel economy, and emission control. The ECM monitors the heated oxygen sensor (HO2S) signal voltage while in Closed Loop and regulates the fuel delivery by adjusting the pulse width of the fuel injectors based on this signal. The ideal fuel trim values are around 0 percent for both short term and long term fuel trim. A positive fuel trim value indicates the ECM is adding fuel in order to compensate for a lean condition by increasing the pulse width. A negative fuel trim value indicates that the ECM is reducing the amount of fuel in order to compensate for a rich condition by decreasing the pulse width. A change made to the fuel delivery changes the short term and long term fuel trim values. The short term fuel trim values change rapidly in response to the HO2S signal voltage. These changes fine tune the engine fueling. The long term fuel trim makes coarse adjustments to the fueling in order to re-center and restore control to short term fuel trim. A scan tool can be used to monitor the short term and long term fuel trim values. The long term fuel trim diagnostic is based on an average of several of the long term speed load learn cells. The ECM selects the cells based on the engine speed and engine load. If the ECM detects an excessive lean or rich condition, the ECM will set a fuel trim diagnostic trouble code (DTC).

Electronic Ignition System Description

Electronic Ignition (EI) System Operation

The electronic ignition (EI) system produces and controls the high energy secondary spark. This spark ignites the compressed air/fuel mixture at precisely the correct time, providing optimal performance, fuel economy, and control of exhaust emissions. The engine control module (ECM) primarily collects information from the crankshaft position (CKP) and camshaft position (CMP) sensors to control the sequence, dwell, and timing of the spark.

Crankshaft Position (CKP) Sensor

The crankshaft position (CKP) sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of the reluctor wheel on the crankshaft. The CKP sensor produces an ON/OFF DC voltage of varying frequency. The CKP sensor sends a digital signal to the ECM as each tooth on the reluctor wheel rotates past the CKP sensor. The ECM uses each CKP signal pulse to determine crankshaft speed and position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses CKP sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

Camshaft Position (CMP) Sensor

The sensor detects magnetic flux changes between the four narrow and wide tooth slots on the reluctor wheel. The CMP sensor provides a digital ON/OFF DC voltage of varying frequency per each camshaft revolution. The ECM will recognize the narrow and wide tooth patterns to identify camshaft position, or which cylinder is in compression and which is in exhaust. The information is then used to determine the correct time and sequence for fuel injection and ignition spark events. The CMP sensor information is used by the ECM to determine the position of the valve train relative to the crankshaft.

Knock Sensor (KS)

The knock sensor (KS) system enables the control module to control the ignition timing for the best possible performance while protecting the engine from potentially damaging levels of detonation, also known as spark knock. The KS system uses one or 2 flat response 2-wire sensors. The sensor uses piezo-electric crystal technology that produces an AC voltage signal of varying amplitude and frequency based on the engine vibration or noise level.

The amplitude and frequency are dependant upon the level of knock that the KS detects. The control module receives the KS signal through the signal circuit. The KS ground is supplied by the control module through the low reference circuit.

The control module learns a minimum noise level, or background noise, at idle from the KS and uses calibrated values for the rest of the RPM range.

The control module uses the minimum noise level to calculate a noise channel. A normal KS signal will ride within the noise channel. As engine speed and load change, the noise channel upper and lower parameters will change to accommodate the normal KS signal, keeping the signal within the channel. In order to determine which cylinders are knocking, the control module only uses KS signal information when each cylinder is near top dead center (TDC) of the firing stroke. If knock is present, the signal will range outside of the noise channel.

If the control module has determined that knock is present, it will retard the ignition timing to attempt to eliminate the knock. The control module will always try to work back to a zero compensation level, or no spark retard. An abnormal KS signal will stay outside of the noise channel or will not be present. KS diagnostics are calibrated to detect faults with the KS circuitry inside the control module, the KS wiring, or the KS voltage output. Some diagnostics are also calibrated to detect constant noise from an outside influence such as a loose/damaged component or excessive engine mechanical noise.

Ignition Coils

Each ignition coil has an ignition 1 voltage feed and a ground circuit. The engine control module (ECM) supplies a low reference and an ignition control (IC) circuit. Each ignition coil contains a solid state driver module. The ECM will command the IC circuit ON, which allows the current to flow through the primary coil windings. When the ECM commands the IC circuit OFF, this will interrupt current flow through the primary coil windings. The magnetic field created by the primary coil windings will collapse across the secondary coil windings, which induces a high voltage across the spark plug electrodes.

Distributor Ignition (DI) System Description

The distributor ignition (DI) system is responsible for producing and controlling a high energy secondary spark. This spark is used to ignite the compressed air/fuel mixture at precisely the correct time. This provides optimal performance, fuel economy, and control of exhaust emissions. This ignition system consists of a single ignition coil and ignition control module (ICM). Spark energy is delivered via a distributor cap, rotor, and secondary spark plug wires. The driver module within the ICM is commanded to operate the coil by the engine control module (ECM), that has complete control over spark timing. The DI system consists of the following components:

Crankshaft Position (CKP) Sensor

The crankshaft position (CKP) sensor is an internally magnetic biased digital output integrated circuit sensing device. The sensor detects magnetic flux changes of the teeth and slots of the reluctor wheel on the crankshaft. The CKP sensor produces an ON/OFF DC voltage of varying frequency. The CKP sensor sends a digital signal to the ECM as each tooth on the reluctor wheel rotates past the CKP sensor. The ECM uses each CKP signal pulse to determine crankshaft speed and position. This information is then used to determine the optimum ignition and injection points of the engine. The ECM also uses CKP sensor output information to determine the camshaft relative position to the crankshaft, to control camshaft phasing, and to detect cylinder misfire.

Camshaft Position (CMP) Sensor

The sensor detects magnetic flux changes between the four narrow and wide tooth slots on the reluctor wheel. The CMP sensor provides a digital ON/OFF DC voltage of varying frequency per each camshaft revolution. The ECM will recognize the narrow and wide tooth patterns to identify camshaft position, or which cylinder is in compression and which is in exhaust. The information is then used to determine the correct time and sequence for fuel injection and ignition spark events. The CMP sensor information is used by the ECM to determine the position of the valve train relative to the crankshaft.

Ignition Coil and ICM

The ICM is connected to the ECM by an ignition control (IC) circuit. The ICM also has a ground circuit and shares an ignition 1 voltage supply with the ignition coil. The coil driver in the ICM controls current through the ignition coil based on signal pulses from the ECM. There is no back-up or by-pass function in the ICM.

Secondary Ignition Components

High Voltage Switch/Distributor

The high voltage switch (HVS) or distributor contains the Camshaft Position (CMP Sensor), cap, rotor and shaft. The HVS is splined by a helical gear to the camshaft and rotates providing a spark to each spark plug wire. When servicing the HVS, it is critical to ensure proper cap sealing to the Distributor body and correct installation to the camshaft. If the HVS is installed a tooth off in relation to the camshaft, a DTC may set, or a misfire will occur.

Ignition Wires

The spark plug wires are a carbon-impregnated cord conductor encased in a silicone rubber jacket. Silicone wiring will withstand very high temperature and is an excellent insulator for the higher voltages. The silicone spark plug boots provide a tight seal on the spark plug.

Engine Control Module (ECM)

The ECM controls all ignition system functions, and constantly corrects the basic spark timing. The ECM monitors information from various sensor inputs that include the following:

- The throttle position (TP) sensor
- The engine coolant temperature (ECT) sensor
- The manifold air temperature (MAT) sensor
- The vehicle speed sensor (VSS)
- The transmission gear position or range information sensors
- The engine knock sensors (KS)

Modes of Operation

There is one normal mode of operation, with the spark under ECM control. If the CKP pulses are lost the engine will not run. The loss of a CMP signal may result in a longer crank time since the ECM cannot determine which stroke the pistons are on. Diagnostic trouble codes are available to accurately diagnose the ignition system with a scan tool.

Special Tools and Equipment

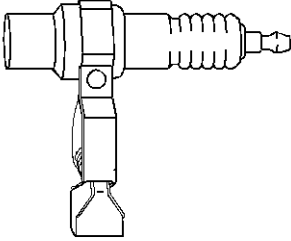
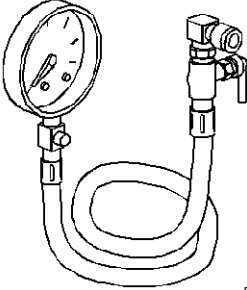
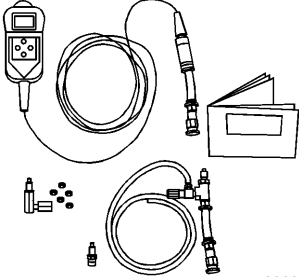
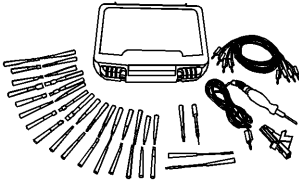
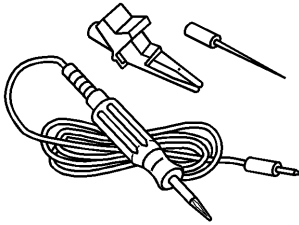
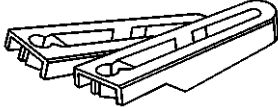
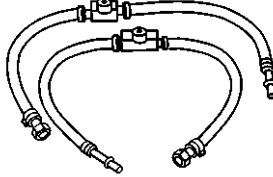
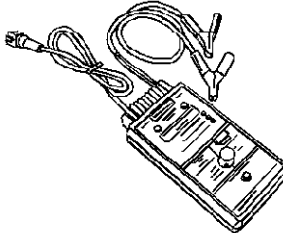
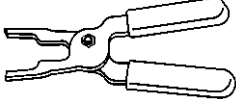
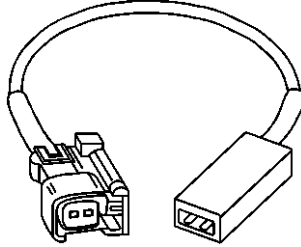
Illustration	Tool Number/Description
 5381	J 26792 HEI Spark Tester
 5389	J 34730-1A Fuel Pressure Gauge
 1738990	CH 48027-5 Digital Pressure Gauge
 8917	J 35616 GM-Approved Terminal Test Kit
 1338380	J 35616-200 Test Light – Probe Kit

Illustration	Tool Number/Description
 13542	J 37088-A Fuel Line Disconnect Tool Set
 13541	J 37287 Fuel Line Shut Off Adapters
 5380	J 39021 Fuel Injector Coil/Balance Tester
 696431	J 43244 Relay Puller Pliers
 649345	J 44602 Injector Test Adapter

9-290 Engine Controls and Fuel - Marine

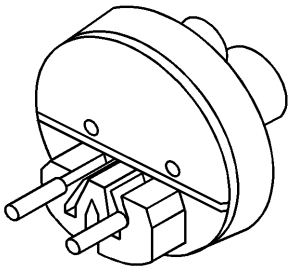
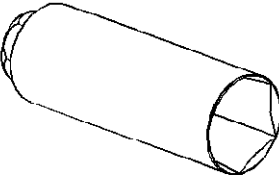
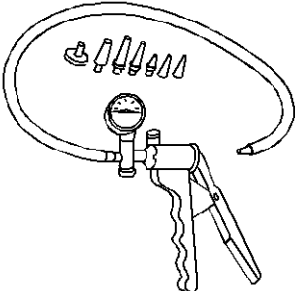
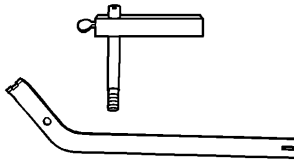
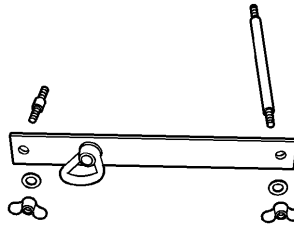
Illustration	Tool Number/Description
 1161158	J 44603 Injector Test Lamp
 67136	J 41712 Oil Pressure Switch Socket
 5386	J 23738-A Mityvac Vacuum Pump

Illustration	Tool Number/Description
 1651410	EN-47814 Supercharger Bypass valve Actuator Setting Tool
 1651407	EN-47748 Supercharger Lifting Fixture

Section 11

Power and Signal Distribution

Data Communications	11-3	Testing for Intermittent Conditions and	
Diagnostic Information and Procedures	11-3	Poor Connections	11-13
Scan Tool Does Not Power Up	11-3	Inducing Intermittent Fault Conditions	11-14
Scan Tool Does Not Communicate with		Testing for Electrical Intermittents	11-15
CAN Device	11-4	Circuit Protection - Fuses	11-15
Description and Operation	11-5	Circuit Protection - Circuit Breakers	11-16
Data Link Communications Description		Circuit Protection - Fusible Links	11-16
and Operation	11-5	Wiring Repairs	11-16
Wiring Systems	11-6	Flat Wire Repairs	11-17
Diagnostic Information and Procedures	11-6	Heated Oxygen Sensor Wiring Repairs	11-17
General Electrical Diagnosis	11-6	Splicing Copper Wire Using Splice	
Checking Aftermarket Accessories	11-6	Clips	11-17
Circuit Testing	11-6	Splicing Copper Wire Using Splice	
Using Connector Test Adapters	11-6	Sleeves	11-21
Probing Electrical Connectors	11-6	Splicing Twisted or Shielded Cable	11-22
Troubleshooting with a Digital		Connector Repairs	11-22
Multimeter	11-8	Connector Position Assurance Locks	11-24
Troubleshooting with a Test Lamp	11-10	Terminal Position Assurance Locks	11-24
Using Fused Jumper Wires	11-10	Push to Seat Connectors	11-25
Measuring Voltage	11-10	Pull to Seat Connectors	11-26
Measuring Voltage Drop	11-11	Weather Pack Connectors	11-26
Measuring Frequency	11-11	Repairing Connector Terminals	11-27
Testing for Continuity	11-12	Repair Instructions	11-28
Testing for Short to Ground	11-12	Relay Replacement (Fuse Block)	11-28
Testing for a Short to Voltage	11-13	Relay Replacement (Harness)	11-29
		Special Tools and Equipment	11-30

BLANK

Data Communications

Diagnostic Information and Procedures

Scan Tool Does Not Power Up

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provide an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Positive Voltage (DLC)	1	1	—	—
Ground (DLC)	—	1	—	—
1. Scan Tool Does Not Power Up				

Circuit/System Description

The data link connector (DLC) is a 6 cavity connector. The connector provides the following:

- Scan tool power battery positive voltage at terminal A
- Scan tool power ground at terminal B
- Controller area network (CAN) HI communication circuit at terminal C
- CAN LO communication circuit at terminal D

Diagnostic Aids

- The scan tool will power up with the ignition OFF. The ECM will not communicate unless the ignition is ON.
- If the battery positive voltage, ground circuits and connections of the DLC are functioning properly, the malfunction must be due to the scan tool.

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Description and Operation

Data Link Communications Description and Operation on page 11-5

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Ignition ON, connect a scan tool to the diagnostic connector. The scan tool should power up.

Circuit/System Testing

1. Test for less than 2 ohms between the DLC ground circuit terminal B and ground.
 - ⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
2. Ignition ON, verify a test lamp illuminates between the DLC battery voltage circuit terminal A and ground.
 - ⇒ If the test lamp does not illuminate, repair the voltage supply circuit for a short to ground or an open/high resistance.
3. If all circuits test normal, refer to the scan tool user guide.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the repair.

Scan Tool Does Not Communicate with CAN Device

Diagnostic Instructions

- Perform the *Powertrain On Board Diagnostic (OBD) System Check* on page 9-64 prior to using this diagnostic procedure.
- Review *Strategy Based Diagnosis* on page 6-4 for an overview of the diagnostic approach.
- *Diagnostic Procedure Instructions* on page 6-5 provides an overview of each diagnostic category.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CAN HI Circuit	1	1	—	—
CAN LO Circuit	1	1	—	—
1. Scan Tool Does Communicate				

Circuit/System Description

The controller area network (CAN) HI and CAN LO circuits transmit information between the engine control module (ECM) and the scan tool. Some vehicles are equipped with multiple engines that require a control module for each engine. Information is transmitted between each ECM via the CAN communication circuits.

The data link connector (DLC) is a 6 cavity connector. The connector provides the following:

- Scan tool power battery positive voltage at terminal A
- Scan tool power ground at terminal B
- Controller area network (CAN) HI communication circuit at terminal C
- CAN LO communication circuit at terminal D

Diagnostic Aids

- The scan tool will power up with the ignition OFF.
- The ECM will not communicate unless the ignition is ON.
- It may be necessary to disconnect each module connected to the CAN communication circuits in order to isolate the condition.
- On vehicles equipped with multiple engine/controllers, the scan tool can only communicate with one ECM at a time. Attempt to establish communication with each ECM. Communication with only one ECM can be caused by the following:
 - An open CAN communication circuit between the splice and the ECM
 - An ECM that is not powered up. Test the B+, ignition feed, and ground circuits for an open or short to ground

Reference Information

Schematic Reference

Engine Controls Schematics on page 9-6

Connector End View Reference

- *Engine Control Module Connector End Views* on page 9-30
- *Engine Controls Connector End Views* on page 9-33

Description and Operation

Data Link Communications Description and Operation on page 11-5

Electrical Information Reference

- *Circuit Testing* on page 11-6
- *Connector Repairs* on page 11-22
- *Testing for Intermittent Conditions and Poor Connections* on page 11-13
- *Wiring Repairs* on page 11-16

Scan Tool Reference

Engine Control Module Scan Tool Information on page 9-54

Circuit/System Verification

Note: If the vehicle is equipped with multiple engines, the scan tool can only communicate with one ECM at a time. Attempt to establish communication with each ECM. The scan tool should display ECM information for each engine.

Ignition ON, attempt to establish communication with the ECM. The scan tool should display ECM information.

Circuit/System Testing

1. Ignition OFF, test for less than 2 ohms between the DLC ground circuit terminal B and ground.
 - ⇒ If greater than the specified range, repair the ground circuit for an open/high resistance.
2. Ignition ON, verify a test lamp illuminates between the DLC battery voltage circuit terminal A and ground.
 - ⇒ If the test lamp does not illuminate, repair the voltage supply circuit for a short to ground or an open/high resistance.
3. Attempt to start the engine. The engine should start and idle.
 - ⇒ If the engine does not start and idle perform the following:
 - 3.1. Ignition OFF, disconnect the ECM harness connectors.
 - 3.2. Ignition ON, verify that B+ is available at the ECM ignition voltage circuit terminal X1–19.
 - ⇒ If less than the specified range, refer to *Run/Crank Relay Diagnosis* on page 9-203 for further diagnosis.
 - 3.3. Test for B+ at the ECM Battery voltage circuit terminal X1–20.
 - ⇒ If less than the specified range, repair the circuit for a short to ground, or an open/high resistance.
 - 3.4. Test for less than 5 ohms between the ground circuit terminal X2–73 and ground.
 - ⇒ If greater than the specified range, repair the circuit for an open/high resistance.
 - 3.5. If all circuits test normal, replace the ECM.
4. Ignition OFF, verify a test lamp does not illuminate between the following data link connector CAN circuit terminals and B+.
 - CAN HI Terminal C
 - CAN LO Terminal D
 - ⇒ If the test lamp illuminates, disconnect each module connected to the CAN circuit one at a time while observing the test lamp. If the test lamp does not illuminate when a module is disconnected replace the module. If the test lamp remains illuminated, repair the appropriate circuit for a short to ground.
5. Ignition ON, test for 2–7 volts between the following data link connector CAN circuit terminals and ground.
 - CAN HI Terminal C
 - CAN LO Terminal D
 - ⇒ If less than the specified range, repair the appropriate circuit for an open. If the circuit tests normal replace the ECM.
 - ⇒ If greater than the specified range, test the appropriate circuit for a short to voltage. If the circuit tests normal replace the ECM.
6. If all circuits test normal, refer to the scan tool user guide.

Repair Instructions

Perform the *Diagnostic Repair Verification* on page 6-22 after completing the repair.

Engine Control Module Programming and Setup on page 6-3 for engine control module replacement, setup, and programming

Description and Operation

Data Link Communications Description and Operation

The communication among control modules and scan tool is performed through the Controller area network (CAN) high speed serial data circuit.

The data link connector (DLC) is a 6 cavity connector. The connector provides the following:

- Scan tool power battery positive voltage at terminal A
- Scan tool power ground at terminal B
- CAN HI communication circuit at terminal C
- CAN LO communication circuit at terminal D

The serial data is transmitted on two twisted wires. The twisted pair is terminated with a 120 ohms resistor. The resistor is located in the engine control module (ECM). The resistor is used to reduce noise on the High Speed CAN bus during normal vehicle operation. The high speed CAN is a differential bus. The high speed CAN serial data bus (+) and high speed CAN serial data (-) are driven to opposite extremes from a rest or idle level. The idle level, which is approximately 2.5 volts, is considered recessive transmitted data and is interpreted as a logic 1. Driving the lines to their extremes, adds one volt to the high speed CAN serial data bus (+) and subtracts one volt from the high speed CAN serial data bus (-) wire. This state is interpreted as a logic 0.

Wiring Systems

Diagnostic Information and Procedures

General Electrical Diagnosis

Basic Knowledge Required

Without a basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in the service manual. You should understand the basic theory of electricity, and know the meaning of potential (voltage), current (amperes), and resistance (ohms). You should also be able to read and understand a wiring diagram, as well as understand what happens in a circuit with an open or a shorted wire.

Checking Aftermarket Accessories

Inspect for aftermarket accessories (non-OEM) as the first step in diagnosing electrical concerns. Inquire with the customer if the condition occurs when an accessory is in use.

Possible causes of vehicle conditions related to aftermarket accessories include:

- Power and ground circuits connected to terminals other than the battery
- Accessory wiring spliced into the ECM wiring harness
- Antenna location
- Transceiver wiring located too close to control modules or wiring
- Poor shielding or poor connectors on antenna cable

Circuit Testing

The Circuit Testing section contains the following diagnostic testing information. Using this information along with the diagnostic procedures will identify the cause of the electrical malfunction.

- *Using Connector Test Adapters on page 11-6*
- *Probing Electrical Connectors on page 11-6*
- *Troubleshooting with a Digital Multimeter on page 11-8*
- *Troubleshooting with a Test Lamp on page 11-10*
- *Using Fused Jumper Wires on page 11-10*
- *Measuring Voltage on page 11-10*
- *Measuring Voltage Drop on page 11-11*
- *Measuring Frequency on page 11-11*
- *Testing for Continuity on page 11-12*
- *Testing for Short to Ground on page 11-12*
- *Testing for a Short to Voltage on page 11-13*
- *Testing for Intermittent Conditions and Poor Connections on page 11-13*
- *Inducing Intermittent Fault Conditions on page 11-14*
- *Testing for Electrical Intermittents on page 11-15*

Using Connector Test Adapters

Caution: Do not insert test equipment probes (DVOM etc.) into any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal will cause a poor connection, which will result in a system failure. Always use the J-35616 GM-Approved Terminal Test Kit in order to front probe terminals. Do not use paper clips or other substitutes to probe terminals.

When using the J-35616 GM-Approved Terminal Test Kit, ensure the terminal test adapter choice is the correct size for the connector terminal. Do not visually choose the terminal test adapter because some connector terminal cavities may appear larger than the actual terminal in the cavity. Using a larger terminal test adapter will damage the terminal. Refer to the J-35616 GM-Approved Terminal Test Kit label on the inside of the J-35616 GM-Approved Terminal Test Kit for the correct adapter along with the connector end view for terminal size.

Probing Electrical Connectors

Special Tools

EL-35616 Terminal Test Probe Kit

For equivalent regional tools, refer to *Special Tools on page 11-30*.

Danger: *This procedure should not be performed on high voltage circuits. Performing this procedure on high voltage circuits may result in serious injury or death.*

Note: Always be sure to reinstall the connector position assurance (CPA) and terminal position assurance (TPA) when reconnecting connectors or replacing terminals.

Front Probe

Disconnect the connector and probe the terminals from the mating side (front) of the connector.

Caution: Refer to *Test Probe Caution on page 0-6*.

Note: When probing female 0.64 terminals, it is important to use the correct adapter. There have been some revisions to the test adapter for 0.64 terminals. The proper adapter for 0.64 terminals is the J-35616-64B which has a gold terminal and a black wire between the base and tip. Failure to use the proper test adapter may result in damage to the terminal being tested and improper diagnosis.

Note: The proper adapter for probing the terminals for fuses, relays, or diodes in an electrical center is J-35616-35. Using any other tool or adapter may damage the terminal being tested.

Refer to the following table as a guide in selecting the correct test adapter for front probing connectors:

Test Adapter	Description
J-35616-2A	150 Male Probe Adapter (gray)
J-35616-3	150 Female Probe Adapter (gray)
J-35616-4A	280 Male Probe Adapter (purple)
J-35616-5	280 Female Probe Adapter (purple)
J-35616-6	100W Male (round) Probe Adapter (brown)
J-35616-7	100W Female (round) Probe Adapter (brown)
J-35616-8	Weather Pack Male Probe Adapter (orange)
J-35616-9	Weather Pack Female Probe Adapter (orange)
J-35616-10	100W Male (round) Probe Adapter (green)
J-35616-11	100W Female (round) Probe Adapter (green)
J-35616-12	130 Male Probe Adapter (blue)
J-35616-13	130 Female Probe Adapter (blue)
J-35616-14	150 Male Probe Adapter (green)
J-35616-16	100 Male Probe Adapter (lt green)
J-35616-17	100 Female Probe Adapter (lt green)
J-35616-18	220 Male Probe Adapter (black)
J-35616-19	220 Female Probe Adapter (black)
J-35616-21	950 Female Probe Adapter (red)
J-35616-22	950 Male Probe Adapter (red)
J-35616-31	500 Male Probe Adapter (orange)
J-35616-32	500 Female Probe Adapter (orange)
J-35616-33	160/180 Male Probe Adapter (yellow)
J-35616-34	160/180 Female Probe Adapter (yellow)
J-35616-35	280 Male Probe Adapter (violet)
J-35616-40	480 Male Probe Adapter (dk blue)
J-35616-41	480 Female Probe Adapter (dk blue)
J-35616-42	630 Male Probe Adapter (red)
J-35616-43	630 Female Probe Adapter (red)
J-35616-44	800 Male Probe Adapter (yellow)
J-35616-45	800 Female Probe Adapter (yellow)
J-35616-54	280 Male (round) Probe Adapter (tan)
J-35616-55	280 Female (round) Probe Adapter (tan)
J-35616-64B	0.64 Male Probe Adapter (lt blue)
J-35616-65B	0.64 Female Probe Adapter (lt blue)
J-35616-66	150 Male (round) Probe Adapter (yellow)
J-35616-67	150 Female (round) Probe Adapter (yellow)

Backprobe

Note:

- Backprobe connector terminals only when specifically required in diagnostic procedures.
- Do not backprobe a sealed (Weather Pack®) connector, less than a 280 series Metri-Pack connector, a Micro-Pack connector, or a flat wire connector.

- Backprobing can be a source of damage to connector terminals. Use care in order to avoid deforming the terminal, either by forcing the test probe too far into the cavity or by using too large of a test probe.
- After backprobing any connector, inspect for terminal damage. If terminal damage is suspected, test for proper terminal contact.

Do not disconnect the connector and probe the terminals from the harness side (back) of the connector.

Troubleshooting with a Digital Multimeter

One of the most useful diagnostic tools is the digital multimeter. These basic operating procedures for a multimeter may vary with the make of meter and the manufacturer's operating instructions should be read and understood before using the multimeter.

Use Of A Multimeter

1. Always turn meter OFF when not in use.
2. Ensure the meter face reads zero.
3. If applicable, touch the leads together then adjust the resistance reading to zero each time a resistance range is selected or changed.
4. If you are not sure of the reading you expect to get, always select the highest scale, then reduce to allow an effective reading.
5. When measuring current, ensure the meter can handle the load and that the test leads are in the correct jacks.
6. Treat the instrument with the respect it deserves.

Note:

- Voltage readings are taken in parallel (i.e. over the load).
- Current readings are taken in series (i.e. break the circuit and use meter leads to complete the open circuit).

Resistance: Disconnect all external power, which includes the discharging of capacitors in electronic components.

Selection Of Multimeters

The best type of multimeter is one which has: Internal protection so that it cannot be damaged if, for example, voltage is put through when the meter is set on ohms. The fuse protects the meter and is the only thing that has to be replaced.

One that you can use to carry out a diode check facility which also provides an audible signal.

An audible signal when carrying out continuity checks.

A data hold facility so when a reading is taken that reading will remain on the display after the leads are removed.

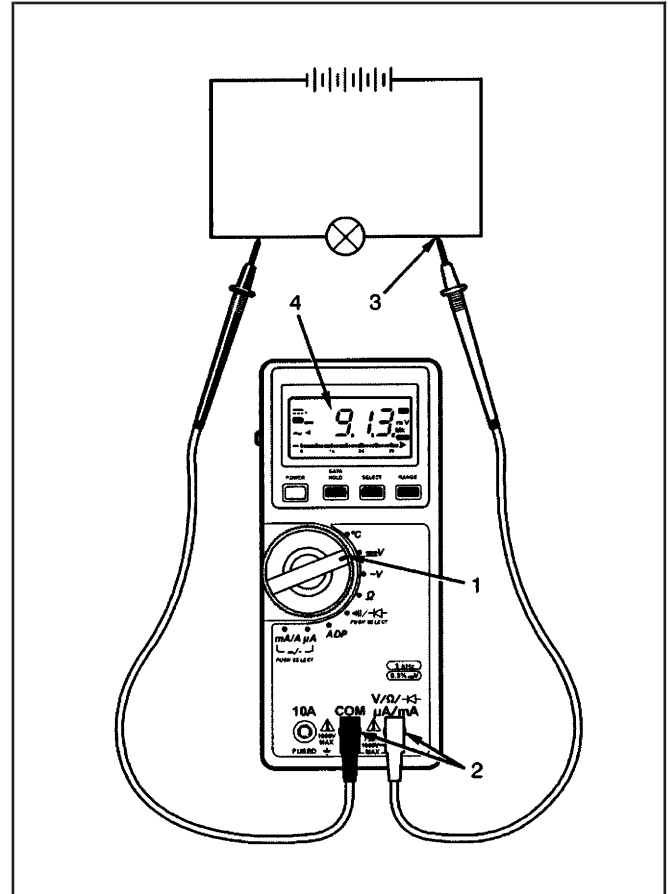
A multimeter today also has to have a high impedance factor. The common analogue type multimeter may be inadequate and may actually damage sensitive electronic circuitry. Analogue meters, due to their low internal resistance (input impedance), draw too much power from the device they are testing for use on computers. Many analogue meters use 9 volts to power the resistance test which is enough to destroy sensitive digital components. Digital multimeters have an input impedance of about 10 Megohms which is much higher than analogue multimeters. The high impedance means that the meter will draw very little power from the device under test. This means the meter will provide a more accurate measurement and will not damage delicate electronic components.

The multimeter used should also be able to test temperature and high amperages. This allows the one tool to do a vast amount of work in the area of diagnosis.

Auto diagnosis is the art of the mechanical trade. To be able to fault find, rectify the fault and have the vehicle back to the owner/operator with minimum delay is what leads to repeat business for the workshop. To do this you must be able to refer to available literature, apply basic theories and use the correct test equipment.

Voltage Measurement

With the Volts DC mode selected, the digital multimeter will operate as a voltmeter.



When using a voltmeter, the circuit power must be ON and the voltmeter must be connected with the correct polarity. This means the red lead should be on the positive (+) side of the load or circuit and the black lead should be on the negative (-) side of the load or circuit.

The voltmeter must be connected in parallel with the load or circuit. It has a high internal resistance and takes only a small amount of current. The meter will display the voltage difference between the points where the meter leads are attached. If the voltmeter is connected in series, the meter's high internal resistance will reduce the circuit current, resulting in an incorrect reading.

Testing for correct supply voltage is usually the first thing measured in a circuit. If there is no voltage present, or if the supply voltage is too high or too low, the voltage problem should be corrected before further testing.

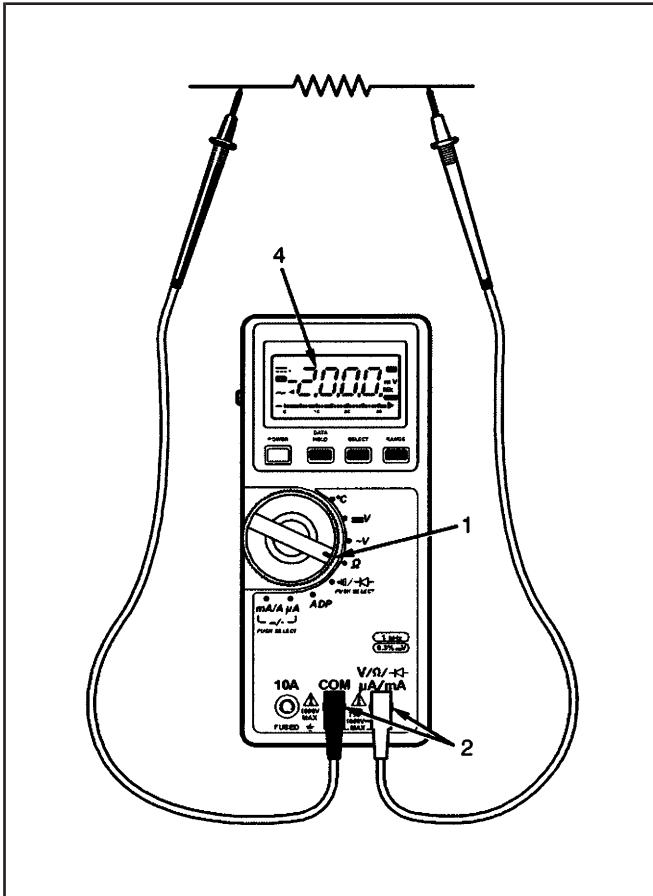
Note: Voltage readings should always be taken in parallel, i.e. across the load.

To make the reading:

1. Select VOLTS DC.
2. Plug the black test probe into the COM input jack and the red test probe into the V input jack.
3. Touch the probe tips to the circuit across the load or power source.
4. View the reading, being sure to note the unit of measurement.

Resistance Measurement

With the resistance mode selected, the digital multimeter will operate as an ohmmeter.



1683682

The ohmmeter can be connected without regard to polarity, unless there is a diode in the circuit. Always remember, however, that an ohmmeter must NEVER be connected to a live circuit, which could blow a fuse in the meter or damage the meter.

The ohmmeter has its own battery, which provides the necessary voltage for testing. If an ohmmeter is connected into a "live" circuit the ohmmeter will be damaged. Components or circuits MUST be disconnected from the power source when being tested.

Resistance Testing

Resistance measurements must be made with the circuit power OFF, otherwise damage to the meter or the circuit may result.

To make the resistance test:

1. Remove the power from the circuit and select ohm Ω on the DMM.
2. Plug the black test probe into the COM input jack and the red test probe into the Ω input jack.
3. Touch the probe tips across the component or the part of the circuit to be tested.
4. Observe the reading, being sure to note the unit of measurement.

Note:

- $1,000 \Omega = 1 \text{ k } \Omega$.
- $1,000,000 \Omega = 1 \text{ M } \Omega$.

Continuity Testing

A continuity test is a quick test that distinguishes between an open and a closed circuit.

A digital multimeter with a continuity beeper allows you to complete many continuity tests easily and quickly as the meter beeps when it detects a closed circuit. The level of resistance required to trigger the beeper varies from model to model of meter.

Continuity tests determine:

- Good or blown fuses.
- Open or shorted conductors.
- Operation of switches.
- Circuit paths.

Note: Circuits which include any solid state control modules, such as the Engine Control Module (ECM), should be tested only with a 10 Megohm or higher impedance digital multimeter.

Diodes and solid state components in a circuit can cause an ohmmeter to give a false reading. To find out if a component is affecting a measurement, take a reading once, reverse the leads and take a second reading. If the readings differ, the solid state component is affecting the measurement.

Diode Testing

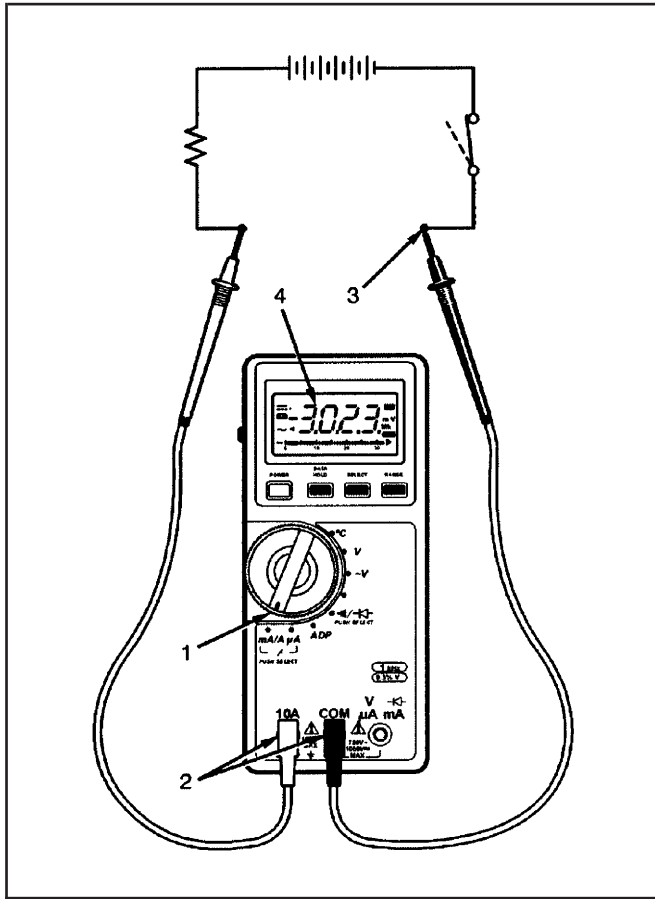
A diode is like an electronic switch. It can be turned ON if the voltage is above a certain level, generally about 0.6 V for a silicon diode, and allows current to flow in one direction.

Some meters have a special mode called diode test. In this mode the readings across the diode should be 0.6 V to 0.7 V in one direction and indicate an open circuit in the other. This indicates a good diode. If both readings are open circuit, the diode is open. If both readings indicate continuity, the diode is shorted.

11-10 Wiring Systems

Current Measurement

With the AMPS DC mode selected, the digital multimeter will operate as an ammeter.



An ammeter is an instrument that measures current flow in a circuit. For this reason ammeters **MUST** be connected in series. The ammeter must also be connected into the circuit according to polarity.

Current measurements are different from other measurements made with a digital multimeter. Current measurements are made in series, unlike voltage or resistance measurements, which are made in parallel. The entire current being measured flows through the meter. Also, the test probes must be plugged into a different set of input jacks on the meter.

Danger: Do not leave the test leads plugged into the current input jacks and then attempt a voltage measurement. This causes a direct short across the source voltage through the low-value resistor inside the digital multimeter and if the meter is not adequately protected, can cause injury to the operator.

Caution: Do not leave the test leads plugged into the current input jacks and then attempt a voltage measurement. This causes a direct short across the source voltage through the low-value resistor inside the digital multimeter and if the meter is not adequately protected, can cause extreme damage to the meter and/or the circuit.

To take a current reading:

1. Remove the power from the circuit, cut or open the circuit and select A.
2. Plug the black test probe into the COM input jack and the red test probe into the 10 A input jack.
3. Touch the probe tips across the cut or open circuit as shown in the following illustration.
4. View the reading, being sure to note the unit of measurement.

Note: If the test leads are reversed, a – sign shows on the meter display.

Troubleshooting with a Test Lamp

Tools Required

J 35616-200 12 Volt Un-powered Test Lamp

Caution: Refer to *Test Probe Caution* on page 0-6.

A test lamp can simply and quickly test a low impedance circuit for voltage.

The J 35616-200 is Micro-Pack compatible and comprised of a 12 volt light bulb with an attached pair of leads.

To properly operate this tool use the following procedure:

1. Attach one lead to ground.
2. Touch the other lead to various points along the circuit where voltage should be present.
3. When the bulb illuminates, there is voltage at the point being tested.

Using Fused Jumper Wires

Tools Required

J 36169-A Fused Jumper Wire

Note:

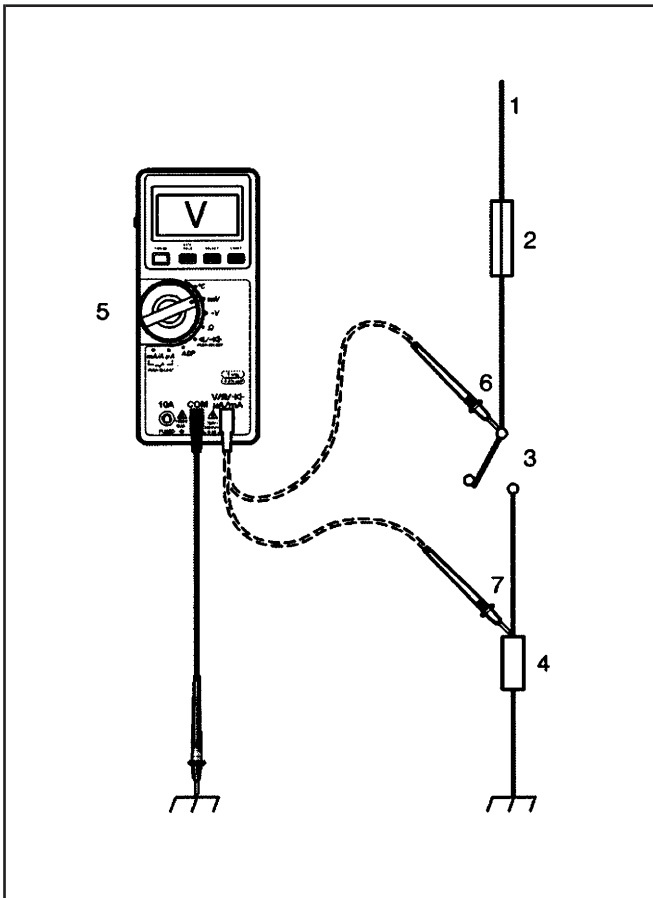
- A fused jumper may not protect solid state components from being damaged.
- Do not use a fuse with a higher rating than the fuse that protects the circuit being tested.

The J 36169-A includes small clamp connectors that provide adaptation to most connectors without damage. This fused jumper wire is supplied with a 20 A fuse which may not be suitable for some circuits.

Measuring Voltage

To perform a voltage test:

1. Connect one lead of a test light to a good ground. If using a voltmeter, ensure the voltmeter's negative (COM) lead is connected to ground (battery negative).
2. Switch the meter to V and connect the other lead of the test light or voltmeter to a selected test point on a connector or terminal.
3. If the test light illuminates, there is voltage present. If using a voltmeter, note the voltage reading. It should be within one volt of the measured battery voltage, unless otherwise specified in the system diagnosis.



1683686

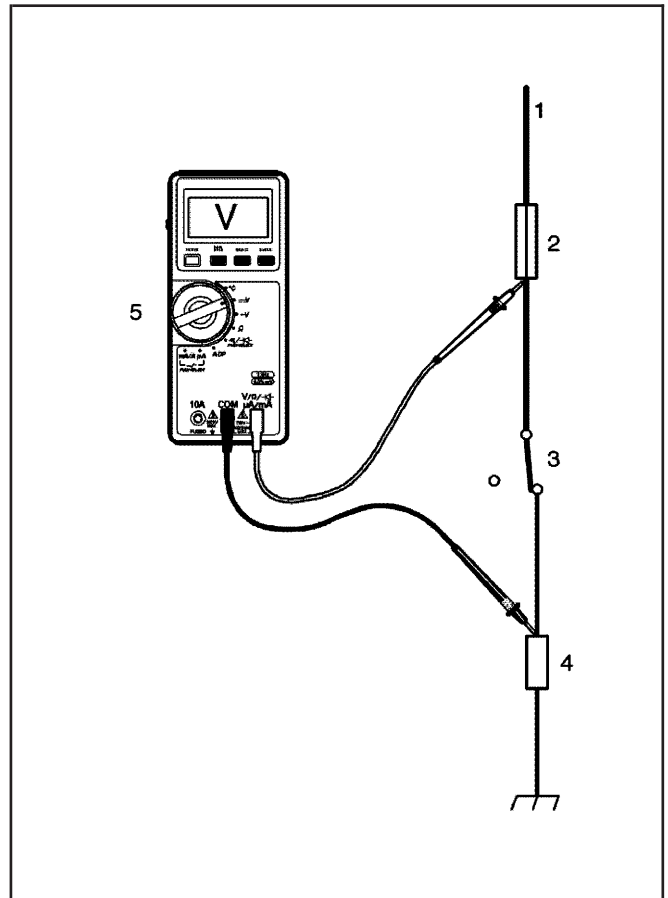
Legend

- (1) Power From Battery
- (2) Fuse
- (3) Switch
- (4) Relay Coil
- (5) Meter
- (6) Voltage Test Point
- (7) Voltage Test Point

Measuring Voltage Drop

This test checks for voltage being lost along a wire or through a connection or switch.

1. Switch the voltmeter to V and connect the positive lead to the end of the wire (or to one side of the connection or switch) which is closest to the battery.
2. Connect the negative lead to the other end of the wire (or other side of the connection or switch).
3. Operate the circuit.
4. The voltmeter will show the difference in voltage between the two points. A difference (or drop) of more than 1 volt indicates a problem.



1683689

Legend

- (1) Power From Battery
- (2) Fuse
- (3) Switch
- (4) Relay Coil
- (5) Meter
- (6) Voltage Test Point

Measuring Frequency

Caution: Refer to *Test Probe Caution* on page 0-6.

The following procedure determines the frequency of a signal.

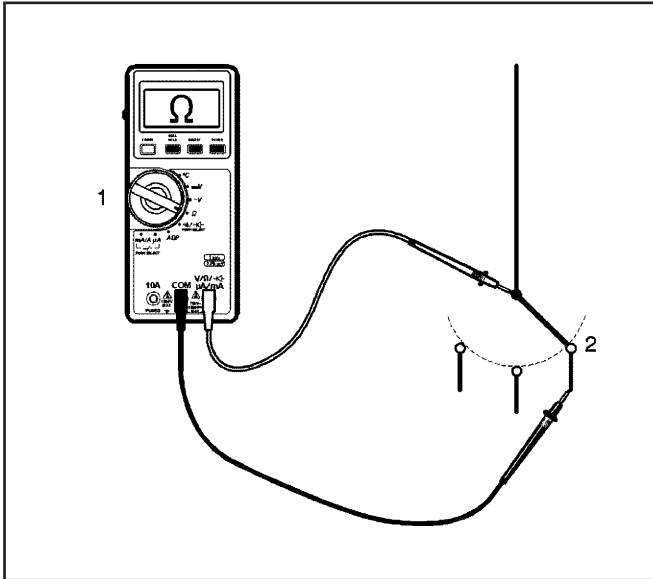
Note: Connecting the DMM to the circuit before pressing the Hz button will allow the DMM to autorange to an appropriate range.

1. Apply power to the circuit.
2. Set the rotary dial of the DMM to the V (AC) position.
3. Connect the positive lead of the DMM to the circuit to be tested.
4. Connect the negative lead of the DMM to a good ground.
5. Press the Hz button on the DMM.
6. The DMM will display the frequency measured.

Testing for Continuity

To test for continuity:

1. Disconnect the battery ground lead.
2. Connect one lead of a self-powered test light or ohmmeter to one end of the part of the circuit under test.
3. Switch the meter to ohm and connect the other lead to the other end of the circuit.
4. If the self-powered test light illuminates, there is continuity. If you are using an ohmmeter, low or no resistance means good continuity.



1683688

Legend

- (1) Meter Switched to Ohms
- (2) Switch Terminal

Testing for Short to Ground

Using A Test Light Or Voltmeter

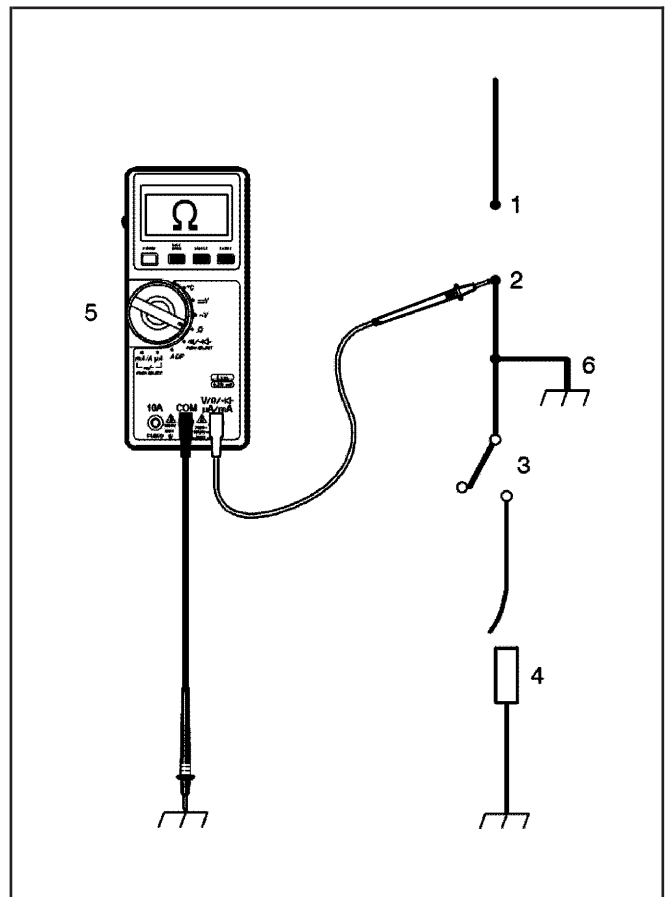
To test for a short to ground using a test light or a voltmeter:

1. Remove the blown fuse and disconnect the load.
2. Ensure that fuse block is powered and connect a test light or voltmeter across the fuse terminals.
3. Beginning near the fuse block, wiggle the harness from side to side. Continue this at convenient points about 150 mm apart while watching the test light or voltmeter.
4. If the test light illuminates, or the voltmeter registers, there is a short to ground in the wiring near that point.

Using A Self-Powered Test Light Or Ohmmeter

To test for a short to ground using a self-powered test light or an ohmmeter:

1. Remove the blown fuse and disconnect the battery and load.
2. Connect one lead of a self-powered test light or ohmmeter to the fuse terminal on the load side.
3. Connect the other lead to a known good ground.
4. Beginning near the fuse block, wiggle the harness from side to side. Continue this at convenient points about 150 mm apart while watching the self-powered test light or ohmmeter.
5. If the self-powered test light illuminates or flickers, or the ohmmeter changes or registers, there is a short to ground in the wiring near that point.



1683692

Legend

- (1) Power From Battery With Fuse Removed
- (2) Starting Test Point
- (3) Switch
- (4) Disconnected Load
- (5) Meter Set To Ohms
- (6) Short To Ground

Using A Short Finder

A short finder is a device used for locating hidden shorts. These create a magnetic field in the shorted circuit and allow you to read its location through body trim or sheet metal.

Using A Compass

An ordinary magnetic compass may be used to locate grounded circuits. It makes use of the fact that a wire carrying current creates a magnetic field. In circuits that are protected by a circuit breaker, a short or ground can be quickly located by use of an ordinary magnetic compass. Turn the circuit breaker on and off and start following the wiring with the compass, the compass will 'kick' each time the circuit breaker closes. As the compass passes the point of the short or ground, the compass will stop 'kicking'. Thus, the compass can pinpoint the problem without removing trim, cover plates or tape. If the circuit is fused, the problem can be found in the same manner by substituting a circuit breaker for the fuse.

Using A Circuit Breaker

By using a circuit breaker as a substitute for a fuse, other tools can be more effectively used to find troubles. A turn signal flasher makes a convenient circuit breaker. Solder a lead to each terminal of the turn signal flasher, and each lead with a terminal from an old fuse. If this unit is inserted in the junction block in place of a fuse, it may operate too fast to produce good compass needle deflection. To slow it down, insert a rheostat in series with the flasher. By cutting in additional resistance, the flashing rate of the unit may be slowed down to produce good compass needle deflection.

Testing for a Short to Voltage

Caution: Refer to *Test Probe Caution* on page 0-6.

The following procedure tests for a short to voltage in a circuit.

1. Set the rotary dial of the DMM to the V (DC) position.
2. Connect the positive lead of the DMM to one end of the circuit to be tested.
3. Connect the negative lead of the DMM to a good ground.
4. Turn ON the ignition and operate all accessories.
5. If the voltage measured is greater than 1 V, there is a short to voltage in the circuit.

Testing for Intermittent Conditions and Poor Connections

Intermittent and Poor Connections

Most intermittents are caused by faulty electrical connections or wiring. Occasionally a sticking relay or solenoid can also cause an intermittent failure.

Some items to check are:

- Poor mating of connector halves, or terminals not fully seated in the connector body (backed out).
- Dirt or corrosion on the terminals.
- The terminals must be clean and free of any foreign material which could impede proper terminal contact.
- Damaged connector body.
- Exposure of terminals to moisture and dirt causing improper terminal orientation with the component or mating connector.
- Improperly formed or damaged terminals.
- Check all connector terminals in problem circuits in order to ensure good contact tension. Use a corresponding mating terminal to check for proper tension. Refer to Checking Terminal Contact in this section for the specific procedure.
- Poor terminal to wire connection.
- Some conditions which fall under this description are poor crimps, poor solder joints, crimping over wire insulation rather than the wire itself, corrosion in the wire to terminal contact area, etc.
- Wire insulation which is rubbed through.
- This causes an intermittent short as the bare area touches other wiring or parts of the vehicle.
- Wiring broken inside the insulation.
- This condition could cause a continuity check to show a good circuit, but if only one or two strands of a multi-strand type wire are intact, resistance could be far too high.

To avoid any of the above problems when making wiring or terminal repairs, always follow the instructions for wiring and terminal repair detailed in Wiring Repairs and Connector Repairs.

Checking Terminal Contact

When diagnosing an electrical system that utilizes Metri-Pack 150/280/480/630 series terminals (refer to the J 38125-A Terminal Repair Kit or the J 38125-4 Instruction Manual for terminal identification), it is important to check terminal contact between a connector and component, or between in-line connectors, before replacing a suspect component. When diagnosing an electrical system that utilizes Metri-Pak.

Frequently, a diagnostic chart leads to a step that reads: Check for poor connection. Mating terminals must be inspected to assure good terminal contact. A poor connection between the male and female terminal at a connector may be the result of contamination or deformation.

Contamination is caused by the connector halves being improperly connected, a missing or damaged connector seal, or damage to the connector itself, exposing the terminals to moisture and dirt. Contamination, usually in underhood or underbody connectors, leads to terminal corrosion, causing an open circuit or intermittently open circuit.

11-14 Wiring Systems

Deformation is caused by probing the mating side of a connector terminal without the proper adapter, improperly joining the connector halves or repeatedly separating and joining the connector halves. Deformation, usually to the female terminal contact tang, can result in poor terminal contact, causing an open or intermittently open circuit.

Follow the procedure below to check terminal contact.

1. Separate the connector halves. Refer to the J 38125-A Terminal Repair Kit or the J 38125-4 instruction manual.
2. Inspect the connector halves for contamination. Contamination will result in a white or green build-up within the connector body or between terminals, causing high terminal resistance, intermittent contact, or an open circuit. An underhood or underbody connector that shows signs of contamination should be replaced in its entirety: terminals, seals, and connector body.
3. Using an equivalent male terminal from the J 38125-A Terminal Repair Kit, check the retention force is significantly different between the two female terminals, replace the female terminal in question (refer to the J 38125-A Terminal Repair Kit).

If a visual (physical) check does not reveal the cause of the problem, you may have the vehicle with a DMM connected to the suspected circuit. An abnormal voltage reading when the problem occurs indicates the problem may be in that circuit.

Inducing Intermittent Fault Conditions

In order to duplicate the customer's concern, it may be necessary to manipulate the wiring harness if the malfunction appears to be vibration related. Manipulation of a circuit can consist of a wide variety of actions, including:

- Wiggling the harness
- Disconnecting a connector and reconnecting
- Stressing the mechanical connection of a connector
- Pulling on the harness or wire in order to identify a separation/break inside the insulation
- Relocating a harness or wires

All these actions should be performed with some goal in mind. For instance, with a scan tool connected, wiggling the wires may uncover a faulty input to the control module. The snapshot option would be appropriate here. You may need to load the vehicle in order to duplicate the concern. This may require the use of weights, floorjacks, jackstands, frame machines, etc. In these cases you are attempting to duplicate the concern by manipulating the suspension or frame. This method is useful in finding harnesses that are too short and their connectors pull apart enough to cause a poor connection. A DMM set to Peak Min/Max mode and connected to the suspect circuit while testing can yield desirable results. Refer to *Testing for Electrical Intermittents* on page 11-15.

Certainly, using the senses of sight, smell, and hearing while manipulating the circuit can provide good results as well.

There may be instances where circuit manipulation alone will not meet the required criteria for the fault condition to appear. In such cases it may be necessary to expose the suspect circuit to other conditions while manipulating the harness. Such conditions would include high moisture conditions, along with exceptionally high or low temperatures. The following discusses how to expose the circuit to these kinds of conditions.

Salt Water Spray

Some compounds possess the ability to conduct electricity when dissolved in water such as ordinary salt. By mixing table salt with water in sufficient quantities, you can enhance the conductive properties of water so that any circuit which may be sensitive to moisture will more readily fail when liberally sprayed with this mixture.

Mixing 0.35L (12 oz) of water with approximately 1 tablespoon of salt will yield a salt solution of 5 percent. Fill a normal spray bottle with this mixture. This mixture is sufficient to enhance the water's own conductivity. This may cause the circuit to fail more easily when sprayed. Once the mixture is completed, spray the suspect area liberally with the solution. Then, while monitoring either a scan tool or DMM, manipulate the harness as discussed previously.

High Temperature Conditions

Tools Required

J 25070 Heat Gun

If the complaint tends to be heat related, you can simulate the condition using the J 25070.

Using the heat gun, you can heat up the suspected area or component. Manipulate the harnesses under high temperature conditions while monitoring the scan tool or DMM to locate the fault condition.

The high temperature condition may be achieved simply by test driving the vehicle at normal operating temperature. If a heat gun is unavailable, consider this option to enhance your diagnosis. This option does not allow for the same control, however.

Low Temperature Conditions

Depending on the nature of the fault condition, placing a fan in front of the vehicle while the vehicle is in the shade can have the desired effect.

If this is unsuccessful, use local cooling treatments such as ice or a venturi type nozzle (one that provides hot or cold air). This type of tool is capable of producing air stream temperatures down to -18°C (0°F) from one end and 71°C (160°F) from the other. This is ideally suited for localized cooling needs.

Once the vehicle, component, or harness has been sufficiently cooled, manipulate the harness or components in an effort to duplicate the concern.

Testing for Electrical Intermittents

Special Tools

J-39200 Digital Multimeter

Perform the following procedures while wiggling the harness from side to side. Continue this at convenient points (about 6 inches apart) while watching the test equipment.

- *Testing for Short to Ground on page 11-12*
- *Testing for Continuity on page 11-12*
- *Testing for a Short to Voltage on page 11-13*

If the fault is not identified, perform the procedure below using the MIN MAX feature on the J-39200 DMM. This feature allows you to manipulate the circuit without having to watch the J-39200. The J-39200 will generate an audible tone when a change is detected.

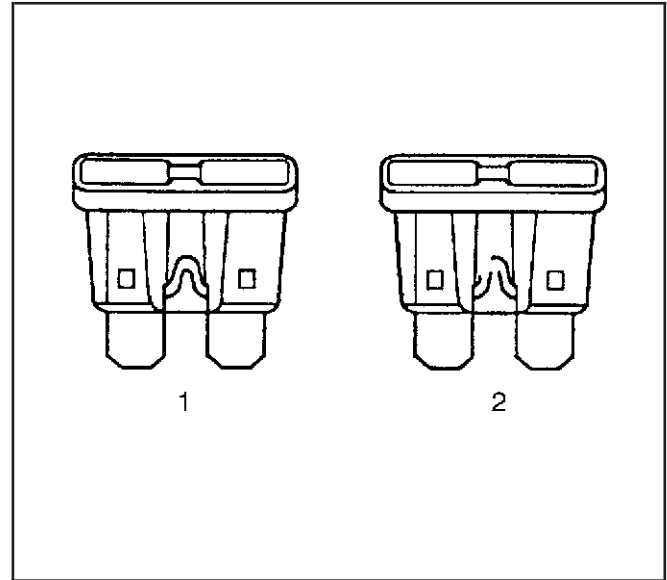
Note: The J-39200 should be used in order to perform the following procedure since the J-39200 can monitor current, resistance or voltage while recording the minimum (MIN), and maximum (MAX) values measured.

1. Connect the J-39200 to both sides of a suspected connector (still connected), or from one end of a suspected circuit to the other. Refer to *Troubleshooting with a Digital Multimeter on page 11-8* for information on connecting the J-39200 to the circuit.
2. Set the rotary dial of the J-39200 to the V (AC) or V (DC) position.
3. Press the range button of the J-39200 in order to select the desired voltage range.
4. Press the MIN MAX button of the J-39200. The J-39200 displays 100 ms RECORD and emits an audible tone (beep).

Note: The 100 ms RECORD mode is the length of time an input must stay at a new value in order to record the full change.

5. Simulate the condition that is potentially causing the intermittent connection, either by wiggling the connections or the wiring, test driving, or performing other operations. Refer to *Inducing Intermittent Fault Conditions on page 11-14*.
6. Listen for the audible Min Max Alert which indicates that a new minimum or maximum value has been recorded.
7. Press the MIN MAX button once in order to display the MAX value and note the value.
8. Press the MIN MAX button again in order to display the MIN value and note the value.
9. Determine the difference between the MIN and MAX values.
 - If the variation between the recorded MIN and MAX voltage values is 1 V or greater an intermittent open or high resistance condition exists. Repair the condition as necessary.
 - If the variation between the recorded MIN and MAX voltage values is less than 1 V, an intermittent open or high resistance condition does not exist.

Circuit Protection - Fuses



8786

The fuse is the most common method of an automotive wiring circuit protection. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt and create an open or incomplete circuit. Fuses are a one time protection device and must be replaced each time the circuit is overloaded. To determine if a fuse is open, remove the suspected fuse and examine the element in the fuse for an open (break). If not broken, also check for continuity using a DMM or a continuity tester. If the element is open or continuity is suspect, replace the fuse with one of equal current rating.

Fuse Types

Current Rating Amperes	Color
Auto Fuses, Mini Fuses	
2	Gray
3	Violet
5	Tan
7.5	Brown
10	Red
15	Blue
20	Yellow
25	White or Natural
30	Green
Maxi Fuses	
20	Yellow
30	Light Green
40	Orange or Amber
60	Blue
50	Red

Circuit Protection - Circuit Breakers

A circuit breaker is a protective device that is designed to open the circuit when a current load is in excess of the rated breaker capacity. If there is a short or other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals. Two types of circuit breakers are used.

Circuit Breaker: This type opens when excessive current passes through it for a period of time. It closes again after a few seconds, and if the cause of the high current is still present, it will open again. The circuit breaker will continue to cycle open and closed until the condition causing the high current is removed.

Positive Temperature Coefficient (PTC) Circuit Breaker: This type greatly increases its resistance when excessive current passes through it. The excessive current heats the PTC device, as the device heats its resistance increases. Eventually the resistance gets so high that the circuit is effectively open. Unlike the ordinary circuit breaker the PTC unit will not reset until the circuit is opened, by removing the voltage from its terminals. Once the voltage is removed the circuit breaker will re-close within a second or 2.

Circuit Protection - Fusible Links

Fusible link is wire designed to melt and break continuity when excessive current is applied. It is often located between or near the battery and starter or electrical center. Use a continuity tester or a DMM at each end of the wire containing the fusible link in order to determine if it is broken. If broken, it must be replaced with fusible link of the same gauge size.

Repairing a Fusible Link

Note: Fusible links cut longer than 225 mm (approximately 9 in) will not provide sufficient overload protection.

Refer to Splicing Copper Wire Using Splice Clips in *Wiring Repairs* on page 11-16.

Wiring Repairs

Circuit Protection

Note: After you make any electrical repair, always test the circuit by operating the devices in the circuit. This confirms not only that the repair is correct, but also that the cause of the customer concern was correctly identified.

All electrical circuits are protected against excessive loads which might occur because of shorts or overloads in the wiring system. A fuse or circuit breaker provides such protection.

Fuses

The fuse is the most common method of an automotive wiring circuit protection. Whenever there is an excessive amount of current flowing through a circuit the fusible element will melt and create an open or incomplete circuit. A short circuit or any other type of overload condition may cause a fuse to open, refer to *Circuit Protection - Fuses* on page 11-15 for additional information.

Circuit Breakers

A circuit breaker is a protective device that is designed to open the circuit when a current load is in excess of the rated breaker capacity. If there is a short circuit or any other type of overload condition in the circuit, the excessive current will open the circuit between the circuit breaker terminals, refer to *Circuit Protection - Circuit Breakers* on page 11-16 for additional information.

Typical Electrical Repairs

An open circuit is an incomplete circuit. Power cannot reach the load or the ground. If a circuit is open, active components do not energize. A short circuit is an unwanted connection between one part of the circuit and either the ground or another part of the circuit. A short circuit may cause a fuse to blow, a circuit breaker to open, or a component to fail or become inoperative. A short circuit may be caused by damaged wire insulation. If the damage is minor, locate the problem and tape over the wire. If the damage is more extensive, replace the faulty segment of the wire. Refer to the following list of instructions to repair copper wire and shielded cables.

- *Flat Wire Repairs* on page 11-17
- *Heated Oxygen Sensor Wiring Repairs* on page 11-17
- *Splicing Copper Wire Using Splice Clips* on page 11-17
- *Splicing Copper Wire Using Splice Sleeves* on page 11-21
- *Splicing Twisted or Shielded Cable* on page 11-22

Wire Size Conversion Table

Metric Wire Sizes (mm[square])	AWG Sizes
0.22	24
0.35	22
0.5	20
0.8	18
1.0	16
2.0	14
3.0	12
5.0	10
8.0	8
13.0	6
19.0	4
32.0	2
50.0	1/0

Splice Sleeve Color	Crimp Tool Nest Color	Wire Gauge AWG/(Metric)
Green	Red	22, 26 / (0.2, 0.35)
Salmon	Red	20, 18 / (0.35, 0.8)
Blue	Blue	16, 14 / (1.0, 2.0)
Yellow	Yellow	12, 10 / (3.0, 5.0)

Flat Wire Repairs

Caution: The flat wire within the flex wiring harness is not serviceable. If an open or short exists within the flex wiring harness the complete harness must be replaced.

Heated Oxygen Sensor Wiring Repairs

Caution: Do not solder repairs under any circumstances as this could result in the air reference being obstructed.

If the heated oxygen sensor pigtail wiring, connector, or terminal is damaged the entire oxygen sensor assembly must be replaced. Do not attempt to repair the wiring, connector, or terminals. In order for the sensor to function properly it must have a clean air reference. This clean air reference is obtained by way of the oxygen sensor signal and heater wires. Any attempt to repair the wires, connectors or terminals could result in the obstruction of the air reference and degrade oxygen sensor performance.

The following guidelines should be used when servicing the heated oxygen sensor:

- Do not apply contact cleaner or other materials to the sensor or vehicle harness connectors. These materials may get into the sensor, causing poor performance. Also, the sensor pigtail and harness wires must not be damaged in such a way that the wires inside are exposed. This could provide a path for foreign materials to enter the sensor and cause performance problems.
- Neither the sensor nor vehicle lead wires should be bent sharply or kinked. Sharp bends, kinks, etc., could block the reference air path through the lead wire.
- Do not remove or defeat the oxygen sensor ground wire (where applicable). Vehicles that utilize the ground wire sensor may rely on this ground as the only ground contact to the sensor. Removal of the ground wire will also cause poor engine performance.
- To prevent damage due to water intrusion, be sure that the peripheral seal remains intact on the vehicle harness connector.

Splicing Copper Wire Using Splice Clips

Splice clips are included in Terminal Repair Kit, J-38125-A. The splice clip is a general-purpose wire repair device. It may not be acceptable for applications having special requirements such as moisture sealing.

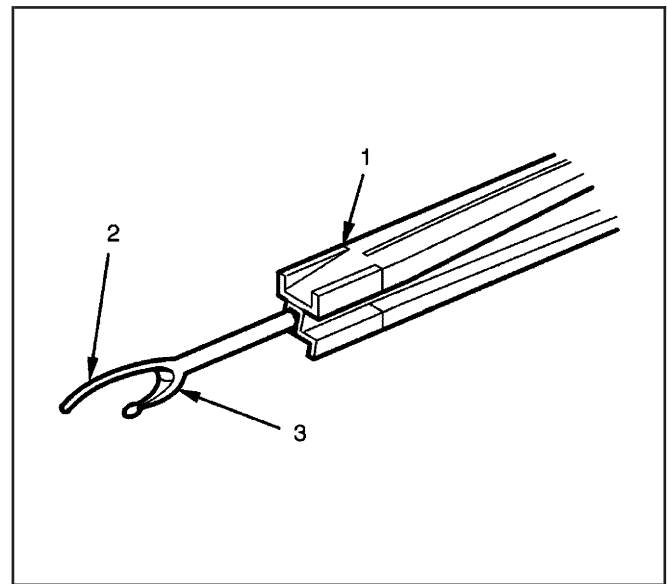
Step 1 – Open the Harness

A wiring harness may be wrapped in tape or enclosed in a plastic conduit.

If it is conduit encased, simply open the conduit and pull out the desired wire.

If the harness is wrapped in tape, use a seam splitter (1) to open the harness. This prevents damage to the insulation of the wire inside the harness. Seam splitters are readily available from sewing supply stores. When using a seam splitter, use the blade with the pointed end (2) to start a small split in the tape away from any wires.

Use the blade with the rounded end (3) to slit the tape as far as necessary. Be careful to avoid cutting into any wire insulation.



1683714

Step 2 – Cut the Wire

Leave as much wire on the harness as possible. More can be cut off later to adjust the location of the splice if necessary.

Note:

- Ensure that each splice is at least 40 mm away from other splices, harness branches and connectors. This helps prevent moisture from bridging adjacent splices and causing damage.
- Do not nick or cut any copper strands as this could limit the current-carrying capabilities of the wire.

11-18 Wiring Systems

Step 3 – Select the Correct Size and Type of Wire

The wire must be of a size equal to or greater than the original except for fusible links. The wire insulation must have the same or higher temperature rating:

Note: XLPE insulated wire may be used to replace PVC, but PVC must not be used to replace XLPE. XLPE insulation is not fuel resistant, so XLPE covered wire must not be used where there is the possibility of fuel contact.

General purpose insulation (PVC) is used in areas not subject to high temperatures.

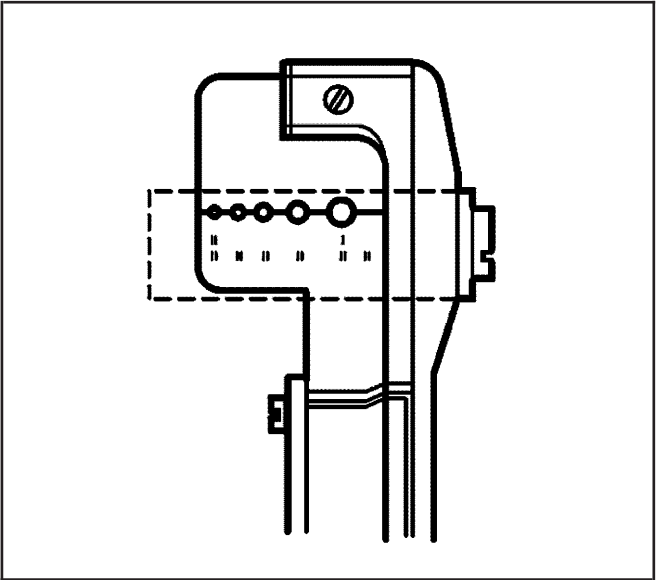
Cross-linked polyethylene (XLPE) insulation wire is used where high temperatures are expected.

Step 4 – Strip the Insulation

Find the wire size using a wire gauge (AWG).

A wire stripper, labelled in AWG sizes, is needed for stripping away the insulation. If the wire size is not known, start with the largest stripper hole and work down until a clean strip of insulation is removed without nicking or cutting the wire. Set the stripper guide to a 7.5 mm long strip.

The splice should be at least 40 mm away from any other splices or outlets.



1683716

Metric Size												
0.22	0.35	0.5	0.8	1.0	2.0	3.0	5.0	8.0	13.0	19.0	32.0	50.0
AWG												
24	22	20	18	16	14	12	10	8	6	4	2	1/0

Use the following procedure when using a wire stripper:

Hold both handles in the right hand, with gripper jaws to the left.

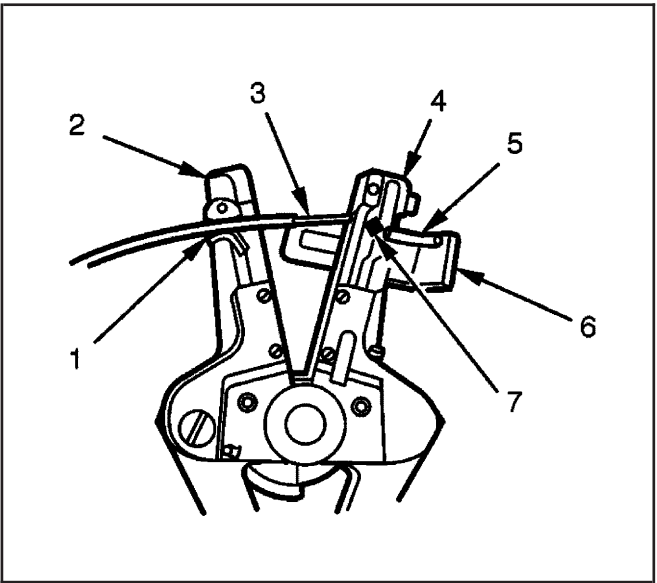
Hold the wire in the left hand and press the end of the wire against the guide and up into the correct notch of the upper blade.

Close left handle first, to grip the wire firmly before cutting the insulation.

If the stripper castings stick open after stripping the wire, pull the handles outward to snap the tool closed.

Check the stripped wire for nicks or cut strands.

If the wire is damaged, repeat the procedure on a new section of wire. The two stripped sections of wire to be joined should be of equal length.



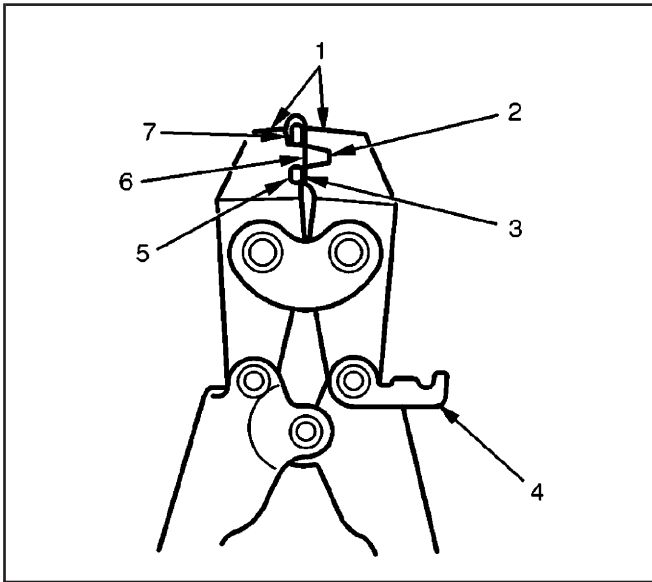
1683718

Legend

- (1) Gripper Jaws
- (2) Gripper Casting
- (3) Stripped Wire
- (4) Cutter Casting
- (5) Insulation
- (6) Guide
- (7) Blades

Step 5 – Crimping the Joint

1. Select the correct sized clip.
2. Unlock the crimping tool.
3. Slightly close the clip using the nose of the crimping tool as shown in the following illustration.

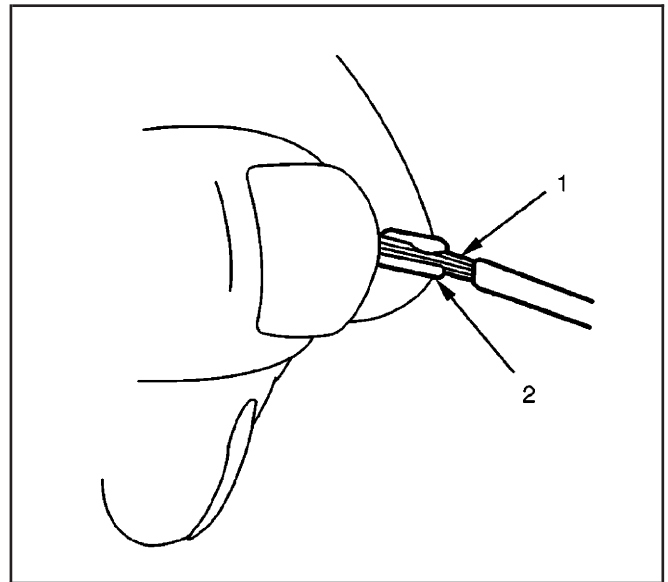


1683721

Legend

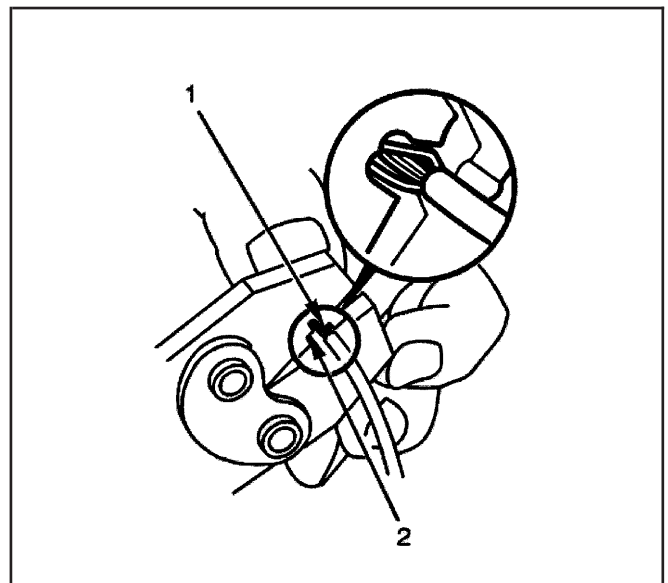
- (1) Nose
- (2) Former
- (3) Small Anvil
- (4) Lock
- (5) Former
- (6) Large Anvil
- (7) Clip

4. Select the correct crimper anvil.
5. Overlap the two stripped wire ends (1) and hold them between the thumb and forefinger as shown in the following illustration.



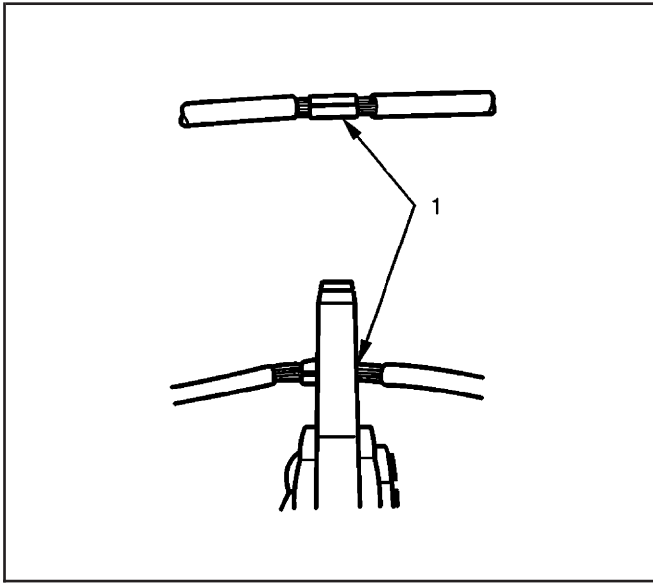
1683723

6. Centre the splice clip (2) under the stripped wires and hold in place as shown.
 - Ensure that the wires extend beyond the clip in each direction.
 - Ensure no insulation is caught under the clip.
 - Strands of wire are not cut or loose.
7. Fully open the crimping tool and rest one handle on a firm, flat surface.



1683724

8. Centre the back of the splice clip on the proper anvil (2) and close the crimping tool to the point where the former touches the wings of the clip (1).
9. Verify the clip and wires are still in the correct position before closing the crimping tool with steady pressure.

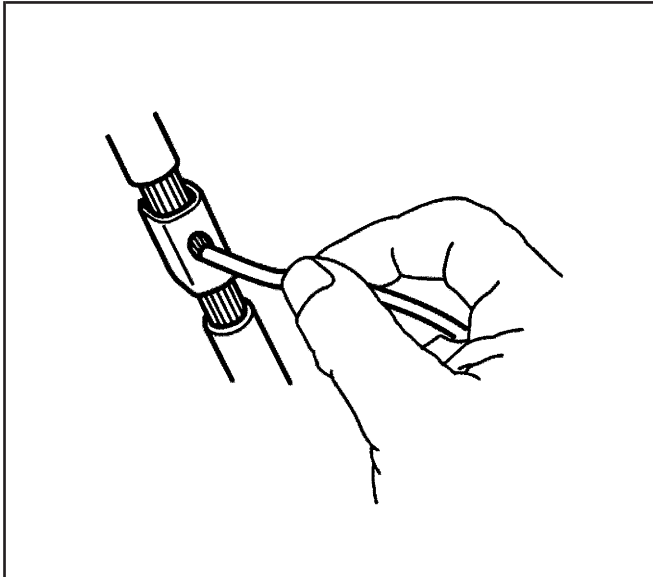


1683725

10. Crimp the splice clip a second and third time, once at each end (1). Do not let the crimping tool extend beyond the edge of the clip when doing so.

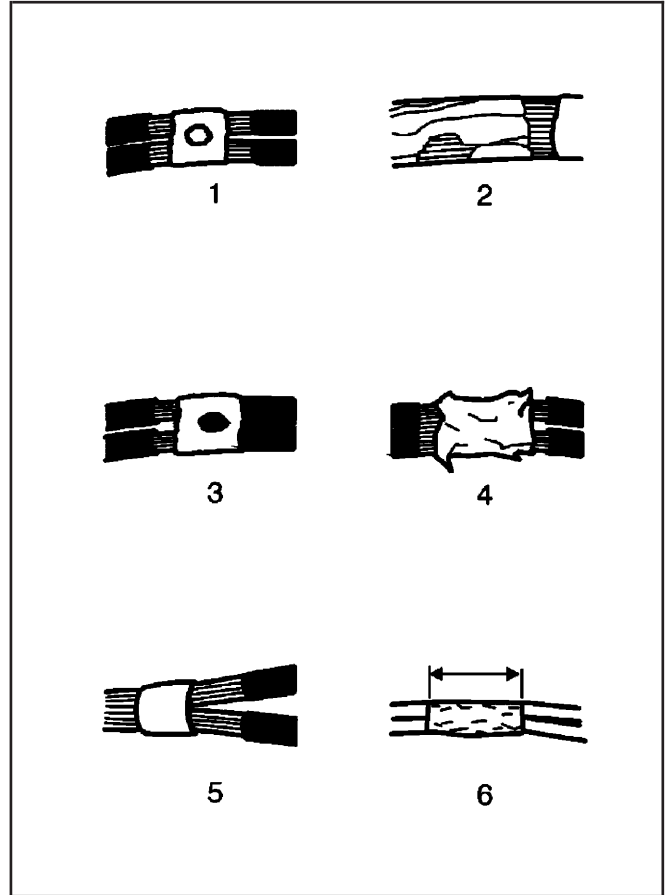
Step 6 – Solder

Apply 50/50 resin core solder to the hole in the back of the clip as shown in the following illustration.



1683727

Ensure there are none of the faults shown in the following illustration.



1683729

Legend

- (1) Poor Solder Application With Bad Solder Fillets
- (2) Excessive Burning Which Cannot Be Covered With 50 mm Splice Tape
- (3) Insulation Clamped Under The Clip
- (4) Sharp Solder Spikes
- (5) Wires Not Fully Inserted Into The Clip
- (6) Tape Width Less Than 50 mm

Step 7 – Tape the Splice

Centre and roll a 50 mm x 50 mm piece of tape around the splice joint.

If the wire is not in conduit or another harness covering, tape it again using a winding motion, entirely overlapping the first piece.

Legend

1. Example Of Properly Rolled Tape
2. Tape Again If Needed
3. Example Of Bad (Flagged) Taping

Splicing Copper Wire Using Splice Sleeves

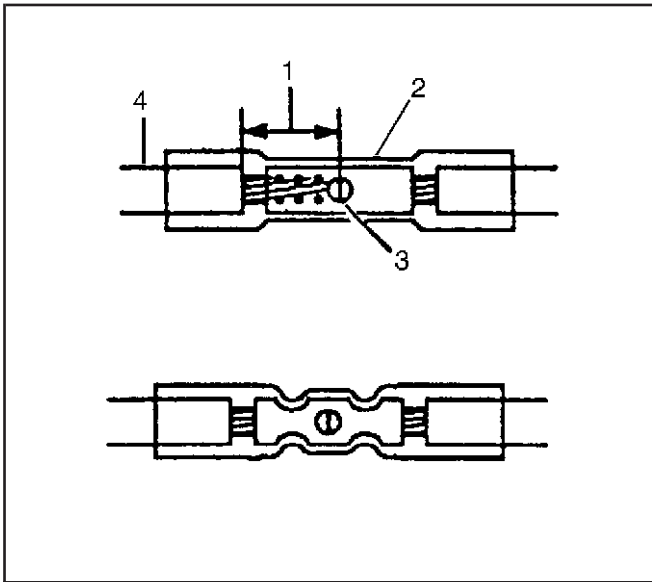
Tools Required

J-38125 Terminal Repair Kit

Note: Use only GM splice sleeves, other splice sleeves may not protect the splice from moisture or provide a good electrical connection.

Use crimp and seal splice sleeves to form a one-to-one splice on all types of insulation except tefzel and coaxial to form a one-to-one splice. Use tefzel and coaxial where there is special requirements such as moisture sealing. Follow the instructions below in order to splice copper wire using crimp and seal splice sleeves.

1. Open the harness.
 - If the harness is taped, remove the tape.
 - To avoid wiring insulation damage, use a sewing ripper in order to cut open the harness.
 - If the harness has a black plastic conduit, pull out the desired wire.
2. Cut the wire.
 - Cut as little wire off the harness as possible.
 - Ensure that each splice is at least 40 mm (1.5 in) away from other splices, harness branches and connectors. This helps prevent moisture from bridging adjacent splices and causing damage.



8796

3. Select the proper size and type of wire.
 - The wire must be of equal or greater size than the original.
 - The wire's insulation must have the same or higher temperature rating (4).
 - Use general purpose insulation for areas that are not subject to high temperatures.

Note:

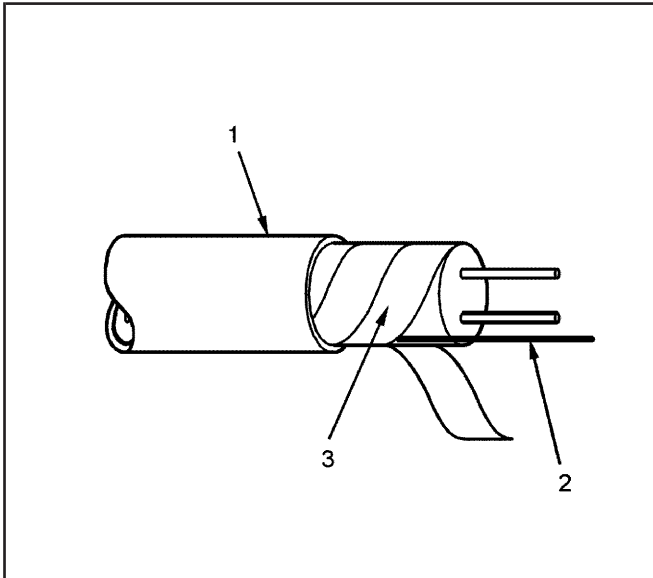
- Use cross-linked polyethylene wire to replace PVC, but do not replace cross-linked polyethylene with PVC.
 - Cross-linked polyethylene wire is not fuel resistant. Do not use to replace wire where there is the possibility of fuel contact.
 - Use a cross-linked polyethylene insulated wire for areas where high temperatures are expected.
4. Strip the insulation.
 - Select the correct size opening in the wire stripper or work down from the largest size.
 - Strip approximately 7.5 mm (5/16 in) of insulation from each wire to be spliced (1).
 5. Select the proper splice sleeve (2) and the required crimp nest tool, refer to the Crimp and Seal Splice Table.
 6. Place the nest tool in the J-38125 crimp tool.
 7. Place the splice sleeve in the crimp tool nest so that the crimp falls at point 1 on the splice.
 8. Close the hand crimper handles slightly in order to hold the splice sleeve firmly in the proper crimp tool nest.
 9. Insert the wires into the splice sleeve until the wire hits the barrel stop. The splice sleeve has a stop in the middle of the barrel in order to prevent the wire from passing through the splice (3).
 10. Close the handles of the J-38125 until the crimper handles open when released. The crimper handles will not open until the proper amount of pressure is applied to the splice sleeve.
 11. Shrink the insulation around the splice.
 - Using the heat torch apply heat to the crimped area of the barrel.
 - Gradually move the heat barrel to the open end of the tubing.
 - The tubing will shrink completely as the heat is moved along the insulation.
 - A small amount of sealant will come out of the end of the tubing when sufficient shrinkage is achieved.

Splicing Twisted or Shielded Cable

Twisted or shielded cable is used to protect wiring from electrical noise. Two-conductor cable is used between the radio and the Delco-Bose® speaker amplifier units and other applications where low level, sensitive signals must be carried.

Step 1 – Strip the Cable

1. Remove the outer jacket (1). Use care not to cut into the drain wire (2) of the mylar tape (3).

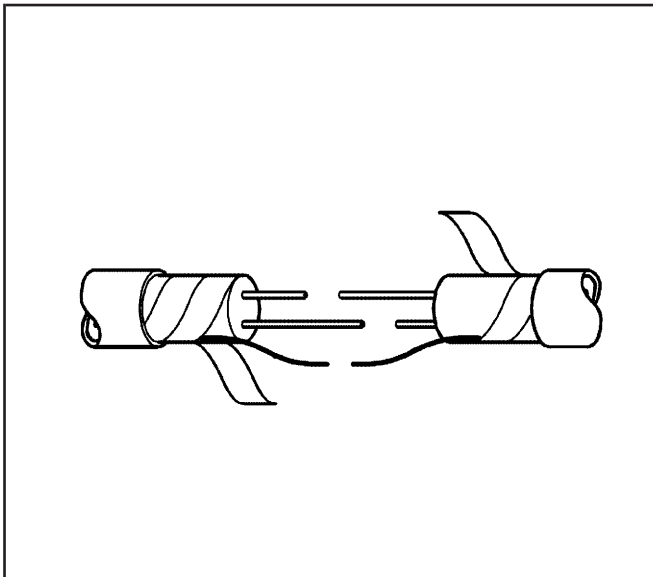


1683739

2. Unwrap the mylar tape. Do not remove the tape because it will be used to re-wrap the conductors after the splice has been made.

Step 2 – Prepare the Splice

1. Straighten the conductors and stagger the splices by 65 mm.



1683740

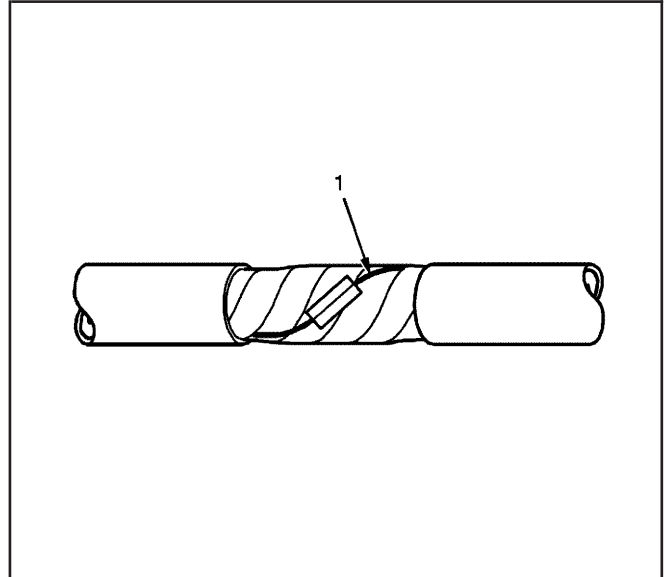
2. Follow the instructions for splicing copper wire.

Step 3 – Reassemble the Cable

1. Re-wrap the conductors with the mylar tape, taking care not to wrap the drain wire (1) in the tape.

Note: Apply the mylar tape with the aluminum side inward to ensure good electrical connection.

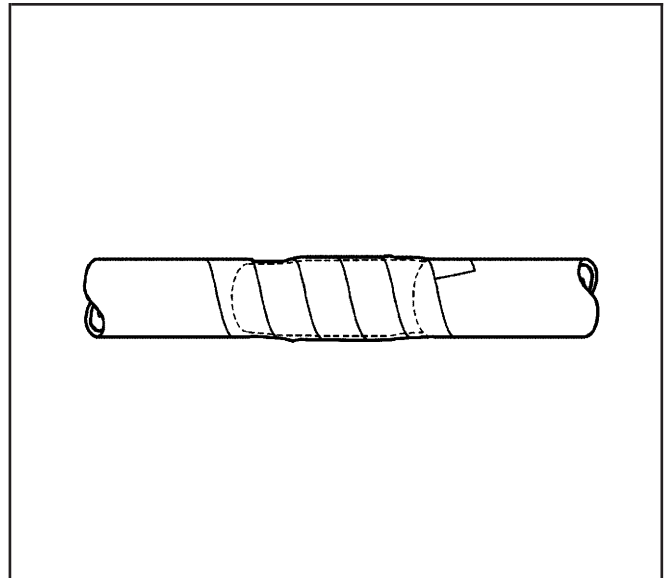
2. Follow the instructions for splicing copper wire and splice the drain wire.
3. Wrap the drain wire around the conductors and tape with mylar tape.



1683742

Step 4 – Tape the Joint

Tape over the entire cable using a winding motion while applying the tape.



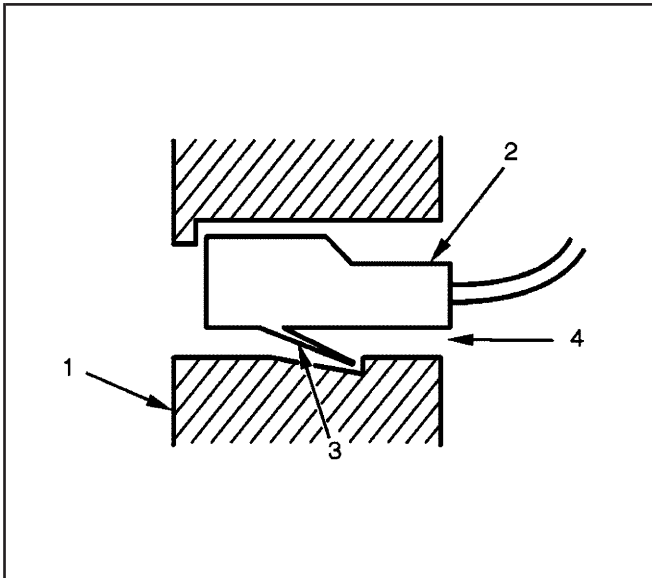
1683745

Connector Repairs

The following general terminal removal procedures can be used on most types of connectors. The removal procedures are divided into three general groups; Push-to-Seat, Pull-to-Seat and Weather Pack®.

Push to Seat Connectors

Push-to-Seat connectors are those which have the terminal inserted in the rear of the connector body when assembled.



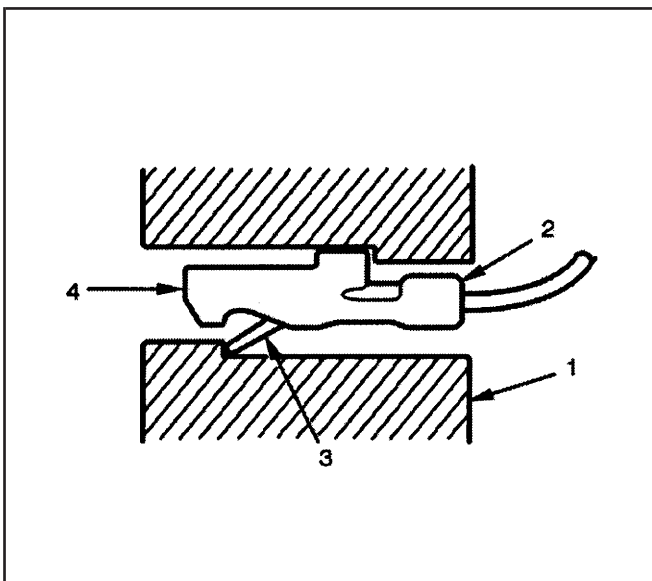
Legend

- (1) Connector Body
- (2) Terminal
- (3) Locking Tang
- (4) Insertion Direction

Pull-to-Seat Connectors

Pull-to-Seat connectors, refer to the following illustration, have the terminal inserted in the front of the connector body when assembled.

Use the proper pick(s) or tool(s) that apply to the appropriate terminal and connector.



Legend

- (1) Connector Body
- (2) Terminal

- (3) Locking Tang
- (4) Insertion Direction

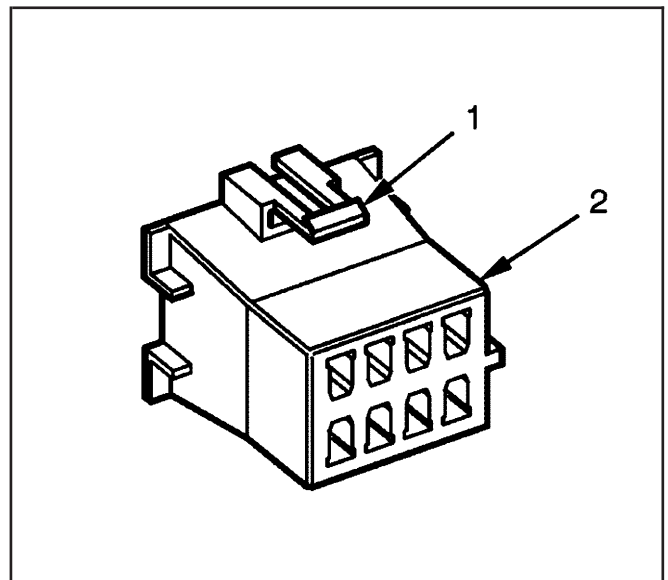
Repairing Push-To-Seat And Pull-To-Seat Connectors

The following steps will enable repair of Push to Seat or Pull to Seat type connectors. The steps are illustrated with typical connectors. A specific connector may differ, but the repair steps are similar. Some connectors do not require all the steps shown.

To repair a connector:

1. Lift up the connector body retaining tangs (1) and pull mating connector bodies (2) apart, or disconnect the connector from the component.

Note: The anti-backout combs must be removed prior to terminal removal and must be replaced when the terminal is repaired and re-seated.

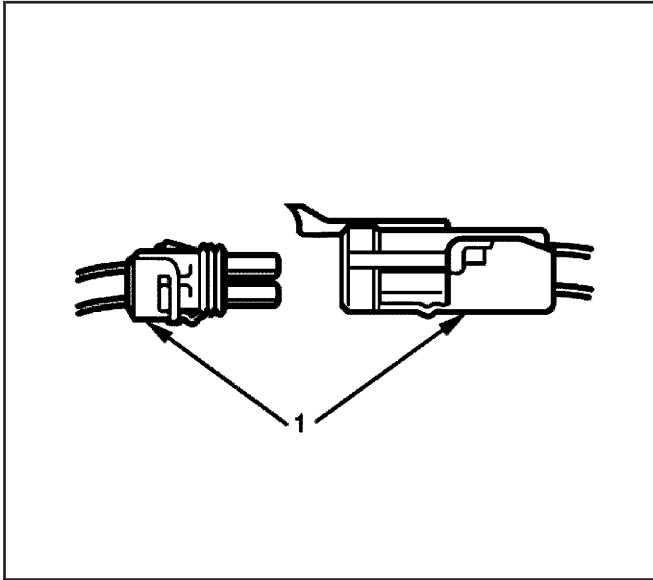


2. Remove any anti-backout combs that may be fitted to the connector.

Anti-backout combs are designed to keep the terminal from backing out of the connector.

11-24 Wiring Systems

Note: A secondary lock aids in terminal retention and is usually moulded as part of the connector body.

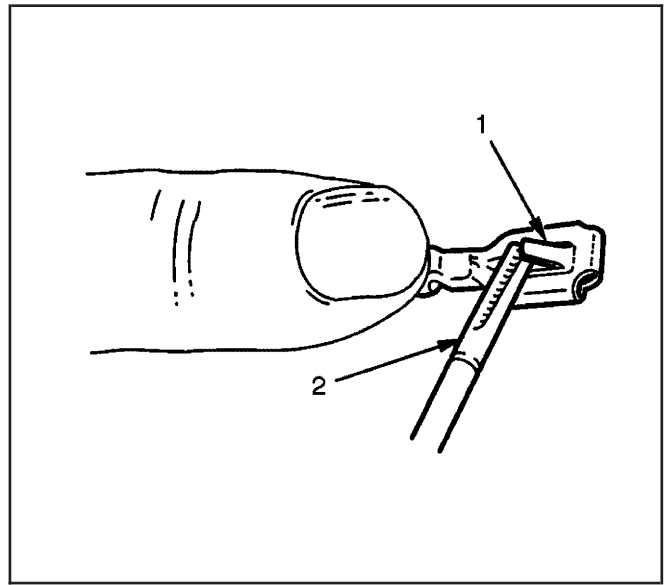


1683758

3. If fitted, open any connector secondary locks (1).
4. Grasp the lead and push the terminal (1) to the forward most position in the connector body (2). Hold the lead at this position.
5. Locate the terminal lock tang (3) in the connector canal.
6. Insert the proper size pick (4) (refer to Terminal Repair Kit J-38125-A) straight into the connector canal at the mating end of the connector.
7. Depress the locking tang to unseat the terminal.
8. For push-to-seat connectors, gently pull on the lead to remove the terminal through the back of the connector.

Note: Never use force to remove a terminal from a connector.

9. For pull-to-seat connectors, gently push on the lead to remove the terminal through the front of the connector.
10. Inspect terminal and connector for damage.
11. Repair or replace parts as necessary.
Refer to Parts Information for availability of terminal/pigtail or connector body assemblies that are serviced separately.
12. Reform lock tang (1) using a wide pick (2) and re-seat terminal in connector body.



1683760

13. Reinstall any anti-backout combs and join the connector bodies.

Connector Position Assurance Locks

The Connector Position Assurance (CPA) is a small plastic insert that fits through the locking tabs of electrical harness connectors. The CPA ensures that the connector halves cannot vibrate apart. You must have the CPA in place in order to ensure good contact between the mating terminals.

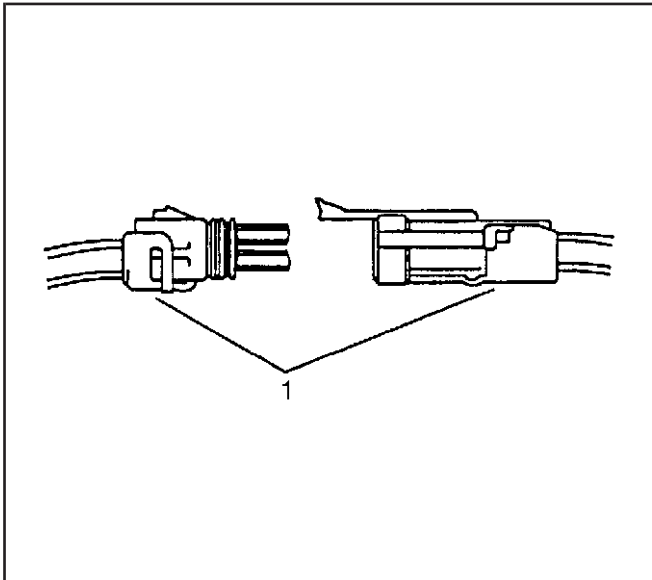
Terminal Position Assurance Locks

The terminal position assurance (TPA) insert resembles the plastic combs used in the control module connectors. The TPA keeps the terminal securely seated in the connector body. Do not remove the TPA from the connector body unless you remove a terminal for replacement.

Push to Seat Connectors

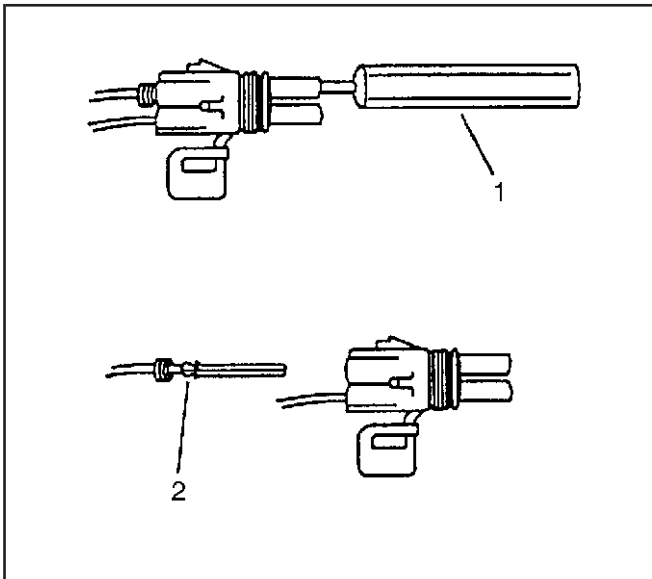
Terminal Removal

Follow the steps below in order to repair push to seat connectors.



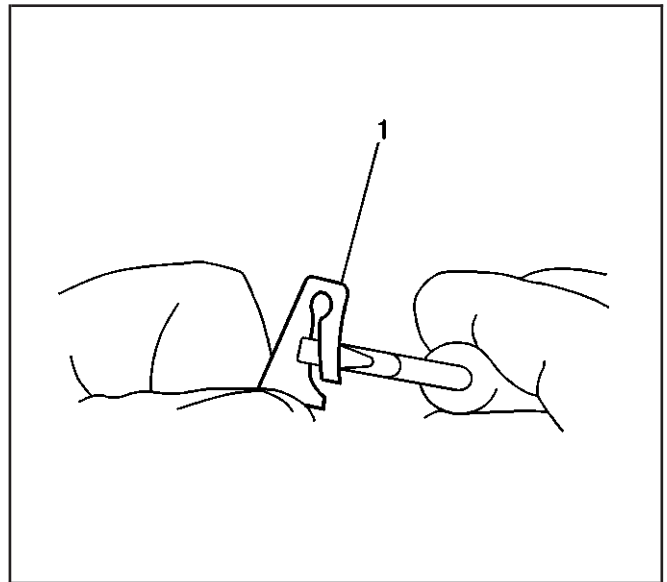
8802

1. Remove the terminal position assurance (TPA) device, the connector position assurance (CPA) device, and/or the secondary lock.
2. Separate the connector halves (1).



8803

3. Use the proper pick or removal tool (1) in order to release the terminal.
4. Gently pull the cable and the terminal (2) out of the back of the connector.



8804

5. Re-form the locking device if you are going to reuse the terminal (1).
6. To repair the terminal, refer to Terminal Repair.

Terminal Repair

1. Slip the cable seal away from the terminal.
2. Cut the wire as close to the terminal as possible.
3. Slip a new cable seal onto the wire.
4. Strip 5 mm (3/16 in) of insulation from the wire.
5. Crimp a new terminal to the wire.
6. Solder the crimp with rosin core solder.
7. Slide the cable seal toward the terminal.
8. Crimp the cable seal and the insulation.
9. If the connector is outside of the passenger compartment, apply grease to the connector.

Reinstalling Terminal

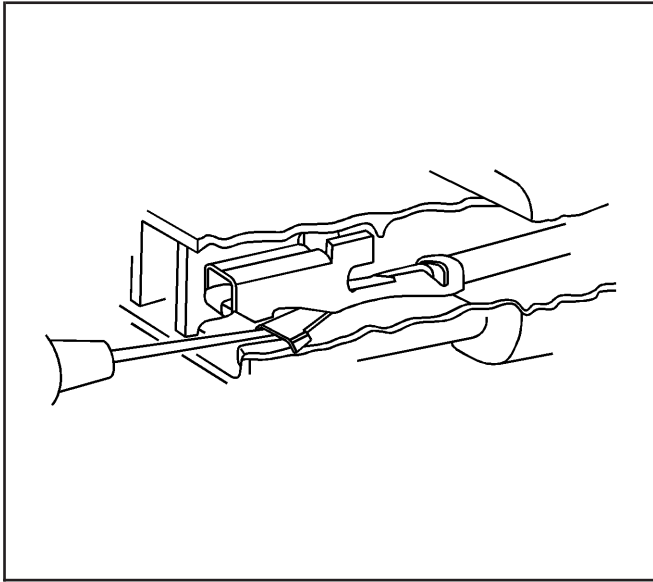
1. In order to reuse a terminal or lead assembly, refer to *Wiring Repairs* on page 11-16.
2. Ensure that the cable seal is kept on the terminal side of the splice.
3. Insert the lead from the back until it catches.
4. Install the TPA, CPA, and/or the secondary locks.

Pull to Seat Connectors

Terminal Removal

If the terminal is visibly damaged or is suspected of having a faulty connection, the terminal should be replaced.

Follow the steps below in order to repair pull-to-seat connectors:



904718

1. Remove the connector position assurance (CPA) device and/or the secondary lock.
2. Disconnect the connector from the component or separate the connectors for in-line connectors.
3. Remove the terminal position assurance (TPA) device.
4. Insert the proper pick or removal tool into the front of the connector body.

Note: On connectors with more than one terminal the service loop may not be large enough to remove the terminal and crimp on a new one. If the terminal wire does not have a large enough service loop for removal, cut the wire 5 cm (2 in) behind the connector before removal.

5. Grasp the wire at the back of the connector body and gently push the terminal (1) out the front of the connector body (3).

Terminal Repair

1. If the wire needed to be cut in order to remove the terminal, gently push a small length of the same size wire through the back of the connector cavity until there is enough wire exposed in order to crimp on a new terminal. If the wire was not cut, cut the existing wire as close to the old terminal as possible.
2. Strip 5 mm (3/16 in) of insulation from the wire.
3. Crimp a new terminal to the wire.
4. Solder the crimp with rosin core solder.

Terminal Installation

1. Align the terminal and pull the wire from the back of the connector in order to seat the terminal.
2. If necessary, cut the new wire to proper length and splice with existing circuit. Refer to Splicing Copper Wire Using Splice Sleeves, in *Wiring Repairs* on page 11-16.
3. If the connector is outside of the passenger compartment, apply dielectric grease to the connector.
4. Install the TPA, CPA and/or the secondary locks.

Weather Pack Connectors

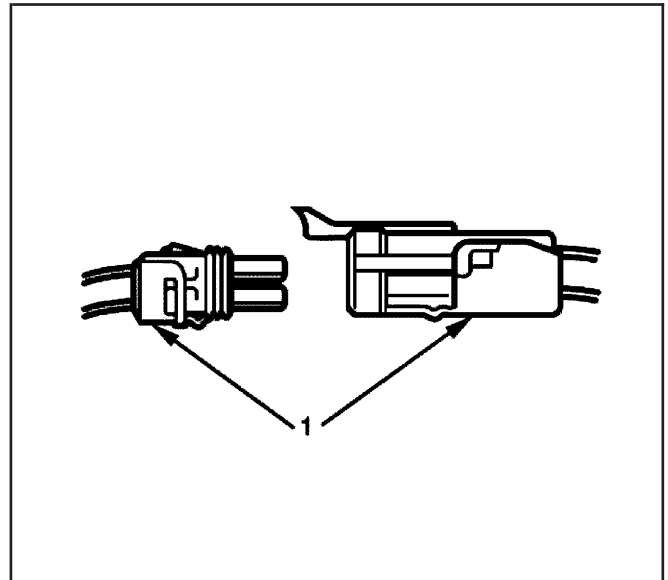
Weather Pack® Connectors

To remove Weather Pack® terminals:

1. Lift up the connector body retaining tangs and pull the mating connector bodies apart, or disconnect the connector from the component.

Note:

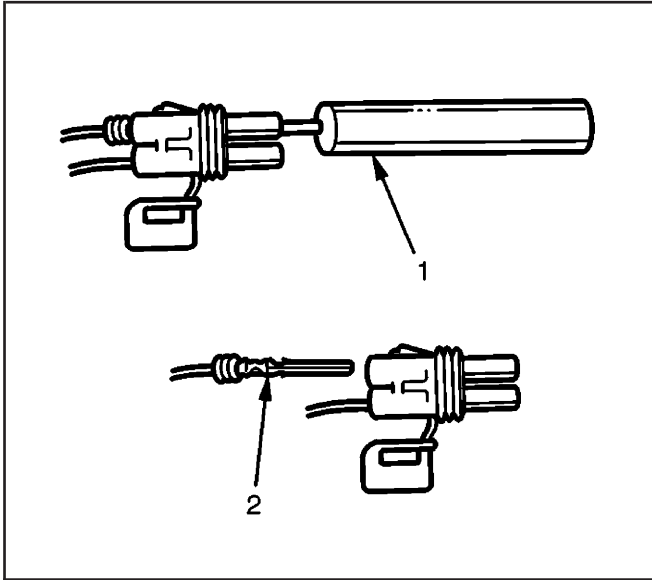
- Anti-backout combs are designed to keep the terminal from backing out of the connector.
- The anti-backout combs must be removed before terminal removal and must be replaced when the terminal is repaired and re-seated.



1683758

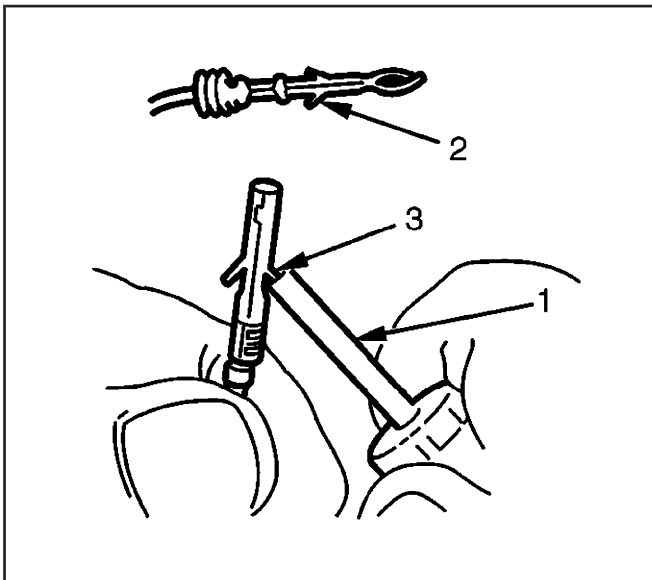
2. If fitted, open secondary lock (1) or remove the anti-backout comb.
3. Grasp the lead and push the terminal to the forward most position. Hold the lead at this position.
4. Insert the Weather Pack® terminal removal tool (1) into the front (mating end) of the connector cavity until it rests on the cavity shoulder.

Note: Never use force to remove a terminal from a connector.



1683762

5. Gently pull on the lead (2) to remove the terminal through the back of the connector.
6. Inspect the terminal and connector for damage.
7. Repair or replace parts as necessary. Refer to Parts Information for availability of terminal/pigtail or connector body assemblies that are serviced separately.
8. Use the Weather Pack® pick (1) to reform the male lock tang (2) or the female lock tang (3).
9. Re-seat the terminal in the connector body.



1683763

10. Close the secondary lock and reinstall the connector to the component or mating connector.

Repairing Connector Terminals

Tools Required

J-38125 Terminal Repair Kit

Use the following repair procedures in order to repair the following:

- Push to Seat terminals
- Pull to Seat terminals
- Weather Pack® terminals

Some terminals do not require all of the steps shown. Skip the steps that do not apply for your immediate terminal repair. The J-38125 contains further information.

1. Cut off the terminal between the core and the insulation crimp. Minimize any wire loss.
For Weather Pack® terminals, remove the seal.
2. Apply the correct seal per gauge size of the wire.
For Weather Pack® terminals, slide the seal back along the wire in order to enable insulation removal.
3. Remove the insulation.
4. For Weather Pack® terminals only, align the seal with the end of the cable insulation.
5. Position the strip in the terminal.
For Weather Pack® terminals, position the strip and seal in the terminal.
6. Hand crimp the core wings.
7. Hand crimp the insulation wings.
For Weather Pack® terminals, hand crimp the insulation wings around the seal and the cable.
8. Solder all of the hand crimp terminals excepting Micro-Pack 100 World terminals. Soldering Micro-Pack 100 World terminals may damage the terminal.

Repair Instructions

Relay Replacement (Fuse Block)

Tools Required

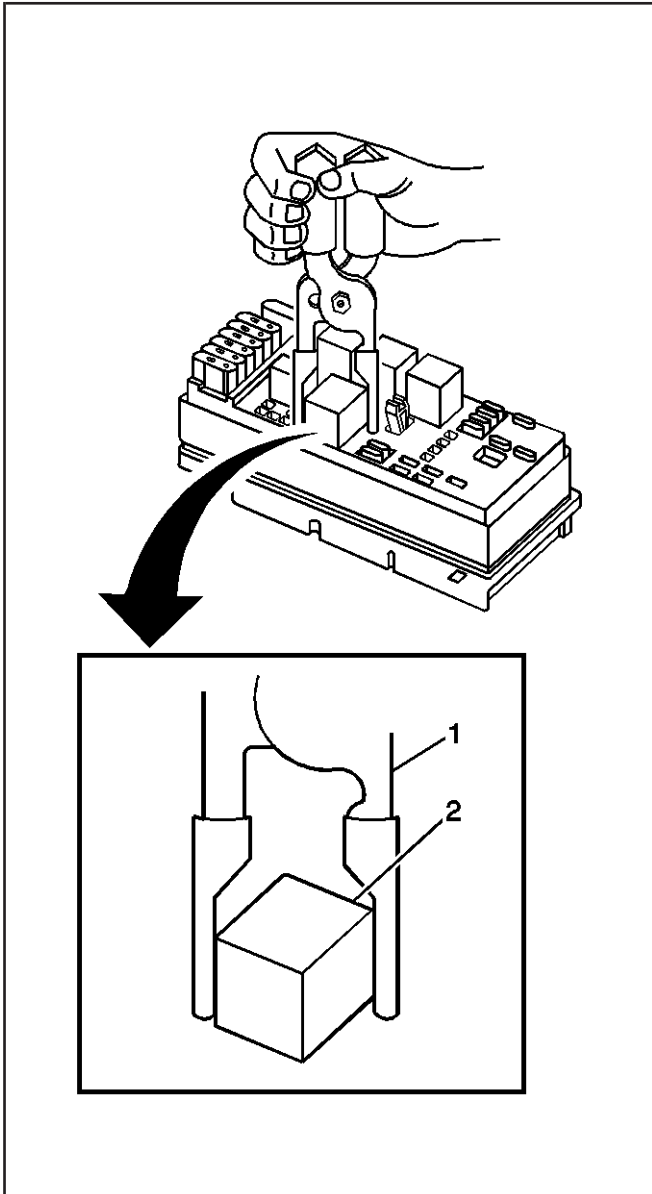
J 43244 Relay Puller Pliers

Removal Procedure

1. Remove the electrical center cover.
2. Locate the relay.

Note:

- Always note the orientation of the relay.
- Ensure that the electrical center is secure, as not to put added stress on the wires or terminals.



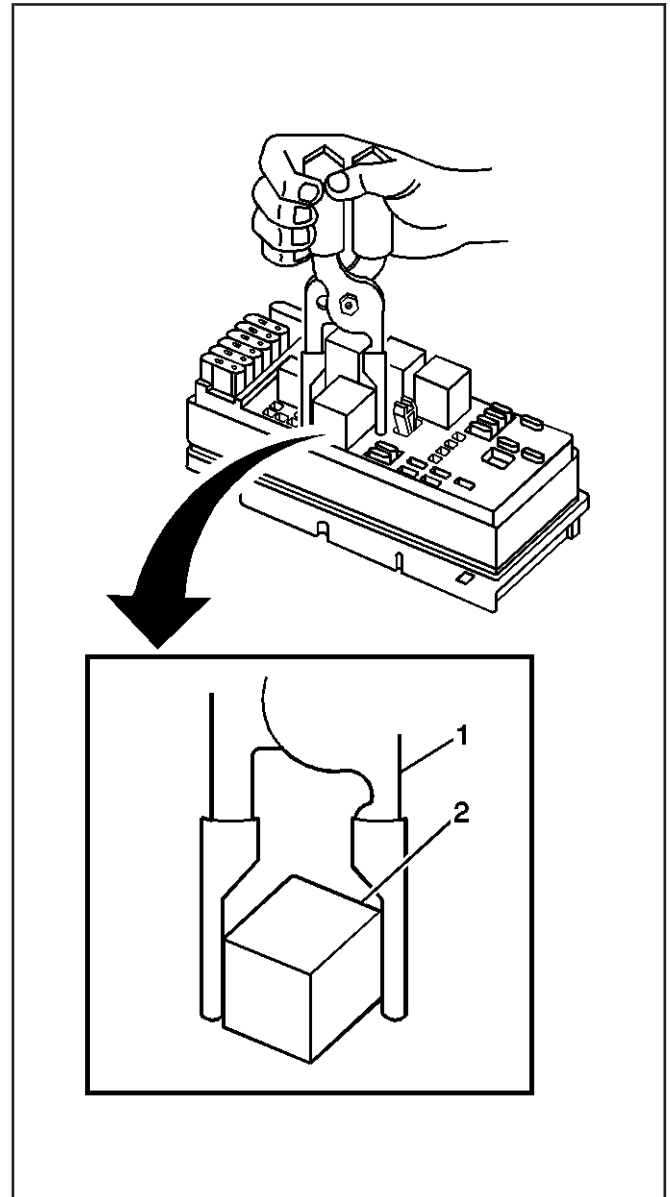
786629

3. Using the J 43244 (1) position the tool on opposing corners of the relay (2).

Notice: Use J43244 to pull the relay straight out from the electrical center terminals. The use of pliers or a flat bladed tool could damage the electrical center.

4. Remove the relay (2) from the electrical center.

Installation Procedure

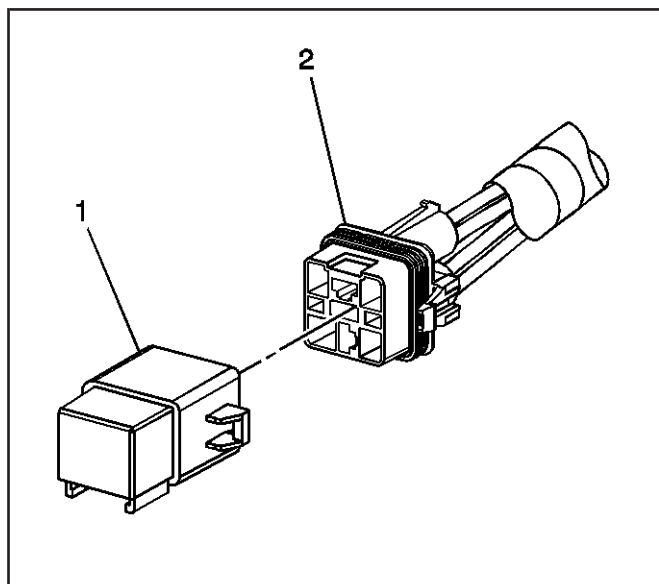


786629

1. Install the relay (2) in the same position as removed.
2. Install the electrical center cover.

Relay Replacement (Harness)

Removal Procedure



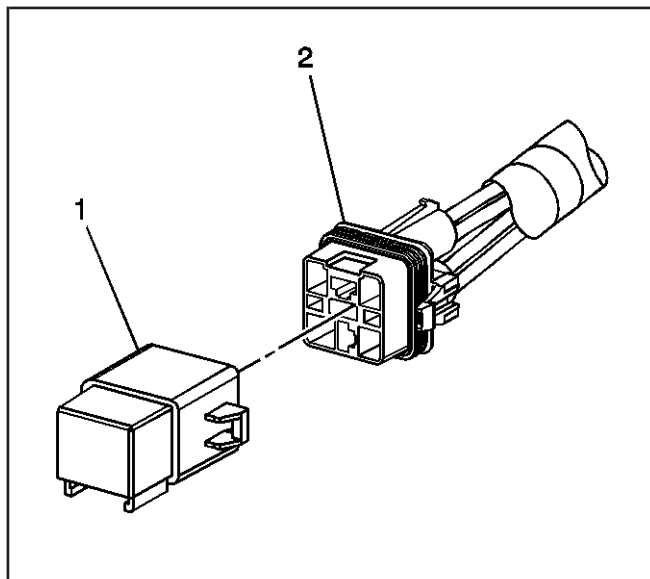
791846

1. Locate the relay.
2. Remove any fasteners which hold the relay in place.
3. Remove any connector position assurance (CPA) devices or secondary locks.

Note: Use care when removing a relay in a wiring harness when the relay is secured by fasteners or tape.

4. Separate the relay (1) from the wire harness connector (2).

Installation Procedure



791846

1. Connect the relay (1) to the wire harness connector (2).
2. Install any connector position assurance (CPA) devices or secondary locks.
3. Install the relay using any fasteners or tape that originally held the relay in place.

Special Tools and Equipment

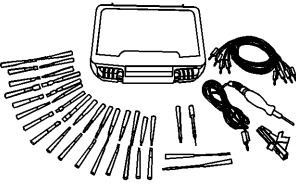
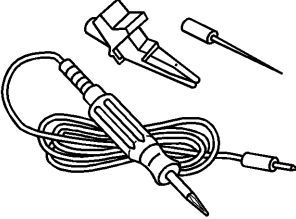
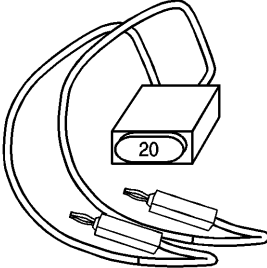
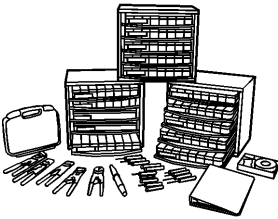
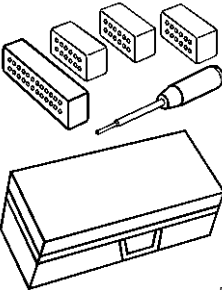
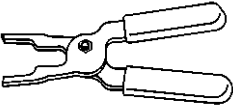
Illustration	Tool Number/ Description
 1423781	J 35616 GM-Approved Terminal Test Kit
 5382	J 35616-200 Test Light – Probe Kit
 1025	J 36169-A Fused Jumper Wire

Illustration	Tool Number/ Description
 9081	J 38125 Terminal Repair Kit
 506278	J 42675 Flat-Wire Probe Adapter
 696431	J 43244 Relay Puller Pliers

SMP0503-12 Preliminary