

Workshop Manual

EFI Diagnostic

c
2(0)

4.3GXi-A/B/C/D, 4.3OSi-A/B/C/D

5.0GXi-A/B/C/D, 5.0OSi-A/B/C/D

5.7Gi-A/B/C/D, 5.7GXi-A/B/C/D/E, 5.7OSi-A/B/C, 5.7OSXi-A/B/C

8.1Gi-B/C/D, 8.1GXi-A/B/C, DPX375-B, DPX420-B

Service Manual Corrections



The Next 4 pages
contain changes to this
service manual

EFI Diagnostic Workshop Manual

Models
7742218

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Page: 1(4)

Volvo Penta has identified various values that were incorrectly published in the original workshop manual. This document is intended as a notice to be used to **replace** information in the original publication. Original text is provided along with the corrections, which are denoted using **boldface italics**.

Page 39: Second sentence "When engine RPM reaches a predetermined value (for this example 400 RPM), the ECM considers the engine running and applies five volts ton the BYPASS line to the IC module"

Should read "When engine RPM reaches a predetermined value (***more than 400 RPMs***), the ECM considers the engine running and applies five volts to the BYPASS line to the IC module."

Page 42: Engine Control Module (ECM) Step 2: "Remove the "J-1" (A) and "J-2" (B) connectors from the ECM (C)."

Change to read "Remove the "***J-2 (A) and J-1 (B)***" connectors from the ECM (C)."

Page 149: DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temperature Indicated

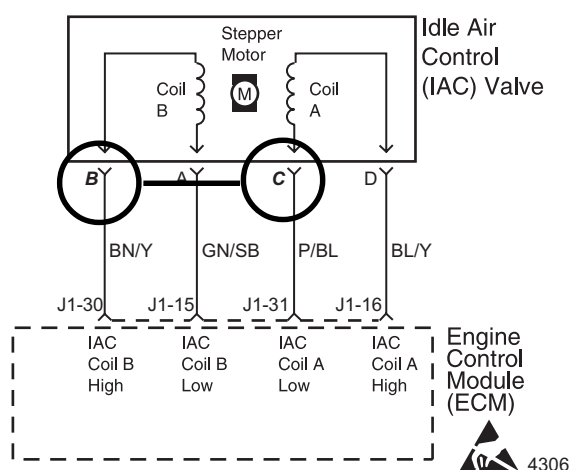
DTC **15** - Engine Coolant Temperature (ECT) Sensor Circuit - High Temperature Indicated

Page 160: Under paragraph "Diagnostic Aids"

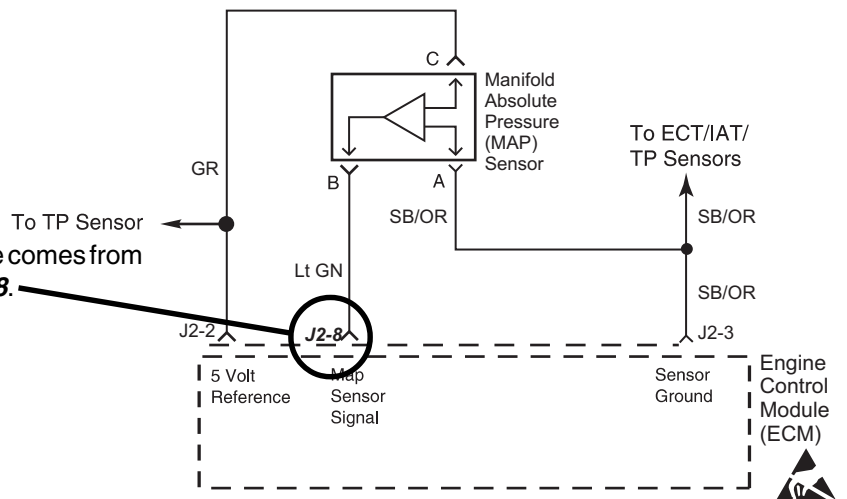
"If engine starts and stalls, it may set a false DTC 41."

"If engine starts and stalls, it may set a false DTC **42**."

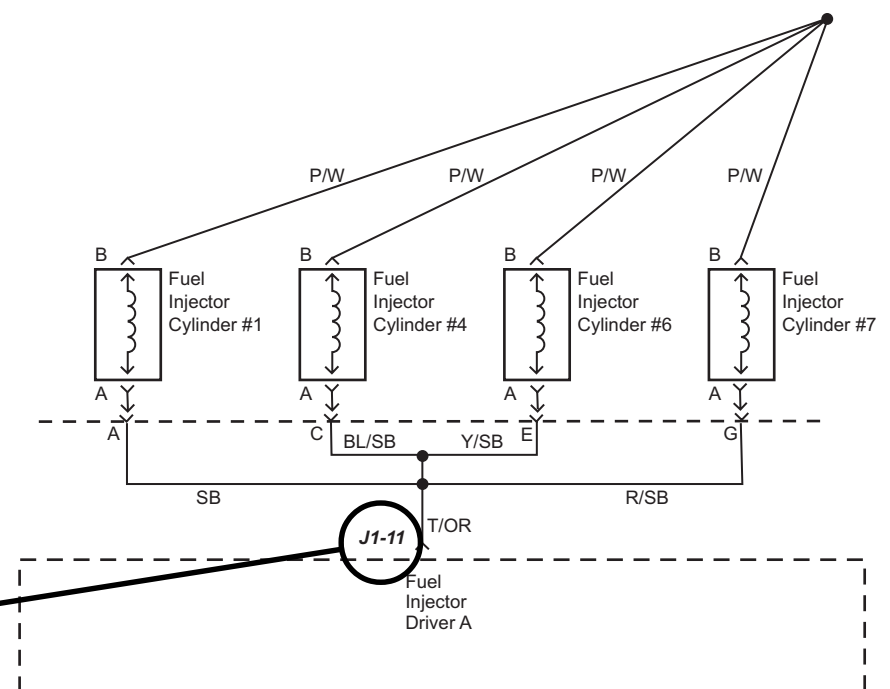
Page 250: B and C terminals on the IAC connector are switched.



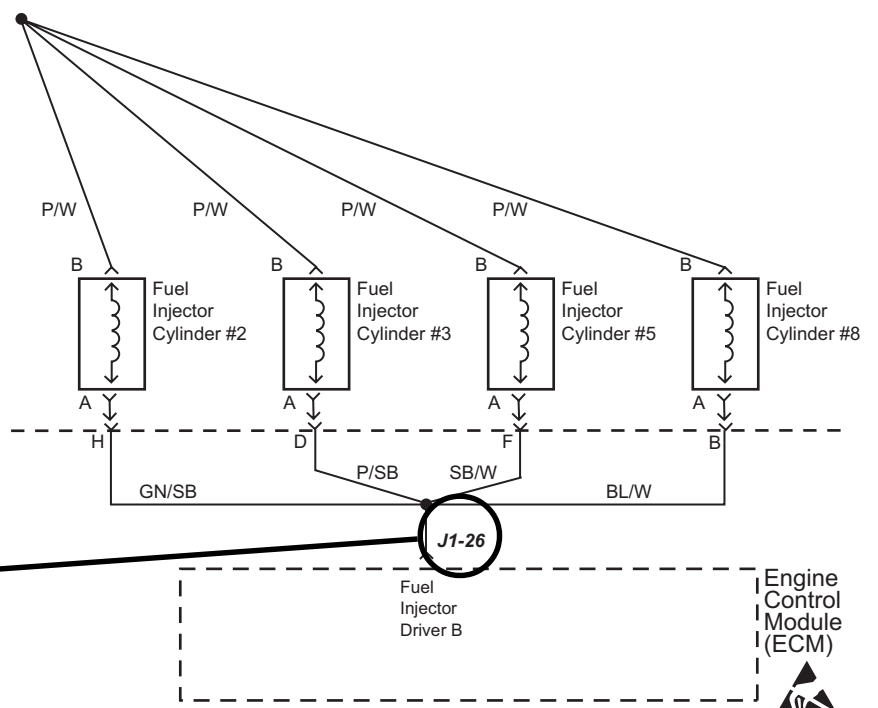
Page 274: MAP diagram. The light green wire comes from pin "B" to J2-6. Make pin "B" **J2-8**.



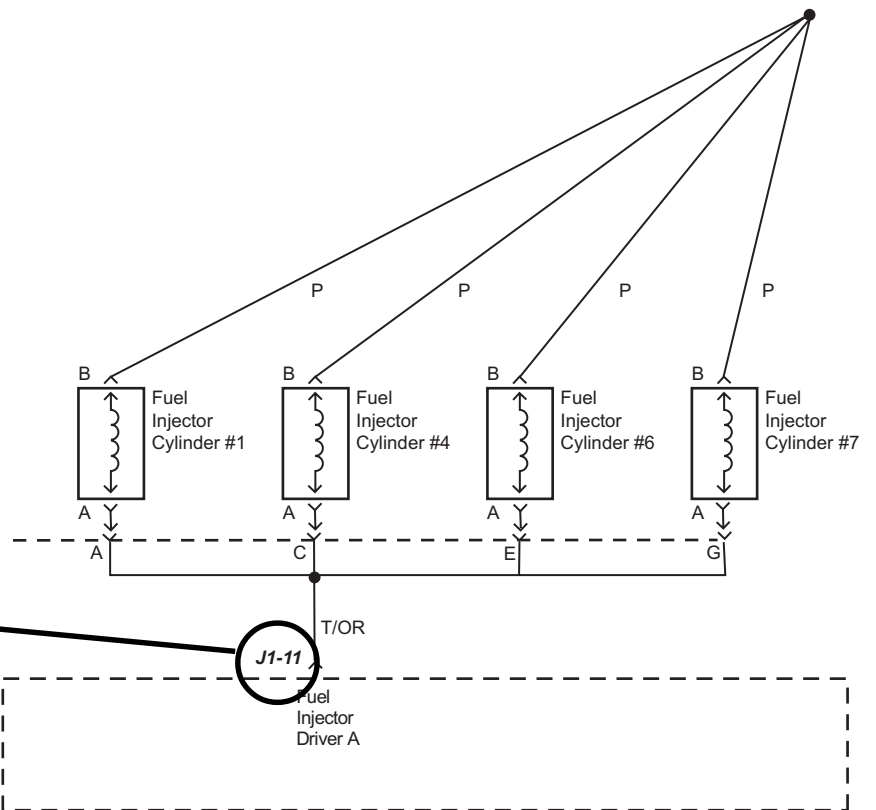
Page 312: J2-26 should be **J2-11**.



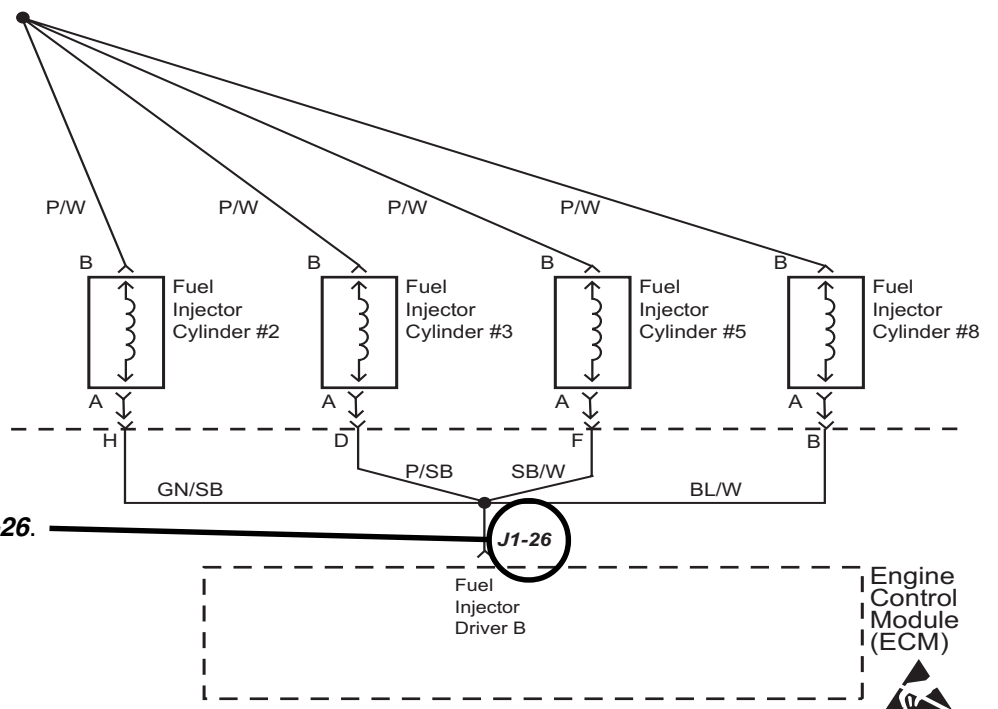
Page 314: J2-11 should be **J2-26**.



Page 416: J2-26 should be **J2-11**.

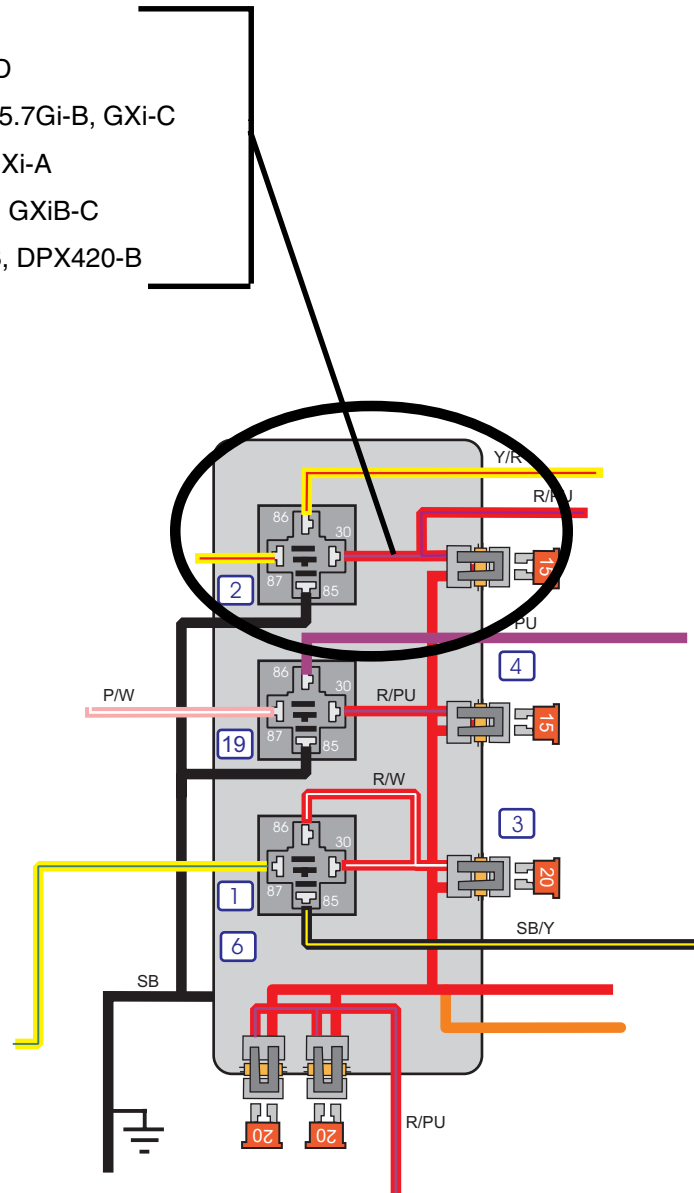


Page 418: J2-11 should be **J2-26**.



Wiring Diagrams: A Red/Blue R/BL wire should connect pin 30 of the Start relay to the adjacent fuse of the following schematics.

4.3GXi-B
4.3GXi-C/D
5.0GXi-B, 5.7Gi-B, GXi-C
8.1Gi-B, GXi-A
8.1Gi-C/D, GXiB-C
DPX375-B, DPX420-B



Wiring Diagrams: Replace the existing Engine Schematic "4.3GXi-A, 4.3OSi-A/B, 5.0GXi-A, 5.0OSi-A/B, 5.7Gi-A, 5.7OSi-A, 5.7GXi-B, 5.7OSXi-A with the attached wiring schematic.

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Safety Warning

To reduce the chance of personal injury and/or property damage, the following cautions must be carefully observed.

Proper service and repair are important to the safety of the service technician and safe, reliable operation of all Electronic Fuel Injection (EFI) equipped engines. If part replacement is necessary, the part must be replaced with one of the same part number or with an equivalent part. Do not use a replacement part of lesser quality.

The service procedures recommended and described in this service manual are effective methods of performing service and repair. Some of these procedures require the use of tools specially designed for the purpose.

Accordingly, anyone who intends to use a replacement part, service procedure or tool, which is not recommended by the manufacturer, must first determine that neither his safety nor the safe operation of the engine will be jeopardized by the replacement part, service procedure or tool selected.

It is important to note that this manual contains various “Safety Warnings” and “Notes” that must be carefully observed in order to reduce the risk of personal injury during service or repair, or the possibility that improper service or repair may damage the engine or render it unsafe. It is also important to understand that these “Safety Warnings” and “Notes” are not exhaustive, because it’s impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.



Danger!

Gasoline and gasoline fumes are extremely flammable and may cause an explosion in certain situations, and may cause personal injury, or death. Always follow all guidelines when working with gasoline to avoid the potential for fire and explosions.

Circuit Protection

⚠ Warning! Do not attempt to connect or disconnect any part of the electrical circuit while the engine is running.

When installing additional electrical accessories always use individual fused circuits. Power takeoff should be made at a terminal strip powered by auxiliary accessory wire and protected by a 20 amp (maximum) fuse.

Circuit Protectors and Locations - TBI Engines

1) 40 Amp Fuse

Protects main harness. Located in fuse box.

2) Spare Fuse

4) 50 Amp Circuit Breaker

Protects trim/tilt motor. Located at front of starboard high-rise exhaust elbow.

5) 15 Amp Fuse

Protects ignition/injector relay and ECM. Located at front of starboard high-rise exhaust elbow inside box.

6) 20 Amp Fuse

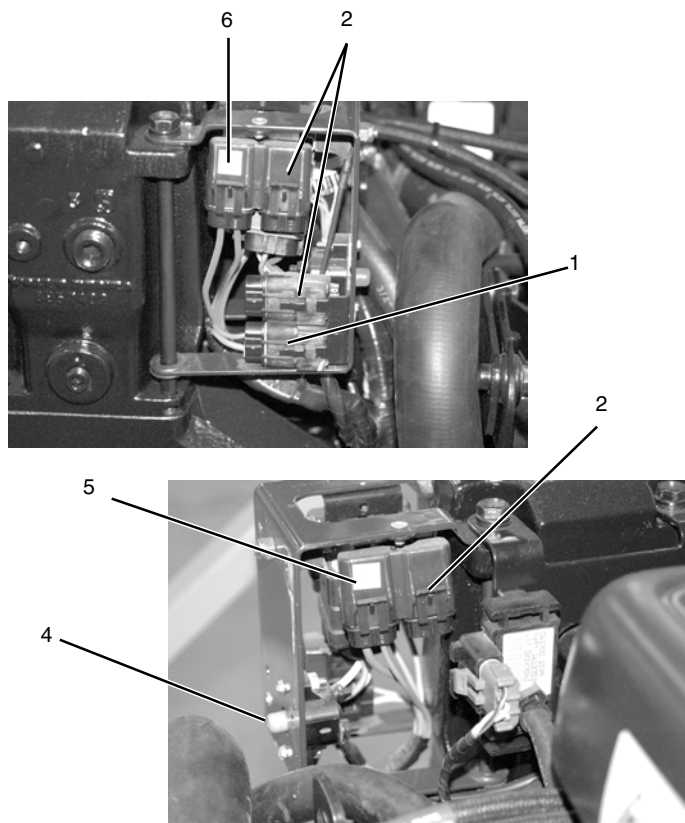
Protects fuel pumps. Located at front of starboard high-rise exhaust elbow.

10 Amp Fuse

Protects trim switch. Located on trim/tilt pump.

SFE 20 Amp Fuse

Protects ignition switch. Located under dash as equipped by boat manufacturer.



Circuit Protectors and Locations - PFI Engines

2) Spare Fuses

4) 50 Amp Circuit Breaker

Protects trim/tilt motor. Located rear starboard adjacent to engine 10 pin connector.

5) 15 Amp Fuse F3

Protects ignition/injector relay and ECM. Located inside fuse box on engine.

6) 20 Amp Fuse F7

Protects fuel pumps. Located inside fuse box on engine.

7) 20 Amp Fuses F1 & F2

Protects main harness. Located inside fuse box.

8) 15 Amp Fuse F4

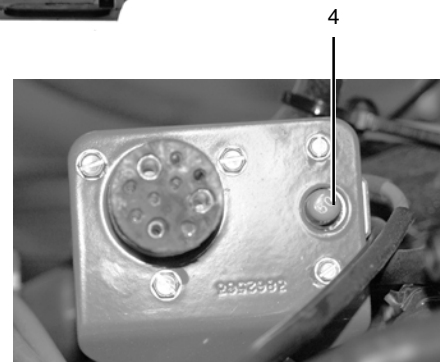
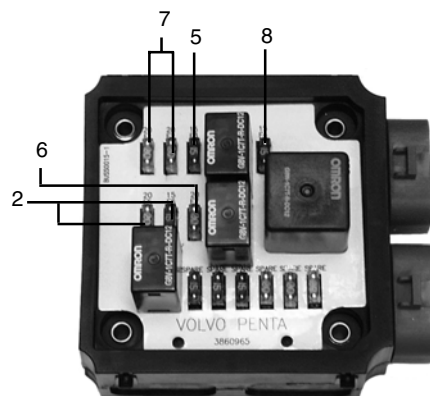
Protects ECM. Located inside fuse box on engine.

10 Amp Fuse

Protects trim switch. Located on trim/tilt pump.

SFE 20 Amp Fuse

Protects ignition switch. Located under dash as equipped by boat-builder.



Battery and Cables

Special Tools Required: Battery Hydrometer

The primary function of the battery is to provide power to operate the starter motor. The battery also supplies power to operate the lights and other electrical equipment which may be used when the engine is not running. On battery ignition systems, the battery must supply the ignition current during the starting period and during the time that the alternator is not producing a sufficient charge to meet operating requirements.

Battery Requirements

- Use a 12 volt battery having a minimum rating of 650 Cold Cranking Amps at 0° F (-18° C), and a 165 minute reserve capacity rating at 80° F (27° C).

Battery Maintenance

There are two things which must be done periodically in order to obtain long life from a battery.

⚠ Warning! Battery electrolyte is a corrosive acid and should be handled with care. If electrolyte is spilled or splashed on any part of the body, immediately flush the exposed area with liberal amounts of water and obtain medical aid as soon as possible.

1. The electrolyte must be kept above the plates and separators at all times. The liquid level should be brought up to the level specified by the battery manufacturer. Acid should never be added except when it is definitely known that some has been lost by spilling, and then only by an experienced battery man.

⚠ Warning! Do not use a jumper cable and a booster battery to start engine. Remove battery from boat and recharge. Fumes vented during charging battery can lead to an explosion.

2. Be sure that the battery is kept nearly at full charge at all times. The state of charge should be checked at frequent intervals by making specific gravity readings with a battery hydrometer. It is suggested that gravity readings and replacement of evaporated water be made every two weeks. Should the gravity fall more than 0.040 specific gravity below a fully charged gravity reading, remove the battery and have it charged.

NOTE! Full charge specific gravity is 1.260 at 80° F (27° C).

Good Battery Servicing Includes the Following Nine Points:

- a. Protect boat against acid damage.
- b. Clean battery.
- c. Inspect cables.
- d. Clean terminals.
- e. Inspect hold-downs.
- f. Inspect casing for leaks.
- g. Make hydrometer test.
- h. Remove battery from boat for tests. Recharge battery if less than 3/4 charged. Make load test.
- i. Add water.

If battery is not in a good state of charge or if it uses an excessive amount of water, check the charging system.

Clean the battery and terminals with a solution of baking soda and water. This will neutralize the acid on the battery. After washing with this solution, flush top of battery with clear water. Care must be taken when washing the battery so that the baking soda and water solution does not enter the battery cells.

Cable Requirements

The battery should be mounted as close to the engine as practical to cut down on battery cable lengths. Follow the recommendations below.

- 0-10 Feet 0 Gauge
- 10-15 Feet 2/0 Gauge
- 15-20 Feet 4/0 Gauge

NOTE! These specifications do not apply to aluminum battery cables. *Volvo Penta* does not recommend the use of aluminum battery cables.

⚠ Warning! To prevent possible explosion or fire, do not substitute automotive parts for the following marine components: starter, alternator, distributor and related ignition parts, spark plug leads, solenoids, fuel pump or fuel filter canister. These components have been specifically designed not to emit fuel vapors or to cause ignition of fuel vapors in the bilge.

Tuning The Engine

The purpose of an engine tune-up is to restore power and performance that has been lost through wear, corrosion or deterioration of one or more parts or components. In the normal operation of an engine, these changes can take place gradually at a number of points, so that it is seldom advisable to attempt an improvement in performance by correction of one or two items only. Time will be saved and more lasting results will be obtained by following a definite and thorough procedure of analysis and correction of all items affecting power and performance. Refer to the **Engine Service Manual** for all tune-up specifications.

Gasoline Requirements

 **DANGER!** Gasoline is extremely flammable and highly explosive under certain conditions. Always stop engine and do not smoke or allow open flames or sparks near the boat when refuelling gas tanks. When filling the gas tank, ground the tank to the source of gasoline by holding the hose nozzle firmly against the side of the deck filler plate, or ground it in some other manner. This action prevents static electricity buildup which could cause sparks and ignite fuel vapors.

USE ONLY UNLEADED FUEL. Use lead-free gasoline with the following minimum or higher octane specification:

Inside the U.S.: (R+M)/2 (AKI) – 87

Outside the U.S.: (RON) – 90

If fuels with 89 AKI pump posted (93 RON) octane number or higher are used an increase in power can be expected with EFI models.

Premium fuel contains injector cleaners and other additives that protect the fuel system and provide optimum performance. *Volvo Penta* suggests the use of 89 AKI or higher fuels.

NOTE! Engine damage resulting from the use of gasoline with octane 86 AKI (89 RON) and lower is considered misuse of the engine and will void the engine warranty.

To prevent gum formation and corrosion in the fuel system, use a Marine Fuel Stabilizer in the gasoline.

Gasoline Containing Alcohol

Many gasolines being sold today contain alcohol. Two commonly used alcohol additives are Ethanol (ethyl alcohol) and Methanol (methyl alcohol).

See the Owner's Manual for your boat to determine if the boat's fuel system is compatible with alcohol blended fuels. If it is compatible, your engine may be operated using gasoline blended with no more than 10% Ethanol (ethyl alcohol) meeting the minimum octane specification. **Do not use any gasoline which contains METHANOL (methyl alcohol).**

NOTE! Serious damage to the boat or engine fuel systems will result from the continued use of fuel containing **METHANOL** (methyl alcohol).

 **DANGER!** Fuel leakage can contribute to a fire and/or explosion.

If you use gasoline containing alcohol, be aware of the following:

- The engine will operate leaner with alcohol blended fuel. This may cause engine problems such as vapor lock, low speed stall, or hard starting.
- Alcohol blended fuels attract and hold moisture. Moisture inside fuel tanks can cause corrosion of the tank material. Inspect fuel tanks at least annually. Replace fuel tanks if inspection indicates leakage or corrosion.
- Inspect nonmetallic parts of fuel system frequently and replace if excessive stiffness, deterioration or fuel leakage is found.

Storage

If the boat is being placed into storage, a gasoline fuel stabilizer must be added to the tank(s) as per the manufacturer's instructions. The amount of stabilizer required is determined by the quantity of fuel and the length of time it will be placed in storage. The maximum period that fuel can be stabilized is six months due to limitations of the stabilizers and fuels.

 **DANGER!** Any fuel leakage should be corrected immediately to prevent possible fire and/or explosion.

 **Caution!** Do not run engine out of fuel or run the electric fuel pumps dry more than 20 seconds. Running the electric fuel pumps dry will cause fuel pump damage.

Prepare a storage mixture

In addition to stabilization of the fuel, it is highly desirable to have the valves and cylinders coated with a light film of oil previously accomplished through "fogging". Today's multiport fuel injection manifolds are designed with a complex air channel design that will not allow the traditional fogging oils to be injected past the throttle plate while running. The oil will get stuck in the plenum and never reach the cylinders. Together with the stabilizer, two-cycle motor oil can be added to fuel for stabilization purposes.

- Using an outboard motor six-gallon fuel tank, add two-cycle motor oil at a ratio of 50:1 (one pint to 6 gallons) and stabilizer at one ounce per gallon (unless stated otherwise on the manufacturer's label). Mix well.
- Disconnect boat fuel line at engine fuel pump. Attach the "storage mix" fuel tank.
- Connect a suitable engine flush device if the boat is not in the water.

Electric fuel pumps and fuel cells

Regardless of the ratio of fuel stabilizer to fuel use, the maximum recommended storage time for gasoline, according to STA-BIL[®], is six months. During final assembly testing at our factory, each engine is run on a fuel mix that is stabilized. Each engine is shut off without running the fuel pumps dry and the fuel system is sealed to prevent damage. Although all reasonable precaution is taken to ensure the fuel system operates properly upon first retail delivery, the amount of time between engine manufacture and retail delivery may exceed the safe stabilization period of the fuel.

Since delivering a quality, dependable product is one of our highest goals; working closely with our suppliers we have determined that some fuel pump failures are the result of gummed fuel and varnish from long term storage.

Noisy Pumps

Electric pumps will often cavitate and become noisy if they are starving for fuel.

A noisy high-pressure pump on a fuel cell may indicate a low fuel level in the reservoir. Check the fuel supply and low pressure pump operation to be sure the reservoir is receiving the correct volume of fuel.

This information may help prevent the needless replacement of pumps in many cases and reduce the repair time for the boat owner.

Periodic Maintenance Chart

Items marked  **Safety Warning** are safety related service points to prevent mechanical failures, fire and explosion. Make sure the safety related service is performed at these points and at the intervals specified.

Electrical

Service Point	Every 25 Hours or as Specified	Every 50 Hours or as Specified	Recommendations
Battery	Check electrolyte level monthly.	Tighten connections.	Recharge battery if specific gravity is below 1.220 corrected for temperature.
 Electrical System		Check connections and insulation.	Tighten loose connections and replace deteriorating wiring.
 High Tension Leads		Check for corrosion, deterioration or arching. Boots must fit snugly on coils and spark plugs.	If damaged, replace with specified Volvo Penta parts. Maintain original routing and support.
 Ignition Coils		Check for arching or cracks in plastic portion of coil.	Replace with specified Volvo Penta parts.
 Spark Plugs		‡ Annually check ceramic for cracks. Replace, or clean and gap.	If damaged, replace with specified Volvo Penta parts. Maintain original routing and support.

‡ Replace Platinum tipped spark plugs at 500 hours or every 3 years whichever occurs first.

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Fuel

Service Point	Every 25 Hours or as Specified	Every 50 Hours or as Specified	Recommendations
 Flame Arrestor – Mounting		Clean and check annually.	Tighten clamp. Replace if damaged.
 Fuel Filter		Replace annually.	Replace fuel filter.
 Fuel System	Check for leaks daily.	† See “Storage” earlier in this section.	Tighten connections. Replace with Volvo Penta components.
 Fuel Tank		Check for water in fuel tank.	Keep tank filled with recommended fuel to prevent condensation.
 Non-Metallic fuel hoses		Check for excessive stiffness, deteriorated and/or leakage every 50 hours or monthly, whichever occurs first.	Replace as necessary with A.B.Y.C.* approved components.

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*American Boat and Yacht Council

† Storage recommendations for fuel systems.

Abbreviations

BARO	Barometric Pressure	I/O	Input/Output
BAT	Battery, Battery Positive Terminal, Battery or System Voltage	kPa	Kilopascal
B+	Battery Positive	KS	Knock Sensor
CKT	Circuit	KV	Kilovolts
CONN	Connector	MAP	Manifold Absolute Pressure
CT	Code Tool	MEFI	Marine Electronic Fuel Injection
CYL	Cylinder	MSEC	Millisecond
DEG	Degrees	N/C	Normally Closed
DI	Distributor Ignition	N/O	Normally Open
DIAG	Diagnostic	OBD	On-Board Diagnostic System Check
DIST	Distributor	OPT	Optional
DLC	Data Link Connector	PFI	Port Fuel Injection
DTC	Diagnostic Trouble Code	PROM	Programmable Read Only Memory
DVOM	Digital Volt Ohmmeter	PWM	Pulse Width Modulation
ECM	Engine Control Module	RAM	Random Access Memory
ECT	Engine Coolant Temperature Sensor	REF HI	Reference High
EEPROM	Electronic Erasable Programmable Read Only Memory	REF LO	Reference Low
EI	Electronic Ignition	ROM	Read Only Memory
EMI	Electromagnetic Interference	SLV	Slave
ENG	Engine	TACH	Tachometer
E-STOP	Emergency Stop	TBI	Throttle Body Injection
GND	Ground	TERM	Terminal
GPH	Gallons Per Hour	TP	Throttle Position Sensor
IAC	Idle Air Control	V	Volts
IAT	Intake Air Temperature	VAC	Vacuum
IC	Ignition Control	WOT	Wide Open Throttle
IGN	Ignition	HG	Inches Of Mercury
INJ	Injector		

Aftermarket (Add-On) Electrical And Vacuum Equipment

Aftermarket, add-on electrical and vacuum equipment is defined as any equipment installed on an engine after leaving the factory that connects to the engine's electrical or vacuum systems.

NOTE! Do not attach add-on vacuum operated equipment to this engine. The use of add-on vacuum equipment may result in damage to engine components or systems.

NOTE! Connect any add-on electrically operated equipment to the engine's electrical system at the accessory battery (power and ground) in order to prevent damage to the vessel.

Add-on electrical equipment, even when installed to these strict guidelines, may still cause the engine system to malfunction. This may also include equipment not connected to the vessel's electrical system such as portable telephones and radios. Therefore, the first step in diagnosing any engine problem, is to eliminate all aftermarket electrical equipment from the vessel. After this is done, if the problem still exists, diagnose the problem in the normal manner.

Visual/Physical Inspection

A careful visual and physical inspection must be performed as part of any diagnostic procedure. This can often lead to fixing a problem without further diagnostics. Inspect all vacuum hoses for correct routing, pinches, cracks or disconnects. Be sure to inspect hoses that are difficult to see. Inspect all the wires in the engine compartment for proper connections, burned or chafed spots, pinched wires or contact with sharp edges or hot manifolds. This visual/physical inspection is very important. It must be done carefully and thoroughly.

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.

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.

Engine Control Module (ECM) Self-Diagnostics

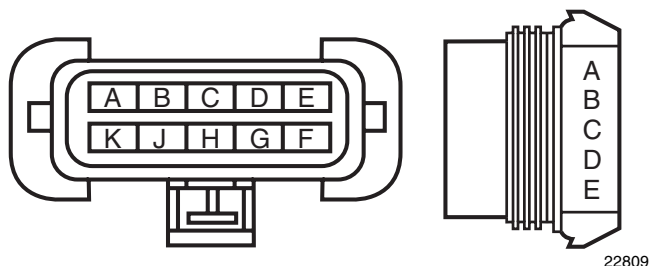
The Engine Control Module (ECM) performs a continuous self-diagnosis on certain control functions. This diagnostic capability is complemented by the diagnostic procedures contained in this manual. The ECM's language for communicating the source of a malfunction is a system of Diagnostic Trouble Codes (DTC's). The DTC's are two digit numbers that can range from 12 to 81. When a malfunction is detected by the ECM, a DTC is set and the Malfunction Indicator Lamp (MIL) is illuminated on the DTC tool.

On 43GXi-A, 43GXi-B, 50GXi-A, 50GXi-B, 57Gi-A, 57Gi-B, 57GXi-B, 57GXi-C, 81Gi-B, 81GXi-A, DPX375-B, DPX420-B, 43OSi-B, 50OSi-B, 57OSi-A, 57OSXi-A an audible warning alarm will be activated any time a code is present.

On 43GXi-C, 50GXi-C, 57Gi-C, 57GXi-D, 81Gi-C, 81GXi-B, DPX375-C, DPX420-C, 43OSi-C, 50OSi-C, 57OSi-B, 57OSXi-B an audible alarm will be activated only when codes for high exhaust temperature, high engine temperature, and low oil pressure are present.

Reading Diagnostic Trouble Codes (DTC's)

The provision for communicating with the ECM is the Data Link Connector (DLC). It is part of the engine wiring harness, and is a 10-pin connector, which is electrically connected to the ECM. It is used in the assembly plant to receive information in checking that the engine is operating properly before it leaves the plant. The DTC(s) stored in the ECM's memory can be retrieved two different ways. One way is with a Diagnostic Trouble Code (DTC) tool. The preferred way is through a scan tool, a hand-held diagnostic scanner plugged into the DLC.



Once the DTC tool has been connected, and “service mode” or “ON” selected, the ignition switch must be moved to the ignition “ON”, engine “OFF” position. At this point, the DTC tool should flash DTC 12 two times consecutively. This would be the following flash sequence: “flash, pause, flash-flash, long pause, flash, pause, flash-flash.” DTC 12 indicates that the ECM's diagnostic system is operating. If DTC 12 is not indicated, a problem is present within the diagnostic system itself, and should be addressed by consulting the “On-Board Diagnostic (OBD) System Check”.

Following the output of DTC 12, the DTC tool will indicate a DTC two times if a DTC is present, or it will continue to flash DTC 12. If more than one DTC has been stored in the ECM's memory, the DTC's will be flashed out from the lowest to the highest, with each DTC being flashed two times. At the end of the DTC's, the ECM will simply go back and start over with flashing DTC 12.

Service Mode

When the DTC tool is installed at the DLC and “service mode” or “ON” is selected, the system will enter what is called the “Service Mode”. In this mode, the ECM will:

- Display a DTC 12 by flashing the DTC tool, indicating that the diagnostic system is working.
- Display any stored DTC's by flashing the DTC tool. Each DTC will be flashed two times, then DTC 12 will be flashed again.
- The ignition timing is controlled to a fixed timing programmed in the ECM.
- Control the Idle Air Control (IAC) valve to maintain approximately 1000 RPM.

Normal Mode

When the DTC tool is in the “normal mode” or “OFF”, it has no affect on the engine operation.

On-Board Diagnostic (OBD) System Check

After the visual/physical inspection, the “On-Board Diagnostic (OBD) System Check” is the starting point for all diagnostic procedures.

The correct procedure to diagnose a problem is to follow two basic steps:

1. Are the on-board diagnostics working? This is determined by performing the “On-Board Diagnostic (OBD) System Check”. Since this is the starting point for the diagnostic procedures, always begin here. If the onboard diagnostics are not working, the OBD system check will lead to a diagnostic table to correct the problem. If the onboard diagnostics are working properly, the next step is:
2. Is there a DTC stored? If a DTC is stored, go directly to the number DTC table. This will determine if the fault is still present.

DLC Scan Tools

The ECM can communicate a variety of information through the DLC. This data is transmitted at a high frequency which requires a scan tool for interpretation.

With an understanding of the data which the scan tool displays, and knowledge of the circuits involved, the scan tool can be very useful in obtaining information which would be more difficult or impossible to obtain with other equipment.

A scan tool does not make the use of diagnostic tables unnecessary, nor do they indicate exactly where the problem is in a particular circuit. Tables are provided for the use of a scan tool (scan diagnostics), or with the DTC tool (non-scan diagnostics). The non-scan diagnostics are limited to basic circuits. For complete diagnostics, a scan tool must be used.

Scan Tool Use With Intermittents

The scan tool provides the ability to perform a “wiggle test” on wiring harnesses or components with the engine not running, while observing the scan tool display.

The scan tool can be plugged in and observed while driving the vessel under the condition when the engine drivability is poor. If the problem seems to be related to certain parameters that can be checked on the scan tool, they should be checked while driving the vessel. If there does not seem to be any correlation between the problem and any specific circuit, the scan tool can be checked on each position, watching for a period of time to see if there is any change in the readings that indicates an intermittent operation.

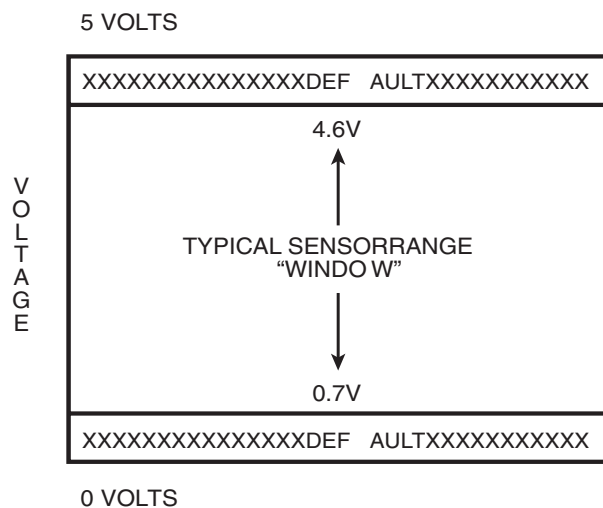
The scan tool is also an easy way to compare the operating parameters of a poorly operating engine with those of a known good one. For example, a sensor may shift in value but not set a DTC. Comparing the sensor's readings with those of a known good identical vessel may uncover the problem.

The scan tool has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the scan tool successfully for diagnosis lies in the technicians ability to understand the system they are trying to diagnose, 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.

How Diagnostic Trouble Codes (DTC) Are Set

The ECM is programmed to receive calibrated voltage signals from the sensors. The voltage signal from the sensor may range from as low as 0.1 volt to as high as 4.9 volts. The sensor voltage signal is calibrated for engine application. This would be the sensor's operating parameter or "window." The ECM and sensors will be discussed further in the *ECM and Sensor* section.

If a sensor is within its operating or acceptable parameters, the ECM does not detect a problem. When a sensor voltage signal falls out of this "window," the ECM no longer receives a signal voltage within the operating "window." When the ECM does not receive the "window" voltage for a calibrated length of time, a DTC will be stored. The MIL will be illuminated and a known default value will replace the sensor value to restore limited engine performance.



Sensor Voltage Parameters

Clearing Diagnostic Trouble Codes (DTC tool TBI only)

1. Install Diagnostic Trouble Code (DTC) tool.
2. Ignition "ON", engine "OFF".
3. Switch DTC tool to "service mode" or "ON."
4. Move the throttle from 0% (idle) to 100% (WOT) and back to 0%.
5. Switch DTC tool to "normal mode" or "OFF." (If this step is not performed, the engine may not start and run).
6. Turn ignition "OFF" for at least 20 seconds.
7. Ignition "ON", engine "OFF".
8. Switch DTC tool to "service mode" or "ON" and verify DTC 12 only. Remove DTC tool.
9. If original DTC(s) are still present, check "NOTE" below and repeat the DTC clearing procedure.
10. If new DTC(s) are displayed, perform the OBD system check.

NOTE! When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the "OFF" position after codes are cleared or the DTC's will not clear.

Clearing Diagnostic Trouble Codes (Scan)

- 1. Install scan tool.
- 2. Start engine.
- 3. Select “clear DTC’s” function.
- 4. Clear DTC’s.
- 5. Turn ignition “OFF” for at least 20 seconds.
- 6. Turn ignition “ON” and read DTC’s. If DTC’s are still present, check “NOTE” below and repeat procedure following from step 2.

NOTE! When clearing DTC’s with or without the use of a scan tool, the ignition must be cycled to the “OFF” position after codes are cleared or the DTC’s will not clear.

Non-Scan Diagnosis Of Drivability Concerns (No DTC’s Set)

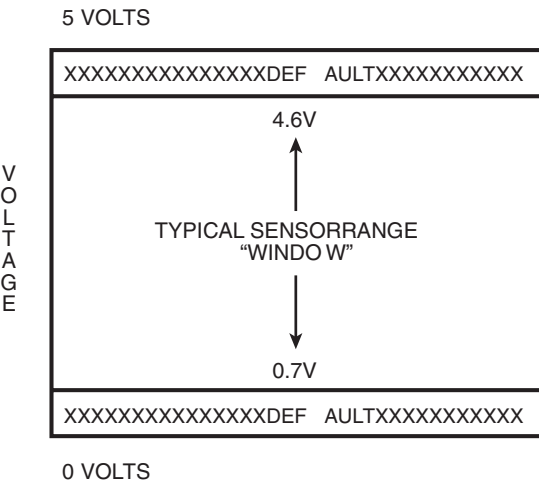
If a drivability concern still exists after following the OBD system check and reviewing the *Symptoms* tables, an out of range sensor may be suspected. Because of the unique design of the MEFI system, the ECM will replace sensed values with calibrated default values in the case of a sensor or circuit malfunction. By allowing this to occur, limited engine performance is restored until the vessel is repaired. A basic understanding of sensor operation is necessary to be able to diagnose an out of range sensor.

If the sensor is out of range, but still within the operating “window” of the ECM, the problem will go undetected by the ECM and may result in a drivability concern.

A good example of this would be if the coolant sensor was reading incorrectly and indicating to the ECM that coolant temperature was at 50°F, but actual coolant temperature was at 150°F. This would cause the ECM to deliver more fuel than what was actually needed by the engine. This resulted in an overly rich condition, causing rough running. This condition would not have caused a DTC to set, as the ECM interprets this as within the operating “window”.

To identify a sensor that is out of range, you may unplug the sensor electrical connector while the engine is running. After about 2 minutes, the DTC for that sensor will set, illuminate the MIL, and replace the sensed value with a calibrated default value. If at that point, a noticeable performance increase is observed, the non-scan DTC table for that particular sensor should be followed to correct the problem.

NOTE! Be sure to clear each DTC after disconnecting and reconnecting each sensor. Failure to do so may result in a mis-diagnosis of the drivability concern.



Sensor Temperature Parameters

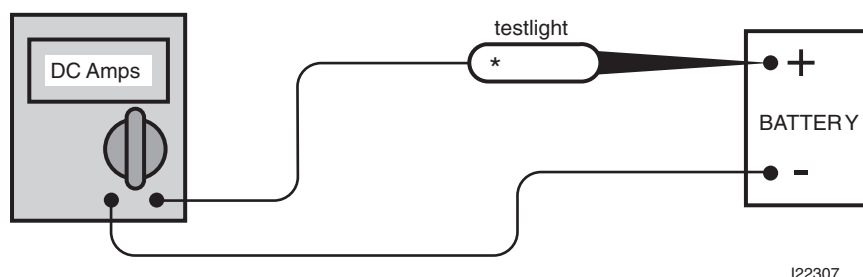
Service Precautions

Tools Needed To Service The System

Refer to *Special Tools and Equipment List*.

The following requirements must be observed when working on MEFI equipped engines.

1. Before removing any ECM system component, disconnect the negative battery cable.
2. Never start the engine without the battery being solidly connected.
3. Never separate the battery from the on-board electrical system while the engine is running.
4. Never separate the battery feed wire from the charging system while the engine is running.
5. When charging the battery, disconnect it from the vessel's electrical system.
6. Ensure that all cable harnesses are connected solid and the battery connections are thoroughly clean.
7. Never connect or disconnect the wiring harness at the ECM when the ignition is switched "ON".
8. Before attempting any electric arc welding on the vessel, disconnect the battery leads and the ECM connector(s).
9. When steam cleaning engines, do not direct the nozzle at any ECM system components. If this happens, corrosion of the terminals or damage of components can take place.
10. Use only the test equipment specified in the diagnostic tables, since other test equipment may either give incorrect test results or damage good components.
11. All measurements using a multimeter must use a digital meter with a rating of 10 megaohm input impedance.
12. When a test light is specified, a "low-power" test light must be used. Do not use a high-wattage test light. While a particular brand of test light is not suggested, a simple test on any test light will ensure it to be safe for system circuit testing. Connect an accurate ammeter (such as the high-impedance digital multimeter) in series with the test light being tested, and power the test light ammeter circuit with the vessel battery.

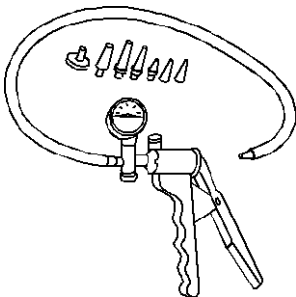
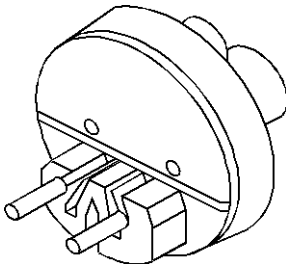
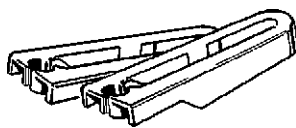
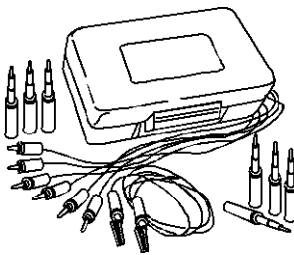
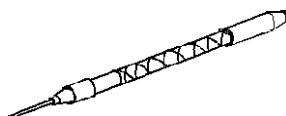
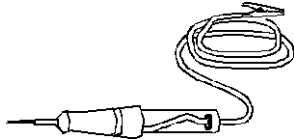
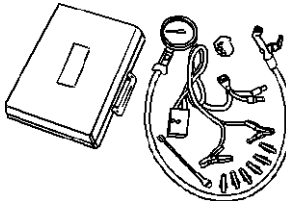


If the ammeter indicates LESS than 3/10 amp (.3A) current flow, the testlight is SAFE to use.

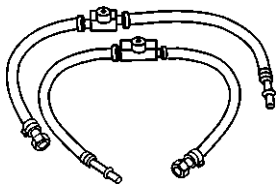
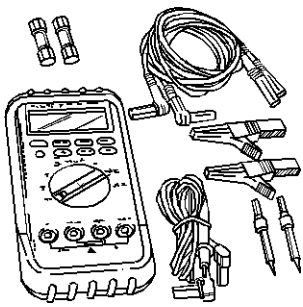
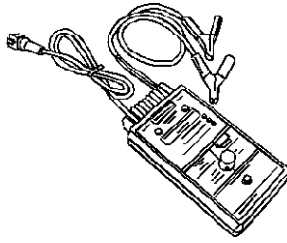
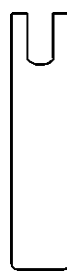
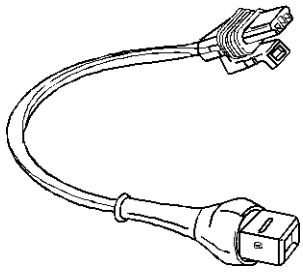
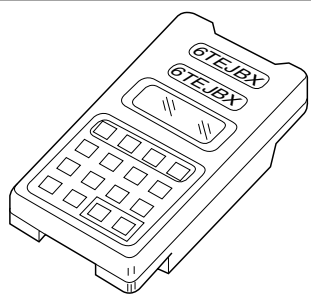
If the ammeter indicates MORE than 3/10 amp (.3A) current flow, the test light is NOT SAFE to use.

Test Light Power Check

Special Tools and Equipment

Illustration	Tool Number/Description	Illustration	Tool Number/Description
	J 23738-A Vacuum Pump		3851090 Injector Test Lamp Kit
	J 41769 Fuel Quick Connect Tool		J 35616-A Connector Test Adapter Kit
	J 28742-A Weather Pack Terminal Remover		3856012 Metri-Pack Terminal Kit
	J 34142-B Test Lamp		3855533 Fuel Pressure Gauge Kit

Special Tools and Equipment (cont.)

Illustration	Tool Number/Description	Illustration	Tool Number/Description
	J 37287 Inlet and Return Fuel Line Shut-Off Adapters		J 39200 Digital Multimeter
	J 39021 Fuel Injector Coil and Balance Tester		J 43013 Fuel Injector Assembly and Removal tool
	J 39021-380 Fuel Injector Test Harness		3855947 Scan Tool

Special tools used in this manual that begin with “J” are available on the internet from Kent-Moore division of SPX Corporation:

<http://www.spxkentmoore.com>

Mail:

SPX Corporation
Kent-Moore
28635 Mound Road
Warren, MI 48092-3499

Phone Orders:

1-800-345-2233

1-810-574-2332

Fax Orders:

1-800-578-7375

1-810-578-7375

All other special tools used in this manual are available from your Volvo Penta dealer/distributor.

To locate a dealer visit us on the internet at:

<http://www.volvopenta.com> and click on “Find a dealer”

Mail:

Volvo Penta of the Americas

1300 Volvo Penta Drive

Chesapeake, VA 23320-9810

Phone: +1 757 436-2800

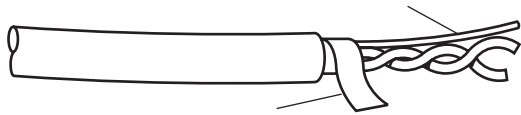
Fax: +1 757 436-5158

Wiring Harness Service

Wiring harnesses should be replaced with proper part number harnesses. When wires are spliced into a harness, use the same gauge wire with high temperature insulation only.

With the low current and voltage levels found in the system, it is important that the best possible bond be made at all wire splices by soldering the splices.

Use care when probing a connector or replacing a connector terminal. It is possible to short between opposite terminals. If this happens, certain components can be damaged. Always use jumper wires with the corresponding mating terminals between connectors for circuit checking. **NEVER** probe through connector seals, wire insulation, secondary ignition wires, boots, nipples or covers. Microscopic damage or holes may result in water intrusion, corrosion and/or component failure.



1. Remove outer jacket.
2. Uwrap aluminum/mylar tape. DO NOT remove mylar



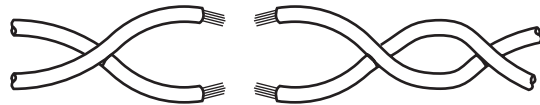
3. Untwist conductors. Strip insulation as necessary.



4. Splice wires using splice clips and rosin core solder. Wrap each splice to insulate.
5. Wrap with Mylar and drain (uninsulated) wire.



6. Tape over whole bundle to secure as before.



1. Locate damaged wire.
2. Remove insulation as required.



3. Splice two wires together using splice clips and rosin core solder.



4. Cover splice with tape to insulate from other wires.
5. Retwist as before and tape with electrical tape and hold in place.

Rs22186

Splicing Wire

Wiring Connector Service

Most connectors in the engine compartment are protected against moisture and dirt which could create oxidation and deposits on the terminals. This protection is important because of the very low voltage and current levels found in the electronic system. The connectors have a lock which secures the male and female terminals together. A secondary lock holds the seal and terminal into the connector.

When diagnosing, open circuits are often difficult to locate by sight because oxidation or terminal misalignment are hidden by the connectors. Merely wiggling a connector on a sensor, or in the wiring harness, may locate the open circuit condition. This should always be considered when an open circuit or failed sensors is indicated. Intermittent problems may also be caused by oxidized or loose connections.

Before making a connector repair, be certain of the type of connector. Some connectors look similar but are serviced differently. Replacement connectors and terminals are listed in the parts catalogue.

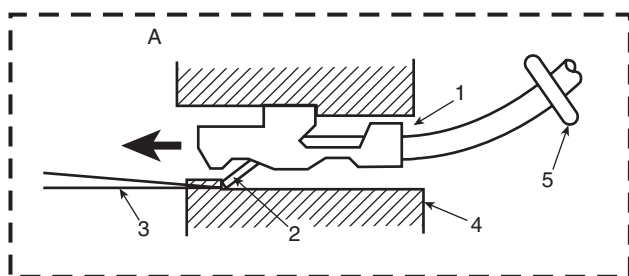
Metri-Pack Series 150 Terminals

Some ECM harness connectors contain terminals called Metri-Pack. These are used at some of the sensors and the distributor connector.

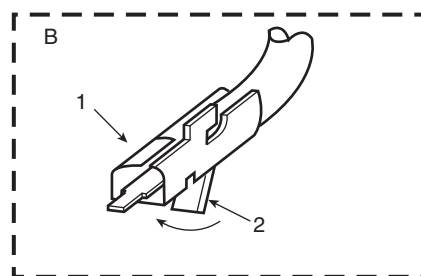
Metri-Pack terminals are also called "Pull-To-Seat" terminals because, to install a terminal on a wire, the wire is first inserted through the seal and connector. The terminal is then crimped on the wire, and the terminal is pulled back into the connector to seat it in place.

To remove a terminal:

1. Slide the seal back on the wire.
2. Insert tool J 35689 or equivalent to release the terminal locking tang.
3. Push the wire and terminal out through the connector. If the terminal is being reused, reshape the locking tang.



1. Metri-Pack Series 150 Female terminal
2. Locking tang



3. Tool J35689 or BT-8446.
4. Connector Body
5. Seal

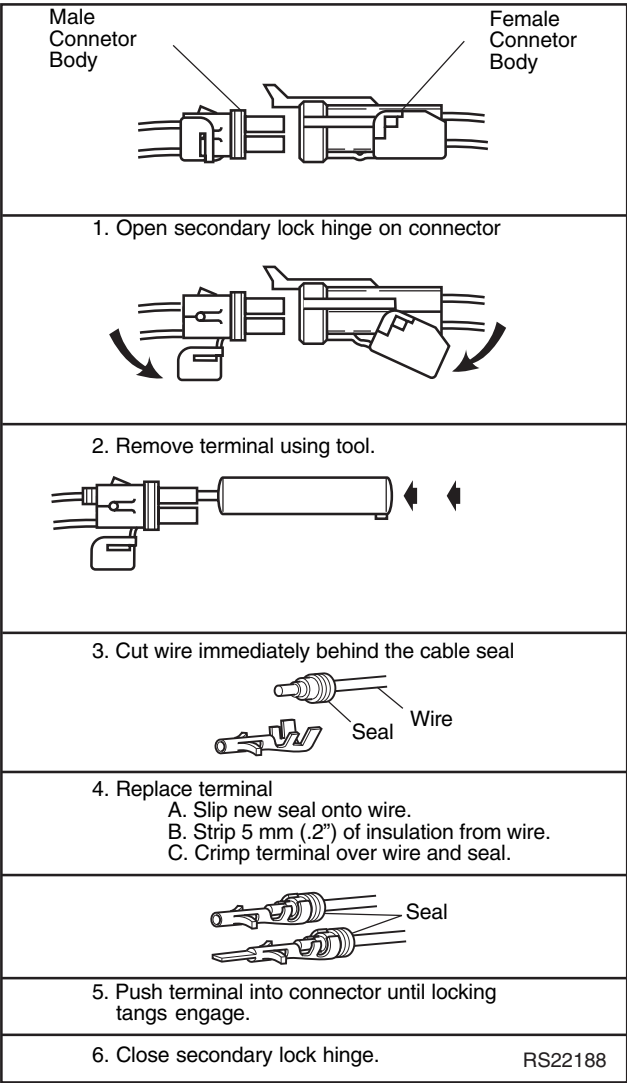
RS22187

Weather-Pack Connectors

This figure shows a Weather-Pack connector and the tool (J 28742 or equivalent) required to service it. This tool is used to remove the pin and sleeve terminals. If terminal removal is attempted without using the special tool required, there is a good chance that the terminal will be bent or deformed, and unlike standard blade type terminals, these terminals cannot be straightened once they are bent.

Make certain that the connectors are properly seated and all of the sealing rings in place when connecting leads. The hinge-type flap provides a secondary locking feature for the connector. It improves the connector reliability by retaining the terminals if the small terminal lock tangs are not positioned properly.

Weather-Pack connections cannot be replaced with standard connections. Instructions are provided with Weather-Pack connector and terminal packages.



Micro-Pack 100/W Series Connectors

The harness connectors used with the ECM “J1” and “J2” connectors are Micro-Pack 100/W Series. It is used for its ruggedized construction, capable of carrying more current and provides good sealing ability. The connector is made up of five different parts: Strain Relief (1), Seal (2), Connector (3), Index Cover (4) and Terminals (not shown).

Remove or Disconnect

1. Negative battery cable.
2. Connector from ECM by lifting up locking tab with thumb and pulling on connector body.

Inspect

- Check strain relief for being cracked or locking tab damaged.
- Check index cover for being cracked.
- Check seal for being torn, twisted or out of shape from improper installation.
- Check terminals for being corroded, out of position, bent or stretched out.
- Use a wire gauge .038 for checking terminal internal fit. Wire gauge should slide with smooth feel and not be loose.

NOTE! If you are only going to clean terminals, complete disassembly is not necessary. Remove index cover from the connector by pushing on Tab C on both sides and sliding off cover. Care must be taken not to move terminals out of their position. The index cover locks the terminals in position. If repair or replacement of parts is needed, DO NOT remove index cover at this time.

3. With a small screwdriver, move Tabs A on strain relief (1) to unlock position.
4. Open strain relief as shown in View B.
5. Release Tabs B (View C) on connector (3) by pushing inward with both thumbs or small screwdriver.
6. Push Tabs B through strain relief (1) with thumbs or small screwdriver while in released position.

Important

- Where there are not wires in strain relief, small plugs are installed. DO NOT lose the plugs, they are important to help keep the connector assembly sealed.
7. Remove plugs where there are not any wires.
 8. Slide strain relief off of seal and back on wires.
 9. Slide seal off of connector and back on wires.

Important

- To insure proper engine operation after repair of connector assembly, wires must be in proper connector location. Before removing index cover, note if there are any wires of the same color. Mark these wires from the location that they were removed. The strain relief is numbered for identifying wire location.

10. Index cover (4) by pushing in on Tabs C with a small screwdriver.
11. Terminals by pulling out of connector.
12. Seal (2) from wires.
13. Strain relief (1) from wires.

Clean and Inspect

- Terminals for corrosion.
 - Use spray electrical contact cleaner.
- Loose crimps on terminals.
- Broken wires at terminals.

NOTE! For terminal replacement, refer to instructions found with terminal repair kit and crimper tool from GM.

Install or Connect

1. Align index cover (4) on connector (3) and lock into position. Make sure Tabs C are locked.
2. Align seal (2) on connector (3) and slide all the way on.
 - DO NOT install strain relief (1) onto connector (3) yet.
3. One wire with terminal installed, through strain relief (1) in location that it was removed.
 - Start with the lowest numbered wire position for that connector.
4. Terminal through seal (2), connector (3) and into index cover (4) until it locks in place.
5. Remaining wires one at a time per same method.
 - Keep wires straight.
 - DO NOT kink wires.
6. Strain relief (1) onto seal (2) and connector (3).
7. Lock Tabs B into strain relief (1).
8. Plugs into strain relief (1) where there are not any wires.
9. Fold strain relief (1) together and lock Tabs A.
10. Connector assembly to ECM.
11. Negative battery cable.

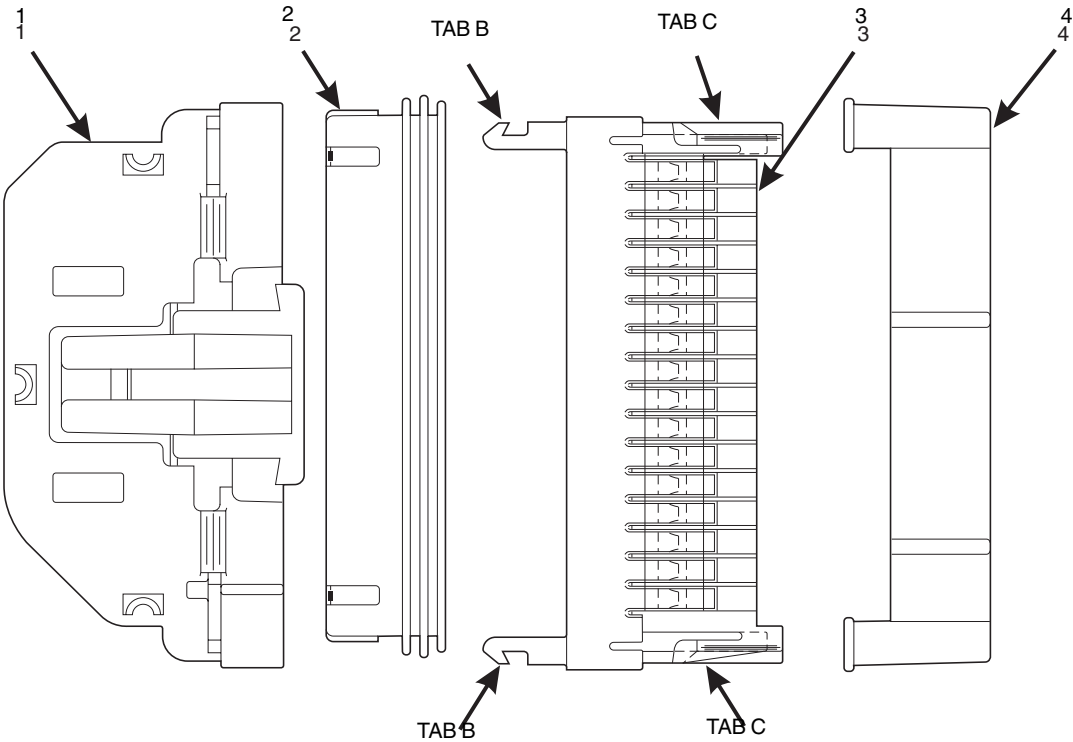


Figure A - Exploded view of connector assembly

1. Strain Relief
2. Seal
3. Connector
4. Index Cover

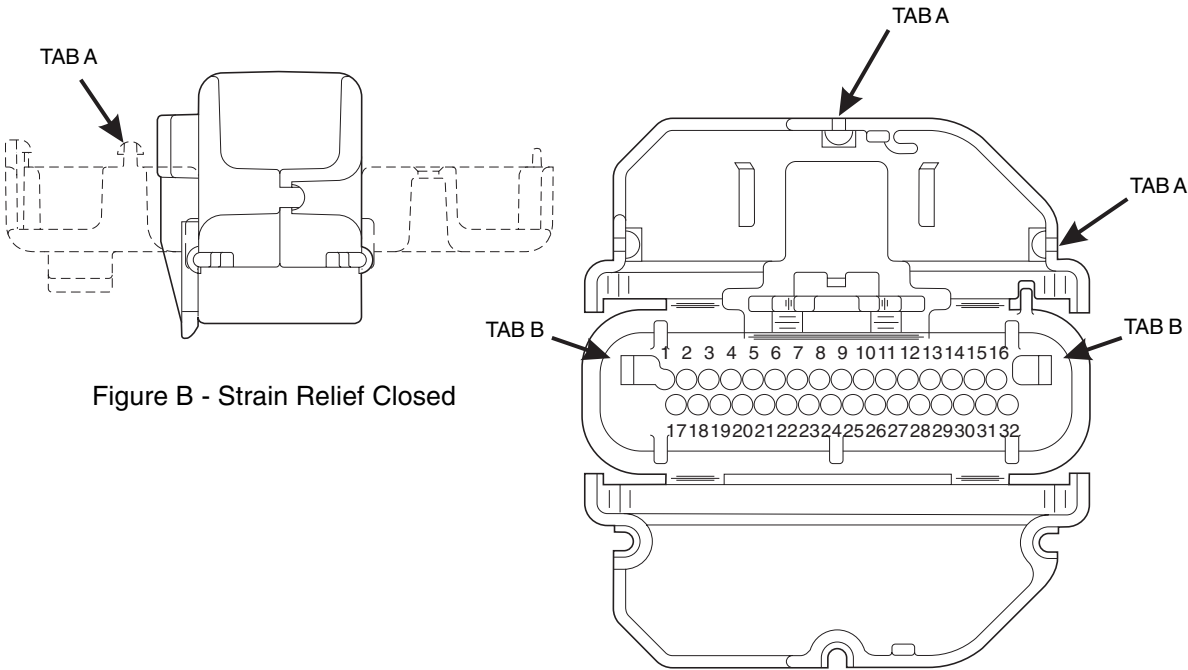


Figure B - Strain Relief Closed

Figure C - Strain Relief Opened

PS19745

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General Description

The Electronic Fuel Injection (EFI) system on 43GXi-A, 50GXi-A, 57Gi-A, and 57GXi-B are equipped with a **Marine Electronic Fuel Injection generation 3 (MEFI 3)** computer that provides the operator with state-of-the-art fuel delivery and spark control. Computers use voltage to send and receive information as described below.

Sensors and Voltage Signals

Voltage is electrical pressure. Voltage does not flow through circuits; instead, voltage causes current. Current does the real work in electrical circuits. It is current, the flow of electrically charged particles, that energizes solenoids, closes relays and lights lamps.

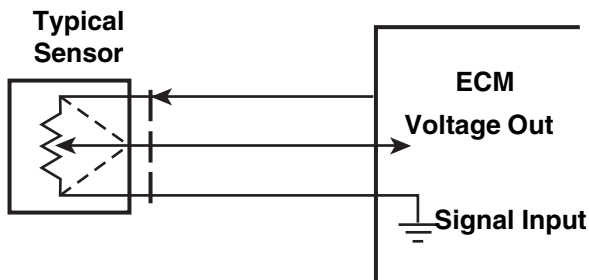
Besides causing currents in circuits, voltage can be used as a signal. Voltage signals can send information by changing levels, changing wave form (shape), or changing the speed at which the signal switches from one level to another. Computers use voltage signals to communicate with one another. The different sections inside computers also use voltage signals to talk to each other. There are two kinds of voltage signals, analog and digital. Both of these are used in computer systems.

Analog Signals

An analog signal is continuously variable. This means that the signal can be any voltage within a certain range.

An analog signal usually gives information about a condition that changes continuously over a certain range. For example, in a marine engine, temperature is usually provided by an analog signal. There are two general types of sensors that produce analog signals, the two wire and three wire sensors.

Three Wire Sensors

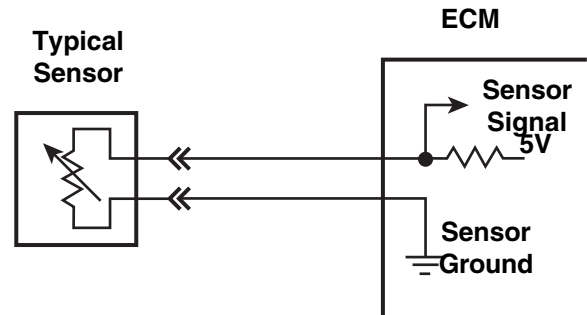


DRC5611

Three Wire Sensors

All 3-wire sensors have a reference voltage, a ground and a variable "wiper". The lead coming off the "wiper" will be the signal to the Engine Control Module (ECM). As the wiper position changes, the signal voltage returned to the computer also changes.

Two Wire Sensors

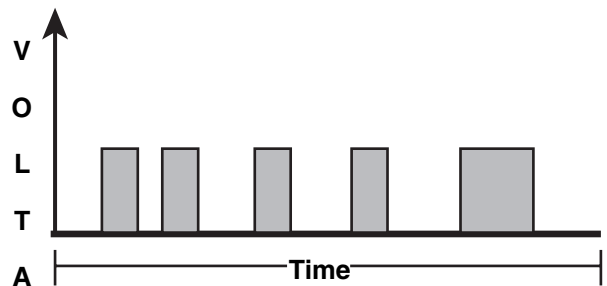


DRC5612

Two Wire Sensors

This sensor is basically a variable resistor in series with a fixed known resistor within the computer. By knowing the values of the input voltage and the voltage drop across the known resistor, the value of the variable resistor can be determined. The variable resistors that are commonly used are called thermistors. A thermistor's resistance varies with temperature.

Digital Signals



DRC5615

Digital Binary Signal

Digital signals are also variable, but not continuously. They can only be represented by distinct voltages within a range. For example, 1V, 2V or 3V would be allowed, but 1.27V or 2.56V would not. Digital signals are especially useful when the information can only refer to two conditions: "YES" and "NO", "ON" and "OFF" or "HIGH" or "LOW". This would be called a digital binary signal. A digital binary signal is limited to two voltage levels. One level is a positive voltage, the other is no voltage (zero volts). A digital binary signal is a square wave.

The ECM uses digital signal in a code that contains only ones and zeros. The high voltage of the digital signal represents a one (1), and no voltage represents a zero (0). Each "zero" and each "one" is called a bit of information, or just a "bit". Eight bits together are called a "word". A word, therefore contains some combination of eight binary code bits.

Binary code is used inside the ECM and between a computer and any electronic device that understands the code. By stringing together thousands of bits, computers can communicate and store an infinite variety of information. To a computer that understands binary, 11001011 might mean that it should turn an output device "ON" at slow speed. Although the ECM uses 8-bit digital codes internally and when talking to another computer, each bit can have a meaning.

Switch Types

Switched inputs to the computer (also known as discretes) can cause one bit to change, resulting in information being communicated to the computer. Switched inputs can come in two types; they are "pull-up" and "pull-down".

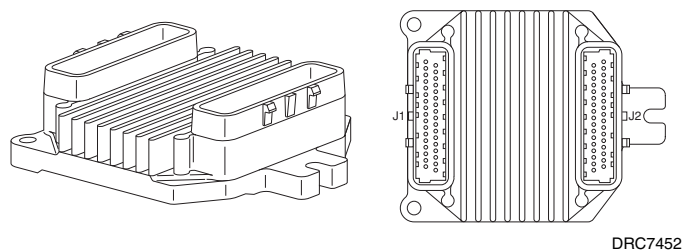
With a "pull-up" type switch, the ECM will sense a voltage when the switch is CLOSED. In the case of the "pull-down", the ECM "sees" the voltage when the switch is OPEN.

Pulse Counters

For a computer to determine frequency information from a switched input, the computer must measure the time between voltage pulses. As a number of pulses are recorded in a set amount of time, the computer can calculate the frequency. The meaning of the frequency number can have any number of meanings to the computer.

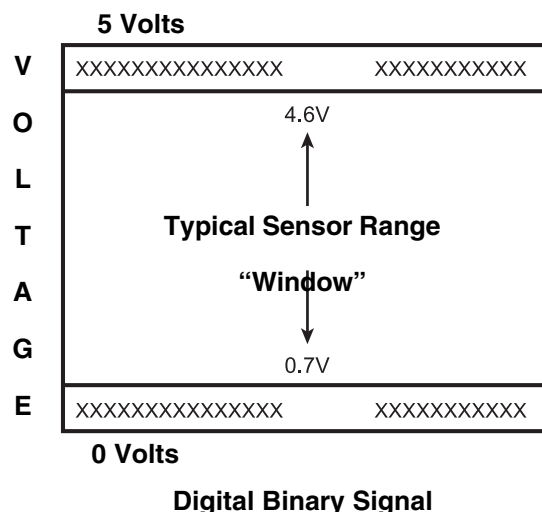
An example of a pulse counter type of input is the distributor reference pulse input. The computer can count a train of pulses, a given number of pulses per engine revolution. In this way, the computer can determine the RPM of the engine.

Engine Control Module (ECM)



Engine Control Module (ECM)

The Engine Control Module (ECM) is the control center of the fuel injection system. It constantly monitors information from various sensors, and controls the systems that affect engine performance.



DR5454

The ECM also performs a diagnostic function check of the system. It can recognize operational problems and store a Diagnostic Trouble Code(s) (DTC) which identifies the problem area to aid the technician in making repairs. "Sensed" values must fall within the sensor 0.1 - 4.9V range. If the sensed value exceeds this range, either high or low, the ECM "defaults" to predetermined values set in the factory ECM programming.

ECM Function

The ECM supplies 5 or 12 volts to power various sensors or switches. This is done through resistances in the ECM which are so high in value that a test light will not light when connected to the circuit. In some cases, even an ordinary shop voltmeter will not give an accurate reading because its resistance is too low. Therefore, the use of a 10 megohms or greater input impedance digital voltmeter is required to assure accurate voltage readings.

Memory

There are three types of memory storage within the ECM: ROM, RAM and EEPROM.

ROM

Read Only Memory (ROM) is a permanent memory that is physically soldered to the circuit boards within the ECM. The ROM contains the overall control programs. Once the ROM is programmed, it cannot be changed. ROM memory is non-erasable, and does not need power to be retained.

RAM

Random Access Memory (RAM) is the microprocessor "scratch pad." The processor can write into, or read from,

this memory as needed. This memory is erasable and needs a constant supply of voltage to be retained. During normal engine operation, acquired DTC's are stored in RAM memory.

EEPROM

Electronic Erasable Programmable Read Only Memory (EEPROM) is the portion of the ECM that contains the different engine calibration information that is specific to each application. Upon engine shut-off, DTC's are stored to the EEPROM from RAM. DTC's will remain in the EEPROM even if B+ voltage is subsequently lost (i.e. battery removed, master switch turned off, etc.).

Speed Density System

The Electronic Fuel Injection (EFI) system is a speed and air density system. The system is based on "speed density" fuel management.

Sensors provide the ECM with the basic information for the fuel management portion of its operation. Signals to the ECM establish the engine speed and air density factors.

Speed

The engine speed signal comes from the Ignition Control (IC) module inside the distributor to the ECM on the (IC) reference high circuit. The ECM uses this information to determine the "speed" or RPM factor for fuel and ignition management.

Density

One sensor contributes to air density data, the Manifold Absolute Pressure (MAP) sensor.

The Manifold Absolute Pressure (MAP) sensor is a 3-wire sensor that monitors the changes in intake manifold pressure which results from changes in engine load. These pressure changes are supplied to the ECM in the form of electrical signals.

As intake manifold pressure increases, vacuum decreases. The air density in the intake manifold also increases, and additional fuel is required.

The MAP sensor sends this pressure information to the ECM, and the ECM increases the amount of fuel injected by increasing the injector pulse width. As manifold pressure decreases, vacuum increases, and the amount of fuel is decreased.

These two inputs MAP and RPM are the major determinants of the air/fuel mixture delivered by the fuel injection system.

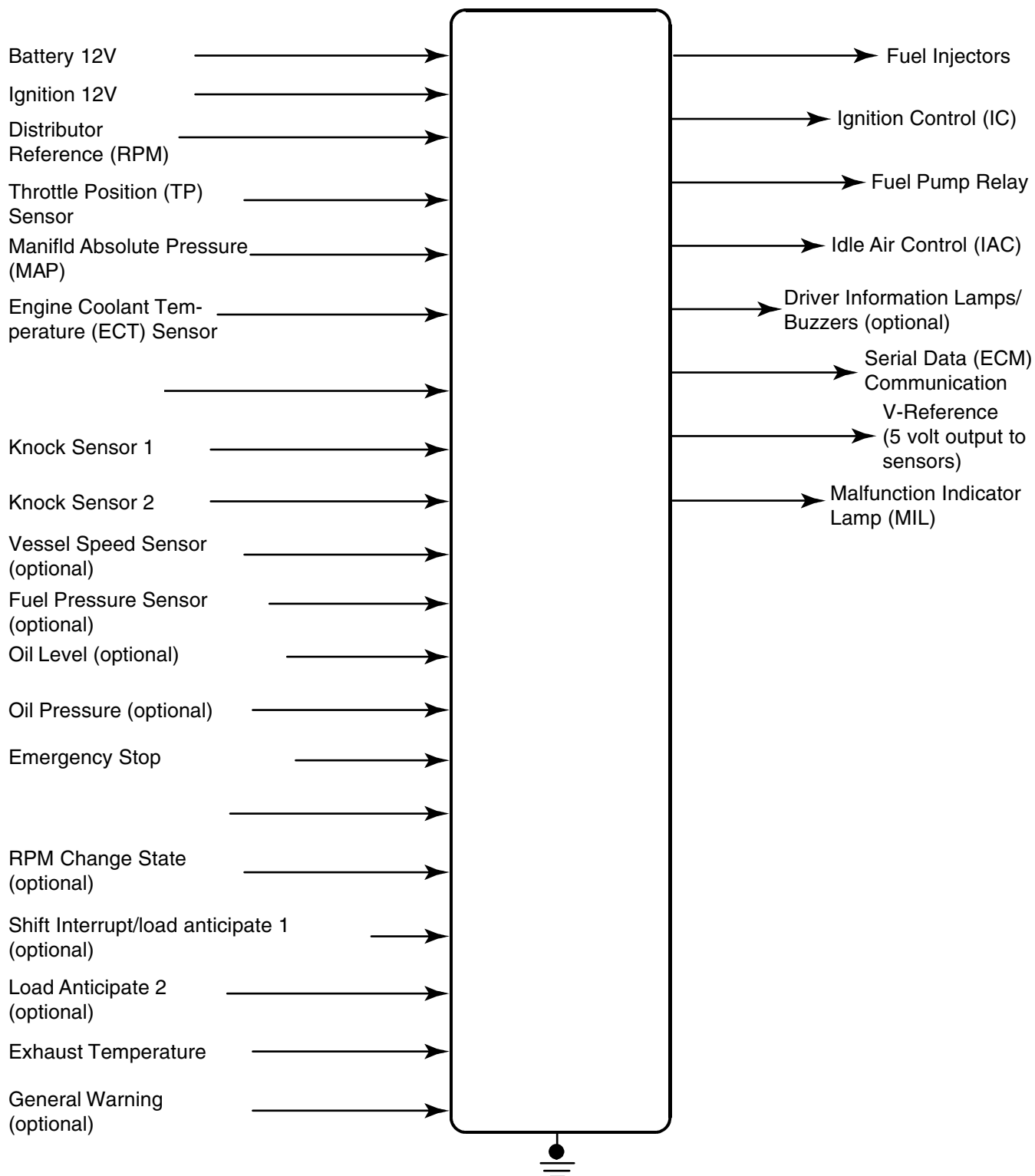
The remaining sensors and switches provide electrical inputs to the ECM which are used for modification of the air/fuel mixture, as well as for other ECM control functions, such as Idle Air Control (IAC).

ECM Inputs / Sensor Descriptions

This illustration shows the sensors, switches, and other inputs that supply data used by the ECM to control its various systems. The following sections provide a brief description of each.

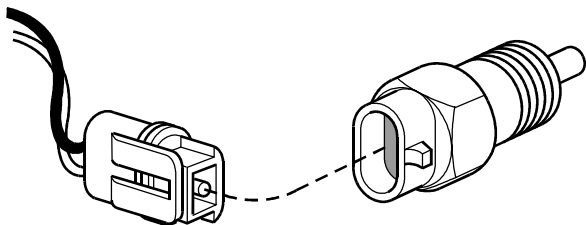
INPUTS

OUTPUTS



ECM Inputs and Outputs

Engine Coolant Temperature (ECT) Sensor



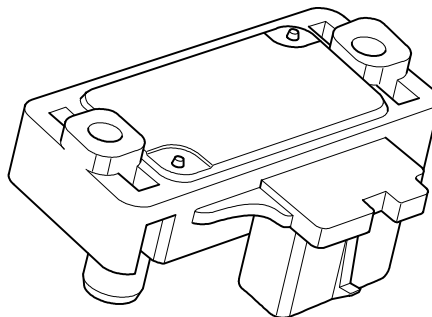
DR5620

The Engine Coolant Temperature (ECT) sensor is a thermistor (a resistor which changes value based on temperature) immersed in the engine coolant stream. Low coolant temperature produces a high resistance, while high temperature causes low resistance. Engine temperature is thermostatically controlled at 160°.

The ECM supplies a 5 volt signal to the ECT through a resistor in the ECM and measures the voltage. The voltage will be high when the engine is cold, and low when the engine is hot. By measuring the voltage, the ECM calculates the engine coolant temperature, and changes injector fuel flow accordingly. Engine coolant temperature affects most systems the ECM controls. The ECT also supplies the signal that actuates the Engine Protection Mode circuit.

A failure in the ECT circuit will set Diagnostic Trouble Code (DTC) 14 or 15. This indicates a failure in the engine coolant temperature sensor circuit. Proper use of the diagnostic chart will lead to either repairing wiring or replacing the sensor to correct the problem.

Manifold Absolute Pressure (MAP) Sensor



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Manifold Absolute Pressure (MAP) Sensor

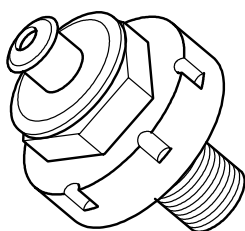
The Manifold Absolute Pressure (MAP) sensor is a pressure transducer that measures the change in the intake manifold pressure. The pressure changes as a result of engine load and speed, and the MAP sensor converts this to a voltage output. During key on/engine off, or during engine start-up, the MAP sensor acts as a barometric pressure sensor and transmits this data to the ECM to compensate for changes in altitude.

A closed throttle on engine deceleration would produce a relatively low MAP output voltage, while wide-open-throttle would produce a high MAP output voltage. This high output voltage is produced because the pressure inside the manifold is the same as outside the manifold, so you measure 100% of outside air pressure. **Manifold Absolute Pressure (MAP) is the OPPOSITE of what you would measure on a vacuum gauge.** When manifold pressure is high, vacuum is low.

The ECM sends a 5 volt reference signal to the MAP sensor. As the manifold pressure changes, the electrical resistance of the MAP sensor also changes. By monitoring the sensor output voltage, the ECM knows the manifold pressure. A higher pressure/low vacuum (high voltage) requires more fuel, while a lower pressure/higher vacuum (low voltage) requires less fuel. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

A failure in the MAP sensor circuit will set a DTC 33 or 34.

Knock Sensor (KS) System



Knock Sensor (KS)

DRC5619

The Knock Sensor (KS) is mounted in the side of the engine block. Some engines have a sensor on either side of the block. When abnormal engine vibrations (spark knock) are present, the sensor produces a voltage signal which is sent to the ECM. The ECM uses this signal to retard ignition timing to prevent internal engine damage.

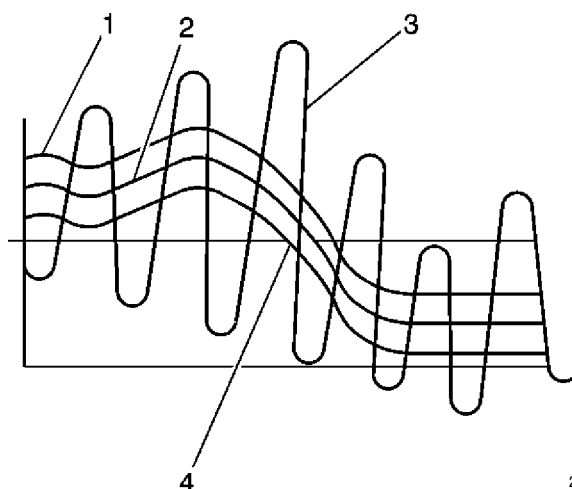
When knock is detected, the ECM immediately adds 5-10% more fuel in an attempt to stop detonation. If knock continues, spark begins to retard. Spark retard will stop if knock stops, or will continue, up to a maximum of 10° retard from the initial starting point. Spark will retard below initial timing if necessary. How quickly spark is retarded is a function of engine RPM and ECM calibration. Spark recovers quickly and automatically immediately after knock ceases. No activity on the knock circuit will set a DTC 44.

Purpose

To control spark knock (detonation), a knock sensor (KS) system is used. This system is designed to retard spark timing when excessive spark knock is detected in the engine. The KS system allows the engine to use maximum spark advance for optimal drivability and fuel economy under all operating conditions.

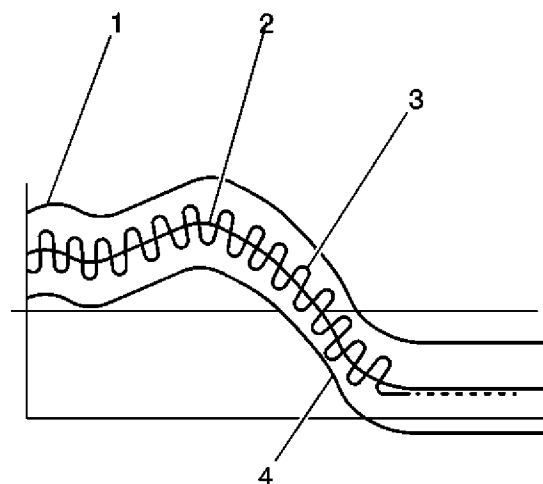
Operation

The ECM uses a knock sensor(s) to detect abnormal vibration in the engine (detonation/spark knock). Mounted on the engine block, the knock sensor(s) produces an AC voltage signal at all engine speeds and loads. The ECM then adjusts the spark timing based on the amplitude and frequency of the KS signal. The ECM uses the KS signal to calculate an average voltage. Then, the ECM assigns a voltage range above and below the average voltage value. The ECM checks the KS and related wiring by comparing the actual knock signal to the assigned voltage range. A normal KS signal should vary outside the assigned voltage range as shown in the NORMAL KS figure. If the ECM detects a KS signal within the assigned voltage range as shown in the ABNORMAL KS figure, the applicable DTC will set.



245253

Normal



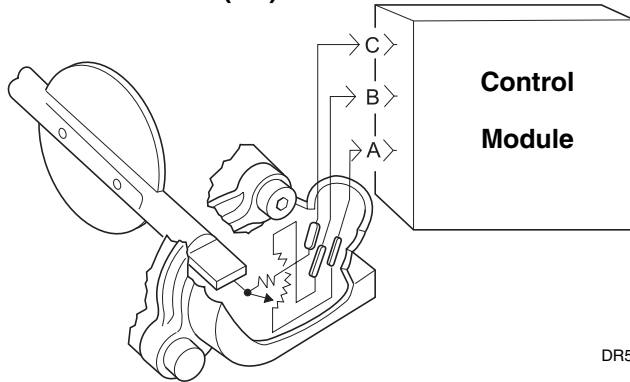
245257

Abnormal

Knock Sensor Signal

1. Upper fail region
2. Knock sensor calculated average
3. Knock sensor signal
4. Lower fail region

Throttle Position (TP) Sensor



DR5613

The Throttle Position (TP) sensor is a potentiometer connected to the throttle shaft on the throttle body. The TP sensor has one end connected to 5 volts from the ECM and the other to ECM ground. A third wire is connected to the ECM to measure the voltage from the TP sensor. As the throttle valve angle is changed, the voltage output of the TP sensor also changes.

At a closed throttle position, the voltage output of the TP sensor is low (approximately 0.5 volts). As the throttle valve opens, the output increases so that at wide open throttle the output voltage should be near 5 volts.

The TP sensor has a feature to aid start-up of a flooded engine. Advance the throttle approximately 3/4 of the way, and crank the engine. The TP sensor will send a zero (0) volt signal to the ECM, and upon receipt of this signal, all injector operation will stop. Once the flooded engine starts, ECM / TP sensor operation returns to normal.

By monitoring the output voltage from the TP sensor, the ECM can determine fuel delivery based on throttle valve angle (operator demand). A broken or loose TP sensor can cause intermittent bursts of fuel from the injector and an unstable idle.

If the TP sensor circuit is open, the ECM will set a DTC 21 or 22. Once a DTC is set, the ECM will calibrate a default value for the throttle position and some engine performance will return.

Ignition Control (IC) Reference

The Ignition Control Reference (engine speed) signal is supplied to the ECM by way of the "IC Ref" line from the ignition module inside the distributor. This pulse counter type input creates the timing signal for pulsing of the fuel injectors, as well as the Ignition Control (IC) functions. This signal is used for a number of control and testing functions within the ECM.

Discrete Switch Inputs

Several Discrete Switch Inputs are utilized by the EFI system to identify abnormal conditions that may affect engine operation. "Pull-up" and "pull-down" switches are currently used in conjunction with the ECM to detect conditions critical to engine operation.

If a switch changes state from its normal at-rest position (i.e. normally closed to open, or normally open to closed), the ECM senses a change in voltage and responds by entering RPM reduction mode. One such switch, for oil pressure (normally open), is used in the *Engine Protection Mode* system. *Engine Protection Mode* allows the operator a safe maneuvering speed while removing the possibility of high RPM operation until the problem is corrected.

RPM Limiter

The RPM limiter is not a switch or sensor, but rather a function of ECM circuitry. The ECM monitors engine speed on the distributor's IC "REF HI" line. If RPM exceeds the upper end of the engine's RPM range by 200 RPM or more, all injector operation immediately stops. Injector operation returns to normal at the moment RPM drops back into the operating range.

Engine Protection Mode

The EFI system includes a protective feature called *Engine Protection Mode*. This system prevents engine damage should oil pressure be lost or engine coolant or exhaust manifold temperature become excessive.

The ECT sensor has a two-fold function; it supplies water temperature data to the ECM in order to control spark and fuel, and also triggers the *Engine Protection Mode* system should temperature reach or exceed 200°F (93°C). A separate oil pressure switch and exhaust temperature switch can also trigger the *Engine Protection Mode* system should oil pressure drop to or below 3-4 PSI (20-27 kPa) or exhaust manifold temperature rises above 160°F (71°C).

Engine operation while in *Engine Protection Mode* is distinctive. If the system is activated at any speed above 2500 RPM, one bank of injectors is immediately shut off and spark timing is fixed at 8°. Boat speed will drop until RPM falls below 2500. The engine will continue to operate on one half the injectors unless RPM drops to 1200. At 1200 RPM, normal injector operation and spark timing is restored (re-set point). The boat can now be operated up to 2500 RPM in a normal manner, but if 2500 RPM is exceeded and the cause of *Engine Protection Mode* activation is still present, one bank of injectors will again be shut off and timing fixed at 8°.

Engine Protection Mode will continue to perform in this manner until the cause is eliminated. Should the cause be self-corrected (i.e. weeds come off water screen, or oil re-covers pickup), engine operation will return to normal when the ECT senses water temperature at 180°F (82°C) or below, oil pressure exceeds 4 PSI (27 kPa).

Fuel System

The function of the fuel system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered to the engine by two injectors.

Modes Of Operation

The ECM looks at input from several sensors to determine how much fuel to give the engine. The fuel is delivered under one of several conditions, called "modes". All the modes are controlled by the ECM and are described below.

Starting Mode

When the ignition switch is turned to the crank position, the ECM turns "ON" the fuel pump relay and the fuel pumps build up pressure. The ECM then checks the Engine Coolant Temperature sensor (ECT), Throttle Position sensor (TP), and then it determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in Starting Mode by changing how long the injectors are turned "ON" and "OFF". This is done by "pulsing" the injectors for very short times.

Clear Flood Mode

If the engine floods, it can be cleared by opening the throttle to 100% of its travel (wide-open- throttle). At this point the ECM shuts down the fuel injectors so no fuel is delivered. The ECM holds this injector rate as long as the throttle stays at 100%, and engine speed is below 300 RPM. If the throttle position becomes slightly greater or less than 100%, the ECM returns to Starting Mode.

Run Mode

When the engine is first started and RPM is above 300, the system operates in Run Mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, Manifold Absolute Pressure (MAP) and Engine Coolant Temperature (ECT).

Higher engine load (from MAP) and colder engine temperature (from ECT) requires more fuel, or a richer air/fuel ratio.

Acceleration Mode

The ECM looks at rapid changes in Throttle Position (TP) and Manifold Absolute Pressure (MAP), and provides extra fuel by increasing the injector pulse width.

Fuel Cutoff Mode

To prevent dieseling, no fuel is delivered by the injectors when the ignition is "OFF". Also, fuel is not delivered if the ECM receives no distributor reference signal, as this would mean the engine is not running. The Fuel Cutoff Mode is also activated at high engine RPM as an overspeed protection for the engine. When cutoff is in effect due to high RPM, injector pulses will resume after engine RPM drops below the maximum RPM specification (rev limit).

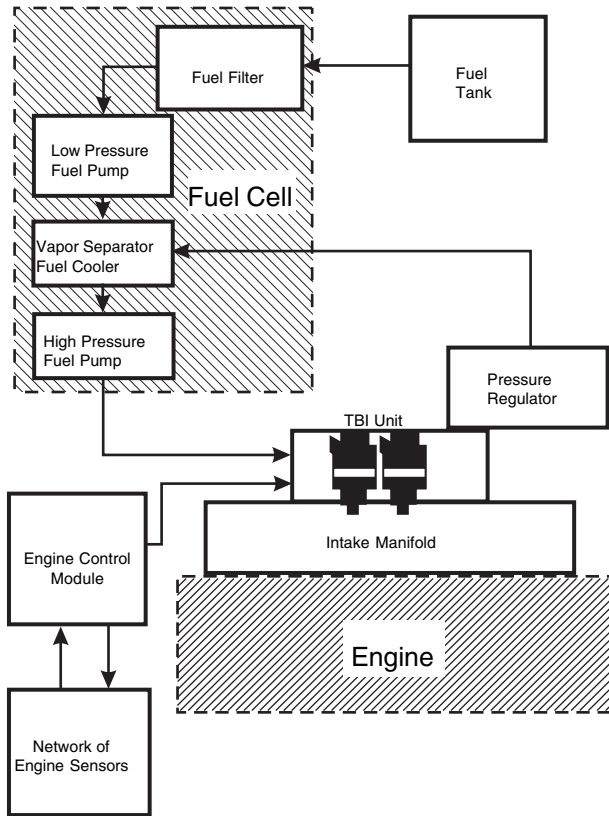
RPM Reduction Mode (*Engine Protection Mode*)

The ECM recognizes the change of state in a discrete switch input that identifies an abnormal condition that may affect proper engine operation. The *Engine Protection Mode* system does this during engine coolant overheat and low oil pressure conditions.

As an engine protection feature, RPM Reduction Mode allows normal fuel delivery up to 2500 RPM. Above 2500 RPM, fuel delivery is limited to half the injectors until engine speed drops below 1200 RPM. Normal engine operation is then restored until the 2500 RPM limit is exceeded. This mode of operation will continue until the overheat/low oil pressure problem is corrected.

This feature allows boat maneuvering while preventing the possibility of high engine speed operation until the problem is corrected.

Fuel Supply Components



DRC6154a

The pump is designed to provide fuel at a pressure greater than is needed by the injectors. The pressure regulator, part of the MFI fuel rail assembly or TBI unit, keeps fuel available to the injectors at a controlled pressure. Unused fuel is returned to the vapor separator by a separate line. The vapor separator is water cooled to keep fuel from vaporizing. A valve inside the separator vents excessive vapor pressure through a vacuum line to the intake manifold.

Fuel Pump Electrical Circuit

When the ignition switch is turned “ON”, the ECM turns the fuel pump relay “ON” for two seconds causing the fuel pumps to pressurize the fuel system. If the engine is not cranked or run, pump operation stops.

When the ignition switch is turned to the “CRANK” position, the ECM turns the fuel pump relay “ON” causing the fuel pumps to run.

If the ECM does not receive ignition reference signals (engine cranking or running), it shuts “OFF” the fuel pump relay causing the fuel pumps to stop.

An inoperative fuel pump relay will result in an “Engine Cranks But Won’t Run” condition.

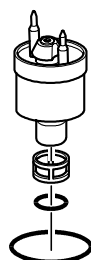
The fuel system is made up of the following parts:

- Fuel supply components (fuel tank, pumps, lines, and filter)
- Fuel pump electrical circuits
- Vapor separator assembly
- Throttle body assembly including Idle Air Control Valve (IAC) and Throttle Position sensor (TP)

The fuel supply is stored in the fuel tank. A low pressure pump, located in the fuel cell, draws fuel from the tank through the fuel supply lines and water separator fuel filter. Fuel is pumped to the integral vapor separator in the fuel cell.

A high pressure fuel pump, located in the fuel cell, pumps fuel from the vapor separator to the TBI unit.

Fuel Injectors



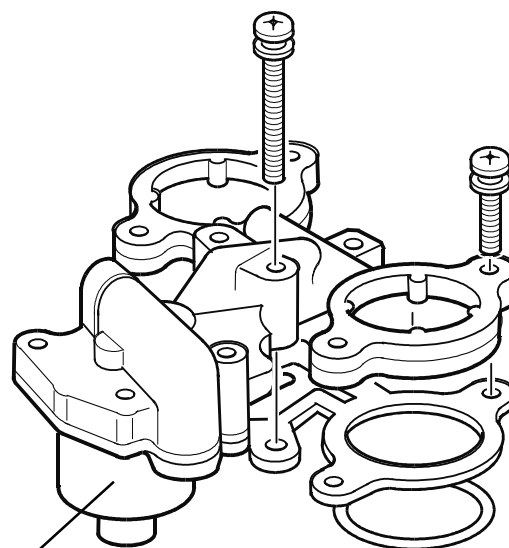
22505

The fuel injector assembly is a solenoid-operated device, controlled by the ECM, that meters pressurized fuel. The ECM energizes the injector solenoid, which opens a ball valve allowing pressurized fuel to flow past the ball valve and through a recessed flow director plate. The director plate has six machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. The amount of fuel injected is controlled by the length of time they're held open (pulse width). Fuel is directed into the intake manifold causing it to become further atomized and vaporized before entering the combustion chamber.

The injectors are normally closed and are operated when the ECM completes a ground circuit. The system fires one injector on a reference signal and the other injector on the next reference signal.

⚠ Caution! Do not apply battery voltage directly to the injector electrical connector terminals. The internal solenoid may be damaged in a matter of seconds.

Pressure Regulator Assembly

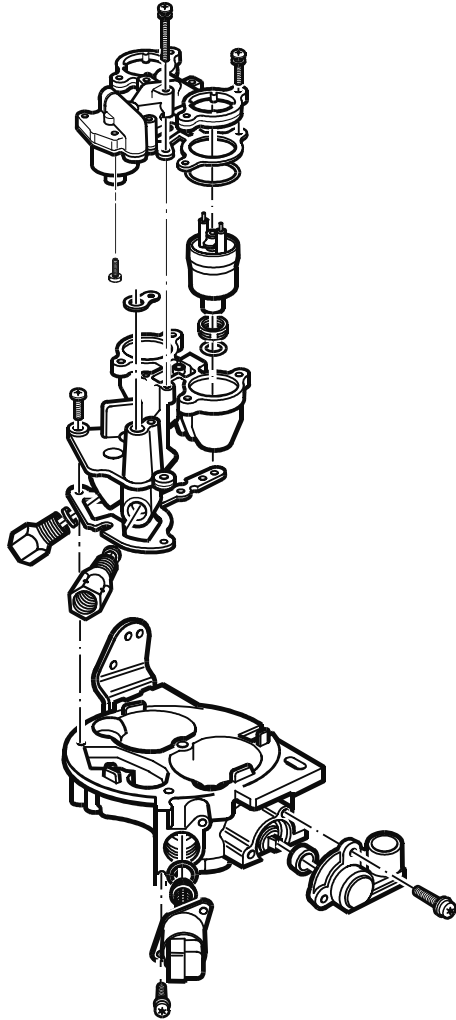


Pressure
Regulator

22507

The pressure regulator is a diaphragm-operated relief valve with fuel pressure on one side, and regulator spring pressure and/or intake manifold vacuum on the other. The regulator's function is to maintain a constant pressure differential across the injectors at all times. It is inside the throttle body, and located in the fuel circuit after the injectors.

Throttle Body Assembly



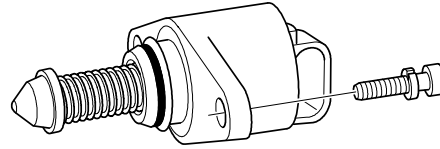
22506

The throttle body assembly is attached to the intake manifold. It is used to control air flow into the engine, thereby controlling engine power. The throttle plates within the throttle body are opened by the boat operator through the throttle control. During engine idle, the throttle plates are almost closed, and air flow control is handled by the Idle Air Control Valve (IAC), whose setting and operation is controlled by the ECM.

The throttle body also provides a location for mounting the Throttle Position sensor (TP) and the IAC valve. The TP sensor senses changes in throttle plate position as the engine accelerates and decelerates, and the ECM compensates fuel flow accordingly.

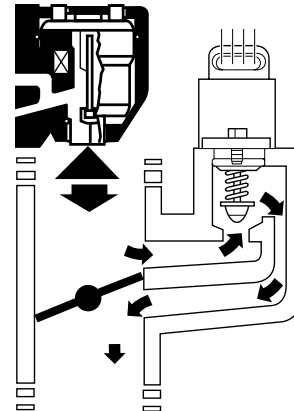
Idle Air Control Valve (IAC)

The purpose of the IAC valve assembly is to control engine idle speed, while preventing stalls due to changes in engine load.



DR5524

The IAC valve, mounted in the throttle body, controls bypass air around the throttle plates. By moving a conical valve (known as a pintle) **IN** towards the seat (to **decrease** air flow), or **OUT** away from the seat (to **increase** air flow), a controlled amount of air moves around the throttle plates. If RPM is too low, more air is bypassed around the throttle plates to increase it. If RPM is too high, less air is bypassed around the throttle plates to decrease it. The ECM moves the IAC valve in small steps. These can be measured by scan tool test equipment which plugs into the Data Link Connector (DLC).



DCR6163

During idle, the proper position of the IAC valve is calculated by the ECM based on battery voltage, coolant temperature and engine RPM. If the RPM drops below specification and the throttle plates are closed, the ECM senses a near stall condition and calculates a new valve position to prevent stalling.

- Engine idle speed is a function of total air flow into the engine based on IAC valve pintle position plus throttle plate opening.

- “Controlled” idle speed is programmed into the ECM, which determines the correct IAC valve pintle position to maintain the desired idle speed for all engine operating conditions and loads.
- The minimum idle air rate (throttle plate opening) is set at the factory with a stop screw. This setting allows enough air flow by the throttle plates to cause the IAC valve pintle to be positioned a calibrated number of steps (counts) from the seat, during “controlled” idle operation. **DO NOT change the position of the factory throttle plate setting.**

Fuel System Operation

A low pressure (LP) electric fuel pump brings fuel from the boat tank through the engine fuel filter. The LP pump transfers fuel to the fuel reservoir in the fuel cell. When the key is turned ON, the LP pump will operate for approximately 2 seconds, then stop. Only after the ECM receives an ignition reference signal (indicating the engine is cranking or running) will the LP continue to operate.

 **Warning!** This safety feature is designed to prevent fuel pump operation should the engine quit running, or suffer a malfunction in which the pump could feed fuel to a fire.

The reservoir is a fuel containment/vapor purging device that eliminates the need for a fuel return line back to the boat tank. The reservoir fills from the bottom up, and supplies fuel to a high pressure (HP) pump mounted on the fuel cell. The HP pump pulls fuel from the bottom of the reservoir and supplies fuel to the fuel injectors. If engine fuel demand is less than the volume of fuel supplied by the HP pump, the fuel pressure regulator on the TBI unit returns fuel to the fuel cell to be cooled and recirculated. The ECM controls power for the fuel delivery system and provides correct timing for the fuel injectors.

A pressure regulator is located in the throttle body. The regulator is a pressure operated diaphragm valve. This valve reacts to fuel pressure only. Pressure at the injectors during cranking is approximately 30 ± 2 PSI (200 ± 13.8 kPa).

At idle, fuel demand is low. Fuel pressure pushes the diaphragm off its seat. As the regulator opens the fuel is allowed to exit the regulator assembly and return to the reservoir. The amount of fuel that returns to the reservoir is determined by fuel pressure and the amount of regulator opening. This opening maintains the pressure at the injectors at approximately 30 ± 2 PSI (200 ± 13.8 kPa).

Fuel entering the reservoir may contain vapor, thus the reservoir has features to control this. The base of the reservoir, and the fuel inside, are cooled by incoming water. Water is piped to the fuel cell reservoir water jacket from a port on the thermostat housing through the reservoir and out to the exhaust riser where it is dumped overboard.

There is a float and needle valve inside the reservoir that purges vapor through a hose that is connected to the intake plenum. If vapor is present, it separates from the fuel and rises to the top of the reservoir. As vapor quantity increases, the reservoir fuel level will drop. The float follows the fuel level and eventually opens the needle valve. Intake manifold vacuum then pulls vapor from the reservoir into the air plenum. A pulse limiter in the vacuum line at the air plenum prevents any sudden backfire from igniting fuel vapor. After vapor is relieved, the LP pump refills the reservoir. As fuel level rises, the float closes the needle valve and the cycle repeats as conditions demand.

 **Caution!** Note that the valve caps have a special internal viton seal to prevent fuel leakage. Do not substitute any other type of cap.

 **Caution!** The needle valve can stick if fuel is not properly stabilized and allowed to varnish over long periods of storage. Excessive amounts of fuel can be pumped into the intake manifold and cause engine hydrolocking if the fuel cell needle valve does not operate properly.

Ignition System

All *Delco* Distributor Ignition (DI) systems include these essential components: battery, distributor, ignition coil, ignition switch, spark plugs, and primary and secondary wiring. The Distributor Ignition (DI) system is connected to the Engine Control Module (ECM). The ECM monitors various engine sensors, computes the desired spark timing and signals the Ignition Control module in the distributor to change timing. The distributor does not contain centrifugal advance weights, springs, or vacuum advance units.

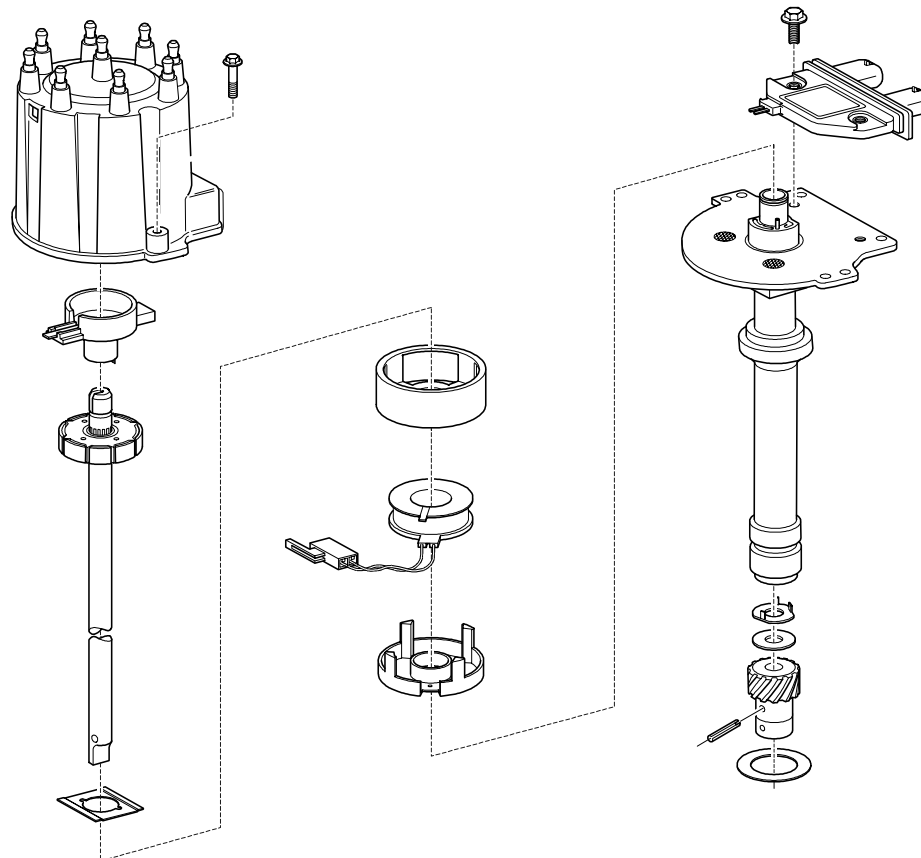
The distributor used on marine Electronic Fuel Injection equipped engines is designed for the marine environment. The distributor base plate is equipped with two special vents to prevent fuel vapors from igniting.

The ignition coil connects to the distributor through a high tension secondary wire and two low voltage primary wires. Due to the high voltage produced by the coil, a special material is used for the distributor cap and rotor. It is a thermoplastic, injection molded, glass reinforced polyester. This material provides the required dielectric and insulation property, and also prevents carbon tracking. The posts in the distributor cap are made up of durable metals to prevent corrosion.

The distributor uses an internal magnetic pickup assembly that consists of a permanent magnet, pole piece with internal teeth, and a pickup coil. The pickup coil is sealed to keep out moisture and prevent electromechanical interference. When the rotating teeth of the timer core line up with the teeth of the pole piece, voltage is induced in the pickup coil. This voltage signals the Ignition Control module to trigger the primary ignition circuit. Current flow in the primary circuit is interrupted and high voltage of up to 35,000 volts is induced in the ignition coil secondary winding. This high voltage is directed through the secondary ignition circuit to fire the spark plugs.

The number of teeth on the stationary pole piece, and on the timer core's rotating shaft, reflects the number of cylinders in the engine (i.e. 8 teeth for eight cylinders). Although there are minor differences between applications, all DI systems operate the same.

There is no scheduled maintenance or periodic lubrication required. Engine oil lubricates the lower bushing, and the upper bushing is pre-lubricated and sealed.



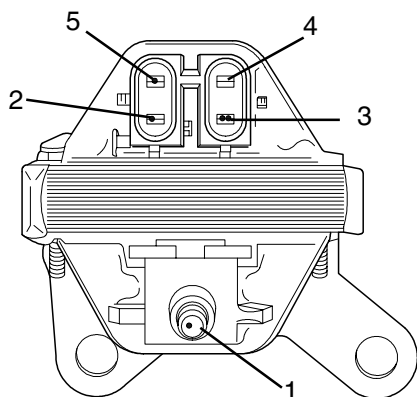
DRC5533

Distributor

Ignition Coil

The design and construction of the ignition coil affects its output. The DI system ignition coil was designed to produce greater spark voltage, longer spark, and operate at higher RPM. The DI system coil has the secondary windings wrapped around the primary windings. The primary windings are wrapped around an iron core. The coil is not oil filled. The windings are covered in an epoxy compound for protection against moisture and arc-over.

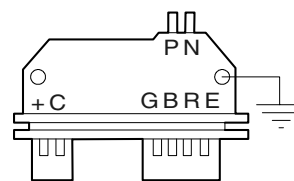
There is an iron laminated square frame around the coil windings. This increases the magnetic flux path and stores energy to produce higher secondary spark voltage. The coil's mounting bracket is attached to the frame.



DR3302

The coil generates a high secondary voltage (up to 35,000 volts) when the primary circuit is broken. It is attached to the distributor by a high tension wire connected to the post (1) mounted on top of the coil. The coil has a pair of 2-wire connectors. They're used for battery voltage input (2), primary voltage sent to the distributor Ignition Control module (3), trigger signal from the Ignition Control module (4), and for a tach output signal (5).

Ignition Control (IC) Module



DR5532

The Ignition Control (IC) module is located in the distributor. It is mounted by two screws that are used for a ground. The IC module is a solid state unit with transistorized relays and switches for controlling circuits. The IC module has several functions:

- It changes the analog signal of the pickup coil to a square digital signal.
- It sends the digital signal as a reference signal (REF HI) to the ECM for ignition control.
- It provides a ground reference (REF LO).
- It provides a means for the ECM to control spark advance (BYPASS and IGNITION CONTROL) called Ignition Control Mode.
- It provides a limited means of controlling spark advance without ECM input, called Module Mode.
- It provides the trigger signal for the ignition coil.

Pole Piece and Coil Assembly

The pole piece and coil assembly (often referred to as the pickup coil assembly) consists of a stationary pole piece with internal teeth, and a pickup coil and magnet that are located between the pole piece and a bottom plate.

The pickup coil produces an alternating signal voltage as the teeth pass the magnet. There is a signal produced for each engine cylinder during one revolution of the distributor. The pickup coil is connected to the IC module by a two wire connector.

Spark Plug Wires

The spark plug wires are a carbon-impregnated cord conductor encased in an 8 mm diameter silicone rubber jacket. Silicone wiring will withstand very high temperature and is an excellent insulator for higher voltages. Proper wire resistance should be approximately 3000 - 7000 ohms per foot. Silicone spark plug boots provide a tight seal on the spark plug.

Silicone is soft, pliable and therefore, more susceptible to scuffing and cutting. It is extremely important that the spark plug cables be handled with care. They should be routed so as not to cross each other or rub against other parts of the engine.

Do not force anything between the boot and wiring or through the silicone jacket. Connections should be made using an appropriate adaptor.

Engine Control Module (ECM)

The Engine Control Module (ECM) controls spark advance and fuel injection for all operating conditions. The ECM monitors input signals for all the following components to determine the required ignition timing.

- Ignition Control (IC) module
- Engine Coolant Temperature sensor (ECT)
- Manifold Absolute Pressure sensor (MAP)
- Throttle Position sensor (TP)

Modes Of Operation

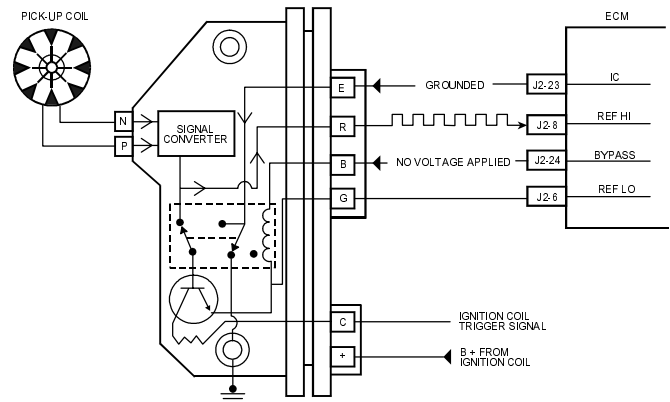
There are two "modes" of ignition system operation: Module Mode (cranking), and Ignition Control Mode (running). In Module Mode, the ignition system operates independently from the ECM. The Ignition Control module maintains a base ignition timing which may be different for each engine, and is able to change the ignition timing slightly with increased engine speed. Module Mode is in effect whenever an Ignition Control fault is detected while the engine is running, and it'll have a noticeable effect on engine operation.

Ignition Timing

In order to change base timing on a DI system, the ECM has to be placed in service mode. See **Setting Initial Timing** in the **On-Board Service** section. In this condition, the IC module does not receive voltage on the BYPASS circuit from the ECM, and will go into Module Mode. The IC module will revert to base ignition timing of the engine so it can be checked or reset.

The ECM incorporates a permanent spark control override. This allows base timing to be powered electronically if spark knock (detonation) is encountered during normal operation. Base ignition timing can be lowered to 6° BTDC using this override.

IC Operation - Module Mode (Cranking)



DRC7489

The following describes IC operation during cranking and when the engine starts running. To help understand how IC circuits operate, a relay with a double set of contact points is shown inside the IC module. Actually solid state circuitry is used, but showing a relay makes it easier to visualize how the IC functions.

During cranking, the relay is in a de-energized position. This allows a set of contact points to connect the pickup coil to the base of the transistor. When the pickup coil applies a positive voltage to the transistor, it turns "ON". When voltage is removed, the transistor turns "OFF". When the transistor turns "ON", current flows through the primary windings of the ignition coil. When it turns "OFF", the primary current stops and a spark is developed at the spark plug. A small amount of advance is built into the IC module, in case the engine remains in Module Mode.

With the relay de-energized, a set of contacts (shown "closed") would ground the IC line signal. No voltage is applied by the ECM to the BYPASS line.

Notes

This image shows a full page of a document template designed for handwriting practice. It consists of numerous evenly spaced, horizontal black dotted lines extending across the entire width of the page. The background is plain white, providing a clear guide for letter height and placement. There are no margins, text, or other markings present.

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General Information

Warning!

The ECM and all EFI sensors are sensitive electronic components. Observe the following cautions when servicing them:

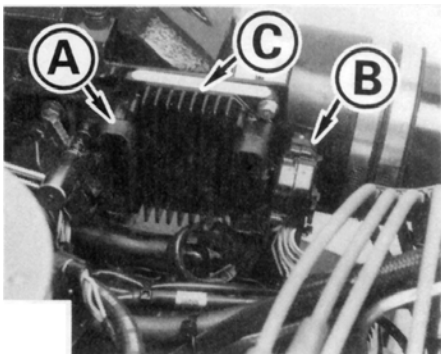
- Verify the ignition switch is in the "OFF" position, and remove both battery cables from the battery.
- **DO NOT** soak components in any liquid cleaner or solvent; this will damage them.
- Handle components carefully; any damage will affect proper operation of the EFI system.
- Make sure new components have the same part number as old ones; this will ensure proper engine performance.

Engine Control Module (ECM)

Removal

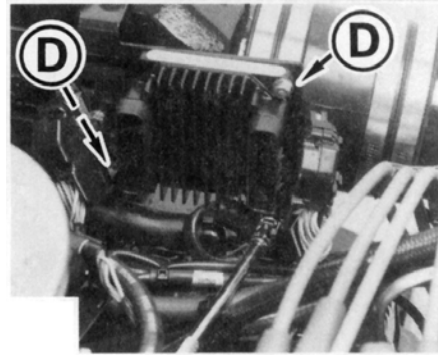
NOTE! When replacing the ECM, the ignition must be "OFF". Remove both battery cables before disconnecting or reconnecting the ECM "J1" and "J2" connectors to prevent internal damage to the ECM.

NOTE! To prevent possible electrostatic discharge damage to the ECM, **DO NOT** touch the connector pins. The ECM is an electrical component that can easily be damaged by static electricity. Do not soak the ECM in any liquid cleaner or solvent, as damage may result.



49479

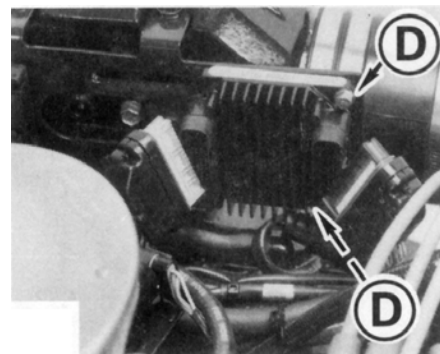
1. Remove flame arrestor cover and set it aside.
2. Remove the "J1" (A) and "J2" (B) connectors from the ECM (C).



49485

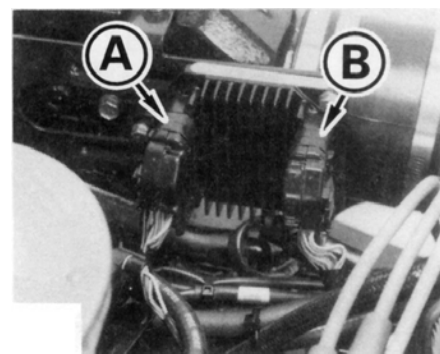
3. Unscrew three ECM mounting screws (D). Remove the ECM from the mounting bracket.

Installation



49486

1. Attach the new ECM to the mounting bracket and secure with three screws. Tighten the screws (D) to 88-124 in. lbs. (10-14 N•m).

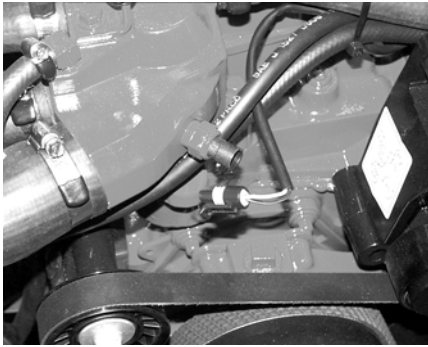


49487

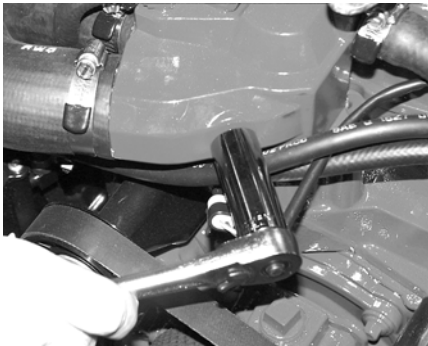
2. Attach "J1" (A) and "J2" (B) connectors to ECM. Check for a secure attachment.
3. Install the flame arrestor cover. Tighten the nut to 25-35 in. lbs. (2,8-4,0 N•m).

Engine Coolant Temperature (ECT) Sensor

Removal



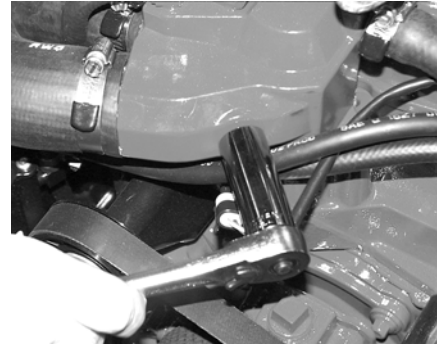
1. Disconnect ECT sensor electrical connector.



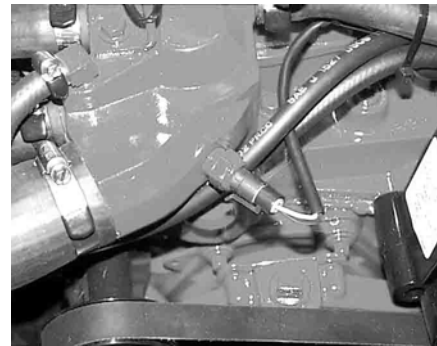
2. Using a $\frac{3}{4}$ inch deep socket, unscrew ECT sensor from thermostat housing.

Installation

1. Coat ECT sensor threads with *Volvo Penta 1141570 Sealant* or equivalent.



2. Screw ECT sensor (B) into thermostat housing. Tighten sensor to 108 in. lbs. (12 N•m).

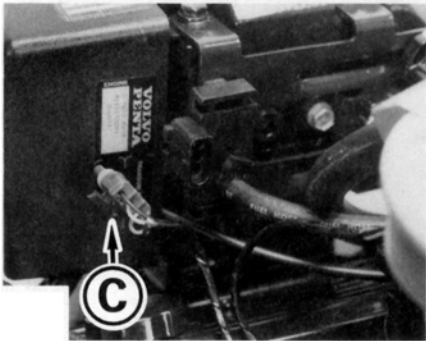


3. Attach ECT sensor electrical connector. Check for a secure attachment.

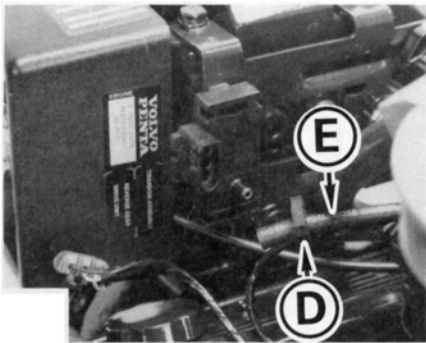
Manifold Absolute Pressure (MAP) Sensor

Removal

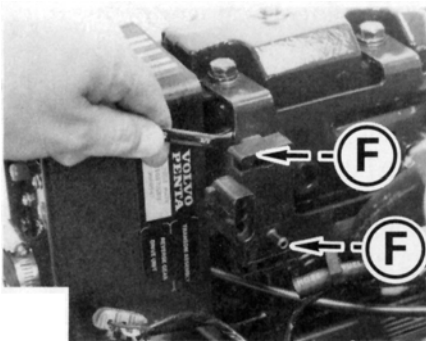
1. Remove flame arrestor cover from engine.



2. Remove MAP sensor electrical connector (C).

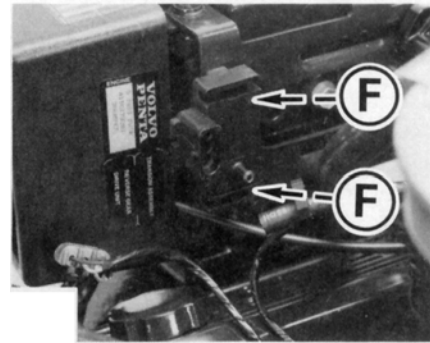


3. Loosen clamp (D) and remove vacuum hose (E) from sensor.

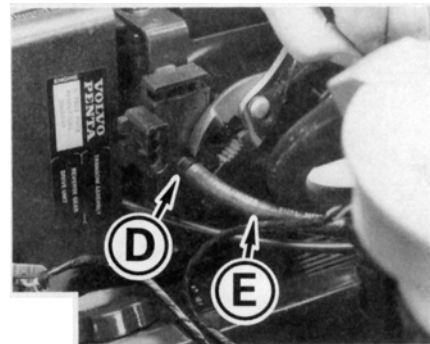


4. Unscrew two screws (F) securing MAP sensor to bracket. Remove MAP sensor.

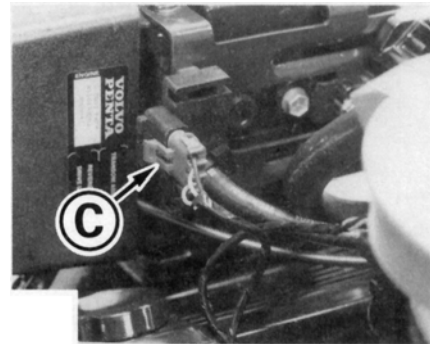
Installation



1. Place MAP sensor on bracket and secure with two screws (F). Tighten screws to 44-62 in. lbs. (5-7 N•m).



2. Attach vacuum hose (E) to MAP sensor. Secure with clamp (D).



3. Attach MAP sensor electrical connector (C). Check for a secure attachment.
4. Install the flame arrestor cover. Tighten the nut to 25-35 in. lbs. (2,8-4,0 N•m).

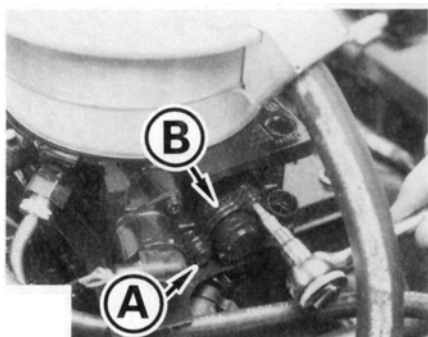
Throttle Position (TP) Sensor

Removal

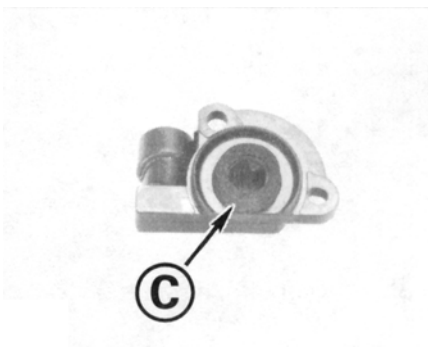
1. Remove flame arrestor cover from the engine.



2. Remove TP sensor electrical connector (G).



3. Unscrew two screws (A) securing TP sensor to throttle body.

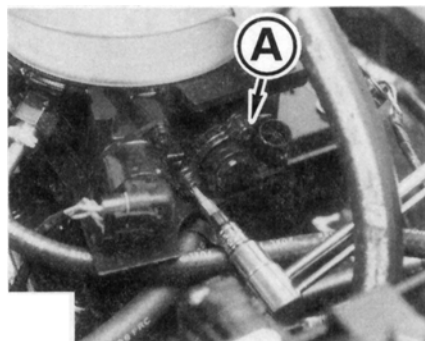


4. Remove TP sensor and seal (C).

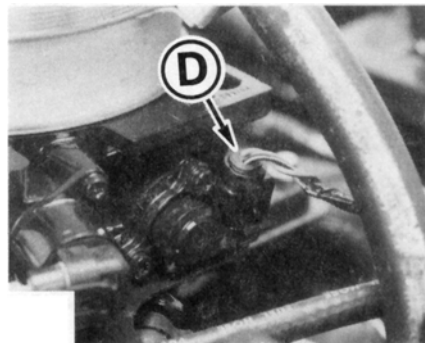
Installation

NOTE! If screws are supplied with the TP sensor service package, they must be used.

1. Place the seal (C) on the TP sensor.



2. Verify that the throttle plates are closed. Position the TP sensor on the throttle shaft and align the screw holes. Install two mounting screws (A) and tighten to 18 in. lbs. (2 N•m).

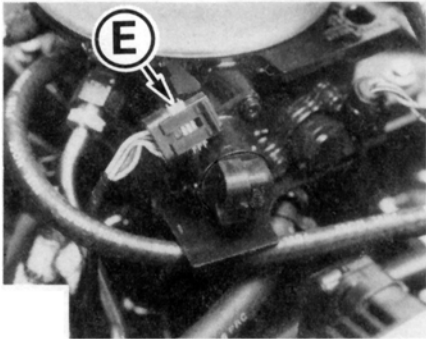


3. Attach the TP sensor electrical connector (D).
4. Install the flame arrestor cover. Tighten the nut to 25-35 in. lbs. (2,8-4,0 N•m).

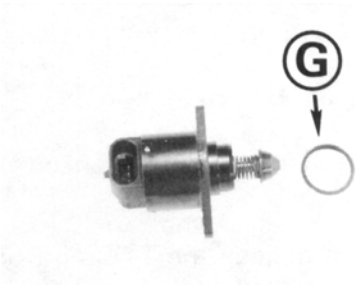
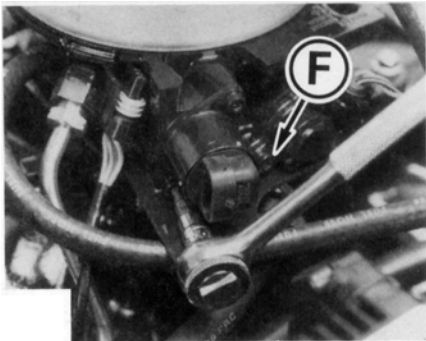
Idle Air Control (IAC) Valve

Removal

1. Remove flame arrestor cover from the engine.



2. Remove IAC valve electrical connector (E).



3. Unscrew two screws (F) securing IAC valve to throttle body. Remove IAC valve and discard O-ring (G).

NOTE! If an IAC valve has been in service, **DO NOT** push or pull on the IAC valve pintle. The force required to move the pintle may damage the threads on the worm drive. Also, **DO NOT** soak the IAC valve in any liquid cleaner or solvent. This will damage the valve.

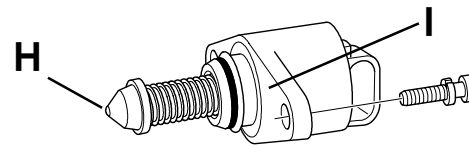
Cleaning and Inspection

NOTE! Both original and replacement IAC valves have a special factory locking compound applied to the screw threads. If the valve removed from the throttle body is being reinstalled, do not remove the thread locking compound that may be on the threads.

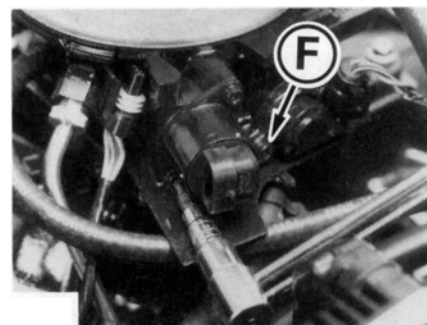
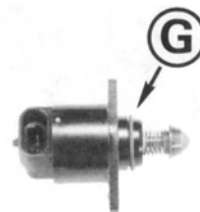
Clean the IAC valve O-ring sealing surface, pintle valve seat and air passage. Use carburetor cleaner to remove carbon deposits. **DO NOT** use a cleaner that contains methyl ethyl ketone, an extremely strong solvent. It is not necessary for this kind of deposit. Shiny spots on the pintle or seat are normal, and do not indicate misalignment or a bent pintle shaft.

Installation

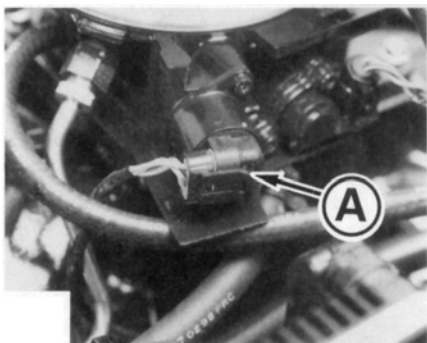
NOTE! If installing a new IAC valve, be sure to replace it with an identical part. The IAC valve pintle shape and diameter are designed for specific applications.



1. If installing a new IAC valve, measure the distance between the tip (H) of the IAC valve pintle and the mounting surface (I). If the measurement is greater than 1.102 in. (28 mm), use finger pressure to slowly retract the pintle. The force required to retract the pintle of a new valve will not cause damage to the valve.



2. Lightly lubricate a new O-ring (G) with engine oil and place it on the IAC valve. Install the valve into the throttle body and secure with two screws (F). Tighten the screws to 28 in. lbs. (3,2 N•m).

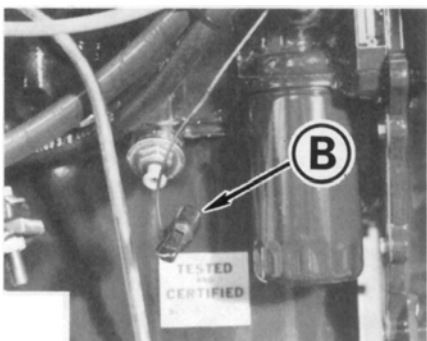


49506

3. Attach the IAC valve electrical connector (A). Check for a secure attachment.
4. Install the flame arrestor cover and tighten the nut to 25-35 in. lbs. (2,8-4,0 N•m).
5. Reset IAC valve pintle position as follows:
 - Start and run engine for 30 seconds
 - Turn ignition "OFF" for 10 seconds
 - Restart engine and check for proper idle operation

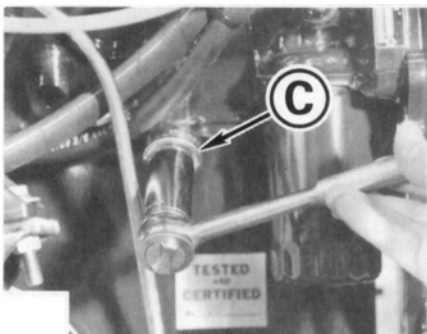
Knock Sensor (KS)

Removal



37719

1. Remove knock sensor electrical connector (B).

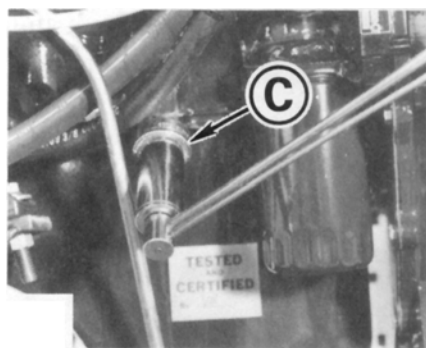


37720

2. Unscrew the knock sensor (C) from the engine block. Use a wrench to keep the T-fitting from rotating.

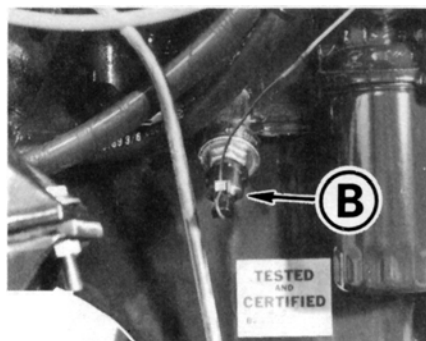
Installation

NOTE! Install the knock sensor in the same location as the old one. Make sure the threads are clean. If installing the knock sensor in a water jacket, coat the threads with *Pipe Sealant With Teflon* Volvo Penta Part no. 1141570 or equivalent.



37721

1. Thread the knock sensor (C) into the engine block and tighten to 11-16 ft. lbs. (15-22 N•m). Use a wrench to keep the T-fitting from rotating.



37722

2. Attach the knock sensor electrical connector (B).

Fuel System Component Replacement

Warning!

- To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing any fuel system components. See fuel relief procedures found elsewhere in this manual for proper relief procedures.
- After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover the fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place the towel in an approved container when service is completed.

Fuel Control Service

Warning!

The following is general information concerning working on the fuel system:

- Always keep a dry chemical fire extinguisher near the work area.
- Fuel line fittings require new O-rings when assembling.
- To reduce the risk of fire and personal injury, relieve the fuel system pressure before servicing any fuel system components. Always allow fuel pressure to bleed off before disassembling parts.
- Do not make any repairs on the fuel system until you have read the instructions and checked the figures relating to the repairs.
- DO NOT replace fuel lines with fuel hose.
- Disable ignition system if cranking the engine while fuel vapors are present to prevent fire or explosion.
- Observe all safety warnings and informational notes.

Fuel Pressure Relief Procedure

⚠ Warning!

Disconnect the negative battery cable from the battery to avoid possible fuel discharge if an accidental attempt is made to start the engine.

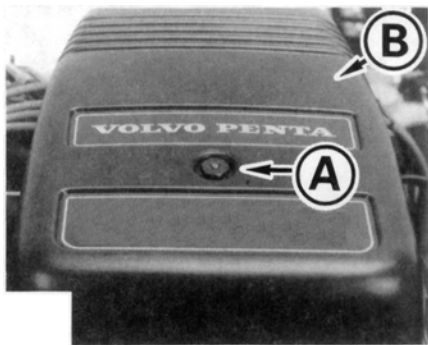
1. The internal constant bleed feature of the TBI unit relieves fuel pump system pressure when the engine is turned "OFF". Therefore, no further pressure relief procedure is required.

⚠ Warning!

After relieving system pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover the fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place the towel in an approved container when service is completed.

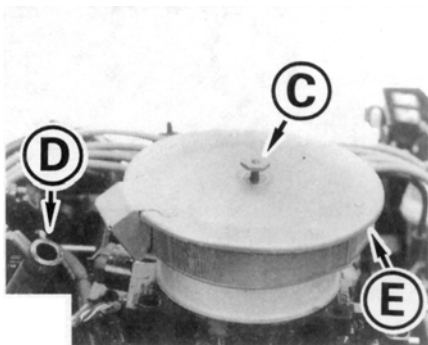
Flame Arrestor

Removal



1. Remove flame arrestor cover retaining nut (A). Remove the cover (B) from the engine.

49507



2. Remove the flame arrestor nut (C), one breather hose (D), and the arrestor (E) from the throttle body.

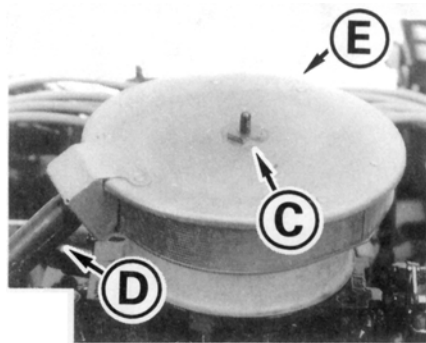
49514

Inspection

⚠ Warning!

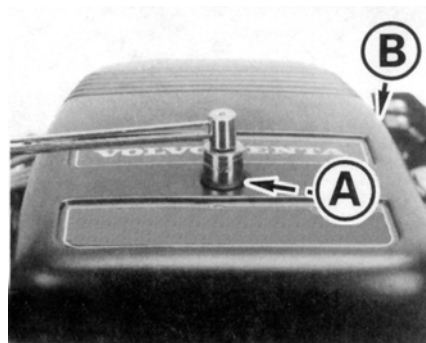
Inspect the flame arrestor element for dust, dirt, water or damage. Clean or replace as necessary.

Installation



49515

1. Place the flame arrestor (E) on the throttle body. Attach one breather hose (D) to the flame arrestor.
2. Secure the flame arrestor with retaining nut (C). Tighten nut to 25-35 in. lbs. (2,8-4,0 N•m).



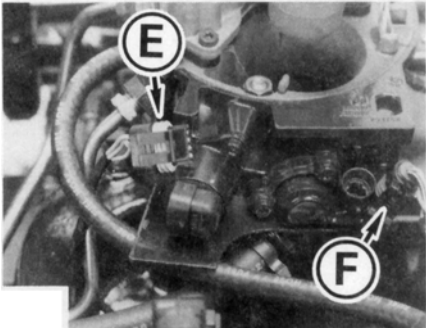
49516

3. Place flame arrestor cover (B) on the engine and secure with nut (A). Tighten nut to 25-35 in. lbs. (2,8-4,0 N•m).

Throttle Body Injector (TBI) Unit

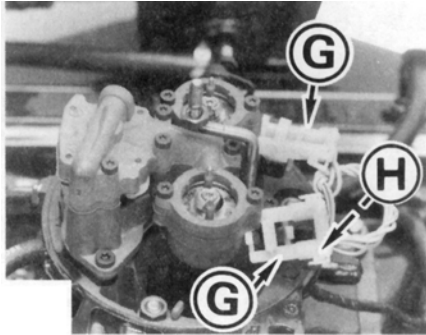
Removal

1. Remove flame arrestor following instructions found elsewhere in this section.



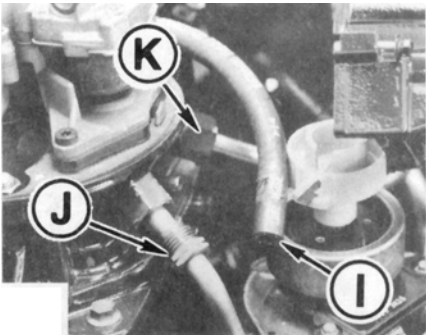
49518

2. Remove the electrical connectors from the IAC valve (E) and TP sensor (F).



49529

3. Remove the electrical connectors (G) from the injectors by squeezing the tabs on the injectors and pulling straight up. Remove grommet (H) with wires from throttle body.
4. Remove cotter pin and washer securing throttle cable to throttle body lever. Remove throttle cable from throttle body.



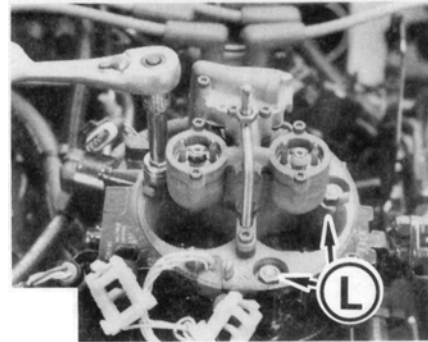
37710

5. It may be necessary to remove the distributor cap and ignition wires to allow access to the back of the throttle body. Disconnect the MAP sensor vacuum hose (I).

Warning!

Refer to Fuel Pressure Relief Procedures before disconnecting fuel lines.

6. Remove high pressure (J) and return (K) fuel lines using a flare nut wrench to prevent damage to lines or fittings. Hold the throttle body line fittings to prevent them from turning. Remove fuel line O-rings and discard.



49530

7. Remove TBI mounting nuts (L) and TBI from adaptor plate. Remove and discard throttle body mounting gasket.

NOTE! Stuff a rag in the intake manifold opening to prevent foreign material from entering the engine. Use care when removing old gasket material from the intake manifold. Failure to do so may result in damage to the manifold. To prevent damage to the throttle valve, it is essential that the unit be placed on a holding fixture before performing service.

Cleaning and Inspection

Throttle bore and valve deposits may be cleaned using carburetor cleaner and a parts cleaning brush. Do not use a cleaner that contains methyl ethyl ketone, an extremely strong solvent, and not necessary for this type of deposit.

The throttle body metal parts may be cleaned following disassembly in a cold, immersion type cleaner.

NOTE! The fuel injectors, pressure regulator, TP sensor, TP sensor gasket, and IAC valve should not come in contact with solvent or cleaner, as they may be damaged. These parts should be removed prior to immersion.

Clean all metal parts thoroughly and blow dry with compressed air. Be sure that all fuel and air passages are free of dirt and burrs.

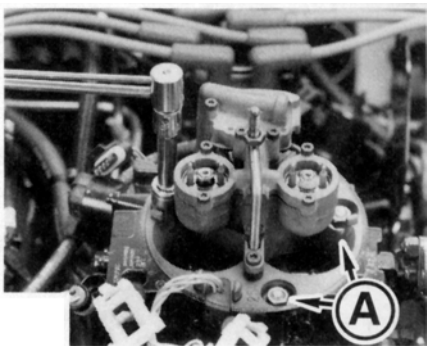
Inspect mating surfaces for damage that could affect gasket sealing, and inspect the throttle body for cracks in the casting.

A small vial of thread locking compound is supplied in the service repair kit with directions for use. If the material is not available, use *Loctite 262* or equivalent.

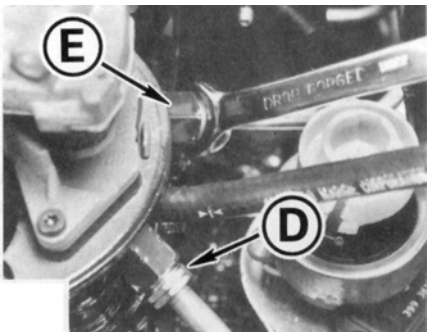
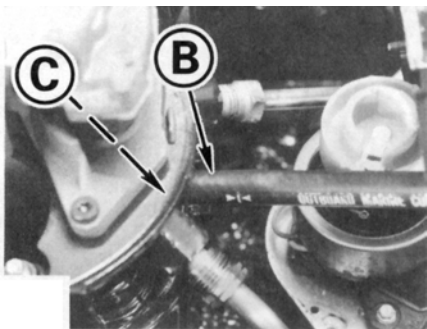
NOTE! Do not use a higher strength locking compound than recommended. To do so could make removing the screw extremely difficult, or result in damaging the screw head.

Inspect the manifold bore for loose parts and foreign material. Check the intake manifold mating surface for cleanliness and burrs that can affect gasket sealing.

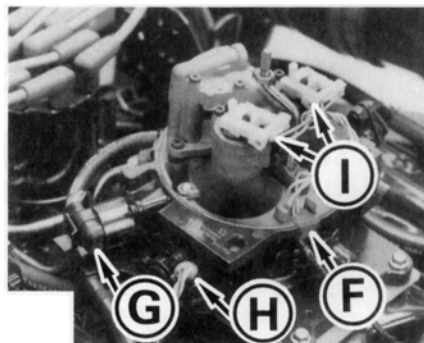
Installation



1. Install a new TBI flange (manifold mounting) gasket. Install the TBI and secure with mounting nuts (A). Tighten the nuts to 12 ft. lbs. (16 N•m).



2. Connect the vacuum hose (B) to the throttle body nipple. Secure with tie strap (C). Install new O-rings on the fuel lines. Connect the high pressure (D) and return (E) fuel lines to the throttle body. Hold the throttle body line fittings to prevent them from turning, and tighten the line nuts to 17 ft. lbs. (23 N•m).
3. Attach the throttle cable to the throttle body. Secure with flat washer and cotter pin. Bend the ends of the cotter pin for a secure attachment. Check for proper adjustment.



4. Attach the grommet (F) with wiring harness to the throttle body. Connect all electrical connectors to the IAC valve (G), TP sensor (H), and fuel injectors (I).
5. Check to see if the throttle is free, by moving the throttle lever to full open and back to full close while the engine is "OFF".
6. Check for fuel leaks with the key switch "ON" and engine "OFF".
7. Install the flame arrestor following the instructions found elsewhere in this section.
8. Start the engine and **check for fuel leaks.**

⚠ Warning! gasoline fumes are explosive. Correct and clean up any fuel leaks found. Ventilate the engine compartment before attempting to start the engine again.

Fuel Meter Cover Assembly

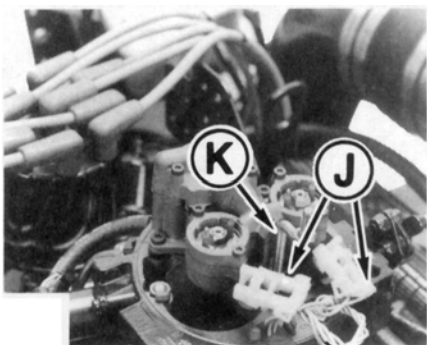
Removal

The fuel meter cover assembly contains the fuel pressure regulator assembly. The regulator has been adjusted at the factory and should only be serviced as a complete preset assembly.

⚠ Warning!

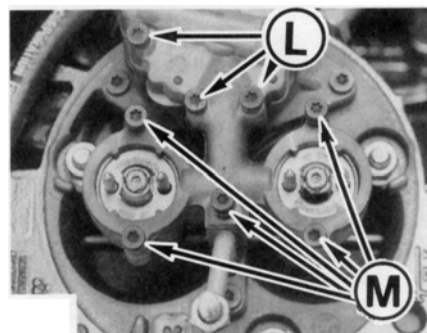
DO NOT remove the four screws securing the pressure regulator to the fuel meter cover. The fuel pressure regulator includes a large spring under heavy compression which, if accidentally released, could cause personal injury. Disassembly may also result in a fuel leak between the diaphragm and the regulator container.

1. Remove the flame arrestor following instructions found elsewhere in this section.

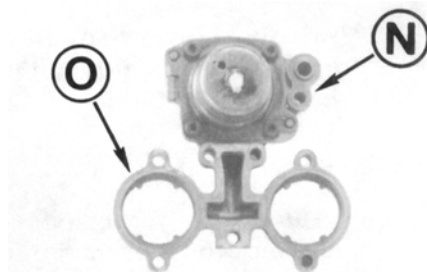


49533

2. Remove electrical connectors (J) from injectors by squeezing plastic tabs on injectors and pulling straight up.



37689a



37690

3. Unscrew the flame arrestor stud (K) 180 degrees to allow access to retaining screws. Remove long (L) and short (M) fuel meter cover screws. Remove the fuel meter cover assembly. Remove and discard gaskets (N) and (O).

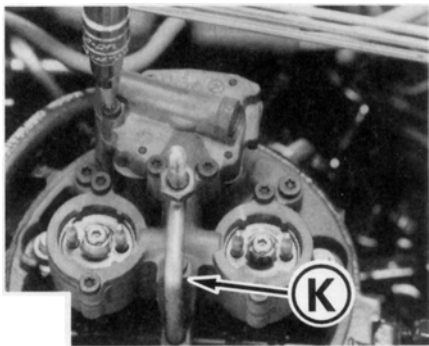
⚠ Caution!

DO NOT immerse the fuel meter cover (with pressure regulator) in cleaner, as damage to the regulator diaphragm and gasket could occur.

Inspection

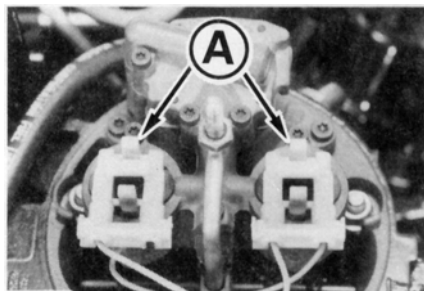
Inspect all components for dirt, foreign material, and casting warping.

Installation



37691a

1. Install a new fuel meter outlet gasket (N) and cover gasket (O) on the fuel meter cover. Install the cover assembly on the throttle body. Install the short retaining screws (M) around the injectors. Install the long retaining screws (L) around the fuel pressure regulator. Tighten the screws to 28 in. lbs. (3,0 N•m). Tighten the flame arrestor stud (K) 180 degrees after tightening the screws.



37692a

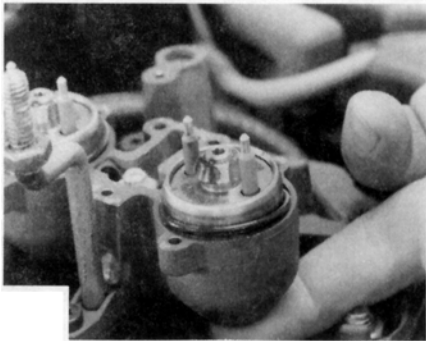
2. Attach the electrical connectors (A) to the fuel injectors.
3.  Caution!
Turn "ON" the ignition switch but DO NOT start the engine. Check for fuel leaks around the gasket and fuel line couplings.
4. Install the flame arrestor following instructions found elsewhere in this section.

Fuel Injector

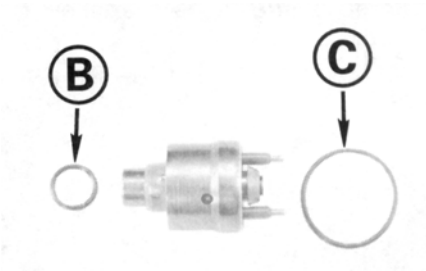
Removal

NOTE! Use care in removing the fuel injectors to prevent damage to the electrical connector terminals, the injector filter, and the fuel nozzle. The fuel injector is serviced as a complete assembly only. Also, since the injectors are electrical components, they should not be immersed in any type of liquid solvent or cleaner as damage may occur.

1. Remove the fuel meter cover assembly, following the procedures found elsewhere in this section.



2. Push with your finger on the injector tip and remove the injector from the throttle body.

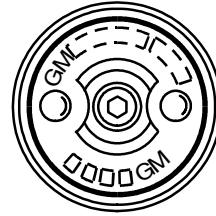


3. Remove lower (small) O-rings (B) from the nozzle of the injectors. Remove the upper (large) O-rings (C) from the top of the fuel injector. Discard the O-rings.

Inspection

Inspect fuel filter for evidence of dirt and contamination. If present, check for presence of dirt in fuel lines and fuel tank.

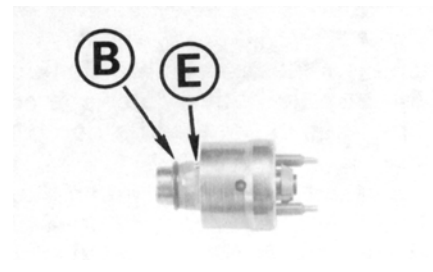
Installation



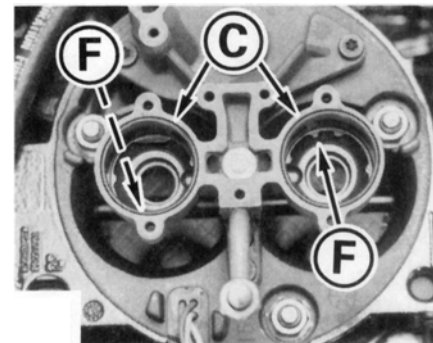
DR5526

Caution!

Be sure to replace the injector with one having an identical part number and paint color marking. Injectors from other models can also fit into the TBI, but are calibrated for different flow rates.

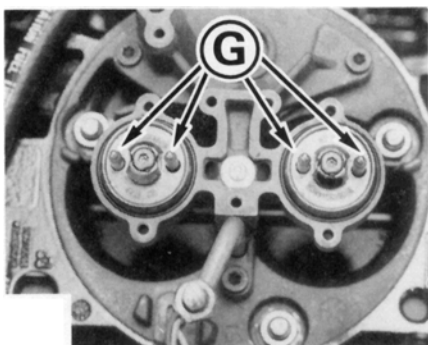


1. Lubricate new lower (small) O-rings (B) with *Volvo Penta Power Trim/Tilt and Power Steering Fluid*, and push on nozzle end of the injector until it presses against the fuel injector filter.



2. Lubricate a new upper (large) O-ring (C) with *Volvo Penta Power Trim/Tilt and Power Steering Fluid* and install it in the injector opening. Be sure O-ring is seated properly and is flush with top of fuel meter body surface.

NOTE! Large O-rings must be installed before injectors, or improper seating of the large O-ring could cause fuel to leak.



37727A

3. Install the injectors. Align the raised lug (E) on each injector base with the notch (F) in the fuel meter body cavity. Push down on the injector until it is fully seated in the fuel meter body. The electrical terminals (G) of the injectors should be in line with the throttle shaft.

⚠ Caution!

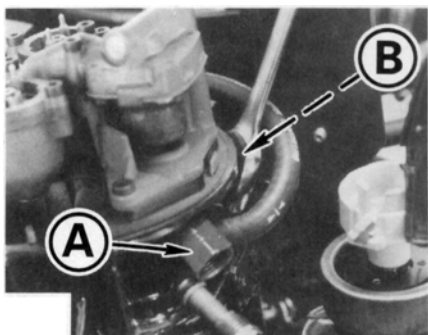
Be sure to install the injectors in their proper location.

4. Install the fuel meter cover and gasket following the procedures found elsewhere in this section.
5. Install the electrical connectors on the fuel injectors.
6. Turn the key switch "ON" but DO NOT start the engine. Check the fuel system for leaks.

Fuel Meter Body Assembly

Removal

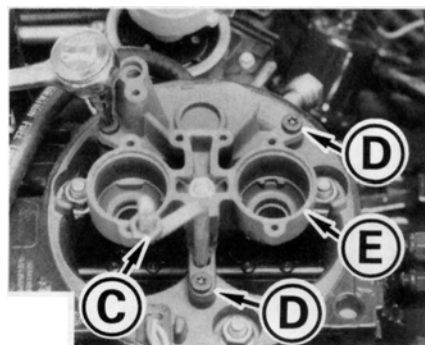
1. Remove fuel meter cover assembly and injectors following the procedures found elsewhere in this section.
2. Remove distributor cap to allow access to high pressure and return fuel lines. Remove both lines and discard the O-rings.



37728

3. Remove the high pressure (A) and return (B) nuts and gaskets. Discard the gaskets.

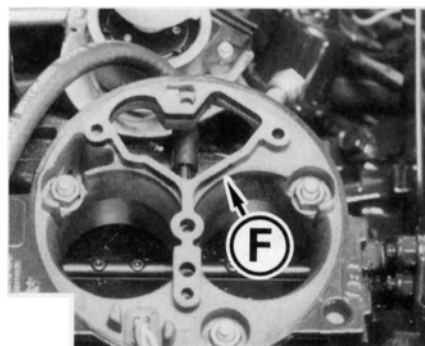
NOTE! Note the location of the nuts for proper reassembly later. The inlet (high pressure) nut has a larger passage than the outlet nut.



37729a

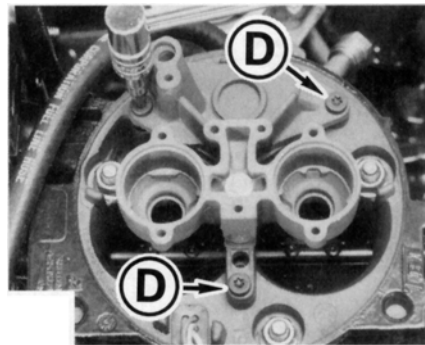
4. Remove the flame arrestor stud (C) and fuel meter body mounting screws (D). Remove the fuel meter body assembly (E) from the throttle body. Discard the gasket between the assemblies.

Installation



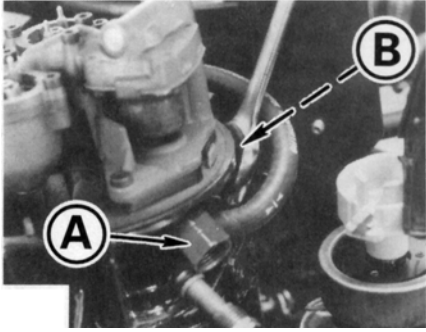
37730a

1. Place a new throttle body to fuel meter body gasket (F) on the throttle body. Match the cut-out portions in the gasket with openings in the throttle body.



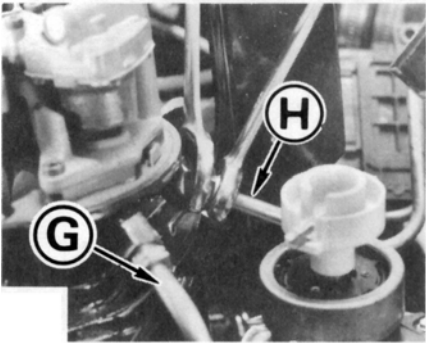
37731a

2. Place the fuel meter body assembly (E) on the throttle body. Apply *Volvo Penta 1161053 locking fluid* to the threads of the mounting screws. Install the mounting screws (D) and tighten the screws to 30 in. lbs. (4,0 N•m). Install the flame arrestor stud (C). Align the bend in the stud over the center of the throttle body.



37728

3. Install the high pressure (A) and return (B) fuel nuts with new gaskets in the fuel meter body assembly. Tighten the high pressure nut to 30 ft. lbs. (40 N•m). Tighten the return nut to 21 ft. lbs. (29 N•m).



37683

4. Install the high pressure (G) and return (H) fuel lines using new O-rings. Tighten the fittings to 17 ft. lbs. (23 N•m). Use a wrench to keep the TBI nuts from turning.
5. Install the fuel injectors and fuel meter cover following procedures found elsewhere in this section.
6. Turn "ON" the ignition switch but DO NOT start the engine. **Check for fuel leaks around fuel meter body, gasket, and fuel line nuts.**

Fuel Cell

⚠ Caution!

The FUEL CELL is a sealed unit and cannot be opened for service. Should any of the components fail, a complete unit must be installed.

Removal

⚠ Warning!

This fuel system component has been designed to meet U.S. Coast Guard fuel systems regulations for marine use. Do not substitute other brands or models that may be similar in appearance. Use of a substitute could result in leakage of fuel or fumes, and cause fire and explosion.

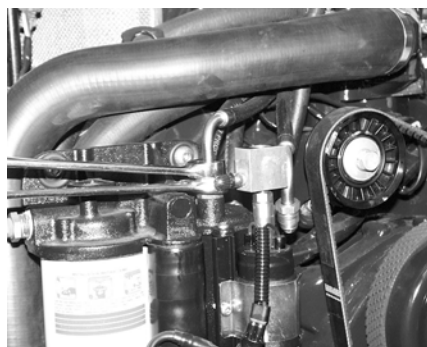
1. Verify the ignition switch is in the "OFF" position. Disconnect negative cable from the battery.
2. Disconnect boat fuel supply line at fuel filter and plug threaded hole.



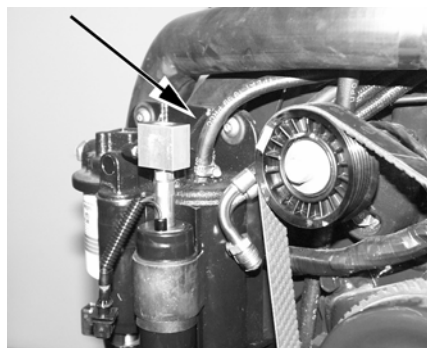
3. Disconnect electrical leads from fuel pumps.



4. Using two wrenches, one holding schrader valve block fitting and other on fuel line nut, unscrew fuel line and pull line out of fitting.



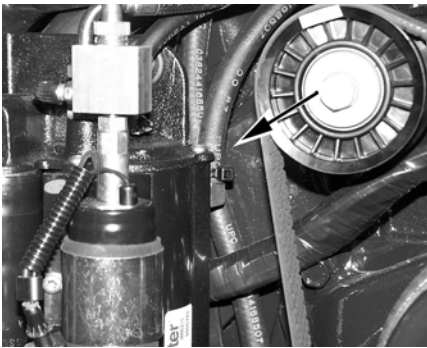
5. Using two wrenches, one holding return line fitting and other on fuel line nut, unscrew fuel line and pull line out of fitting.



6. Disconnect the vapor hose from the FUEL CELL.

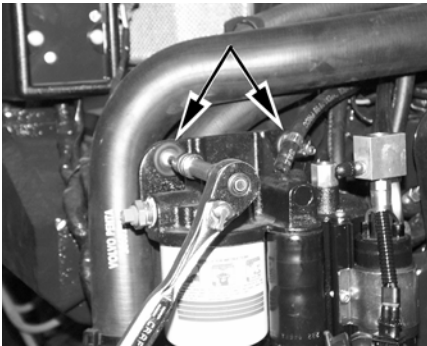


7. Remove the cooling water inlet line from the lower fitting of the FUEL CELL.



8. Remove the outlet cooling line from the FUEL CELL.

30635

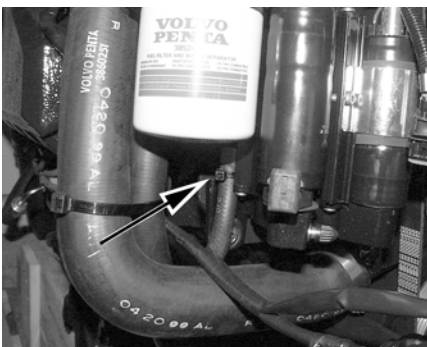


9. Using a 7/32 allen key, remove the four mounting screws that hold the FUEL CELL in place. Remove the unit.

30636

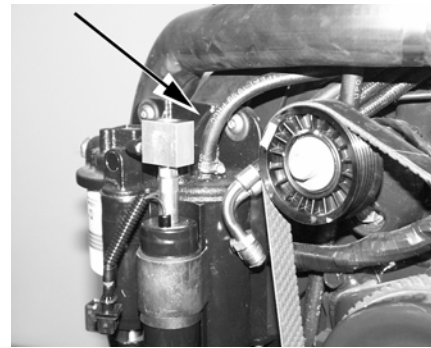
Installation

1. Install a new FUEL CELL. Coat the mounting screws with Volvo Penta thread locking compound 1161053 and install the mounting screws. Torque to 24-29 ft. lb. (31-39 N•m).
2. Connect the water outlet line to the FUEL CELL and secure with a tie strap.



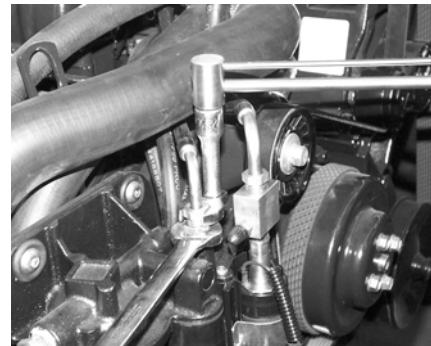
3. Install the water inlet line to the FUEL CELL and secure with a tie strap.

30628



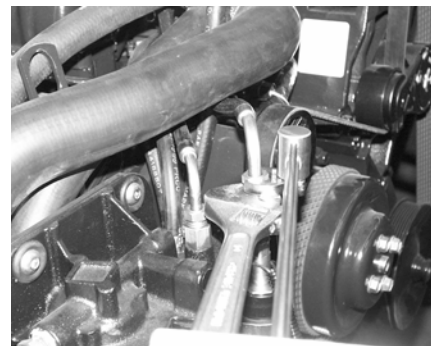
49570

4. Inspect the vapor hose for deterioration. If hose is in good condition connect the vapor hose the FUEL CELL and tighten the clamp.



49571

5. Install new fuel line O-rings onto the fuel lines. Connect the return line the FUEL CELL. While supporting the FUEL CELL fitting, tighten the fuel line nut.



30641

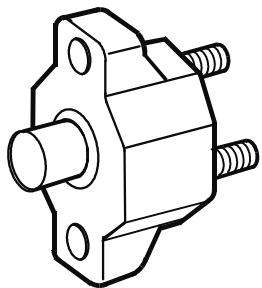
6. Connect the high pressure fuel line to the schrader valve block. While supporting the block with an adjustable wrench, tighten the fuel line nut.

⚠ Caution!

Do not turn the schrader valve block as this may damage the fuel pump or O-ring and cause fuel leakage.

7. Reconnect the boat fuel line. **Tighten securely.** Attach negative cable to battery. **Tighten nut securely. Run engine and check for fuel leaks.**

Circuit Breaker



DR4640

EFI engines have three fuses and one circuit breaker as protection devices.

- A 15 amp fuse protects the fuel injector relay and ECM
- A 50 amp circuit breaker protects the trim/tilt motor
- A 40 amp fuse protects the main engine harness
- A 20 amp fuse protects the fuel pump relay and circuit

A 10 amp in-line fuse is located in the trim/tilt pump wiring harness to protect the pump relays. If one of these components or circuits fails, the ECM won't recognize it, nor store a service code in memory.

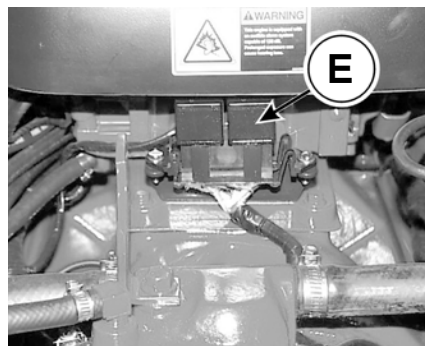
Circuit Breaker Replacement

Warning!

To prevent sparks, damaged components or possible personal injury, disconnect battery before servicing any circuit breaker.

1. Make a note of the lead position, then remove all the leads from the circuit breaker. Remove the screws and nuts, and lift circuit breaker out of bracket.
2. Install new circuit breaker and secure with screws and nuts. Tighten screws to 20-25 in. lbs. (2,3-2,8 N•m).
3. Attach the leads to their original positions on the circuit breaker and secure with the nuts. Tighten the nuts to 20-25 in. lbs. (2,3-2,8 N•m). Coat the terminals with Black Neoprene Dip or equivalent.

Relay Replacement



37869

Replace the relay (E) by pulling it off its mounting bracket. Install the relay by aligning the terminals of the relay with the bracket. Push the relay in until it seats.

Relay Ohmmeter Tests

NOTE! Throughout this section two symbols are used to interpret electrical troubleshooting results.



DR2065

This symbol indicates **continuity** or very low resistance.



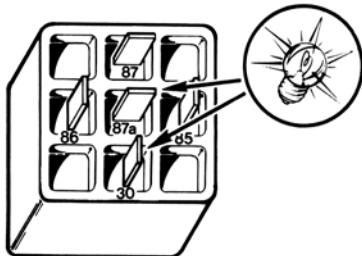
DR2066

This symbol indicates **no continuity** or very high resistance.

⚠ Caution!

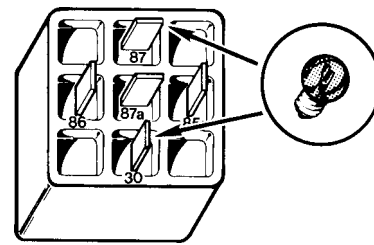
To avoid damaging components or troubleshooting equipment, disconnect the battery cables from the battery and remove the relays before proceeding.

1. Use a continuity light or ohmmeter calibrated on appropriate scale to test continuity.



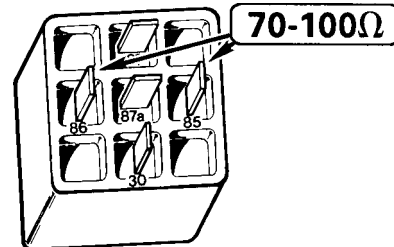
DR2149

2. Connect meter leads to relay terminals 87a and 30.
 - The meter must show **continuity**.



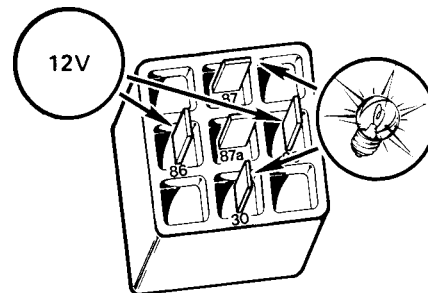
DR2149a

3. Connect meter leads to relay terminals 87 and 30.
 - The meter must show **no continuity**.



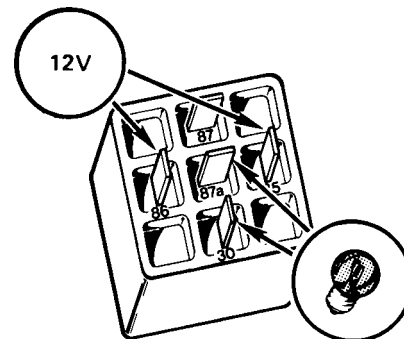
DR2149b

4. Calibrate an ohmmeter on appropriate scale and connect the leads to relay terminals 85 and 86.
 - The meter must show 70 - 100 ohms.



DR2149c

5. Connect meter leads to relay terminals 87 and 30. Connect a 12 volt source to relay terminals 85 and 86.
 - The meter must show **continuity**.



DR2149d

6. Connect meter leads to relay terminals 87a and 30. Connect a 12 volt source to relay terminals 85 and 86.
 - The meter must show **no continuity**.
7. Replace relay if your test results vary.

Troubleshooting Electric Pump(s)

1. Start by verifying the pumps are receiving a minimum of 12.0 ± 1 volt. Remove the connector from each pump suppressor. Disable ignition to prevent engine from running, then crank engine and check yellow/green lead with a voltmeter. Turn key off, then check connector black lead with an ohmmeter for a good ground. If voltage is not as specified, or ground path is suspect, check:

- relay and bracket
- fuse
- wiring related to all of the above

Ensure all items are functioning correctly before proceeding. As voltage to the pump drops, so will its output capability.

2. Once it's been established that the pumps are receiving proper voltage, separate the engine fuel system from the boat's fuel system. Disconnect the supply line at the pump's fuel filter, and place a pick-up hose in a vented fuel container. **The pick-up hose must have a minimum I.D. of 3/8 in.**

Warning!

Do not connect engine fuel system to any supply system having a pressure producing device such as an outboard fuel tank with primer bulb, or another electric fuel pump located elsewhere in the boat or at the fuel tank. The pumps are sensitive to additional fuel pressure, and will add this to its own output. The result will be a continually flooding fuel reservoir with the possibility of external fuel leaks and the potential for fire and explosion.

3. Run engine to see if problem still exists. If problem has been eliminated, source is located somewhere in boat fuel system back to, and including, the boat fuel tank. If problem still occurs, it's located somewhere in engine fuel system.
4. The electric fuel pumps require an unrestricted, air tight fuel supply. Unscrew the low pressure fuel pump filter and check it for debris. Also check that the filter seals tightly against its fixture and the center mounting threads. **Make sure the filter is the correct one for this application.** Check threads of filter inlet elbow to ensure a tight seal. If any of these conditions are in doubt, correct them before continuing.
5. Check both fuel pump mounting positions.

Warning!

Pumps must always be located on engine in original factory position. This position is determined by U.S. Coast Guard regulations and must be complied with. Never relocate pump to transom, stringer, fuel tank, or any point other than its original location on the engine.

Pressure Testing Fuel System

NOTE! Pressure test fuel system using appropriate equipment. The following pieces are available from Owatonna Tool Co. They feature leak-free connections and the ability to depressurize and drain the fuel lines.

- EFI Fuel Pressure Gauge OTC-7211
- Adaptor OTC-7272

Warning!

Pump(s) performance can be verified by checking pump(s) PSI at specific engine RPM. This test must be performed with engine under load; either running in gear on water, or in gear and connected to a dynamometer. Use a good quality fuel pressure gauge. Follow the gauge manufacturer's instructions for installation, and ensure that connections are leak free. Refer to the Fuel System section found elsewhere in this manual to check pump's operating pressure.

NOTE! New pumps will generally have lower operating pressures. As the gears break in, contact improves and the pump's pressure will increase slightly.

Troubleshooting Boat Fuel System

The most common causes of failures in the boat fuel system are due to line restrictions or air entry. Typical restrictions are:

- kinked, bent, or internally swollen fuel lines
- fuel lines and/or tank selector valve I.D.'s too small
- restricted or wrong anti-siphon valve
- cracked or blocked fuel pick-up or screen inside tank
- blocked tank vent

Air entry can occur at any point on the suction side of the fuel system. Air in the fuel system is usually indicated by a humming or squealing noise from the pumps.

NOTE! Fuel pump noise can be caused by air being drawn through the fuel pump gears, but is not always an indicator that something is wrong. Momentary noise has several causes that are not linked to fuel system failures:

- pump(s) may squeal for a short time upon start-up as air is expelled
- if ambient temperatures are high, the engine compartment will be subjected to hot operating conditions that may create vapor in the fuel lines
- a hot engine after shutdown will go into a "hot soak" condition that may produce fuel vapors
- the use of ethanol fuel will also aggravate this condition as it's more susceptible to vapor formation

All of these situations are temporary, but may produce vapor that would cause pump(s) noise. Pump(s) noise that is continuous, and/or cannot be attributed to any of these conditions, could be an indicator of fuel system problems.

Vacuum Testing Fuel System

Caution!

This test must be performed with engine under load; either running in gear on water, or in gear and connected to a dynamometer. Ensure that all fuel line connections are leak free.

1. Install Vacuum and Fuel Pressure Gauge such as *Snap-on*® Tools MT311JB (or equivalent), and 8 in. (20,3 cm) of clear, fuel resistant vinyl hose into the fuel line at the filter bracket inlet.
2. Start engine and allow it to reach normal operating temperature. Run engine at full throttle for at least 2 minutes; observe vacuum gauge reading and check clear hose for air or vapor bubbles. Gauge reading must not exceed 3 in. of mercury (Hg) at any time, and there should be no bubbles visible in the clear hose. compare observations to the following:

Gauge reads 1-3 in. of mercury - air bubbles present

Supply side of fuel system has an air leak. Check points of possible failure as noted under *Checking Boat Fuel System*. Repair or replace suspect part, then make another vacuum test to verify repair.

Gauge reading exceeds 3 in. of mercury

Supply side of fuel system has a restriction. Check points of possible failure as noted under *Checking Boat Fuel System*. Repair or replace suspect part, then make another vacuum test to verify repair.

Engine Fuel System Troubleshooting

Engine Does Not Start - Improper Starting Procedure Used

1. Check the following: fuel level in tank, fuel tank vent, fuel lines for blockage, tank to pump fuel line for air leaks, fuel filters for blockage, and anti-siphon valve.
2. Check fuel pump for correct pressure.

Engine Will Start When Primed - Will Not Continue to Run

1. Check fuel supply.
2. Check fuel lines for blockage, air leaks, anti-siphon valve.
3. Check for plugged fuel filters.
4. Check fuel pump for correct pressure/vacuum.

Engine Hard Starting, Cold

1. Check fuel pump for correct pressure/vacuum.
2. Check for blockage in fuel lines, air leaks in fuel line from tank to fuel pump.

Engine Hard Starting, Hot

1. Check for fuel line on or near hot surfaces, causing percolating in lines.
2. Check fuel tank vent.

Engine Runs Rough, Low Speed

1. Check for dirt or water in fuel, excessive or insufficient fuel pump pressure.
2. Check other systems; intake manifold for vacuum leaks, sticking valves, overheating, etc.
3. Check setting and operation of throttle plate opening.

Engine Runs Rough, High Speed

1. Check for sufficient fuel in tank, blocked tank vent, anti-siphon valve, proper fuel.
2. Check for water or dirt in fuel; check for correct fuel pump pressure/vacuum; check for blockage or air leaks in fuel line.
3. Check for plugged fuel filters.

Engine Dies (On Initial Acceleration) or Has Acceleration Flat Spot

1. Check fuel lines for fuel leaks or partially plugged tank vent.
2. Check for water or dirt in fuel; check fuel pump for correct pressure/vacuum.

Engine Will Not Run at Recommended RPM

1. Check throttle linkage adjustments to be sure throttle opens fully.
2. Check fuel lines for leaks; check fuel pump for correct pressure/vacuum.
3. Check boat for proper trim and propeller; check hull for marine growth.
4. Check ignition system components.
5. Check engine and drive unit for partial seizure.
6. Check fuel tank for plugged vent; check pickup tube for vacuum leaks.
7. Check for plugged fuel filters.
8. Check for full opening of throttle.
9. Check exhaust system for restrictions.
10. Check lower gearcase and propeller for exhaust restrictions.
11. Check for restricted air intake.

Ignition System Description

Volvo Penta uses the DI (Distributor Ignition) system for EFI engines. It consists of a distributor with an electronic ignition control module and pickup coil, a cap, rotor and remote coil. It does not contain breaker points, condenser, or centrifugal advance.

Ignition Troubleshooting

The following tests are used to check various components. These tests should be conducted as necessary to solve a particular problem, and should not be part of a normal tune-up procedure. The following equipment will be needed:

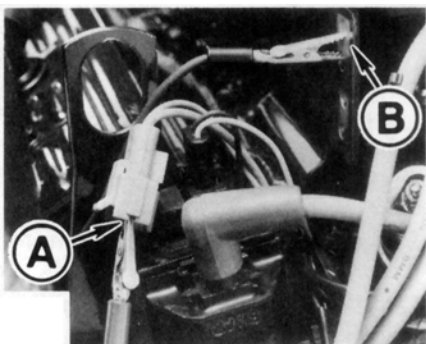
- Ohmmeter
- Voltmeter
- Terminal Adaptors
- Timing Light
- Tachometer
- Test Propeller
- Jumper Wire or Code Tool

NOTE! All running tests must be conducted in water with the correct test propeller to properly load engine. Do not perform tests with a flushing adaptor.

12 Volt (B+) Test

Ignition Coil

1. Disconnect the purple and gray wire connector at coil.

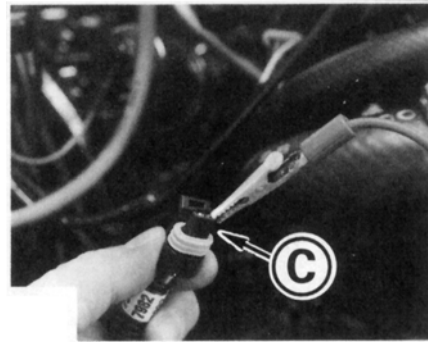


34932

2. Connect voltmeter positive (+) lead to purple wire terminal (A) in connector and the negative (-) lead to engine ground (B). Turn on ignition switch, meter should read a minimum of 8 volts.

Distributor

1. Attach purple and gray wire connector to coil. Disconnect pink and brown wire connector at distributor.

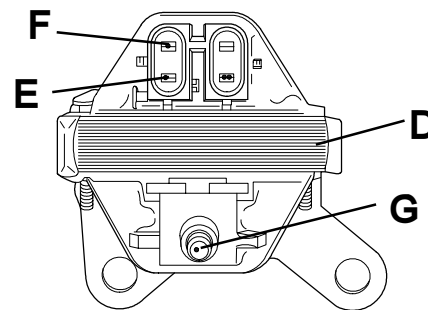


37708

2. Connect voltmeter positive (+) lead to pink wire terminal (C) in connector and the negative (-) lead to engine ground. Turn on ignition switch, meter should read a minimum of 8 volts.

Ignition Coil Test

The ignition coil can be checked for open circuits and shorts with an ohmmeter. If the ignition coil fails any one of the following checks replace it. **Remove both wire connectors from coil before performing tests.**



Dr3302

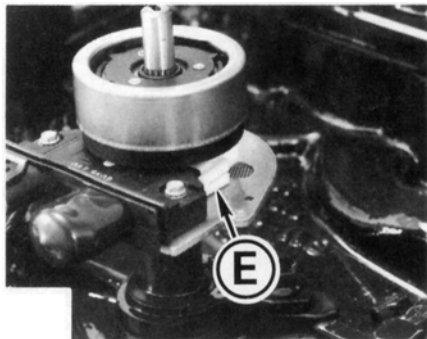
1. To check for a short to ground, connect ohmmeter to the frame (D) and purple wire terminal (E). With the ohmmeter set on the high scale, reading should be infinity (h). If not, replace coil.
2. To check for an open or shorted primary circuit, connect ohmmeter to purple wire terminal (E) and gray wire terminal (F). With the ohmmeter set on the low scale, reading should be 0.35-0.45 ohms. If reading is more than 0.45 ohms (indicates a possible open circuit) or less than 0.35 ohms (indicates a shorted circuit), replace the coil.
3. To check for an open or shorted secondary circuit, connect ohmmeter to purple wire terminal (E) and high tension terminal (G). With the ohmmeter set on the high scale, reading should be 7500-9000 ohms. If reading is higher than 9000 ohms or lower than 7500 ohms, replace the coil.

NOTE! If using a marine KV Tester, coil should provide a minimum of 34,000 volts when conducting a no-load, open circuit test.

Pickup Coil Test

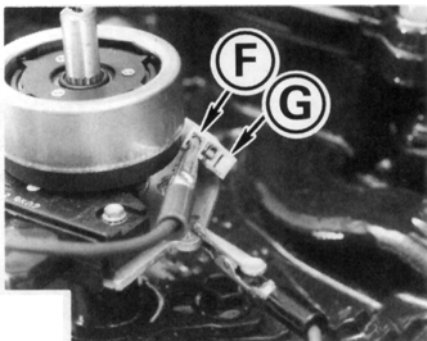
The pickup coil can be checked for an open circuit and shorts with an ohmmeter. If the pickup coil fails either one of the following checks replace it.

1. Remove screws securing distributor cap. Remove cap and rotor.



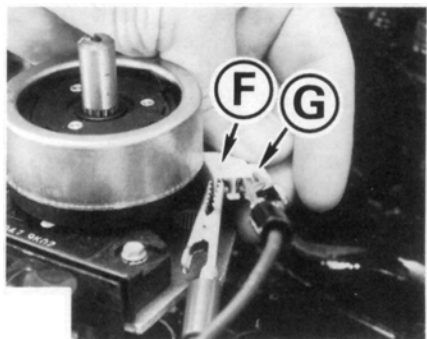
34935

2. Release locking tab (E) and unplug pickup coil connector.



34936

3. To check for a short to ground, connect ohmmeter to the body of distributor and either terminal (F) or (G). With the ohmmeter set on the high scale, reading should be infinity (h). If not, replace the coil.



34937

4. To check for an open or shorted coil, connect ohmmeter to terminals (F) and (G). With the ohmmeter set on the high scale, a good coil should have a constant value between 700 and 900 ohms. If reading is higher than 900 ohms or lower than 700 ohms, replace the pickup coil.

Ignition Module Test

The distributor's ignition module has only two failure modes, "no spark" and "no spark advance". After all other checks have been made and these conditions still exist, replace ignition module.

Inductor

The primary circuit pink wire, between the ignition coil and distributor 2-way terminal, contains an inductor to protect against RFI interference. If the inductor fails, disconnect and replace the 2-lead primary circuit wire harness.

Distributor

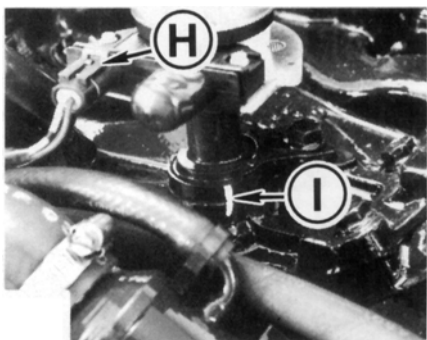
Service

⚠ Warning!

Do not substitute automotive parts. *Volvo Penta* marine components meet U.S. Coast Guard regulations for external ignition proof operation and marine use. *Volvo Penta* marine components are specially designed not to cause ignition of fuel vapors in the bilge or engine compartment. The use of automotive parts can result in fire and explosion.

Removal

1. Disconnect high tension leads from distributor cap.



34939

2. Lift locking tabs (H) and unplug 2 and 4-terminal connectors. Crank engine so number 1 cylinder is in firing position.
3. Remove two attaching screws and distributor cap. Note rotor tip position, and place a reference mark at this point on distributor housing so rotor/distributor housing can be realigned during installation.
4. Make a mark (I) on distributor base and engine, so the distributor can be replaced in its original position during installation.

NOTE! If engine is cranked while distributor is out, complete ignition timing procedure must be followed. See **Distributor Installation** and **Setting Initial Timing** procedures.

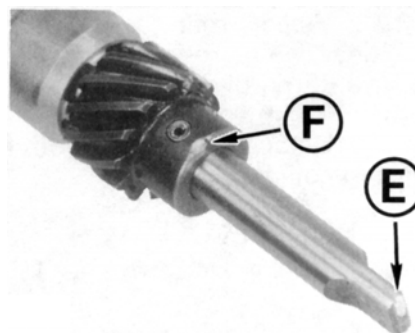
5. Remove distributor clamp and lift distributor from engine. Discard gasket.

Disassembly

Remove distributor from engine (if necessary) following previous procedure.

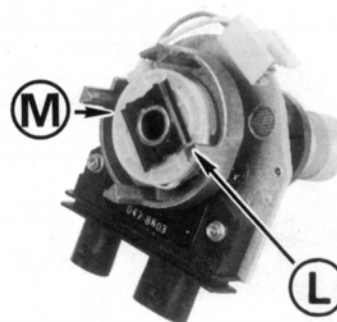
Ignition Pickup Coil

1. Pull off rotor.



22817

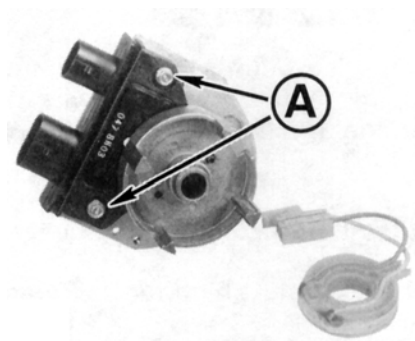
2. Place a mark on the gear (F) and the drive tang (E) so that the gear can be installed in its original location. Drive pin from gear and remove shaft assembly.



22819

3. Detach leads from module. Pry off retainer (L), and remove pickup coil (M).

Ignition Module



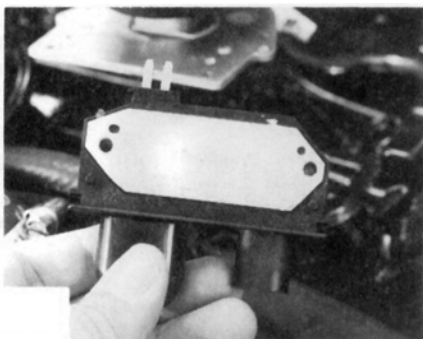
22818

Detach leads and remove the mounting screws (A). Remove module. Module may be stuck to housing and require prying off.

Reassembly

Ignition Module:

1. Clean old heat sink compound or silicone grease from mounting surfaces of module and distributor.



2. Apply *Heat Sink Compound* or silicone grease to mounting surface of module.

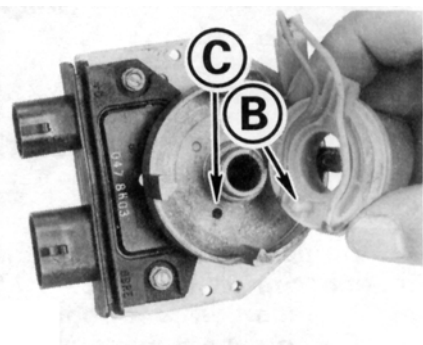


Caution!

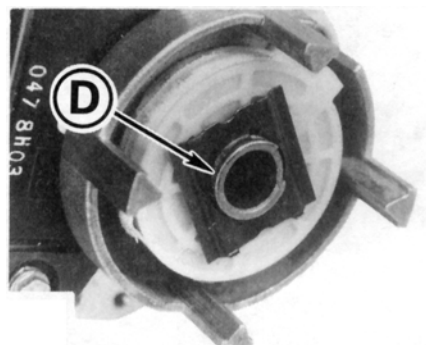
Heat sink compound or silicone grease is necessary for proper heat dissipation.

3. Position module on mounting area of distributor and install the two mounting screws. Tighten securely.

Ignition Pickup Coil:

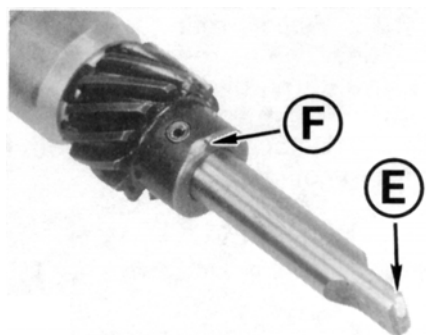


1. Align tab (B) and hole (C) and attach pickup coil to pole piece as shown. Reattach pickup coil leads to module.



2. Install retainer with locking tabs securely positioned in shaft groove (D).

Shaft, Gear and Rotor



1. Install shaft into housing and assemble gear on shaft. Align gear (F) with tang mark (E) and secure with roll pin.
2. Align rotor with notch in shaft and press on securely.

Installation

Engine Not Disturbed

NOTE! Use this procedure if the rotor/housing/block relationship was marked, and the crankshaft has not been rotated. If ignition/valve timing relationship has been disrupted or engine has been cranked with distributor out, install distributor following **Timing Out of Synch** procedure.

1. Position rotor about one-eighth turn counter-clockwise from the rotor reference mark previously placed on the distributor housing.
2. Place a new distributor gasket on engine block. Align reference mark on distributor housing with mark on engine. Push distributor down into block until the housing is in a normal installed position.

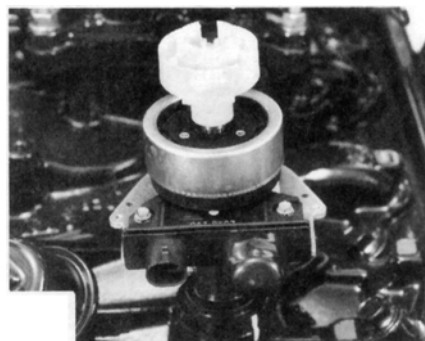
NOTE! It may be necessary to move rotor slightly to engage distributor with camshaft gear and oil pump driveshaft, but rotor/housing/block reference marks should properly align when distributor is down in place.

3. Reinstall hold-down clamp and screw. Tighten screw enough so you can just turn the distributor. Attach the 2-wire and 4-wire connectors to the distributor.
4. Install distributor cap. Tighten screws securely to maintain external ignition proof characteristics. Lubricate terminals on the distributor cap with EP/Wheel Bearing Grease or equivalent and install spark plug wires if they were removed.
5. Time ignition as required. See *Setting Initial Timing* procedure.

Timing Out of Synch

NOTE! Use this procedure if the rotor/housing/block relationship was not marked, or if the crankshaft has been rotated and the ignition timing is completely off.

1. Move number 1 piston to firing position (both valves for number 1 cylinder are completely closed) and align harmonic balancer timing mark with timing grid. Number 1 cylinder is now in position to fire.



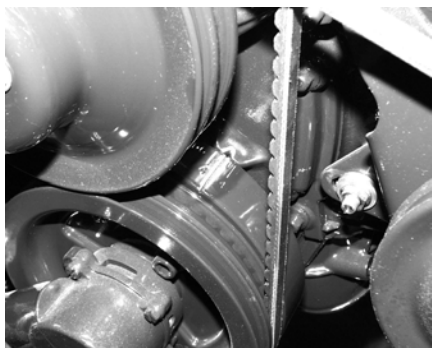
34928

2. Install distributor into engine. After distributor seats, rotor must be in position to fire number 1 cylinder. If distributor does not seat in engine block, press down lightly on distributor housing while turning rotor. After distributor engages oil pump shaft, install distributor clamp and bolt, leaving bolt just loose enough to permit movement of distributor with heavy hand pressure.
3. Place cap on distributor housing. Rotate housing left or right until rotor lines up with terminal for number 1 spark plug wire.
4. Check all high tension wiring, and connect spark plugs wires to cap in proper sequence if they have been removed.
5. Attach 2-wire and 4-wire connectors to distributor. Continue on to *Setting Initial Timing* procedure.

Warning!

To prevent a possible explosion, operate the blower as recommended by the boat manufacturer before starting engine. If the boat is not equipped with bilge blower, open engine cover or hatch prior to starting and leave open until after engine is running.

Setting Initial Timing



49478

The timing mark is cast into the timing chain cover. The timing grid is a scale cast into the harmonic balancer. It shows Top Dead Center (marked with a line) and degrees of advance (before) or retard (after). Each division on the scale represents 2 degrees.

Preparation

1. Connect a 12-volt timing light to number 1 spark plug lead, and use the timing light following the manufacturer's instructions.

Warning!

Be careful not to puncture the wire or boot as this would cause a high voltage leak. Make sure that spark plug wires are pushed all the way down into the distributor cap terminals and onto the spark plugs. Nipples must be firmly pushed over the terminals, and boots over the spark plugs. Failure to do so can result in ignition of fuel vapors in engine compartment or bilge, and may result in fire or explosion.

2. Start engine and leave running until thoroughly warmed up.

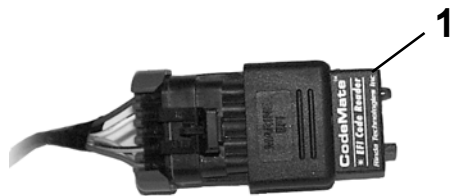
Warning!

Have someone at the controls. Keep hands, hair and clothing away from rotating parts while making adjustments when engine is running.

Setting Timing

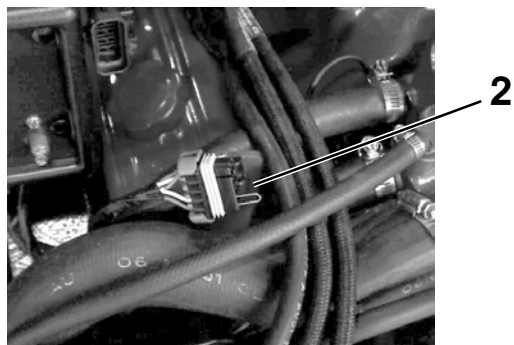
The timing procedure for *Delco* DI systems requires shunting (shutting off) the electronic spark advance.

1. Start engine and manually set idle speed to 1000 RPM, then do one of the following:



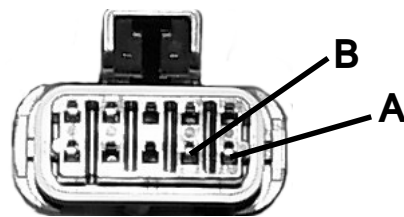
37005a

At the 10-way DLC (Data Link Connector), starboard front of engine, install a Trouble Code Tool (1) and turn it on - **OR**



22522

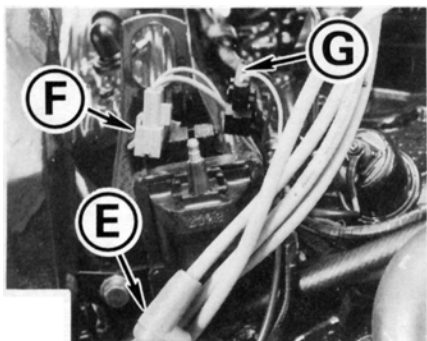
If a Code Tool is not available, use a jumper wire (2) and connect the white/black wire pin (B) to the black wire pin (A) inside the connector.



22520

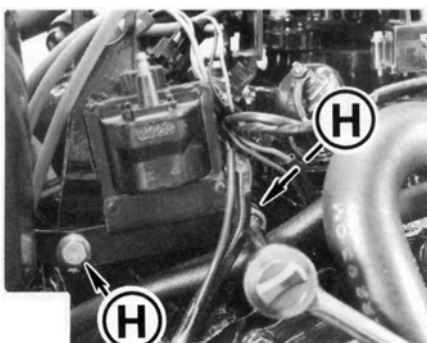
2. Direct beam of timing light onto timing grid. Loosen distributor clamp, then turn distributor slowly by hand until timing mark is set at the appropriate timing figure.
3. Recheck timing mark; reset if necessary. Tighten clamp bolt.
4. Stop engine. Remove jumper lead or Trouble Code Tool.

Ignition Coil Replacement



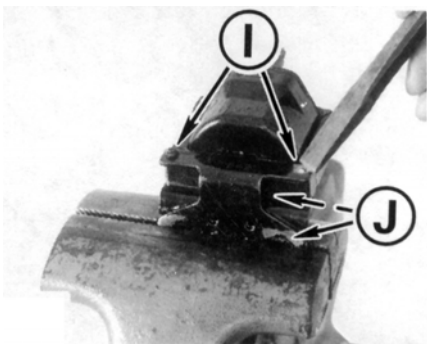
1. Remove ignition coil to distributor cap high tension lead (E), two pin connector (purple and gray wires) (F), and two pin connector (pink and brown wires) (G) from the ignition coil.

34930



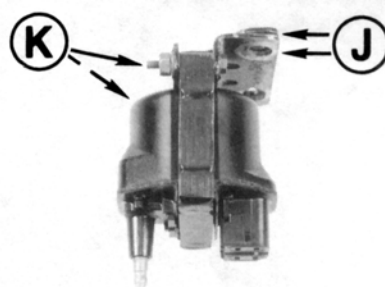
2. Remove two screws (H) securing coil to engine block and remove ignition coil.

34931



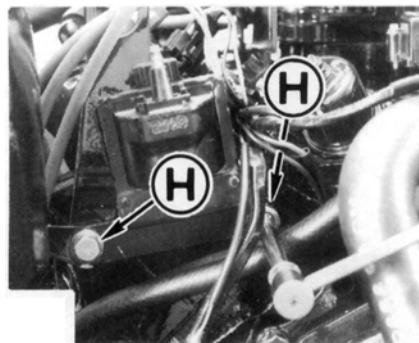
3. Place coil in a vise. **Wear eye protection.** Remove two rivet heads (I). Drive the rivets out of the coil. Save the bracket pieces (J).

25545



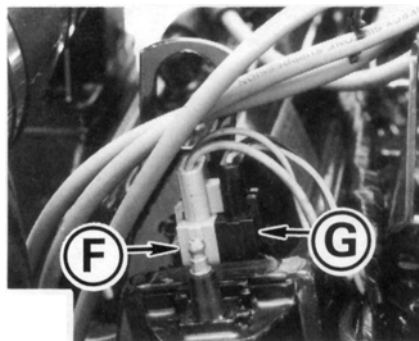
25551

4. Assemble the two bracket pieces (J) and the coil using two screws and nuts (K) provided in the replacement ignition coil kit. Tighten screws securely.



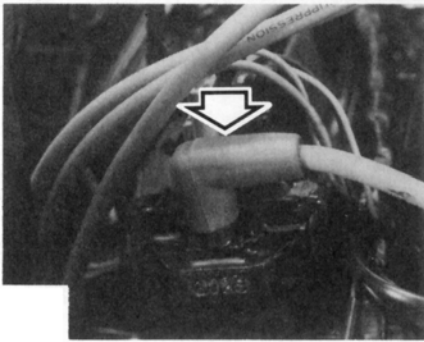
34942

5. Mount the coil assembly to the engine block. Secure with two bolts (H). Tighten to 20-25 ft. lbs. (27-34 N•m).



34943

6. Attach two pin connector (pink and brown wires) (G) to the coil as shown. Attach two pin connector (purple and gray wires) (F) to the coil as shown.



34944

7. Apply *EP/Wheel Bearing Grease* or equivalent to the high tension lead terminal and attach it to the ignition coil.

Specifications

Initial Timing Setting

ENGINE	TIMING SETTING
4.3 GXi-A	8° BTDC with 86 AKI or higher Service Mode Required
5.0 GXi-A	8° BTDC with 86 AKI or higher Service Mode Required
5.7 Gi-A 5.7GXi-A/B	8° BTDC with 86 AKI or higher Service Mode Required

22822

NOTE! All timing figures are with engine set in service mode.

To test the ignition module, Kent-Moore Module Tester, P/N J24642 or equivalent is required. If a module tester is used, follow the tester manufacturer’s directions exactly.

Ignition and Pickup Coils

Ignition Coil	
Primary Resistance, in Ohms @ 75° F	0.35-0.45
Secondary Resistance, in Ohms @ 75° F	7500 - 9000
Pickup Coil	
Resistance, in Ohms @ 75° F	700-900

Ignition System Problems

Engine runs sluggish, overheats.

Check the following:

- timing
- for proper fuel
- compression and for carbon buildup

Engine pings.

Check the following:

- timing
- for proper fuel
- compression and for carbon buildup
- spark plugs for proper heat range

Engine starts hard.

Check the following:

- for spark
- spark plugs
- compression
- battery
- distributor cap

Engine misfires.

Check the following:

- spark plugs and leads
- rotor and distributor cap
- coil
- engine firing order and plug wire routing
- engine timing
- engine operating in *ENGINE PROTECTION MODE*

Engine cranks but doesn't start.

Check the following:

- for spark
- coil primary and secondary circuit wiring
- tachometer and wiring
- primary circuit wiring to ignition coil
- primary circuit wiring to distributor
- ignition pickup coil
- ignition module

Torque Specifications

NUTS

ITEM	TORQUE
Circuit Breaker	20-25 in. lbs. (2,3-2,8 N•m)
TBI Fuel Line Nut-to-In/Outlet	17 ft. lbs. (23 N•m)
TBI Fuel Meter Body Inlet	30 ft. lbs. (40 N•m)
TBI Fuel Meter Body Outlet	21 ft. lbs. (29 N•m)

Torque Specs (Nuts) Sect3A

SCREWS

ITEM	TORQUE
Circuit Breaker	20-25 in. lbs. (2,3-2,8 N•m)
Engine Control Module	88-124 in. lbs. (10-14 N•m)
Idle Air Control Valve	28 in. lbs. (3,2 N•m)
Manifold Absolute Pressure Sensor	44-62 in. lbs. (5-7 N•m)
TBI Fuel Meter Body	30 in. lbs. (4 N•m)
TBI Fuel Meter Cover	28 in. lbs. (3 N•m)
Throttle Body Injector Unit	12 ft. lbs. (16 N•m)
Throttle Position Sensor	18 in. lbs. (2 N•m)

Torque Specs (Screws) Sect 3A

SENSORS

ITEM	TORQUE
Engine Coolant Temperature	108 in. lbs. (12 N•m)
Knock Sensor	11-16 ft. lbs. (15-22 N•m)

Torque Specs (Sensors) Sect3A

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Important Preliminary Checks

Before using this section you should have referred to the **On-Board Diagnostic (OBD) System Check** and determined that:

- The ECM is operating correctly
- There are no DTC's stored
- Verify the customer complaint, and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

Visual / Physical Checks

Several of the symptom procedures call for a careful visual physical check. The importance of this step cannot be stressed too strongly. It can lead to correcting a problem without further checks, saving valuable time. These checks should include:

- ECM grounds and sensors for being clean, tight and in their proper locations.
- Vacuum hoses for splits, kinks, and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches, and cuts. If wiring harness or connector repair is necessary, refer to **General Information** section or **On-Board Service** section for correct procedure.
- Moisture in primary or secondary ignition circuit connections.
- Salt corrosion on electrical connections and exposed throttle body linkages.

Intermittents

Problem occurs randomly. May or may not store a DTC.

Caution!

DO NOT use the DTC charts for intermittent problems, unless instructed to do so. If a fault is intermittent, incorrect use of diagnostic trouble code charts may result in replacement of good parts.

Most intermittent problems are caused by faulty electrical connections or wiring. Perform careful check of suspected circuits for:

- Poor mating of the connector halves, or terminals not fully seated in the connector body (backed out or loose).
- Improperly formed or damaged terminals and or connectors. All connector terminals and connectors in problem circuit should be carefully reformed or replaced to insure proper contact tension.
- Poor terminal to wire connection (crimping). This requires removing the terminal from the connector body to check. Refer to **Wiring Harness Service** in **General Information** or **On-Board Service** section.
- If a visual / physical check does not find the cause of the problem, the EFI system can be tested with a voltmeter connected and observing the suspected circuit. An abnormal reading, when the problem occurs, indicates the problem may be in that circuit.

An intermittent may be caused by:

- Electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
- Improper installation of electrical options, such as lights, ship to shore radios, sonar, etc.
- Knock sensor wires should be routed away from spark plug wires, ignition and charging system components.
- Secondary ignition shorted to ground.
- Arcing at spark plug wires, plugs, or open ignition coil ground (coil mounting brackets).
- Part internal circuitry shorted to ground such as starters, relays, and alternators.
- Poor connection or open circuit from ECM J1-3 to the IC 4-way connector terminal "A".

Hard Start Symptom

Checks	Action
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	— Make sure proper starting procedure is being used. See Owner's Manual. — Perform the careful visual / physical checks as described under <i>Symptoms</i>.
Sensor and Control	• Check ECT and MAP sensor - Ground circuit could be open between the ECM J2-3 to the ECT terminal "A" and could set a DTC 14 and/or a DTC 33. Refer to code system diagnostics. • Check TP sensor - Ground circuit could be open between the ECM J2-18 to the TP terminal "B" and could set a DTC 21. • Check TP sensor - If a sticking throttle shaft or binding linkage causes a high TP sensor voltage, a voltmeter should read between 0.4 and 0.5 volts with throttle closed or at idle position. • Check IAC operation - Refer to <i>Idle Air Control Function Test</i>.
Fuel System	• Check fuel pump relay - Fuel pumps should operate for 2 seconds when ignition is turned "ON". Also look for an open circuit from ECM J1-23 to the fuel relay terminal "85". Refer to <i>Fuel System Diagnoses</i>. • Check fuel filter / water separator. • Check contaminated fuel. • Check vapor lock condition or engine flooding, check fuel pressure. Refer to <i>Fuel System Diagnoses</i> in Section.
Ignition System	• Check ignition timing - Refer to <i>On-Board Service</i> Section. • Check ignition wires for cracking, hardness, and proper connections at both distributor cap and spark plugs. • Check for wet plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. • Check distributor cap inside and out for moisture, dust, cracks, burns, and arcing to coil mounting screws. • Check distributor for: • Worn shaft. • Bare and shorted wires. • Pick-up coil resistance and connections. • Try to turn distributor shaft by hand. Drive pin may be broken.
Engine Mechanical	• Check restricted exhaust. • Check engine compression. • Check proper camshaft timing / valve train problem.

22609

Surges Symptom

Checks	Action
Definition: Engine power variation under steady throttle or cruise. Feels like the vessel speeds up and slows down with no change in throttle position. Note! Make sure that the vessel is checked in calm water. Light chop or small seas can produce a surging sensation.	
Preliminary	Perform the visual / physical checks as described under <i>Symptoms</i> .
Fuel System	• Check fuel filter. Replace if dirty or plugged. • Check fuel pressure while condition exists. Refer to <i>Fuel System Diagnoses</i> in Section 5A. • Check throttle linkage sticking, binding or worn. • Check injector connectors for proper mating and connected to proper cylinder.
Ignition System	• Check 4-way IC connector at distributor and if routing of wires are near spark plug wires. • Check condition of IC module, coil, and spark plug wires. • Check intermittent ground connection on ignition coil. • Check proper operation of IC, ignition timing for advance or retard. • Check condition of distributor cap, rotor, and spark plug wires. • Check distributor pick-up coil terminal for clean connection. • Check spark plugs. Remove spark plugs; check for fuel fouled, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. • Check ignition voltage output.
Sensor	• Check MAP or ECT ground circuits from sensor connector terminal "A" to ECM J2-3 for intermittent opens. If intermittent for very brief period will not set DTC and cause a surge. • Check MAP sensor 5 volt reference from "C" terminal of MAP sensor connector to ECM J2-4 and MAP sensor signal from "B" terminal of MAP sensor connector to J2-27 for intermittent short to ground or opens.
Additional	• Check proper alternator output voltage. • Check vacuum lines for leaks or kinks. • Check for RPM reduction mode. • Check ECM grounds for being clean, tight, and in their proper locations. • Check items that can cause the engine to run rich or lean.

22610

Hesitation, Sag, or Stumble Symptom

Checks	Action
Definition: Momentary lack of response as the throttle is opened. Can occur at all engine speeds. May cause engine to stall if severe enough.	
Preliminary	— Perform the important preliminary checks as described under <i>Symptoms</i> .
Sensor System	• Ensure that the engine is not going into RPM reduction mode. • Use a scan tool in order to monitor the knock sensor system for excessive spark retard activity.
Fuel System	• Check for water contaminated fuel, and dirty or restricted fuel filter. • Check fuel pressure. Refer to <i>Fuel System Diagnoses</i>. • Check worn throttle linkage. • Check fuel injectors.
Ignition System	• Check IC system for proper timing and advance. • Check spark plug wires for being faulty. • Check for RPM reduction mode. • Check spark plugs for being fouled or improper gap. • Check integrity of primary and secondary wiring, IC module, pickup coil, and distributor.
Sensor	• Check TP sensor - For binding, sticking, or salt corrosion. TP sensor voltage should increase as throttle is moved toward Wide Open Throttle (WOT). • Check TP sensor - 5 volt reference for open circuit from TP sensor connector terminal "A" to J2-19. DTC 22 may be set. • Check TP sensor circuit for open or grounds from TP sensor connector terminal "B" to J2-26. DTC 21 may be set. • Check MAP output voltage check, Refer to <i>MAP Sensor Diagnosis</i>. • Check ECT for shifted value.
Additional	• Check for proper alternator output voltage. • Check for faulty or incorrect thermostat. • Check throttle linkage for sticking, binding, or wear. • Check intake valves for deposits.

22611

Detonation / Spark Knock Symptom

Checks	Action
Definition: A mild to severe ping, usually worse under acceleration or heavy load. The engine makes sharp metallic knocks that change with throttle opening.	
Preliminary	— Perform the careful visual / physical checks described under <i>Symptoms</i> .
Ignition System	• Check ignition timing. • Check KS system operation, and if routing of wires are near secondary or primary ignition wires. • Check ignition system ground. • Check spark plugs for proper heat range and gap.
Cooling System	• Check for obvious overheating problems: • Check loose water pump belt, faulty water pump. • Check Restriction in cooling system. • Check faulty or incorrect thermostat.
Fuel System	• Check for contaminated fuel. • Check for poor fuel quality and proper octane rating. • Check fuel pressure. Refer to <i>Fuel System Diagnoses</i>.
Sensor	• Check ECT - Refer to <i>Code System Diagnoses</i>. • Check TP sensor - For binding, sticking, or salt corrosion. Voltage should increase as throttle is moved toward Wide Open Throttle (WOT).
Engine Mechanical	• Check for low oil level. • Check for excessive oil in the combustion chamber. Valve oil seals leaking. • Perform a compression test. • Check combustion chambers for excessive carbon buildup. Remove carbon with top engine cleaner and follow instructions on can. • Check camshaft timing. • Check for incorrect basic engine parts such as cam, heads, pistons, etc.

22612

Lack of Power, Sluggish, or Spongy Symptom

Checks	Action
Definition: Engine delivers less than expected power. Little or no increase in speed when throttle control is moved toward Wide Open Throttle (WOT).	
Preliminary	— Perform the careful visual / physical checks as described under <i>Symptoms</i>. — Remove flame arrestor and check for dirt, or for being plugged. Clean or replace as necessary.
Fuel System	• Check for dirty or plugged fuel / water separator filter. Refer to <i>Fuel System Diagnoses</i>. • Check for contaminated fuel. • Check for open injector driver circuit from ECM J1-1 or J1-17 to “A” side of injectors. • Check for improper fuel pressure.
Ignition System	• Check initial engine timing • Check secondary ignition voltage • Check for proper IC / KS operation, an open or short to ground from the IC 4-way connector terminal “D” to the ECM J1-10, or from the KS connector to the ECM J1-30. • Check KS will set a DTC 44. Refer to <i>Scan or Non-Scan Diagnostics</i>. • Check spark plugs for wet plugs, cracks, wear, improper gap, burned electrodes or heavy deposits. • Check ignition coil for cracks or carbon tracking.
Sensor and Control	• Check ECT and MAP sensor - Ground circuit from ECM J2-3 to the “A” terminals of the ECT and MAP sensor. Refer to <i>Scan or Non-Scan Diagnostics</i>. • Check TP sensor circuit if DTC 21 or 22 set for open or grounds. Refer to <i>Scan or Non-Scan Diagnostics</i>. • Check TP sensor - If a sticky throttle shaft or binding linkage causes a high TP sensor voltage, a voltmeter should read between 0.4 and 0.5 volts with throttle closed or at idle position. Refer to <i>Diagnoses</i>. • Check if engine is in <i>ENGINE PROTECTION MODE</i>. • Check diagnostic test circuit for being grounded from ECM J2-22 to the DLC terminal “B”, will lower maximum RPM's.
Engine Mechanical	• Check for restricted exhaust. • Check engine compression. • Check valve timing and for proper or worn camshaft.
Additional	• Check for proper alternator output voltage. • Check ECM grounds for being clean, tight, and in their proper locations. • Check for excessive resistance on bottom of boat due to marine growth. • Check for propeller for proper size, pitch, and condition.

22613

Cuts Out, Misses Symptom

Checks	Action
Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. The exhaust has a steady spitting sound at idle or low speed.	
Preliminary	— Perform the important preliminary checks as described under <i>Symptoms</i> .
Ignition System	• Check for cylinder miss: • Step 1. Start engine, allow engine to stabilize, record RPM, then disconnect IAC. Stop engine, ground one spark plug wire. Restart engine and record RPM. Repeat test for remaining spark plug wires. • Step 2. If there is an RPM drop on all cylinders, go to <i>Rough, Unstable, or Incorrect Idle; Stalling Symptoms</i>. With engine "OFF" reconnect IAC connector. • Step 3. If there is no RPM drop on one or more cylinder's, or excessive variation in RPM drop, check for spark on the suspected cylinders. • Step 4. If no spark, refer to <i>Distributor Ignition Diagnosis</i>. • Step 5. If there is spark, remove spark plug(s) in these cylinders and check for: • Insulator cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Check spark plug wire resistance, should not exceed 30,000 ohms • Ignition coil. Refer to <i>Distributor Ignition</i>. • With engine running, spray distributor cap and spark plug wires with a fine mist of water to check for shorts.
Fuel System	• Check for contaminated fuel or restricted fuel filter. • Check fuel pressure. Refer to <i>Fuel System Diagnosis</i>. • Check fuel injectors.
Sensor	• Check TP sensor circuit for open or ground from ECM J2-26 to TP connector sensor signal terminal "C", or from J2-19 to TP connector 5 volt reference terminal "A".
Engine Mechanical	• Check cylinder compression • Remove rocker covers; check for bent push rods, worn rocker arms, broken valve springs, worn camshaft lobes. Repair or replace as necessary.
Additional	• Check for EMI interference. Electromagnetic Interference (EMI) can cause a missing condition on the reference circuit. EMI can usually be detected by monitoring engine RPM with a tachometer. A sudden increase in RPM with little change in actual engine RPM change indicates EMI is present. If the problem exists, check routing of secondary wires, check ground circuit.

22614

Rough, Unstable or Incorrect Idle and Stalling Symptom

Checks	Action
Definition: Engine runs unevenly or rough at idle, also the idle may vary in RPM (called hunting). Either condition may be severe enough to cause stalling. Engine idles at incorrect speed.	
Preliminary	— Perform the important preliminary checks as described under <i>Symptoms</i> .
Fuel System	• Check for open circuit from ECM J1-1 or J1-17 to “A” terminal of injector connector. Refer to <i>Engine Cranks, Won't Run Diagnosis</i>. • Check fuel injectors leaking, fuel pressure. Refer to <i>Fuel System Diagnosis</i>.
Ignition System	• Check ignition timing • Check following circuits for possible open. From J2-10, J1-10, and J1-24 to IC 4-way connector terminals “C”, “D”, and “B”. • Check ignition system spark plugs, wires, etc.
Sensor and Control	• Check IAC operation. Refer to <i>Idle Air Control Diagnoses</i>. • Check the following for a possible open circuit: • From ECM J2-11 to ECT connector terminal “B” • From ECM J2-26 to TP connector terminal “C” • From ECM J2-19 to TP connector terminal “A” • From ECM J2-18 to TP connector terminal “B” • From ECM J2-3 to MAP and ECT connectors terminals “A” • Check the following for a possible grounded circuit: • From ECM J2-26 to TP connector terminal “C” • From ECM J2-19 to TP connector terminal “A” • From ECM J2-22 to DLC connector terminal “B” • MAP sensor for response and accuracy. Refer to <i>MAP Sensor Diagnoses</i>. • TP sensor - For sticking throttle shaft, binding linkage, and for salt corrosion. This causes a high TP sensor voltage (open throttle indication), the ECM will not control idle. • Voltage with a voltmeter. Voltage should read between 0.4 and 0.5 volts at closed throttle and less than 4.9 volts at Wide Open Throttle (WOT).
Engine Mechanical	• Perform a cylinder compression check • Check for correct camshaft or weak valve springs • Check for faulty motor mounts.
Additional	• Check throttle linkage for sticking, binding, and salt corrosion • Check for proper alternator output voltage • Check that battery cables and ground straps are clean and secure. Erratic voltage will cause IAC to change its position, resulting in poor idle quality. • Check for items that can cause the engine to run rich or lean.

22615

Backfire (intake) Symptom

Checks	Action
Definition: Fuel ignites in manifold making a loud popping noise.	
Preliminary	— Perform the important preliminary checks as described under <i>Symptoms</i> .
Fuel System	• Check flame arrestor for proper installation and tightness • Perform fuel system diagnosis. Use <i>Fuel System Diagnosis</i>.
Sensor	• Check TP sensor circuit for opens or grounds from ECM J2-19 to TP connector terminal "A", and from ECM J2-26 to TP connector terminal "C". • Check DTC 21 or 22 will be set. Refer to <i>Scan or Non-Scan Diagnostics</i>.
Ignition System	• Check for opens or grounds in the following circuits: • From ECM J1-10 to IC 4-way connector terminal "D" • From ECM J1 -24 to IC 4-way connector terminal "B" • From ECM J2-10 to IC 4-way connector terminal "C" • Refer to <i>Distributor Ignition System Diagnoses</i>. • Ignition timing and for IC functioning properly, see <i>On-Board Ignition Timing Check</i> • Proper output voltage of ignition coil • Crossfire between cylinders, (distributor cap, spark plug wires, and proper routing of plug wires) • Spark plug wires and boots • Faulty spark plugs
Engine Mechanical	• Check compression - Look for sticking or leaking valves • Check valve timing, broken or worn valve train parts

22616

Backfire (exhaust) Symptom

Checks	Action
Definition: Fuel ignites in the exhaust system making a loud popping noise.	
Preliminary	— Perform the important preliminary checks as described under <i>Symptoms</i> .
Fuel System	• Perform fuel system diagnosis. Refer to <i>Fuel System Diagnosis</i>.
Ignition System	• Check for opens or grounds in the following circuits: • From ECM J1-10 to IC 4-way connector terminal "D". • From ECM J1-24 to IC 4-way connector terminal "B". • From ECM J2-10 to IC 4-way connector terminal "C". • Refer to <i>Distributor Ignition System Diagnoses</i>. • For IC proper function, timing for advance and retard. • Proper output voltage of ignition coil. • Crossfire between cylinders, (distributor cap, spark plug wires, and proper routing of plug wires). • Spark plug wires and boots. • Faulty spark plugs.
Engine Mechanical	• Check Compression - Look for sticking or leaking valves. • Check valve timing, broken or worn valve train parts.

22617

Dieseling, Run-On Symptom

Checks	Action
Definition: Engine continues to run after key is turned "OFF", but runs very roughly. If engine runs smoothly, check ignition switch and circuit.	
Preliminary	— Perform the important preliminary checks as described under <i>Symptoms</i> .
Ignition System	• Check IC circuit for proper function, timing advance and retard. • Check Ignition relay for proper operation.
Cooling System	• Check for faulty or incorrect thermostat. • Check engine for overheating, resulting from cooling water restriction. • Check serpentine belt condition.
Fuel System	• Check for leaking injectors. Refer to <i>Fuel System Diagnosis</i>.

22618

Poor Fuel Economy Symptom

Checks	Action
Definition: Fuel economy is noticeably lower than expected.	
Preliminary	— Perform the important preliminary checks as described under <i>Symptoms</i> . • Check owner's boating habits. • Check flame arrestor for dirt, too tight, or plugged. • Check for fuel leaks.
Ignition System	• Check IC circuit for proper function, timing advance and retard. • Check spark plugs. Remove spark plugs, check for fuel fouled plugs, cracks, wear, improper gap, burned electrodes, or heavy deposits. Repair or replace as necessary. • Check KS system operation. Refer to KS system diagnostics.
Fuel System	• Check fuel type. Quality of fuel. • Check fuel pressure. Refer to <i>Fuel System Diagnosis</i>.
Engine Mechanical	• Check compression.
Additional	• Check for exhaust system restriction. • Check for excessive resistance on bottom of boat (marine growth). • Check propeller for proper size, pitch, and condition.

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ECM J1 Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational. The voltages are to help identify what voltage is needed to operate the different circuits. **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring, or connectors, with the loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B+" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION "ON"	ENGINE OPERATING		
1	INJECTOR DRIVER BANK A	TAN/BLUE	INJECTOR	B+	B+	NONE	ROUGH IDLE, LACK OF POWER, STALL
2	NOT USED	-	-	-	-	-	-
3	IC REF LOW	BLACK/TAN	IC MODULE	(5)	(5)	NONE	LACK OF PERFORMANCE, POOR FUEL ECONOMY
4	ECM GROUND	BLACK	ENGINE BLOCK	(5)	(5)	NONE	AN OPEN GROUND OR HIGH RESISTANCE MAY CAUSE ANY OR ALL SYMPTOMS
5	ECM GROUND	BLACK	ENGINE BLOCK	(5)	(5)	NONE	AN OPEN GROUND OR HIGH RESISTANCE MAY CAUSE ANY OR ALL SYMPTOMS
6	NOT USED	-	-	-	-	-	-
7	NOT USED	-	-	-	-	-	-
8	NOT USED	-	-	-	-	-	-
9	DLC	GREEN/YELLOW	DLC	(1)(5)	(5)	NONE	-
10	IC SIGNAL	WHITE+	IC MODULE	(5)	1.2V	41 & 42	STALL, WILL RESTART IN BYPASS MODE, LACK OF POWER
11	IAC "B" HIGH	BROWN/YELLOW	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH, UNSTABLE OR INCORRECT IDLE
12	IAC "A" LOW	PINK/BLUE	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH, UNSTABLE OR INCORRECT IDLE
13	NOT USED	-	-	-	-	-	-
14	NOT USED	-	-	-	-	-	-
15	NOT USED	-	-	-	-	-	-
16	NOT USED	-	-	-	-	-	-

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS

(2) VARIES WITH TEMPERATURE

(3) VARIES WITH MANIFOLD VACUUM

(4) VARIES WITH THROTTLE MOVEMENT

(5) **LESS THAN 0.5 VOLT (500mV)**

* GRAY/WHITE 5.0 GXi and 5.7 Gi models only

TBL22620

ECM J1 Connector and Symptoms Identification (cont.)

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION "ON"	ENGINE OPERATING		
17	INJECTOR DRIVER BANK B	TAN/ORANGE	INJECTOR	B+	B+	NONE	ROUGH IDLE, LACK OF POWER, STALL
18	NOT USED	-	-	-	-	-	-
19	NOT USED	-	-	-	-	-	-
20	ECM GROUND	BLACK	ENGINE BLOCK	(5)	(5)	NONE	AN OPEN GROUND OR HIGH RESISTANCE MAY CAUSE ANY OR ALL SYMPTOMS
21	NOT USED	-	-	-	-	-	-
22	NOT USED	-	-	-	-	-	-
23	FUEL PUMP RELAY DRIVER	BLACK/YELLOW	FUEL PUMP RELAY	(1)(5)	B+	NONE	NO START
24	IC BYPASS	WHITE/TAN	IC MODULE	(5)	4.5V	42	LACK OF POWER, FIXED TIMING
25	NOT USED	-	-	-	-	-	-
26	S.L.O.W. TM WARNING HORN	TAN/BLACK	10 PIN CONNECTOR	(5)	(5)	NONE	RPM REDUCTION MODE
27	IAC "B" LOW	GREEN/BLACK	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH, UNSTABLE OR INCORRECT IDLE
28	IAC "A" HIGH	BLUE/YELLOW	IAC VALVE	NOT USABLE	NOT USABLE	NONE	ROUGH, UNSTABLE OR INCORRECT IDLE
29	NOT USED	-	-	-	-	-	-
30	#1 KNOCK SIGNAL	BLACK/GREEN	#1 KNOCK SENSOR	9.5V	9.5V	44	POOR FUEL ECONOMY, POOR PERFORMANCE, DETONATION
31	NOT USED	-	-	-	-	-	-
32	SERIAL DATA	ORANGE/BLACK	SPLICE	B+	B+	NONE	NO SERIAL DATA

TBL22621

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS

(2) VARIES WITH TEMPERATURE

(3) VARIES WITH MANIFOLD VACUUM

(4) VARIES WITH THROTTLE MOVEMENT

(5) LESS THAN 0.5 VOLT (500Mv)

* GRAY/WHITE 5.0 GXi and 5.7 Gi models only

ECM J2 Connector and Symptoms Identification

This chart is to further aid in diagnosis of symptoms. These voltages were derived from a known good engine. The voltages shown were done with the electrical system completely hooked up and operational. The voltages are to help identify what voltage is needed to operate the different circuits. **NEVER ATTEMPT TO OBTAIN THESE VOLTAGES BY PROBING WIRES OR CONNECTORS.** Serious damage could result to wiring, or connectors, with the loss of engine operation. The voltages you may get may vary due to low battery charge or other reasons, but they should be close.

The "B+" symbol indicates a system voltage.

THE FOLLOWING CONDITIONS MUST BE MET BEFORE TESTING:

- Engine at operating temperature
- Engine idling (for "Engine Operating" column)
- Test terminal not grounded

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION "ON"	ENGINE OPERATING		
1	ECM B+	RED/ PURPLE	SPLICE	B+	B+	NONE	NO START
2	NOT USED	-	-	-	-	-	-
3	MAP & ECT SENSOR GROUND <i>S.L.O.W.TM</i>	BLACK/ ORANGE	MAP & ECT SENSORS	(5)	(5)	14 & 33	LACK OF PERFORMANCE, EXHAUST ODOR, STALL
4	MAP, 5V REFERENCE	GRAY/ ORANGE	MAP SENSOR	5V	5V	34	LACK OF POWER, SURGE, ROUGH IDLE, EXHAUST ODOR
5	NOT USED	-	-	-	-	-	-
6	NOT USED	-	-	-	-	-	-
7	OIL PRESSURE SWITCH, AUDIBLE WARNING	TAN/ BLACK	OPTIONAL SENSOR	(5)	(5)	NONE	NO OPTIONAL HORN ON LOSS OF OIL PRESSURE
8	NOT USED	-	-	-	-	-	-
9	SHIFT INTERRUPT	WHITE/ BLUE	INTERRUPT SWITCH	-	-	NONE	IMPROPER OR HARD SHIFTING
10	IC REF HIGH	GRAY/ BLACK	IC MODULE	5V	1.6V	NONE	NO START
11	ECT SIGNAL <i>S.L.O.W.TM</i>	YELLOW/ BLUE	ECT SENSOR	1.95V (2)	1.95V (2)	14 & 15	POOR PERFORMANCE, EXHAUST ODOR, ROUGH IDLE, RPM REDUCTION
12	NOT USED	-	-	-	-	-	-
13	NOT USED	-	-	-	-	-	-
14	NOT USED	-	-	-	-	-	-
15	NOT USED	-	-	-	-	-	-
16	NOT USED	-	-	-	-	-	-

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS

(2) VARIES WITH TEMPERATURE

(3) VARIES WITH MANIFOLD VACUUM

(4) VARIES WITH THROTTLE MOVEMENT

(5) LESS THAN 0.5 VOLT (500mV)

* GRAY/WHITE 5.0 GXi and 5.7 Gi models only

TBL22623

ECM J2 Connector and Symptoms Identification (cont.)

PIN	PIN FUNCTION	WIRE COLOR	COMPONENT CONNECTOR	NORMAL VOLTAGE		DTC(s) AFFECTED	POSSIBLE SYMPTOMS
				IGNITION "ON"	ENGINE OPERATING		
17	NOT USED	-	-	-	-	-	-
18	TP & IAT* GROUND	BLACK/WHITE	TP, IAT SENSOR*	(5)	(5)	21 & 23	HIGH IDLE, ROUGH IDLE, POOR PERFORMANCE
19	TP 5V REF	GRAY/BLUE	TP SENSOR	5V	5V	22	LACK OF POWER, IDLE HIGH
20	NOT USED	-	-	-	-	-	-
21	MASTER/SLAVE	YELLOW/GRAY	IN-LINE BOAT HARNESS	B+	B+	NONE	LACK OF DATA FROM OTHER ENGINE
22	DIAGNOSTIC TEST TERMINAL	WHITE/BLACK	DLC	B+	B+	NONE	INCORRECT IDLE, POOR PERFORMANCE
23	NOT USED	-	-	-	-	-	-
24	NOT USED	-	-	-	-	-	-
25	NOT USED	-	-	-	-	-	-
26	TP SIGNAL	ORANGE/BLUE	TP SENSOR	0.4-0.5 (4)	0.4-0.5 (4)	21 & 22	POOR ACCELERATION & PERFORMANCE, INCORRECT IDLE
27	MAP SIGNAL	LIGHT GREEN	MAP SENSOR	4.9V	1.46V (3)	33 & 34	POOR PERFORMANCE, SURGE, POOR FUEL ECONOMY, EXHAUST ODOR
28	NOT USED	-	-	-	-	-	-
29	NOT USED	-	-	-	-	-	-
30	IAT SIGNAL*	TAN/YELLOW	IAT SENSOR*	3.2V (2)	3.2V (2)	23 & 25	ROUGH IDLE
31	NOT USED	-	-	-	-	-	-
32	ECM SWITCHED 12V	PINK/WHITE	SPLICE	B+	B+	NONE	NO START, CT INOPERABLE

TBL22624

(1) BATTERY VOLTAGE FOR FIRST TWO SECONDS, THEN 0 VOLTS

(2) VARIES WITH TEMPERATURE

(3) VARIES WITH MANIFOLD VACUUM

(4) VARIES WITH THROTTLE MOVEMENT

(5) LESS THAN 0.5 VOLT (500Mv)

* GRAY/WHITE 5.0 GXi and 5.7 Gi models only

Notes

[illegible]

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Electronic Control Module (ECM)

The technology behind Electronic Fuel Injection (EFI) and engine management is very sophisticated, but the basic concepts are easy to understand. The following are the major Inputs that the ECM continuously monitors and the major Outputs that it precisely controls.

Connections To The ECM J1 Connector

Knock Sensor - The KS detects detonation (engine knock) if it's present, which allows the ECM to modify spark and fuel to eliminate the detonation.

Fuel Pumps and Injectors - The ECM operates a relay controlling both fuel pumps, and controls fuel injector firing for optimum performance and fuel economy.

Electronic Spark Timing - The ECM continuously controls the amount of spark advance and retard for optimum performance and fuel efficiency during varying engine load conditions.

Electronic Spark Control - Occurs when engine knock is detected by the Knock Sensor (KS) and the ECM retards spark timing as necessary to eliminate engine knock.

Idle Air Control - Idle Air Control (IAC) valve is controlled by the ECM to automatically vary the amount of air supplied to the engine when idling or decelerating. This improves idle smoothness, prevents stalls due to changes in engine load, and makes quick acceleration possible.

Diagnostics - Diagnostic capabilities allow the ECM to monitor sensor functions for proper operation. If operation is found to be outside of programmed parameters, the ECM will store service code(s).

Connections To The ECM J2 Connector

Throttle Position Sensor - The TP sensor supplies throttle position information so that the ECM can control acceleration and idle speed.

Engine Coolant Temperature Sensor - The ECT sensor tells the ECM the engine water temperature, which allows the ECM to automatically adjust fuel, spark, and idle speed control, and to warn the operator of possible overheating.

Manifold Absolute Pressure Sensor - The MAP sensor measures the absolute air pressure in the intake manifold, which the ECM uses as an indicator of engine load and altitude in supplying the precise amount of fuel and spark advance.

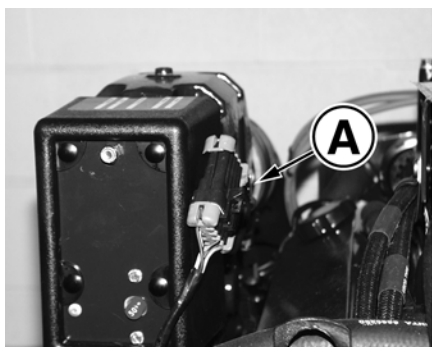
Engine Protection Mode Switches - Detect low oil pressure and water temperature overheat (this latter function combined in the ECT sensor).

Diagnostic Code Tool Installation and Operation

Upon activation, the Code Tool (CT) will first flash Diagnostic Trouble Code (DTC) 12, indicating the ECM system is functioning properly. If other DTC's are stored in the ECM memory, they will follow DTC 12.

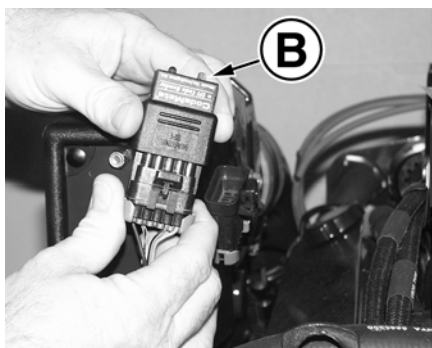
Record all DTC's that follow code 12. In numerical order, refer to the chart for the lowest numbered code first, correct the problem, then refer to next numerically lowest DTC.

Installation and Operation



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1. With ignition "OFF", remove protective Data Link Connector (DLC) cover (A).



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2. Push CT switch (B) to "OFF" position, then install diagnostic code tool onto the DLC connector.
3. Turn ignition "ON", don't start engine. The CT light will be a steady "ON" light. If CT light is not steady "ON", see *No Code Tool (CT) Light*, for possible problem.
4. Push CT switch to "ON" position and the light should flash a Code 12 three times and then any other code(s) that are stored in the ECM memory.

All codes are flashed three times per the following examples:

Code 12 - One flash - long pause - one flash, short pause, one flash - long pause. The flash sequence repeats two more times.

If other code(s) are stored in the ECM they will flash their code three times after Code 12. Example:

Code 21 - One flash, short pause, one flash - long pause - one flash - long pause.

One flash, short pause, one flash - long pause - one flash - long pause.

One flash, short pause, one flash - long pause - one flash - long pause.

DTC's are not stored in the ECM memory in numerical order, only in the order of failure. You will have to arrange the DTC's in numerical order, then correct the problem of the lowest DTC first before proceeding to the next lowest DTC.

Scan Tools

Scan tools are electronic testers that, among other functions, display DTC's in numerical form. They provide a wide range of diagnostic data, and are available from a number of reputable manufacturers. Make sure you purchase a **marine version**. When using them, follow the manufacturer's instructions.

Manually Clearing DTC's

Non-scan Tool Procedure

NOTE! Some ECM's may not respond to the following non-scan tool manual clearing procedure. In such cases, an electronic scan tool must be used to clear codes while the engine is running. Scan tools are available from a number of reliable manufacturers. Make sure you use a **marine version**. Clear DTC's following the tool manufacturer's instructions.

1. Turn ignition "OFF". Remove protective Data Link Connector (DLC) cover. Push diagnostic Code Tool (CT) switch to "OFF" position and attach to DLC.
2. Turn ignition switch to "ON", do not start engine.
3. Push CT switch to "ON" position.
4. To clear DTC'S, disengage the remote control's shift function, then SLOWLY move the throttle from 0% (idle) to 100% (wide open throttle) and back to 0% (idle).
5. Push CT switch to "OFF" position. If this step is not performed, the engine may not start and run.
6. Turn ignition "OFF" for 20 seconds.
7. Turn ignition switch to "ON", do not start engine. Push CT switch to "ON" position and verify that DTC 12 is flashed. Remove CT, and install DLC protective cover. Turn the ignition switch to the "OFF" position.

If original DTC's are still present, check "Note" below and repeat the DTC clearing procedure.

NOTE! If new DTC's are displayed, perform **On-Board Diagnostic (OBD)** system check.

Diagnostic Trouble Code (DTC) Identification

The diagnostic code tool light will be "ON" if the malfunction exists under the condition listed below. If the malfunction clears, the light will go out and the DTC will be stored in the ECM. Any DTC's stored will be erased if no problem reoccurs within 25 engine power-ups.

NOTE! There are time periods (instantly or up to 2 minutes) that can be programmed in the ECM before the light comes "ON" or the DTC will set. In doing diagnosis for an intermittent, a wiggle of a wire or connector might not set the DTC. The times below are examples only.

DTC and Circuit		Probable Cause
DTC 14	Engine Coolant Temperature (ECT) sensor circuit low temperatures indicated.	Sets code if the sensor signal circuit becomes grounded, or connections or wires open for 3 seconds.
DTC 15	Engine Coolant Temperature (ECT) sensor circuit high temperatures indicated.	
DTC 21	Throttle Position (TP) sensor circuit signal too high.	TP signal inconsistent with RPM and MAP, or a shorted to ground or open signal circuit.
DTC 22	Throttle Position (TP) sensor circuit signal too low.	
DTC 33	Manifold Absolute Pressure (MAP) sensor circuit signal voltage too high.	MAP sensor output too high for 3 seconds, or an open signal circuit. Or low or no output from sensor with engine running. MAP inconsistent with RPM and throttle position.
DTC 34	Manifold Absolute Pressure (MAP) sensor circuit signal voltage too low.	
DTC 41	Ignition Control (IC) system circuit open.	ECM has seen an open or grounded IC or bypass circuit.
DTC 42	Ignition Control (IC) system circuit shorted.	
DTC44	Knock Sensor (KS) circuit inactive	ECM has not sensed any activity from the sensor.
DTC 51	Fault in Electronic Erasable Programmable Read-Only Memory (EEPROM)	Faulty EEPROM in ECM

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Diagnostic Code Tool (CT) Check

Step	Action	Value	Yes	No
1	1. Turn ignition key "OFF". 2. Install diagnostic code tool (CT). 3. Switch CT to the "OFF" position. 4. Turn ignition key "ON". Note CT light: - Steady Light - Go on to STEP 5. - No Light - Use Chart A-1, Page 6-8. - Flashing DTC 12 - Check volts at Data Link Connector (DLC) terminal "B". Is voltage very low (near "0" volts)?	—	Verify Repair	Verify Repair
2	1. Turn CT on. Does light flash DTC 12?	—	Go to Step 6	Verify Repair
3	Is DTC 51 present?	—	Verify Repair	Go to Step 7
4	1. Turn CT off. Does engine start?	—	Go to Step 8	Verify Repair
5	Are any additional DTC's displayed?	—	Verify Repair	Go to Step 9
6	Does a customer complaint or driveability problem currently exist?	—	Verify Repair	Verify Repair

22641

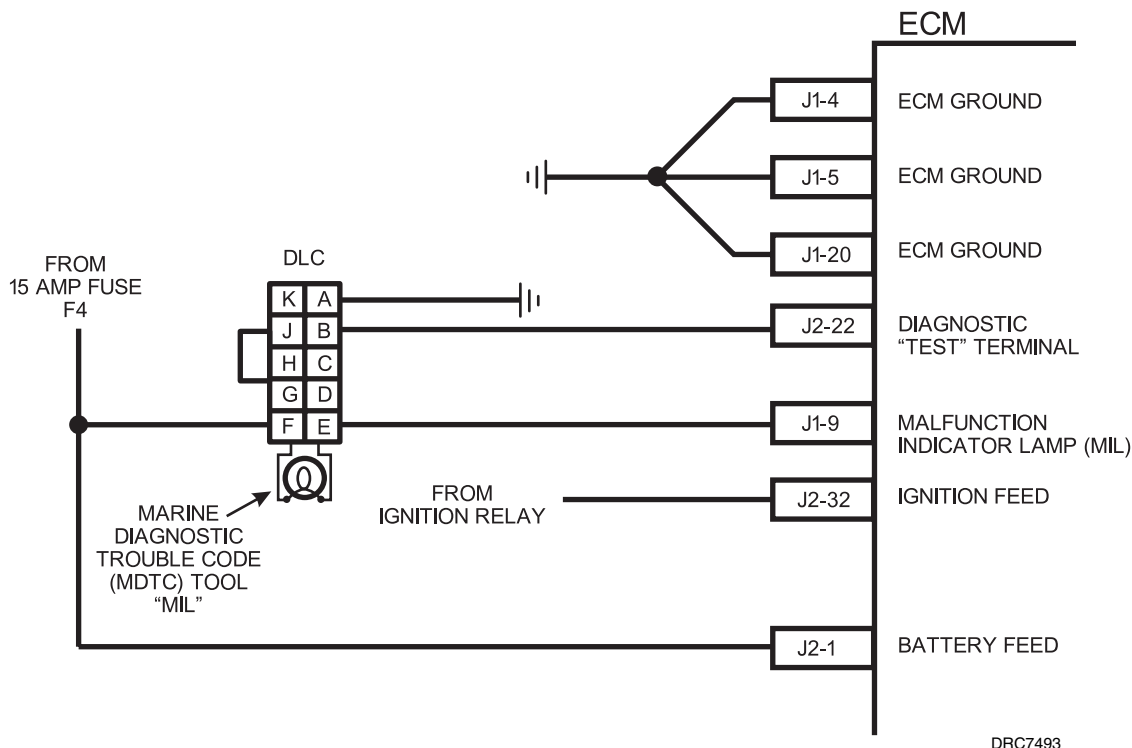
Important Diagnostic Information

NOTE! Do not disconnect or connect any electrical test equipment to the engine harness or to the DLC unless both the engine ignition switch and electrical test equipment switches are in the "OFF" position. Electrical components can be damaged by either static electricity and/or an electrical surge.

The following information applies to all of the diagnostic charts, wiring, and wiring connections:

- Step numbers refer to an accompanying diagnostic chart.
- An intermittent problem may be caused by a poor or corroded connection, worn-through wire connection, a wire that is broken inside the insulation, or a corroded wire.
- Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for:
 - backed out terminals
 - improper mating
 - broken locks
 - improperly formed or damaged terminals
 - poor terminal to wiring connections
 - corroded terminals and/or wiring, or
 - wires not in their proper place in receptacle
 - physical damage to the wiring harness
- After repairs, clear DTC's following either the:
 - Manually Clearing DTC's** procedure in this section, if using a non-scan code tool, or
 - the procedure suitable for the scan tool being used
 Failure to do so may result in DTC's not properly being cleared.
- Always verify proper circuit operation after repairs are completed.**

No Code Tool (CT) Light



DRC7493

Circuit Description

With Code Tool (CT) and ignition switch "OFF", plug CT into Diagnostic Link Connector (DLC). The CT receives voltage through Terminal "F" from the 12.5 amp circuit breaker. Terminal "E" is grounded through J1-9. There should always be a steady CT light when ignition is in the "ON" position, engine not running, and the CT switch is in the "OFF" position. The ECM controls the light and turns it "ON" by providing ground.

Test Description

After determining whether or not the engine starts, follow the appropriate **YES** or **NO** column. These steps will check whether the code tool is receiving B+ power and is properly grounded. The steps also check various circuits, the code tool itself and the ECM.

Diagnostic Aids

Engine runs okay, check:

- Faulty light bulb
- Circuit between J1-9 and DLC terminal "E" is open

Engine cranks but will not run, check:

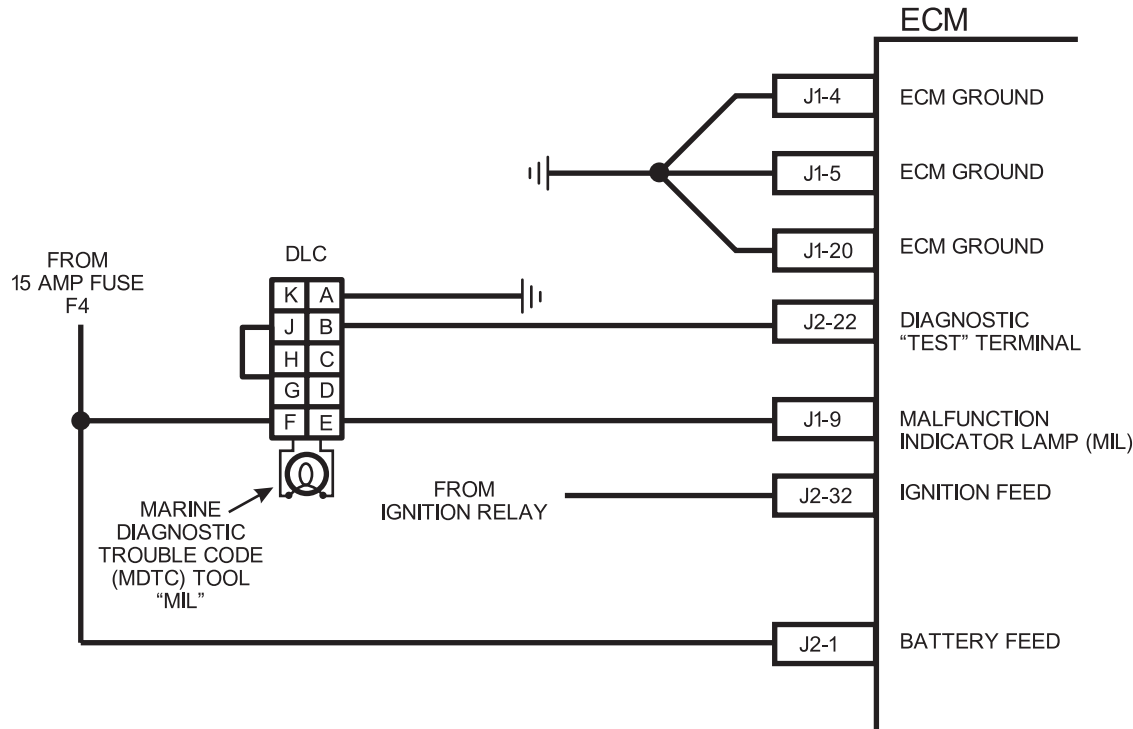
- Continuous battery feed, circuit breaker open
- ECM breaker open
- Battery circuit to ECM open
- Ignition circuit to ECM open
- Poor connection to ECM
- Faulty ECM ground circuit(s)
- Perform system relay check

No Code Tool (CT) Light

Step	Action	Value	Yes	No
	ENGINE STARTS			
1	1. Remove Code Tool. 2. Turn ignition on. 3. Using a test light, probe DLC terminal "F". Does test light go on?	—	Go to Step 2	Verify Repair
2	1. Leave key on. 2. Connect test light to a B+ source. 3. Probe DLC terminal "E". Does test light go on?	—	Go to Step 3	Verify Repair
3	1. Connect test light between DLC terminals "F" and "E". Does test light go on?	—	Verify Repair	Verify Repair
	ENGINE DOES NOT START			
1	1. Check ECM circuit breaker. Is it okay?	—	Go to Step 2	Verify Repair
2	1. Turn ignition off. 2. Disconnect ECM J2 connector. 3. Probe pin J2-1 with a test light connected to ground. Does test light go on?	—	Go to Step 3	Verify Repair
3	1. Turn ignition on. 2. Probe ECM connector pin J2-32 with a test light connected to ground. Is test light on?	—	Verify Repair	Verify Repair

22642

CT Light On Steady, Will Not Flash Code 12



DRC7493

Circuit Description

The Code tool (CT) plugs into the engine DLC and receives voltage through the "F" terminal. Terminal "E" is grounded thru ECM J1-9. There should always be a steady CT light when the CT is in the "OFF" position, the ignition "ON", and the engine isn't running.

When the CT is in the "ON" position, it completes a ground circuit through terminals "A" and "B", and will flash a DTC 12 followed by any other code(s) stored in memory. A steady light suggests a short to ground from terminal "E" to J1-9, an open from terminal "B" to J2-22, or an open from terminal "A" to ground.

Test Description

The number(s) below refer to the step number(s) on the diagnostics table.

1. If there is a problem with the ECM it will not flash a DTC 12 when the CT switch is in the "ON" position. If CT, with switch in the "OFF" position does flash a DTC 12, make sure CT is working properly. Test CT on another engine. If CT tests good, check for a short or ground between DLC terminal "B" and J2-22.
2. If the code light goes "OFF" when the ECM J-1 connector is disconnected, J1-9 is not shorted to ground.
3. This step will check for an open diagnostic input circuit thru terminal J2-22.

At this point, the CT light wiring is okay. If Code 12 does not flash, the ECM should be replaced.

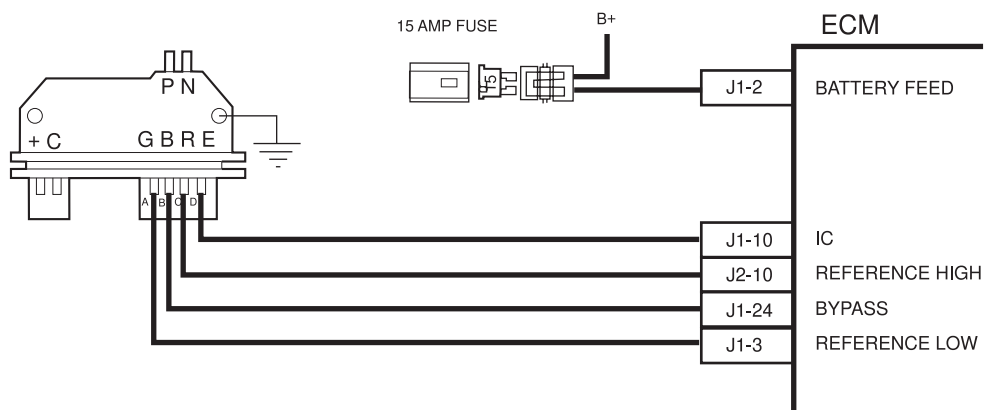
NOTE! Before replacing ECM, check CT on another engine to make sure it's working properly.

CT Light On Steady, Will Not Flash Code 12 (CT Installed)

Step	Action	Value	Yes	No
	Is CT light On? (ignition on, engine off, CT off)	—	Continue Below	See No Code Tool Light
1	1. Turn CT on. Does light flash DTC 12?	—	Verify Repair	Go to Step 2
2	2. Turn ignition off. 3. Disconnect ECM J1 connector 4. Turn ignition on. Is CT light on?	—	Verify Repair	Go to Step 3
3	1. Turn ignition off. 2. Disconnect ECM J2 connector. 3. Attach a jumper wire between DLC terminals "A" and "B." 4. Connect a test light between J2-22 and a B+ source. Does test light go on?	—	Verify Repair	Verify Repair

22643

Engine Cranks But Will Not Run



DRC7495

Circuit Description

Voltage is supplied from the ignition/injector relay to the fuel injectors, Distributor Ignition (DI), and ignition coil. Voltage supply branches into two separate circuits. One supplies the injectors, the other supplies the ECM J2-22. The ECM controls the operation of the fuel injectors through J1-1 and J1-17 by connecting them to ground.

The Ignition Control (IC) module receives voltage from a coil connection. The IC module controls spark from the coil through the 2-way connector. The IC module 4-way connector terminal interfaces with the ECM J1 and J2 connectors. For a further explanation of the DI system, see the **Electrical / Ignition** service manual.

Test Description

ECT Sensor Failure: An ECT sensor that indicates coolant temperature less than actual temperature can flood the engine with fuel. An ECT that indicates coolant temperature greater than actual can starve the engine of fuel.

TP Sensor Failure: If TP sensor is over 2.5 volts, the engine may be in the Clear Flood Mode, which will cause starting problems. Disconnect TP sensor to eliminate this possibility.

IC Module Failure: The engine will not start without ignition reference pulses.

The number(s) below refer to the step number(s) on the diagnostics table.

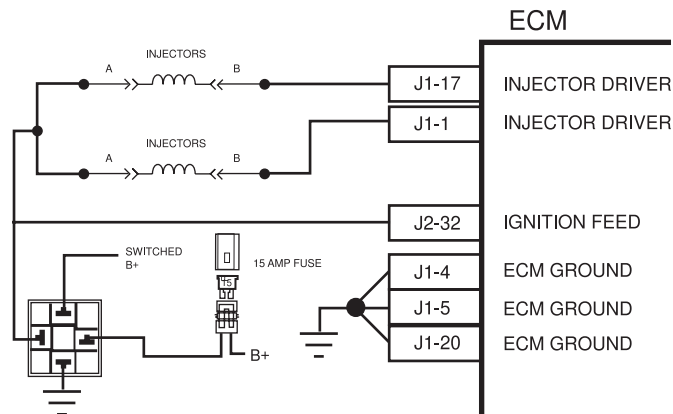
1. Check fuel pumps operation. In a non-cranking or non-running situation, pumps must operate for only 2 seconds, then shut off.
2. Check to see if IC module signal to ECM is shorted or grounded.
3. Proper fuel pressure is critical to EFI system operation. Correct any faults in this area before proceeding.
4. No spark may be caused by one of several components related to the DI / IC system. The DI ignition system check will address all problems related to the causes of a no-spark condition.
5. Checks B+ supplied to the ECM by the 12.5 amp circuit breaker and battery.
6. Checks power and ground at the injector.
7. Check for B+ at injector connector.
8. Checks if ECM is receiving reference pulse.
9. Checks reference pulse from IC module.
10. Checks power and switched ground to each injector connector.

Engine Cranks But Will Not Run

Step	Action	Value	Yes	No
1	1. Perform code tool check and read scan data if a scan tool is available. If no scan tool is available see diagnostic aids. Are any codes found or sensor readings out of range?	—	Verify Repair	Go to Step 2
2	1. Check spark using an approved spark tester. Is there spark?	—	Verify Repair	Go to Step 3
3	1. Turn the ignition off a minimum of 10 seconds. 2. Turn the ignition on and listen for the fuel pumps. Do they run for 2 seconds?	2 seconds	Verify Repair	Go to Step 4
4	1. Attach a fuel pressure gauge to the test point for the high pressure pump. 2. Turn the ignition on and read the fuel pressure. Does gauge show 30 ± 3 PSI (207 ± 13.8 kPa)	30 ± 3 PSI (207 ± 13.8 kPa)	Go to Step 5	Verify Repair
5	WARNING: Run bilge blowers 5 minutes prior to cranking the engine. Always check for fuel vapors in the bilge before cranking the engine. Leave bilge blowers running while performing this test to remove any fuel vapors that may accumulate. Make sure there are no open electrical sparks to ignite any fuel vapors that may be present. 1. Remove the flame arrestor and observe the injector spray while cranking. Do both injectors spray while cranking?	—	Go to Step 6	Go to Step 7
6	1. Disconnect electrical connectors at the injectors and crank engine. Do the injectors spray or drip fuel while cranking?	—	Verify Repair	Verify Repair
7	1. Connect an injector test light to each injector connector and crank the engine. Does the light flash?	—	Verify Repair	Go to Step 8
8	1. With the ignition on, check for battery voltage at the pink/white wire terminal of the injector connector. Is battery voltage present at the pink/white terminal?	—	Verify Repair	Go to Step 10
9	1. Connect an injector test light to the low pressure fuel pump electrical connector. 2. Crank the engine for 4 seconds. Does the light go out after 2 seconds or does the light stay on for 4 seconds ?	—	Light stays on for 4 seconds. Go to Step 12	Light goes out after 2 seconds Go to Step 10
10	1. Disconnect ECM. J2 connector. 2. Using a D.V.O.M. probe terminal J2-10 while cranking engine. Does the meter read 1-2 volts? If the wiring and the connections are good., replace the ignition module.	1-2 volts	Go to Step 11	Verify Repair

22644

Engine Cranks But Will Not Run (cont.)



DRC7503

11. Checks injector driver and ECM ground circuit for open and poor connections.
12. Checks resistance of injectors and for open circuits and poor connections in the injector harness and ECM grounds.
13. Checks injector driver circuit for open circuits.
14. Checks injector driver circuit for short circuits.

Diagnostic Aids

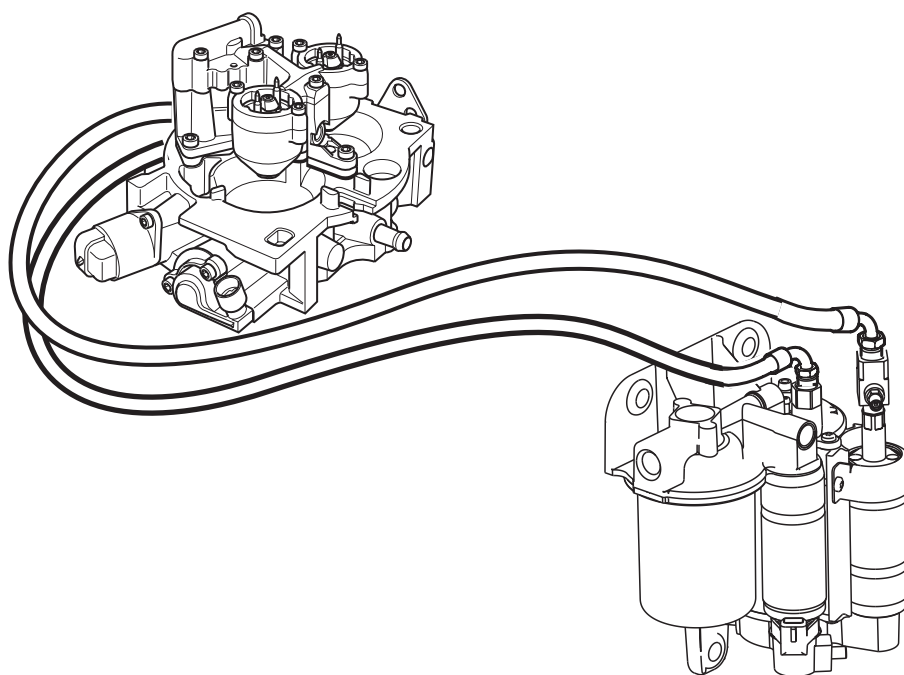
- This chart assumes battery condition and engine cranking RPM are okay, and adequate fuel is in the fuel tank.
- Unless engine enters "Clear Flood" at the first indication of a flooding condition, it can result in a no-start.
- Check for fouled plugs.
- Water or foreign material in fuel line can cause no-start.
- A defective MAP sensor may cause a no-start or a stall after start. To determine if the sensor is causing the problem, disconnect it. The ECM will then use a default value for the sensor. If the condition is corrected and the connections are okay, replace the sensor.
- If above are all okay, refer to *Symptoms*.

Engine Cranks But Will Not Run (cont.)

Step	Action	Value	Yes	No
11	Connect an injector test light to one injector connector. Observe test lights while cranking. Repeat this test for each injector harness connector. Does light flash on each connector?	—	Verify Repair	No lights flash Go to Step 13 Lights stay on all the time in one or more connectors Go to Step 14
12	Check for poor connections and opens in the following circuits: • Injector connector terminal, tan/blue wire to ECM. Terminal J1-1. • Injector connector terminal tan/orange to ECM. Terminal J1-17. • ECM ground terminals J1-4, J1-5, J1-20 and engine block. If all connections and circuits check good, replace ECM.	—	—	—
13	If light did not blink on all 4 cylinders of one bank, disconnect injectors and check resistance of injector. Each injector must be 13 ohms. Check for poor connections and opens in the following circuits: • Injector connectors for cylinders 1, 4, 6, and 7 to ECM connector J1-17. • Injector connectors for cylinders 2, 3, 5, and 8 to ECM connector J1-1. • ECM ground terminals J1-4, J1-5, J1-20 and engine block. If all connections and circuits are good replace ECM.	—	—	—
14	1. Disconnect the ECM J1 connector. 2. Check terminal J1-17 and J1-1 for short to ground. If harness is good, replace ECM.	—	—	—

22645

Fuel System Diagnosis #1



DRC6299

Circuit Description

When the ignition is turned on, the ECM will turn both fuel pumps on for only 2 seconds. During engine cranking or running, they will remain on as long as the ECM is receiving ignition reference pulses (a tachometer signal). If there are no reference pulses, the ECM will shut off the fuel pumps.

The low pressure pump delivers fuel to the vapor separator. The high pressure pump delivers fuel to the injectors. System pressure is controlled by a non-adjustable fuel pressure regulator. Excess fuel is returned to the fuel reservoir / vapor separator.

Test Description

The number(s) below refer to the step number(s) on the diagnostics table.

1. Checks static (non-running) fuel system pressure.

⚠ Warning!

Be extremely careful conducting this check; fuel and fumes are explosive. Make sure there are no electrical sparks or open flame to ignite the vapor.

NOTE! Fuel pump pressure will read lower if battery isn't fully charged.

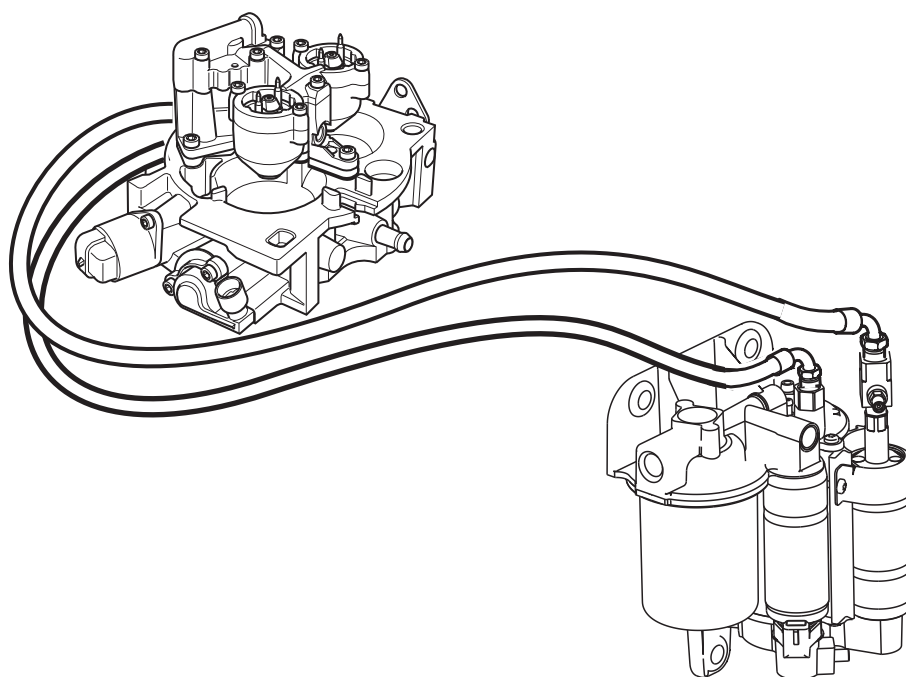
2. Checks fuel pressure at idle.
3. Pressure less than 24 PSI-165 kPa falls into two areas:
 - Defective pressure regulator. System will be running lean. Engine will be hard starting when cold, and overall performance will be poor.
 - Fuel system is restricted. If less than 22 PSI-152 kPa at idle, engine may not run. If pressure drop occurs while running, engine will surge then may stop running.
4. Check of the high pressure pump's ability to hold pressure when deadheaded. Will determine pump's internal condition.
5. Check of return line fuel pressure. Helps determine pressure regulator leakage.

Fuel System Diagnosis #1

Step	Action	Value	Yes	No
1	1. Turn ignition off. 2. Attach fuel pressure gauge to high-pressure test point. 3. Turn ignition on. Pumps should run for 2 seconds, then shut off. Note pressure while pumps run. Is pressure 29 ± 2 PSI ($200 \pm 13,8$ kPa)? NOTE! It is normal for fuel pressure to drop to 0 after fuel pumps shut off on TBI systems.	29 ± 2 PSI ($200 \pm 13,8$ kPa)	Go to Step 2	Verify Repair
2	1. Start and idle engine. 2. Bring up to normal operating temperature. Fuel pressure should be slightly less than static pressure. Is idling pressure within 1 PSI (6,9 kPa) of static pressure reading from step 1?	1 PSI (6,9 kPa)	Verify Repair	Go to Step 3
3	1. Check for restricted fuel lines, or a restricted filter. Are lines and filter okay?	—	Go to Step 4	Verify Repair
4	1. Turn off ignition. ⚠ WARNING! Be prepared to collect spilled fuel. 2. Disconnect fuel line at high pressure pump outlet. 3. Attach fuel pressure gauge directly to high pressure pump (not to test point). 4. Turn ignition on. Does pressure hold 15-20 seconds after pump stops?	15-20 seconds	Go to Step 5	Verify Repair
5	1. Turn ignition off. 2. Connect a pressure gauge to high pressure test point. ⚠ WARNING! Be prepared to collect spilled fuel. 3. Disconnect fuel return line at vapor separator. 4. Attach another pressure gauge directly to return line. DO NOT connect return line to vapor separator. 5. Turn ignition on. Does high pressure gauge hold 29 ± 2 PSI ($200 \pm 13,8$ kPa) while pumps are running?	29 ± 2 PSI ($200 \pm 13,8$ kPa)	Verify Repair	Verify Repair

22646

Fuel System Diagnosis #2



DRC6299

The number(s) below refer to the step number(s) on the diagnostics table.

Fuel Pressure Less Than 27 PSI-186 kPa

Pressure less than 27 PSI-186 kPa falls into two categories:

Regulated Pressure Less Than 27 PSI-186 kPa

Under such conditions, the system will be running lean. The operator will also experience hard starting when cold, and overall poor performance.

Restricted Flow Causing Pressure Drop

Normally, an engine with less than 22 PSI-152 kPa fuel pressure will not be runnable. However, if the pressure drop occurs only while running, the engine will surge then stop running as pressure begins to drop rapidly. This is most likely caused by a restricted fuel line or plugged filter.

1.  **WARNING!** Besides lowering fuel system pressure, leaks present a hazardous condition. **Always correct a leakage situation before conducting tests with an active electrical system.**
2. Check of battery state of charge. Low battery voltage can produce low fuel system pressure.
3. Check for fuel line or filter restrictions. Conduct checks back to, and including, the boat fuel tank,

pickup and vent. EFI filters will not pass water; a water-soaked filter will then not pass fuel.

4. Check of the low pressure fuel pump. It should be noted that the high and low pressure pumps must both function properly in order for the fuel system to maintain correct pressure and volume.

NOTE! Check for pressure regulator leakage. A regulator can leak internally or externally, or back through the return line to the vapor separator. Internal leakage results in an overly rich idle fuel mixture that the ECM cannot compensate for.

5. Check for vapor separator internal leakage. The vapor vent valve connects to an intake manifold vacuum line. Leakage through this line will create an overly rich idle fuel mixture that the ECM cannot compensate for. Vent leakage and regulator leakage will cause loping, surging, uncontrolled idle RPM.

Fuel Pressure Greater Than 31 PSI-214 kPa

1. Confirms existence of high fuel pressure.
2. Determines if problem is caused by an external device, a faulty regulator or a return line restriction.

Fuel System Diagnosis #2 (Fuel Pressure Less Than 27 PSI-186 kPa)

Step	Action	Value	Yes	No
1	1. Check for external leaks throughout fuel system. 2. Check for fuel leakage from regulator tube. Are leaks present?	—	Verify Repair	Go to Step 2
2	1. Check battery voltage. Is battery fully charged?	—	Go to Step 3	Verify Repair
3	1. Check for restricted fuel supply lines or fuel filter. 2. Look for water in fuel filter canister. Are lines and filter okay?	—	Go to Step 4	Verify Repair
4	1. Turn ignition off. 2. Attach pressure gauge to low pressure test point on vapor separator. 3. Turn ignition on. Is pressure 6 ± 2 PSI (28-55 kPa)?	6 ± 2 PSI (28-55 kPa)	Go to Step 4	Verify Repair
5	1. Turn ignition off. 2. Remove vent vacuum line from vapor separator. 3. Connect a length of clear plastic hose between vapor separator and vacuum line. 4. Turn ignition on. Does fuel appear in plastic hose?	—	Verify Repair	Verify Repair

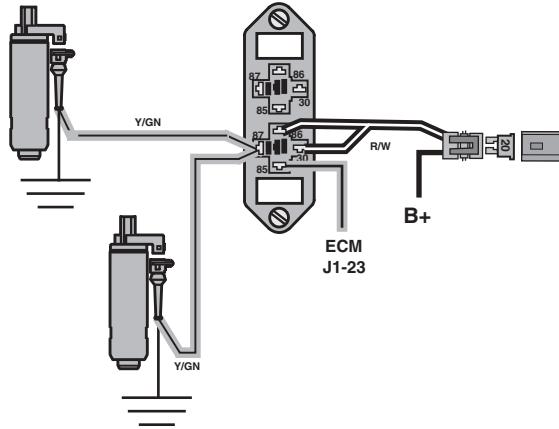
22647

Fuel System Diagnosis #2 (Fuel Pressure Greater Than 31 psi-214 kPa)

Step	Action	Value	Yes	No
1	1. Disconnect fuel return line at vapor separator. 2. Attach a fuel pressure gauge in series between the line and reservoir. 3. Reconnect line to reservoir. 4. Turn ignition on. Note pressure while pumps are operating. Is fuel pressure above 31 PSI-214 kPa?	31 PSI-214 kPa	Go to Step 2	Verify Repair
2	1. Check fuel supply line from filter back to fuel tank. Is an electric fuel pump or other pressure-producing device present?	—	Verify Repair	Verify Repair

22648

Fuel System Diagnosis - Electrical (pumps do not operate)



DRC7492

Circuit Description

The fuel pump circuit receives voltage from a relay through a 20 amp. fuse. Relay terminals 86 and 30 are supplied battery voltage from the 20 amp. fuse. Relay terminal 85 is grounded by the ECM which close terminals 87 and 30 to supply power to the fuel pumps.

During key on, the ECM will turn the pumps on (Ground terminal 85 of pump relay) for 2 seconds. During engine cranking or running the ECM will continue to ground terminal 85 for as long as it receives an ignition reference signal from the ignition module. If there are no reference pulses, the ECM will shut off the fuel pump relay.

Test Description

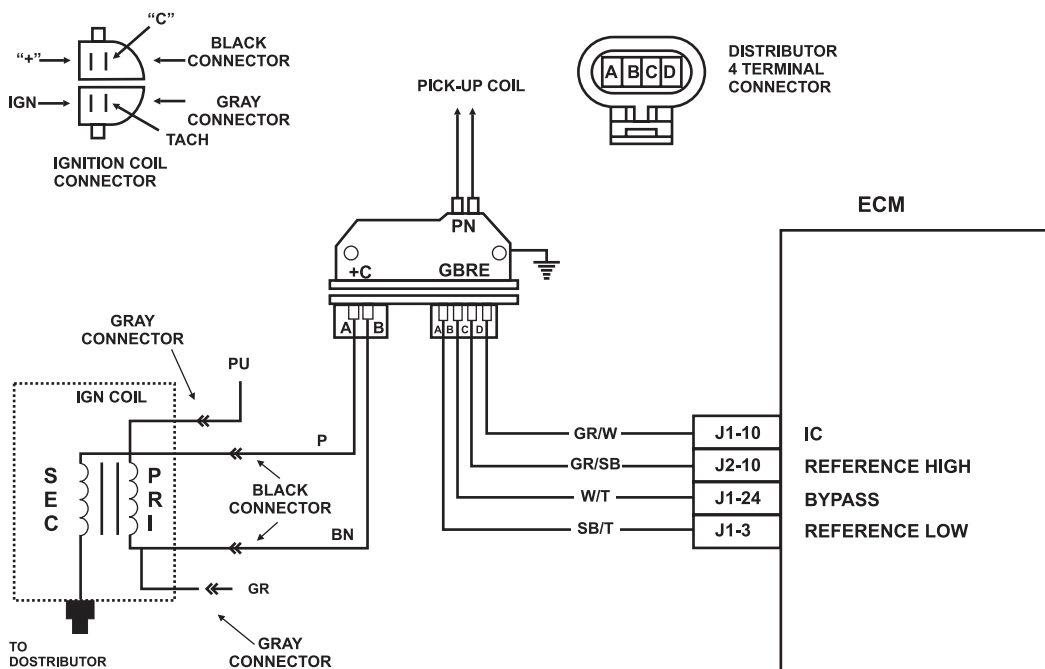
The number(s) below refer to the step number(s) on the diagnostics table.

1. Makes sure the Code Tool Check was performed to eliminate power supply or ground problems.
2. Checks circuit breaker and its B+ circuit back to the battery.
3. Checks B+ circuit from circuit breaker to relay.
4. Checks for switched ground supplied to the relay by the ECM.
5. Supplies B+ to pump circuit, to eliminate the pump relay as the cause of the problem.
6. Checks B+ to fuel pump connectors.
7. Checks fuel pumps ground circuits.
8. Checks circuit between fuel pump relay connector terminal and ECM terminal for continuity.

Fuel System Siagnosis - Electrical (pumps do not operate)

NOTE! If only one pump fails to operate the problem is with that pump circuit or pump. Make sure the battery is fully charged and connections are good before proceeding with tests. When removing connectors or components to perform test, visually inspect the condition of the terminals for corrosion, and physical damage.

Step	Action	Value	Yes	No
1	1. Was the Code Tool Check performed?	—	Go to Step 2	Verify Repair
2	1. Check 20 amp fuel pump circuit breaker. Does it need to be reset?	—	Verify Repair	Verify Repair
3	2. Turn off ignition. 3. Remove pump relay. 4. Connect a test light to ground. 5. Probe relay sockets for terminals 30 and 87 (red/white wires). Does test light come on?	—	Go to Step 4	Verify Repair
4	1. Connect a test light to B+. 2. Probe relay socket for terminal 85 (black/yellow wire) then turn ignition on. Does test light come on for 2 seconds and then go off? 3. Turn ignition off.	—	Go to Step 5	Go to Step 8
5	1. Install a fused jumper wire from relay socket terminal 30 (red/white wire) to relay socket terminal 87 (yellow/green wire). Do fuel pumps run?	—	Verify Repair	Go to Step 6
6	1. Connect test light to ground. 2. Disconnect fuel pump electrical connectors and probe terminals with yellow/green wire. Does test light come on?	—	Go to Step 7	Verify Repair
7	1. Connect test light to B+. 2. Probe fuel pump connector terminals with black wire. Does test light come on?	—	Verify Repair	Verify Repair
8	1. Make sure the ignition is off. 2. Disconnect negative battery cable and then ECM J1 connector. 3. Using an ohm meter check continuity between terminal J1-23 and fuel pump relay socket terminal 85 (black/yellow) wire. Does ohm meter show continuity (zero ohms)?	0 ohms	Verify Repair	Verify Repair



DRC7497

Circuit Description

The Distributor Ignition (DI) system receives voltage from the ignition relay. It is supplied to the ignition coil gray connector terminal “B”. Terminal “B” connects through the coil primary circuit to terminal “B” of the black connector. Voltage is then delivered to the “A” terminal of the 2-wire Ignition Control (IC) module connector at the distributor.

Inside the distributor the pick-up coil and pole piece will produce a voltage signal for cylinder spark. The voltage signals are processed thru the IC module and sent to the ECM. The ECM will decide if the engine is in a running or cranking mode, and adjust the timing accordingly. Voltages or signals are sent between the IC module 4-wire connector and ECM terminals J1-3, J2-10, J1-10, and J1-24. Terminal J1-3 is a ground circuit.

Wires “A” and “B” linking the 2-wire distributor and IC module connectors control the operation of the ignition coil primary circuit. The pink wire powers the module. The brown wire controls the build up and collapse of the coil primary circuit, and subsequent secondary current output.

Test Description

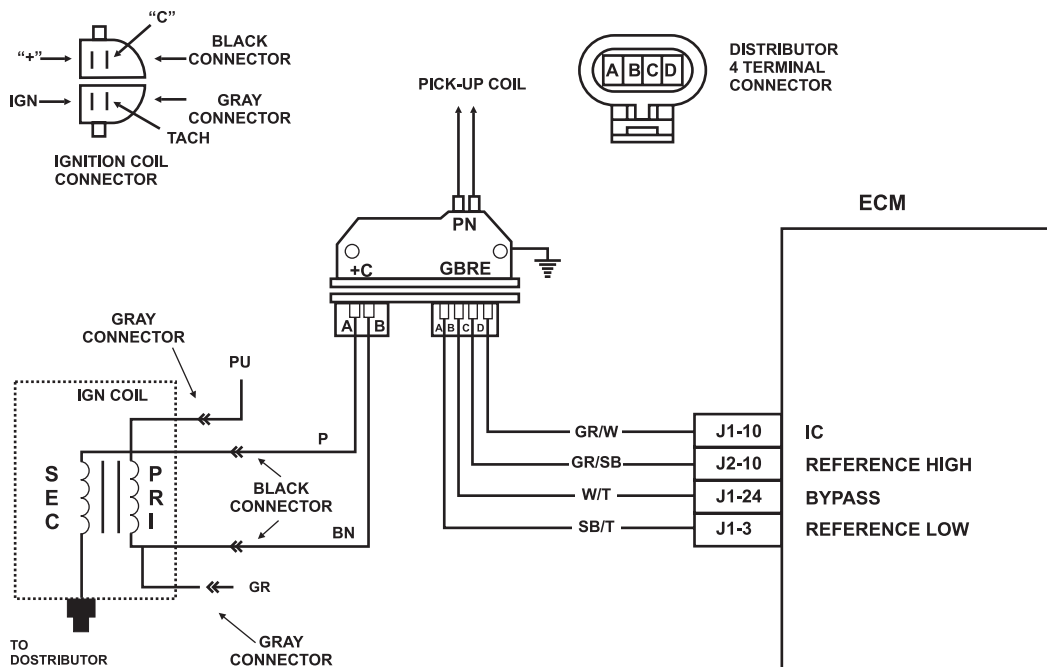
The number(s) below refer to the step number(s) on the diagnostics table.

1. Determines whether problem is fuel or ignition related.
2. Takes ECM out of ignition system to determine in which direction problem lies.
3. Isolates ECM as possible cause of problem.
4. Determines if knock circuit is grounded.
5. Determines if coil is receiving switched B+.
6. Isolates tach / lead as possible cause of problem.
7. Checks coil's primary and secondary circuit resistance.
8. Checks continuity of both primary circuit wire between coil and distributor.
9. Eliminates ignition system as cause of problem.
10. Determines whether mechanical failure is cause of problem.

Distributor Ignition System

Step	Action	Value	Yes	No
1	1. Crank the engine and check for spark at the coil tower using a known good coil wire and approved spark tester. Is their spark?	—	Verify Repair	Go to Step 2
2	1. Disconnect 4-wire connector at distributor. 2. Crank the engine. Is their spark?	—	Go to Step 3	Go to Step 4
3	1. Disconnect ECM J-1 & J-2 connector. 2. Crank the engine. Is their spark ?	—	Verify Repair	Verify Repair
4	1. Remove the gray two wire connector at the ignition coil. 2. Turn the ignition switch on and check for battery voltage at the purple wire terminal. Is their battery voltage?	—	Go to Step 5	Verify Repair
5	1. Install a jumper wire between the purple wire in the gray connector and the coil. 2. Install a short test lead into tach. terminal of the coil (gray wire terminal of coil). DO NOT reconnect the jumper to the gray wire. 3. Crank the engine and check for spark. Is their spark ?	—	Verify Repair	Go to Step 6
6	1. Using a test light connected to ground, probe the tach test lead while cranking the engine. 2. Observe the test light while cranking. Does the light flash from bright to dim while cranking ? NOTE: The starter will make the light go dim as engine is first cranked. DO NOT confuse this with a blinking light.	—	Verify Repair	Go to Step 7
7	1. Remove the two wire connector at the ignition module. 2. Turn the ignition key on and check for battery voltage at both terminals of the harness. Battery voltage at both terminals?	—	Go to Step 8	Verify Repair
8	Remove the distributor cap and check for rotation of the rotor.	—	Go to Step 9	Verify Repair
9	1. Remove the pick-up coil connector at the ignition module. 2. Connect the leads of a D.V.O.M. to the pick-up coil connector. 3. With the meter scale on A.C. millivolts crank the engine. Does the pick-up coil produce 300 millivolts or more?	300 millivolts	Go to Step 10	Verify Repair
10	1. With the meter still attached to the pick-up coil, check the coil for proper resistance and shorts. The resistance should be 700-900 Ohms, is it?	700-900 Ohms	Go to Step 11	Verify Repair

Distributor Ignition System (cont.)



DRC7497

Circuit Description

The Distributor Ignition (DI) system receives voltage from the ignition relay. It is supplied to the ignition coil gray connector terminal "B". Terminal "B" connects through the coil primary circuit to terminal "B" of the black connector. Voltage is then delivered to the "A" terminal of the 2-wire Ignition Control (IC) module connector at the distributor.

Inside the distributor the pick-up coil and pole piece will produce a voltage signal for cylinder spark. The voltage signals are processed thru the IC module and sent to the ECM. The ECM will decide if the engine is in a running or cranking mode, and adjust the timing accordingly. Voltages or signals are sent between the IC module 4-wire connector and ECM terminals J1-3, J2-10, J1-10, and J1-24. Terminal J1-3 is a ground circuit.

Wires "A" and "B" linking the 2-wire distributor and IC module connectors control the operation of the ignition coil primary circuit. The pink wire powers the module. The brown wire controls the build up and collapse of the coil primary circuit, and subsequent secondary current output.

- Checks ignition control (IC) module inside distributor for proper grounding.
- Checks pickup coil resistance. Determines whether coil or ECM is cause of problem.

Diagnostic Aids

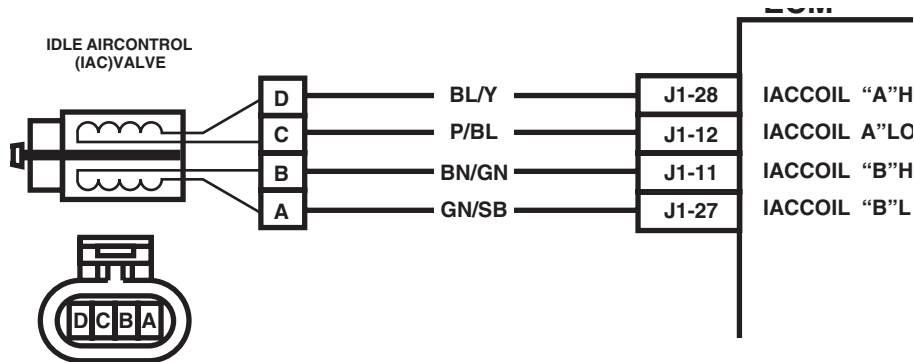
The tachometer needs to be disconnected while testing the ignition system. After tachometer is disconnected, try starting engine. If engine starts, check for a ground in the tachometer circuit.

Distributor Ignition System (cont.)

Step	Action	Value	Yes	No
11	1. Connect an approved spark tester to the coil tower or wire. 2. Using a 1.5 volt test battery with jumper leads, connect the positive battery lead to P terminal of the ignition module (pick-up coil male terminal on module closest to dist. Shaft). 3. With ignition switch on, make and break the ground of the test battery negative lead. Does the spark tester show a spark each time that you make and break the ground?	—	Verify Repair	Go to Step 12
12	1. Connect a D.V.O.M. positive lead to the tach test lead and the negative lead to ground. 2. With the meter on volts scale, and the ignition on , make and break the test battery ground. Does the meter voltage reading drop?	—	Verify Repair	Verify Repair

22651

Idle Air Control



DRC7498

Circuit Description

The ECM controls idle speed to a calculated, "desired" RPM based on sensor inputs and actual engine RPM. This is determined by the time between successive ignition reference pulses from the ignition module. The ECM uses four circuits to move an IAC valve, which allows varying amounts of air flow into the intake manifold, controlling idle speed.

Test Description

The number(s) below refer to the step number(s) on the diagnostics table.

1. Shows reaction of engine to disconnection of IAC valve.
2. Checks system's ability to recover from disconnection.
3. Determines whether IAC valve, circuit or ECM is faulty.

Diagnostic Aids

Check for vacuum leaks, unconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper sealing. Check open, shorts, or poor connections from connector terminals J1-11, J1-12, J1-27, and J1-28 to the IAC valve.

An open, short, or poor connection in the above circuits will result in improper idle control.

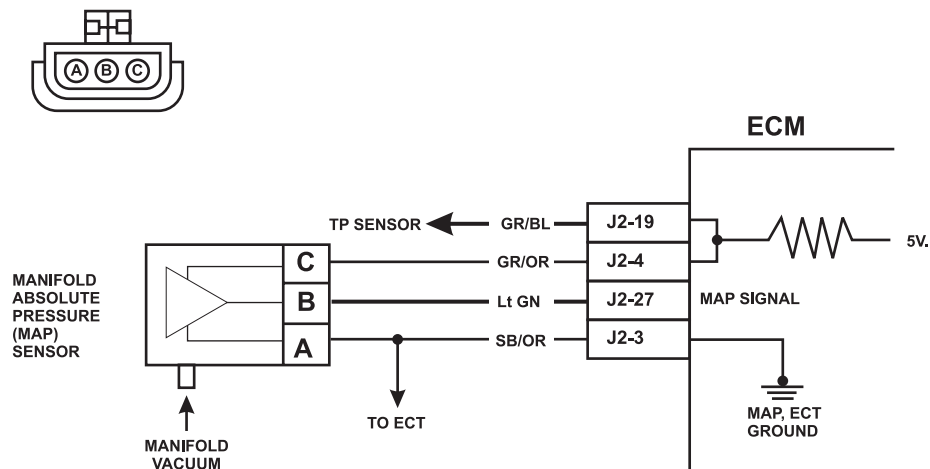
Poor idle can be caused by an IAC valve which is jammed and cannot respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage.

Idle Air Control

Step	Action	Value	Yes	No
1	1. Start engine. 2. Allow idle to stabilize and record engine RPM. 3. Turn ignition off for 10 seconds. 4. Unplug IAC valve connector. 5. Restart engine and note RPM. Is engine speed at least 200 RPM higher than that previously recorded?	200 RPM	Go to Step 2	Go to Step 3
2	1. Reconnect IAC valve. Within 30 seconds, does engine speed gradually return within 75 RPM of recorded RPM?	75 RPM	Verify Repair	Go to Step 3
3	1. Turn ignition off for 10 seconds. 2. Leave IAC valve disconnected, or disconnect it if you have come here from Step 2. 3. Restart engine. 4. With a grounded test light, probe each of the four IAC connector terminals. Does the test light blink on all four terminals? NOTE! If two terminals show solid test lights and two terminals show no test light, check for shift interrupt connector plugged into trim sender connector located at rear of engine.	—	Verify Repair	Verify Repair

22652

Manifold Absolute Pressure (MAP) Sensor - (Output Check)



DRC7496

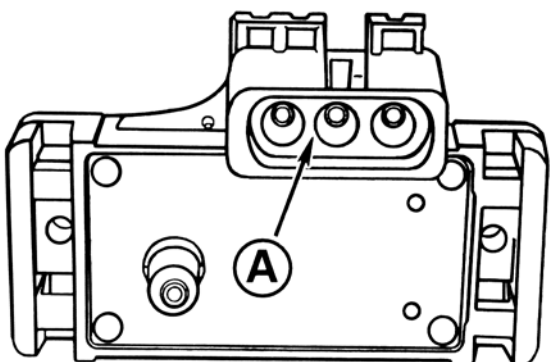
Circuit Description

The MAP sensor measures the change in the intake manifold pressure, which results from engine load (intake manifold vacuum) and RPM changes, and converts these into a voltage output. The ECM sends a 5 volt reference voltage to the MAP sensor. As manifold pressure changes, the output voltage of the sensor also changes.

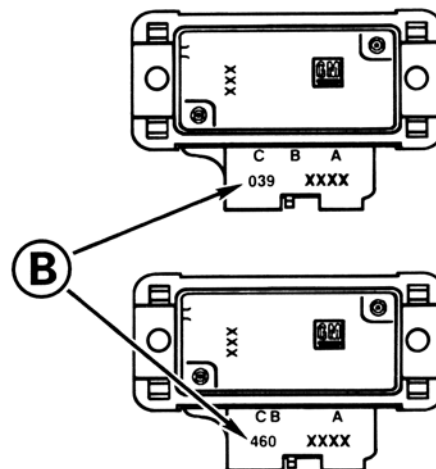
By monitoring the sensor output voltage, the ECM calculates the manifold pressure. A low pressure (low voltage) signal will be about 1 to 2 volts at idle. A high pressure (high voltage) signal will be about 4 to 4.8 volts at Wide Open Throttle (WOT).

The MAP sensor is also used, under certain conditions, to measure barometric pressure, allowing the ECM to make adjustments for altitude changes. The ECM uses the MAP sensor to control fuel delivery and ignition timing.

Test Description



DR5459



DR5460

The number(s) below refer to the step number(s) on the diagnostics table.

1. When comparing MAP sensor readings to a known good running engine, it is important to compare engines that use a MAP sensor having the same color insert (A) and the same "hot stamped" number (B).
2. Applying 10 inch Hg (34 kPa) vacuum to the MAP sensor should result in voltage readings of 1.5 to 2.1 volts less than the voltage in Step 1. Upon applying vacuum to the sensor, the change in voltage should be instantaneous. A slow voltage change indicates a faulty sensor.

NOTE! Make sure electrical connector remains securely fastened.

Remove sensor from the intake plenum and twist sensor **(by hand only)** to check for intermittent connection. Output changes greater than 0.10 volt indicate a faulty sensor or connection. If okay, replace sensor. Refer to *Sensors and Controls*

Manifold Absolute Pressure (MAP) Sensor - (Output Check)

Step	Action	Value	Yes	No
1	1. Turn ignition on but do not start engine 2. Scan diagnostic trouble codes (DTCs). If DTC 33 or 34 is present, use that chart first. 3. Scan tool should indicate a map sensor voltage 4. Compare this reading with the reading of a known good engine. Voltage reading should be within ± 0.4 volts. Is it?	± 0.4 volts	Go to Step 2	Replace MAP sensor
2	1. Remove MAP sensor and plug vacuum port on intake manifold. 2. Connect a hand vacuum pump to MAP sensor 3. Start engine. 4. Note MAP sensor voltage. 5. Apply 34 kPa (10" Hg) of vacuum and note voltage change. Subtract second reading from the first. Voltage value should be greater than 1.5 volts. Is it?	>1.5 volts	Go to Step 3	Check MAP sensor connections, if OK replace sensor
3	No trouble found. Check sensor inlet for port restriction or leaking seal.	—	Verify Repair	Verify Repair

22653

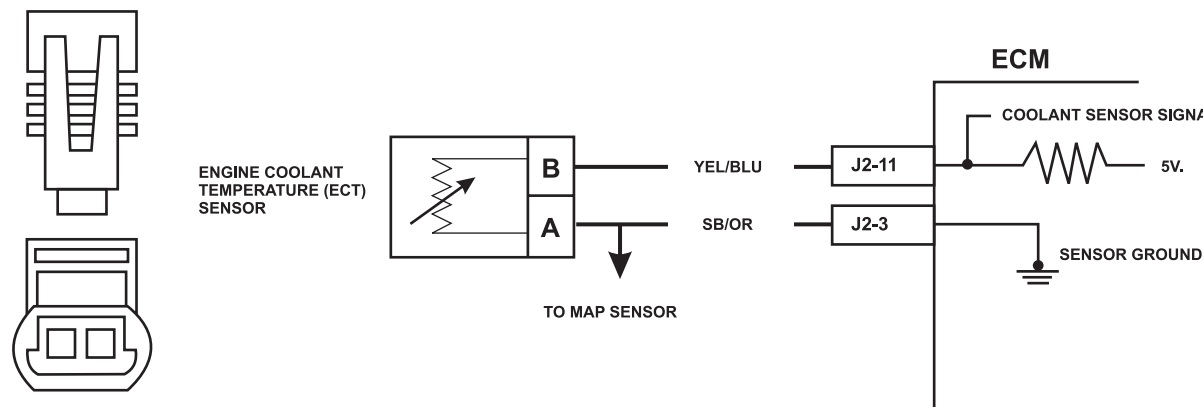
Notes

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DTC 14 - Engine Coolant Temperature (ECT) Sensor - Low Temperature Indicated



DRC7500

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies about 5 volts to the "B" terminal of the sensor. When engine coolant is cold, the sensor (thermistor) resistance is high, therefore the ECM will see a high voltage signal. As the engine coolant warms, the sensor resistance becomes less, therefore the ECM will see low voltage. At normal operating temperature 85°C-95°C (185°F-203°F), the voltage will measure about 1.5-2.0 volts. See *Temperature / Resistance* chart.

Test Description

- 1. Checks for a problem with the ECM and wiring, or a problem with the engine coolant sensor.
- 2. Isolates problem to 5 volt reference or ground circuit.
- 3. Check the harness terminals thoroughly for loose connections. If the resistance of the engine coolant sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading should stabilize when the thermostat opens.

Diagnostic Aids

An intermittent problem may be caused by a poor or corroded connection, worn-through insulation, a broken wire inside the insulation, or a corroded wire.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. If DTC 33 is also set, check for an open circuit between J2-3 to "A" terminal of sensor.

After repairs, properly clear the DTC.

Temperature / Resistance chart

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

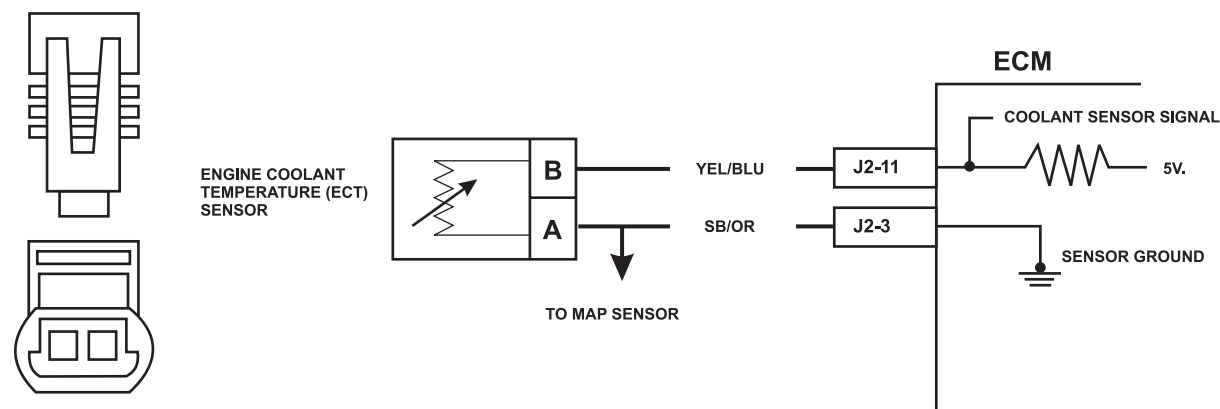
22681

DTC 14 - Engine Coolant Temperature (ECT) Sensor Low Temperature Indicated

Step	Action	Value	Yes	No
1	1. Turn off ignition. 2. Disconnect ECT sensor. 3. Turn on ignition, do not start engine. Connect a DVOM across the ECT sensor harness terminals. Is voltage 4.0 volts or higher?	4 volts	Verify Repair	Go to Step 2
2	1. Connect DVOM positive lead to connector terminal "B". 2. Connect negative lead to a good engine ground. 3. Turn on ignition. Is voltage 4.0 volts or higher?	4 volts	Verify Repair If both OK, go to Step 3.	Verify Repair If both OK, go to Step 3.
3	With harness disconnected from ECM and sensor, check continuity of both ECT circuits from ECM to ECT connector. Each circuit must show continuity ONLY to its respective connector terminal (i.e. circuit J2-11 to terminal "B" must show zero (0) ohms resistance, but J2-3 to terminal "A" must show infinity). Is continuity of both circuits correct?	—	Verify Repair	Verify Repair

22682

DTC 15 - Engine Coolant Temperature (ECT) Sensor - High Temp Indicated



DRC7500

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies about 5 volts to the "B" terminal of the sensor. When engine coolant is cold, the sensor (thermistor) resistance is high, therefore the ECM will see a high voltage signal. As the engine coolant warms, the sensor resistance becomes less, therefore the ECM will see low voltage. At normal operating temperature 185°F-203°F (85°C-95°C), the voltage will measure about 1.5-2.0 volts. See *Temperature / Resistance* chart.

Test Description

- 1. Checks for a problem with the ECM and wiring, or a problem with the engine coolant sensor.
- 2. Check the harness terminals thoroughly for loose connections. If the resistance of the engine coolant sensor is monitored, the resistance should steadily decrease as the engine coolant warms up. The resistance reading should stabilize when the thermostat opens.

Diagnostic Aids

An intermittent problem may be caused by a poor or corroded connection, worn-through insulation, a broken wire inside the insulation, or a corroded wire.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. Check harness routing for a potential short to ground from J2-11 to sensor. See "Intermittents" in *Symptoms Section*.

After repairs, properly clear the DTC.

Temperature / Resistance chart

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

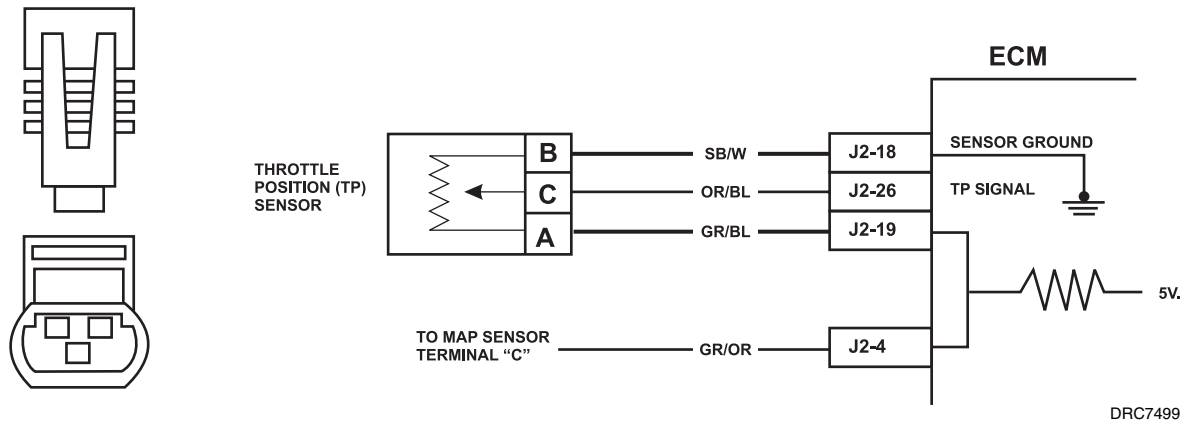
22681

DTC 15 - Engine Coolant Temperature (ECT) Sensor High Temp Indicated

Step	Action	Value	Yes	No
1	1. Turn off ignition. 2. Disconnect ECT sensor. 3. Turn on ignition, do not start engine. Connect a DVOM across the ECT sensor harness terminals. Is voltage 4.0 volts or higher?	4 volts	Verify Repair	Go to Step 2
2	Locate and repair short to ground in circuit between sensor and J2-11. Was problem found?	—	Verify Repair	Verify Repair

22683

DTC 21 - Throttle Position (TP) Sensor - Signal Voltage High



Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides voltage signal changes relative to the throttle blade. Signal voltage should vary from about .7 volts at idle to about 4.8 volts at WOT.

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

ECM circuit J2-19 supplies 5.0 volts to terminal "A" of the TP sensor connector.

ECM circuit J2-18 to terminal "B" is the TP sensor ground circuit.

The TP sensor signal circuit, J2-26 to terminal "C", will send voltage back to the ECM relevant to throttle blade position.

Test Description

1. This step simulates a DTC 22. If the ECM recognizes the low signal voltage and sets DTC 22, the ECM and wiring are okay.
2. Checks for open circuit from sensor to ECM ground.

Diagnostic Aids

Check terminals at sensor for good contact. Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

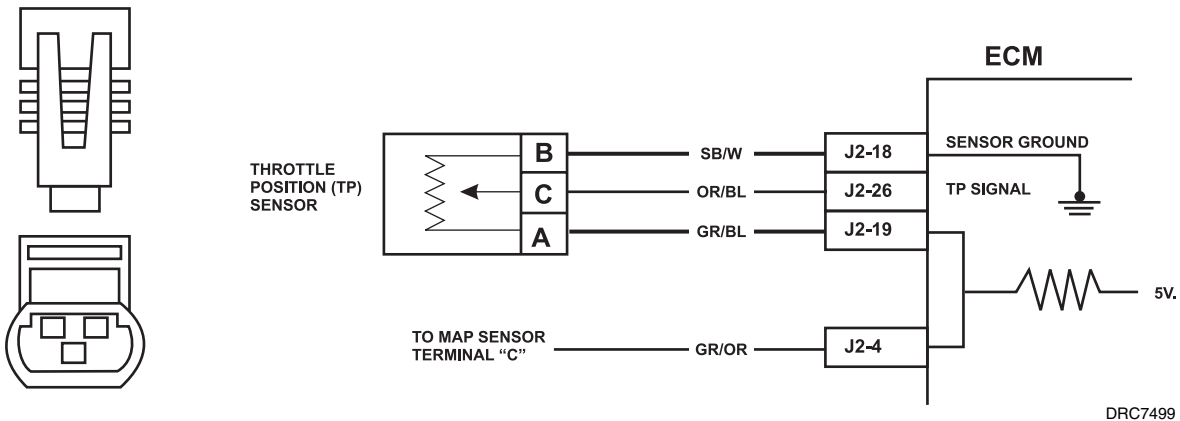
After repairs, properly clear the DTC.

DTC 21 - Throttle Position (TP) Sensor - Signal Voltage High

Step	Action	Value	Yes	No
1	1. Install CT tool. 2. Place CT tool switch in the "normal mode" or "OFF". 3. Turn off ignition. 4. Disconnect TP sensor. 5. Start engine and idle for 2 minutes or until the CT tool indicates a stored code. 6. Shut down the engine. Use CT tool to retrieve trouble codes. Is DTC 22 present?	—	Verify Repair	Go to Step 2
2	1. Turn off ignition. 2. Disconnect TP sensor. 3. Turn on ignition, do not start engine. Connect a DVOM between harness terminals "A" and "B". Is voltage 4.0 volts or higher?	4 volts	Verify Repair	Verify Repair

22684

DTC 22 - Throttle Position (TP) Sensor - Signal Voltage Low



Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides voltage signal changes relative to the throttle blade. Signal voltage should vary from about .7 volts at idle to about 4.8 volts at WOT.

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

ECM circuit J2-19 supplies 5.0 volts to terminal "A" of the TP sensor connector.

ECM circuit J2-18 to terminal "B" is the TP sensor ground circuit.

The TP sensor signal circuit, J2-26 to terminal "C", will send voltage back to the ECM relevant to throttle blade position.

Test Description

1. This step simulates a DTC 21. If the ECM recognizes the high signal voltage and sets a DTC 21, the ECM and wiring are okay.
2. Checks for ECM voltage at sensor connector terminal "A" (5V reference). Determines direction in which problem lies.

Diagnostic Aids

Check terminals at sensor for good contact. Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

If DTC 34 is also set, check for a short to ground in circuit from ECM J2-19 and TP sensor terminal "A" or ECM J2-4 and MAP sensor terminal "C".

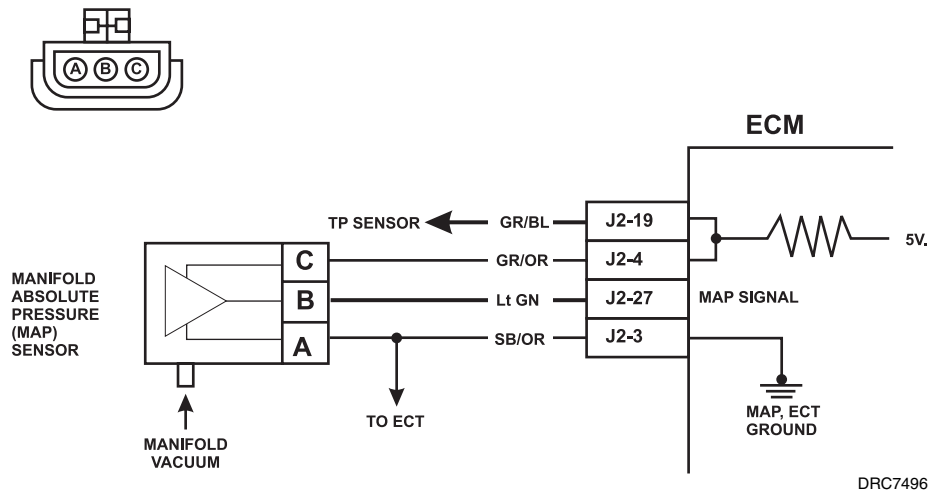
If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, properly clear the DTC.

DTC 22 - Throttle Position (TP) Sensor - Signal Voltage Low

Step	Action	Value	Yes	No
1	1. Install CT tool. 2. Place CT tool switch in the "normal mode" or "OFF". 3. Turn off ignition. 4. Disconnect TP sensor. 5. Connect a jumper wire from harness terminal "A" to terminal "C". 6. Start engine and idle for 2 minutes or until the CT tool indicates a stored code. 7. Shut down the engine. Use CT tool to retrieve trouble codes. Is DTC 21 present?	—	Verify Repair	Go to Step 2
2	1. Remove jumper wire installed in step above. 2. Connect a DVOM between harness terminals "A" and "B". Is voltage 4.0 volts or higher?	4 volts	Verify Repair	Verify Repair

22685



The MAP sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0 - 1.5 volts at closed throttle (idle high vacuum) to 4.0 - 4.5 volts at wide open throttle (WOT - low vacuum).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

MAP sensor voltage of 5V is delivered from J2-4 to the MAP sensor connector terminal "C". J2-3 is the ground circuit for the MAP sensor "A" terminal. The MAP sensor "B" terminal will send voltage to terminal J2-27 of the ECM according to manifold pressure.

1. Will determine if there is an adequate vacuum supply to the MAP sensor. If the gauge reading is erratic, refer to the *"Rough or Unstable Idle" Symptom in Section*. Low manifold vacuum may result from a restriction in the MAP sensor hose, or from vacuum leaks in the engine induction system.
2. Simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are okev.
3. Checks sensor ground circuit from ECM to sensor.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

If idle is rough or unstable, refer to *Symptoms Section* for items which may cause an unstable idle.

With the ignition "ON", engine "OFF", the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO.

If Code 14 is also set, check for an open ground circuit between J2-3 and MAP sensor terminal "A".

If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, properly clear the DTC.

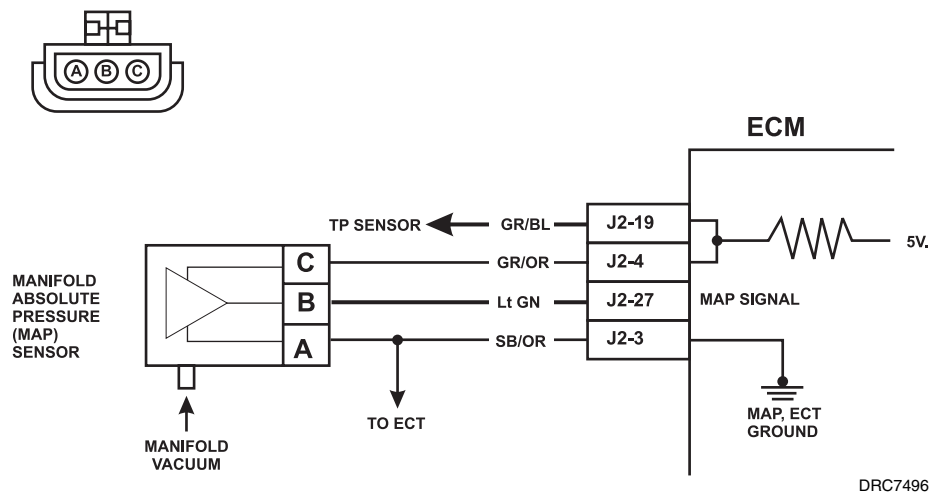
NOTE! If engine idle is rough or unstable, correct condition before continuing. Refer to *Symptoms* Section.

DTC 33 - Manifold Absolute Pressure (MAP) Sensor - Signal Voltage High

Step	Action	Value	Yes	No
1	1. Turn off ignition. 2. Disconnect vacuum cap at throttle body and install a vacuum gauge in the vacuum port. 3. Start engine and raise engine speed to about 1000 RPM. Is vacuum reading 14 in. Hg (44,5 kPa) or higher, and steady?	—	Go to Step 2	Verify Repair
2	1. Install CT tool. 2. Place CT tool switch in the "normal mode" or "OFF". 3. Turn off ignition. 4. Disconnect MAP sensor. 5. Start engine and idle for 2 minutes or until the CT tool indicates a stored code. 6. Shut down the engine. Use CT tool to retrieve trouble codes. Is DTC 34 present?	DTC 34	Verify Repair	Go to Step 3
3	1. Turn off ignition. 2. Remove vacuum gauge and reconnect vacuum cap. 3. Disconnect MAP sensor electrical connector. 4. Connect a DVOM between harness terminals "A" and "C". 5. Turn on ignition, do not start engine. Is voltage 4.0 volts or higher?	4 volts	Verify Repair	Verify Repair

22686

DTC 34 - Manifold Absolute Pressure (MAP) Sensor - Signal Voltage Low



Circuit Description

The MAP sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0 - 1.5 volts at closed throttle (idle high vacuum) to 4.0 - 4.5 volts at wide open throttle (WOT - low vacuum).

If the MAP sensor fails, the ECM will substitute a default MAP value that vary with RPM.

MAP sensor voltage of 5V is delivered from J2-4 to the MAP sensor connector terminal "C". J2-3 is the ground circuit for the MAP sensor "A" terminal. The MAP sensor "B" terminal will send voltage to terminal J2-27 of the ECM according to manifold pressure.

Test Description

1. Simulates a DTC 33. If the ECM recognizes the high signal voltage and sets a DTC 33, the ECM and wiring are okay.
2. Checks 5V reference circuit from ECM to sensor.

Diagnostic Aids

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

If idle is rough or unstable, refer to *Symptoms* Section for items which may cause an unstable idle.

With the ignition "ON", engine "OFF", the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO.

If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

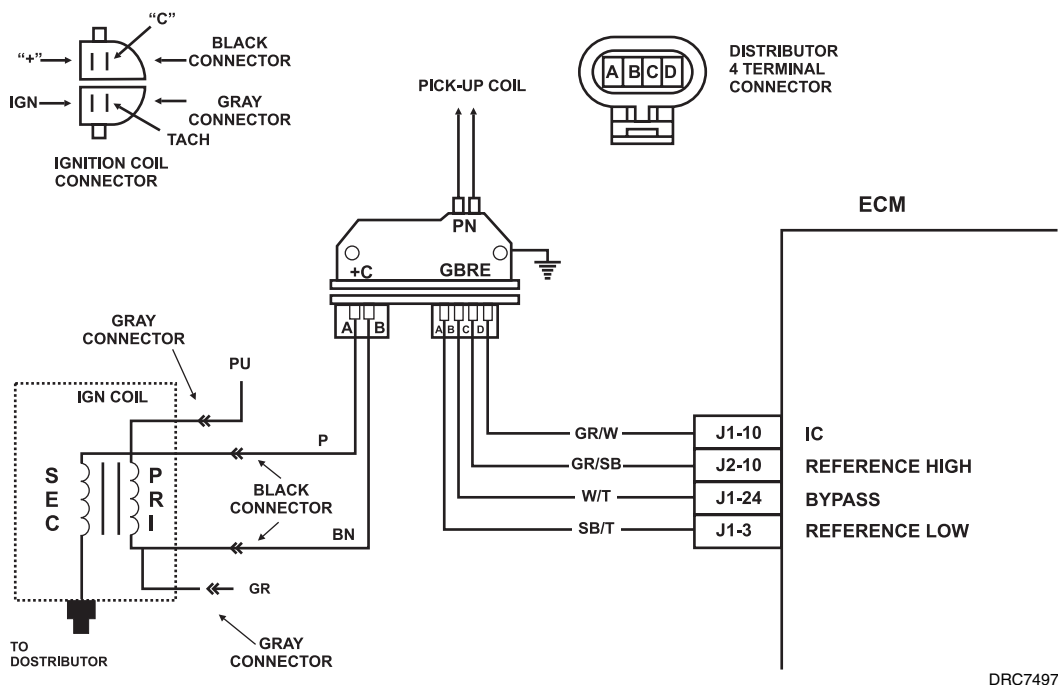
After repairs, properly clear the DTC.

NOTE! If engine idle is rough or unstable, correct condition before continuing. Refer to *Symptoms* Section.

DTC 34 - Manifold Absolute Pressure (MAP) Sensor - Signal Voltage Low

Step	Action	Value	Yes	No
1	1. Install CT tool. 2. Place CT tool switch in the "normal mode" or "OFF". 3. Turn off ignition. 4. Disconnect MAP sensor. 5. Connect a jumper wire from harness terminals "B" and "C". 6. Start engine and idle for 2 minutes or until the CT tool indicates a stored code. 7. Shut down the engine. Use CT tool to retrieve trouble codes. Is DTC 33 present?	DTC 33	Verify Repair	Go to Step 2
2	1. Remove jumper wire from connector. 2. Connect a DVOM between harness terminals "A" and "C". 3. Turn on ignition, do not start engine. Is voltage 4.0 volts or higher?	—	Verify Repair	Verify Repair

22687



Circuit Description

When the system is running in ignition module (Crank) mode, there is no voltage on the bypass line, and the IC module grounds the IC signal. The ECM expects to see the IC line grounded during this mode. If not, it sets DTC 41 and will not go into IC mode.

When the RPM for IC Mode is reached (about 300 RPM), and bypass voltage is applied, the IC signal should no longer be grounded in the IC module. The IC voltage should be varying at this point.

If the bypass line is open or shorted to ground, the IC module will not switch to IC Mode. The IC voltage will be low and DTC 42 will be set. If the IC line is grounded, there will be no IC signal. A DTC 42 will be set.

Test Description

1. DTC 41 means the ECM has seen an open in the IC circuit. This test confirms DTC 41 and that the fault causing the DTC is present.
2. Checks for a normal ground path through the IC module.
3. Confirms that DTC 41 is a faulty ECM and not an intermittent open in the ignition control circuit.

Diagnostic Aids

If engine starts and stalls, it may set a false DTC 41. Clear DTC and repair cause of stalling condition.

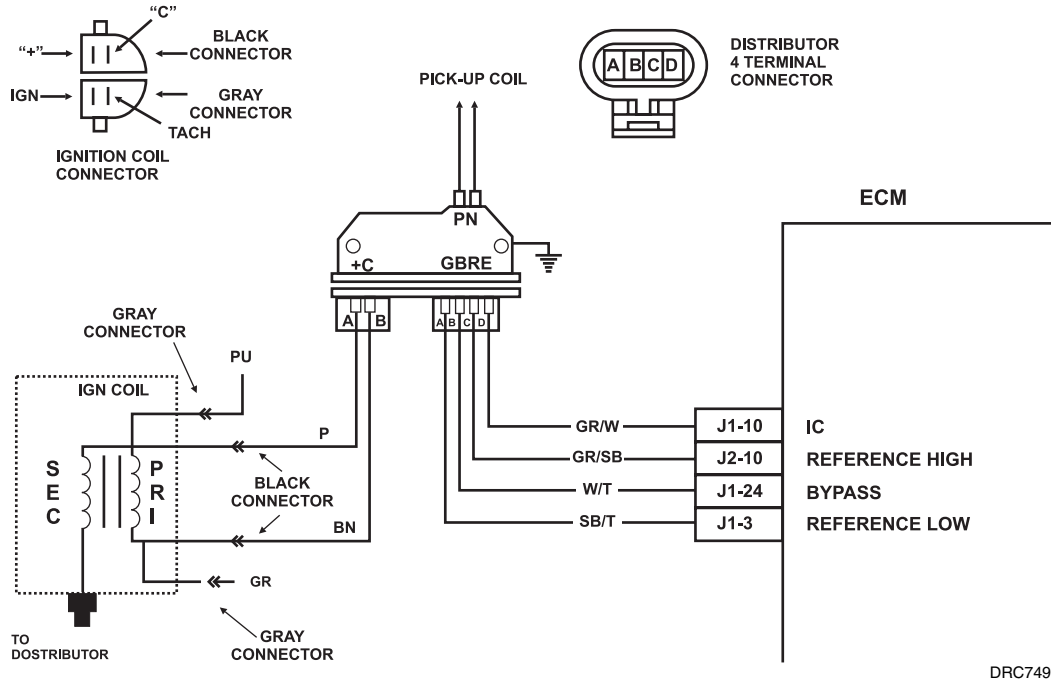
Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

After repairs, properly clear the DTC.

DTC 41 - Ignition Control (IC) - Open IC Circuit

Step	Action	Value	Yes	No
1	1. Install Code Tool. 2. Clear DTC's. Idle engine for one minute, or until MIL comes on. 3. Stop engine, leave ignition on. 4. Enter service mode on Code Tool and note DTC's. Is DTC 41 shown?	DTC 41	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Disconnect ECM J1 and J2 connectors. 3. Set DVOM to ohms scale. 4. Check circuit between ECM harness terminal J1-10 and engine ground. Does ohmmeter read 3000 - 6000 ohms?	—	Go to Step 3	Verify Repair
3	1. Reconnect ECM. 2. Start engine and idle for 2 minutes or until CT tool indicates a stored trouble code. 3. Shut down the engine. 4. Use CT tool to retrieve trouble codes. Is DTC 41 present?	DTC 41	Verify Repair	Verify Repair

22688



When the system is ru

When the system is running in ignition module (Crank) mode, there is no voltage on the bypass line, and the IC module grounds the IC signal. The ECM expects to see the IC line grounded during this mode. If not, it sets DTC 41 and will not go into IC mode.

When the RPM for IC mode is reached (about 3000 RPM), and bypass voltage is applied to the bypass circuit, the IC signal should no longer be grounded in the IC module. The IC circuit should have varying voltage on it at this time.

If the bypass line is open or shorted to ground, the IC module will not switch to IC Mode. The IC voltage will be low and DTC 42 will be set. If the IC line is grounded, there will be no IC signal. A DTC 42 will be set.

1. DTC 42 means t

1. DTC 42 means the ECM has seen an open or short to ground in the IC or bypass circuits. This test confirms DTC 42 and that the fault causing the DTC is present.
2. Checks for a normal ground path through the IC module. If the circuit from J1-10 to module terminal "D" is shorted to ground, it will read less than 3000 ohms.
3. As test light voltage touches the bypass circuit terminal (J1-24), the module should switch, causing the DVOM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched".

4. If the module did not switch, this step checks for an open or shorted to ground bypass circuit J1-24, or a faulty IC module or connection.
5. Confirms that DTC 42 is a faulty ECM and not an intermittent in the IC or bypass circuit.
6. Confirms that DTC 42 is a faulty ECM and not an intermittent in the IC or bypass circuit.

Diagnostic Aids

If engine starts and stalls, it may set a false DTC 42. Clear DTC and repair cause of stalling condition.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

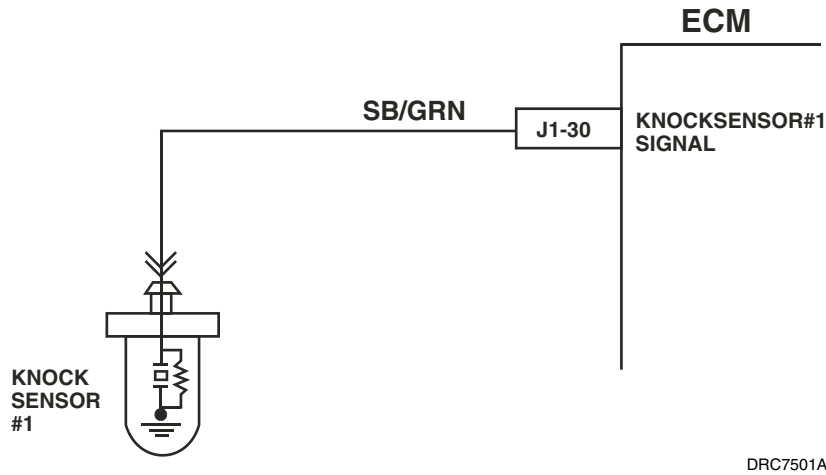
After repairs, properly clear the DTC.

DTC 42 - Ignition Control (IC) - Grounded IC Circuit, Open Or Grounded Bypass

Step	Action	Value	Yes	No
1	1. Install Code Tool. 2. Clear DTC's. 3. Idle engine for two minutes, or until MIL comes on. 4. Stop engine, leave ignition on. 5. Enter service mode on Code Tool and note DTC's. Is DTC 42 shown?	—	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Disconnect ECM J1 and J2 connectors. 3. Set DVOM to ohms scale. 4. Check circuit between ECM harness terminal J1-10 and engine ground. Does ohmmeter read 3000 - 6000 ohms?	—	Go to Step 3	Verify Repair
3	1. Leave ohmmeter connected as in STEP 2. 2. Attach a test light to a B+ source. 3. Probe bypass terminal J1-24 with test light. Does resistance reading drop from over 3000 ohms to under 1000 ohms as tester makes contact?	—	Go to Step 4	Go to Step 5
4	1. Reattach ECM J1 and J2 connectors. 2. Start and idle engine for two minutes or until MIL comes on. Does MIL come on?	—	Verify Repair	Verify Repair
5	1. Attach test light to a B+ source. 2. Probe ECM harness bypass terminal J1-24. Does test light come on?	—	Go to Step 6	Verify Repair
6	1. Disconnect 4-way connector at IC module. 2. Attach test light to a B+ source. 3. Probe ECM harness bypass terminal J2-24. Does test light comes on?	—	Verify Repair	Verify Repair

22689

DTC 44 - Knock Sensor (KS) 1 System Inactive



Circuit Description

The ECM uses the Knock Sensor in order to detect engine detonation. This detection allows the ECM to first enrich the mixture, then retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit.

Test Description

1. Ensures that the knock sensor is secured properly to the engine block and electrical connections are secure.

2. Checks to see that KS circuit is within specifications.

Diagnostic Aids

If KS sensor wiring is routed too close to secondary ignition wire, the ECM may see the interference as a knock signal, resulting in false timing retard.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

After repairs, properly clear the DTC.

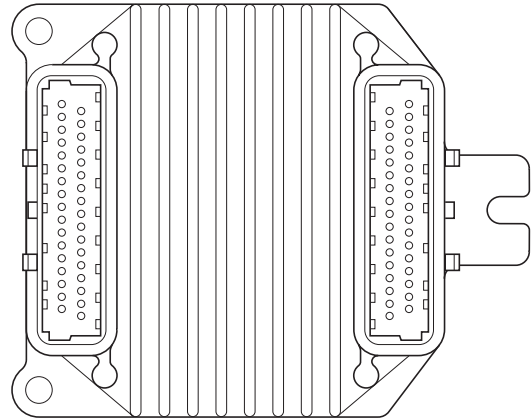
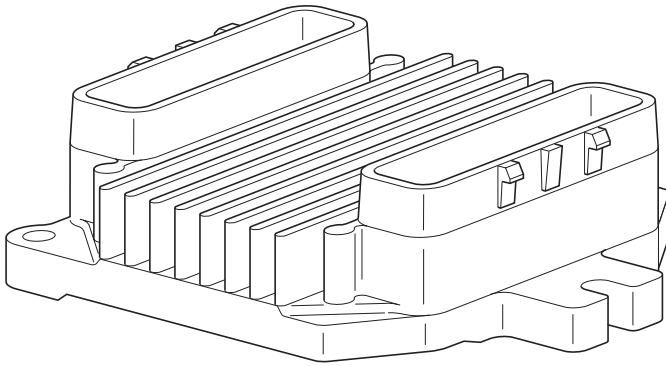
NOTE! Repair any engine mechanical problems that could introduce a knocking noise into the engine. The KS sensor can pick-up mechanical engine noise that the ECM will interpret as engine detonation. Engine timing and fuel quality should also be verified.

DTC 44 - Knock Sensor (KS) 1 System Inactive

Step	Action	Value	Yes	No
1	1. Check all sensors for proper seating in the engine block. 2. Verify all electrical connections are secure. Were any sensors or connectors found loose?	—	Verify Repair	Go to Step 2
2	1. Verify ignition "OFF". 2. Disconnect ECM J1 harness connector. 3. Using a DVOM, measure resistance between ECM J1-30 and a good ground near knock sensor. Is resistance between 85,000 - 100,500 ohms?	—	Verify Repair	Verify Repair

22690

DTC 51 - Calibration Memory Failure



3004

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations, or changes to these calibrations, that may alter the designed function of the EFI system.

Test Description

1. Checks to see if the fault is present during diagnosis. If present, the ECM is not functioning correctly and must be replaced.

NOTE! Engines with this failure must have the ECM replaced with a factory programmed ECM for your specific application.

Diagnostic Aids

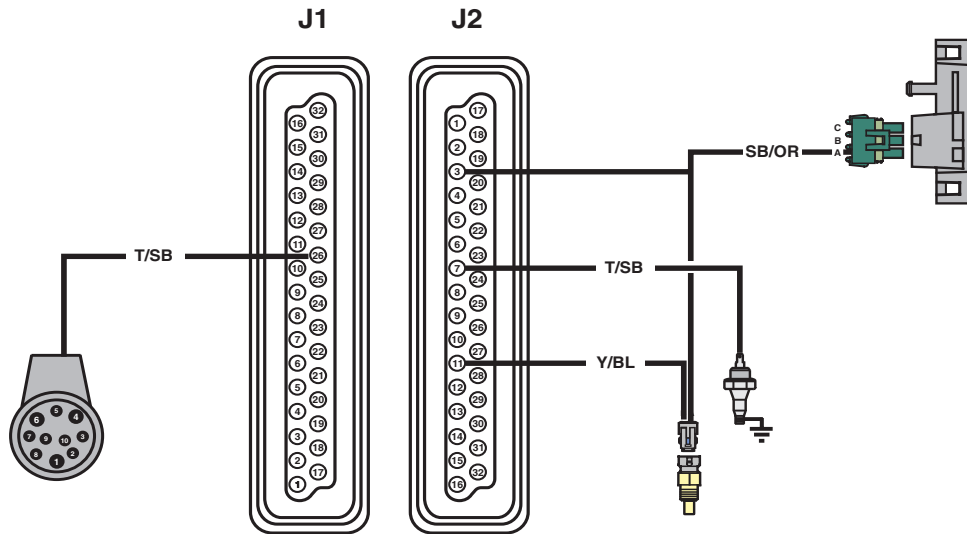
An intermittent DTC 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If DTC 51 occurred more than once, but is intermittent, replace the ECM.

DTC 51 - Calibration Memory Failure

Step	Action	Value	Yes	No
1	1. Turn ignition on. 2. Clear DTC's. Does DTC 51 reset?	—	Replace or reprogram ECM	Verify Repair

22691

Engine Protection Mode Circuit



DRC7543

Circuit Description

Three grounding type switches and one thermistor detect conditions critical to engine longevity:

- a water temperature thermistor (engine overheat)
- two temperature switches (exhaust overheat)
- an oil pressure switch (loss of pressure)

When closed, the ECM responds by entering *ENGINE PROTECTION MODE*. A warning horn will also sound.

This engine protection feature disables half the fuel injectors above 2500 RPM. If engine speed drops back to 1200 RPM, the system will reset and allow normal operation. Should the overheat or loss of oil pressure condition still exist, *ENGINE PROTECTION MODE* will again activate if engine speed exceeds 2500 RPM.

Test Description

1. Determines if warning horn is activated by ECM or if

horn lead is grounded.

2. Determines if oil pressure or exhaust temperature switches are causing the problem.
3. Determines if ECT sensor is cause of problem.
4. Checks oil pressure J2-7 for an open circuit.
5. Checks oil pressure J2-7 for a grounded circuit.
6. Checks ECT sensor J2-3 for an open circuit.
7. Checks ECT sensor J2-3 for a grounded circuit.
8. Checks MAP sensor J2-3 for a grounded circuit. Replace ECM if problem is not located in previous tests.
9. Check of warning horn circuit.

Diagnostic Aids

- Check engine crankcase oil level, add oil as necessary.
- See **Cooling System** section of **Engine** service manual for possible overheat causes.
- See appropriate engine section of **Engine** service manual for possible causes of loss of oil pressure.

If above diagnostics were performed, and no change in performance was made, refer to *Symptoms Section*.

An intermittent problem may be caused by a poor or corroded connection, a worn-through wire, a wire that's broken inside the insulation, or a defective switch.

Engine Protection Mode Circuit

Step	Action	Value	Yes	No
1	1. Turn ignition off. 2. Remove connector at oil pressure switch. 3. Turn ignition on. If equipped, does audible warning horn sound? If not equipped, go to STEP 2.	—	Go to Step 9	Go to Step 2
2	1. Turn ignition off. 2. Leave oil pressure switch disconnected. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ?	—	Go to Step 3	Verify Repair
3	1. Turn ignition off. 2. Remove connector at ECT sensor. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ? NOTE: ECT sensor serves a dual function; it provides water temperature data to ECM for spark / fuel control, and warns of engine overheat to activate <i>Engine Protection Mode</i> circuit.	—	Go to Step 4	Verify Repair
4	1. Turn ignition off. 2. Remove J2 connector at ECM. 3. Using a DVOM, check resistance from terminal J2-7 to oil pressure switch connector terminal. Does ohmmeter read at or near zero (0)?	0	Go to Step 5	Verify Repair
5	1. Check resistance between ECM terminal J2-7 and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 6	Verify Repair
6	1. Using a DVOM, check resistance from terminal J2-3 to ECT connector terminal "A". Does ohmmeter read at or near zero (0)?	0	Go to Step 7	Verify Repair
7	1. Check resistance between ECT connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 8	Verify Repair
8	1. Remove connector at MAP sensor. 2. Check resistance between MAP connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Verify Repair	Verify Repair
9	1. Check of warning horn circuit only (engine otherwise responds correctly to <i>Engine Protection Mode</i> conditions). 2. Turn ignition off. Remove J2 connector at ECM. 3. Disconnect 10-way engine cable connector. 4. Using a DVOM, check circuit between J2-12 and Pin 4 for opens and grounds. Does circuit pass both tests?	—	Verify Repair	Verify Repair

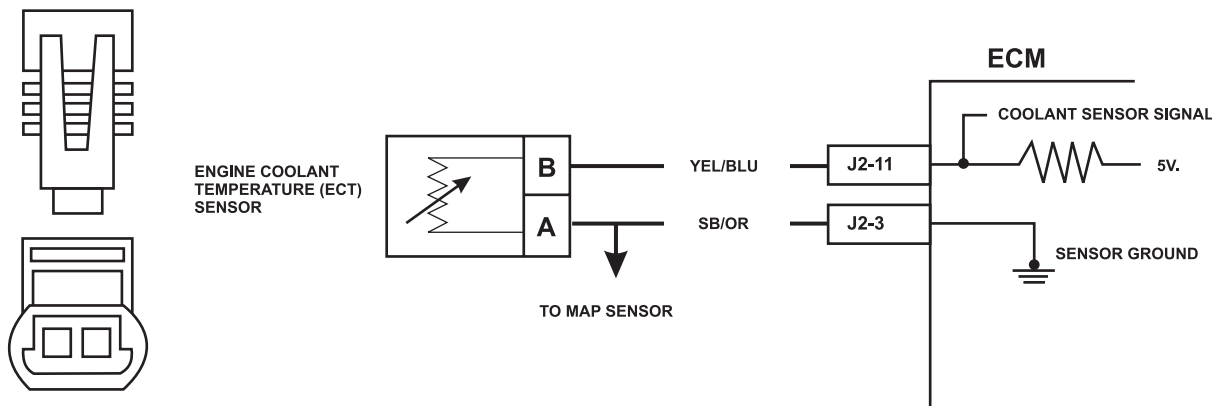
Notes

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DTC 14 - Engine Coolant Temperature (ECT) Sensor Low Temperature Indicated



DRC7500

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies about 5 volts to the "B" terminal of the sensor. When engine coolant is cold, the sensor (thermistor) resistance is high, therefore the ECM will see a high voltage signal. As the engine coolant warms, the sensor resistance becomes less, therefore the ECM will see low voltage. At normal operating temperature 85°-95°C (185°-203°F), the voltage will measure about 1.5-2.0 volts. See *Engine Coolant Temperature Sensor* table.

A scan tool displays engine temperature in degrees Celsius and Fahrenheit. After engine is started, the temperature should rise steadily, reach normal operating temperature, and then stabilize when the thermostat opens.

Test Description

DTC 14 will set if the signal voltage indicates a coolant temperature below -30°C (-22°F).

- 1. Determines whether DTC is intermittent, or whether failure is out-of-range low.
- 2. Simulates a DTC 15. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are okay.

Diagnostic Aids

Check the harness terminals thoroughly for loose connections. Check harness routing for a possible short to ground in circuit J2-11. If DTC 33 is also set, check for open circuit between J2-3 to "A" terminal of sensor.

An intermittent problem may be caused by a poor or corroded connection, worn-through insulation, a broken wire inside the insulation, or a corroded wire. See "Intermittents" in the *Symptoms* section.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, properly clear the DTC.

Engine Coolant Temperature Sensor Table

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4405
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

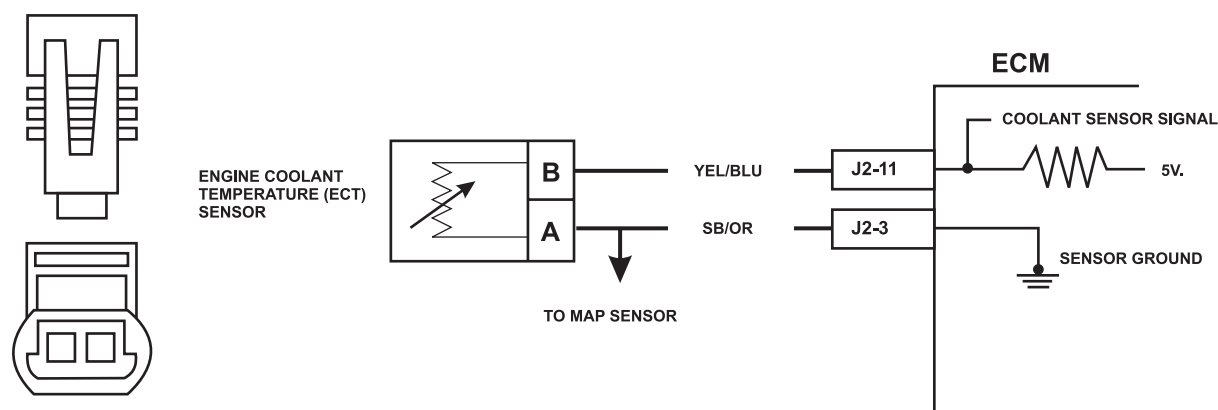
22713

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temperature Indicated

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Turn on ignition and choose appropriate display. Is sensor reading less than -22°F (30°C)?	-22°F (30°C)	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Remove connector at ECT sensor. 3. Jump together harness terminals "A" and "B". 4. Turn on ignition. Is sensor reading now above 266°F (130°C)?	266°F (130°C)	Verify Repair	Verify Repair

22714

DTC 15 - Engine Coolant Temperature (ECT) Sensor - High Temperature Indicated



DRC7500

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies about 5 volts to the "B" terminal of the sensor. When engine coolant is cold, the sensor (thermistor) resistance is high, therefore the ECM will see a high voltage signal. As the engine coolant warms, the sensor resistance becomes less, therefore the ECM will see low voltage. At normal operating temperature 185°F - 203°F (85°C - 95°C), the voltage will measure about 1.5-2.0 volts. See *Engine Coolant Temperature Sensor* table.

A scan tool displays engine temperature in degrees Celsius and Fahrenheit. After engine is started, the temperature should rise steadily, reach normal operating temperature, and then stabilize when the thermostat opens.

Test Description

DTC 15 will set if the signal voltage indicates a coolant temperature above 130°C (266°F).

- 1. Determines whether DTC is intermittent, or whether failure is out-of-range high.
- 2. Simulates a DTC 14. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are okay.

Diagnostic Aids

Check the harness terminals thoroughly for loose connections. Check harness routing for a possible short to ground in circuit J1-2. If DTC 33 is also set, check for open circuit between J2-3 to "A" terminal of sensor.

An intermittent problem may be caused by a poor or corroded connection, worn-through insulation, a broken wire inside the insulation, or a corroded wire. See "Intermittents" in the *Symptoms* Section.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals/or wiring, or physical damage to wiring harness. After repairs, properly clear the DTC.

Engine Coolant Temperature Table

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
80	176	332
60	140	667
45	113	1188
35	95	1802
25	77	2796
15	59	4405
5	41	7280
-5	23	12300
-15	5	21450
-30	-22	52700
-40	-40	100700

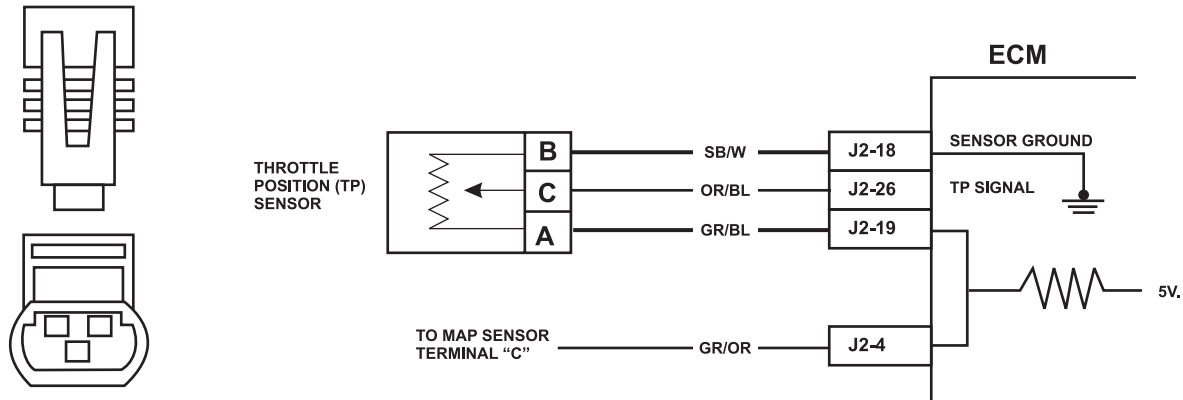
22713

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temperature Indicated

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Turn on ignition and choose appropriate display. Is sensor reading greater than 266°F (130°C)?	266°F (130°C)	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Remove connector at ECT sensor. 3. Jump together harness terminals "A" and "B". 4. Turn on ignition. Is sensor reading now below -22°F (-30°C)?	-22°F (30°C)	Verify Repair	Verify Repair

22715

DTC 21 - Throttle Position (TP) Sensor - Signal Voltage High



DRC7499

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides voltage signal changes relative to the throttle blade. Signal voltage should vary from about 0.7 volts at idle to about 4.8 volts at WOT.

The TP sensor signal is one of the important inputs used by the ECM for fuel control and for IAC control.

ECM circuit J2-19 supplies 5.0 volts to terminal "A" of the TP sensor connector. ECM circuit J2-18 to terminal "B" is the TP sensor ground circuit. The TP sensor signal circuit, J2-26 to terminal "C", will send voltage back to the ECM relevant to throttle blade position.

Test Description

1. With throttle closed, TP sensor should read between 0.3 and 0.9 volts. If it does not, check the throttle cable adjustment or for bent or binding linkage.
2. Simulates a DTC 22. If ECM recognizes the low voltage signal, the ECM and wiring are okay.
3. Checks sensor ground circuit. A faulty sensor ground circuit will cause a DTC 21. Also considers faulty connections and a failed ECM.

Diagnostic Aids

A scan tool reads throttle position in voltage and percentage of throttle blade opening. Voltage should increase at a steady rate as the throttle is opened.

An intermittent problem may be caused by a poor or corroded connection, worn-through insulation, a broken wire inside the insulation, or a corroded wire.

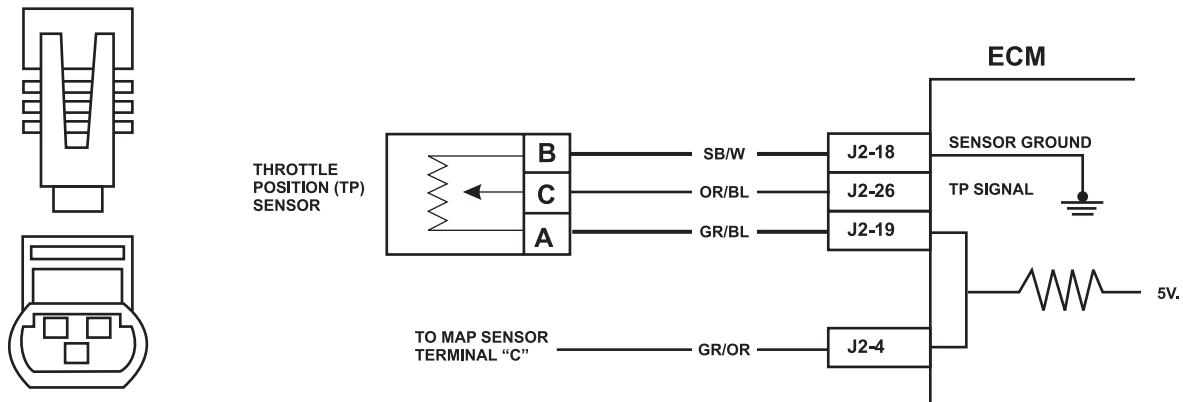
Check terminals at sensor for good contact. Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, properly clear the DTC.

DTC 21 - Throttle Position (TP) Sensor - Signal Voltage High

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Make sure throttle is closed. 3. Turn on ignition and choose appropriate display. Is voltage greater than 4.0 volts?	4.0 volts	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Remove connector at TP sensor. 3. Turn on ignition. Is voltage now .36 volts or lower?	.36 volts	Go to Step 3	Verify Repair
3	Turn ignition off. Connect a DVOM between harness terminal "A" and "B". Turn on ignition. Is voltage now 4.0 volts or higher?	4.0 volts	Verify Repair	Verify Repair

22716

DTC 22 - Throttle Position (TP) Sensor - Signal Voltage Low



DRC7499

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides voltage signal changes relative to the throttle blade. Signal voltage should vary from about 0.7 volts at idle to about 4.8 volts at WOT.

The TP sensor signal is one of the important inputs used by the ECM for fuel control and for IAC control.

ECM circuit J2-19 supplies 5.0 volts to terminal "A" of the TP sensor connector. ECM circuit J2-18 to terminal "B" is the TP sensor ground circuit. The TP sensor signal circuit, J2-26 to terminal "C", will send voltage back to the ECM relevant to throttle blade position.

Test Description

1. With throttle closed, TP sensor should read between 0.3 and 0.9 volts. If it does not, check the throttle cable adjustment or for bent or binding linkage.
2. Simulates a DTC 21. If the ECM recognizes the high signal voltage, the ECM and wiring are okay.
3. Checks 5 volt reference circuit. Also considers faulty connections and a failed ECM.

Diagnostic Aids

A scan tool reads throttle position in voltage and percentage of throttle blade opening. Voltage should increase at a steady rate as the throttle is opened.

If DTC 34 is also set, check for a short to ground in the circuit from ECM J2-19 and TP terminal "A".

If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

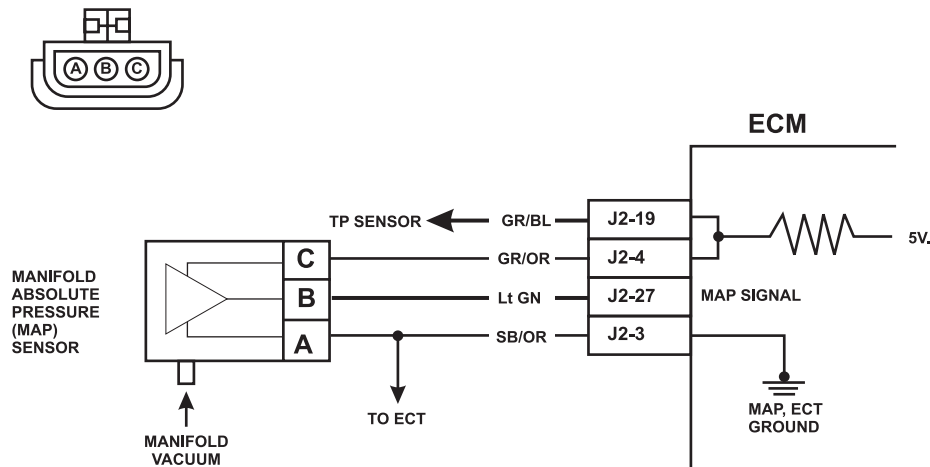
Check terminals at sensor for good contact. Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. After repairs, properly clear the DTC.

DTC 22 - Throttle Position (TP) Sensor - Signal Voltage Low

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Make sure throttle is closed. 3. Turn on ignition and choose appropriate display. Is voltage less than 0.36 volts?	0.36 volts	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Remove connector at TP sensor. 3. Jump together harness terminals "A" and "C". 4. Turn on ignition. Is voltage now 4.0 volts or higher?	4.0 volts	Verify Repair	Go to Step 3
3	1. Turn ignition off. 2. Connect a DVOM between harness terminal "A" and a good engine ground. 3. Turn on ignition. Is voltage now 4.0 volts or higher?	4.0 volts	Verify Repair	Verify Repair

22717

DTC 33 - Manifold Absolute Pressure (MAP) Sensor - Signal Voltage High



DRC7496

Circuit Description

The MAP sensor responds to changes in manifold pressure. The ECM receives this information as a signal voltage that will vary from about 1.0 - 1.5 volts at closed throttle (low manifold pressure) to 4.0 - 4.5 volts at wide open throttle (WOT - high manifold pressure).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

MAP sensor voltage of 5V is delivered from J2-4 to the MAP sensor connector terminal "C". J2-3 is the ground circuit for the MAP sensor "A" terminal. The MAP sensor "B" terminal will send voltage to terminal J2-27 of the ECM according to manifold pressure.

Test Description

1. Determines if there is an adequate vacuum supply to the MAP sensor. If the vacuum reading is erratic, refer to the "Rough or Unstable Idle" symptom.
2. Simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are okay.
3. Checks for an open in the sensor ground circuit.

Diagnostic Aids

If Code 14 is also set, check for an open ground circuit between J2-3 and MAP sensor terminal "A"

With ignition on and engine off, manifold pressure is equal to atmospheric pressure, and the signal voltage will be high. The ECM uses this information as an indication of altitude. Comparison of this barometric reading with a known good sensor is an accurate way to check the suspect sensor. Readings should be the same, ± 0.4 volts.

If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

After repairs, properly clear the DTC.

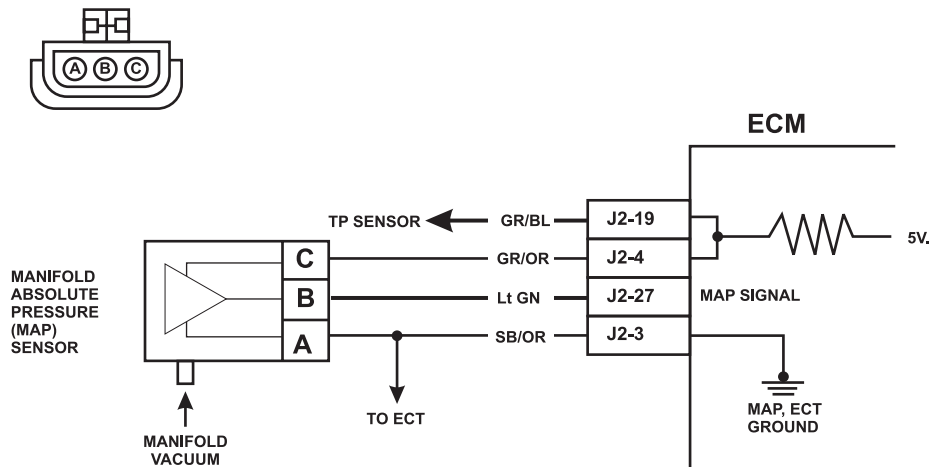
NOTE! If engine idle is rough or unstable, correct condition before continuing. Refer to *Symptoms Section*.

DTC 33 - Manifold Absolute Pressure (MAP) Sensor - Signal Voltage High

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Turn "ON" the ignition and choose appropriate display. 3. Install a vacuum gauge to a manifold vacuum source. 4. Start the engine and raise the engine speed to about 1000 RPM in neutral. The vacuum reading should be steady. Is the vacuum gauge reading steady and above 14 in. Hg. (45.5 kPa)? Allow engine to idle. If scan tool indicates MAP sensor voltage greater than 4 volts, go to STEP 2. If scan tool indicated voltage less than 4 volts, DTC 33 is intermittent, check for loose connections. Refer to <i>Diagnostic Aids</i> .	14 in. Hg. (45.5 kPa)	Go to Step 2	Verify Repair
2	1. Turn ignition "OFF". 2. Disconnect MAP sensor. 3. Turn ignition on but do not start the engine. Is sensor voltage less than 1.0 volt?	1.0 volt	Go to Step 3	Verify Repair
3	1. Turn off ignition. 2. Leave connector off at MAP sensor. 3. Connect DVOM to harness terminals "A" and "C". 4. Turn on ignition. Is sensor reading now above 4.0 volts?	4.0 volts	Verify Repair	Verify Repair

22718

DTC 34 - Manifold Absolute Pressure (MAP) Sensor - Signal Voltage Low



DRC7496

Circuit Description

The MAP sensor responds to changes in manifold pressure. The ECM receives this information as a signal voltage that will vary from about 1.0 - 1.5 volts at closed throttle (low manifold pressure) to 4.0 - 4.5 volts at wide open throttle (WOT - high manifold pressure).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

MAP sensor voltage of 5V is delivered from J2-4 to the MAP sensor connector terminal "C". J2-3 is the ground circuit for the MAP sensor "A" terminal. The MAP sensor "B" terminal will send voltage to terminal J2-27 of the ECM according to manifold pressure.

Test Description

1. Determines if there is an adequate vacuum supply to the MAP sensor. If the vacuum reading is erratic, refer to the "Rough or Unstable Idle" symptom.
2. Determines if DTC 34 is the result of a hard failure or an intermittent condition. A DTC will set when the MAP signal voltage is low when the engine is running.
3. Checks for 5v reference signal.

Diagnostic Aids

With ignition on and engine off, manifold pressure is equal to atmospheric pressure, and the signal voltage will be high. The ECM uses this information as an indication of altitude. Comparison of this barometric reading with a known good sensor is an accurate way to check the suspect sensor. Readings should be the same, ± 0.4 volts.

If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

After repairs, properly clear the DTC.

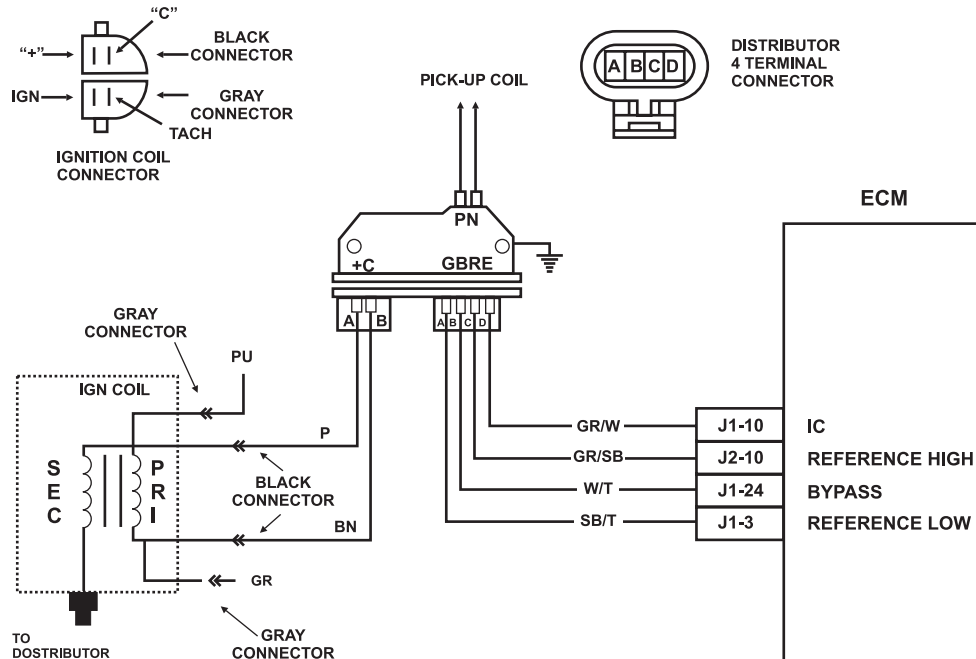
NOTE! If engine idle is rough or unstable, correct condition before continuing. Refer to *Symptoms* in Section 4A.

DTC 34 - Manifold Absolute Pressure (MAP) Sensor - Signal Voltage Low

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Turn on ignition and choose appropriate display. 3. Install a vacuum gauge to a manifold vacuum source. 4. Start the engine and raise the engine speed to about 1000 RPM in neutral. 5. The vacuum reading should be steady. Is the vacuum gauge reading steady and above 45.5 kPa. (14 in. Hg)? Allow engine to idle. If scan tool indicates MAP sensor voltage less than 1 volt, go to STEP 2. If scan tool indicated voltage more than 1 volt, DTC 34 is intermittent, check for loose connections. Refer to <i>Diagnostic Aids</i> .	45.5 kPa. (14 in. Hg.)	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Remove connector at MAP sensor. 3. Jump together harness terminals "B" and "C". 4. Turn on ignition. Is sensor reading now above 4.0 volts?	4.0 volts	Verify Repair	Go to Step 3
3	1. Turn off ignition. 2. Connect a DVOM between harness terminal "C" (circuit J2-4) and a good engine ground. 3. Turn on ignition. Is sensor reading now above 4.0 volts?	4.0 volts	Verify Repair	Verify Repair

22719

DTC 41 - Ignition Control (IC) - Open IC Circuit



DRC7497

Circuit Description

When the system is running in ignition module (Crank) mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see the IC line grounded during this mode. If not, it sets DTC 41 and will not go into IC mode.

When the RPM for IC Mode is reached (about 300 RPM), and bypass voltage is applied, the IC signal should no longer be grounded in the IC module. The IC voltage should be varying.

If the bypass line is open or shorted to ground, the IC module will not switch to IC Mode. The IC voltage will be low and DTC 42 will be set. If the IC line is grounded, IC module will switch to IC mode but, because the line is grounded, there will be no IC signal. A DTC 42 will be set.

Test Description

1. DTC 41 means the ECM has seen an open in the IC circuit. This test confirms DTC 41 and that the fault causing the DTC is present.
2. Checks for a normal ground path through the IC module.
3. Confirms that DTC 41 is a faulty ECM and not an intermittent problem in circuits J1-10 (terminal "D").

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- If engine starts and stalls, it may set a false DTC 41. Clear DTC and repair cause of stalling condition.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. Refer to "Intermittents" in *Symptoms* in Section 4A.

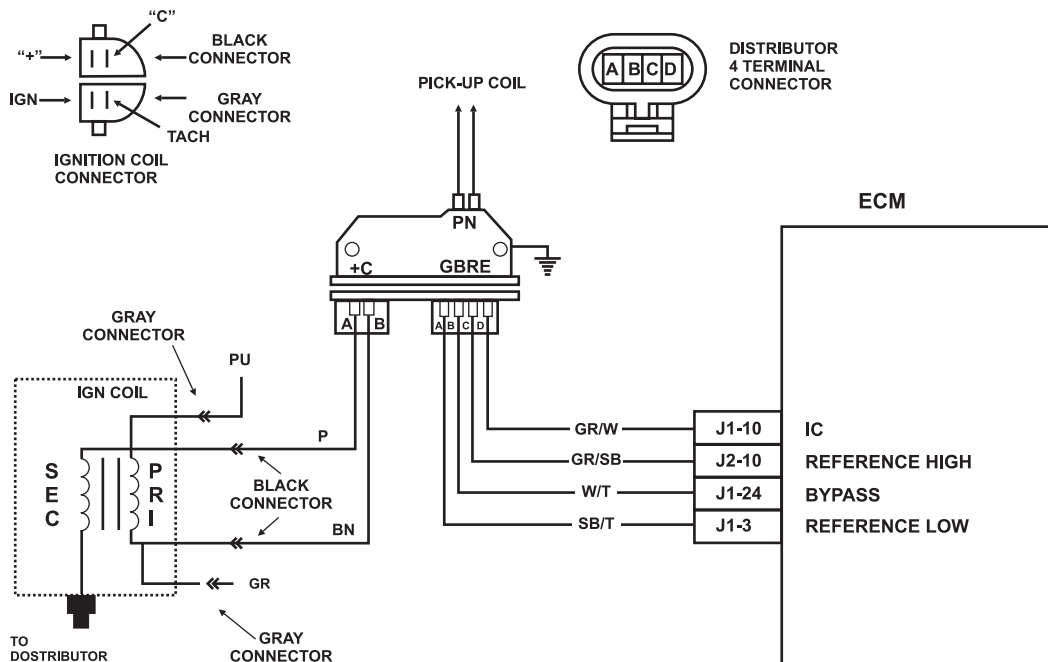
After repairs, properly clear the DTC.

DTC 41- Ignition Control (IC) - Open IC Circuit

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Clear DTC's. 3. Start and idle engine for two minutes, or until DTC sets. 4. Check codes. Is DTC 41 shown?	—	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Disconnect ECM J1 and J2 connectors. 3. Set DVOM to ohms scale. 4. Check IC circuit between ECM harness terminal J1-10 and engine ground. Does ohmmeter read 3000-6000 ohms?	3000-6000 ohms	Go to Step 3	Verify Repair
3	1. Reattach ECM J1 and J2 connectors. 2. Start and idle engine for two minutes or until DTC 41 is set. Is DTC 41 present?	4.0 volts	Verify Repair	Verify Repair

22720

DTC 42 - Ignition Control (IC) - Grounded IC Circuit, Open or Grounded Bypass



DRC7497

Circuit Description

When the system is running in ignition module (Crank) mode, there is no voltage on the bypass line, and the Ignition Control (IC) module grounds the IC signal. The ECM expects to see the IC line grounded during this mode. If not, it sets DTC 41 and will not go into IC mode.

When the RPM for IC Mode is reached (about 300 RPM), and bypass voltage is applied, the IC signal should no longer be grounded in the IC module. The IC voltage should be varying.

If the bypass line is open or shorted to ground, the IC module will not switch to IC Mode. The IC voltage will be low and DTC 42 will be set. If the IC line is grounded, the IC module will switch to IC mode but, because the line is grounded, there will be no IC signal. A DTC 42 will be set.

Test Description

1. DTC 42 means the ECM has seen an open or short to ground in the bypass circuit or a short to ground in the IC circuit. This test confirms DTC 42 and that the fault causing the DTC is present.
2. Checks for a normal ground through the IC module. If the circuit from J1-10 to module terminal "D" is shorted to ground will read less than 3000 ohms.

3. As test light voltage touches the bypass circuit terminal (J1-24), the module should switch, causing the DVOM reading to go from over 3000 ohms to under 1000 ohms. The important thing is that the module "switched".
4. If the module did not switch, this step checks for an open or shorted to ground bypass circuit J1-24, or a faulty IC module or connection.
5. Confirms that DTC 42 is a faulty IC module and not an intermittent IC or bypass circuit.
6. Confirms that DTC 42 is a faulty IC module and not an intermittent IC or bypass circuit.

Diagnostic Aids

If engine starts and stalls, it may set a false DTC 41. Clear DTC and repair cause of stalling condition.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness. Refer to "Intermittents" in *Symptoms* in Section 4A.

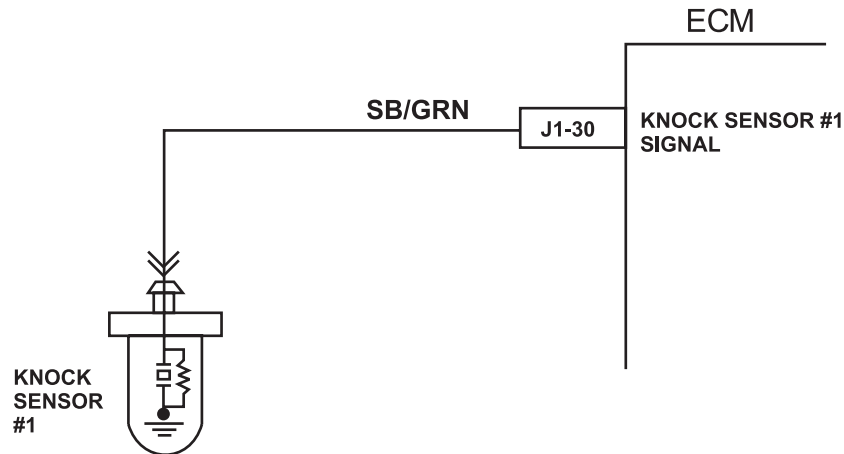
After repairs, properly clear the DTC.

DTC 42 - Ignition Control (IC) - Grounded IC Circuit, Open or Grounded Bypass

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Clear DTC's. 3. Start and idle engine for two minutes, or until DTC sets. 4. Check codes. Is DTC 42 shown?	—	Go to Step 2	Verify Repair
2	1. Turn off ignition. 2. Disconnect ECM J1 and J2 connectors. 3. Set DVOM to ohms scale. 4. Check IC circuit between ECM harness terminal J1-10 and engine ground. Does ohmmeter read 3000 - 6000 ohms?	3000-6000 ohms	Go to Step 3	Verify Repair
3	1. Leave ohmmeter connected as in Step 2. 2. Attach a test light to a B+ source. 3. Probe bypass terminal J1-24 with test light. Does resistance reading drop from over 3000 ohms to under 1000 ohms as tester makes contact?	>1000 ohms	Go to Step 4	Go to Step 5
4	1. Reattach ECM J1 and J2 connectors. 2. Start and idle engine for two minutes or until DTC 42 is set. Is DTC 42 present?	—	Verify Repair	Verify Repair
5	1. Attach test light to a B+ source. 2. Probe ECM harness bypass terminal J1-24. Does test light come on?	—	Go to Step 6	Verify Repair
6	Disconnect 4-way connector at IC module. Does test light illuminate brightly?	—	Verify Repair	Verify Repair

22721

DTC 44 - Knock Sensor (KS) - System Inactive



22722

Circuit Description

The ECM uses the Knock Sensor in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit.

Test Description

1. This test ensures the Knock Sensor is secured properly in the engine block.
2. Determines if mechanical noise or the knock sensor are at fault. Check to see that Knock Sensor circuit is within specifications.

Diagnostic Aids

If KS sensor wiring is routed too close to secondary ignition wire, the ECM may see the interference as a knock signal, resulting in false timing retard.

Any circuitry that is suspected of causing the intermittent complaint should be thoroughly checked for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, poor terminal-to-wiring connections, corroded terminals and/or wiring, or physical damage to the wiring harness.

After repairs, properly clear the DTC.

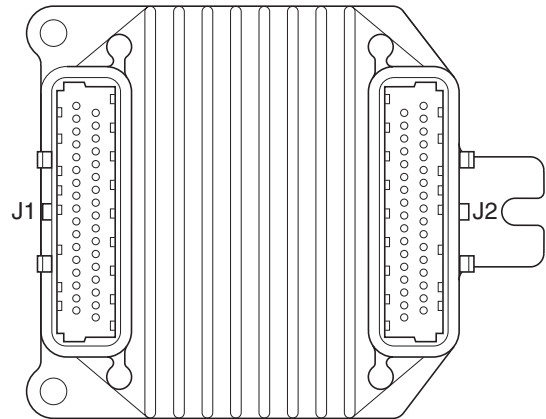
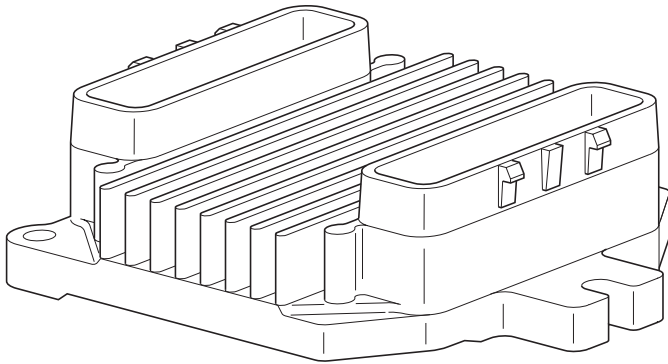
NOTE! Repair any engine mechanical problems that could introduce a knocking noise into the engine. The KS sensor can pick-up mechanical engine noise that the ECM will interpret an engine detonation. Engine timing and fuel quality should also be verified.

DTC 44 - Knock Sensor (KS) - System Inactive

Step	Action	Value	Yes	No
1	1. Check all sensors for proper seating in the engine block. 2. Verify all electrical connections are secure. Were any sensors or connectors found loose?	—	Verify Repair	Go to Step 2
2	1. Attach scan tool to diagnostic connector. 2. Turn on ignition and choose appropriate display. 3. Disconnect the J1 connector. If KS 1 is indicating a fault, connect a DVOM to J1-30 and a known good engine ground near the sensor. If KS 2 is indicating a fault, connect a DVOM to J1-14 and a known good engine ground near that sensor. Is resistance between the 85,000 and 100,000 ohms?	85,000-100,000 ohms	Verify Repair	Verify Repair

22723

DTC 51 - ECM Calibration Memory Failure



DRC7452

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibrations, or changes to these calibrations, that may alter the designed function of the EFI system.

Test Description

1. Checks to see if the fault is present during diagnosis.
If present, the ECM is not functioning correctly and must be replaced.

NOTE! Engines with this failure must have the ECM replaced with a factory programmed ECM for your specific application.

Diagnostic Aids

An intermittent DTC 51 may be caused by a bad cell in the EEPROM that is sensitive to temperature changes. If DTC 51 occurred more than once, but is intermittent, replace the ECM.

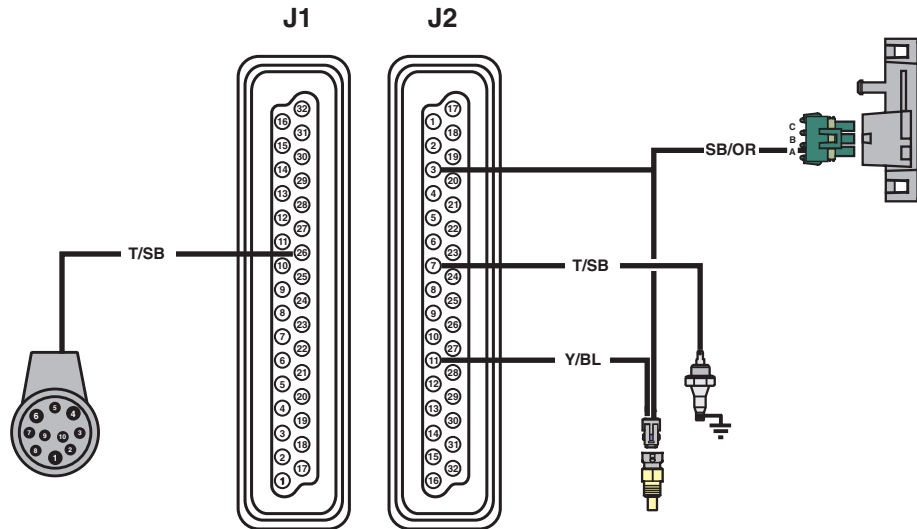
After repairs, properly clear the DTC.

DTC 51 - ECM Calibration Memory Failure

Step	Action	Value	Yes	No
1	1. Attach scan tool to diagnostic connector. 2. Turn on ignition and choose appropriate display. 3. Clear DTC's. Does DTC 51 reset?	—	Reprogram or replace ECM	Verify Repair

22724

Engine Protection Mode Circuit



DRC7543

Circuit Description

Three grounding type switches and one thermistor detect conditions critical to engine longevity:

- a water temperature thermistor (engine overheat)
- two temperature switches (exhaust overheat)
- an oil pressure switch (loss of pressure)

When closed, the ECM responds by entering *ENGINE PROTECTION MODE*. A warning horn will also sound.

This engine protection feature disables half the fuel injectors above 2500 RPM. If engine speed drops back to 1200 RPM, the system will reset and allow normal operation. Should the overheat or loss of oil pressure condition still exist, *ENGINE PROTECTION MODE* will again activate if engine speed exceeds 2500 RPM.

Test Description

1. Determines if warning horn is activated by ECM or if horn lead is grounded.
2. Determines if oil pressure or exhaust temperature switches are causing the problem.
3. Determines if ECT sensor is cause of problem.
4. Checks oil pressure J2-7 for an open circuit.
5. Checks oil pressure J2-7 for a grounded circuit.
6. Checks ECT sensor J2-3 for an open circuit.
7. Checks ECT sensor J2-3 for a grounded circuit.
8. Checks MAP sensor J2-3 for a grounded circuit. Replace ECM if problem is not located in previous tests.
9. Check of warning horn circuit.

Diagnostic Aids

- Check engine crankcase oil level, add oil as necessary.
- See **Cooling System** section of **Engine** service manual for possible overheat causes.
- See appropriate engine section of **Engine** service manual for possible causes of loss of oil pressure.

If above diagnostics were performed, and no change in performance was made, refer to *Symptoms Section*.

An intermittent problem may be caused by a poor or corroded connection, a worn-through wire, a wire that's broken inside the insulation, or a defective switch.

Engine Protection Mode Circuit

Step	Action	Value	Yes	No
1	1. Turn ignition off. 2. Remove connector at oil pressure switch. 3. Turn ignition on. If equipped, does audible warning horn sound? If not equipped, go to STEP 2.	—	Go to Step 9	Go to Step 2
2	1. Turn ignition off. 2. Leave oil pressure switch disconnected. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ?	—	Go to Step 3	Verify Repair
3	1. Turn ignition off. 2. Remove connector at ECT sensor. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ? NOTE: ECT sensor serves a dual function; it provides water temperature data to ECM for spark / fuel control, and warns of engine overheat to activate <i>Engine Protection Mode</i> circuit.	—	Go to Step 4	Verify Repair
4	1. Turn ignition off. 2. Remove J2 connector at ECM. 3. Using a DVOM, check resistance from terminal J2-7 to oil pressure switch connector terminal. Does ohmmeter read at or near zero (0)?	0	Go to Step 5	Verify Repair
5	1. Check resistance between ECM terminal J2-7 and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 6	Verify Repair
6	1. Using a DVOM, check resistance from terminal J2-3 to ECT connector terminal "A". Does ohmmeter read at or near zero (0)?	0	Go to Step 7	Verify Repair
7	1. Check resistance between ECT connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 8	Verify Repair
8	1. Remove connector at MAP sensor. 2. Check resistance between MAP connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Verify Repair	Verify Repair
9	1. Check of warning horn circuit only (engine otherwise responds correctly to Engine Protection Mode conditions). 2. Turn ignition off. Remove J2 connector at ECM. 3. Disconnect 10-way engine cable connector. 4. Using a DVOM, check circuit between J2-12 and Pin 4 for opens and grounds. Does circuit pass both tests?	—	Verify Repair	Verify Repair

Notes

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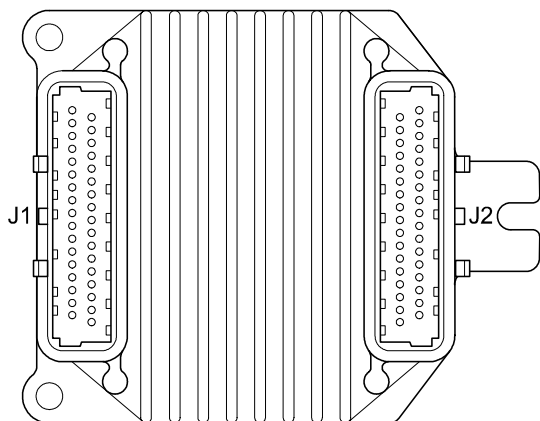
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Engine Control Module (ECM)

The engine control module (ECM) of the **Marine Electronic Fuel Injection** system generation **4 (MEFI 4)** is designed to maintain exhaust emission levels while maintaining excellent drivability and fuel efficiency. The ECM controls the following conditions:

- The fuel control
- The ignition control (IC)
- The knock sensor (KS) system
- The idle air control (IAC)
- Various other discrete outputs

Engine Control Module (ECM)



22508

Engine Control Module (ECM)

The engine control module (ECM) is the control center of the engine and controls the following systems:

- The fuel metering system
- The ignition timing
- The on-board diagnostics

The ECM constantly monitors the information from various sensors and controls the systems that affect vessel performance and emissions. The ECM also performs the diagnostic functions for those systems. The ECM can recognize operational problems and alert the operator through the malfunction indicator lamp (MIL) when a malfunction has occurred. When a malfunction is detected, the ECM stores a diagnostic trouble code (DTC) or a logged warning which helps to identify problem areas. This is done to aid the technician in making repairs.

The ECM supplies either 5.0 or 12.0 volts to power various sensors and switches. This is done through

resistance in the ECM. The resistance is so high in value that a test lamp does not illuminate when connected to the circuit. In some cases, even an ordinary shop voltmeter does not give an accurate reading because the voltmeter's resistance is too low. Therefore, a DMM with a minimum of 10 megaohms input impedance is required to ensure accurate voltage readings.

The ECM controls output circuits such as the fuel injectors, ignition coils, the idle air control (IAC) and various relays by controlling the ground or power feed circuit through transistors or a device called an output driver module (ODM).

RPM Reduction Mode

RPM reduction mode is a function of the ECM that reduces engine power under certain conditions. RPM reduction will disable one fuel injector driver when the engine speed goes above a certain RPM and enable the fuel injector driver when the engine speed drops below a certain RPM. RPM reduction may be active for the following conditions:

- Engine coolant temperature too high
- Low oil pressure
- High exhaust riser temperature

ECM Function

The ECM supplies a buffered voltage to various sensors and switches. The ECM controls most components with electronic switches which complete a ground circuit when turned ON.

Input Components

The ECM monitors the input components for circuit continuity and out-of-range values. This includes performance checking. Performance checking refers to indicating a fault when the signal from a sensor does not seem reasonable, such as a throttle position (TP) sensor that indicates high throttle position at low engine loads or MAP voltage. The input components may include, but are not limited to, the following sensors:

- Manifold air temperature (MAT) sensor (8.1 Only)
- Crankshaft position (CKP) sensor
- Camshaft position (CMP) sensor
- Knock sensor (KS)
- Throttle position (TP) sensor
- Engine coolant temperature (ECT) sensor
- Manifold absolute pressure (MAP) sensor
- Exhaust Temperature Sensors

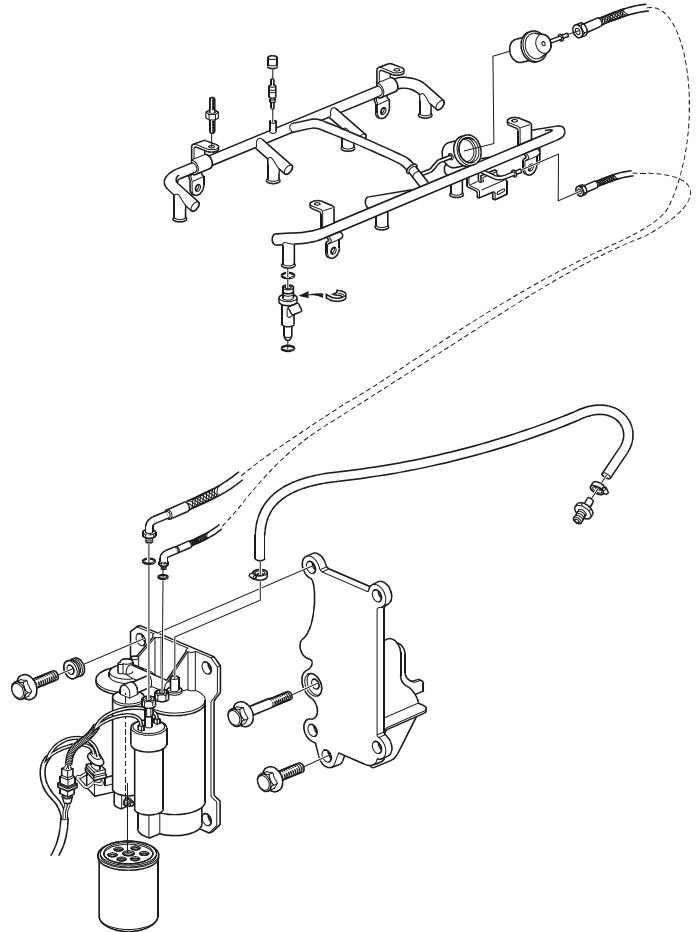
Output Components

Diagnose the output components for the proper response to ECM commands. Components where functional monitoring is not feasible, will be monitored for circuit continuity and out-of-range values, if applicable.

Output components to be monitored include, but are not limited to, the following circuits:

- The malfunction indicator lamp (MIL) control
- The buzzer control

Fuel System



22509

The fuel tank stores the fuel supply. The low pressure fuel pump contained in the Fuel Cell draws fuel through a replaceable fuel filter mounted on the fuel cell. It then sends the filtered fuel into a cooling/venting/chamber where the fuel is cooled and any vapor is vented to the intake manifold for burning in the combustion process. Any fuel that is not demanded by the high pressure pump is re-circulated through the cooling/venting chamber. The high pressure pump, which is integral to the fuel cell, then draws fuel from the cooling/venting chamber and supplies fuel at a pressure more than is needed by the injectors. The fuel pressure regulator, part of the fuel rail assembly, keeps fuel available to the fuel injectors at a regulated pressure. A separate pipe returns unused fuel to the fuel cell cooling/venting chamber. The engine control module (ECM) controls the electric fuel pumps operation through a fuel pump relay.

Important! The fuel cell is NOT serviceable. In the unlikely event that a fuel pump fails, the entire fuel cell must be replaced.

Fuel Feed and Return Pipes

The fuel feed pipe carries fuel from the fuel tank to the fuel rail assembly. The fuel return pipe carries unused fuel from the fuel rail assembly back to the fuel tank.

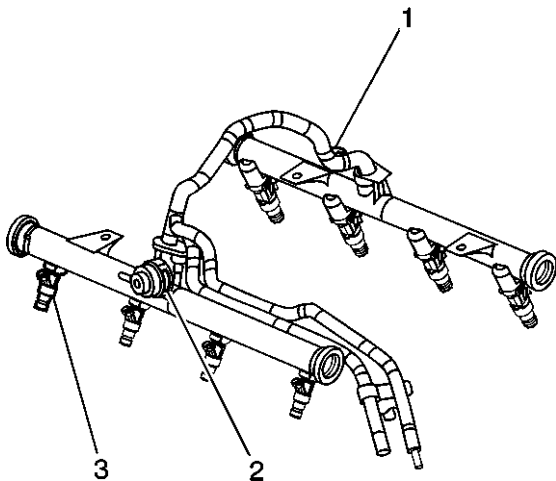
Quick-Connect Fittings

Quick-Connect fittings provide a simplified means of installing and connecting fuel system components. The fittings consists 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

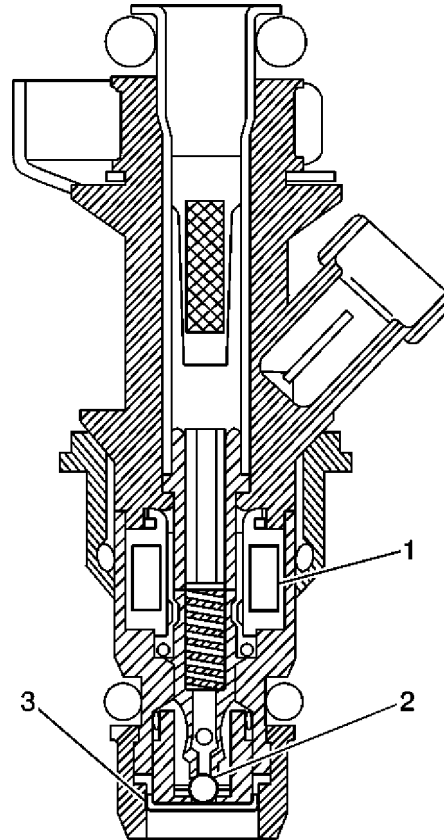


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The fuel rail assembly attaches to the engine intake manifold. The fuel rail assembly performs the following functions:

- Positions the injectors (3) in the intake manifold
- Distributes fuel evenly to the injectors
- Integrates the fuel pressure regulator (2) with the fuel metering system

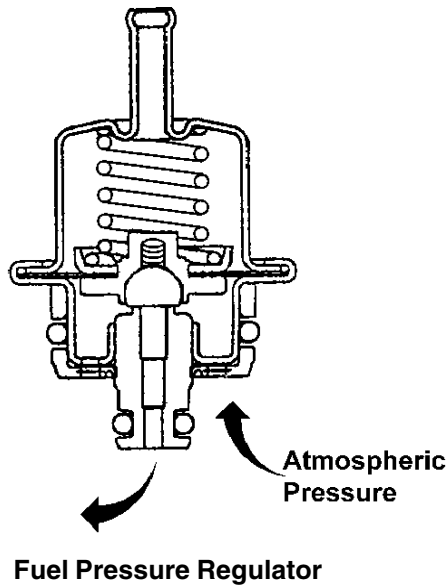
Fuel Injectors



351198

The Multec 2 fuel injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM energizes the high-impedance (12.2 ohms) injector solenoid (1) to open a normally closed ball valve (2). This allows fuel to flow into the top of the injector, past the ball valve and through a director plate (3) at the injector outlet. The director plate has four 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 it to become further atomized and vaporized before entering the combustion chamber. An injector stuck partly open can cause a loss of pressure after engine shutdown. Consequently, long engine cranking times would be noticed on some engines.

Fuel Pressure Regulator Assembly



69059

The fuel pressure regulator is a vacuum operated diaphragm relief valve with fuel pump pressure on one side and regulator spring pressure and intake manifold vacuum on the other side. The fuel pressure regulator maintains a constant pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as the engine vacuum drops.

Fuel Metering Modes of Operation

The engine control module (ECM) reads voltages from several sensors in order to determine how much fuel to give the engine. The fuel is delivered under one of several conditions called modes. The ECM controls all modes.

Starting Mode

With the ignition switch in the ON position, before engaging the starter, the ECM energizes the fuel pump relay for 2 seconds allowing the fuel pumps to build up pressure. The ECM uses the engine coolant temperature (ECT), the throttle position (TP) and the manifold absolute pressure (MAP) sensors to determine the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing the pulse width of the injectors. This is done by pulsing the injectors for very short times.

Clear Flood Mode

If the engine floods, clear the engine by opening the throttle plates to 100 percent. When the throttle position (TP) sensor is at wide open throttle, the ECM reduces the 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

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.

Specified values for the above conditions exist for each different engine, and are stored in the electrically erasable programmable read-only memory (EEPROM).

Acceleration Mode

When the operator moves the throttle, air flow into the cylinders increases rapidly, while fuel flow tends to lag behind. To prevent possible hesitation, the ECM increases the pulse width to the injectors to provide extra fuel during acceleration. The ECM determines the amount of fuel required based upon the throttle position, the coolant temperature, the manifold pressure and the engine speed.

Deceleration Mode

When the operator retards the throttle, air flow into the engine is reduced. The ECM reads the corresponding changes in throttle position and manifold pressure. The ECM shuts OFF fuel completely if the deceleration is very rapid, or for long periods.

Battery 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 engine from damage and improve drivability:

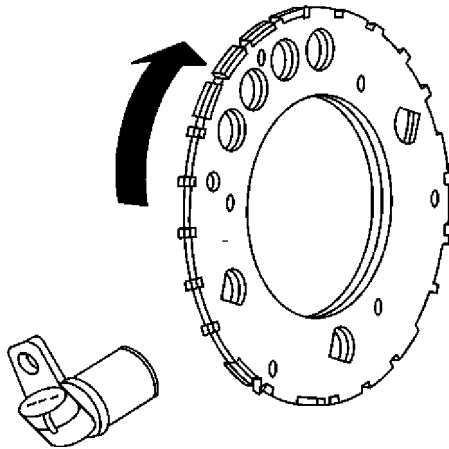
- The ignition is OFF. This prevents engine run-on.
- The ignition is ON but there is no ignition reference signal. This prevents flooding or backfiring.
- Engine speed is too high, above rev limit.

Electronic Ignition (EI) System

The ignition system consists of the following components or circuits:

- The 8 ignition secondary wires
- The 8 ignition coils
- The 8 ignition control (IC) circuits
- The camshaft position (CMP) sensor
- The camshaft reluctor wheel
- The crankshaft position (CKP) sensor
- The crankshaft reluctor wheel
- The related connecting wires
- The engine control module (ECM)

Crankshaft Position (CKP) Sensor and Reluctor Wheel



Crankshaft and Camshaft Position Sensor

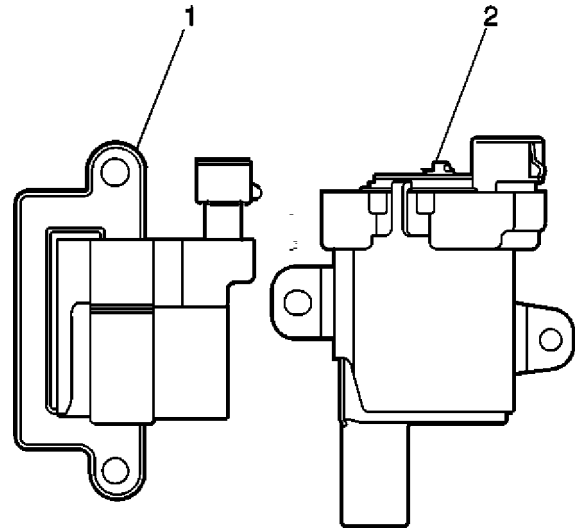
65872

The crankshaft position (CKP) sensor is a magneto resistive type sensor. The CKP sensor works in conjunction with a 24X reluctor wheel. The reluctor wheel is mounted on the rear of the crankshaft. The 24X reluctor wheel uses 2 different width notches that are 15 degrees apart. This pulse width encoded pattern allows cylinder position identification within 90 degrees of crankshaft rotation. In some cases, this can be achieved within 45 degrees of crankshaft rotation. The reluctor wheel also has dual track notches that are 180 degrees out of phase. This design allows for quicker starts and accuracy. The CKP sensor also outputs a 4X signal for spark control, tachometer output and fuel control. All CKP signals are output as a digital waveform.

Camshaft Position (CMP) Sensor and Reluctor Wheel

The camshaft position (CMP) sensor works in conjunction with a 1X reluctor wheel mounted at the front of the camshaft. The CMP is used to determine the top dead center position of cylinder #1, and will synchronize with the 24X CKP sensor signal for quicker starting. The CMP signals are output as a digital waveform.

Ignition Coils



Ignition Coils

260177

The ignition system on this engine features a multiple coil configuration and is known as coil near plug. There are two styles of ignition coil assemblies (1, 2). The engine could have either style. The ignition coil mounting bracket is attached to the rocker cover.

The 8 ignition coils are individually mounted above each cylinder on the rocker covers, the coils are fired sequentially. There is an ignition control (IC) circuit for each ignition coil. The 8 ignition control circuits are connected to the ECM. The ECM triggers each ignition coil individually and makes all timing decisions. The ignition coils are supplied with the following circuits:

- The ignition voltage circuit
- The ignition control circuit
- The ground circuit
- The reference low circuit

The ignition voltage circuits also supply the power for the fuel injectors. Each coil is serviced separately.

This system puts out very high ignition energy for plug firing. Less energy is lost to ignition wire resistance because the ignition wires are much shorter than in a conventional ignition system.

A diagnostic trouble code (DTC) may set for the following conditions or faults:

- The ECM malfunctions in a manner which will not allow the ECM to run a diagnostic of the KS circuit.
- The KS signal is within the assigned voltage range.
- The KS signal is not present.
- The ECM is unable to eliminate the knocking condition using maximum spark retard.

Circuits Affecting Ignition Control

To properly control ignition timing, the ECM relies on the following information:

- The engine load, manifold pressure or vacuum
- The atmospheric, barometric, pressure
- The engine temperature
- The manifold air temperature, if applicable
- The crankshaft position
- The engine speed (RPM)

The ignition control (IC) system consists of the following components:

- The ignition coils
- The 24X crankshaft position sensor
- The engine control module (ECM)
- All connecting wires

The ignition control utilizes the following to control spark timing functions:

- The 24X signal - The 24X crankshaft position sensor sends a signal to the ECM. The ECM uses this signal to determine crankshaft position.
- The ignition control (IC) circuits - The ECM uses these circuits to trigger the ignition coils.

Noteworthy Ignition Information

There are important considerations to point out when servicing the ignition system. The following noteworthy information will list some of these to help the technician in servicing the ignition system.

- The ignition coils secondary voltage output capabilities are very high - more than 40,000 volts. Avoid body contact with ignition high voltage secondary components when the engine is running or personal injury may result.
- The 24X crankshaft position (CKP) sensor is the most critical part of the ignition system. If the sensor is damaged so that the pulses are not generated, the engine does not start.
- The CKP sensor clearance is very important. If the interrupter ring is bent or damaged in any way, the CKP sensor may be destroyed. Extreme care must be exercised during removal and installation procedures.
- The ignition timing is not adjustable. There are no timing marks on the crankshaft balancer or the timing chain cover.
- Be careful not to damage the secondary ignition wires or boots when servicing the ignition system. Rotate each boot in order to dislodge the boot from the plug or coil tower before pulling the boot from the spark plug or the ignition coil tower.

Engine Control Module (ECM)

The ECM is responsible for maintaining proper spark and fuel injection timing for all operating conditions. To provide optimum operation and emissions, the ECM monitors input signals from the additional following components in calculating ignition control (IC) spark timing:

- The engine coolant temperature (ECT) sensor
- The manifold air temperature (MAT) sensor
- The throttle position (TP) sensor

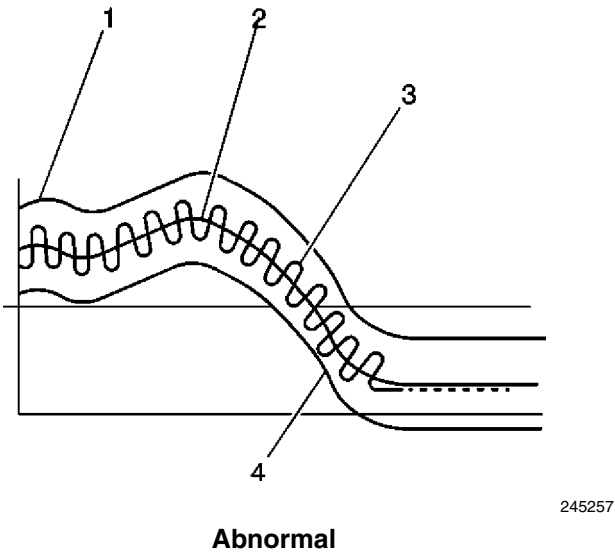
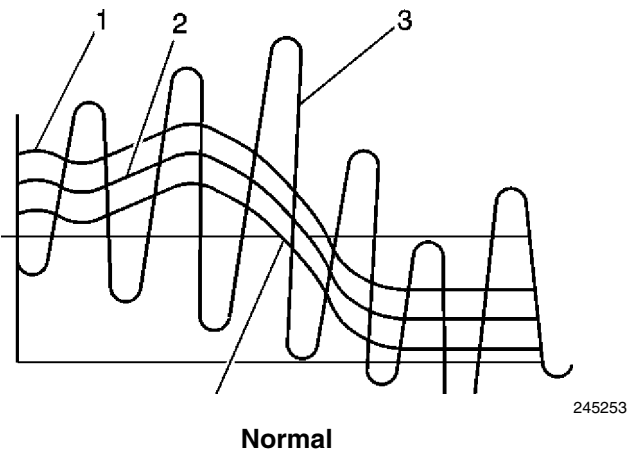
Knock Sensor (KS) System

Purpose

To control spark knock (detonation), a knock sensor (KS) system is used. This system is designed to retard spark timing when excessive spark knock is detected in the engine. The KS system allows the engine to use maximum spark advance for optimal drivability and fuel economy under all operating conditions.

Operation

The ECM uses a knock sensor(s) to detect abnormal vibration in the engine (detonation/spark knock). Mounted on the engine block, the knock sensor(s) produces an AC voltage signal at all engine speeds and loads. The ECM then adjusts the spark timing based on the amplitude and frequency of the KS signal. The ECM uses the KS signal to calculate an average voltage. Then, the ECM assigns a voltage range above and below the average voltage value. The ECM checks the KS and related wiring by comparing the actual knock signal to the assigned voltage range. A normal KS signal should vary outside the assigned voltage range as shown in the NORMAL KS figure. If the ECM detects a KS signal within the assigned voltage range as shown in the ABNORMAL KS figure, the applicable DTC will set.



Knock Sensor Signal

- 1. Upper fail region
- 2. Knock sensor calculated average
- 3. Knock sensor signal
- 4. Lower fail region

Contents

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Engine Control Module (ECM)

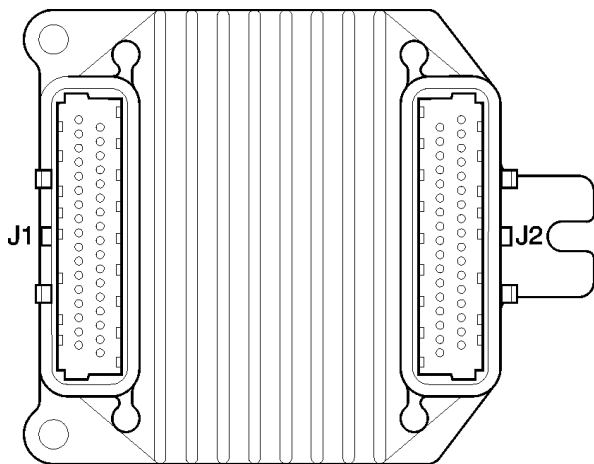
⚠ Caution!

When replacing the ECM, the ignition must be "OFF" and the battery disconnected before disconnecting or reconnecting the ECM "J1" and "J2" connectors to prevent internal damage to the ECM.

⚠ Caution!

To prevent possible electrostatic discharge damage to the ECM, do not touch the connector pins. The ECM is an electrical component. Do Not soak in any liquid cleaner or solvent, as damage may result.

Removal



MEFI4332

1. Disconnect the negative battery cable.
2. Disconnect the "J1" and "J2" connectors from ECM.
3. Remove the three ECM mounting screws.
4. Remove the ECM from mounting bracket.

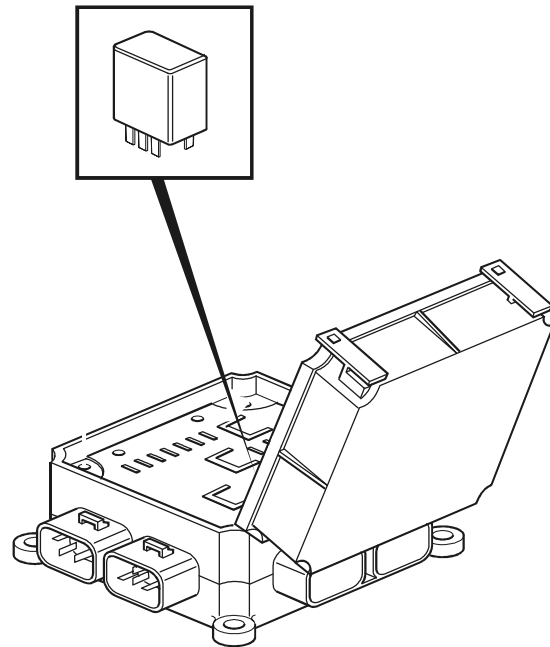
Installation

Important: Make sure the new ECM has the same part number and service number as the old ECM, to ensure proper engine performance.

1. Install the new ECM to the mounting bracket.
2. Install the three ECM mounting screws. Tighten the screw to 10-14 N•m (88-124 lb in).
3. Reconnect the "J1" and "J2" connectors to the ECM.
4. Reconnect the negative battery cable.

System/Ignition Relay

Removal



MEFI4337A

1. Turn the ignition OFF.
2. Open the cover.
3. Remove the system/ignition relay from the socket.

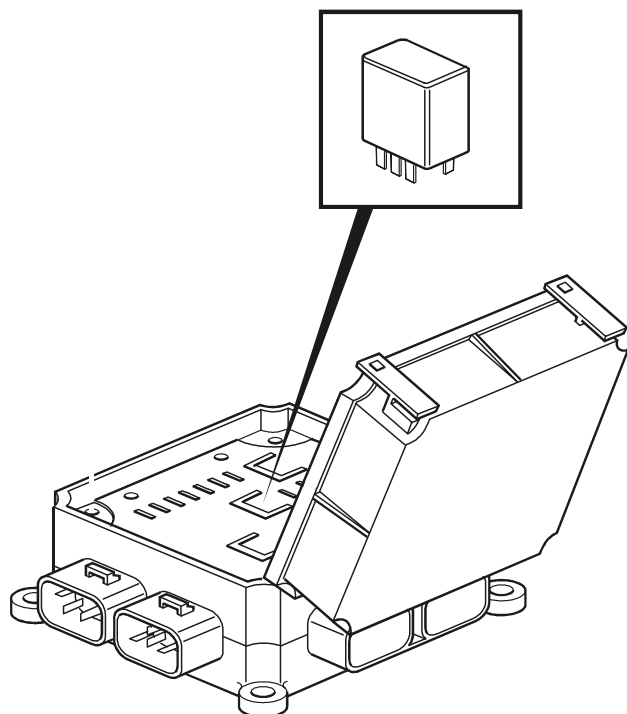
Important: The system relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation

1. Install the system relay in the socket.
2. Close the cover.

Fuel Pump Relay

Removal



MEFI4337B

1. Turn the ignition OFF.
2. Open the cover.
3. Remove the fuel pump relay from the socket.

⚠ Caution!

The fuel pump relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation

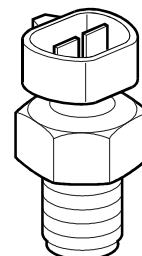
1. Install the fuel pump relay.
2. Close the cover.

Engine Coolant Temperature (ECT) Sensor

⚠ Caution!

Care must be taken when handling the ECT sensor. Damage to the sensor will affect proper operation of the EFI system.

Removal



MEFI4333

1. Turn OFF the ignition.
2. Drain the cooling system below the level of the ECT sensor.
3. Disconnect the ECT electrical connector.
4. Remove the ECT sensor.

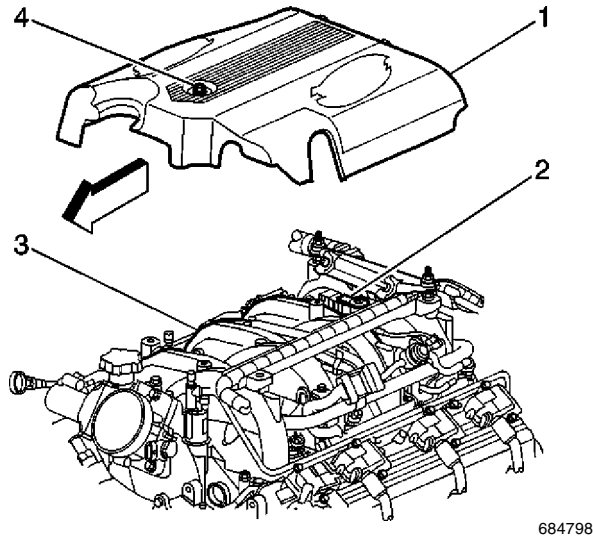
Installation

Important: Coat ECT sensor threads with Teflon® tape sealant prior to installation.

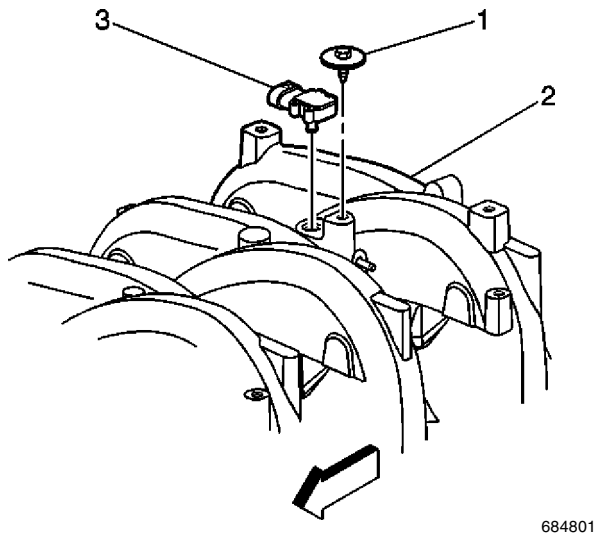
1. Install the ECT sensor. Tighten the ECT sensor to 20 N•m (15 lb ft).
2. Reconnect the ECT electrical connector.
3. Refill the cooling system.

Manifold Absolute Pressure (MAP) Sensor

Removal



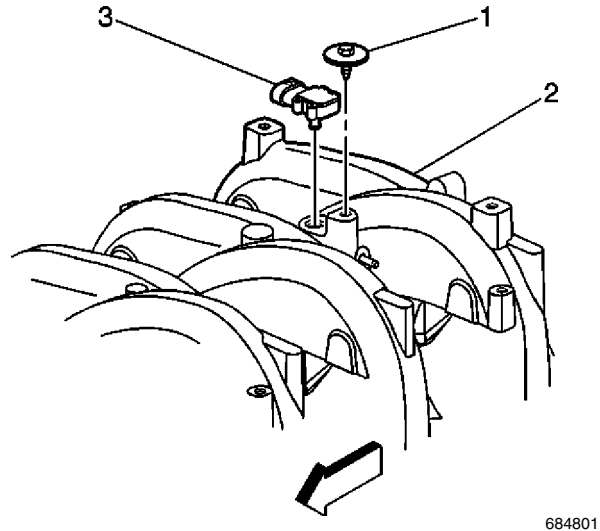
1. Loosen the fastener (4) from the intake manifold engine cover.
2. Remove the engine cover (1) from the intake manifold (3).
3. Disconnect the manifold absolute pressure (MAP) sensor electrical connector (2).



4. Remove the MAP sensor retaining bolt and washer (1).
5. Remove the MAP sensor (3) from the intake manifold (2).
6. Inspect the MAP sensor seal for wear or damage and replace as necessary.

Installation

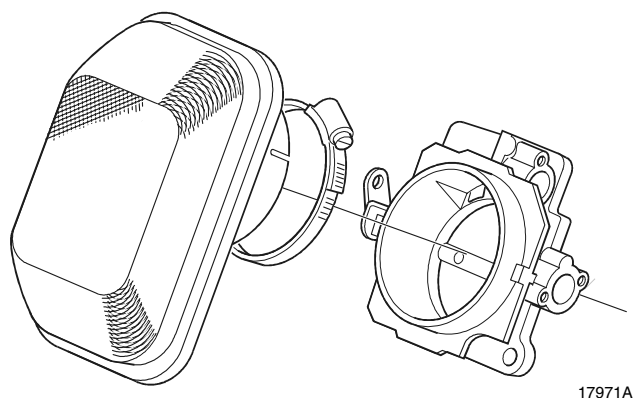
Important: Lightly coat the MAP sensor seal with motor oil before installing the sensor. The lubricant should be applied with a sponge or brush. To prevent blockage, avoid dipping the sensor port directly into the lubricant.



1. Install the MAP sensor (3).
2. Install the MAP sensor retaining bolt and washer (1). Tighten the MAP sensor retaining bolt to 12 N•m (106 lb. in.).
3. Connect the MAP sensor electrical connector (2).
4. Install the intake manifold engine cover (1). Tighten the engine cover fastener to 10 N•m (89 lb in.).

Flame Arrestor

Removal



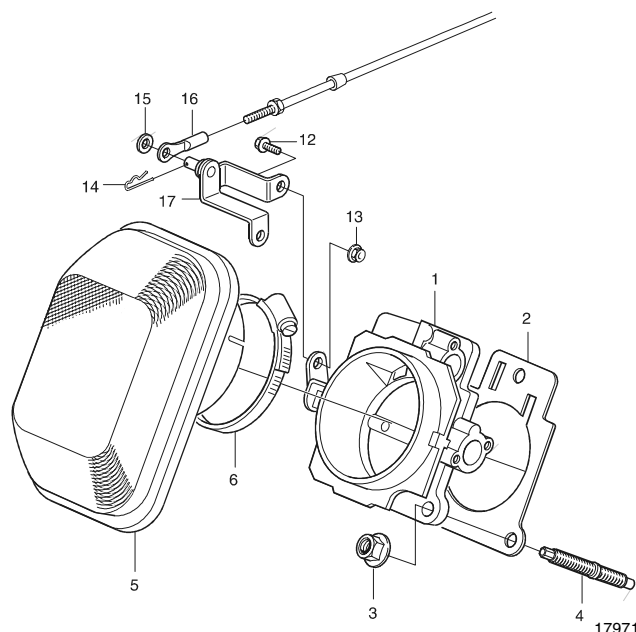
1. Turn ignition OFF.
 2. Disconnect MAT sensor harness connector.
 3. Loosen the flame arrestor element retaining clamp.
 4. Remove the flame arrestor element.
- Important:** Inspect the flame arrestor for dust, dirt or damage. Replace if required.

Installation

1. Install the flame arrestor element to the throttle body.
2. Tighten the flame arrestor retaining clamp to flame arrestor element.
3. Reconnect the MAT sensor harness connector.

Throttle Body Assembly

Removal



1. Disconnect the negative battery cable.
2. Disconnect the MAT sensor harness connector
3. Remove the flame arrestor (if applicable).
4. Disconnect the electrical connectors from the IAC and TP sensor.
4. Disconnect the throttle linkage.
6. Remove the throttle body assembly attaching nuts.
7. Remove the throttle body assembly and gasket.
8. Discard the gasket.

⚠ Caution!

To o prevent damage to the throttle valve, it is essential that the unit be placed on a holding fixture before performing service.

Important: Stuff a rag in the intake manifold opening to prevent foreign material from entering the engine while throttle body is removed.

Inspect

- Manifold bore for loose parts and foreign material.
- Manifold mating surface for cleanliness or burrs that could affect gasket sealing.

Important: Clean the throttle bore and valve deposits using carburetor cleaner and a parts cleaning brush. Do Not use a cleaner that contains methyl ethyl ketone (MEK), an extremely strong solvent, and not necessary for this type of deposit.

The throttle body metal parts may be cleaned in a cold, immersion type cleaner following the disassembly of the unit.

Caution!

The TP sensor and IAC valve should not come in contact with solvent or cleaner, as they may be damaged. These components must be removed before immersion. Follow the procedures outlined in this section.

Warning!

Safety glasses must be worn when using compressed air, as flying dirt particles may cause eye injury.

- Clean all metal parts thoroughly and blow dry with compressed air. Be sure that all fuel and air passages are free of dirt and burrs.
- Inspect the mating surfaces for damage that could affect gasket sealing.
- Inspect throttle body for cracks in casting.
- Use Loctite® 262 or equivalent when thread locking is required.

Caution!

When pre-coating the mounting bolts, do not use a higher strength locking compound than recommended. This may cause the removal of the bolts to be very difficult.

Installation

1. Install a new throttle body gasket.
2. Install the throttle body assembly and the throttle body assembly attaching nuts. Tighten the throttle body assembly attaching nuts to 10 N•m (89 lb in).
3. Reconnect the throttle linkage.
4. Reconnect the electrical connectors to the IAC valve and the TP sensor.
5. Install the flame arrestor and reconnect the MAT sensor harness connector.
6. Reconnect the negative battery cable.

Fuel Pressure Relief Procedure

⚠ Caution!

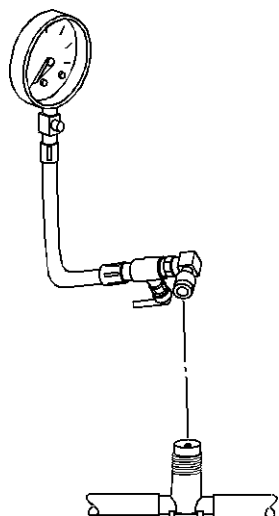
To reduce the risk of fire and personal injury, relieve fuel system pressure before servicing fuel system components. After relieving fuel pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place the towel in an approved container when disconnection is completed.

The following is general information required when working on the fuel system:

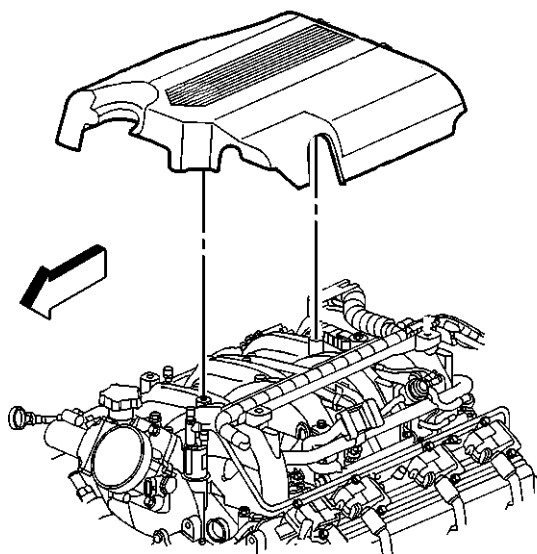
- Always keep a dry chemical fire extinguisher near the work area.
- Do not replace fuel pipe with fuel hose.
- Always bleed off fuel pressure before servicing any fuel system components.
- Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- Observe all notices and cautions.

Tools Required

3855353 Fuel Pressure Gauge



180378



665445

1. Turn the ignition OFF.
2. Disconnect the negative battery cable in order to avoid possible fuel discharge if an accidental attempt is made to start the engine.
3. Remove the fuel injector engine cover.
4. Connect the 3855353 fuel pressure gauge to the fuel pressure valve. Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
5. Install the bleed hose of the gauge into an approved container.
6. Open the valve on the gauge to bleed the system pressure. The fuel connections are now safe for servicing.
7. Drain any fuel remaining in the gauge into an approved container.

Quick Connect Fitting(s) Service (Metal Collar)

Tools Required

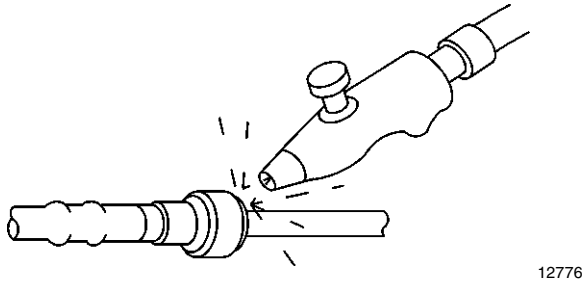
Volvo Penta 885384 Fuel Line Disconnect Tool

Removal

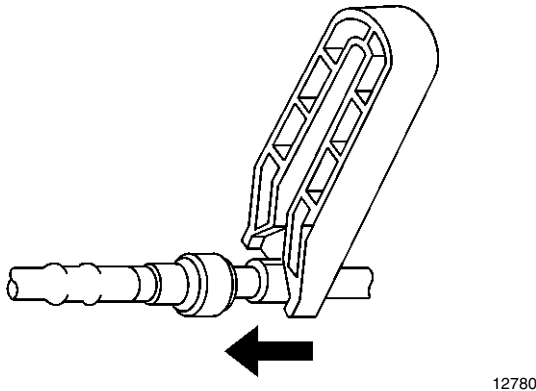
1. Relieve the fuel system pressure before servicing an fuel system connection. Refer to *Fuel Pressure Relief Procedure*.
2. Remove the retainer from the quick-connect fitting.

⚠ Caution!

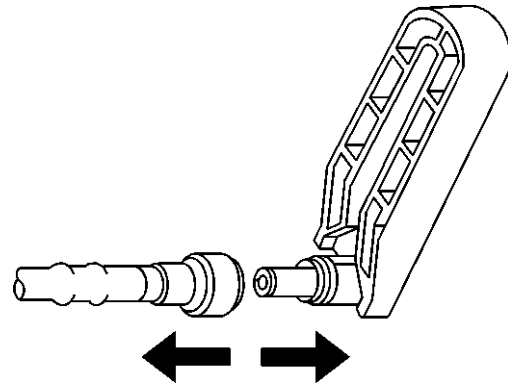
Wear safety glasses to avoid eye damage.



3. Blow dirt out of the fitting using compressed air.

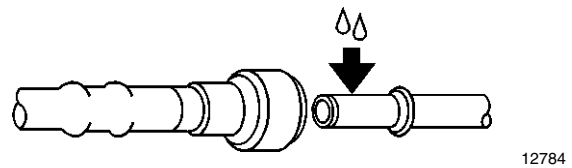


4. Choose the correct tool from the tool set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.

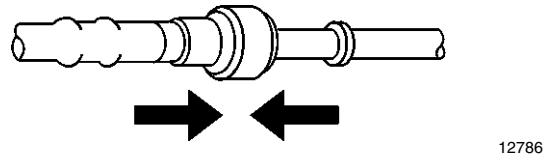


5. Pull the connection apart.
6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

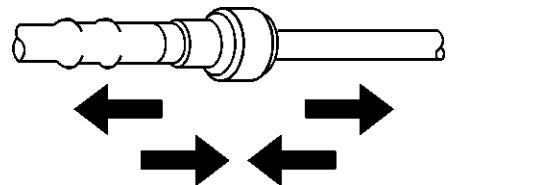
Installation



1. Apply a few drops of clean engine oil to the male pipe end.



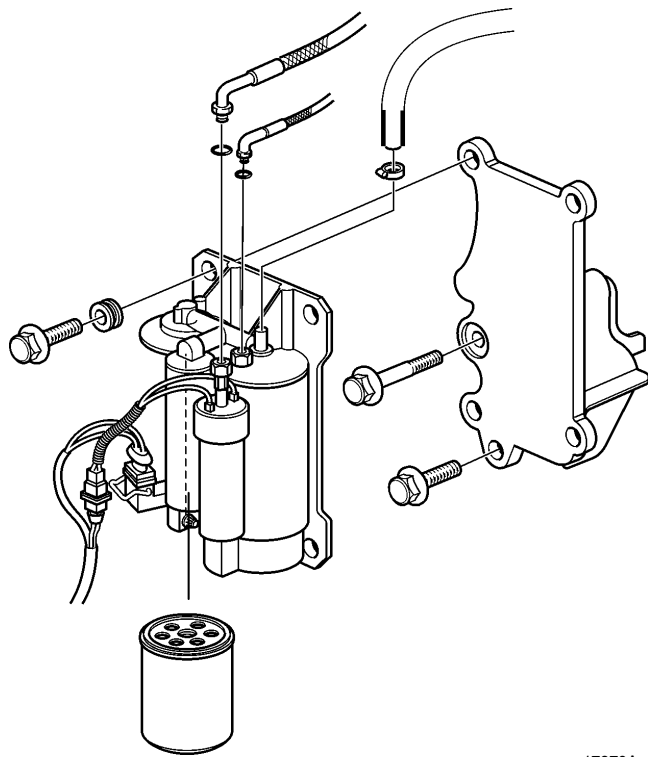
2. Push both sides of the fitting together in order to snap the retaining tabs into place.



3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.
4. Install the retainer to the quick-connect fitting.

Fuel Pump

NOTE! The fuel pumps on this Volvo Penta engine are not serviceable. The entire fuel cell must be replaced if either or both fuel pumps fail.



17970A

Installation

Important! Make sure to replace the fuel cell with the identical part number.

1. Install the fuel cell.
2. Reconnect the fuel pump electrical connectors.
3. Remove the caps from the fuel pipes.
4. Reconnect the threaded fittings into the fuel pump. Tighten the fittings to 25 N•m (18 lb ft).
5. Reconnect the cooling lines.
6. If a fuel filter does not come installed on the new fuel cell, install a new fuel filter.
7. Connect the negative battery cable.
8. Inspect for leaks.
 - a) Turn the ignition ON for 2 seconds.
 - b) Turn the ignition OFF for 10 seconds.
 - c) Turn the ignition ON.
 - d) Inspect for fuel leaks.

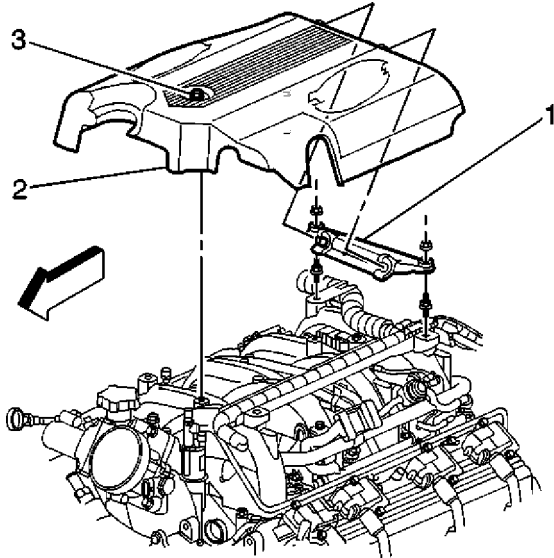
Removal

1. Disconnect negative battery cable.
2. Relieve the fuel system pressure before servicing any fuel system component. Refer to *Fuel Pressure Relief Procedure*.
3. Clean all the fuel fitting connections and the surrounding areas before disconnecting the fuel pipes in order to avoid possible contamination of the fuel system.
4. Disconnect the threaded fittings from the fuel cell.
5. Cap the fuel pipes in order to prevent possible fuel system contamination.
6. Disconnect the fuel pump electrical connectors.
7. Disconnect the cooling lines to the fuel cell.
8. Remove the fuel filter and dispose of it in an approved manner.
9. Remove the 4 retaining screws and retain for installation on the new fuel cell.
10. Remove the fuel cell.

Fuel Rail Assembly

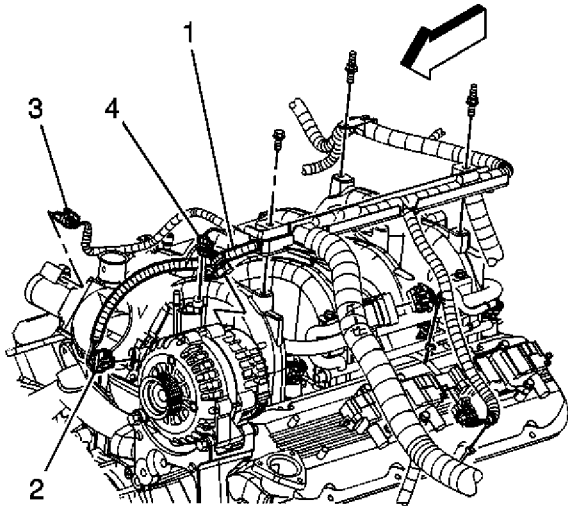
Removal

An eight digit identification number is located on the fuel rail assembly. Refer to this model identification number if servicing or part replacement is required.



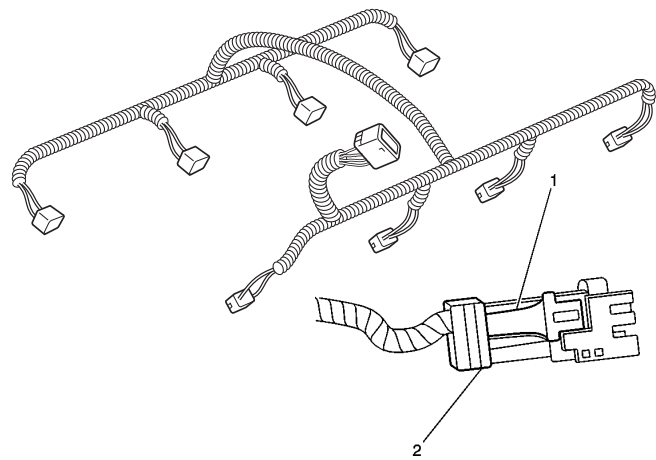
665445

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.
2. Before removal, clean the fuel rail assembly with a spray type engine cleaner, if necessary. Do not soak fuel rails in liquid cleaning solvent.
3. Remove the engine cover and brackets.

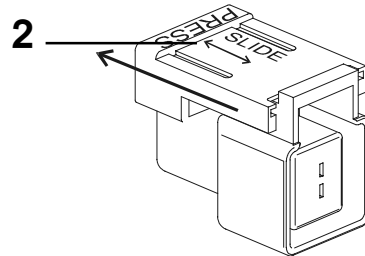


MEFI43

4. Disconnect the alternator harness connector (1).
5. Disconnect the TP sensor harness connector (2).
6. Disconnect the IAC valve harness connector (3).
7. Remove the upper engine wiring harness bracket studs and position the upper engine wire harness aside.

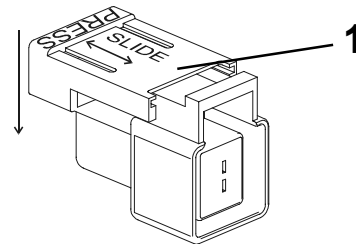


8. Identify the connectors to their corresponding injectors to ensure correct injector firing order after re-assembly.



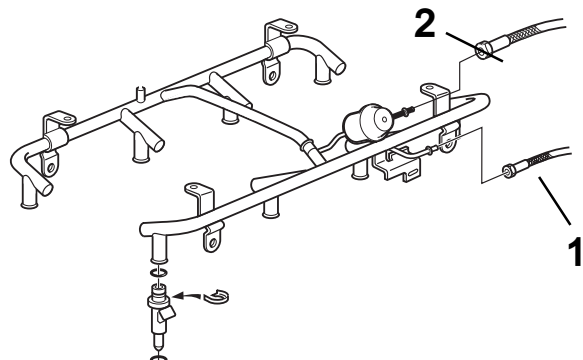
22531

9. Pull the top portion (2) of the injector connector up. Do not pull the top portion of the connector past the top of the white portion (1).

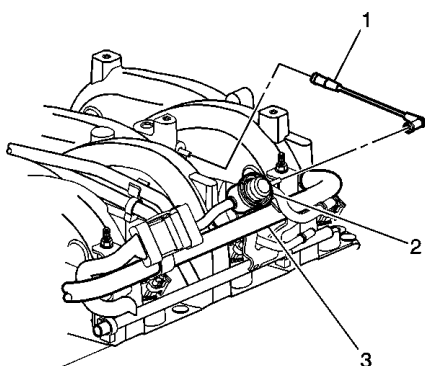


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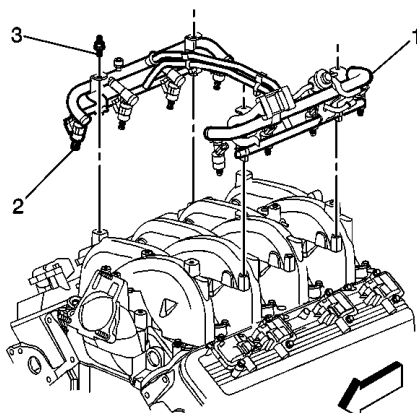
10. Push the tab (1) on the lower side of the injector connector in order to release the connector from the injector.
11. Repeat step 9 and step 10 for each injector connector.



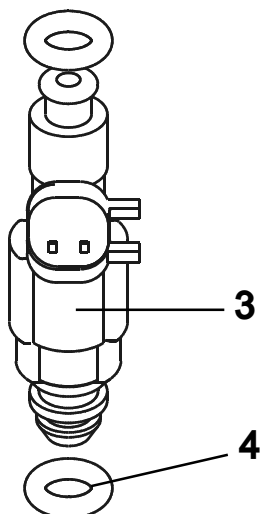
12. Disconnect the fuel feed and return pipes (1), (2) from the fuel rail.



13. Disconnect the fuel pressure regulator vacuum line (1).



14. Remove the fuel rail attaching bolts (3).
15. Remove the fuel rail assembly (1).



16. Remove injector lower O-ring seal (4) from the spray tip end of each injector.

⚠ Caution!

Make note of the O-ring locations. The injectors have different O-rings on top and bottom.

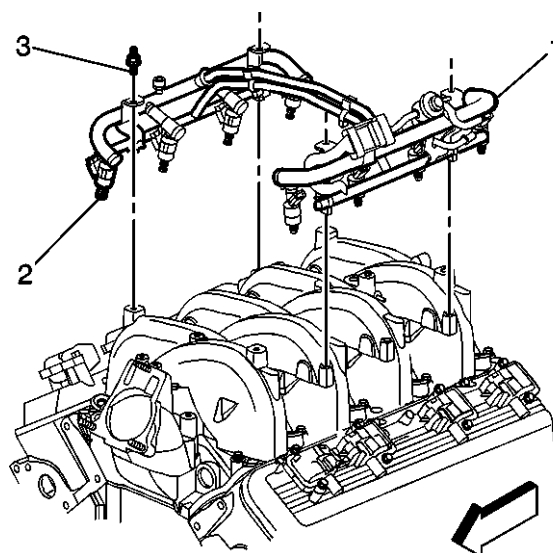
17. Discard the O-ring seals.

Installation

1. Lubricate the new lower injector O-ring seals (4) with clean engine oil.
2. Install the new O-ring seals (4) on the spray tip end of each injector (3).

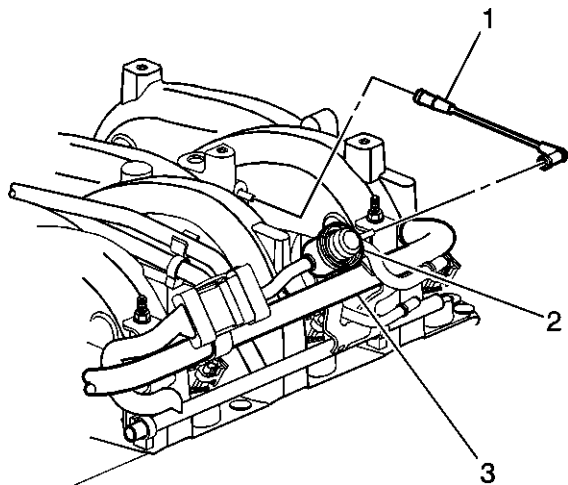
⚠ Caution!

The top and bottom o-rings are different and should not be mixed. Be sure they are used in their correct locations.

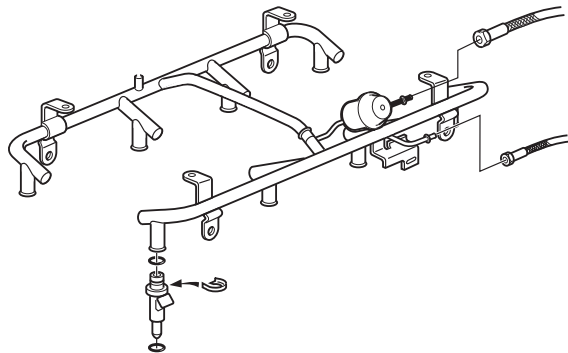


3. Install the fuel rail assembly to the intake manifold.
4. Apply a 5 mm (0.020 in) band of GM P/N 12345382 threadlock or equivalent to the threads of the fuel rail attaching bolts.
5. Install the fuel rail attaching bolts. Tighten the fuel rail attaching bolts to 12 N•m (106 lb in).

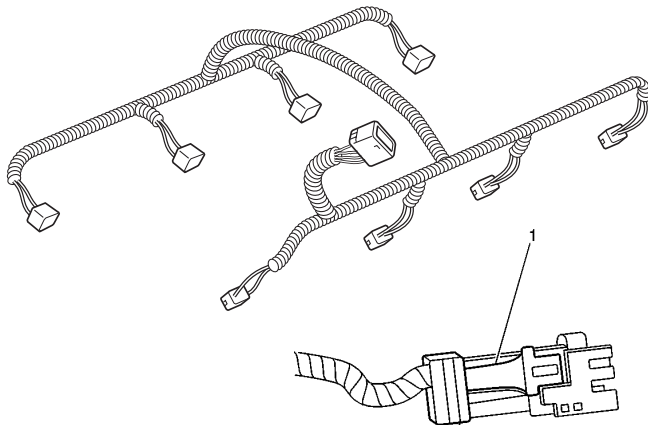
22540



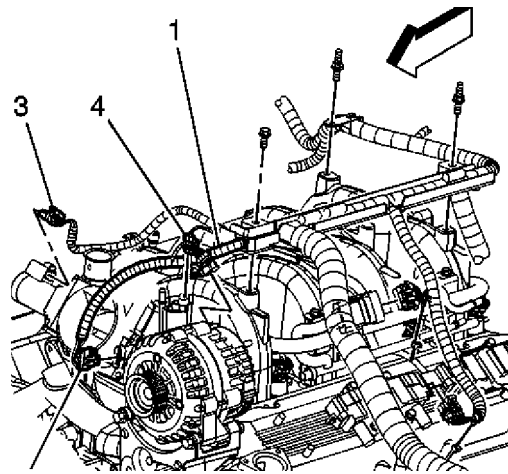
6. Connect the fuel pressure regulator vacuum line.



7. Connect the fuel feed and return pipes (1), (2) to the fuel rail.

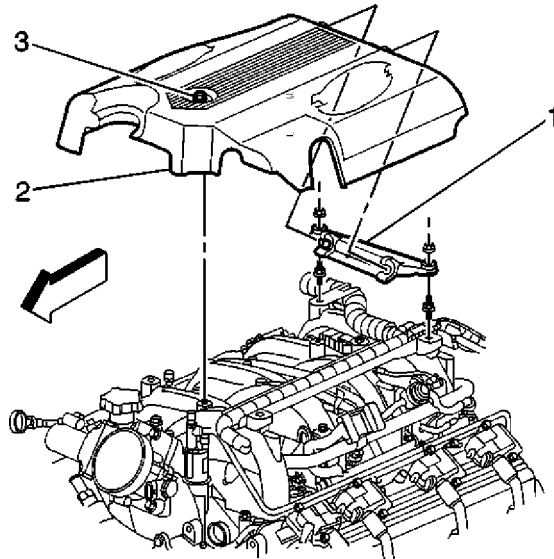


8. Connect the injector electrical connectors as follows:
 - a) Install each connector on the proper injector in order to ensure correct injector firing order.
 - b) Rotate the injectors as required in order to avoid stretching the wire harness.
9. Install the upper engine wire harness bracket.
10. Install the retainer studs to the upper engine wire harness. Tighten the nut to 10 N•m (89 lb in).



MEFI43

11. Reconnect the alternator harness connector (1).
12. Reconnect the TP sensor harness connector (2).
13. Reconnect the IAC valve harness connector (3).



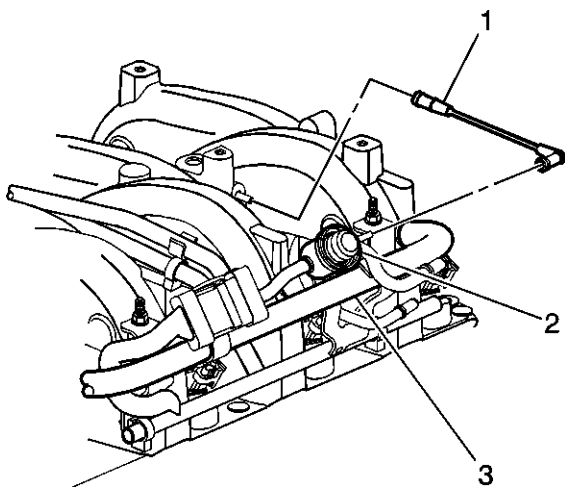
665445

14. Install the engine engine cover mounting bracket and nuts. Tighten the bolts 10 N•m (89 lb in).
15. Connect the negative battery cable.
16. Inspect for leaks.
 - a) Turn the ignition ON for 2 seconds.
 - b) Turn the ignition OFF for 10 seconds.
 - c) Turn the ignition ON.
 - d) Inspect for fuel leaks.
17. Install the engine engine cover. Tighten the bolts 10 N•m (89 lb in).

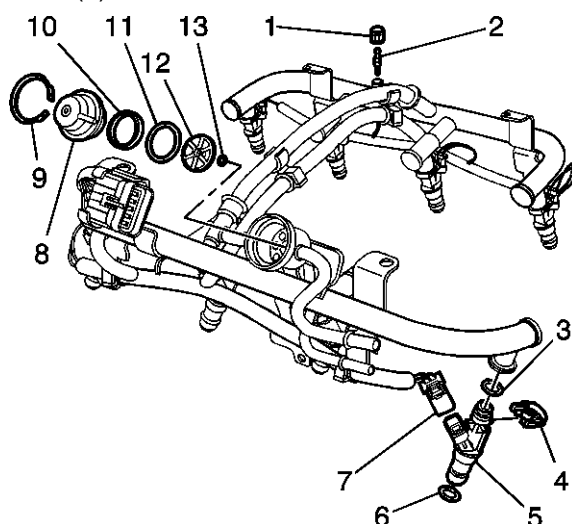
Fuel Pressure Regulator

Removal

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.



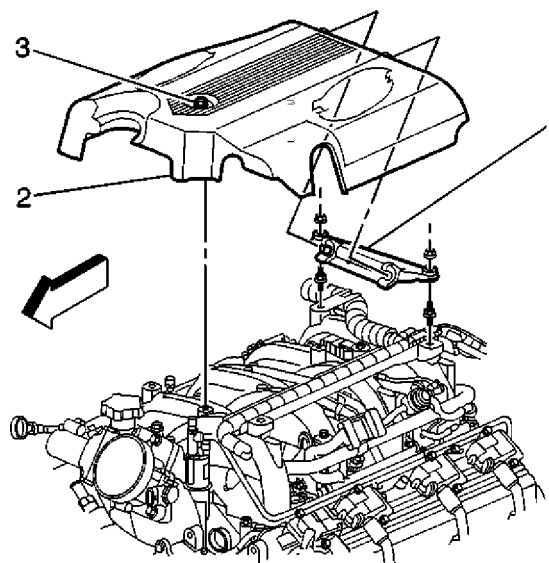
2. Disconnect the fuel pressure regulator vacuum line (1).



3. Clean any dirt from the fuel pressure regulator retainer and the surrounding area.
4. Remove the fuel pressure regulator retainer (9).
5. Remove the fuel pressure regulator (8) from the fuel pressure regulator housing.

Installation

1. Install the backup ring (10) on the fuel pressure regulator (8).
2. Install the new large O-ring (11) on the fuel pressure regulator.
3. Install the regulator filter (12) on the fuel pressure regulator.
4. Install the new small O-ring (13) on the fuel pressure regulator.
5. Lubricate the fuel pressure regulator large O-ring and the small O-ring with clean engine oil.
6. Push the fuel pressure regulator into the regulator housing on the fuel rail.
7. Install a new fuel pressure regulator retainer (9).
8. Connect the fuel pressure regulator vacuum line.
9. Connect the negative battery cable.
10. Inspect for leaks.
 - a) Turn the ignition ON for 2 seconds.
 - b) Turn the ignition OFF for 10 seconds.
 - c) Turn the ignition ON.
 - d) Inspect for fuel leaks.



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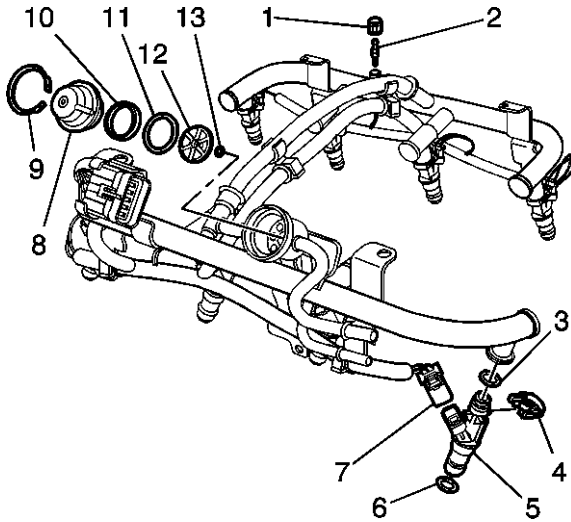
11. Install the engine cover.

Fuel Injector

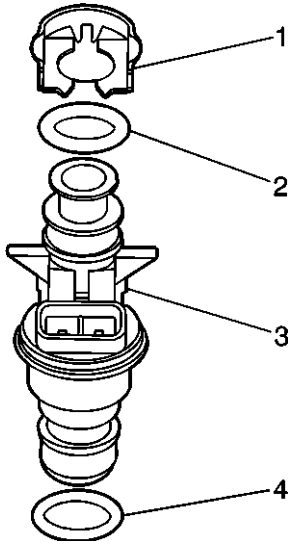
Removal

Important: The engine oil may be contaminated with fuel if the fuel injectors are leaking.

1. Remove the fuel rail assembly. Refer to *Fuel Rail Assembly Replacement*.



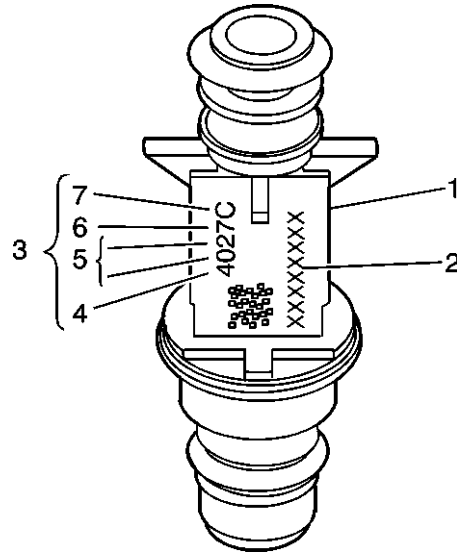
2. Remove the injector retainer clip (4).
3. Insert the fork of J 43013, the fuel injector assembly removal tool, between the fuel rail pod and the 3 protruding retaining clip ledges. Use a prying motion while inserting the tool in order to force the injector out of the fuel rail pod.



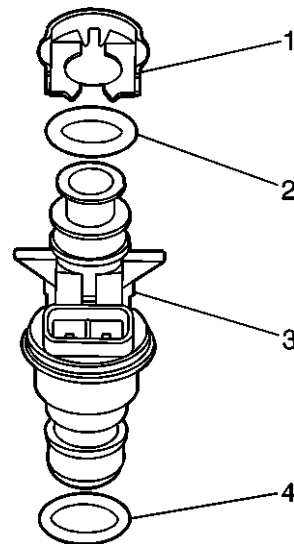
4. Discard the injector retainer clip (1).
5. Remove the injector O-ring seals (2), (4) from both ends of the injector. Discard the O-ring seals.

Installation

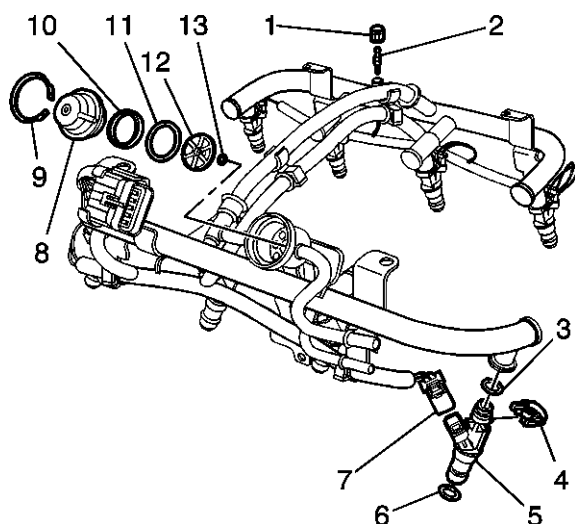
Important: When ordering new fuel injectors, be sure to order the correct injector for the application being serviced.



The fuel injector assembly (1) is stamped with a part number identification (2). A four digit build date code (3) indicates the month (4), day (5), year (6) and the shift (7) that built the injector.



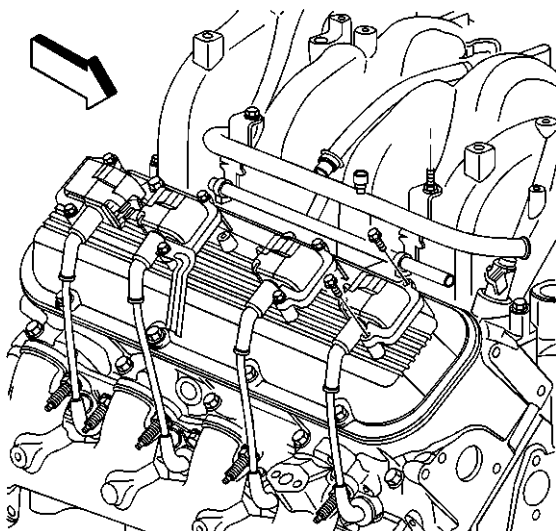
1. Lubricate the new O-ring seals (2), (4) with clean engine oil.
2. Install the new injector O-ring seals on the injector.
3. Install a new retainer clip (1) on the injector.



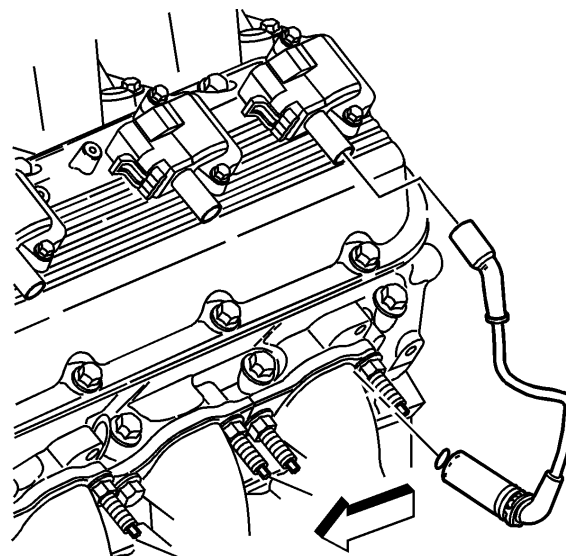
4. Push the fuel injector (5) into the fuel rail injector socket with the electrical connector facing outwards. The retainer clip (4) locks on to a flange on the fuel rail injector socket.
5. Install the fuel rail assembly. Refer to *Fuel Rail Assembly Replacement*.

Ignition Coil(s)

Removal



1. Disconnect the spark plug wires at the ignition coils. Refer to *Spark Plug Wire Replacement*.



2. Disconnect the ignition coil harness connector.
3. Remove the ignition coil mounting bolts.
4. Remove the ignition coil.

Installation

1. Install the ignition coil.
2. Install the ignition coil mounting bolts. Tighten the ignition coil mounting bolts to 12 N•m (106 lb in).
3. Connect the ignition coil harness connector.
4. Connect the spark plug wires at the ignition coils. Refer to *Spark Plug Wire Replacement*.

Spark Plug Wire Inspection

Spark plug wire integrity is vital for proper engine operation. A thorough inspection will be 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 the following conditions:
 - a) Tearing
 - b) Piercing
 - c) Arcing
 - d) Carbon tracking
 - e) Corroded terminal

If corrosion, carbon tracking or arcing are indicated on a spark plug wire boot or on a terminal, replace the wire and the component connected to the wire.

Spark Plug Wire Replacement

Removal

1. Disconnect the spark plug wire at each spark plug.
 - a) Twist each spark plug wire 1/2 turn.
 - b) Pull only on the boot in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from each ignition coil.
 - a) Twist each spark plug wire 1/2 turn.
 - b) Pull only on the boot in order to remove the wire from each ignition coil.

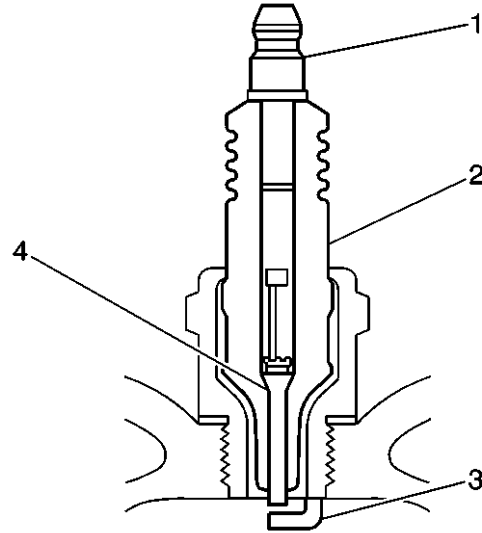
Installation

1. Install the spark plug wire at each ignition coil.
2. Install the spark plug wire at each spark plug.
3. Inspect the wires for proper installation:
 - a) Push sideways on each boot in order to inspect the seating.
 - b) Reinstall any loose boot.

Spark Plug Inspection

Spark Plug Usage

1. Ensure that the correct spark plug is installed. An incorrect spark plug causes drivability conditions.
2. Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - a) Spark plug fouling - colder plug.
 - b) Pre-ignition causing spark plug and/or engine damage - hotter plug.

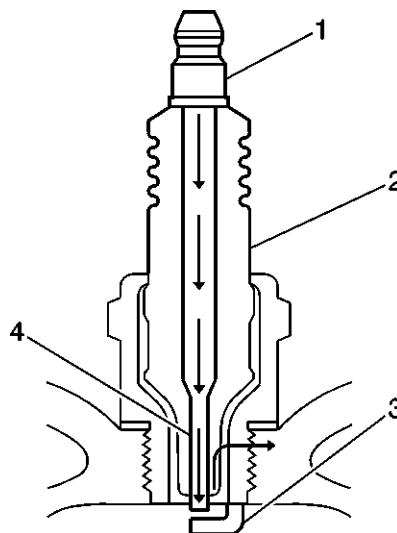


3. Inspect the terminal post (1) for damage.
 - a) Inspect for a bent or broken terminal post (1).
 - b) Inspect the spark plug boot for damage.
 - c) Inspect the spark plug recess area of the cylinder head for moisture, such as oil, coolant or water. A spark plug boot that is saturated causes arcing to ground.
4. Inspect the insulator (2) for cracks. All or part of the electrical charge may arc through the crack instead of the electrodes (3, 4).

5. Inspect for evidence of improper arcing.
 - a) 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.
 - b) Inspect for the correct spark plug torque. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug may cause the insulator (2) to crack.
 - c) Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - d) Inspect for a broken or worn side electrode (3).
 - e) Inspect for a broken, worn or loose center electrode (4) by shaking the spark plug.
6. A rattling sound indicates internal damage.
7. A loose center electrode (4) reduces the spark intensity.
 - a) Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - b) Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
 - c) Inspect for excessive fouling.
8. 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

1. Normal Operation - Brown to greyish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
2. Carbon Fouled - Dry, fluffy black carbon, or soot caused by rich fuel mixtures.
3. Leaking fuel injectors
4. Excessive fuel pressure
5. Restricted flame arrestor/air filter element
6. Incorrect combustion. Reduced ignition system voltage output.
7. Weak coil(s)
8. Worn ignition wires
9. 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.



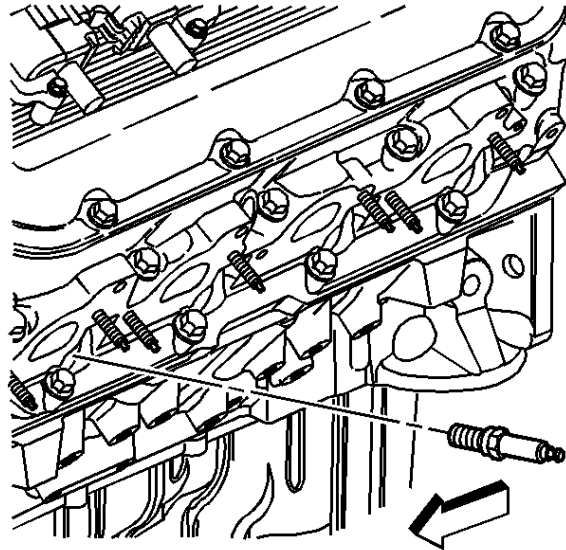
10. Inspect for evidence of improper arcing.
 - a) Measure the gap between the center electrode (4) and the side electrode (3) terminals. An excessively wide electrode gap can prevent correct spark plug operation.
 - b) Inspect for the correct spark plug torque. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug may cause the insulator (2) to crack.
 - c) Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - d) Inspect for a broken or worn side electrode (3).
 - e) Inspect for a broken, worn or loose center electrode (4) by shaking the spark plug.

11. A rattling sound indicates internal damage.
12. A loose center electrode (4) reduces the spark intensity.
 - a) Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - b) Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
 - c) Inspect for excessive fouling.
13. 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

Removal

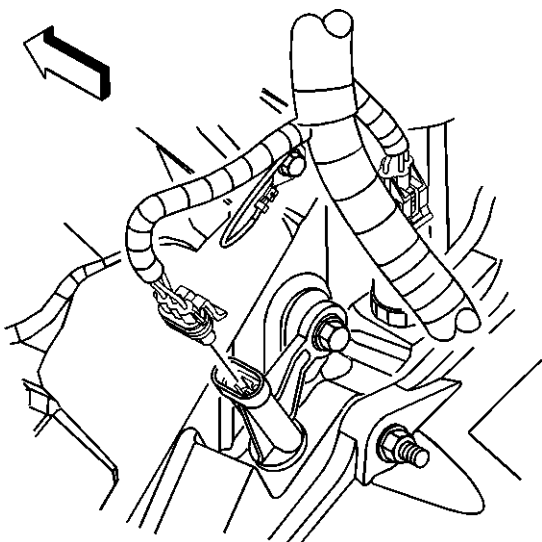
1. Remove the spark plug wires. Refer to *Spark Plug Wire Replacement*.
2. Loosen each spark plug one or two turns.
3. Brush or air blast away any dirt from around the spark plugs.



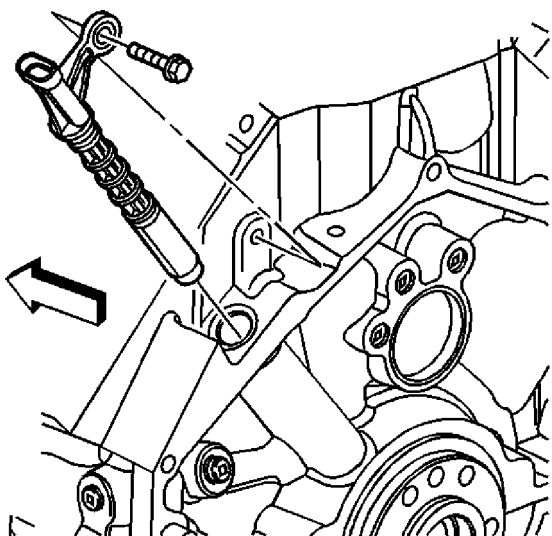
4. Remove the spark plugs one at a time and place each plug in a tray marked with the corresponding cylinder numbers.

Installation

1. Inspect each spark plug gap. Adjust each plug gap as needed. Spark plug gap: 1.524 mm (0.060 in)
2. Install the spark plugs. Tighten the spark plugs to 20 N•m (15 lb ft).
3. Install the spark plug wires. Refer to *Spark Plug Wire Replacement*.

Crankshaft Position (CKP) Sensor**Removal**

1. Disconnect the crankshaft position (CKP) sensor harness connector at the CKP sensor.



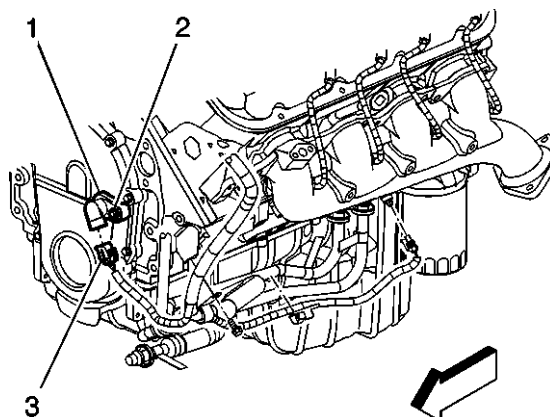
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2. Remove the CKP sensor retaining bolt.
3. Remove the CKP sensor.

Installation**⚠ Caution!**

Inspect the CKP sensor O-ring for wear or damage. If a problem is found, replace the O-ring. Lubricate the new O-ring with clean engine oil before installing.

1. Install the CKP sensor.
2. Install the CKP sensor retaining bolt. Tighten the bolt 10 N•m (88 lb in).
3. Connect the CKP sensor harness connector.

Camshaft Position (CMP) Sensor**Removal**

1. Disconnect the camshaft position (CMP) sensor harness connector (3) from the CMP sensor (1).
2. Remove the CMP sensor retaining bolt (2).
3. Remove the CMP sensor (1).
4. Inspect the CMP sensor for wear, cracks or leakage if the sensor is not being replaced.

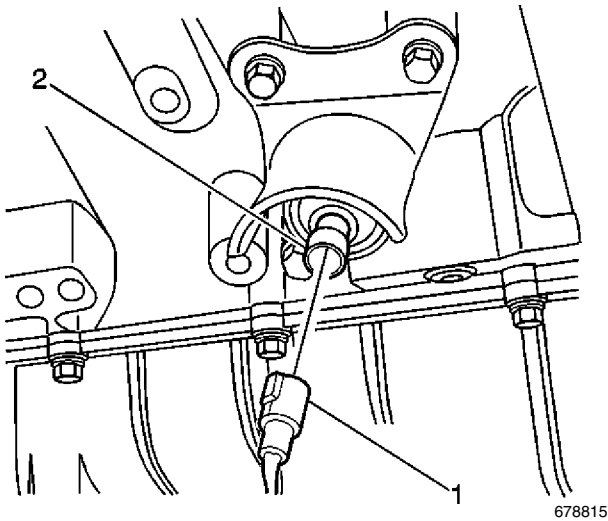
Installation**⚠ Caution!**

Inspect the CMP sensor O-ring for wear or damage. If a problem is found, replace the O-ring. Lubricate the new O-ring with clean engine oil before installing.

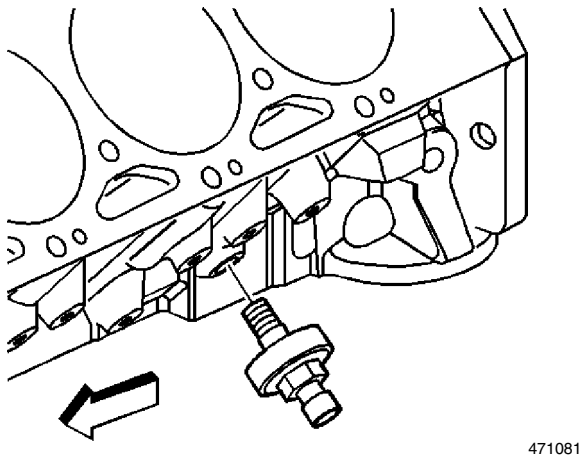
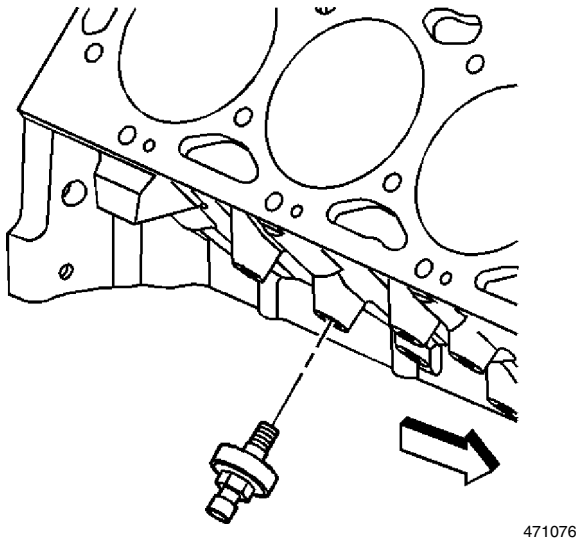
1. Install the CMP sensor (1).
2. Install the CMP sensor retaining bolt (2). Tighten the bolt 10 N•m (88 lb in).
3. Connect the CMP sensor harness connector (3).

Knock Sensor (KS)

Removal



1. Remove the wiring harness connector (1) from the knock sensor (2).



2. Remove the knock sensor (2) from the engine block. Use 7/8 inch deep socket.

Installation

1. Install the knock sensor into the engine block. Tighten the knock sensor to 19 N•m (14 lb ft).
2. Connect the knock sensor harness connector (1) to the knock sensor (2).

Temperature vs. Resistance IAT and ECT

°C	°F	Ohms	°C	°F	Ohms
100	212	177	25	77	2796
90	194	241	20	68	3520
80	176	332	15	59	4450
70	158	467	10	50	5670
60	140	667	5	41	7280
50	122	973	0	32	9420
45	133	1188	-5	23	12300
40	104	1459	-10	14	16180
35	95	1802	-15	5	21450
30	86	2238	-20	-4	28680
25	77	2796	-30	-22	52700
20	68	3520	-40	-40	100700

TBL22552

Ignition System Specifications

Application	Specifications	
	Metric	English
Firing Order	1-8-7-2-6-5-4-3	
Spark Plug Wire Resistance	10,000 Ohms per foot	
Spark Plug Torque	15 N•m	11 lb. ft
Spark Plug Gap	1.52 mm	.060 in.
Spark Plug Type	Volvo Penta Part no. 3861325 TJ14R-P15	

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Fastener Tightening Specifications

Application	Specification	
	Metric	English
Camshaft Position Sensor (CMP)	10 N•m	88 lb. in.
Crankshaft Position Sensor Bolt (CKP)	10 N•m	88 lb. in.
Engine Control Module (ECM) Mounting Screws	10-14 N•m	88-142 lb. in.
Engine Coolant Temperature Sensor (ECT)	20 N•m	15 lb. ft.
Fuel Rail Attachment Bolts	10 N•m	89 lb. in.
Idle Air Control (IAC) Valve Attaching Screws	2 N•m	18 lb. in.
Ignition Coil Attachment Bolts	12 N•m	106 lb. in.
Knock Sensor	19 N•m	14 lb. ft.
Throttle Body Attaching bolts	9 N•m	80 lb. in.
Throttle Position (TP) Sensor Attaching Screws	2 N•m	18 lb. in.

TBL22608

Notes

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Important Preliminary Checks Before Starting

Before using this section you should have performed the “On-Board Diagnostic (OBD) System Check” and determined that:

- The ECM and MIL (Malfunction Indicator Lamp) are operating correctly.
- There are no DTC(s) stored.
- Ensure that the engine is not in RPM reduction mode. The ECM turns certain injectors off when the ECM detects certain conditions such as engine over-temp.
- Verify the customer complaint and locate the correct symptom in the table of contents. Check the items indicated under that symptom.

Visual/Physical Check

Several of the symptom procedures call for a careful Visual/Physical Check. The importance of this step cannot be stressed too strongly - it can lead to correcting a problem without further checks and can save valuable time. This check should include:

- ECM grounds and sensor connections for being clean, tight and in their proper location.
- Vacuum hoses for splits, kinks and proper connections. Check thoroughly for any type of leak or restriction.
- Air leaks at throttle body mounting area and intake manifold sealing surfaces.
- Ignition wires for cracking, hardness, proper routing and carbon tracking.
- Wiring for proper connections, pinches and cuts.
- Moisture in primary or secondary ignition circuit connections.
- Corrosion on electrical connections and exposed throttle body linkages.

Intermittents

Important: Check for improper installation of electrical components if an intermittent condition exists. Inspect for aftermarket theft deterrent devices, lights, cellular phones, etc. If you cannot locate an intermittent condition, a cellular phone signal communication may cause the condition.

Important: Problem may or may not turn “ON” the Malfunction Indicator Lamp (MIL) or store a DTC. DO NOT use the Diagnostic Trouble Code (DTC) tables for intermittent problems. The fault must be present to locate the problem.

Most intermittent problems are caused by faulty

electrical connections or wiring. Perform careful visual/physical check. Check for the following conditions:

- Poor mating of the connector halves, or a terminal not fully seated in the connector body (backed out or loose).
- Improperly formed or damaged terminals and/or connectors.
- All connector terminals in the problem circuit should be carefully checked for proper contact tension.
- Poor terminal to wire connection (crimping). This requires removing the terminal from the connector body to check. Refer to “Wiring Harness Service” in *General Information* section.

The vessel may be driven with a J 39200 Digital Multimeter connected to a suspected circuit. An abnormal voltage when malfunction occurs is a good indication that there is a fault in the circuit being monitored.

A scan tool may also be used to help detect intermittent conditions. The Snapshot feature (if applicable) can be triggered to capture and store engine parameters within the scan tool when the malfunction occurs. This stored information then can be reviewed by the service technician to see what caused the malfunction.

To check loss of DTC memory, disconnect TP sensor and idle engine until the MIL comes "ON". DTC 22 should be stored and kept in memory when ignition is turned "OFF". If not the ECM is faulty. When this test is completed, make sure that you clear the DTC 22 from memory using "Clearing DTC Procedure".

An intermittent MIL with no stored DTC may be caused by the following:

- Ignition coil shorted to ground and arcing at ignition wires or plugs.
- MIL wire to ECM shorted to ground.
- Poor ECM grounds.
- Check for an electrical system interference caused by a sharp electrical surge. Normally, the problem will occur when the faulty component is operated.
- Check for improper installation of electrical options such as lights, radios, etc.
- Check that knock sensor wire(s) are routed away from spark plug wires, ignition system components and charging system components.
- Check for secondary ignition components shorted to ground, or an open ignition coil ground (coil mounting brackets).
- Check for components internally shorted to ground such as starters, alternators or relays.

All Ignition Coil wiring should be kept away from the alternator. Check all wires from the ECM to the ignition coils for poor connections.

If problem has not been found go to "ECM Connector Symptom Tables" at the end of *Symptoms* section.

Hard Start Symptom

Checks	Action
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i> section. — Check the ECM grounds for being clean, tight and in the proper locations. — Search Service Bulletins.
Sensor/System	• Check the engine coolant temperature (ECT) sensor for being shifted in value. Connect a Scan tool. Compare the engine coolant temperature against the intake air temperature (IAT) on a cold engine. The ECT sensor and IAT sensor values should be within 3°C (5°F) of each other. If the ECT sensor is out of range with the IAT sensor, check the resistance of the ECT sensor. Replace the ECT sensor if the resistance is not within specification. If the sensor is within specification, check and repair the ECT signal circuit for high resistance. • Check the camshaft position (CMP) sensor for proper mounting and or a bad connection. A long crank time occurs if the ECM does not receive a CMP signal.
Fuel System	• Check the fuel pump relay operation. The fuel pump should turn ON for 2 seconds when you turn ON the ignition. • A faulty fuel pump check valve allows the fuel in the lines to drain back to the tank after the engine stops. • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition.
Ignition System	• Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: • Correct heat range • Wet plugs • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	• Check for excessive oil in combustion chamber - Leaking valve seals. • Check for low cylinder compression • Check combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. • Inspect the following components for incorrect basic engine parts: • Cylinder Heads • Camshaft • Pistons, etc. • Refer to the appropriate procedures in Engine Mechanical.

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Surges Symptom

Checks	Action
Definition: Engine power variation under steady throttle or cruise. Feels like the vessel speeds up and slows down with no change in throttle position. NOTE! Make sure that the vessel is checked in calm water. Light chop or small seas can produce a surging sensation.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Fuel System	• Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector or cylinder according to the firing order. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	• 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 and listen for arcing or misfiring as you apply the water • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: • Correct heat range • Wet plugs • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	• Ensure that the engine is not overheating, causing the engine to go into RPM reduction mode.
Additional	• Visually check the vacuum hoses for splits, kinks and proper connections and routing.

22625

Lack of Power, Sluggishness or Sponginess Symptom

Checks	Action
Definition: Engine cranks OK, but does not start for a long time. Does eventually run, or may start but immediately dies.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins. — Remove the flame arrestor and check for dirt or for being restricted.
Sensor System	• Ensure that the engine is not going into RPM reduction mode. • Use a scan tool in order to monitor the knock sensor system for excessive spark retard activity.
Fuel System	• Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	• 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 and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: • Correct heat range • Wet plugs • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Mechanical	• Excessive oil in combustion chamber - Leaking valve seals. • Low cylinder compression • Combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. • Inspect the following components for incorrect basic engine parts: • Cylinder Heads • Camshaft • Pistons, etc. Refer to the appropriate procedures in Engine Mechanical.

22626

Detonation/Spark Knock Symptom

Checks	Action
Definition: A mild to severe ping, usually worse under acceleration. The engine makes sharp metallic knocks that change with throttle opening.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins. — If the scan tool readings are normal, refer to supporting text of the Diagnostic Check, and there are no engine mechanical faults, fill the fuel tank with a known high quality fuel that meets the vessels minimum octane requirements. Refer to <i>Fuel System Specifications</i>. Test the vessel and re-evaluate the performance.
Fuel System	• Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the items that cause an engine to run lean long term.
Ignition System	• Check the spark plugs for being the proper heat range.
Engine Cooling System	• Check for obvious overheating problems. • Insufficient coolant flow through the engine. • Wrong or stuck thermostat. • Inoperative water supply pump.
Engine Mechanical	• Check for excessive oil in combustion chamber - Leaking valve seals. • Check for low cylinder compression • Check combustion chambers for excessive carbon buildup. Clean the chambers using top engine cleaner. Follow the instructions on the can. • Inspect the following components for incorrect basic engine parts: • Cylinder Heads • Camshaft • Pistons, etc. Refer to the appropriate procedures in Engine Mechanical.

22627

Hesitation, Sag or Stumble Symptom

Checks	Action
Definition: Momentary lack of response as the throttle is increased. Can occur at any vessel speed. Usually more pronounced when first trying to make the vessel move, as from a stop. May cause the engine to stall if severe enough.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Sensor System	• Check the MAP sensor operation. • Check the TP sensor operation.
Fuel System	• Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Ignition System	• 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 and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: • Correct heat range • Wet plugs • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds.
Engine Cooling System	• Check the engine thermostat for proper operation and heat range.
Additional	• Check the alternator output voltage. Repair the charging system if the alternator output voltage is less than 10 volts or more than 16 volts.

22628

Cuts Out, Misses Symptom

Checks	Action
Definition: Steady pulsation or jerking that follows engine speed, usually more pronounced as engine load increases. This condition is not normally felt above 1,500 RPM. The exhaust has a steady spitting sound at idle or low speed.	
Preliminary	— Refer to Important Preliminary Checks before starting in Symptoms. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Fuel System	• Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Sensor System	• Use a scan to in order to monitor the knock sensor system for excessive spark retard activity.
Ignition System	• 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 and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: • Correct heat range • Wet plugs • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: • Ignition wires arcing to ground • Ignition wires for proper engagement to spark plug and coil • Ignition coils for cracks or carbon tracking
Engine Mechanical	• Check engine mechanical for the following: • Low compression • Sticking or leaking valves • Worn camshaft lobes • Valve timing • Bent push rods • Worn rocker arms • Broken Valve Springs • Excessive oil in the combustion chamber - Leaking valve seals.

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Cuts Out, Misses Symptom (cont'd)

Checks	Action
Engine Mechanical (cont'd)	- Inspect the following components for incorrect basic engine parts: - Camshaft - Cylinder heads - Pistons, etc. Refer to the appropriate procedures in Engine Mechanical.
Additional	- Inspect the exhaust system for possible restriction. - Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. - Check the intake manifold and the exhaust manifold passages for casting flash.

22630

Poor Fuel Economy Symptom

Checks	Action
Definition: Fuel economy, as measured by actual fuel used, is noticeably lower than expected. Also, fuel economy is noticeably lower than it was on this vessel at one time, as previously shown by actual measurement.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins. — Check how the vessel is operated. - Are there excessive loads being carried? - Is the acceleration rate too much, too often? - Remove the flame arrestor element and check for dirt or for restrictions.
Fuel System	- Check the type, quality and alcohol content of the fuel. Oxygenated fuels have lower energy and may deliver reduced fuel economy. - Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35°C (50-95°F)</i>. - Check for incorrect fuel pressure. - Check for a restricted fuel filter. - Check for a contaminated fuel condition. - Check that each injector harness is connected to the correct injector and cylinder. - Check for foreign material accumulation in the throttle bore, coking on the throttle valve or on the throttle shaft. Also check for throttle body tampering. - Check the items that cause an engine to run rich long term.
Sensor System	- Check the air intake system and crankcase for air leaks. - Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace valve. - Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity.

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Checks	Action
Ignition System	- 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 and listen for arcing or misfiring as you apply the water. - Check for proper ignition voltage output. - Remove the spark plugs and check for the following: - Correct heat range - Wet plugs - Cracks - Wear - Improper gap - Burned electrodes - Heavy deposits - Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. - Check for bare or shorted ignition wires. - Check for loose ignition coil grounds. - Visually and physically inspect the secondary ignition for the following: - Ignition wires arcing to ground - Ignition wires for proper engagement to spark plug and coil - Ignition coils for cracks or carbon tracking
Engine Cooling	- Check for water flow restrictions. - Check the engine thermostat for proper operation and for the correct heat range.
Engine Mechanical	- Check engine mechanical for the following: - Low compression - Sticking or leaking valves - Worn camshaft lobes - Valve timing - Bent push rods - Worn rocker arms - Broken Valve Springs - Excessive oil in the combustion chamber - Leaking valve seals. - Inspect the following components for incorrect basic engine parts: - Camshaft - Cylinder heads - Pistons, etc. Refer to the appropriate procedures in Engine Mechanical.
Additional	- Inspect the exhaust system for possible restriction. - Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem. - Check the intake manifold and the exhaust manifold passages for casting flash. - Check for excessive drag on the vessel (e.g. barnacles on bottom and sterndrive).

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Rough, Unstable or Incorrect Idle and Stalling Symptom

Checks	Action
Definition: Engine runs unevenly at idle. If severe, the engine or vehicle may shake. Engine idle speed may vary in RPM. Either condition may be severe enough to stall the engine.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins. — Remove the flame arrestor element and check for dirt or for restrictions
Fuel System	• Check the fuel injectors. Refer to Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10°-35°C (50°-95°F). • Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check that each injector harness is connected to the correct injector and cylinder. • Check for foreign material accumulation in the throttle bore, coking on the throttle valve or on the throttle shaft. Also check for throttle body tampering. • Check the items that cause an engine to run rich long term. • Check the items that cause an engine to run lean long term.
Sensor System	• Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace valve. • Check the Cam sensor (CMP) for code 81. Refer to DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault (Scan Diagnostics). • Check the idle air control (IAC) valve for proper operation. • Use a scan tool in order to monitor the knock sensor (KS) system for excessive spark retard activity.
Ignition System	• 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 and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output per manufacturers recommendations. • Remove the spark plugs and check for the following: • Correct heat range. • Wet plugs. • Cracks. • Wear. • Improper gap. • Burned Electrodes. • Heavy deposits. • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: • Ignition wires arcing to ground • Ignition wires for proper engagement to spark plug and coil • Ignition coils for cracks or carbon tracking

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Continued next page.

Checks	Action
Engine Mechanical	- Check engine mechanical for the following: - Low compression - Sticking or leaking valves - Worn camshaft lobes - Valve timing - Bent push rods - Worn rocker arms - Broken Valve Springs - Excessive oil in the combustion chamber - Leaking valve seals. - Inspect the following components for incorrect basic engine parts: - Camshaft - Cylinder heads - Pistons, etc. Refer to the appropriate procedures in Engine Mechanical.
Additional	- Inspect the exhaust system for possible restriction. - Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. Check for faulty motor mounts. - Check the intake manifold and the exhaust manifold passages for casting flash.

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Dieseling, Run-On Symptom

Checks	Action
Definition: Engine continues to run after key is turned OFF, but runs very rough. If the engine runs smooth, check the ignition switch and the ignition switch adjustment.	
Preliminary	- Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. - Check the ECM grounds for being clean, tight and in the proper locations. - Search for Service Bulletins.
Fuel System	Inspect the injectors for a leaking condition.

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Backfire Symptom

Checks	Action
Definition: Fuel ignites in manifold making a loud popping noise.	
Preliminary	— Refer to <i>Important Preliminary Checks</i> before starting in <i>Symptoms</i>. — Check the ECM grounds for being clean, tight and in the proper locations. — Search for Service Bulletins.
Fuel System	• Check for incorrect fuel pressure. • Check for a restricted fuel filter. • Check for a contaminated fuel condition. • Check the fuel injectors. Refer to <i>Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 degrees C (50-95 Degrees F)</i>. • Check that each injector harness is connected to the correct injector and cylinder.
Sensor System	• Check the air intake system and crankcase for air leaks. • Check the crankcase ventilation valve for proper operation. Place a finger over the inlet hole in the valve end several times. The valve should snap back. If not, replace the valve. • Use a scan to in order to monitor the knock sensor system for excessive spark retard activity.
Ignition System	• 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 and listen for arcing or misfiring as you apply the water. • Check for proper ignition voltage output. • Remove the spark plugs and check for the following: • Correct heat range • Wet plugs • Cracks • Wear • Improper gap • Burned electrodes • Heavy deposits • Determine the cause of the fouling before replacing the spark plugs if the spark plugs are gas, coolant or oil fouled. • Check for bare or shorted ignition wires. • Check for loose ignition coil grounds. • Visually and physically inspect the secondary ignition for the following: • Ignition wires arcing to ground • Ignition wires for proper routing • Ignition coils for cracks or carbon tracking
Engine Cooling	• Check for restrictions to the water intake. • Check the engine thermostat for proper operation and for the correct heat range.

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Checks	Action
Engine Mechanical	• Check engine mechanical for the following: • Low compression. • Sticking or leaking valves. • Worn camshaft lobes. • Valve timing. • Bent push rods. • Worn rocker arms. • Broken valve springs. • Excessive oil in the combustion chamber – leaking valve seals. • Inspect the following components for incorrect basic engine parts: • Camshaft. • Cylinder heads. • Pistons, etc. Refer to the appropriate procedures in the Engine Components Workshop Manual.
Additional	• Inspect the exhaust system for possible restriction. • Electromagnetic interference (EMI) on the reference circuit can cause an engine miss condition. A sudden increase in indicated RPM with little change in actual engine RPM change indicates EMI is present. Check for high voltage components near ignition control circuits if a problem exists. • Check for faulty motor mounts. • Check the intake manifold and the exhaust manifold passages for casting flash. • Visually and physically check the vacuum hoses for splits, kinks and proper connections and routing.

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Notes

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Engine Scan Tool List

Scan Tool Parameter	Units	Parameter Range
Calibration ID	Numeric	0-255 Identification number assigned specific calibration
Calibration Checksum	Numeric	0-65535
Engine Speed	RPM	0-6000
Desired Idle	RPM	0-1600
ECT	C, F	-40°C – 151°C, -40°F – 304°F
IAT	C, F	-40°C – 151°C, -40°F – 304°F
MAP	kPa / Volts	8-207 kPa / 0.00-4.98 volts
Baro	KPa / Volts	8-207 kPa / 0.00-4.98 volts
TP Sensor	Volts	0.00 – 4.98 Volts
Throttle Angle	Percent	0-100%
Injector A Pulse Width	Milliseconds	0.0 – 500 ms
Injector B Pulse Width	Milliseconds	0.0 – 500 ms
Spark Advance	Degrees	-20° – 69.6484°
Cam retard	Degrees	0° – 90°
Knock Retard	Degrees	0° – 89.6484°
KS System Enabled	Yes/No	Yes/No
Knock Signal	Yes/No	Yes/No
IAC Position	Counts	0-255 counts
IAC Throttle Follower	Counts	0-255 counts
Closed Throttle	Yes/No	Yes/No
Vessel Speed	MPH	0-255
Battery Ignition Voltage	Volts	0.0 – 25.5
System Voltage Warning	Discrete	OK/Low Voltage
J1-20 Input	Discrete	On/Off
J2-20 Input	Discrete	On/Off
Emergency Stop Mode	Discrete	On/Off
Troll RPM Limit	Discrete	On/Off
Malfunction Indicator Lamp	Discrete	On/Off
Fuel Pump Relay	Discrete	On/Off
Cause Power Reduction	Discrete	On/Off
Power Reduction	Discrete	On/Off
Overheat Detection	Discrete	On/Off
Oil Pressure Input	Discrete	Ok/Low Pressure
J1-9 Output	Discrete	On/Off
Oil Level Input	Discrete	Ok/Low
Buzzer	Discrete	On/Off
J1-19 Input	Discrete	On/Off
J1-22 Output	Discrete	On/Off
J1-4 Input	Discrete	On/Off
J1-23 Output	Discrete	On/Off
Master/Slave	Discrete	Master/Slave
J1-7 RPM Output	Discrete	On/Off
Time From Start	Hour: Minutes: Seconds	00:00:00 – 18:12:15
Engine Hour Meter	Hours	0.0 – 1193046.47
Fuel Consumption	Gallon per hour	0.0 – 255 gph
Fuel Pressure Volts	Volts	0.00 – 5.00 volts
Low Fuel Pressure Warning	Discrete	OK/Low Pressure
Fuel Temperature	Volts	0 – 5 volts

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Engine Scan Tool List

The Engine Scan Tool Data List contains all engine related parameters that are available on the scan tool. Use the Engine Scan Tool Data List only after the following is determined:

- On-Board Diagnostic System Check is completed.
- No Diagnostic Trouble Codes (DTCs).
- On-board diagnostics are functioning properly.

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 normal running engine.

Important: A scan tool that displays faulty data should not be used. The scan tool problem should be reported to the manufacturer. Use of a faulty scan tool can result in mis-diagnosis and unnecessary parts replacement.

Only the parameters listed below are referenced in this service manual for use in diagnosis. If all values are within the typical range described below, refer to *Symptoms* for diagnosis.

Engine Scan Tool Data Definitions

The Engine Scan Tool Data Definitions contains a brief description of all engine related parameters available on the scan tool.

ECM Data Descriptions

CALIBRATION ID - Scan Tool Range 0-255 - This is an identification number given to each calibration by the OEM.

CALIBRATION CHECKSUM - Scan Tool Range 0-65535 - This number is automatically calculated by the ECM. This number may also be used as a calibration identifier.

ENGINE SPEED - Scan Tool Range 0-9999 RPM - Engine speed is computed by the ECM from the Ignition Control reference input. It should remain close to the desired idle under various engine loads with engine idling.

DESIRED IDLE - Scan Tool Range 0-3187 RPM - The idle speed that is commanded by the ECM. The ECM will compensate for various engine loads based on engine coolant temperature to keep the engine at the desired speed.

ECT - Scan Tool Range -40°C to 151°C, -40°F to 304°F - The Engine Coolant Temperature (ECT) sensor is mounted in the coolant stream and sends engine temperature information to the ECM. The ECM supplies 5 volts to the ECT sensor circuit. The sensor is a thermistor which changes internal resistance as temperature changes. When the sensor is cold (internal resistance high), the ECM monitors a high signal voltage and interprets it as a cold engine. As the sensor warms (internal resistance decreases), the voltage signal will decrease and the ECM will interpret the lower voltage as a warm engine.

IAT - Scan Tool Range -40°C to 151°C, -40°F to 304°F - The ECM converts the resistance of the intake air temperature sensor to degrees. Intake Air Temperature (IAT) is used by the ECM to adjust fuel delivery and spark timing according to incoming air density. (Big Block Multiport Fuel Injection Application Only).

MAP - Scan Tool Range 10-210 kPa/0.00-5.00 Volts - The Manifold Absolute Pressure (MAP) sensor measures the change in the intake manifold pressure from engine load and speed changes. As intake manifold pressure increases, intake vacuum decreases resulting in a higher MAP sensor voltage and kPa reading.

BARO - Scan Tool Range 10-105 kPa/0.00-5.00

Volts - The Barometric Pressure reading displayed is measured from the MAP sensor signal monitored at ignition "ON", engine "OFF" and WOT conditions. The Barometric Pressure is used to compensate for altitude differences.

TP SENSOR - Scan Tool Range 0.00-5.00 Volts -

This is the voltage being monitored by the ECM on the TP sensor signal circuit.

TP ANGLE - Scan Tool Range 0% - 100% - TP

Angle is computed by the ECM from the TP Sensor voltage. TP Angle should display 0% at idle and 100% at wide open throttle.

FUEL CONSUMPTION - Scan Tool Range 0-100

gph - This is the gallons per hour of fuel that the engine is consuming.

INJ. PULSE WIDTH - Scan Tool Range 0-1000

msec. - Indicates the amount of time the ECM is commanding the injectors "ON" during each engine cycle. A larger injector pulse width will cause more fuel to be delivered. Inj. Pulse Width should increase with increased engine load.

SPARK ADVANCE - Scan Tool Range -90° to 90°-

This is a display of the spark advance (IC) calculations which the ECM calculates and then provides all spark advance to the ignition system. The ECM computes the desired spark advance using data such as engine temperature, RPM, engine load, vessel speed, and operating mode. There is no adjustment for spark advance. The ECM also uses spark advance to help maintain idle speed. Under normal operating condition, with the engine warmed up and 0% throttle angle, it is normal to see timing vary continuously.

KNOCK RETARD - Scan Tool Range 0.0°-45.5° -

Indicates the amount of spark the ECM is removing from IC spark advance in response to the signal from the knock sensor (KS).

KS ENABLED - Scan Tool Displays "YES" or

"NO" - This is informing you whether or not the Knock System is enabled.

KNOCK SIGNAL - Scan Tool Displays "YES" or

"NO" - Indicates whether or not a knock signal is being detected by the ECM. Should display "NO" at idle.

KNOCK SENSOR 1 - Scan Tool Displays "OK" or

"Fault" - Indicates whether or not a fault is being detected on the knock sensor 1 circuit. Some early models use one knock sensor. Later models use 2 knock sensors.

KNOCK SENSOR 2 - Scan Tool Displays "OK" or

"Fault" - Indicates whether or not a fault is being detected on the knock sensor 2 circuit.

IAC POSITION - Scan Tool Range 0-255 - Displays

the commanded position of the idle air control pintle in counts. A larger number of counts means that more air is being commanded through the idle air passage. Idle air control should respond fairly quickly to changes in engine load to maintain desired idle RPM.

IAC THROTTLE FOLLOWER - Scan Tool Range 0-

255 - When the throttle is moved from the closed throttle position, some idle air control counts are added to prevent stalling when returned to the closed throttle position.

CLOSED THROTTLE - Scan Tool Displays "YES"

or "NO" - Indicates whether the throttle is in the closed position.

VESSEL SPEED - Scan Tool Range 0-255 MPH -

Indicates the speed of the vessel in MPH. Used for EVC system.

BATTERY / IGNITION VOLTAGE - Scan Tool Range

0.0 - 25.5 volts - This represents the system voltage

SYSTEM VOLTAGE WARNING - Scan Tool Dis-

plays "OK" or "LOW VOLTAGE" - Indicates if there may be a fault in the charging system.

J2-9 INPUT - Scan Tool Displays “ON” or “OFF” - This is a discrete input to the ECM that is determined and calibratable per OEM.

J2-20 INPUT - Scan Tool Displays “ON” or “OFF” - This is a discrete input to the ECM that is determined and calibratable per OEM.

EMERGENCY STOP MODE - Scan Tool Displays “YES” or “NO” - Indicates whether you are in emergency stop mode or not.

TROLL RPM LIMIT - Scan Tool Displays “ON” or “OFF” - This is a discrete input to the ECM which limits the RPM for such things as trolling. This RPM limit is calibratable by the OEM.

MIL - Scan Tool Displays “ON” or “OFF” - Indicates the ECM commanded state of the Malfunction Indicator Lamp.

FUEL PUMP RELAY - Scan Tool Displays “ON” or “OFF” - Indicates the ECM commanded state of the fuel pump relay driver circuit.

CAUSE POWER REDUCTION - Scan Tool Displays “YES” or “NO” - Indicates whether or not the ECM has recognized a fault which would put the engine into Power Reduction when the appropriate RPM is achieved.

POWER REDUCTION - Scan Tool Displays “YES” or “NO” - Indicates whether or not the ECM is functioning in Power Reduction mode. During this mode, the ECM only triggers one injector driver resulting in fuel to only half of the cylinders.

OVERHEAT DETECTED - Scan Tool Displays “YES” or “NO” - Indicates if the ECM has recognized an overheat condition with the engine.

OIL PRESSURE WARNING - Scan Tool Displays “OK” or “LOW PRESSURE” - Indicates if the ECM has recognized a fault in the oil pressure circuit and on earlier models exhaust cooling system.

CHECK GAUGES LAMP - Scan Tool Displays “ON” or “OFF” - Indicates the ECM commanded state of the Check Gauges lamp.

BUZZER - Scan Tool Displays “ON” or “OFF” - Indicates the ECM commanded state of the Buzzer.

GENERAL WARNING 1 - Scan Tool Displays “OK” or “Fault Detected” - Indicates a fault in the exhaust cooling system on later models.

J1-21 OUTPUT - Scan Tool Displays “ON” or “OFF” - Indicates the ECM commanded state of this output circuit.

GENERAL WARNING 2 - Scan Tool Displays “OK” or “Fault Detected” - This is a discrete input to the ECM that is determined and calibratable per OEM.

J1-22 OUTPUT - Scan Tool Displays “ON” or “OFF” - ECM driven output that is determined and calibratable per OEM.

ECM MASTER / SLAVE - Scan Tool Displays “MASTER” or “SLAVE” - Indicates whether you are receiving data from a master or a slave engine.

J1-8 RPM OUTPUT - Scan Tool Displays “ON” or “OFF” - ECM driven output that is determined and calibratable per OEM.

TIME FROM START - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec - Indicates the amount of time the ignition key was in the “ON” or “RUN” position. Once the key has been cycled to the “OFF” position, this counter will reset to 00:00.

ENGINE HOUR METER - Scan Tool Range 00:00:00-99:99:99 Hrs:Min:Sec - Indicates the engine run time.

ECM Diagnostic Trouble Codes

The Malfunction Indicator Lamp (MIL) will be “ON” if the malfunction exists under the conditions listed below. If the malfunction clears, the lamp will go out and the Diagnostic Trouble Code (DTC) will be stored in the ECM. Any DTC's stored will be erased if no problem re-occurs within 50 engine starts. The amount of time after the malfunction occurs before the MIL illuminates is calibratable. (Instantly or up to one minute).

Many of the DTC tables include a functional check of the system that may pinpoint a problem. However, it is important to remember that the DTC tables are specifically designed for use only when a DTC is set. Therefore, a thorough understanding of the normal operation of the system being diagnosed is necessary, and use of the tables for this purpose is at the discretion of the technician.

NOTE! Some DTC's are referred as “Latching Codes”. A latching code will cause the MIL lamp to stay “ON” during an ignition cycle whether the malfunction is corrected or not. This also means you can not clear the DTC during the same ignition cycle.

Logged Warnings

These warnings will be displayed following the Diagnostic Trouble Codes. They can be cleared the same as the trouble codes. Unlike trouble codes, these warnings can not be flashed out through the MIL using the DTC tool.

Clearing Diagnostic Trouble Codes - Scan

1. Install scan tool.
2. Start engine.
3. Select “Clear DTC's” function.
4. Clear DTC's.
5. Turn ignition “OFF” for at least 20 seconds.
6. Turn ignition “ON” and read DTC's. If DTC's are still present, check “Note” below and repeat procedure following from step 2.

NOTE! When clearing DTC's with or without the use of a scan tool, the ignition must be cycled to the “OFF” position or the DTC's will not clear.

Diagnostic Trouble Code (DTC) Table

DTC	Description
13	Oxygen Sensor Circuit 1 (inactive)
13	Oxygen Sensor Circuit 2 (inactive)
14	Engine Coolant Temperature (ECT) Sensor Circuit. Low Temperature Indicated.
15	Engine Coolant Temperature (ECT) Sensor Circuit. High Temperature Indicated
21	Throttle Position (TP) Sensor Circuit High Signal Voltage Indicated
22	Throttle Position (TP) Sensor Circuit Low Signal Voltage Indicated
23	Intake Air Temperature (IAT) Sensor Circuit Low Temperature Indicated
24	Not Used
25	Intake Air Temperature (IAT) Sensor Circuit High Temperature Indicated
31	Not Used
33	Manifold Absolute Pressure (MAP) Sensor Circuit High Signal Voltage Indicated
34	Manifold Absolute Pressure (MAP) Sensor Circuit Low Signal Voltage Indicated
41	Ignition Control (IC) H Fault
41	Ignition Control (IC) G Fault
41	Ignition Control (IC) F Fault
41	Ignition Control (IC) E Fault
41	Ignition Control (IC) D Fault
41	Ignition Control (IC) C Fault
41	Ignition Control (IC) B Fault
41	Ignition Control (IC) A Fault
44	Knock Sensor (KS) 1 Circuit
44	Knock Sensor (KS) 2 Circuit
51	Calibration Checksum Failure
54	Not Used
55	Not Used
61	Not Used
62	Not Used
63	Not Used
64	Not Used
81	Crankshaft Position (CKP) Sensor Circuit Fault
81	Camshaft Position (CMP) Sensor Circuit Fault
81	Injector Driver A Circuit High, Low, Open
81	Injector Driver B Circuit High, Low, Open
81	Recirc J1-32 Fault
81	5 Volt Reference Circuit Out of Range
81	DEPSPWR Circuit out of range
81	CAN Bus Fault

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System Configuration Options

Scan Tool Parameter	Units	Parameter Range
Cam Sensor	Discrete	Yes/No
7X Crank Sensor	Discrete	Yes/No
24X Encode Crank Sensor	Discrete	Yes/No
Knock Sensor	Discrete	Yes/No
Intake Air Temperature	Discrete	Yes/No
GPH Calculation Enabled	Discrete	Yes/No
Alternate Fuel Spark Curve	Discrete	Yes/No
Shift Interrupt	Discrete	Yes/ No
Power Balance	Discrete	Yes/No
Bosch IAT/MAP Sensor	Discrete	Yes/No

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Diagnosis

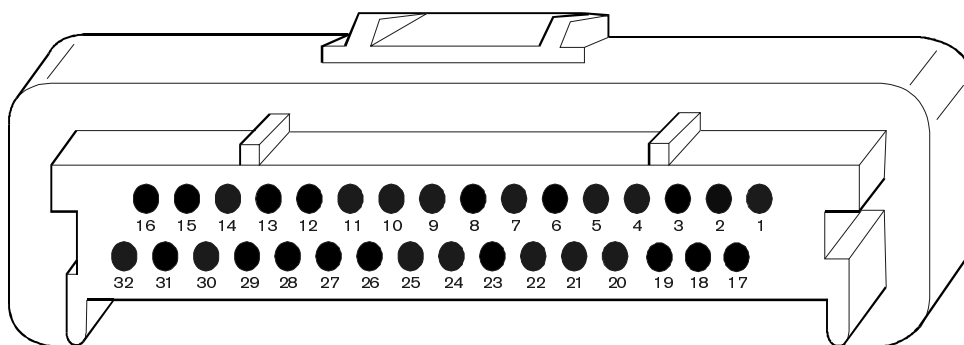
The diagnostic tables and functional checks in this manual are designed to locate a faulty circuit or component through logic based on the process of elimination. The tables are prepared with the requirement that the system functioned correctly at the time of assembly and that there are no multiple failures.

Engine control circuits contain many special design features not found in standard vessel wiring. Environmental protection is used extensively to protect electrical contacts. Proper splicing methods must be used when necessary.

The proper operation of low amperage input/output circuits depend upon good continuity between circuit connectors. It is important before component replacement and/or during normal troubleshooting procedures that a visual inspection of any questionable mating connector is performed. Mating surfaces should be properly formed, clean and likely to make proper contact. Some typical causes of connector problems are listed below:

- Improperly formed contacts and/or connector housing.
- Damaged contacts or housing due to improper engagement.
- Corrosion, sealer or other contaminants on the contact mating surfaces.
- Incomplete mating of the connector halves during initial assembly or during subsequent troubleshooting procedures.
- Tendency for connectors to come apart due to vibration and/or temperature cycling.
- Terminals not fully seated in the connector body.
- Inadequate terminal crimps to the wire.

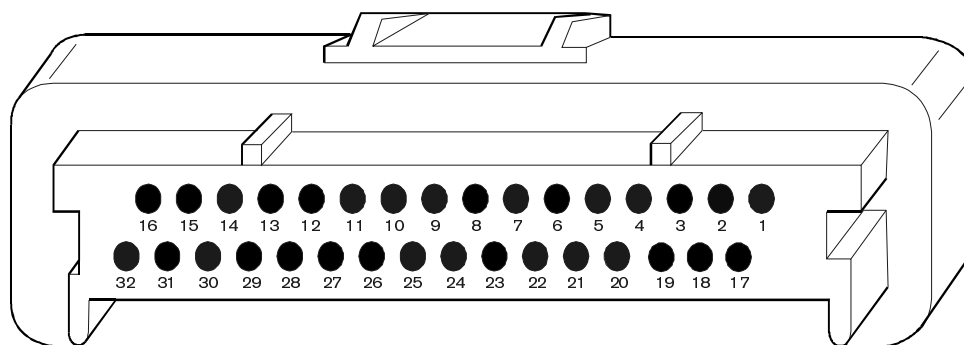
J-1 ECM 32 Pin Connector



J1-1	SB/GN	Knock sensor number 2 signal
J1-2	W/SB	Diagnostic test terminal
J1-3	Y/GR	Master/Slave
J1-4		
J1-5		
J1-6	SB/Y	Fuel pump relay control
J1-7		RPM Change state
J1-8	T/SB	Alarm
J1-9		
J1-10		
J1-11	T/OR	Fuel injector B driver
J1-12		
J1-13	SB	ECM ground
J1-14	GR	Tachometer output
J1-15	GN/SB	Idle air control (IAC) coil B low
J1-16	BL/Y	Idle air control (IAC) coil A high
J1-17	SB/GN	Knock sensor number 1 signal
J1-18		
J1-19		Exhaust temperature sensor
J1-20		Shift interrupt
J1-21		
J1-22		
J1-23		
J1-24		
J1-25		
J1-26	T/BL	Fuel injector A driver
J1-27	GN/Y	Check engine light
J1-28	SB	ECM ground
J1-29	SB	ECM ground
J1-30	P/BL	Idle air control (IAC) coil B high
J1-31	BN/Y	Idle air control (IAC) coil A low
J1-32		

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J-2 ECM 32 Pin Connector



J2-1	R/PU	Battery Feed
J2-2	GR/O	5 Volt reference
J2-3	SB/O	Sensor ground
J2-4		
J2-5		
J2-6		
J2-7	Y/BL	ECT sensor signal
J2-8	Lt GN	MAP sensor signal
J2-9		
J2-10	O/SB	Serial data
J2-11		
J2-12	BL/W	Ignition control H
J2-13	GN/W	Ignition control F
J2-14	R	Ignition control D
J2-15	PU	Ignition control B / bypass (distributor applications)
J2-16	GR/BL	Crank sensor
J2-17	SB/W	DESPower
J2-18	GR/SB	DEPSLO
J2-19	P/W	Ignition feed
J2-20	T/SB	Oil pressure input
J2-21	T/Y	IAT sensor signal
J2-22		
J2-23	O/BL	TP sensor signal
J2-24		
J2-25		
J2-26		
J2-27		
J2-28	GN	Ignition control G
J2-29	Lt BL	Ignition control E
J2-30	R/W	Ignition control C
J2-31	PU/W	Ignition control A
J2-32	SB/T	Cam sensor signal

Diagnostic Information and Procedures

A Diagnostic Starting Point

Begin the system diagnosis with *A Diagnostic System Check-Engine Controls*. The Diagnostic System Check will provide the following information:

- The ability of the control module to communicate through the serial data circuit.
- The identification of any stored Diagnostic Trouble Codes (DTCs) and Logged Warnings.

The use of the Diagnostic System Check will identify the correct procedure for diagnosing the system.

A Diagnostic System Check

Description

The Diagnostic System Check is an organized approach to identifying a condition that is created by a malfunction in the electronic engine control system. The Diagnostic System Check must be the starting point for any drivability concern. The Diagnostic System Check directs the service technician to the next logical step in order to diagnose the concern. Understanding, and correctly using the diagnostic table reduces diagnostic time, and prevents the replacement of good parts.

Test Description

Number(s) below refer to the Step number(s) on the Diagnostic Table:

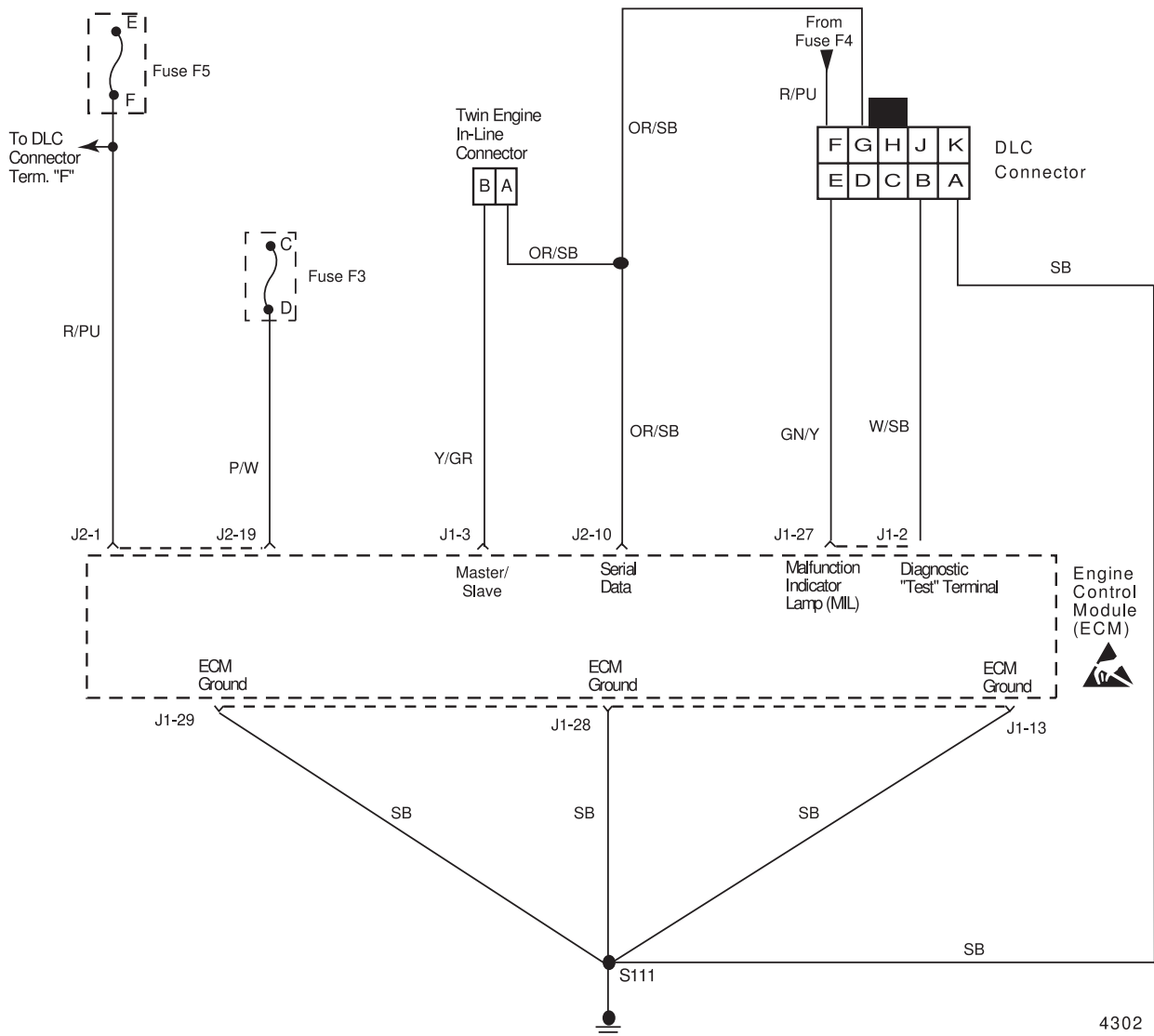
1. The MIL should be "ON" steady with the ignition "ON", engine "OFF".
3. Checks the serial data circuit and ensures that the ECM is able to transmit serial data.
5. If the engine will not start, *Engine Cranks but Does Not Run* should be used to diagnose the condition.
8. A scan tool parameter which is not within the typical range may help to isolate the area which is causing the problem.

On-Board Diagnostic (OBD) System Check

Step	Action	Value	Yes	No
1	IMPORTANT: - Do not perform this diagnostic if there is not a drivability concern, unless another procedure directs you to this diagnostic. - Before you proceed with diagnosis, search for applicable service Bulletins. - Unless a diagnostic procedure instructs you, DO NOT clear DTC's. - If there is a condition with the starting system, repair that first. - Insure the battery has a full charge. - Ensure the battery cables ore clean, tight, and the correct size. - Ensure the ECM grounds are clean, tight, and in the correct location. Install a Scan Tool. Does the scan tool turn ON?	—	Go to Step 2	Go to Data Link Connector Diagnosis
2	1. Attempt to start the engine. Does the engine start and idle.	—	Go to Step 3	Go to Engine Cranks But Does Not Run
3	1. Select the DTC display function on the Scan tool. Does the scan tool display DTCs?	—	Go to Applicable DTC Table	Go to Step 4
4	1. Review the following symptoms. Refer to the applicable symptom diagnostic table Hard Start Surges Lack of Power Detonation/Spark Knock Hesitation Cuts out, Misses Poor Fuel Economy Rough, Unstable or Incorrect Idle and Stalling Dieseling, Run-On Backfire Did you find and correct the condition?	—	System OK	Go to Intermittent Conditions

22659

Data Link Connector Diagnosis



Circuit Description

Use a properly functioning scan tool with the diagnostic tables in this section. DO NOT clear the DTC's unless directed by a diagnostic procedure. Clearing the DTC's may also clear valuable diagnostic information.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

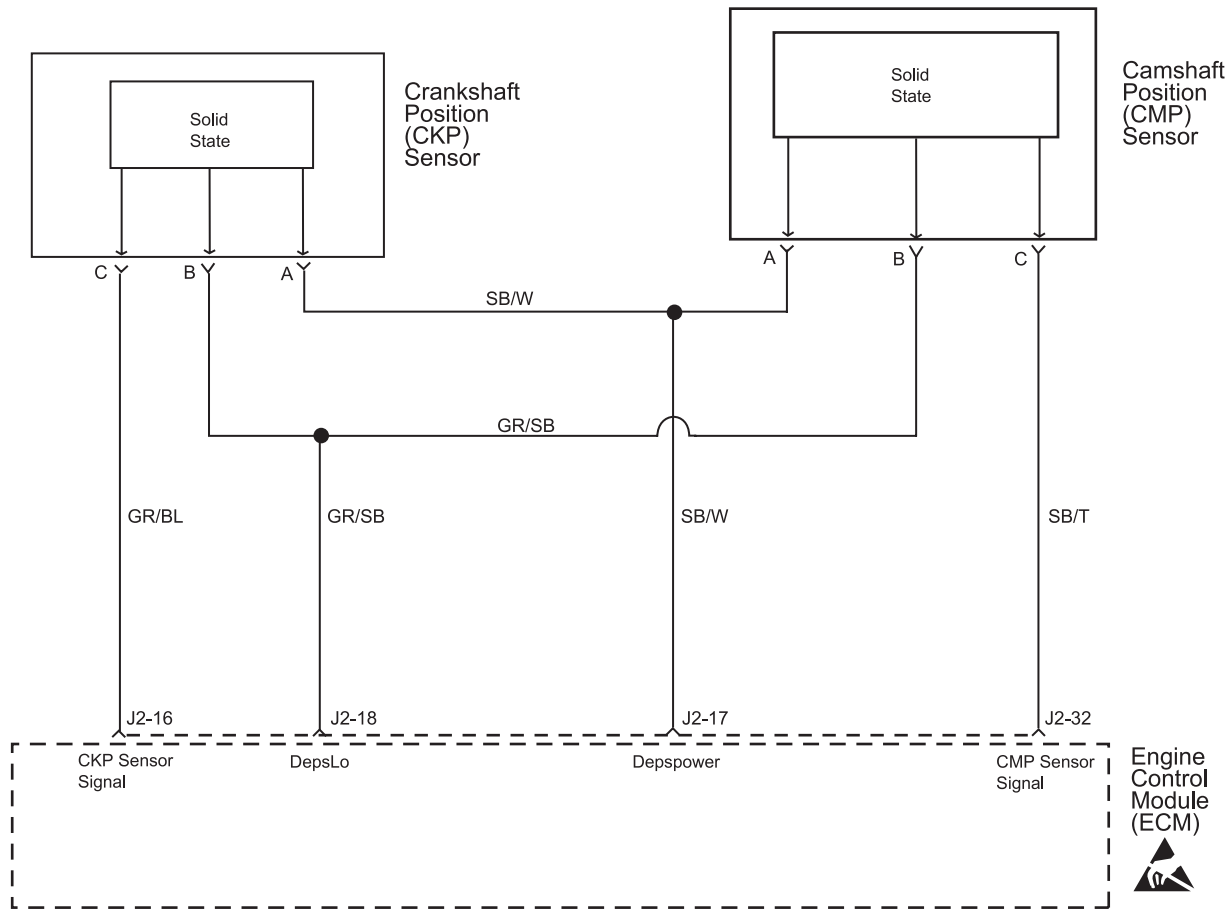
3. An engine that just cranks and does not attempt to start indicates that the ECM is not powered-up.
5. This step is checking for a B+ supply to the Data Link Connector (DLC).
6. A ground must be available for the scan tool to function properly.
9. A no start condition occurs when the fuse(s) for the battery or ignition feed circuits is open. The MIL is inoperative when the battery and ignition feed circuit fuses open. Inspect the circuits for being grounded when either of these fuses open.
12. The scan tool does not communicate when the serial data circuit from the ECM to the DLC is open.
14. If the test lamp not illuminate for a circuit, inspect the fuse for being open. If the fuse is open, inspect the circuit for a short to ground.
15. Inspect for an open ground circuit.
16. Inspect for an open fuse that supplies the DLC. If the fuse is open, repair the grounded circuit.

Data Link Connector Diagnosis

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	IMPORTANT: This test assumes that the Scan tool you are using is functional. 1. Turn ON the ignition leaving the engine OFF. 2. Connect the Scan tool to the DLC. Does the scan tool power-up?	—	Go to Step 3	Go the Step 5
3	Does the engine start and continue to run?	—	Go to Step 6	Go to Step 4
4	Does the engine start and stall?		Go to Step 12	Go to Step 9
5	1. Disconnect the Scan tool for the DLC. 2. Turn ON the ignition leaving the engine OFF. 3. Probe the DLC terminal F using a test lamp connected to the battery ground. Is the test lamp illuminated?	—	Go to Step 6	Go to Step 16
6	Probe the DLC terminal A using a test lamp connected to B+ Is the test lamp illuminated?	—	Go to Step 7	Go to Step 8
7	Inspect the scan tool connections at the DLC. Also inspect the terminals for proper terminal tension at the DLC. Did you find and repair the condition?	—	Go to OBD System Check	Go to Step 12
8	Repair the open ground circuit to the DLC terminal A. Is the action complete?	—	Go to OBD System Check	—
9	1. Turn OFF the ignition. 2. Disconnect the ECM J-2 connector. 3. Turn the ignition ON leaving the engine OFF. 4. Probe the ECM battery and ECM ignition feed circuits (J2-1 and J2-19) in the ECM harness connector using a test lamp connected to ground. Does the test lamp illuminate for each circuit?	—	Go to Step 10	Go to Step 14
10	1. Turn OFF the ignition. 2. Disconnect the ECM connector J1. 3. Measure the resistance between the battery ground and the ECM ground circuits J1-12, J1-28 and J1-29 in the ECM harness connectors using a digital multimeter (DMM). Does the DMM display between the specified range on each circuit?	0-2 Ohms	Go to OBD System Check	Go to Step 15
11	Inspect the ECM for proper connections. Did you find and correct the condition	—	Go to OBD System Check	Go to Step 13
12	Inspect the serial data circuit for open, shorted or a poor connection at the ECM. Did you find and repair the condition?	—	Go to OBD System Check	Go to Step 13
13	Replace the ECM. Is the action complete?	—	Go to OBD System Check	—
14	Repair the circuit that did not illuminate the test lamp. Is the action complete?	—	Go to OBD System Check	—
15	Repair the faulty ECM ground circuits. Is the action complete?	—	Go to OBD System Check	—
16	Repair the faulty B+ supply circuit. Is the action complete	—	Go to OBD System Check	—

22660

Engine Cranks but Does Not Run



4331

Circuit Description

The Engine Cranks but Does Not Run diagnostic table assumes that battery condition and engine cranking speed are OK. If the battery condition and the cranking speed are not OK, refer to those conditions first. Make sure that there is adequate fuel in the fuel tank(s).

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

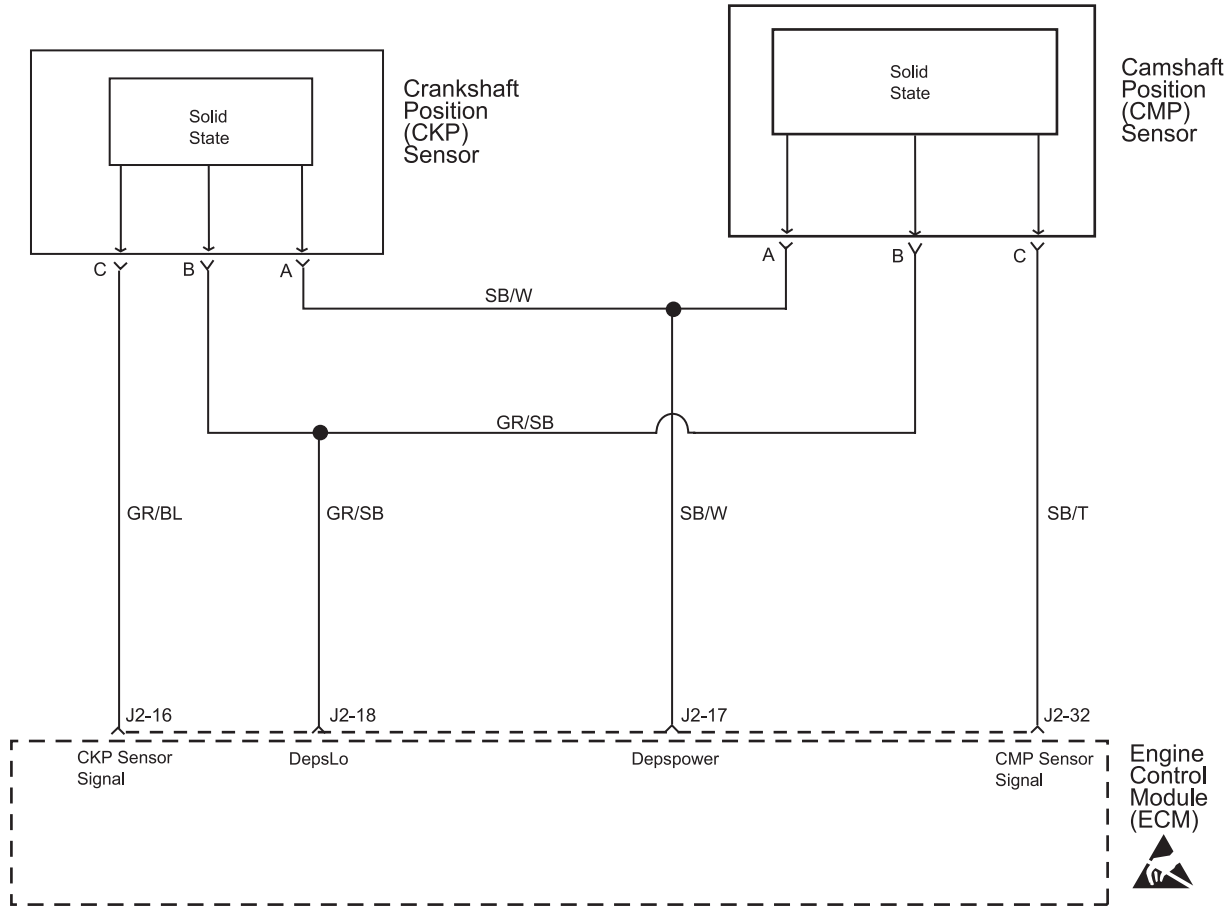
4. It may be necessary to connect a battery charger to the battery for this step. If the battery state of charge is low, the scan tool may reset during the cranking test.
5. This step tests the system relay for proper operation. The system relay supplies voltage to the injectors and the ignition coils. When the system relay is not operating properly, a no start condition occurs. If the test lamp does not illuminate, this indicates the system relay is not supplying a voltage to the fuses.
6. The Crankshaft Position sensor is located at the left rear of the engine.
7. The Camshaft Position sensor is located in the front engine cover.
8. The ignition feed circuit for the Camshaft and Crank shaft Position sensors is internally connected within the ECM. A short to ground on either circuit will cause a no start condition.
10. You may need to get close to the fuel pump in order to hear if the fuel pump is operating.
12. At this point, the engine should start. Refer to *Hard Start Symptoms* in Section 4B for further diagnosis.

Engine Cranks but Does Not Run

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	IMPORTANT: Refer to the applicable DTC table if DTC 41 or 81 are set. 1. Monitor the engine speed while cranking the engine. Is the engine RPM indicated on the scan tool?		Go to Step 3	Go to Step 4
3	1. Turn ON the ignition leaving the engine OFF. 2. Probe both sides of the fuses listed below using a test lamp connected to ground. • Fuse F3 • Fuse F4		Go to Step 7	Go to System Relay Diagnosis
4	1. Disconnect the Crankshaft Position Sensor (CKP) electrical connector 2. Measure the voltage at the ignition feed circuit at the CKP electrical connector using a Digital Multi-meter. Does the DMM display near the specified voltage?	B+	Go to Step 11	Go to Step 5
5	1. Disconnect the Camshaft Position Sensor (CMP) electrical connector. 2. Measure the voltage at the ignition feed circuit at the CMP electrical connector using a Digital Multi-meter. Does the DMM display the specified voltage?	B+	Go to Step 12	Go to Step 6
6	1. Inspect the Camshaft and Crankshaft Position sensor ignition feed circuits for a short to ground. Did you find and correct the condition?		Go to Step 14	Go to Step 13
7	1. Monitor the engine coolant temperature using the scan tool. Is the engine coolant temperature on the scan tool close to the actual engine temperature?		Go to Step 8	Go to DTC 15 ECT Sensor Circuit High Volt
8	1. Enable the fuel pumps using the scan tool. Do the pumps operate?		Go to Step 9	Go to Fuel System Relay Diagnosis
9	1. Turn OFF the ignition. 2. Install a fuel pressure gauge. IMPORTANT: The fuel pumps operate for about 2 seconds when the ignition is turned ON. The fuel pressure must be observed when the fuel pumps are operating. 3. Turn ON the ignition leaving the engine OFF. 4. Observe the fuel pressure with the fuel pumps operating. Is the fuel pressure within the specified range?	344-413 kPa(50-60) psi	Go to Step 10	Go to Fuel System Diagnosis
10	Perform the following additional inspections: • Inspect the throttle angle is at 0% at closed throttle. If the throttle angle is not 0%, refer to DTC 21 Throttle Position (TP) sensor circuit Low Voltage. • Inspect the spark plugs for gas fouling. If the spark plugs are fouled, determine what caused the rich condition. • Inspect for an engine mechanical failure that causes an engine not to start (i.e. slipped timing chain, low compression, etc.) Refer to <i>Engine Compression</i> test in the <i>Engine Components Workshop Manual</i> . • Compare the MAP/BARO parameters to another engine. The parameter values should be close to each other.	—	Go to Step 14	Go to Hard Start for Diagnosis
11	1. Replace the CKP sensor. Refer to <i>Crankshaft Position Sensor Replacement</i> . Is the action complete?	—	Go to Step 14	—

22661

Engine Cranks but Does Not Run (cont.)



Circuit Description

The Engine Cranks but Does Not Run diagnostic table assumes that battery condition and engine cranking speed are OK. If the battery condition and the cranking speed are not OK, refer to those conditions first. Make sure that there is adequate fuel in the fuel tank(s).

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

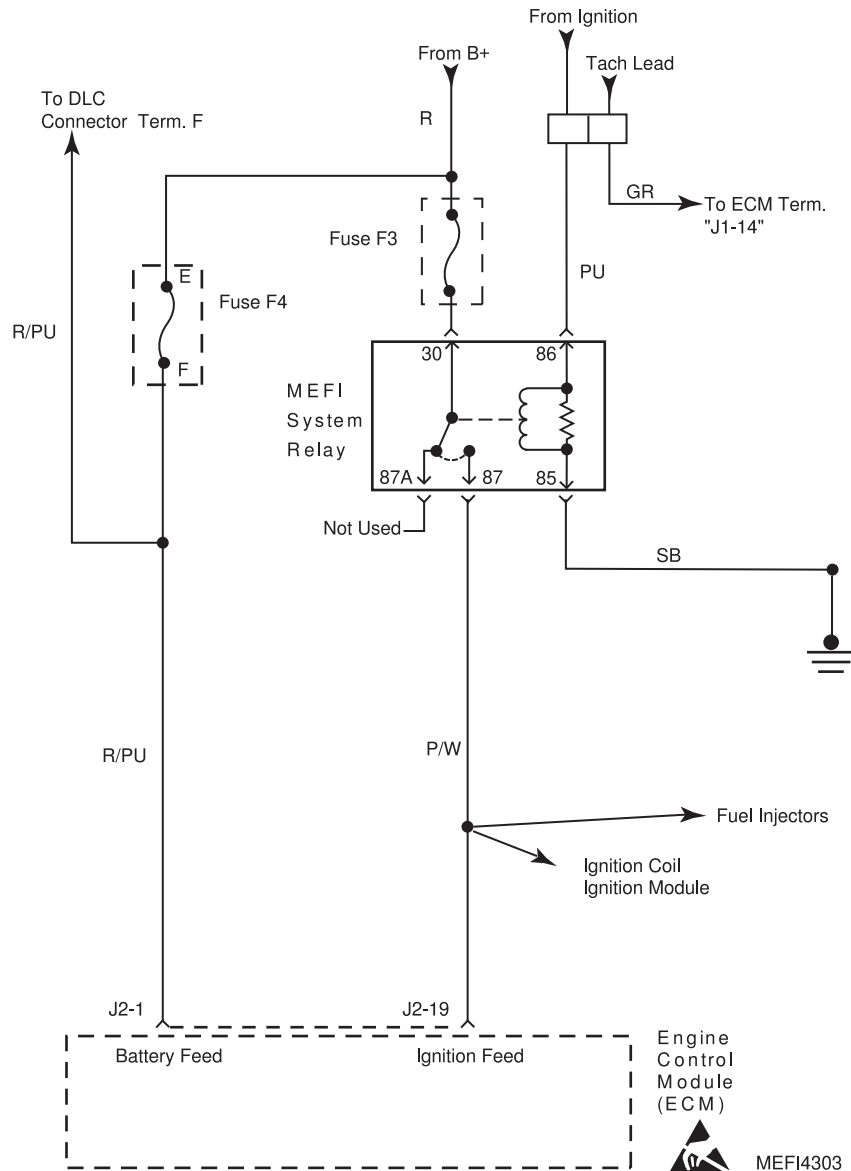
4. It may be necessary to connect a battery charger to the battery for this step. If the battery state of charge is low, the scan tool may reset during the cranking test.
5. This step tests the system relay for proper operation. The system relay supplies voltage to the injectors and the ignition coils. When the system relay is not operating properly, a no start condition occurs. If the test lamp does not illuminate, this indicates the system relay is not supplying a voltage to the fuses.
6. The Crankshaft Position sensor is located at the left rear of the engine.
7. The Camshaft Position sensor is located in the front engine cover.
8. The ignition feed circuit for the Camshaft and Crank shaft Position sensors is internally connected within the ECM. A short to ground on either circuit will cause a no start condition.
10. You may need to get close to the fuel pump in order to hear if the fuel pump is operating.
12. At this point, the engine should start. Refer to *Hard Start Symptoms* in Section 4B for further diagnosis.

Engine Cranks but Does Not Run (cont.)

Step	Action	Value	Yes	No
12	Replace the CMP sensor. Refer to Camshaft Position Sensor Replacement. Is the action complete?	—	Go to Step 14	—
13	Replace the ECM Is the action complete?	—	Go to Step 14	—
14	1. Select the Diagnostic Trouble codes (DTC) option and clear the DTC option using the scan tool. 2. Attempt to start the engine. Does the engine start and continue to run?	—	Go to Step 15	Go to Step 2
15	1. Idle the engine at normal operating temperature. 2. Select the Diagnostic Trouble Codes (DTC) option using the scan tool. Are there any DTCs displayed	—	Go to the applicable DTC table	System OK

22662

Ignition Relay Diagnosis



Circuit Description

The system relay powers the following components:

- Injectors
- Ignition Coils

Diagnostic Aids

The following may cause an intermittent:

- Poor connections. Check for adequate terminal tension.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

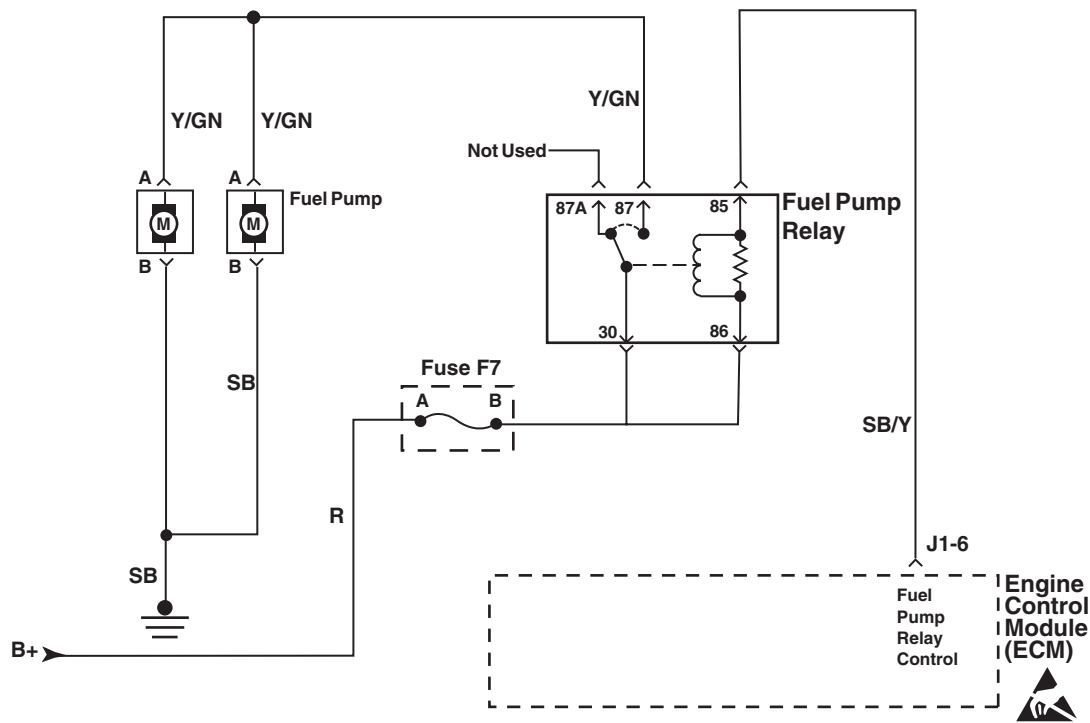
2. Refer to *Schematic* for proper relay terminal identification.
4. This step is testing the relay ground circuit.
5. This step isolates the circuit from the system relay. All of the circuits are good if the test lamp illuminates.

Ignition Relay Diagnosis

Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System check?	—	Go to Step 2	Go to OBD System Check
2	1. Turn OFF the ignition. 2. Remove the ignition relay from the socket in the fuse box. 3. Probe the ignition relay B+ feed circuit (switch side of the relay) using a test lamp connected to a ground. Does the test lamp illuminate?	—	Go to Step 3	Go to Step 8
3	1. Turn ON the ignition leaving the engine OFF. 2. Probe the ignition relay ignition feed circuit using a test lamp connected to a ground. Does the lamp illuminate?	—	Go to Step 4	Go to Step 9
4	1. Turn OFF the ignition. 2. Measure the resistance of the ignition relay ground circuit using a Digital Multi-meter connected to battery ground. Is the resistance less than the specified value?	0-5 Ohms	Go to Step 5	Go to Step 10
5	1. Turn OFF the ignition. 2. Jumper the ignition relay B+ feed circuit and the ignition relay load circuit together using a fused jumper wire. 3. Probe the fuses for the following components with a test lamp connected to a ground. • Injectors • Ignition Coils Does the lamp illuminate?	—	Go to Step 6	Go to Step 11
6	1. Inspect for poor terminal contact at the ignition relay connector. Did you find and correct the condition?	—	System OK	Go to Step 7
7	1. Replace the ignition relay. Is the action complete?	—	System OK	—
8	1. Repair the open B+ supply to the ignition relay. Is the action complete?	—	System OK	—
9	1. Repair the ignition feed circuit to the ignition relay. Is the action complete?	—	System OK	—
10	1. Repair the ignition relay ground circuit. Is the action complete?	—	System OK	—
11	1. Repair the ignition relay load circuit. Is the action complete?	—	System OK	—

22663

Fuel Pump Relay Circuit Diagnosis



4304

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pump. The fuel pump remains ON as long as the ECM receives reference pulses from the ignition system. If there are no reference pulses, the ECM turns the fuel pump OFF after about 2 seconds. The pump delivers fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure remains at 344-413 kPa (50-60 psi) for 4.3, 5.0, and 5.7 models and 248-303 kPa (36-44 psi) for 8.1 models while the fuel pump is running. Excess fuel returns to the fuel tank. When the engine is stopped, a scan tool in the output controls function can turn ON the fuel pump.

Improper fuel system pressure results in one or many of the following symptoms:

- Cranks but will not run
- Cuts out, may feel like an ignition problem
- Poor fuel economy
- Loss of power
- Hesitation
- DTCs

Diagnostic Aids

The following conditions may have caused the fuel pump fuse to open:

- The fuse is faulty
- There is an intermittent short in the fuel pump power feed circuit.
- The fuel pump has an intermittent internal problem.

For an intermittent condition, refer to *Symptoms* Section.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

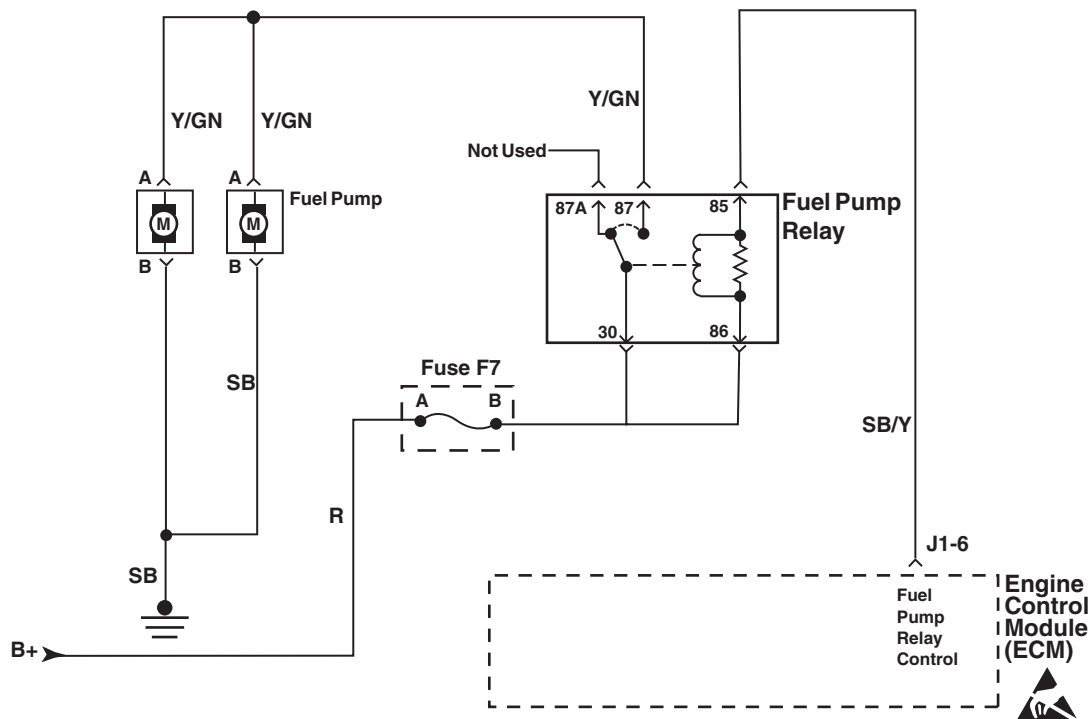
3. Refer to *Schematic* for proper terminal identification.
5. The test lamp only illuminates for two seconds even through the scan tool commanded position is ON. You will have to command the fuel pump OFF then ON to re-enable the ECM fuel pump control.
12. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.
20. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.

Fuel Pump Relay Circuit Diagnosis

Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	1. Check the fuel pump fuse (F7). Is the fuse open?	—	Go to Step 9	Go to Step 3
3	1. Install a scan tool. 2. Remove the fuel pump relay. 3. Turn the ignition ON, leave the engine OFF. 4. Probe the fuel pump relay battery feed circuit at the socket with a test lamp connected to a ground. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 12
4	1. Probe the fuel pump relay ground circuit at the socket with a test lamp connected to B+. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 13
5	1. Probe the fuel pump control circuit at the harness connector with a test lamp connected to a ground. 2. Enable the fuel pumps using the scan tool. Does the test lamp illuminate?	—	Go to Step 6	Go to Step 11
6	IMPORTANT: Ignition must be ON performing this step. 1. Jumper the fuel pump relay battery feed circuit to the fuel pump load circuit at the fuse box socket with a fused jumper wire. Does the fuel pump operate?	—	Go to Step 18	Go to Step 7
7	1. Leave the fused jumper wire connected. 2. Disconnect the fuel pump harness connectors at the fuel pumps. 3. Probe the power feed circuit in the fuel pump harness connector with a test lamp connected to a ground. Does the lamp illuminate?	—	Go to Step 8	Go to Step 14
8	1. Leave the fused jumper wire connected. 2. Connect the test lamp between the battery feed circuit and the ground circuit in the fuel pump harness connector. Does the lamp illuminate?	—	Go to Step 25	Go to Step 15
9	1. Turn the ignition OFF. 2. Remove the fuel pump fuse. 3. Disconnect the fuel pump harness connector at the fuel pumps. 4. Probe the load circuit for the fuel pump relay at the fuse box socket with a test lamp connected to B+. Does the test lamp illuminate?	—	Go to Step 16	Go to Step 10
10	1. Probe the battery feed circuit to the fuel pump relay at the harness connector with a test lamp connected to B+. Does the test lamp illuminate?	—	Go to Step 20	Go to Step 21
11	1. Turn the ignition OFF. 2. Disconnect the ECM connector J1. 3. Measure the continuity of the fuel pump relay control circuit for the fuel pump relay harness connector to the ECM connector using a Digital Multi-meter. Does the DMM display the specified value or lower?	5 Ohms	Go to Step 22	Go to Step 17
12	1. Repair the open or grounded battery feed circuit to the relay. 2. Replace the fuel pump fuse (F7) if the fuse is open. Is the action complete?	—	Go to Step 26	—
13	1. Repair the open fuel pump relay ground circuit. Is the action complete?	—	Go to Step 26	—

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Fuel Pump Relay Circuit Diagnosis (cont.)



4304

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pump. The fuel pump remains ON as long as the ECM receives reference pulses from the ignition system. If there are no reference pulses, the ECM turns the fuel pump OFF after about 2 seconds. The pump delivers fuel to the fuel rail and injectors, then to the pressure regulator, where the system pressure remains at 344-413 kPa (50-60 psi) for 4.3, 5.0, and 5.7 models and 248-303 kPa (36-44 psi) for 8.1 models while the fuel pump is running. Excess fuel returns to the fuel tank. When the engine is stopped, a scan tool in the output controls function can turn ON the fuel pump.

Improper fuel system pressure results in one or many of the following symptoms:

- Cranks but will not run
- Cuts out, may feel like an ignition problem
- Poor fuel economy
- Loss of power
- Hesitation
- DTCs

Diagnostic Aids

The following conditions may have caused the fuel pump fuse to open:

- The fuse is faulty
- There is an intermittent short in the fuel pump power feed circuit.
- The fuel pump has an intermittent internal problem.

For an intermittent condition, refer to *Symptoms* Section.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

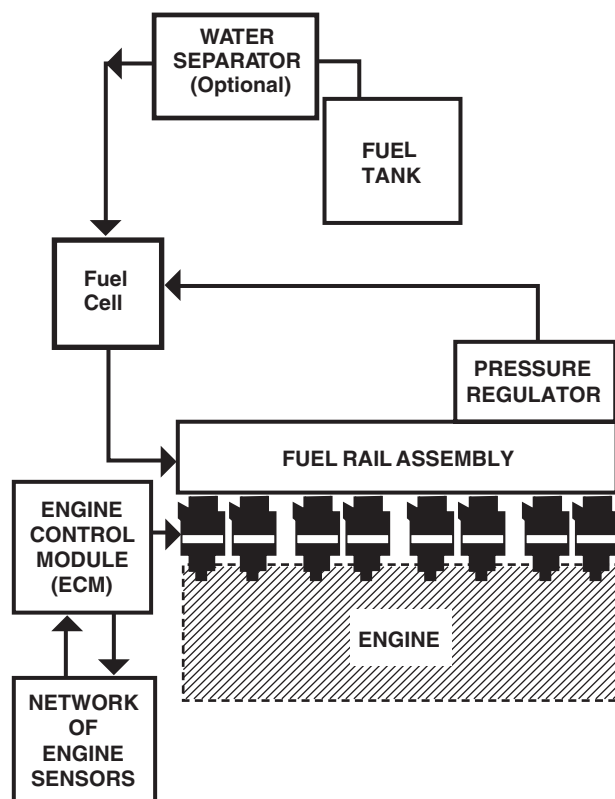
3. Refer to *Schematic* for proper terminal identification.
5. The test lamp only illuminates for two seconds even through the scan tool commanded position is ON. You will have to command the fuel pump OFF then ON to re-enable the ECM fuel pump control.
12. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.
20. Inspect the fuel pump fuse for an open. If the fuse is open, inspect the circuit for a short to ground.

Fuel Pump Relay Circuit Diagnosis (cont.)

Step	Action	Value	Yes	No
14	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 26	—
15	1. Repair the open fuel pump ground circuit. Is the action complete?	—	Go to Step 26	—
16	1. Repair the short to ground in the fuel pump relay load circuit between the relay and the fuel pump. Is the action complete?	—	Go to Step 26	—
17	1. Repair the fuel pump relay control circuit. Is the action complete?	—	Go to Step 26	—
18	1. Inspect for poor connections at the relay socket in the fuse box. Did you find and correct the condition?	—	Go to Step 26	Go to Step 19
19	1. Replace the fuel pump relay. Is the action complete?	—	Go to Step 26	—
20	1. Repair the short to ground in the battery feed circuit to the fuel pump relay. Is the action complete?	—	Go to Step 26	—
21	1. Turn OFF the ignition. 2. Re-install the fuel pump relay. 3. Install a new fuse. 4. Connect the fuel pump harness to the fuel pumps. 5. Turn ON the ignition leaving the engine OFF. 6. Command the fuel pump relay ON using the scan tool. Is the fuel pump fuse open?	—	Go to Step 24	Go to Diagnostic Aids
22	1. Inspect for a poor connection at the ECM. Did you find and correct the condition?	—	Go to Step 26	Go to Step 23
23	1. Replace the ECM. Is the action complete?	—	Go to Step 26	—
24	1. Inspect the fuel pump harness for a short to ground. 2. If you find a short, repair the circuit as necessary. Did you find and correct the condition?	—	Go to Step 26	Go to Step 25
25	IMPORTANT: Inspect for poor electrical connections at the fuel pump harness before replacing the fuel cell. 1. Replace the fuel cell. Is the action complete?	—	Go to Step 26	—
26	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Attempt to start the engine. Does the engine start and continue to operate?	—	Go to Step 27	Go to Step 2
27	1. Idle the engine until the normal operation temperature is reached. 2. Select the Diagnostic Trouble Code (DTC) option. Are there any DTCs displayed?	—	Go to the applicable DTC Table	System OK

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Fuel System Diagnosis



22798

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pumps. The fuel pumps remain ON as long as the ECM receives reference pulses from the ignition system. If there are no reference pulses, the ECM turns the fuel pumps OFF after about 2 seconds.

The electric fuel pumps deliver filtered fuel to the fuel rail assembly. The fuel pumps provide fuel at a pressure above the pressure needed by the fuel injectors. A fuel pressure regulator, attached to the fuel rail, keeps the fuel available to the fuel injectors at a regulated pressure. Unused fuel returns to the fuel cell by a separate fuel return pipe.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

2. When the ignition switch is ON and the fuel pumps are running, the fuel pressure indicated by the fuel pressure gauge should read 344-413 kPa (50-60 psi) for 4.3, 5.0, and 5.7 models and 248-303 kPa (36-44 psi) for 8.1 models. The spring pressure inside the fuel pressure regulator controls the fuel pressure.
3. A fuel system that drops more than 14 kPa (2 psi) in 10 minutes has a leak in one or more of the following areas:
 - The fuel pump check valve.
 - The fuel pump flex pipe.
 - The valve or valve seat within the fuel pressure regulator.
 - The fuel injector(s).
4. A fuel system that drops more than 14 kPa (2 psi) in 10 minutes after being relieved to 69 kPa (10 psi) indicates a leaking fuel pump check valve.
5. Fuel pressure that drops off during acceleration, cruise or hard cornering may cause a lean condition. A lean condition can cause a loss of power, surging or misfire.
8. When the engine is at idle, the manifold pressure is low (high vacuum). This low pressure (high vacuum) is applied to the fuel pressure regulator diaphragm. The low pressure (high vacuum) will offset the pressure being applied to the fuel pressure regulator diaphragm by the spring inside the fuel pressure regulator. When this happens, the result is lower fuel pressure. The fuel pressure at idle will vary slightly as the barometric pressure changes, but the fuel pressure at idle should always be less than the fuel pressure noted in step 2 with the engine OFF.

Fuel System Diagnosis

12. A rich condition may result from the fuel pressure being above 310 kPa (45 psi). Drivability conditions associated with rich conditions can include hard starting followed by black smoke, transom sooting and a strong fuel smell in the exhaust.
13. This test determines if the high fuel pressure is due to a restricted fuel return pipe or if the high fuel pressure is due to a faulty fuel pressure regulator.
15. A lean condition may result from the fuel pressure being below 269 kPa (39 psi). Drivability conditions associated with lean conditions can include hard starting (when the engine is cold), hesitation, poor drivability, lack of power, surging and misfiring.

NOTE! Do not allow the fuel pressure to exceed 517 kPa (75 psi). Excessive pressure may damage the fuel pressure regulator.

16. Restricting the fuel return pipe with the J 37287 fuel pipe shut-off adapter causes the fuel pressure to rise above the regulated pressure. Using a scan tool to pressurize the fuel system, the fuel pressure should rise above 427 kPa (62 psi) as the valve on the fuel pipe shut-off adapter connected to the fuel return pipe becomes partially closed.

 **Caution!**

Wrap a shop towel around the fuel pressure connection 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.

22. Check the spark plug associated with a particular fuel injector for fouling or saturation in order to determine if that particular fuel injector is leaking. If checking the spark plug associated with a particular fuel injector for fouling or saturation does not determine that a particular fuel injector is leaking, use the following procedure.
 - a. Remove the fuel rail. Refer to *Fuel Rail Assembly Replacement*.
 - b. Reinstall the crossover pipe to the right fuel rail. Refer to *Fuel Rail Assembly Replacement*.
 - c. Connect the fuel feed pipe and the fuel return pipe to the fuel rail. Refer to *Fuel Rail Assembly Replacement*.
 - d. Lift the fuel rail just enough to leave the fuel injector nozzles in the fuel injector ports.

 **Caution!**

To reduce the risk of fire and personal injury that may result from fuel spraying on the engine, verify that the fuel rail is positioned over the fuel injector ports. Also verify that the fuel injector retaining clips are intact.

- e. Pressurize the fuel system by using the scan tool fuel pump enable.
- f. Visually and physically inspect the fuel injector nozzles for leaks.

Step	Action	Value	Yes	No
1	Did you perform the On-Board Diagnostic (OBD) System Check?	—	Go to Step 2	Go to OBD System Check
2	1. Turn OFF the ignition. 2. Install the J34730-1A fuel pressure gauge. 3. Place the bleed hose from the fuel pressure gauge into an approved gasoline container. 4. Turn ON the ignition leaving the engine OFF. 5. Bleed the air out of the fuel pressure gauge. 6. Turn the ignition OFF for 10 seconds. 7. Turn the ignition ON leaving the engine OFF. IMPORTANT: The fuel pumps will run for approximately 2 seconds. Cycle the ignition as necessary in order to achieve the highest possible fuel pressure. 8. Observe the fuel pressure with the fuel pumps running. Is the fuel pressure within specified limits?	4.3, 5.0, 5.7 models 344-413 kPa (50-60 psi) 8.1 models 248-303 kPa (36-44 psi)	Go to Step 3	Go to Step 12

Fuel System Diagnosis (cont.)

Step	Action	Value	Yes	No
3	IMPORTANT: The fuel pressure may vary slightly when the fuel pumps stop running. After the pumps stop, the fuel pressure should stabilize and remain constant. Does the fuel pressure drop more than the specified value in 10 minutes?	> 14 kPa (2 psi)	Go to Step 10	Go to Step 4
4	1. Relieve the fuel pressure to the first specified value. Does the fuel pressure drop more than the second specified value in 10 minutes.	69 kPa (10 psi) 14 kPa (2 psi)	Go to Step 19	Go to Step 5
5	Do you suspect the fuel pressure is dropping-off during acceleration, cruise or hard turning?	—	Go to Step 6	Go to Step 8
6	1. Visually and physically inspect the following items for a restriction: - Fuel Filter - Fuel feed pipe Did you find a restriction?	—	Go to Step 24	Go to Step 7
7	1. Start the engine. 2. Allow the engine to idle at normal operating temperature. Does the fuel pressure drop by the specified amount?	21-69 kPa (3-10 psi)	Go to Symptoms	Go to Step 8
8	1. Disconnect the vacuum hose from the fuel pressure regulator. 2. With the engine idling, apply 30-35 cm. Hg. (12-14 in. Hg.) to the fuel pressure regulator. Does the fuel pressure drop by the specified amount?	21-69 kPa (3-10 psi)	Go to Step 19	Go to Step 20
9	1. Relieve the fuel pressure. 2. Disconnect the fuel feed pipe and the fuel return pipe from the fuel rail. 3. Install the J 37287 fuel pipe shut-off adapters between the fuel feed pipe and the fuel return pipe and the fuel rail. 4. Open the valves on the fuel pipe shut-off adapters. 5. Turn the ignition ON. 6. Pressurize the fuel system using the acan tool. 7. Place the bleed hose of the fuel pressure gauge into an approved gasoline container. 8. Bleed the air out of the fuel pressure gauge. 9. Wait for the fuel pressure to build. 10. Close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe. Does the fuel pressure remain constant? Does the fuel pressure drop by the specified amount?	—	Go to Step 18	Go to Step 10
10	1. Open the valve in the fuel pipe shut-off adapter that is connected to the fuel feed pipe. 2. Pressurize the fuel system using a scan tool. 3. Wait for the fuel pressure to build. 4. Close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe. Does the fuel pressure remain constant?	—	Go to Step 20	Go to Step 21
11	Is the fuel pressure above the specified limit?	4.3, 5.0, 5.7 models 413 kPa (60 psi) 8.1 models 303 kPa (44 psi)	Go to Step 12	Go to Step 14

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Fuel System Diagnosis (cont'd)

Step	Action	Value	Yes	No
12	- Relieve the fuel pressure. - Disconnect the fuel return pipe from the fuel rail. - Attach a length of flexible fuel hose to the fuel rail outlet passage. - Place the open end of the hose into an approved gasoline container. - Turn the ignition OFF for 10 seconds. - Turn the ignition ON. - Observe the fuel pressure with the fuel pumps running. Is the fuel pressure within the specified limits?	4.3, 5.0, 5.7 models 344-413 kPa (50-60 psi) 8.1 models 248-303 kPa (36-44 psi)	Go to Step 22	Go to Step 13
13	Visually and physically inspect the fuel rail outlet passages for a restriction. Was a restriction found?	—	Go to Step 23	Go to Step 20
14	Is the fuel pressure above the specified value?	0 kPa (0 psi)	Go to Step 15	Go to Step 16
15	- Relieve the fuel pressure. - Disconnect the fuel return pipe from the fuel rail. - Install the J 37287 fuel pipe shut-off adapter between the fuel return pipe and the fuel rail. - Open the valve on the fuel pipe shut-off adapter. - Turn the ignition ON. - Pressurize the fuel system using the scan tool. - Place the bleed hose of the pressure gauge into an approved gasoline container. - Bleed the air out of the fuel pressure gauge. CAUTION! Do not allow the fuel pressure to exceed 517 kPa (75 psi). Excessive pressure may damage the fuel pressure regulator. - Slowly close the valve in the fuel pipe shut-off adapter that is connected to the fuel return pipe. Does the fuel pressure rise above the specified value?	4.3, 5.0, 5.7 models 413 kPa (60 psi) 8.1 models 303 kPa (44 psi)	Go to Step 20	Go to Step 6
16	Turn ON the fuel pump using the scan tool. Does the fuel pumps run?	—	Go to Step 17	Go to <i>Fuel Pump Relay Diagnosis</i>
17	Visually and physically inspect the following items: - Fuel filter for obstructions - Fuel feed pipe for a restriction. - Anti-siphon valve if equipped. - Fuel Cell for leaks Did you find a problem in any of these areas?	—	Go to Step 23	Go to Step 18
18	Replace the fuel cell Is the action complete?	—	System OK	—
19	Locate and repair the loss of vacuum to the fuel pressure regulator. Is the action complete?	—	System OK	—
20	Replace the fuel pressure regulator. Is the action complete?	—	System OK	—
21	Locate and replace any leaking fuel injector(s). Is the action complete?	—	System OK	—
22	Locate and repair the restriction in the fuel return pipe. Is the action complete?	—	System OK	—
23	Repair the problem as necessary. Is the action complete?	—	System OK	—

22668

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10°-35°C (50°-95°F)

Test Description

- 2. The engine coolant temperature affects the ability of the fuel injector tester to detect a faulty fuel injector. If the engine coolant temperature is NOT between 10°-35°C (50°-95°F), use *Fuel Injector Test - Engine Coolant Temperature (ECT) Outside 10°-35°C (50°-95°F)* table.
- 3. The first second of the voltage displayed by the DMM may be inaccurate due to the initial current surge. Therefore, record the lowest voltage displayed by the DMM after the first second of the test. The voltage displayed by the DMM should be within the specified range. Refer to the Example. The voltage displayed by the DMM may increase throughout the test as the fuel injector windings warm and the resistance of the fuel injector windings changes. An erratic voltage reading with large fluctuations in voltage that do not stabilize, indicates an intermittent connection with the fuel injector.

Resistance Ohms	Voltage Specification at 10°-35°C (50°-90°F)	
11.8 – 12.8	5.7 – 6.6	
Fuel Injector	Voltage reading	Pass/Fail
1	6.3	P
2	5.9	P
3	6.2	P
4	6.1	P
5	4.8	F
6	6.0	P
7	5.0	P
8	5.3	P

22669

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10°-35°C (50°-95°F)

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect the scan tool. 2. Check the engine coolant temperature. Is the engine coolant temperature within the specified limits?	10°-35°C (50°-95°F)	Go to Step 3	Go to <i>Fuel Injector Coil Test - ECT Outside 10°-35°C (50°-95°F)</i>
3	1. Turn the ignition OFF. CAUTION! Do not flood a single cylinder. 2. Relieve the fuel pressure. 3. Access the fuel injector electrical connectors. 4. Connect the J 39021 fuel injector tester to B+ and an engine ground. 5. Set the amperage supply selector switch on the fuel injector tester to the Coil Test 0.5 amp position. 6. Connect the leads from the Digital Multi-Meter to the fuel injector tester. 7. Set the DMM to the tenths scale (0.0). 8. Connect the fuel injector tester to a fuel injector using the J 39021-380 injector test adapter. IMPORTANT: Check the engine coolant temperature again in order to ensure that the correct chart is being used. 9. Press the "Push to Start Test" button on the fuel injector tester. IMPORTANT: The voltage reading may rise during the test. 10. Observe the voltage reading on the DMM. 11. Record the lowest voltage observed after the first second of the test. 12. Repeat steps 8 through 11 for each fuel injector. Did any fuel injector have an erratic voltage reading with large fluctuations in voltage that do not stabilize, or a voltage reading outside the specified limits?	5.7 - 6.6 V	Go to Step 4	Go to <i>Fuel Injector Balance Test with Special Tool</i>
4	Replace the faulty fuel injectors. Refer to <i>Fuel Injector Replacement</i> .	—	Go to <i>Fuel Injector Balance Test with Special Tool</i>	—

22670

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Not Between 10°-35°C (50°-95°F)

Test Description

- 2. The engine coolant temperature affects the ability of the fuel injector tester to detect a faulty fuel injector. If the engine coolant temperature is between 10°-35°C (50°-95°F), use *Fuel Injector Test - Engine Coolant Temperature (ECT) Between 10°-35°C (50°-95°F)* table.
- 3. The first second of the voltage displayed by the DMM may be inaccurate due to the initial current surge. Therefore, record the lowest voltage displayed by the DMM after the first second of the test. The voltage displayed by the DMM may increase throughout the test as the fuel injector windings warm and the resistance of the fuel injector windings changes. An erratic voltage reading with large fluctuations in voltage that do not stabilize, indicates an intermittent connection with the fuel injector. From the voltages recorded, identify the highest voltage, excluding any voltages above 9.5 volts. Subtract each voltage that is not above 9.5 volts from the highest voltage. Record each subtracted value. Refer to the Example. The subtracted value that is more than 0.6 volt is faulty. Replace the fuel injector. A fuel injector with a recorded voltage above 9.5 volts is also faulty. Replace the fuel injector.

Highest Voltage Reading		Voltage Specification at 10°-35°C (50°-90°F)	
7.1V		0.6V	
Fuel Injector	Voltage	Subtracted Value	Pass/Fail
1	9.8	—	F
2	606	0.5	P
3	6.9	0.2	P
4	5.8	1.3	F
5	7.0	0.1	P
6	7.1	0.0	P
7	9.6	—	F
8	6.0	1.1	F

22671

Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10°-35°C (50°-95°F)

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Connect the scan tool. 2. Check the engine coolant temperature. Is the engine coolant temperature within the specified limits?	10°-35°C (50°-95°F)	Go to Step 3	Go to <i>Fuel Injector Coil Test - ECT Outside 10°-35°C (50°-95°F)</i>
3	1. Turn the ignition OFF. CAUTION! Do not flood a single cylinder. 2. Relieve the fuel pressure. 3. Access the fuel injector electrical connectors. 4. Connect the J 39021 fuel injector tester to B+ and an engine ground. 5. Set the amperage supply selector switch on the fuel injector tester to the Coil Test 0.5 amp position. 6. Connect the leads from the Digital Multi-Meter to the fuel injector tester. 7. Set the DMM to the tenths scale (0.0). 8. Connect the fuel injector tester to a fuel injector using the J 39021-380 injector test adapter. IMPORTANT: Check the engine coolant temperature again in order to ensure that the correct chart is being used. 9. Press the "Push to Start Test" button on the fuel injector tester. IMPORTANT: The voltage reading may rise during the test. 10. Observe the voltage reading on the DMM. 11. Record the lowest voltage observed after the first second of the test. 12. Repeat steps 8 through 11 for each fuel injector. 13. Identify the highest voltage reading recorded below 9.5 volts. 14. Subtract any other voltage readings recorded from the highest voltage reading recorded. Are there any values result from subtraction more than the specified value.	0.6V	Go to Step 4	Go to <i>Fuel Injector Balance Test with Special Tool</i>
4	Replace the faulty fuel injectors. Refer to <i>Fuel Injector Replacement</i> .	—	Go to <i>Fuel Injector Balance Test with Special Tool</i>	—

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Fuel Injector Balance Test with Special Tool

Test Description

4. The engine coolant temperature must be below the operating temperature in order to avoid irregular fuel pressure readings due to Hot Soak fuel boiling.
5. The fuel pressure should be within the specified range.
6. The fuel pressure should reach a steady value.
7. If the fuel pressure drop value for each injector is within 10 kPa (1.5 psi) of the average pressure drop value, the fuel injectors are flowing properly. Calculate the pressure drop value for each fuel injector by subtracting the second pressure reading from the first pressure reading.

Fuel Injector Balance Test with Special Tool

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Did you perform the Fuel Injector Coil Test Procedure?	—	Go to Step 3	Go to <i>Fuel Injector Coil Test - ECT between 10°-35°C</i>
3	Is the engine coolant temperature above the specified value?	62°C(145°F)	Go to Step 4	Go to Step 5
4	1. Allow the engine to cool below the specified value. Is the engine coolant temperature below the specified value?	62°C(145°F)	Go to Step 5	—
5	1. Turn the ignition OFF. 2. Connect the J34730-1A fuel pressure gauge to the fuel pressure test port. 3. Turn ON the ignition leaving the engine OFF. 4. Install the scan tool. 5. Energize the fuel pumps using the scan tool. 6. Place the bleed hose of the fuel pressure gauge into an approved gasoline container. 7. Bleed the air out of the fuel pressure gauge. 8. Again, energize the fuel pumps using the scan tool. IMPORTANT: The fuel pumps will run for approximately 2 seconds. Repeat step 8 as necessary to achieve the highest possible fuel pressure. 9. Wait for the fuel pressure to build. 10. Observe the reading on the fuel pressure gauge while the fuel pumps are running. Is the fuel pressure within the specified limits?	269-310 kPa(39-45 psi)	Go to Step 6	Go to <i>Fuel System Diagnosis</i>
6	1. After the fuel pumps stop, the fuel pressure may vary slightly, then should hold steady. Does the fuel pressure remain constant within the specified value?	269-310 kPa(39-45 psi)	Go to Step 7	Go to <i>Fuel System Diagnosis</i>

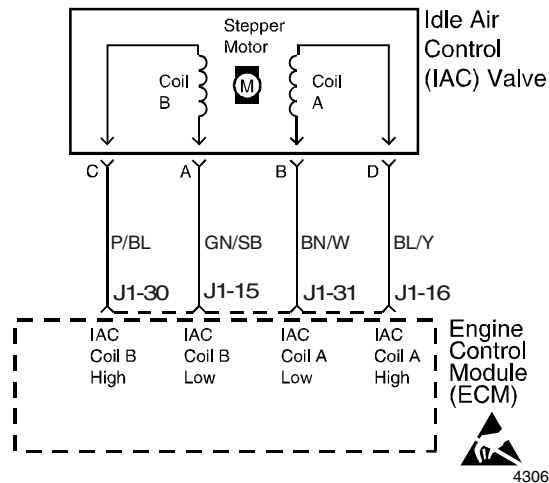
22674

Fuel Injector Balance Test with Special Tool (cont.)

Step	Action	Value	Yes	No
7	1. Connect the J 39021 fuel injector tester to a fuel injector tester to a using the J 39021-380 injector test adapter. 2. Set the amperage supply selector switch to the fuel injector tester to the balance test 0.5-2.5 amp position. 3. Energize the fuel pump using the scan tool to pressurize the fuel system. 4. Record the fuel pressure indicated by the fuel pressure gauge after the fuel pressure stabilizes. This is the 1st pressure reading. 5. Energize the fuel injector by pressing the ""Push to Start Test"" button on the fuel injector tester. 6. Record the fuel pressure indicated by fuel pressure gauge after the pressure has stabilized. This is the 2nd pressure reading. 7. Repeat steps 1 through 6 for each of the fuel injectors. 8. Subtract the 2nd pressure reading from the 1st pressure reading for each of the injectors. The result is the pressure drop value. 9. Add all of the individual pressure drop values. The sum is the total pressure drop. 10. Divide the total pressure drop by the number of fuel injectors. This is the average pressure drop. Does any fuel injector have a value that is either higher or lower than the specified value?	10 kPa (1.5 psi)	Go to Step 8	Go to Symptoms
8	CAUTION! To prevent flooding the engine, do not repeat any portion of the test before running the engine. 1. Retest any fuel injector that falls outside the pressure drop limits from step 7. Does any fuel injector have a value that is either higher or lower than the specified value?	10 kPa (1.5 psi)	Go to Step 9	Go to Symptoms
9	1. Replace the faulty fuel injector(s). Refer to <i>Fuel Injector Replacement</i>. Is the action complete?	—	System OK	—

22675

Idle Air Control Function Test



Circuit Description

The ECM controls idle speed to a calibrated desired RPM based on sensor inputs and actual engine RPM. The ECM uses four (4) circuits to move the Idle Air Control (IAC) valve. The movement of the IAC valve varies the amount of air flow bypassing the throttle plates. The ECM controls idle speed by determining the position of the IAC valve.

Diagnostic Aids

An intermittent may be caused by a poor connection, rubbed through wire insulation or a wire broken inside the insulation. Check for the following items:

- Poor connection or damaged harness. Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
- Check for vacuum leaks, disconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold.
- Check for poor connections, opens or short to grounds in circuits J1-16, J1-31, J1-15, and J1-30. This may result in improper idle control.
- An IAC valve which is “frozen” and will not respond to the ECM, a throttle stop screw which has been tampered with, or a damaged throttle body or linkage may cause improper idle.

Test Description

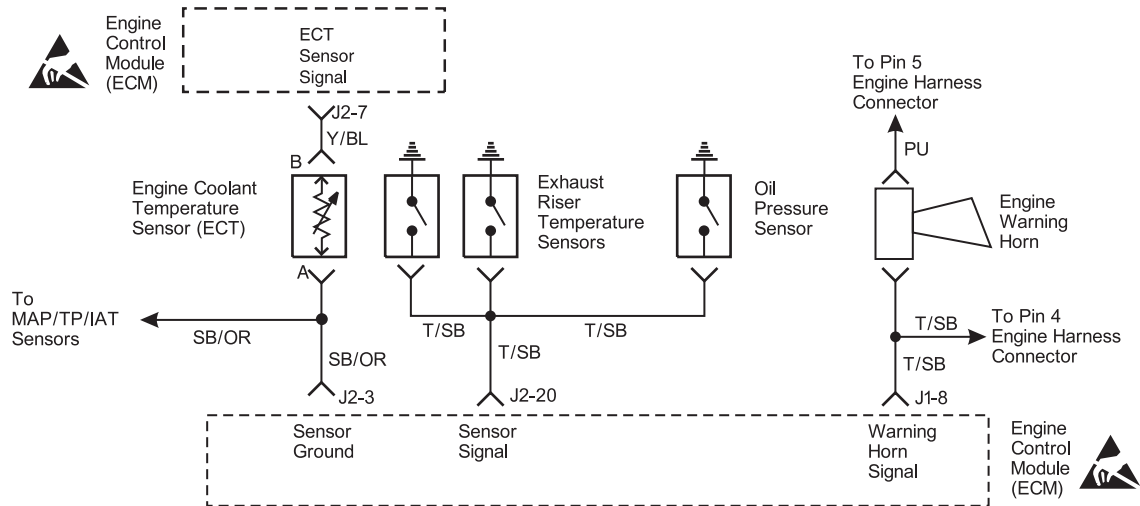
2. This step determines if the IAC valve is functioning properly.
4. This step determines if the circuitry or the IAC valve is faulty.

Idle Air Control Function Test

Step	Action	Value	Yes	No
1	Was the On-Board Diagnostic (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Engine should be at normal operating temperature. 2. Start the engine and allow the idle to stabilize. 3. Record the RPM. 4. Ignition OFF for 10 seconds. 5. Disconnect the IAC harness connector. 6. Restart the engine and record the r/m. Is the r/m higher than the first recorded RPM by more than the specified value	200 r/m	Go to Step 3	Go to Step 4
3	1. Reinstall the IAC harness connector 2. Idle speed should gradually return within 75 r/m of the original recorded r/m within 30 seconds.	—	Go to Step 5	Go to Step 4
4	1. Ignition OFF for 10 seconds. 2. Disconnect IAC harness connector. 3. Restart the engine. 4. Using a test lamp connected to ground, probe each of the four IAC harness terminals. Does the test lamp blink on all four terminals.	—	Go to Step 7	Go to Step 6
5	IAC circuit is functioning properly.	—	—	—
6	1. Locate and repair poor connection, open, or shorted IAC circuits that did not blink. Was a condition found and corrected?	—	Go to OBD System Check	Go to Step 8
7	1. Check for poor IAC connections or replace the IAC valve. Is the action complete?	—	Go to OBD System Check	—
8	1. Repair the faulty ECM connections or replace the faulty ECM. Is the action complete?	—	Go to OBD System Check	—

22676

Audible Warning Horn Diagnoses - Engine Mounted Horn



Circuit Description:

The MEFI 4 Volvo Penta EFI engines have provisions for an audible warning horn. The horn will sound under the following conditions:

Self test:

The horn will sound **2 beeps** each time the key is turned to the "ON" position

Low Oil Pressure:

The horn will sound a **steady beeping tone** if low oil pressure is detected by the oil pressure switch with the engine running. The switch sends a ground signal to the ECM at pin J2-20 when oil pressure is below 5 psi. As long as the ECM detects an RPM signal that indicates the engine is running, it will send a ground signal to the J1-8 pin to activate the warning horn. "*ENGINE PROTECTION MODE*" will also be activated. The horn will remain activated until oil pressure rises above 5 psi.

High Exhaust Riser Temperature:

The horn will sound a **steady beeping tone** if temperatures above 210 deg. F are detected at either of the 2 exhaust riser temperature switches. The switch sends a ground signal to the ECM at pin J2-20 when exhaust riser temperature exceeds 210 deg F. As long as the ECM detects an RPM signal that indicates the engine is running, it will send a ground signal to the J1-8 pin to activate the warning horn. "*ENGINE PROTECTION MODE*" will also be activated. The horn will remain activated until exhaust riser temperature drops below 160 deg F.

High Engine Coolant Temperature:

The horn will sound a **steady beeping tone** if engine coolant temperature over 200 deg. F is detected by the ECT sensor. The temperature value is programmed into the ECM. If the ECM reads engine coolant temperature above 200 deg. F while the engine is running, it will send a ground signal to the J1-8 pin to activate the warning horn. "*ENGINE PROTECTION MODE*" will also be activated. The horn will remain activated until engine coolant temperature drops below 180 deg. F.

Active Diagnostic Trouble Code:

The horn will sound **an intermittent beeping tone** whenever the ECM detects an active trouble code. The horn will continue to sound as long as an active trouble code exists. "*ENGINE PROTECTION MODE*" **will not** be activated.

ENGINE PROTECTION MODE:

ENGINE PROTECTION MODE is a function of the ECM designed to reduce engine damage during loss of oil pressure, high exhaust riser temperatures, or high engine coolant temperatures. *ENGINE PROTECTION MODE* is engaged at the same time the warning horn is activated with a steady beeping tone. It is not activated for an active trouble code.

When *ENGINE PROTECTION MODE* engages above 2500 rpm, one of the two injector drivers is shut off until RPM drops below 1200 rpm. Once the throttle is brought back to idle, both injector drivers are activated. When throttle is advanced, one injector will be shut off again at 2500 rpm if the fault (high ECT, riser temperature, low oil pressure) is still present.

Symptom:**Warning Horn Sounding****Normal Function**

None. The horn should not continue to sound after the 2 initial test beeps under any conditions until engine is running.

Malfunction of Warning System

Shorted driver in ECM. The J1-8 pin on the ECM may be shorted to ground internally.

Test – Unplug the J-1 connector. Turn key to “on” position. If horn still sounds, check for another grounding source, possibly within harness or Pin 4 in the 10 pin connector.

If horn is silent with J-1 unplugged and key “on”, ECM output to J1-8 is likely shorted to ground. Confirm by leaving key “on” and plugging in J-1, Horn will start sounding again. Replace shorted ECM.

Symptom:

Warning horn sounds at all speeds when engine is running, and enters *Engine Protection Mode* above 2500 rpm.

Normal Function

Low Oil Pressure. (oil pressure below 5 psi) Confirm oil pressure is low at instrument panel oil pressure gauge, then confirm with mechanical gauge at engine. Find and correct cause of low oil pressure.

High Exhaust Riser Temperature. (exhaust riser casting temperature exceeds 210deg F, and remains above 160 deg F) Confirm that exhaust riser temperature is excessive with a separate surface temperature gauge such as an infrared gun. Correct the cause of the overheat, most commonly lack of cooling water flow through the riser.

High Engine Coolant Temperature. (ECT sensor reads over 200 deg F to activate, stays active until temp falls below 180 deg F) Confirm coolant temperature is high at instrument panel gauge. ECT readings will be above 180 deg F. Find and correct the cause of overheating.

Malfunction of Warning System

Shorted Oil Pressure Switch or Exhaust Riser Temperature Sender. Start engine and operate at 1000 rpm in “N” (horn sounding due to malfunction). Check scan tool data list for “Oil Press sw – Low” or “Overheat det – Yes”.

If scan tool reads “Oil Press sw – Low”, first confirm that oil pressure is normal, then check the oil pres-

sure switch for a short to ground. If no fault is found, check that exhaust riser temperatures are normal, then check to be sure that the exhaust temperature sensors are not shorted to ground. The engine may be run with each riser sensor and the oil pressure switch disconnected one at a time to isolate the problem. If no fault is found, test the wire harness from the sensors to the ECM for shorts to ground. Repair as required.

If scan tool reads “Overheat det – Yes”, confirm that the engine temperature gauge at the instrument panel does not indicate that the engine is overheating (temperature at the gauge should be below 180 deg F). If the gauge indicates in the normal range, check the ECT sensor reading with the scan tool and if sensor is reading incorrectly, find the cause (see troubleshooting chart for DTC 15). Repair as required.

If scan tool does not indicate “Oil Press sw – Low” or “Overheat det – Yes”, but still activates warning horn and *Engine Protection Mode* with engine operating normally, ECM is likely at fault. Unplug ECT sensor, low oil pressure switch, and both exhaust riser sensors and tie back all the wiring. If problem duplicates ECM is at fault. (Unplugging ECT sensor will cause an

intermittent beep due to setting a DTC, but will not engage *Engine Protection Mode*).

Warning horn sounds at higher throttle settings and enters *Engine Protection Mode* at the same time horn sounds.

Normal Function

Test run boat at higher RPM range to duplicate failure with scan tool connected. When warning horn and slow mode activate, check the scan tool data list for readings of “Oil Press sw – Low” or “Overheat det – Yes”.

“Oil Press sw – Low”. The oil pressure switch or the exhaust temperature sensors may be setting off the warning horn. If there is no obvious indication of low oil pressure or a hot riser, test run boat again with the oil pressure switch and then the exhaust temperature sensors disconnected, to find which sensor is activating. Then test to confirm that the warning is valid (low oil pressure switch should only activate if oil pressure is below 5 psi, exhaust temperature sensors should only activate if exhaust riser casting temperature exceeds 210 deg F and remains above 160 deg F. Exhaust riser overheat at high RPM is usually caused by poor cooling water flow. Find and repair the cause of failure.

“Overheat det – Yes”. ECT sensor readings have

exceeded 200 deg F and have remained above 180 deg F. If there is no obvious indication of engine overheat, compare ECT readings from scan tool with instrument panel temperature gauge. If incorrect ECT readings are found, follow troubleshooting for DTC 15 to find the fault, and repair as required.

Malfunction of Warning System

Follow the test procedures above to determine if warning horn is valid. If a false warning is occurring, check the suspected component:

Oil Pressure Switch. With a test light, determine if the switch is providing a ground with oil pressure above 5 psi, if so, replace the switch. If not, test for shorts to ground in the wiring harness between the oil pressure switch and pin J2-20. Repair as required.

Exhaust Riser Temperature Sensors. With a test light, and a surface temperature gauge such as an infrared heat gun, determine if the switch is providing a ground with exhaust riser temperature below 160 deg F, if so, replace the switch. If not, test for shorts to ground in the wiring harness between the oil pressure switch and pin J2-20. Repair as required.

ECT Sensor. If there is no indication of engine overheat, compare ECT readings from scan tool with instrument panel temperature gauge. If incorrect ECT readings are found, follow troubleshooting for DTC 15 to find the fault, and repair as required.

Warning horn sounds an INTERMITTENT beeping tone at all speeds when engine is running, engine is not entering *ENGINE PROTECTION MODE*.

Normal Function

The warning horn will sound an intermittent (widely spaced) beeping tone when an **ACTIVE diagnostic trouble code is set** due to sensor or circuit failures (such as shorted or open circuits). In many cases, the a failed sensor reading will be substituted with a default value, and engine may operate normally but still have an active code. Check for active codes with scan tool and refer to diagnostic chart for the specific code displayed.

Malfunction of Warning System

No common malfunction is likely in this mode.

Warning horn DOES NOT SOUND at any time. Does not sound 2 test beeps when key is turned to the "ON " position.

Normal Function

None. Horn should always sound 2 test beeps when

key is turned to the on position.

Malfunction of Warning System

ECM is not "turning on". When key is turned "on", power to the purple wire at Pin 4 of the 10 pin connector activates the ignition relay, and provides power to the J2-20 pin on the ECM, turning the ECM on. At that time, the ECM sends out 2 ground pulses from ECM pin J1-8 to test the horn. You should also hear the fuel pumps activate for 2 seconds at that time.

If neither the warning horn nor the fuel pumps activate when key is turned "on", the ECM is likely not powering up at all. Follow the troubleshooting procedure under "Ignition Relay Diagnosis".

Other Faults. If the fuel pumps activate when key is turned "on", but the horn is still silent, turn the key "on" and test for B+ at the warning horn terminal. Repair faults in the engine harness or connections as required. If B+ source is ok, provide a ground to the warning horn to test the horn itself. If the horn tests ok, turn the key off, disconnect the tan/black wire at the warning horn and test for two ground pulses when key is turned "on". If no ground pulse is detected, test for continuity in the tan/black wire from the warning horn to the ECM connector J2-8 pin. If the continuity check is good the ECM has a failed driver, replace the ECM and retest.

Warning Horn Activation Points

FAULT	Warning Horn Tone	Activates	De-Activates	Engine Protection Mode
Low Oil Pressure	Steady Beeping Tone	Below 5 psi	Press. Rises Above 5 psi	Yes
High Ex. Riser Temp	Steady Beeping Tone	Above 210 deg F	Temp drops Below 160 deg F	Yes
High ECT Temp.	Steady Beeping Tone	Above 200 deg F	Temp drops Below 180 deg F	Yes
Active DTC	Intermittent Beeping Tone	When Active Code is logged	When Active Code Clears	No

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Scan Tool Readings During Warning Horn Activation

VP 2000 Display	Low Oil Pressure		High Ex. Riser Temp		High ECT Temp.		Active DTC
	Below 2500	Above 2500	Below 2500	Above 2500	Below 2500	Above 2500	
Cause Pwr Reduct	YES	YES	YES	YES	YES	YES	NO
Power Reduction	NO	YES	NO	YES	NO	YES	NO
Overheat Det	NO	NO	NO*	NO*	YES	YES	NO
Low Oil Press Switch	LOW	LOW	LOW*	LOW*	OK	OK	OK
Trouble Codes: Active	Oil Press / Cat Temp	Oil Press / Cat Temp	Oil Press / Cat Temp*	Oil Press / Cat Temp*	Overheat	Overheat	(Displays Active Codes)

22797

- * Exhaust riser temp sensors are wired into the same ECM input as the oil pressure switch, the Scantool display will indicate low oil pressure rather than high exhaust riser temperature.

Symptom:**Warning Horn Sounding (Constant Tone)****Normal Operation:**

The horn should not continue to sound after the 2 initial test beeps under any conditions unless engine has a malfunction.

Malfunction of Warning System**Shorted driver in ECM:**

The J1-8 pin on the ECM may be shorted to ground internally.

1. To test the circuit – Unplug the J-1 connector. Turn key to “on” position. If horn still sounds, check for another grounding source, possibly within harness or Pin 4 in the 10 pin connector.
2. If horn is silent with J-1 unplugged and key “on”, ECM output to J1-8 is likely shorted to ground. Confirm by leaving key “on” and plugging in J-1, Horn will start sounding again. Replace shorted ECM.

Symptom:**Warning horn sounds at all speeds when engine is running, and enters *Engine Protection Mode* above 2500 rpm.****Normal Function**Low Oil Pressure. (oil pressure below 34 kPa (5 psi)

Confirm oil pressure is low with mechanical gauge at engine. Find and correct cause of low oil pressure.

High Exhaust Riser Temperature.

If exhaust riser temperature exceeds 129°C (265°F), and remains above 118°C (245°F) Confirm that exhaust riser temperature is excessive with a separate surface temperature gauge such as an infrared gun. Correct the cause of the overheat, most commonly lack of cooling water flow through the riser.

High Engine Coolant Temperature.

If ECT sensor reads over 93°C (200°F) to activate, stays active until temp falls below 82°C (180°F) Confirm coolant temperature is high at instrument panel gauge. ECT readings will be above 82°C (180°F). Find and correct the cause of overheating.

Malfunction of Warning SystemShorted Oil Pressure Switch or Exhaust Riser Temperature Sender.

Start engine and operate at 1000 rpm in Neutral (horn sounding due to malfunction). Check scan tool data list for “Oil Press sw – Low” or “Overheat det – Yes”.

If scan tool reads “Oil Press sw – Low”, first confirm that oil pressure is normal, then check the oil pressure switch for a short to ground. If no fault is found, test the wire harness from the sensors to the ECM for shorts to ground. Repair as required.

If scan tool reads “Overheat det – Yes”, confirm that the engine temperature gauge at the instrument panel does not indicate that the engine is overheating (temperature at the gauge should be below 180 deg F). If the gauge indicates in the normal range, check the ECT sensor reading with the scan tool and if sensor is reading incorrectly, find the cause (see troubleshooting chart for DTC 15). Repair as required.

If scan tool reads “General Warning 1— Fault Detected”, check that exhaust riser temperatures are normal, then check to be sure that the exhaust temperature sensors are not shorted to ground. The engine may be run with each riser sensor switch disconnected one at a time to isolate the problem. If no fault is found, test the wire harness from the sensors to the ECM for shorts to ground. Repair as required.

If scan tool does not indicate “Oil Press sw – Low,” “Overheat det – Yes” or “General Warning 1— Fault Detected” but still activates warning horn and *Engine Protection Mode* with engine operating normally, ECM is likely at fault. Unplug ECT sensor, low oil pressure switch, and both exhaust riser sensors and tie back all the wiring. If problem duplicates ECM is at fault. (Unplugging ECT sensor will cause an intermittent beep due to setting a DTC, but will not engage *Engine Protection Mode*).

Warning horn sounds at higher throttle settings and enters *Engine Protection Mode* at the same time horn sounds.

Normal Function

Test run boat at higher RPM range to duplicate failure with scan tool connected. When warning horn and slow mode activate, check the scan tool data list for readings of “Oil Press sw – Low,” “Overheat det – Yes,” or General Warning 1.

“Oil Press sw – Low”. The oil pressure switch may be setting off the warning horn. If there is no obvious indication of low oil pressure, test run boat again with the oil pressure switch to find if the sensor is activating. Then test to confirm that the warning is valid (low oil pressure switch should only activate if oil pressure is below 5 psi. Find and repair the cause of failure.

“Overheat det – Yes”. ECT sensor readings have exceeded 200 deg F and have remained above 180 deg F. If there is no obvious indication of engine

overheat, compare ECT readings from scan tool with instrument panel temperature gauge. If incorrect ECT readings are found, follow troubleshooting for DTC 15 to find the fault, and repair as required.

“General Warning 1— Fault Detected”. The exhaust temperature sensors may be setting off the warning horn. If there is no obvious indication of a hot riser, test run boat again with the exhaust temperature sensors disconnected, to find which sensor is activating. Then test to confirm that the warning is valid. Exhaust temperature sensors should only activate if exhaust riser casting temperature exceeds 129°C (265°F) and remains above 118°C (245°F). Exhaust riser overheat at high RPM is usually caused by poor cooling water flow. Find and repair the cause of failure.

Malfunction of Warning System

Follow the test procedures above to determine if warning horn is valid. If a false warning is occurring, check the suspected component:

Oil Pressure Switch. With a test light, determine if the switch is providing a ground with oil pressure above 5 psi, if so, replace the switch. If not, test for shorts to ground in the wiring harness between the oil pressure switch and pin J2-20. Repair as required.

Exhaust Riser Temperature Sensors. With a test light, and a surface temperature gauge such as an infrared heat gun, determine if the switch is providing a ground with exhaust riser temperature below 118°C (245°F), if so, replace the switch. If not, test for shorts to ground in the wiring harness between the temperature switches and pin J1-19. Repair as required.

ECT Sensor. If there is no indication of engine overheat, compare ECT readings from scan tool with instrument panel temperature gauge. If incorrect ECT readings are found, follow troubleshooting for DTC 15 to find the fault, and repair as required.

Malfunction of Warning System

No common malfunction is likely in this mode.

Warning horn DOES NOT SOUND at any time. Does not sound 2 test beeps when key is turned to the “ON “ position.

Normal Function

Horn should always sound 2 test beeps when key is turned to the on position.

With the ignition key in the run position, check for power from the ignition switch and at the warning horn with a test light. This is usually a purple wire. If no power is present, check for open wires between the ignition switch and the warning horn.

If there is power at the horn, ground the other wire leading away from the warning horn with a jumper wire. If horn sounds, check for open wires between the horn and pin 4 of the engine 10 pin connector, repair as necessary. If horn does not sound, replace horn.

Warning Horn Activation Points

FAULT	Warning Horn Tone	Activates	De-Activates	Engine Protection Mode
Low Oil Pressure	Steady Beeping Tone	Below 34 kPa (5 psi)	Press. Rises Above 34 kPa (5 psi)	Yes
High Ex. Riser Temp	Steady Beeping Tone	Above 129°C (265°F)	Temp drops Below 101°C (215°F)	Yes
High ECT Temp.	Steady Beeping Tone	Above 93°C (200°F)	Temp drops Below 82°C (180°F)	Yes

22677

Scan Tool Readings During Warning Horn Activation

VP 2000 Display	Low Oil Pressure		High Ex. Riser Temp		High ECT Temp.		Active DTC
	Below 2500	Above 2500	Below 2500	Above 2500	Below 2500	Above 2500	All RPM's
Cause Pwr Reduct	YES	YES	YES	YES	YES	YES	NO
Power Reduction	NO	YES	NO	YES	NO	YES	NO
Overheat Det	NO	NO	NO	NO	YES	YES	NO
Low Oil Press Switch	LOW	LOW	OK	OK	OK	OK	OK
General Warning 1 Input	NO	NO	YES	YES	NO	NO	NO
Trouble Codes: Active	Oil Pressure	Oil Pressure	General Warning 1	General Warning 1	Overheat	Overheat	(Displays Active Codes)

22678

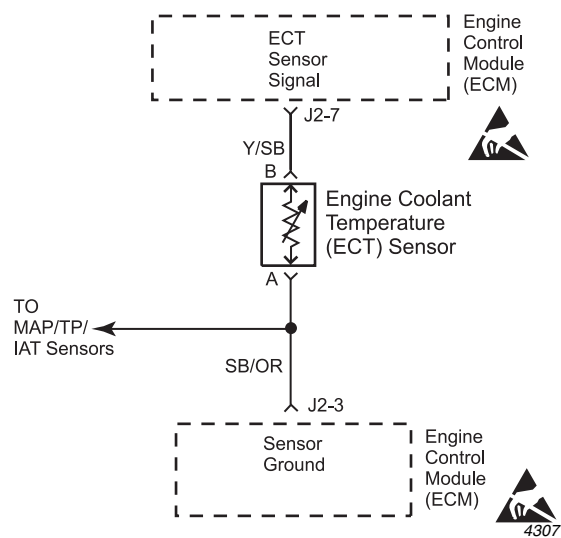
Notes

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DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temp Indicated



Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table. At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” coolant sensor. After engine is started,

the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.

- If DTC 33 is also set, check for open ground on J2-3.

After repairs, clear DTC’s following “Clear DTC’s Procedure”. Failure to do so may result in DTC’s not properly being cleared.

Test Description

2. DTC 14 will set if signal voltage indicates a coolant temperature below -30°C (-22°F).
3. This test simulates a DTC 15. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

Engine Coolant Temperature (ECT) Sensor

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

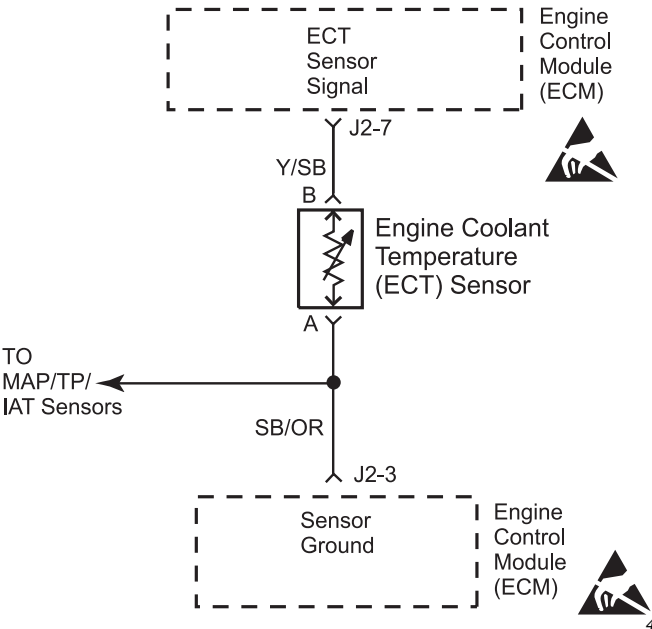
22681

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temp Indicated

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, leave engine OFF. Does the scan tool display a coolant temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect the ECT sensor harness connector. 3. Connect a jumper wire from harness terminal "A" to harness terminal "B". 4. Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature above the specified value?	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 14 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair open in 5 volt reference circuit J2-7 to terminal "B" ECT harness connector or ground circuit J2-3 to terminal "A" ECT harness connector. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

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DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated



coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.

- Check harness routing for a potential short to ground between J2-7 and ECT harness connector “B”.

After repairs, clear DTC’s following “Clear DTC’s Procedure”. Failure to do so may result in DTC’s not properly being cleared.

Test Description

2. DTC 15 will set if signal voltage indicates a coolant temperature above 130°C or 266°F.
3. This test simulates a DTC 14. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to pin B on the ECT sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table. At normal operating temperature (70°C - 73°C or 157°F - 163°F), the voltage will measure about 1.36 volts.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted”

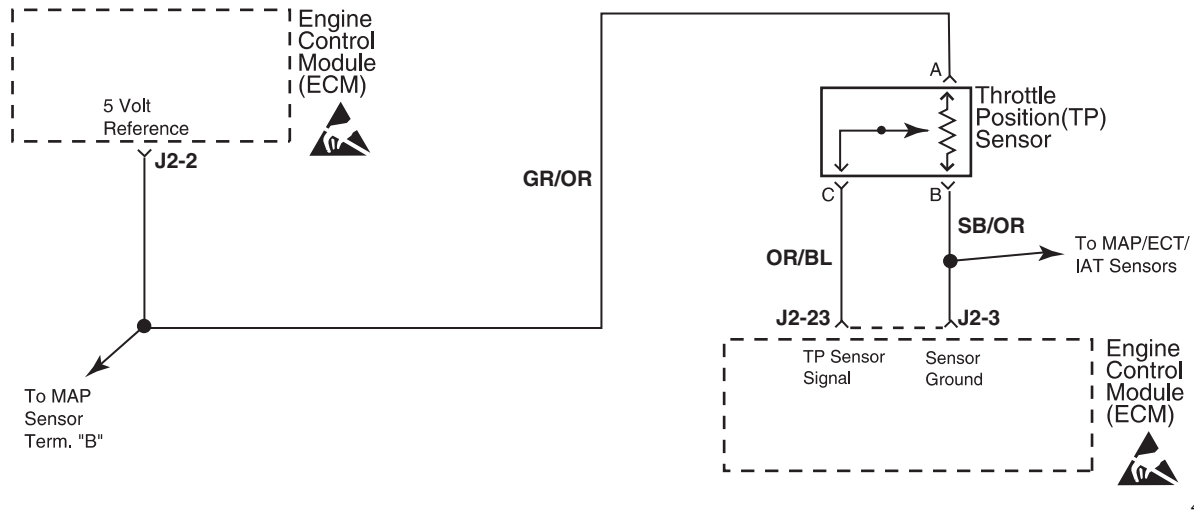
Engine Coolant Temperature (ECT) Sensor table

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, engine OFF. Does the scan tool display a coolant temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect ECT sensor harness connector. 3. Turn ignition ON, engine OFF. Does scan tool display a coolant temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 15 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair short to ground between J2-7 and pin "B" ECT harness connector. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22726



Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor from pin J2-2 to TP sensor connector terminal A. Terminal B to pin J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, to pin J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.

- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition “ON”, engine “OFF”, throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

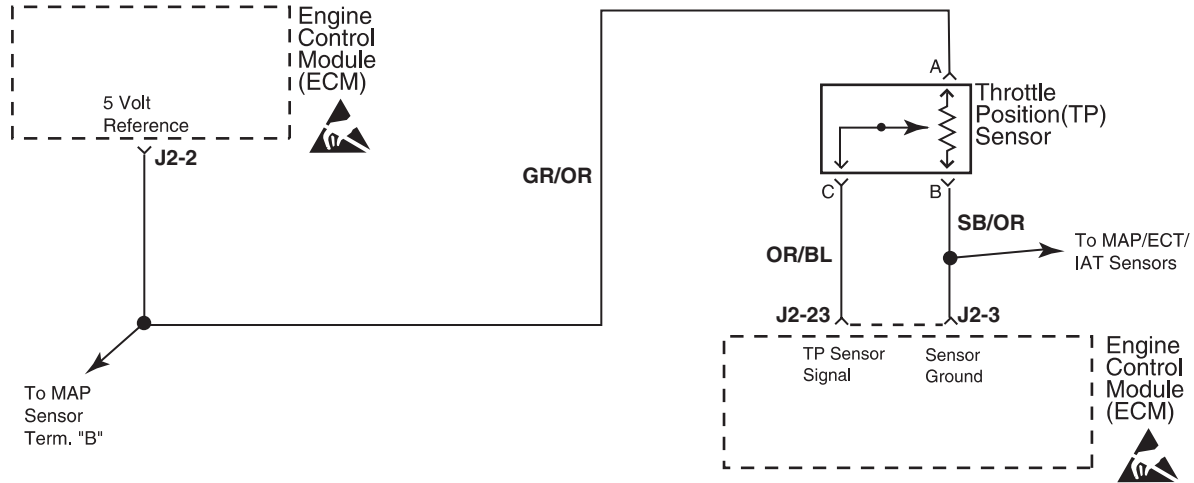
2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 22. If the ECM recognizes the low voltage signal, the ECM and wiring are OK.
4. Using DVOM from harness terminal "A" harness terminal "B" checks the sensor ground circuit. A faulty sensor ground will cause a DTC 21.

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, engine OFF. Does scan tool indicate TP sensor voltage greater than specified value?	4 volts	Go to Step 3	Go to Step 5
3	1. Turn ignition OFF. 2. Disconnect TP sensor harness connector. 3. Turn ignition ON, engine OFF. Does the Digital Volt-Ohm Meter indicate a voltage less than the specified value?	.36 volt	Go to Step 4	Go to Step 6
4	Connect Digital Volt-Ohm Meter from harness terminal "A" to harness connector terminal "B". Does Digital Volt-Ohm Meter indicate a voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 7
5	DTC 21 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
6	Locate and repair short to voltage in circuit between J2-23 and terminal "C" TP harness connector. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
7	Locate and repair open in ground circuit between J2-3 and terminal "B" TP harness connector. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	—	Verify Repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22727

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low



4308

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor through J2-2 to Pin A on the TP sensor. Pin B to J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, from Pin C to J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.

- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition "ON", engine "OFF", throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in the 5 volt reference circuit.
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

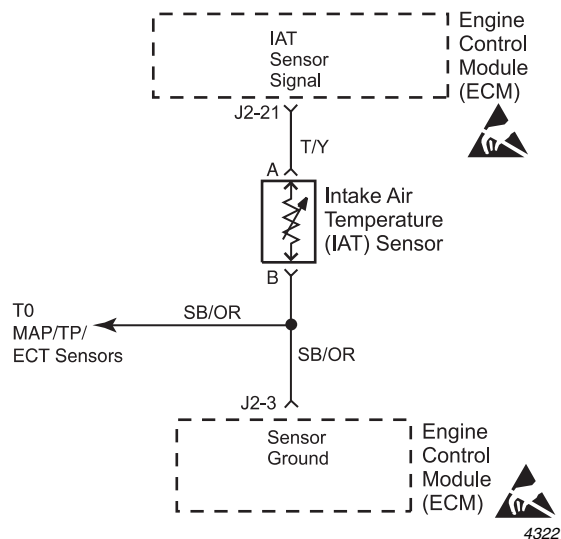
2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 21. If the ECM recognizes the high signal voltage, the ECM and wiring are OK.
4. This test checks for the 5 volt reference.

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, engine OFF. Does scan tool indicate TP sensor voltage less than the specified value?	.36 volts	Go to Step 3	Go to Step 5
3	1. Turn ignition OFF. 2. Disconnect TP sensor harness connector. 3. Connect a jumper wire between harness terminal "A" and harness terminal "C". 4. Turn ignition ON, engine OFF. Does the scan tool indicate TP sensor voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 4
4	1. Turn ignition OFF. 2. Connect Digital Volt-Ohm Meter from harness terminal "A" to a known good engine ground. 3. Turn ignition ON, engine OFF. Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 7	Go to Step 6
5	DTC 22 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	—	—
6	Locate and repair open or short to ground in circuit between J2-2 and harness connector "A". Also check the circuit to the MAP sensor for a short to ground. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
7	Locate and repair open or short to ground in TP sensor signal circuit between J2-23 and harness connector "C". If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	—	Verify Repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22728

DTC 23 - Manifold Air Temperature (MAT) Sensor Circuit - Low Temp



After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

- 2. DTC 23 will set if signal voltage indicates an intake air temperature below -30°C (-22°F).
- 3. This test simulates a DTC 25. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

Circuit Description

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts to the sensor. When the manifold air temperature is cold, the sensor (thermistor) resistance is high. As the manifold air temperature warms up, the sensor resistance becomes less. See *Manifold Air Temperature Sensor* table.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAT display on the scan tool while moving connectors and wiring harnesses related to the MAT sensor. A change in the MAT display will indicate the location of the fault.
- The scan tool displays manifold air temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a MAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a "shifted" MAT sensor.
- If DTC 33 is also set, check for open ground circuit (J2-3 to harness connector terminal "B").

Manifold Air Temperature Sensor Table

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

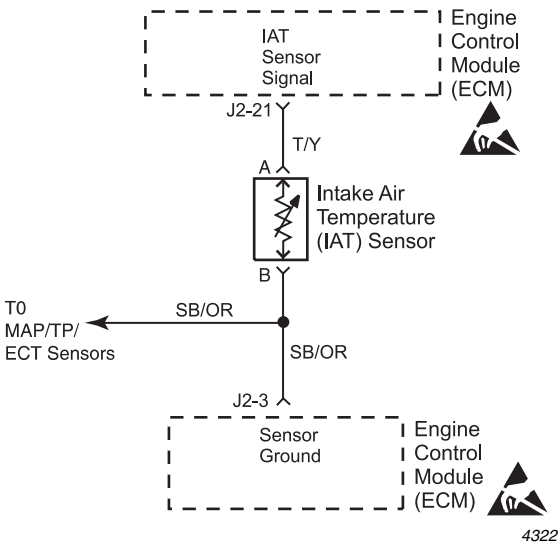
22681

DTC 23 - manifold Air Temperature (MAT) Sensor Circuit - Low Temp

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, engine OFF. Does the scan tool display an intake air temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect MAT sensor harness connector. 3. Connect a jumper wire between the MAT harness connector terminals "A" and "B". 4. Turn ignition ON, engine OFF. Does the scan tool display a coolant temperature above the specified value	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 23 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair open in the MAT sensor signal circuit (J2-21 to MAT harness terminal "A") or the MAT sensor ground circuit (J2-3 to MAT harness terminal "B"). Was a problem found and corrected?	—	Verify Repair	Go to Step 7
6	Repair faulty MAT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22729

DTC 25 - Manifold Air Temperature (MAT) Sensor Circuit - High Temp



- Check harness routing for a potential short to ground in the MAT sensor signal circuit (J2-21 to MAT harness connector terminal “A”).

After repairs, clear DTC’s following “Clear DTC’s Procedure”. Failure to do so may result in DTC’s not properly being cleared.

Test Description

2. DTC 25 will set if signal voltage indicates an intake air temperature above 130°C or 266°F.
3. This test simulates a DTC 23. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

Circuit Description

The Manifold Air Temperature (MAT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts to the sensor. When the manifold air temperature is cold, the sensor (thermistor) resistance is high. As the manifold air temperature warms up, the sensor resistance becomes less. See *Manifold Air Temperature Sensor* table.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAT display on the scan tool while moving connectors and wiring harnesses related to the MAT sensor. A change in the MAT display will indicate the location of the fault.
- The scan tool displays manifold air temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display an MAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” MAT sensor.

Manifold Air Temperature Sensor Table

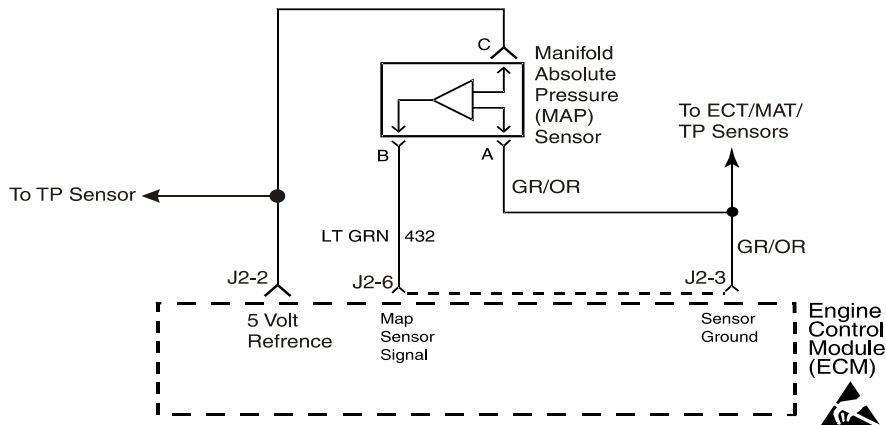
C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 25 - Manifold Air Temperature (MAT) Sensor Circuit - High Temp

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Ignition ON, engine OFF. Does scan tool display intake air temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect MAT sensor harness connector. 3. Turn ignition ON, engine OFF. Does scan tool display an intake air temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 25 is intermittent. Locate and repair faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair short to ground in the MAT sensor signal circuit (J2-21 to MAT harness connector terminal "A"). Was a problem found and corrected?	—	Verify Repair	—
6	Repair faulty MAT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22730

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High



4309

Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through pin J2-2 and terminal "C" of the MAP sensor harness connector. Terminal "A" in the is the ground circuit for the MAP sensor and connects to pin J2-3 of the ECM. The MAP signal terminal "B" sends a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to *Symptoms* in Section 4B for items which may cause an unstable idle.

- With the ignition "ON", engine "OFF", the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground in the sensor ground circuit (J2-3 to MAP harness connector terminal "B").
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

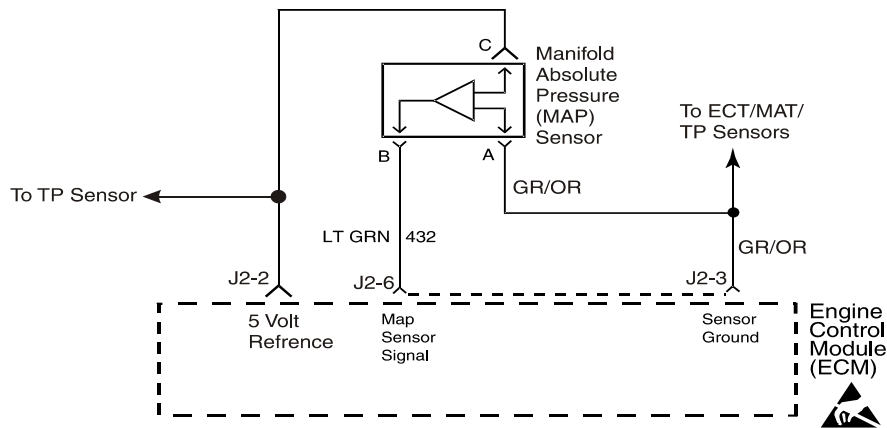
2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
4. This step simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are OK.
5. This step checks for an open in ground in the sensor ground circuit.

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Install a vacuum gauge to a manifold vacuum source. 2. Start engine and raise to 1000 r/m in neutral. 3. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified	35.56 cm Hg 45.5 kPa (14 in. Hg)	Go to Step 3	Go to Step 6
3	1. Install a scan tool. 2. Start the engine and allow engine to idle. Does the scan tool indicate MAP sensor voltage greater than the specified value?	4 volts	Go to Step 4	Go to Step 7
4	1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. Does scan tool indicate MAP sensor voltage greater than the specified value?	1 volt	Go to Step 5	Go to Step 8
5	1. Turn the ignition OFF. 2. Connect Digital Multi-Meter (DMM) between MAP sensor harness terminal "A" and "C". 3. Turn ignition ON, engine OFF. Does the DMM indicate a voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 9
6	Repair low or unsteady vacuum problem. Is action complete?	—	Verify Repair	—
7	DTC 33 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	—	—
8	Locate and repair short to voltage in MAP sensor signal circuit (J2-8 to MAP harness connector terminal "B"). Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	Locate and repair open in MAP sensor ground circuit (J2-3 to MAP harness connector terminal "A"). Was a problem found and corrected?	—	Verify Repair	Go to Step 11
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22731

DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low



4309

Circuit Description

The Manifold Absolute Pressure (MAP) sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through pin J2-2 and terminal "C" of the MAP sensor harness connector. Terminal "A" in the is the ground circuit for the MAP sensor and connects to pin J2-3 of the ECM. The MAP signal terminal "B" sends a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to *Symp-*

toms in Section 4B for items which may cause an unstable idle.

- With the ignition "ON", engine "OFF", the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
3. This step determines if DTC 34 is the result of a hard failure or an intermittent condition. A DTC will set when MAP signal voltage is too low with engine running.
4. This step simulates a DTC 33. If the ECM recognizes the high signal voltage, the ECM and wiring are OK.
5. This step checks for the 5 volt reference circuit.

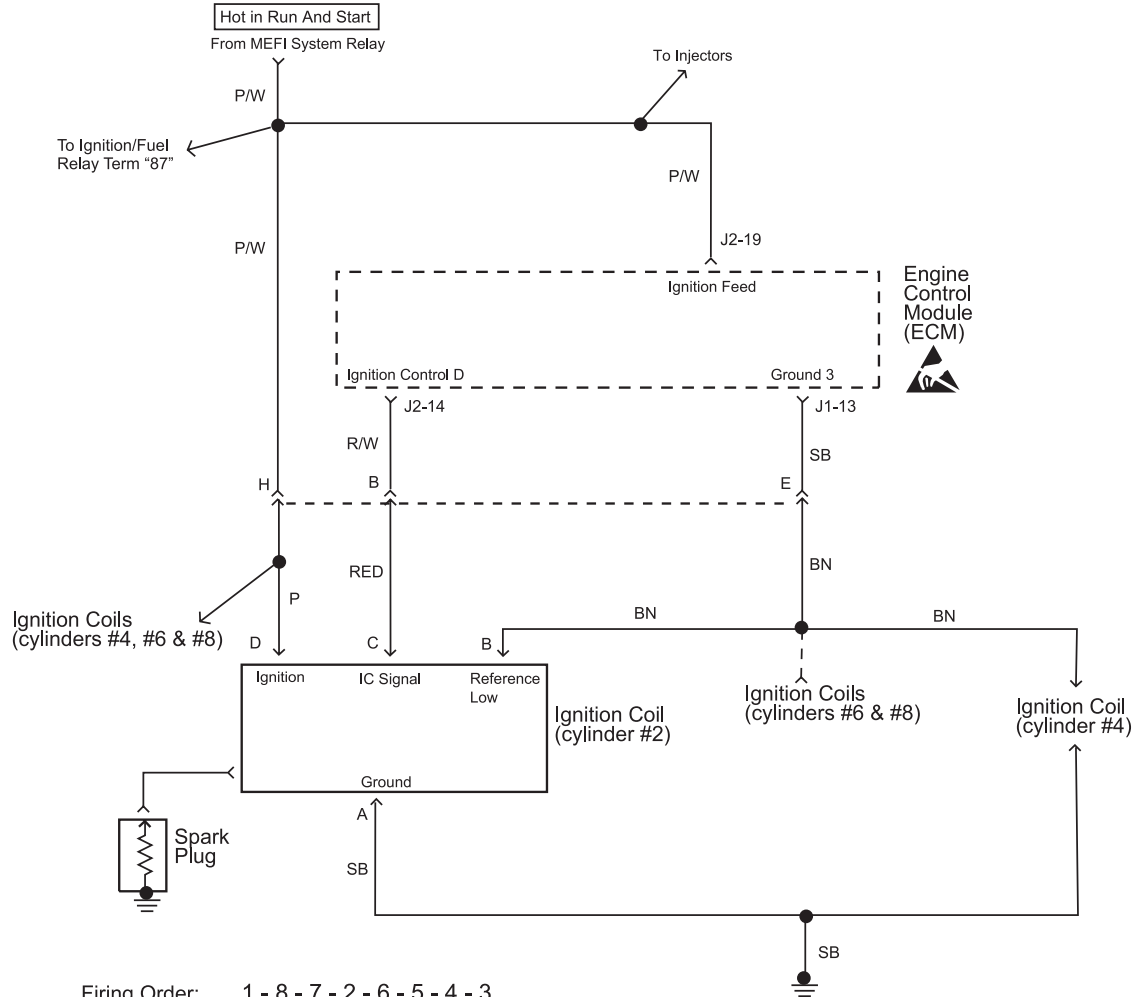
DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Turn ignition OFF. 2. Install vacuum gauge to a manifold vacuum source. 3. Start engine and raise to 1000 r/m in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	35.5 cm Hg 45.5 kPa (14 in. Hg)	Go to Step 3	Go to Step 6
3	1. Install a scan tool. 2. Start the engine and allow to engine to Idle. Does scan tool indicate map sensor voltage less than the specified value?	1 volt	Go to Step 4	Go to Step 7
4	1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. 3. Connect a jumper wire between MAP sensor harness connector terminals "B" and "C". 4. Turn ignition ON, engine OFF. Does the scan tool indicate MAP sensor voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 5
5	1. Turn OFF ignition. 2. Connect a Digital Multi-Meter between MAP sensor harness connector terminal "C" and a known good engine ground. 3. Turn ignition ON, engine OFF. Does the Digital Multi-Meter indicate a voltage greater than the specified value?	4 volts	Go to Step 9	Go to Step 8
6	Repair low or unsteady vacuum problem. Is action complete?	—	Verify Repair	—
7	DTC 34 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	—	—
8	Locate and repair open or short to ground in 5 volt reference circuit J2-2 to MAP harness connector terminal "C". Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	Locate and repair open or short to ground in MAP sensor signal circuit J2-8 to MAP harness connector terminal "B". Was a problem found and corrected?	—	Verify Repair	—
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

DTC 41- Ignition Coil 1 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 1?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

Hot in Run And Start



Firing Order: 1 - 8 - 7 - 2 - 6 - 5 - 4 - 3

Ignition Control: A - B - C - D - E - F - G - H

4312

The ignition system on

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequence and timing are ECM controlled. This DTC sets when the IC circuit is out of range.

Check for the follow

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

2. This step verifies

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 2 Control Circuit

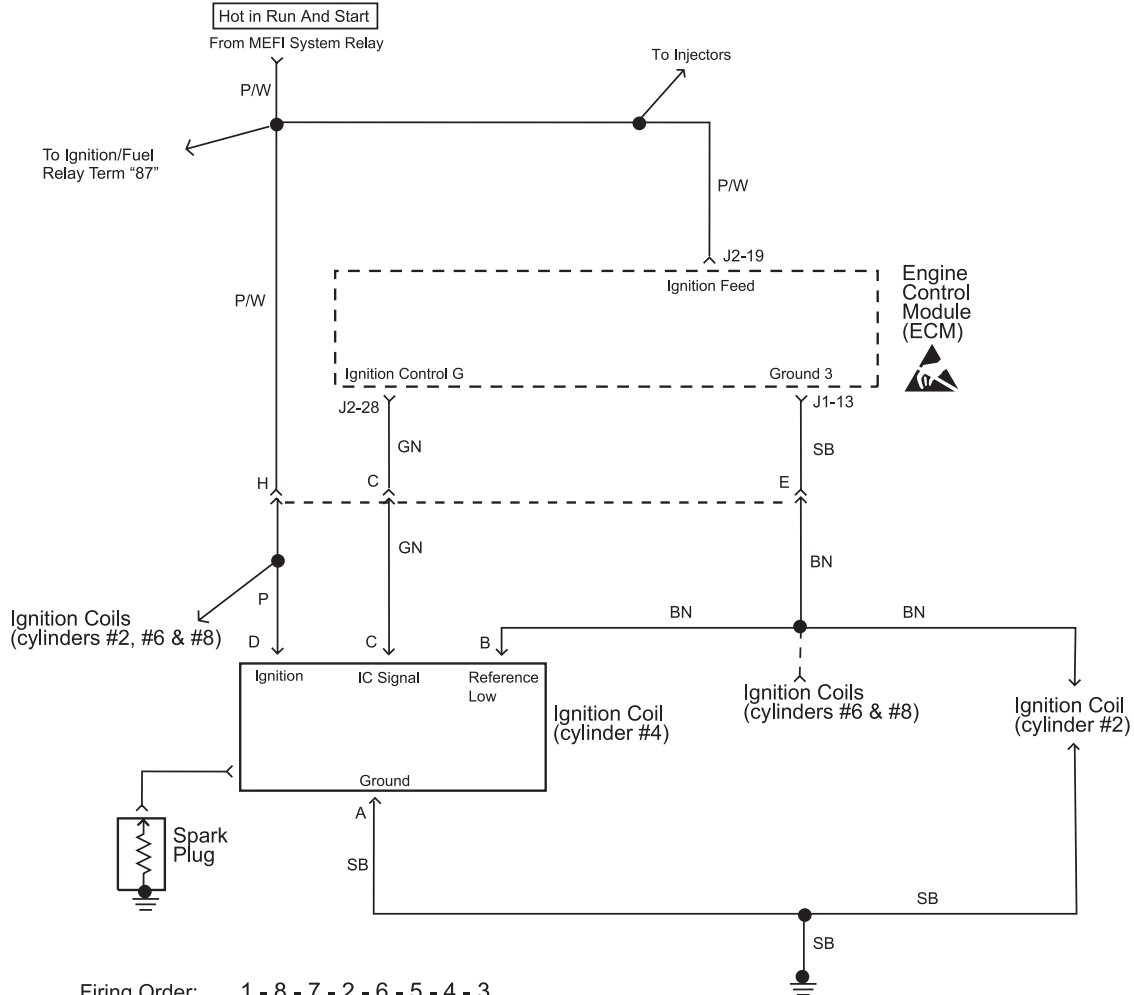
Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 2?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

DTC 41 - Ignition Coil 3 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 3?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

22738

Hot in Run And Start



4316

Ignition Control: A - B - C - D - E - F - G - H

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequence and timing are ECM controlled. This DTC sets when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

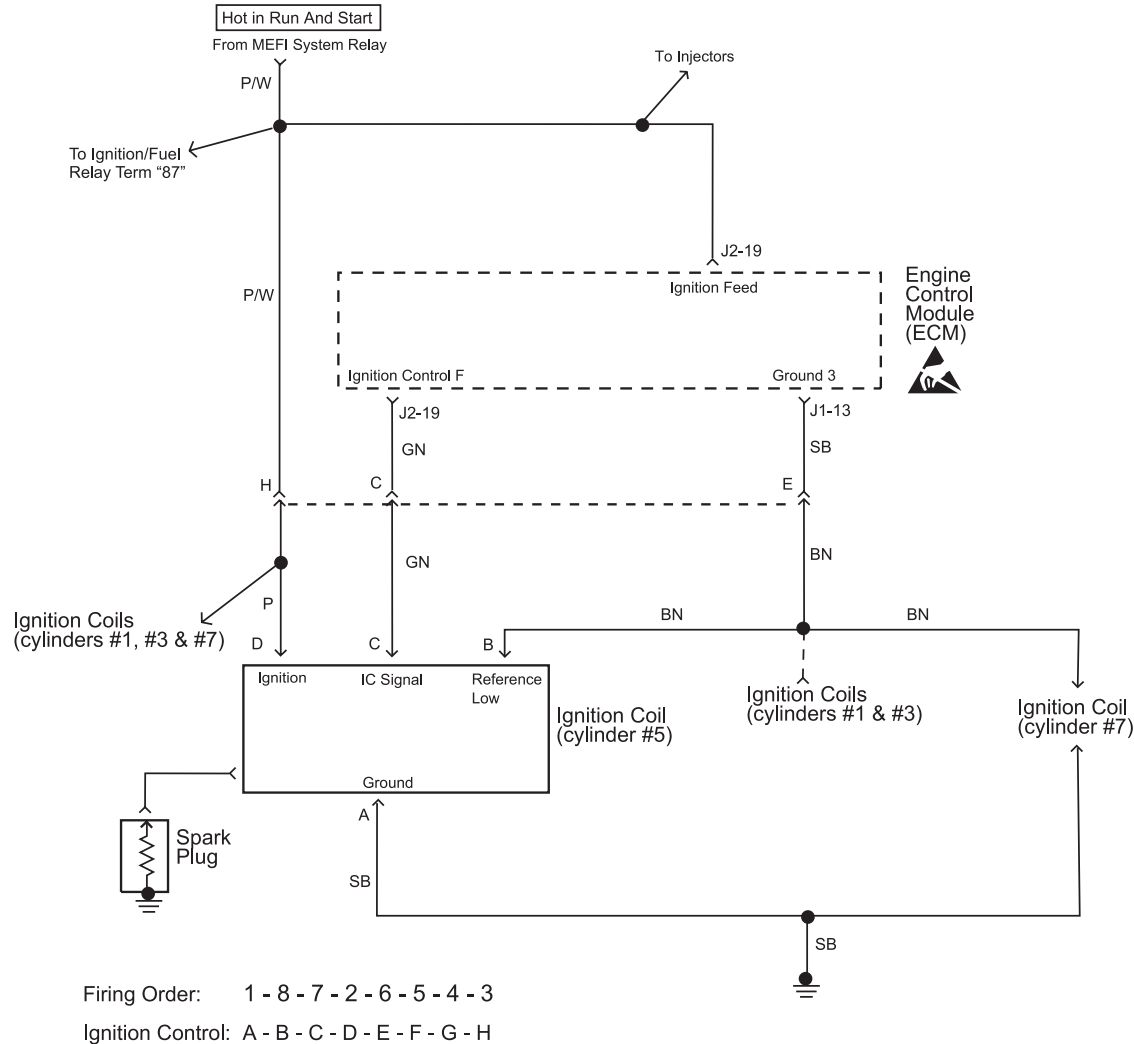
Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 4 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 4?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

DTC 41 - Ignition Coil 5 Control Circuit



4317

Circuit Description

The ignition system on this engine uses an individual ignition coil/module for each cylinder. The ECM controls the ignition system operation. The ECM controls each coil using one of eight Ignition Control (IC) circuits. The ECM commands the IC circuit low when a spark event is requested. This causes the IC module to energize the ignition coil to create a spark at the spark plug. Each ignition coil/module has the following circuits:

- A power feed
- A ground circuit
- An Ignition Control (IC) circuit
- A reference low circuit

Sequence and timing are ECM controlled. This DTC sets when the IC circuit is out of range.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Corrosion
- Mis-routed harness
- Rubbed through wire insulation
- Broken wire inside the insulation

Test Description

2. This step verifies the fault is present.
4. This step tests the integrity of the IC circuit and the ECM output.
5. This step tests for a short to ground on the IC signal circuit.

DTC 41 - Ignition Coil 5 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 5?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

DTC 41 - Ignition Coil 6 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 6?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

22741

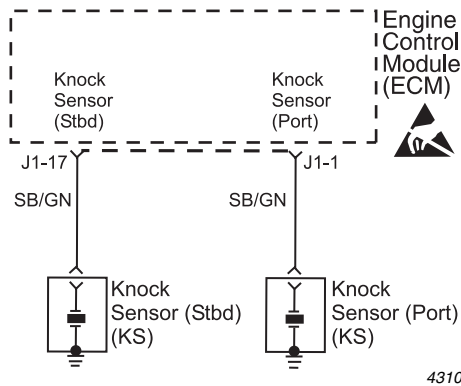
DTC 41 - Ignition Coil 7 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 7?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. 2. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

DTC 41 - Ignition Coil 8 Control Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If an Ignition Control (IC) DTCs are set at the same time, inspect the IC ground circuits for an open. 1. Install a scan tool. 2. Using a scan tool, clear DTCs. 3. Start and idle the engine for 2 minutes. 4. Check for DTCs. Does the scan tool indicate a DTC 41 for ignition coil 8?	—	Go to Step 3	Go to Diagnostic Aids
3	1. Turn OFF the engine. 2. Disconnect the ignition coil electrical harness. 3. Measure the frequency at the ignition control signal circuit using a Digital Volt-Ohm Meter capable of measuring DC Hertz. Is the frequency within the specified range?	3.0-20 Hz	Go to Step 7	Go to Step 4
4	Measure the voltage at the ignition control signal circuit using the Digital Volt-Ohm Meter. Is the voltage greater than the specified value	1.0 volt	Go to Step 8	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect the ECM J2 connector. 3. Test the continuity from the IC circuit (at the ignition coil harness connector) to the ECM connector using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate continuity?	—	Go to Step 6	Go to Step 9
6	Test the resistance from the IC circuit (at the ignition coil harness connector) to ground using the Digital Volt-Ohm Meter. Does the Digital Volt-Ohm Meter indicate OL?	—	Go to Step 10	Go to Step 9
7	Replace the ignition coil. Is the action complete?	—	Go to Step 12	—
8	Repair the ignition control circuit for a short to voltage. Is action complete?	—	Go to Step 12	—
9	Repair the Ignition control circuit for an open or grounded circuit. Is the action complete?	—	Go to Step 12	—
10	1. Inspect for poor connections at the ECM connector. 2. Replace the terminal if necessary. Did you find and correct the problem?	—	Go to Step 12	Go to Step 11
11	Replace the ECM. Is action complete?	—	Go to Step 12	—
12	Select the Diagnostic Trouble Code (DTC) option and the Clear DTC information option using the scan tool. Idle the engine at the normal operating temperature. Is DTC 41 indicated?	—	Go to Step 2	Go to Step 13
13	Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

DTC 44 - Knock Sensor (KS) Starboard Circuit



Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's

not properly being cleared.

If the knock sensor wires are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

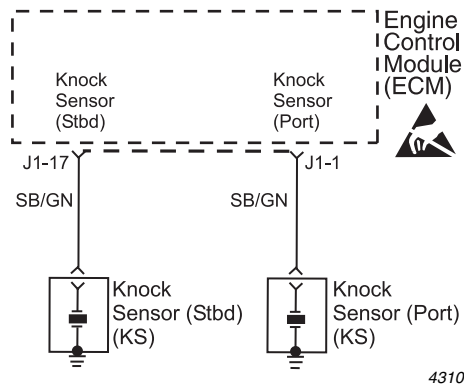
4. This step ensures the knock sensor is secured properly in the engine block.
5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) Starboard Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the spark plug wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Check knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 parameter. 4. Disconnect "J1" harness from the ECM. 5. Connect a Digital Multi-Meter from "J1-17" (knock signal 1) to a known good engine ground near the knock sensor. Is the resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found and repaired?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor (s). Is the action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is the action complete?	—	Verify Repair	—

22743

DTC 44 - Knock Sensor (KS) Port Circuit



Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's

not properly being cleared.

If the knock sensor wires are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

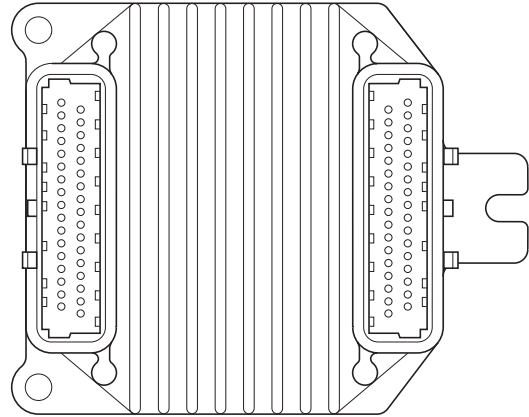
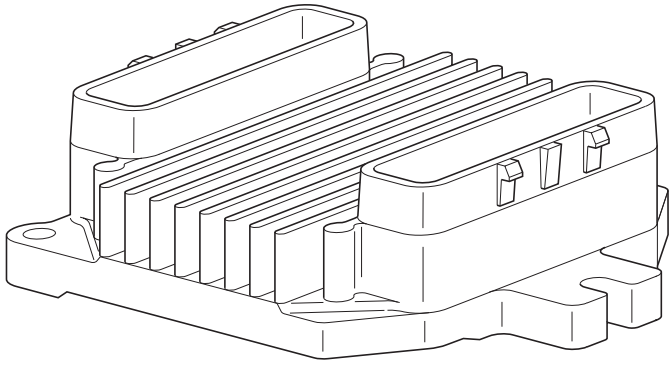
4. This step ensures the knock sensor is secured properly in the engine block.
5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) Port Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the spark plug wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Check knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 parameter. 4. Disconnect "J1" harness from the ECM. 5. Connect a Digital Multi-Meter from "J1-1" (knock signal 2) to a known good engine ground near the knock sensor. Is the resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found and repaired?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor (s). Is the action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is the action complete?	—	Verify Repair	—

22744

DTC 51 - Calibration Checksum Failure



3004

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibration or changes to these calibrations that may alter the designed func-

tion of MEFI.

Diagnostic Aids

If DTC 51 failed more than once, but is intermittent, replace the ECM.

Test Description

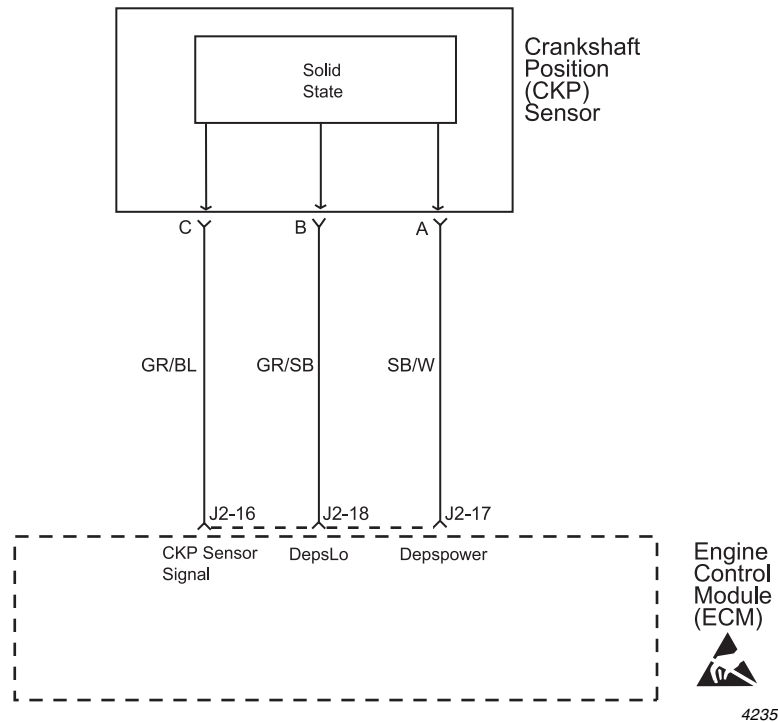
2. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning properly and must be replaced or reprogrammed.

DTC 51 - Calibration Checksum Failure

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Install scan tool. 2. Ignition ON, engine OFF 3. Clear DTC 51. 4. Switch to Diagnostic Trouble Codes (DTC). Does DTC 51 reset?	—	Go to Step 3	Refer to Diagnostic Aids
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?	—	Verify Repair	—

22745

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault



Circuit Description

The CKP sensor works in conjunction with a 24X reluctor wheel. The CKP sensor has a B+ power supply, a ground and a signal circuit.

As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this signal to accurately measure crankshaft velocity which is a variable used in order to detect misfire, and control spark and fueling.

Diagnostic Aids

Check for the following conditions:

- Poor connection in harness. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Crankshaft reluctor wheel damage or improper installation

- Excessive air gap between the CKP sensor and the reluctor wheel

Excess crankshaft end play causes the CKP sensor reluctor wheel to move out of alignment with the CKP sensor. This could result in any one of the following:

- A no start
- A start and stall
- Erratic performance

Test Description

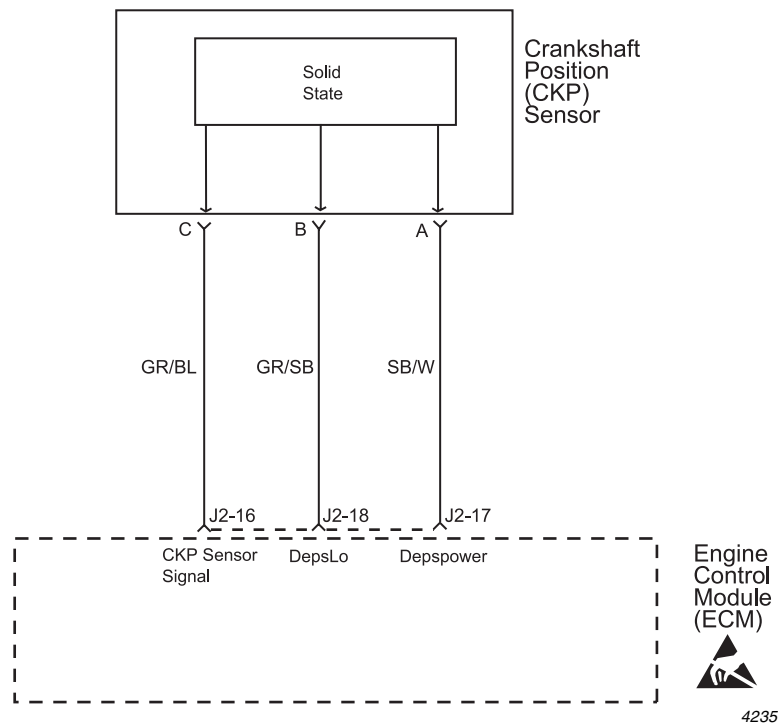
2. This test determines if the conditions exist in order to set DTC 55.

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the Camshaft Position (CMP) sensor harness connector. 2. Ignition ON, engine OFF. Using a Digital Multi-Meter, connected to a known good engine ground, measure the voltage at terminal "A" (Depspower) at the CMP sensor harness. Does the Digital Multi-Meter display the specified value?	B+	Go to Step 3	Go to Step 5
3	1. Using a Digital Multi-Meter measure the voltage between the CMP sensor harness connector terminal "A" (Depspower) and terminal "B" (Depslo). Does the Digital Multi-Meter display the specified value?	B+	Go to Step 4	Go to Step 7
4	1. Start the engine. 2. Monitor the CAM signal input - high to low and low to high transition using the scan tool. 3. Using a test lamp connected to the harness connector terminal "A" (Depspower) momentarily touch the other end to terminal "C" (CMP sensor signal). Does the CAM signal input - High to Low and Low to High transition counters increment when the test lamp contacts the signal circuit?	—	Go to Step 14	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect ECM connector J2. 3. Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depspower) circuit between the ECM and the CMP sensor. Does the resistance measure with the specified range?	0-5 ohms	Go to Step 6	Go to Step 11
6	1. Locate and repair a short to ground or poor connections to the CMP sensor (Depspower) circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 15
7	1. Ignition OFF 2. Disconnect the ECM J2 connector. 3. Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depslo) circuit between the ECM and the CMP sensor. Does the resistance measure within the specified range?	0-5 ohms	Go to Step 15	Go to Step 8
8	1. Locate and repair an open or poor connection in the CMP sensor (Depslo) circuit. Is action complete?	—	Verify Repair	—
9	1. Ignition OFF 2. Disconnect the ECM J2 connector. 3. Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depslo) circuit between the ECM and the CMP sensor. Does the resistance measure within the specified range?	0-5 ohms	Verify Repair	Go to Step 13

22746

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault cont'd



Circuit Description

The CKP sensor works in conjunction with a 24X reluctor wheel. The CKP sensor has a B+ power supply, a ground and a signal circuit.

As the crankshaft rotates, the reluctor wheel teeth interrupt a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this signal to accurately measure crankshaft velocity which is a variable used in order to detect misfire, and control spark and fueling.

Diagnostic Aids

Check for the following conditions:

- Poor connection in harness. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Crankshaft reluctor wheel damage or improper installation

- Excessive air gap between the CKP sensor and the reluctor wheel

Excess crankshaft end play causes the CKP sensor reluctor wheel to move out of alignment with the CKP sensor. This could result in any one of the following:

- A no start
- A start and stall
- Erratic performance

Test Description

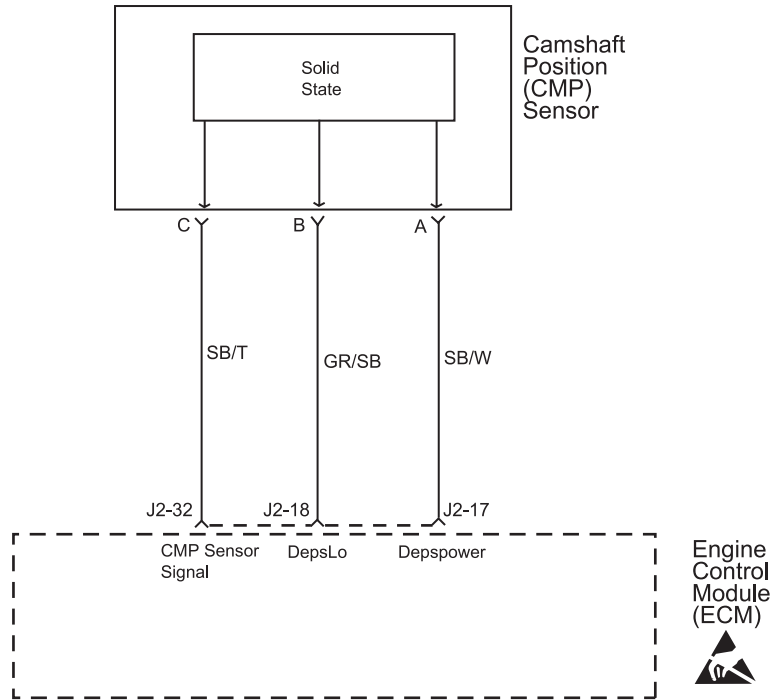
2. This test determines if the conditions exist in order to set DTC 55.

DTC 81 - Crankshaft Position (CKP) Sensor Circuit Fault (cont.)

Step	Action	Value	Yes	No
9	Locate and repair an open, short to ground or short to voltage in the CKP sensor signal circuit. Was a problem found?	—	Verify Repair	Go to Step 10
10	1. Remove the CKP sensor 2. Visually inspect the CKP sensor for physical damage, loose or improper installation or wiring routed too close to secondary ignition components. 3. Repair the circuit as necessary. Was a problem found?	—	Verify Repair	Go to Step 11
11	Inspect for poor connections at the CKP sensor. Was a problem found?	—	Verify Repair	Go to Step 12
12	Replace the faulty CKP sensor. Is action complete?	—	Verify Repair	—
13	Replace the ECM. Is the action complete?	—	Verify Repair	—

22747

DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault



4326

Circuit Description

The CMP sensor works in conjunction with a 1X reluctor wheel on the camshaft. The Engine Control Module (ECM) provides a 12 volt reference to the CMP sensor as well as a low reference and a signal circuit.

The CMP sensor determines whether a cylinder is on a firing stroke or on an exhaust stroke. As the camshaft rotates, the reluctor wheel interrupts a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this 1X signal in combination with the crankshaft position (CKP) sensor 24X signal in order to determine crankshaft position and stroke.

Observe that as long as the ECM receives the CKP sensor 24X signal, the engine will start. The ECM can determine top dead center for all cylinders by using the CKP sensor 24X signal alone. The CMP sensor 1X signal is used by the ECM to determine if the cylinder at top dead center is on the firing stroke or the exhaust stroke. The system attempts synchronization and looks for an increase in engine speed indicating the engine started. If the ECM does not detect an increase in engine speed, the ECM assumes it is incorrectly synchronized to the exhaust stroke and re-synchronizes to the exhaust stroke and re-synchronizes to the opposite cam position. A slightly longer cranking time may be a symptom of this condition.

Diagnostic Aids

Check for the following conditions:

- Camshaft reluctor wheel damage
- The sensor coming in contact with the reluctor wheel
- A cracked or damaged sensor
- Foreign material passing between the sensor and reluctor wheel

If you find damage to the reluctor wheel or camshaft, refer to *Camshaft Replacement* in Engine Mechanical.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

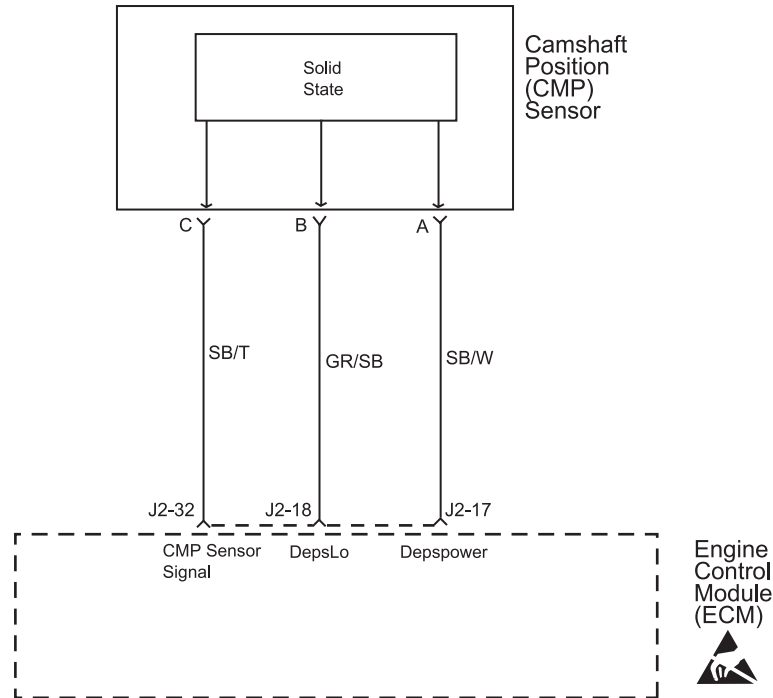
2. This test determines if the conditions exist in order to set DTC 55.

DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the Camshaft Position (CMP) sensor harness connector. 2. Ignition ON, engine OFF. Using a Digital Multi-Meter, connected to a known good engine ground, measure the voltage at terminal "A" (Depspower) at the CMP sensor harness. Does the Digital Multi-Meter display the specified value?	B+	Go to Step 3	Go to Step 5
3	1. Using a Digital Multi-Meter measure the voltage between the CMP sensor harness connector terminal "A" (Depspower) and terminal "B" (Depslo). Does the Digital Multi-Meter display the specified value?	B+	Go to Step 4	Go to Step 7
4	1. Start the engine. 2. Monitor the CAM signal input - high to low and low to high transition using the scan tool. 3. Using a test lamp connected to the harness connector terminal "A" (Depspower) momentarily touch the other end to terminal "C" (CMP sensor signal). Does the CAM signal input - High to Low and Low to High transition counters increment when the test lamp contacts the signal circuit?	—	Go to Step 14	Go to Step 9
5	1. Turn OFF the engine. 2. Disconnect ECM connector J2. 3. Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depspower) circuit between the ECM and the CMP sensor. Does the resistance measure with the specified range?	0-5 ohms	Go to Step 6	Go to Step 11
6	1. Locate and repair a short to ground or poor connections to the CMP sensor (Depspower) circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 15
7	1. Ignition OFF 2. Disconnect the ECM J2 connector. 3. Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depslo) circuit between the ECM and the CMP sensor. Does the resistance measure within the specified range?	0-5 ohms	Go to Step 15	Go to Step 8
8	1. Locate and repair an open or poor connection in the CMP sensor (Depslo) circuit. Is action complete?	—	Verify Repair	—
9	1. Ignition OFF 2. Disconnect the ECM J2 connector. 3. Using a Digital Multi-Meter, measure the resistance of the CMP sensor (Depslo) circuit between the ECM and the CMP sensor. Does the resistance measure within the specified range?	0-5 ohms	Verify Repair	Go to Step 13

22748

DTC 81 - Camshaft Position (CMP) Sensor Circuit Fault (cont.)



4326

Circuit Description

The CMP sensor works in conjunction with a 1X reluctor wheel on the camshaft. The Engine Control Module (ECM) provides a 12 volt reference to the CMP sensor as well as a low reference and a signal circuit.

The CMP sensor determines whether a cylinder is on a firing stroke or on an exhaust stroke. As the camshaft rotates, the reluctor wheel interrupts a magnetic field produced by a magnet within the sensor. The sensor's internal circuitry detects this and produces a signal which the ECM reads. The ECM uses this 1X signal in combination with the crankshaft position (CKP) sensor 24X signal in order to determine crankshaft position and stroke.

Observe that as long as the ECM receives the CKP sensor 24X signal, the engine will start. The ECM can determine top dead center for all cylinders by using the CKP sensor 24X signal alone. The CMP sensor 1X signal is used by the ECM to determine if the cylinder at top dead center is on the firing stroke or the exhaust stroke. The system attempts synchronization and looks for an increase in engine speed indicating the engine started. If the ECM does not detect an increase in engine speed, the ECM assumes it incorrectly synchronized to the exhaust stroke and re-synchronizes to the exhaust stroke and re-synchronizes to the opposite cam position. A slightly longer cranking time may be a symptom of this condition.

Diagnostic Aids

Check for the following conditions:

- Camshaft reluctor wheel damage
- The sensor coming in contact with the reluctor wheel
- A cracked or damaged sensor
- Foreign material passing between the sensor and reluctor wheel

If you find damage to the reluctor wheel or camshaft, refer to *Camshaft Replacement* in Engine Mechanical.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

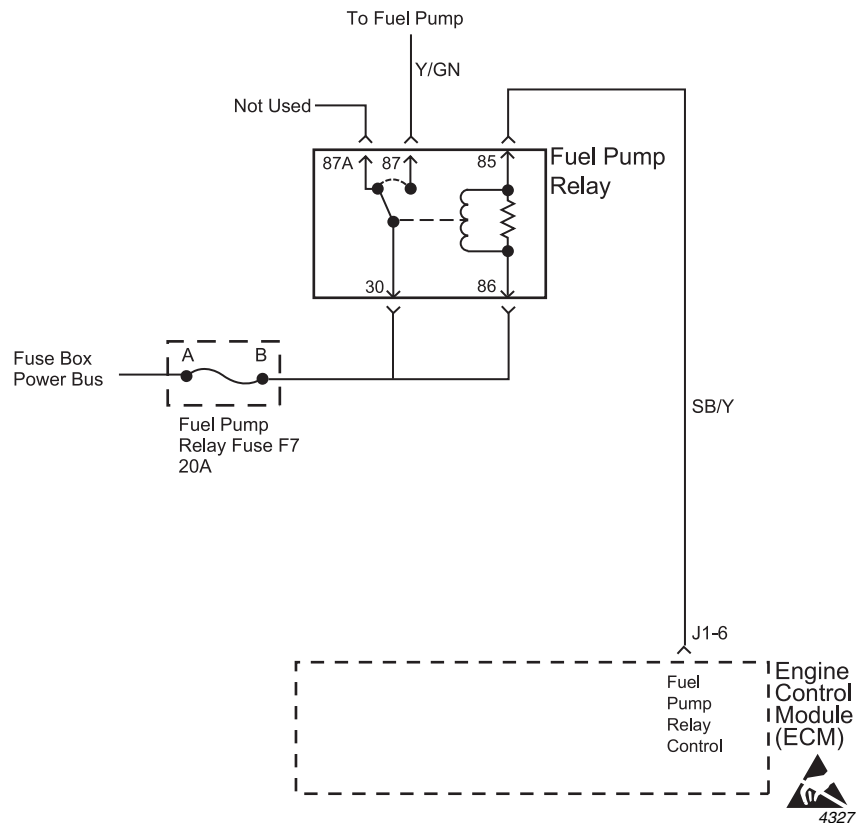
2. This test determines if the conditions exist in order to set DTC 55.

DTC 81 - Camshaft Position (CMP) (cont.)

Step	Action	Value	Yes	No
10	1. Ignition ON, engine OFF. 2. Locate and repair a short to ground or a short to voltage on the CMP sensor circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 15
11	1. Locate and repair an open in CMP sensor (Depspower) circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 15
12	1. Locate and repair an open in CMP sensor (Depslope) circuit. Was a problem found and corrected?	—	Verify Repair	—
13	1. Locate and repair an open in the CMP sensor signal circuit. Was a problem found and corrected?	—	Verify Repair	—
14	1. Locate and repair a poor connections at the CMP connector. Was a problem found and corrected?	—	Verify Repair	Go to Step 16
15	1. Locate and repair a poor connections at the ECM connector. Was a problem found and corrected?	—	Verify Repair	Go to Step 17
16	1. Replace the faulty CMP sensor. Is action complete?	—	Verify Repair	—
17	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22749

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open



Circuit Description

The Engine Control Module (ECM) controls the relay by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the controlled component. This driver has a fault line which the ECM monitors. When the ECM commands the relay ON, the voltage of the control circuit should be low, near 0 volts. When the ECM commands the relay OFF, the voltage should be high, near battery voltage. If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes causing a DTC to set.

The relay controls the high current flow to the fuel pumps. This allows the ECM driver to only have to control the relatively low current used by the relay.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

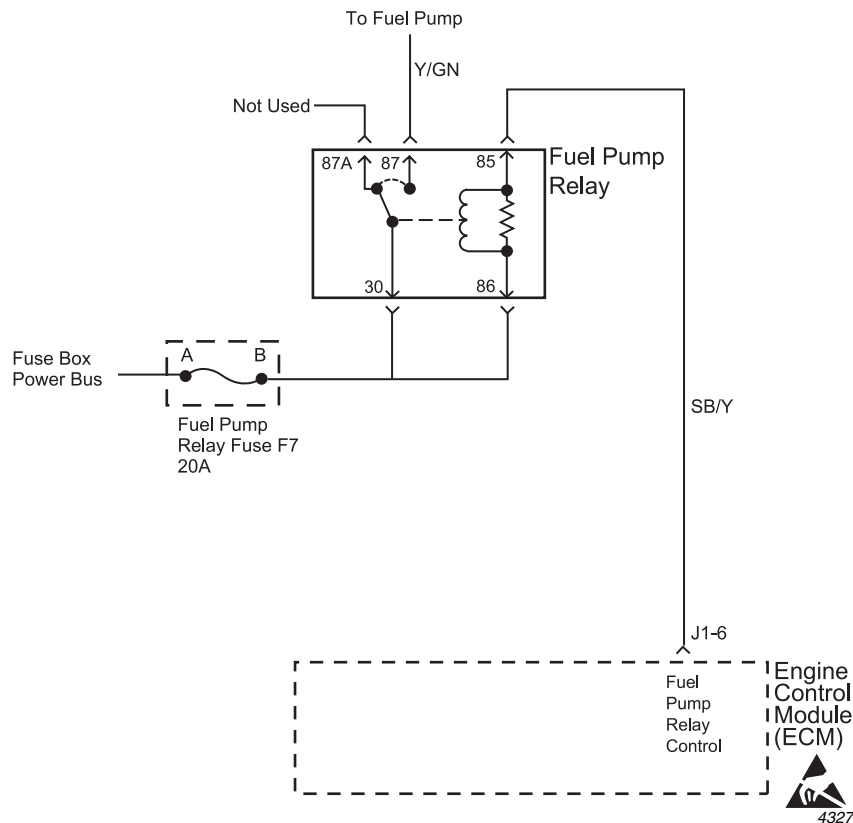
2. Listen for an audible click when the relay operates. Command both the ON and OFF states. Repeat the commands if necessary.
3. This test can detect a partially shorted coil which would cause an excessive current flow. Leaving the circuit energized for 2 minutes allows the coil to warm up. When warm, the coil may open, and the current drops to 0, or the coil may short, and the current goes above 0.75 amp.
5. Identify and test the relay coil terminals in order to avoid improper diagnosis.
12. If no trouble is found in the control circuit or the connection at the ECM, the ECM may be faulty. However, this is an extremely unlikely failure.

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF. 2. Command the relay ON and OFF using the scan tool. Does the relay turn ON and OFF when commanded?	—	Go to Step 3	Go to Step 5
3	1. Ignition OFF 2. Disconnect the ECM J1 connector. 3. Install a 5 amp fused jumper wire from a known good engine ground to the control circuit at the ECM J1 connector pin J1-6. 4. Ignition ON, engine OFF. 5. Using a DMM on the 40 amp scale, measure the current from the relay control circuit in the ECM harness connector to ground for 2 minutes. Important! If the DMM goes to 0 during the current draw test, replace the relay. Does the current draw measure less than the specified value?	0.75A	Go to Diagnostic Aids	Go to Step 4
4	1. Ignition OFF. 2. Disconnect the fuel pump relay connector. 3. Using a DMM measure the resistance from the relay control circuit in the ECM harness connector to ground. Does the DMM display infinite resistance or OL?	—	Go to Step 12	Go to Step 10
5	1. Ignition OFF 2. Disconnect the fuel pump relay connector. 3. Connect a test lamp between the fuel pump relay control circuit(relay pin 85) and the fuel pump relay ignition feed circuit, on the coil side of the relay (relay pin 86), at the fuel pump relay socket in the fuse box. 4. Ignition ON, engine OFF. 5. Using a scan tool, command the relay ON and OFF. Does the test lamp turn ON and OFF when commanded?	—	Go to Step 8	Go to Step 6
6	Using a test lamp connected to a known good engine ground, probe the ignition feed circuit, on the coil side of the fuel pump relay harness connector. Is the test lamp illuminated?	—	Go to Step 7	Go to Step 11
7	1. Ignition OFF. 2. Reconnect the relay. 3. Disconnect the ECM connector J2 4. Ignition ON, engine OFF. 5. Using a fused jumper wire connected to a known good engine ground, momentarily probe the relay control circuit in the ECM harness connector. Does the relay turn ON when the circuit is grounded and OFF when the circuit is opened?	—	Go to Step 9	Go to Step 10

22751

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open (cont.)



Circuit Description

The Engine Control Module (ECM) controls the relay by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the controlled component. This driver has a fault line which the ECM monitors. When the ECM commands the relay ON, the voltage of the control circuit should be low, near 0 volts. When the ECM commands the relay OFF, the voltage should be high, near battery voltage. If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes causing a DTC to set.

The relay controls the high current flow to the fuel pumps. This allows the ECM driver to only have to control the relatively low current used by the relay.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

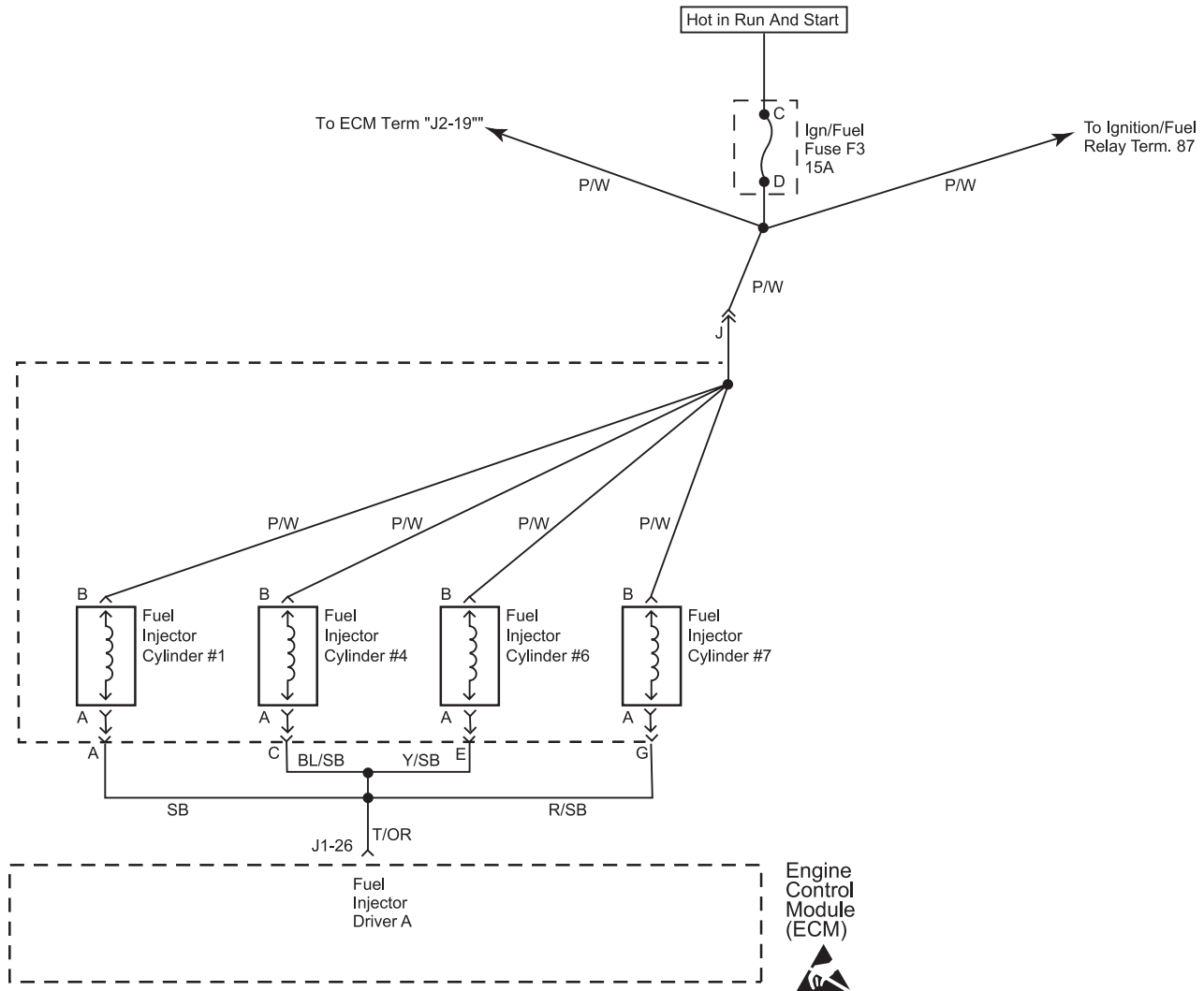
2. Listen for an audible click when the relay operates. Command both the ON and OFF states. Repeat the commands if necessary.
3. This test can detect a partially shorted coil which would cause an excessive current flow. Leaving the circuit energized for 2 minutes allows the coil to warm up. When warm, the coil may open, and the current drops to 0, or the coil may short, and the current goes above 0.75 amp.
5. Identify and test the relay coil terminals in order to avoid improper diagnosis.
12. If no trouble is found in the control circuit or the connection at the ECM, the ECM may be faulty. However, this is an extremely unlikely failure.

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open (cont.)

Step	Action	Value	Yes	No
8	Locate and repair faulty connections at the relay. Was a problem found and repaired	—	Verify Repair	Go to Step 12
9	Locate and repair faulty connections at the ECM. Was a problem found and corrected?	—	Verify Repair	Go to Step 13
10	Repair the faulty connections at the ECM.	—	—	—
11	Repair the faulty ignition feed circuit.	—	—	—
12	Replace the faulty relay	—	—	—
13	Replace the ECM	—	—	—

22752

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open



4328

Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)* or *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F)*.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

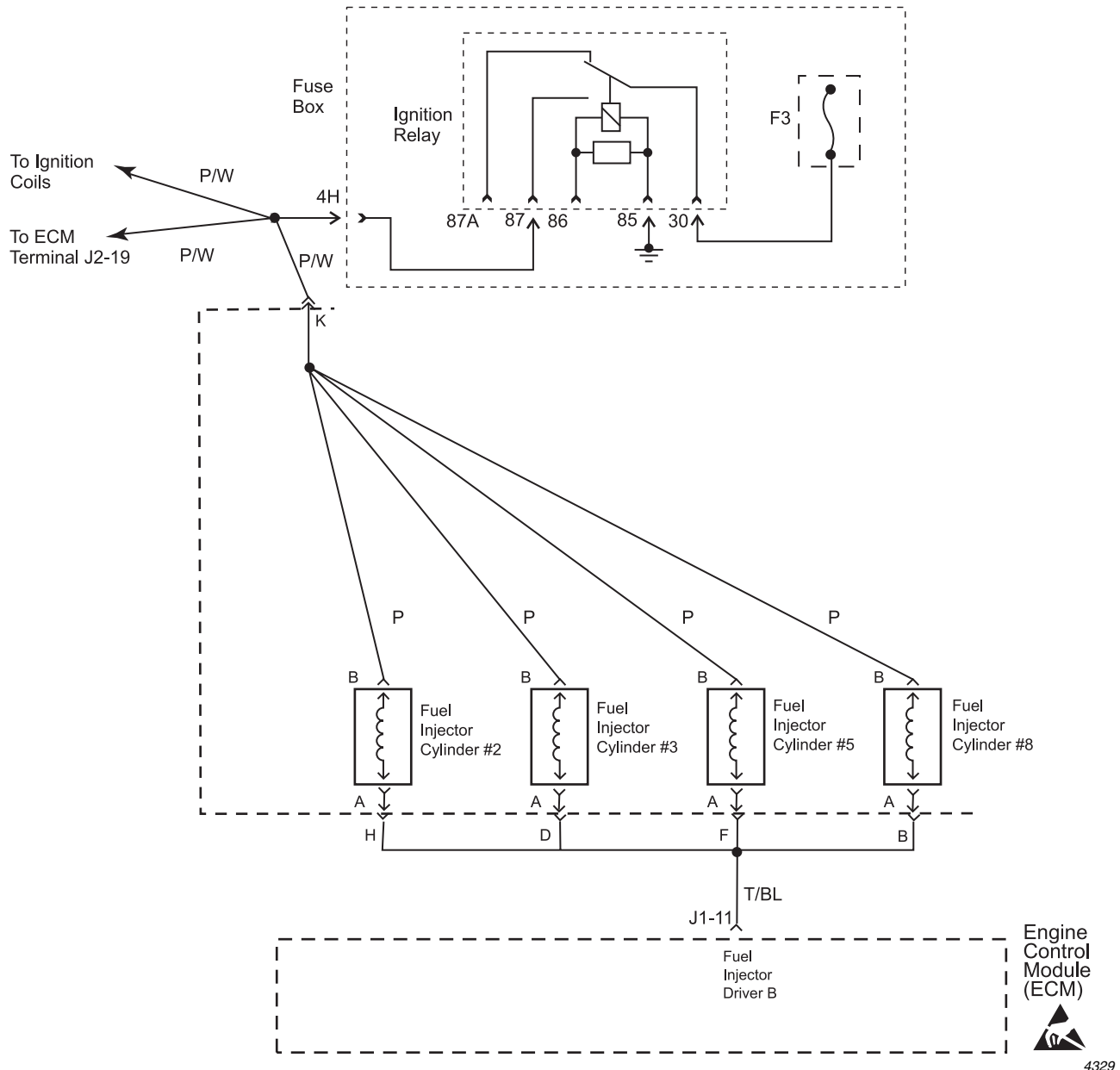
- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply circuit is indicated. The ECM/INJ fuse also supplies voltage to the ignition coils. If the fuse is open, inspect the circuits to the ignition coils for a short to ground.
- This test verifies that the ECM is able to control the fuel injector. If the test lamp blinks, then the ECM and wiring are OK.
- This step tests if a ground is constantly being applied to the fuel injector.

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to <i>Step 2</i>	Go to OBD System Check
2	1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Ignition ON, engine OFF. 3. Using a test lamp connected to a known good engine ground, probe the ignition voltage circuits for each fuel injector on the harness connector. Does the test lamp illuminate in all four circuits?	—	Go to <i>Step 3</i>	Go to Step 8
3	1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors 2. Start the engine. Does the test lamp blink on all four injector harness connections?	—	Go to <i>Step 7</i>	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	—	Go to Step 6	Go to Step 5
5	1. Locate and repair open or short to ground or short to voltage in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 8
6	1. Locate and repair a short to ground in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
7	1. Locate and repair poor connections at the harness connector for the fuel injector. Was a problem found and corrected?	—	Verify Repair	Go to Step 10
8	1. Locate and repair poor connections at the harness connector of the ECM. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	1. Repair an open or short to ground in the fuel injector ignition voltage circuit. Important! The ECM/INJ fuse (F3) also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground. Was a problem found and corrected?	—	Verify Repair	—
10	1. Replace the fuel injector. Is action complete?	—	Verify Repair	—
11	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22753

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open



4329

Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F) or Fuel*

Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F).

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

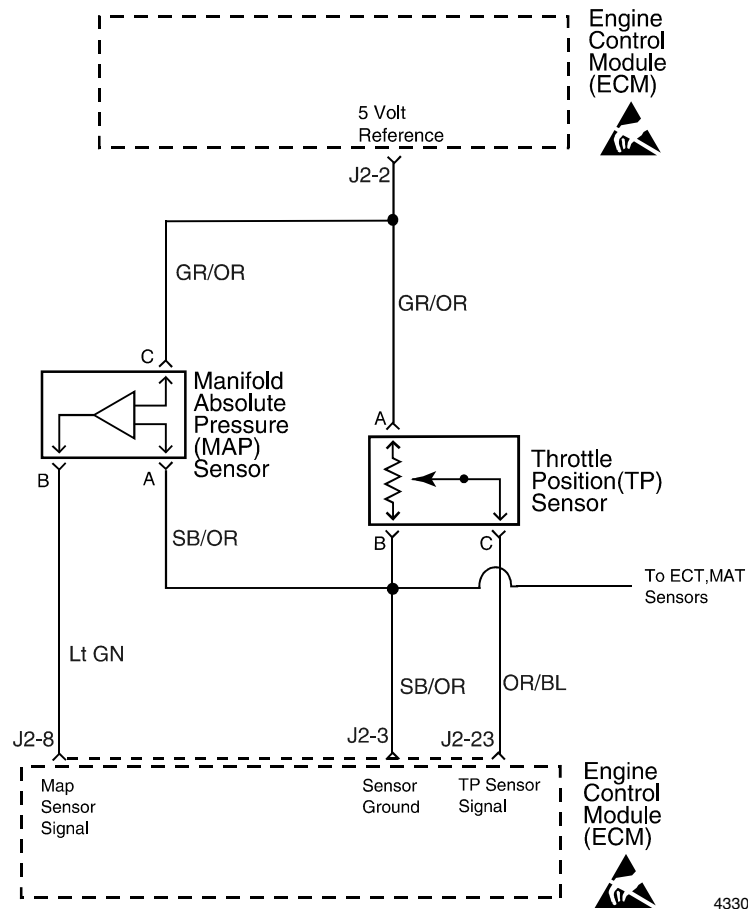
- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply.

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to <i>Step 2</i>	Go to OBD System Check
2	1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Ignition ON, engine OFF. 3. Using a test lamp connected to a known good engine ground, probe the ignition voltage circuits for each fuel injector on the harness connector. Does the test lamp illuminate in all four circuits?	—	Go to <i>Step 3</i>	Go to Step 8
3	1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors 2. Start the engine. Does the test lamp blink on all four injector harness connections?	—	Go to <i>Step 7</i>	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	—	Go to Step 6	Go to Step 5
5	1. Locate and repair open or short to ground or short to voltage in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 8
6	1. Locate and repair a short to ground in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
7	1. Locate and repair poor connections at the harness connector for the fuel injector. Was a problem found and corrected?	—	Verify Repair	Go to Step 10
8	1. Locate and repair poor connections at the harness connector of the ECM. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	1. Repair an open or short to ground in the fuel injector ignition voltage circuit. Important! The ECM/INJ fuse (F3) also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground. Was a problem found and corrected?	—	Verify Repair	—
10	1. Replace the fuel injector. Is action complete?	—	Verify Repair	—
11	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22754

DTC 81 - 5 Volt Reference Circuit Out of Range



Circuit Description

The Engine Control Module (ECM) uses a common 5 volt reference circuit as a sensor feed. This circuit supplies 5 volts to the Manifold Absolute Pressure (MAP) sensor and the Throttle Position (TP) sensor. The ECM monitors the voltage on the 5 volt reference circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

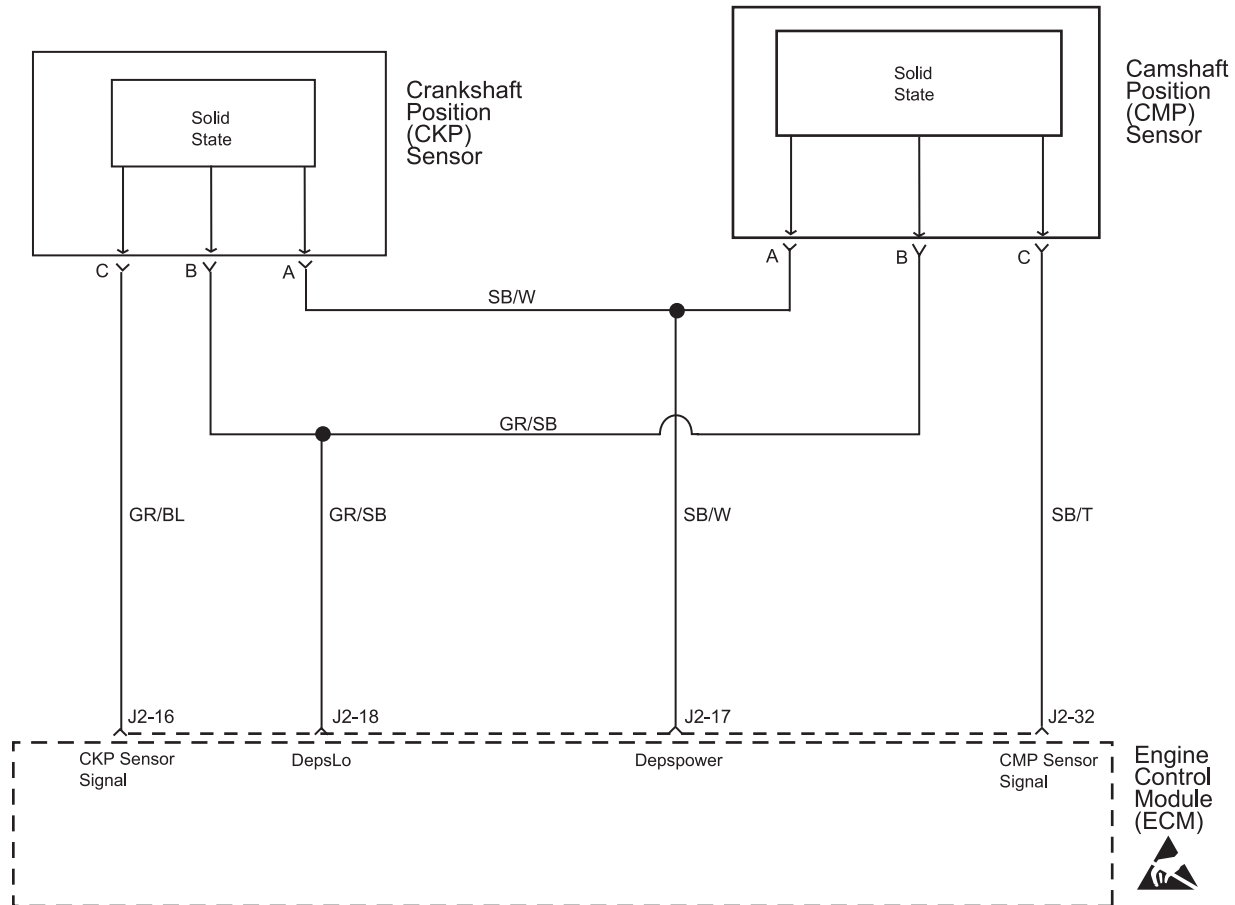
3. The 5 volt reference circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

DTC 81 - 5 Volt Reference Circuit Out of Range

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to <i>Step 2</i>	Go to OBD System Check
2	1. Disconnect the ECM harness connector J2 2. Ignition ON, engine OFF. 3. Using a Digital Multi-Meter connected to a known good engine ground, probe the other lead of the Digital Multi-Meter to the 5 volt reference circuit (J2-2) at the ECM harness connector. Does the circuit measure more than the specified value?	5.1 volts	Go to <i>Step 6</i>	Go to Step 3
3	Before proceeding, remove the following fuses: - F3 - F7 1. Disconnect the MAP sensor and the TP sensor harness connectors 2. Using a Digital Multi-Meter, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
4	1. Ignition OFF. 2. Disconnect the ECM connector J2. 3. Using a test lamp connected to B+, probe the 5 volt reference circuit (J2-2) at the ECM harness connector. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 5
5	1. Using a Digital Multi-Meter, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
6	1. Locate and repair a short to voltage on the 5 volt reference circuit. Is action complete?	—	Verify Repair	—
7	1. Locate and repair short between the 5 volt reference circuit and the ECM circuit that had continuity. Is action complete?	—	Verify Repair	—
8	1. Locate and repair short to ground on the 5 volt reference circuit. Is action complete?	—	Verify Repair	—
9	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22755

DTC 81 - Depspower Circuit Out of Range



4331

Circuit Description

The Engine Control Module (ECM) uses a dedicated 5 volt reference circuit for the Crankshaft Position (CKP) sensor and the Camshaft Position (CMP) sensor. This circuit supplies 5 volts to only the CKP and the CMP sensor circuits. This circuit is referred to as Depspower. The ECM monitors the voltage on the Depspower circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

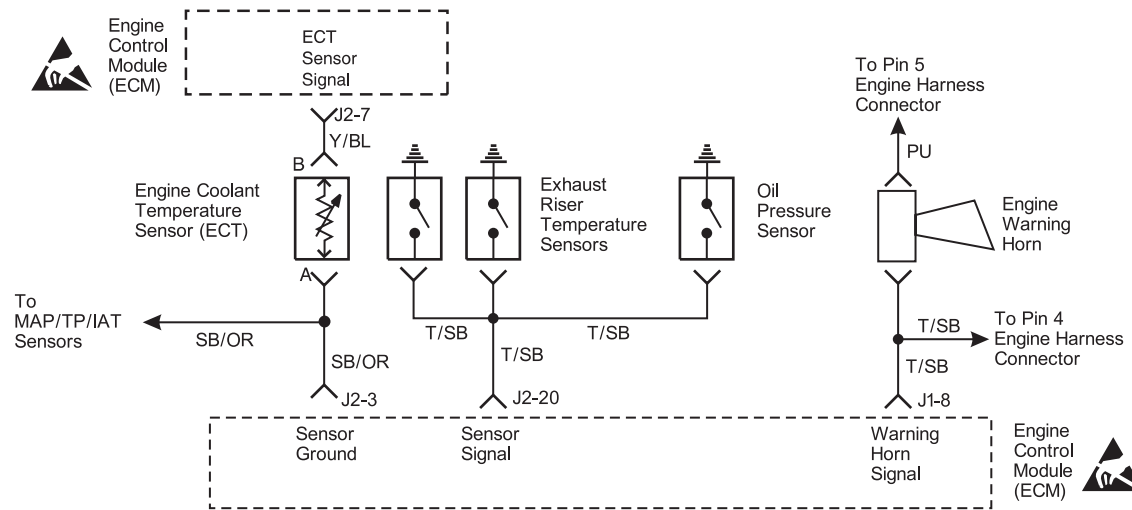
3. The Depspower circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

DTC 81 - Depspower Circuit Out of Range

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the ECM harness connector J2. 2. Ignition ON, engine OFF. 3. Using a Digital Multi-Meter connected to a known good engine ground, probe the other lead of the Digital Multi-Meter to the Depspower circuit (J2-17) at the ECM harness connector. Does the circuit measure more than the specified value?	5.1 volts	Go to Step 6	Go to Step 3
3	Before proceeding, remove the following fuses: - F3 - F7 1. Disconnect the CKP sensor and the CMP sensor harness connectors. 2. Using a Digital Multi-Meter, test the continuity from the Depspower circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
4	1. Ignition OFF. 2. Disconnect the ECM connector J2. 3. Using a test lamp connected to B+, probe Depspower circuit (J2-17) at the ECM harness connector. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 5
5	1. Using a Digital Multi-Meter, test the continuity from Depspower circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
6	1. Locate and repair a short to voltage on the Depspower circuit. Is action complete?	—	Verify Repair	—
7	1. Locate and repair short between the Depspower circuit and the ECM circuit that had continuity. Is action complete?	—	Verify Repair	—
8	1. Locate and repair short to ground on the Depspower circuit. Is action complete?	—	Verify Repair	—
9	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22756

Engine Protection Mode Circuit 8.1Gi-B, GXi-A



22679

Circuit Description

Three grounding type switches and one thermistor detect conditions critical to engine longevity:

- a water temperature thermistor (engine over-heat)
- two temperature switches (exhaust overheat)
- an oil pressure switch (loss of pressure)

When closed, the ECM responds by entering **ENGINE PROTECTION MODE**. An engine mounted warning horn will also sound.

This engine protection feature disables half the fuel injectors above 2500 RPM. If engine speed drops back to 1200 RPM, the system will reset and allow normal operation. Should the overheat or loss of oil pressure condition still exist, **ENGINE PROTECTION MODE** will again activate if engine speed exceeds 2500 RPM.

Test Description

1. Determines if warning horn is activated by ECM or if horn lead is grounded.
2. Determines if oil pressure or exhaust temperature switches are causing the problem.
3. Determines if ECT sensor is cause of problem.
4. Checks oil pressure J2-7 for an open circuit.
5. Checks oil pressure J2-7 for a grounded circuit.
6. Checks ECT sensor J2-3 for an open circuit.
7. Checks ECT sensor J2-3 for a grounded circuit.
8. Checks MAP sensor J2-3 for a grounded circuit. Replace ECM if problem is not located in previous tests.
9. Check of warning horn circuit.

Diagnostic Aids

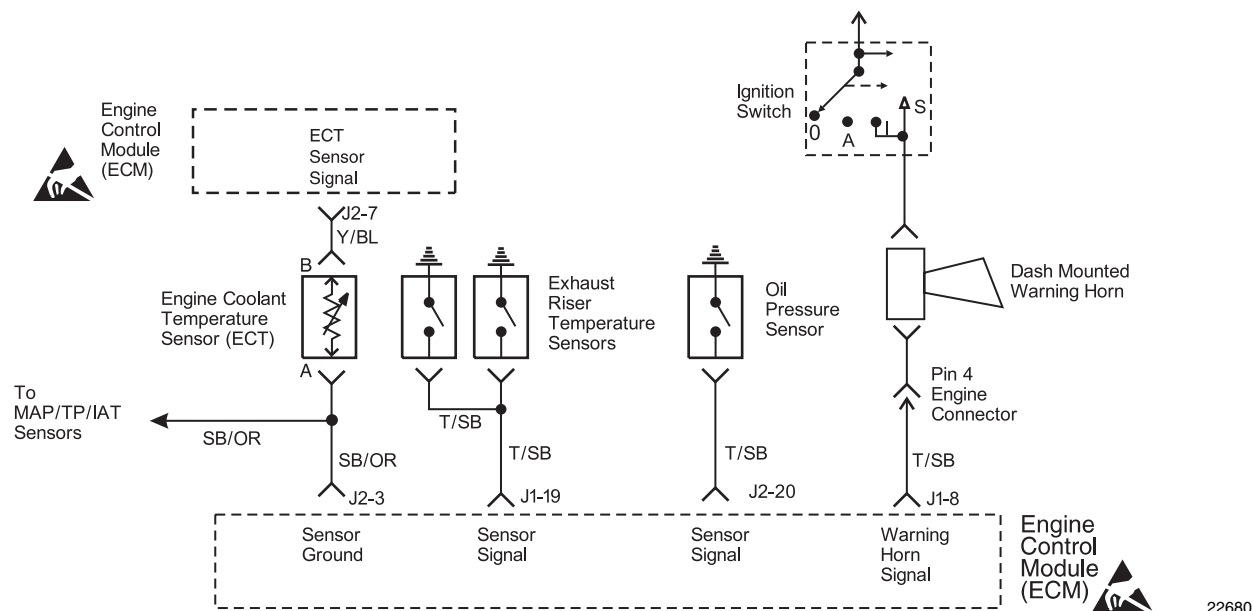
- Check engine crankcase oil level, add oil as necessary.
- See **Cooling System** section of **Engine** service manual for possible overheat causes.
- See appropriate engine section of **Engine** service manual for possible causes of loss of oil pressure.

If above diagnostics were performed, and no change in performance was made, refer to *Symptoms Section*.

An intermittent problem may be caused by a poor or corroded connection, a worn-through wire, a wire that's broken inside the insulation, or a defective switch.

Engine Protection Mode Circuit 8.1Gi-B, GXi-A

Step	Action	Value	Yes	No
1	1. Turn ignition off. 2. Remove connector at oil pressure switch. 3. Turn ignition on. If equipped, does audible warning horn sound? If not equipped, go to STEP 2.	—	Go to Step 9	Go to Step 2
2	1. Turn ignition off. 2. Leave oil pressure switch disconnected. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ?	—	Go to Step 3	Verify Repair
3	1. Turn ignition off. 2. Remove connector at ECT sensor. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ? NOTE: ECT sensor serves a dual function; it provides water temperature data to ECM for spark / fuel control, and warns of engine overheat to activate <i>Engine Protection Mode</i> circuit.	—	Go to Step 4	Verify Repair
4	1. Turn ignition off. 2. Remove J2 connector at ECM. 3. Using a DVOM, check resistance from terminal J2-7 to oil pressure switch connector terminal. Does ohmmeter read at or near zero (0)?	0	Go to Step 5	Verify Repair
5	1. Check resistance between ECM terminal J2-7 and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 6	Verify Repair
6	1. Using a DVOM, check resistance from terminal J2-3 to ECT connector terminal "A". Does ohmmeter read at or near zero (0)?	0	Go to Step 7	Verify Repair
7	1. Check resistance between ECT connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 8	Verify Repair
8	1. Remove connector at MAP sensor. 2. Check resistance between MAP connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Verify Repair	Verify Repair
9	1. Check of warning horn circuit only (engine otherwise responds correctly to <i>Engine Protection Mode</i> conditions). 2. Turn ignition off. Remove J2 connector at ECM. 3. Disconnect 10-way engine cable connector. 4. Using a DVOM, check circuit between J2-12 and Pin 4 for opens and grounds. Does circuit pass both tests?	—	Verify Repair	Verify Repair



Circuit Description

Three grounding type switches and one thermistor detect conditions critical to engine longevity:

- a water temperature thermistor (engine over-heat)
- two temperature switches (exhaust overheat)
- an oil pressure switch (loss of pressure)

When closed, the ECM responds by entering *ENGINE PROTECTION MODE* mode (Speed Limiting Operational Warning). A dash-mounted warning horn will also sound.

This engine protection feature disables half the fuel injectors above 2500 RPM. If engine speed drops back to 1200 RPM, the system will reset and allow normal operation. Should the overheat or loss of oil pressure condition still exist, *ENGINE PROTECTION MODE* will again activate if engine speed exceeds 2500 RPM.

Test Description

1. Determines if warning horn is activated by ECM or if horn lead is grounded.
2. Determines if oil pressure or exhaust temperature switches are causing the problem.
3. Determines if ECT sensor is cause of problem.
4. Checks oil pressure J2-7 for an open circuit.
5. Checks oil pressure J2-7 for a grounded circuit.
6. Checks ECT sensor J2-3 for an open circuit.
7. Checks ECT sensor J2-3 for a grounded circuit.
8. Checks MAP sensor J2-3 for a grounded circuit.
Replace ECM if problem is not located in previous tests.
9. Check of warning horn circuit.

Diagnostic Aids

- Check engine crankcase oil level, add oil as necessary.
- See **Cooling System** section of **Engine** service manual for possible overheat causes.
- See appropriate engine section of **Engine** service manual for possible causes of loss of oil pressure.

If above diagnostics were performed, and no change in performance was made, refer to *Symptoms Section 4A*.

An intermittent problem may be caused by a poor or corroded connection, a worn-through wire, a wire that's broken inside the insulation, or a defective switch.

Engine Protection Mode Circuit 8.1Gi-B, GXi-A

Step	Action	Value	Yes	No
1	1. Turn ignition off. 2. Remove connector at oil pressure switch. 3. Turn ignition on. If equipped, does audible warning horn sound? If not equipped, go to STEP 2.	—	Go to Step 9	Go to Step 2
2	1. Turn ignition off. 2. Leave oil pressure switch disconnected. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ?	—	Go to Step 3	Verify Repair
3	1. Turn ignition off. 2. Remove connector at ECT sensor. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ? NOTE: ECT sensor serves a dual function; it provides water temperature data to ECM for spark / fuel control, and warns of engine overheat to activate <i>Engine Protection Mode</i> circuit.	—	Go to Step 4	Verify Repair
4	1. Turn ignition off. 2. Remove J2 connector at ECM. 3. Using a DVOM, check resistance from terminal J2-7 to oil pressure switch connector terminal. Does ohmmeter read at or near zero (0)?	0	Go to Step 5	Verify Repair
5	1. Check resistance between ECM terminal J2-7 and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 6	Verify Repair
6	1. Using a DVOM, check resistance from terminal J2-3 to ECT connector terminal "A". Does ohmmeter read at or near zero (0)?	0	Go to Step 7	Verify Repair
7	1. Check resistance between ECT connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 8	Verify Repair
8	1. Remove connector at MAP sensor. 2. Check resistance between MAP connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Verify Repair	Verify Repair
9	1. Check of warning horn circuit only (engine otherwise responds correctly to <i>Engine Protection Mode</i> conditions). 2. Turn ignition off. Remove J2 connector at ECM. 3. Disconnect 10-way engine cable connector. 4. Using a DVOM, check circuit between J2-12 and Pin 4 for opens and grounds. Does circuit pass both tests?	—	Verify Repair	Verify Repair

22693

Notes

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Engine Control Module (ECM)

The engine control module (ECM) of the **Marine Electronic Fuel Injection system generation 4 (MEFI 4)** is designed to maintain exhaust emission levels while maintaining excellent drivability and fuel efficiency. The ECM controls the following conditions:

- The fuel control
- The ignition control (IC)
- The knock sensor (KS) system
- The idle air control (IAC)
- Various other discrete outputs

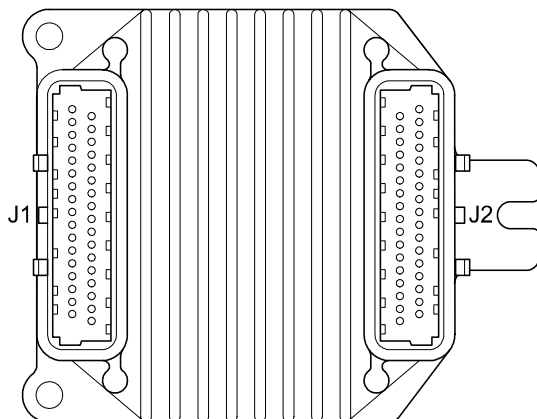
Basic Knowledge Required

Without a basic knowledge of electricity, it will be difficult to use the diagnostic procedures contained in this section. You should understand the basic theory of electricity and know the meaning of voltage (volts), current (amps) and resistance (ohms). You should understand what happens in a circuit with an open or a shorted wire. You should be able to read and understand a wiring diagram.

ECM Service Precautions

The ECM is designed to withstand normal current draws associated with vessel operations. Avoid overloading any circuit. When testing for opens or shorts, do not ground any of the ECM circuits unless instructed. When testing for opens or shorts, do not apply voltage to any of the ECM circuits unless instructed. Only test these circuits with a DMM while the ECM connectors remain connected.

Engine Control Module (ECM)



Engine Control Module (ECM)

22508

The engine control module (ECM) is the control center of the engine and controls the following systems:

- The fuel metering system
- The ignition timing
- The on-board diagnostics

The ECM constantly monitors the information from various sensors and controls the systems that affect vessel performance and emissions. The ECM also performs the diagnostic functions for those systems. The ECM can recognize operational problems and alert the operator through the malfunction indicator lamp (MIL) when a malfunction has occurred. When a malfunction is detected, the ECM stores a diagnostic trouble code (DTC) or a logged warning which helps to identify problem areas. This is done to aid the technician in making repairs.

The ECM supplies either 5.0 or 12.0 volts to power various sensors and switches. This is done through resistance in the ECM. The resistance is so high in value that a test lamp does not illuminate when connected to the circuit. In some cases, even an ordinary shop voltmeter does not give an accurate reading because the voltmeters resistance is too low. Therefore, a DMM with a minimum of 10 megaohms input impedance is required to ensure accurate voltage readings.

The ECM controls output circuits such as the fuel injectors, ignition coils, the idle air control (IAC) and various relays by controlling the ground or power feed circuit through transistors or a device called an output driver module (ODM).

RPM Reduction Mode

RPM reduction mode is a function of the ECM that reduces engine power under certain conditions. RPM reduction will disable one fuel injector driver when the engine speed goes above a certain RPM and enable the fuel injector driver when the engine speed drops below a certain RPM. RPM reduction may be active for the following conditions:

- Engine coolant temperature too high
- Low oil pressure
- High exhaust riser temperature

Input Sensors

The ECM monitors the input sensors for circuit continuity and out-of-range values. This includes performance checking. Performance checking refers to indicating a fault when the signal from a sensor does not seem reasonable, such as a throttle position (TP) sensor that indicates high throttle position at low engine loads or MAP voltage. The input components may include, but are not limited to, the following sensors:

- Manifold air temperature (MAT) sensor
- Manifold absolute pressure (MAP) sensor
- Crankshaft position (CKP) sensor
- Camshaft position (CMP) sensor
- Knock sensor (KS)
- Throttle position (TP) sensor
- Engine coolant temperature (ECT) sensor
- Exhaust Temperature Switches

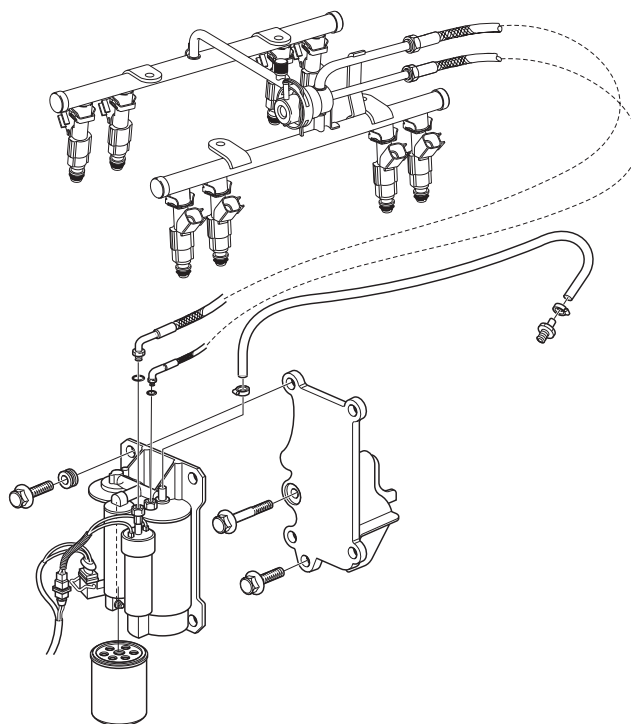
Output Actuators

Diagnose the output actuators for the proper response to ECM commands. Actuators where functional monitoring is not feasible, will be monitored for circuit continuity and out-of-range values, if applicable.

Output actuators to be monitored include the following circuit:

- Idle air controller (IAC)

Fuel System



22790

The fuel tank stores the fuel supply. The low pressure fuel pump contained in the Fuel Cell draws fuel through a replaceable fuel filter mounted on the fuel cell. It then sends the filtered fuel into a cooling venting/chamber where the fuel is cooled and any vapor is collected for venting to the intake manifold for burning in the combustion process. Any fuel that is not demanded by the fuel injectors is re-circulated through the cooling/venting chamber. The high pressure pump, which is integral to the fuel cell, then draws fuel from the cooling/venting chamber and supplies fuel at a volume more than is needed by the injectors. The fuel pressure regulator, part of the fuel rail assembly, keeps fuel available to the fuel injectors at a regulated pressure. A separate pipe returns unused fuel to the fuel cell cooling/venting chamber. The engine control module (ECM) controls the electric fuel pumps operation through a fuel pump relay.

Important! The fuel cell is NOT serviceable. In the unlikely event that a fuel pump fails, the entire fuel cell must be replaced.

Fuel Feed and Return Pipes

The fuel feed pipe carries fuel from the fuel tank to the fuel rail assembly. The fuel return pipe carries unused fuel from the fuel rail assembly back to the fuel cell.

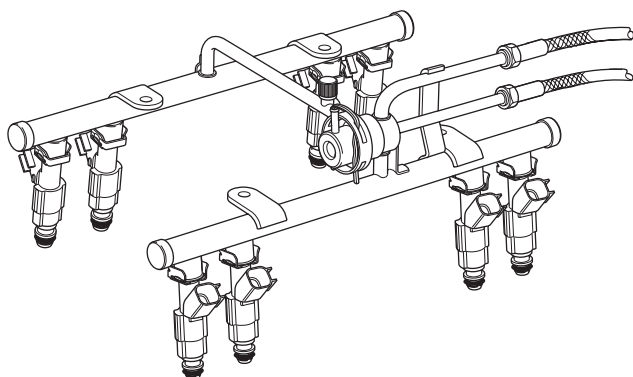
Quick-Connect Fittings

Quick-Connect fittings provide a simplified means of installing and connecting fuel system hoses. The fittings consists 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

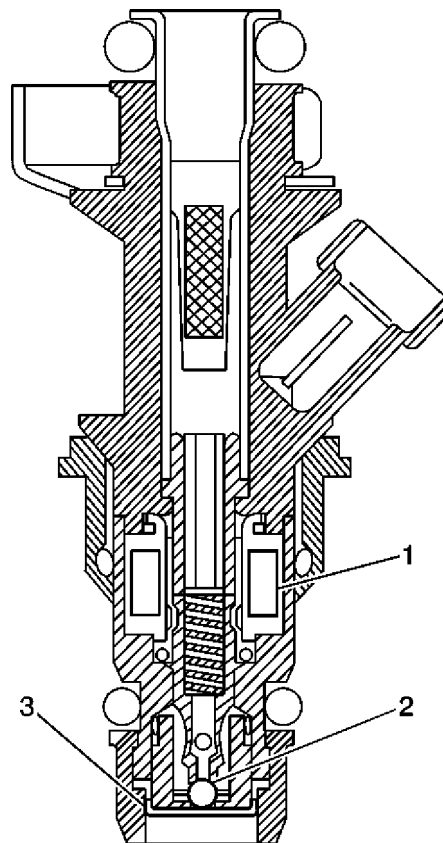


22791

The fuel rail assembly attaches to the engine intake manifold. The fuel rail assembly performs the following functions:

- Positions the injectors in the intake manifold
- Distributes fuel evenly to the injectors
- Integrates the fuel pressure regulator with the fuel metering system

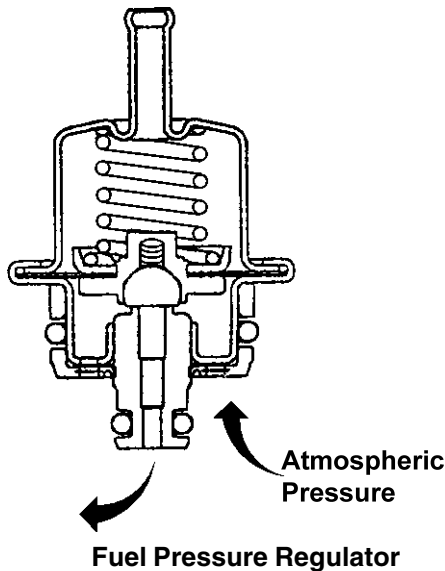
Fuel Injectors



351198

The Multec 2 fuel injector assembly is a solenoid operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM energizes the high-impedance (12.2 ohms) injector solenoid (1) to open a normally closed ball valve (2). This allows fuel to flow, past the ball valve and through a director plate (3) at the injector outlet. The director plate has four 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 it to become further atomized and vaporized before entering the combustion chamber. An injector stuck partly open can cause a loss of pressure after engine shutdown. Consequently, long engine cranking times would be noticed on some engines because of flooded condition.

Fuel Pressure Regulator Assembly



The fuel pressure regulator is a vacuum operated diaphragm relief valve with fuel pump pressure on one side and regulator spring pressure and intake manifold vacuum on the other side. The fuel pressure regulator maintains an adequate pressure differential across the injectors at all times. The pressure regulator compensates for engine load by increasing fuel pressure as the engine vacuum drops.

Fuel Metering Modes of Operation

The engine control module (ECM) reads voltages from several sensors in order to determine how much fuel to give the engine. The fuel is delivered under one of several conditions called modes. The ECM controls all modes.

Starting Mode

With the ignition switch in the ON position, before engaging the starter, the ECM energizes the fuel pump relay for 2 seconds allowing the fuel pumps to build up pressure. The ECM uses the engine coolant temperature (ECT), the throttle position (TP) and the manifold absolute pressure (MAP) sensors to determine the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing the pulse width of the injectors. This is done by pulsing the injectors for very short times.

Clear Flood Mode

If the engine floods, clear the engine by opening the throttle plates to 100%. When the throttle position (TP) sensor is at wide open throttle, the ECM reduces the 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

When the engine is first started and the engine speed is above 400 RPM, the system begins Open Loop operation. The ECM calculates the air/fuel ratio based on inputs from the ECT, MAP and TP sensors.

Specified values for the above conditions are mapped for each engine, and are stored in the electrically erasable programmable read-only memory (EEPROM).

Acceleration Mode

When the operator moves the throttle, air flow into the cylinders increases rapidly, while fuel flow tends to lag behind. To prevent possible hesitation, the ECM increases the pulse width to the injectors to provide extra fuel during acceleration. The ECM determines the amount of fuel required based upon the throttle position, the coolant temperature, the manifold pressure and the engine speed.

Deceleration Mode

When the operator retards the throttle, air flow into the engine is reduced. The ECM reads the corresponding changes in throttle position and manifold pressure. The ECM shuts OFF fuel completely if the deceleration is very rapid, or for long periods.

Battery 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 engine from damage:

- 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.
- Engine speed is too high, above appropriate rev limit.

Knock Sensor (KS) System

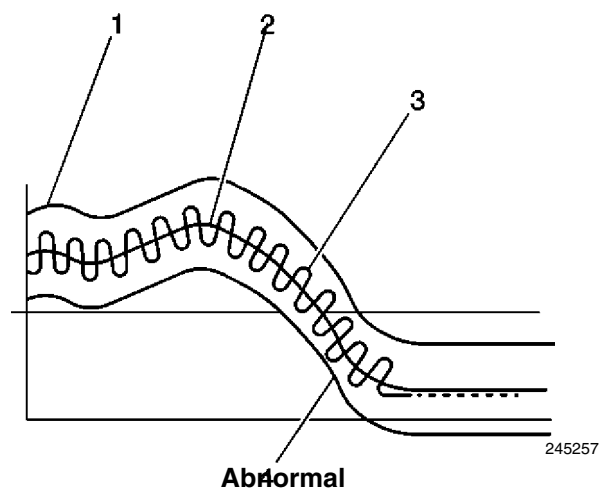
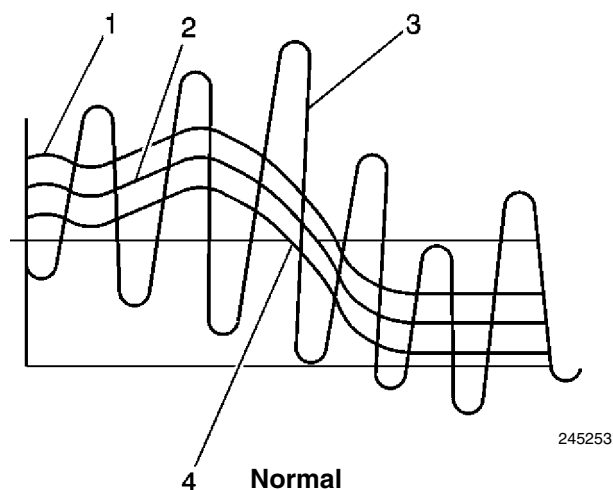
Purpose

To control spark knock (detonation), a knock sensor (KS) system is used. This system is designed to retard spark timing when excessive spark knock is detected in the engine. The KS system allows the engine to use maximum spark advance for optimal drivability and fuel economy under all operating conditions.

Operation

The ECM uses a knock sensor(s) to detect abnormal vibration in the engine (detonation/spark knock). Mounted on the engine block, the knock sensor(s) produces an AC voltage signal at all engine speeds and loads. The ECM then adjusts the spark timing based on the amplitude and frequency of the KS signal. The ECM uses the KS signal to calculate an average voltage. Then, the ECM assigns a voltage range above and below the average voltage value. The ECM checks the KS and related wiring by comparing the actual knock signal to the assigned voltage range. A normal KS signal should vary outside the assigned voltage range as shown in the NORMAL KS figure. If the ECM detects a KS signal within the assigned voltage range as shown in the

ABNORMAL KS figure, the applicable DTC will set.

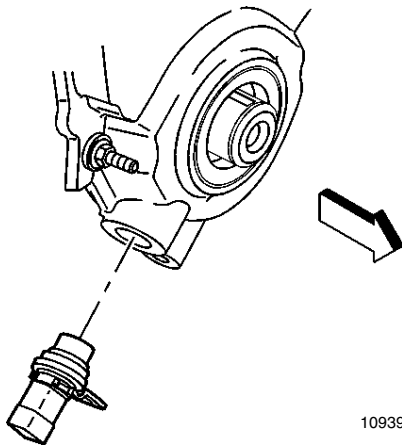


Knock Sensor Signal

1. Upper fail region
2. Knock sensor calculated average
3. Knock sensor signal
4. Lower fail region

Distributor Ignition (DI) System

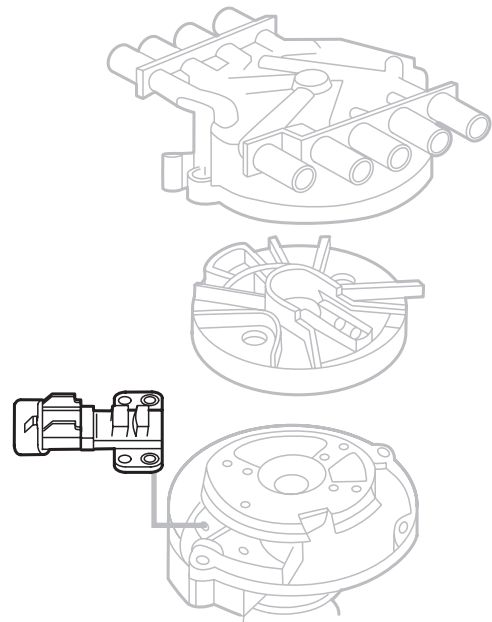
The distributor ignition (DI) system is responsible for producing and controlling a high energy secondary spark. This spark is used to ignite the compressed air/fuel mixture at precisely the correct time. This provides optimal performance, fuel economy, and control of exhaust emissions. This ignition 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:



10939

Crankshaft Position (CKP) Sensor

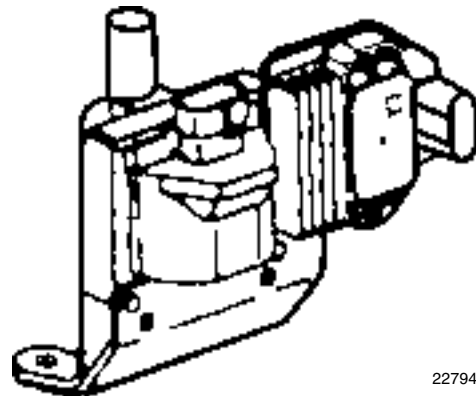
The CKP sensor is a three wire sensor based on the magneto resistive principle. A magneto resistive sensor uses two magnetic pickups between a permanent magnet. As an element such as a reluctor wheel passes the magnets the resulting change in the magnetic field is used by the sensor electronics to produce a digital output pulse. The ECM supplies a 12-volt, low reference, and signal circuit to the CKP sensor. The sensor returns a digital ON/OFF pulse 3 times per crankshaft revolution for the V6 engine, 4 times for the V8 engine. The CKP sensor reads the crankshaft mounted reluctor wheel to identify pairs of cylinders at top dead center (TDC).



22793

Camshaft Position (CMP) Sensor

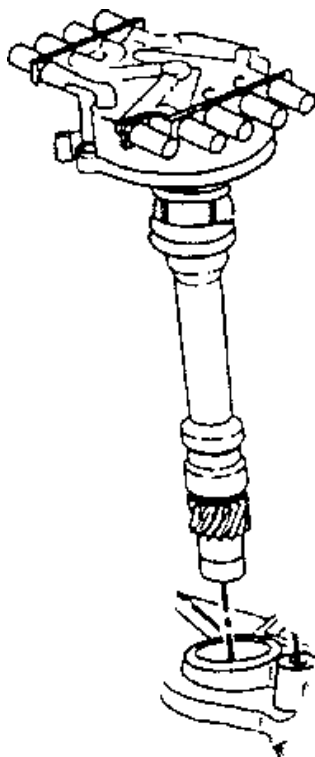
The CMP sensor is a hall-effect sensor located in the ignition distributor and uses similar type of circuits as the CKP sensor. The CMP sensor signal is a digital ON/OFF pulse, output once per revolution of the camshaft. The CMP sensor information is used by the ECM to determine the position of the valve train relative to the CKP.



22794

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 pulse from the ECM. There is no back-up or by-pass function in the ICM.



22795

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 pressure (MAP) sensor
- The manifold air temperature (MAT) sensor
- The engine knock (KS) sensor

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.

Secondary Ignition Components

The distributor is only used as a means to operate the CMP sensor and to distribute spark in the correct sequence. The distributor position is adjustable but has no influence on base timing. If the distributor is rotated, there is a chance of crossfire between terminals due to the proximity of the terminals in the distributor cap. The spark is distributed through marine grade carbon core wires to the spark plugs. The plugs are tipped with platinum for long wear and higher efficiency.

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Repair Instructions Engine Control Module (ECM)

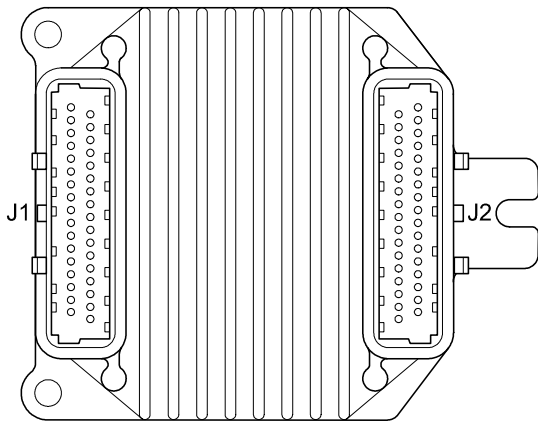
⚠ Caution!

When replacing the ECM, the ignition must be "OFF" and disconnect the battery before disconnecting or reconnecting the ECM "J1" and "J2" connectors to prevent internal damage to the ECM.

⚠ Caution!

To prevent possible electrostatic discharge damage to the ECM, do not touch the connector pins. The ECM is an electrical component. Do Not soak in any liquid cleaner or solvent, as damage may result.

Removal



22508

1. Disconnect the negative battery cable.
2. Disconnect the "J1" and "J2" connectors from ECM.
3. Remove the three ECM mounting screws.
4. Remove the ECM from mounting bracket.

Installation

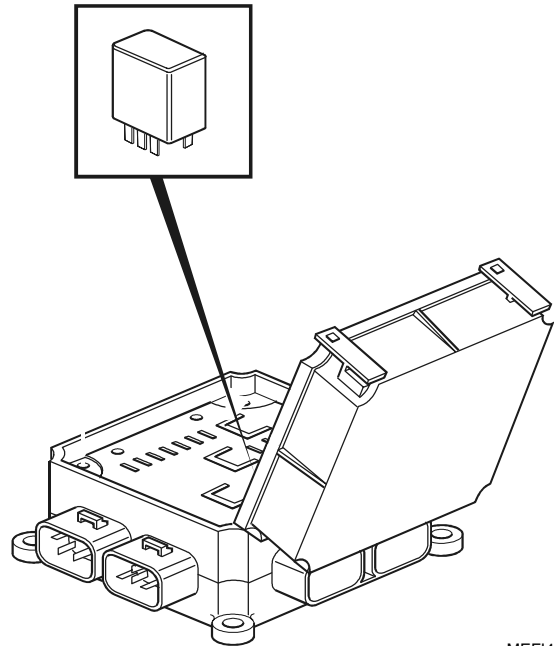
⚠ Caution!

Make sure the new ECM has the same part number and service number as the old ECM, to ensure proper engine performance.

1. Install the new ECM to the mounting bracket.
2. Install the three ECM mounting screws. Tighten the screw to 10-14 N•m (88-124 lb in).
3. Reconnect the "J1" and "J2" connectors to the ECM.
4. Reconnect the negative battery cable.

System/Ignition Relay

Removal



MEFI4337A

NOTE! The fuse box is located under the engine cover.

1. Turn the ignition OFF.
2. Open the cover.
3. Remove the system/ignition relay from the socket.

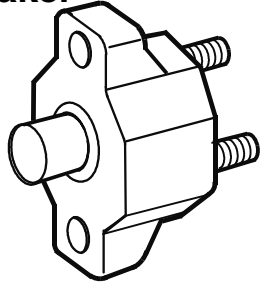
⚠ Caution!

The system relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation

1. Install the system relay in the socket.
2. Close the cover.

Circuit Breaker



DR4640

EFI engines have three fuses and one circuit breaker as protection devices.

- A 15 amp fuse protects the fuel injector relay and ECM
- A 50 amp circuit breaker protects the trim/tilt motor
- A 40 amp fuse protects the main engine harness
- A 20 amp fuse protects the fuel pump relay and circuit

A 10 amp in-line fuse is located in the trim/tilt pump wiring harness to protect the pump relays. If one of these components or circuits fails, the ECM won't recognize it, nor store a service code in memory.

Circuit Breaker Replacement

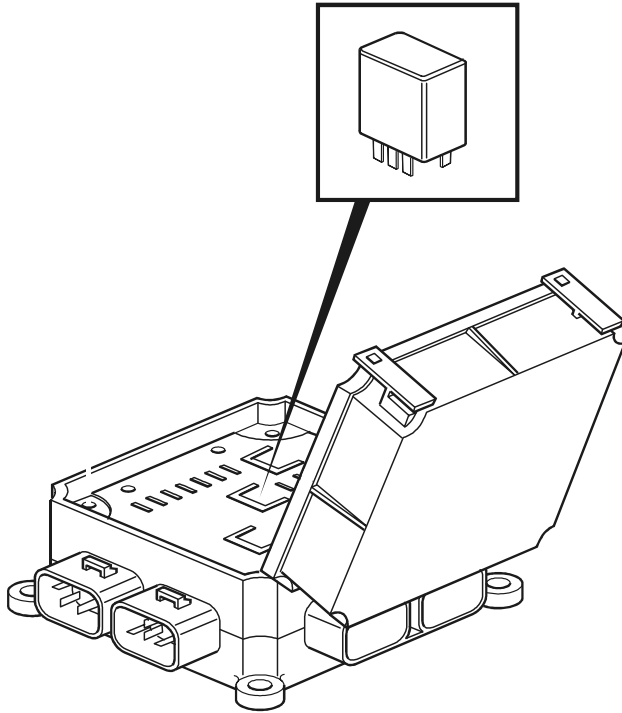
Warning!

To prevent sparks, damaged components or possible personal injury, disconnect battery before servicing any circuit breaker.

1. Make a note of the lead positions, then remove all the leads from the circuit breaker. Remove the screws and nuts, and lift circuit breaker out of bracket.
2. Install new circuit breaker and secure with screws and nuts. Tighten screws to 20-25 in. lbs. (2,3-2,8 N•m).
3. Attach the leads to their original positions on the circuit breaker and secure with the nuts. Tighten the nuts to 20-25 in. lbs. (2,3-2,8 N•m). Coat the terminals with Black Neoprene Dip or equivalent.

Fuel Pump Relay

Removal



MEFI4337B

NOTE! The fuse box is located under the engine cover.

1. Turn the ignition OFF.
2. Open the cover.
3. Remove the fuel pump relay from the socket.

Caution!

The fuel pump relay is an electrical component. Do Not soak in any liquid or solvent as damage may result.

Installation

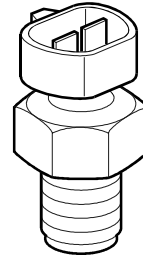
1. Install the fuel pump relay.
2. Close the cover.

Engine Coolant Temperature (ECT) Sensor

Caution!

Care must be taken when handling the ECT sensor. Damage to the sensor will affect proper operation of the MEFI system.

Removal



MEFI4333

1. Turn OFF the ignition.
2. Drain the cooling system below the level of the ECT sensor (closed cooled engines).
3. Disconnect the ECT electrical connector.
4. Remove the ECT sensor.

Installation

NOTE! Coat ECT sensor threads with Teflon® tape sealant prior to installation.

1. Install the ECT sensor. Tighten the ECT sensor to 20 N•m (15 lb ft).
2. Reconnect the ECT electrical connector.
3. Run the engine and check for leaks.

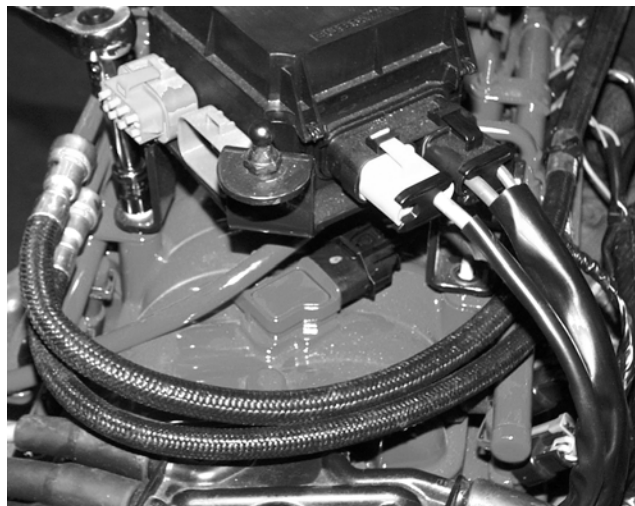
Caution!

Do not run the engine without a water supply to the engine raw water pump.

Manifold Absolute Pressure (MAP/ MAT) Sensor

Removal

Other than checking for a worn grommet and loose electrical connectors, the only service possible is a unit replacement if the diagnosis shows a malfunctioning manifold absolute pressure/manifold air temperature (MAP/MAT) sensor.



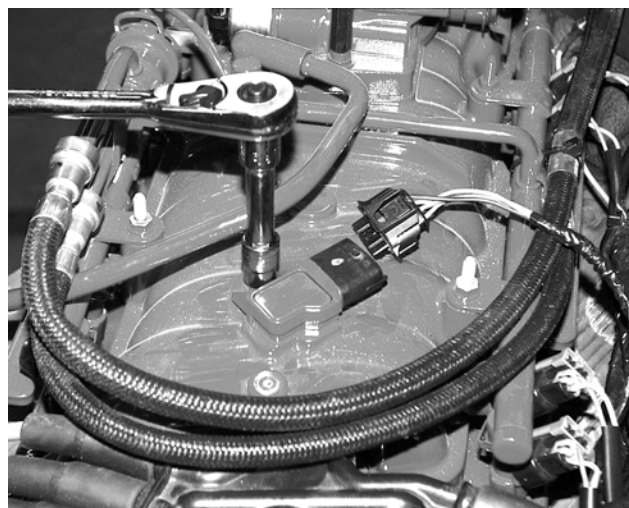
PIC22582

1. Turn OFF the ignition.
2. Remove the engine cover.
3. Remove fuse box retaining nuts.
4. Remove fuse box and bracket and lay to side.



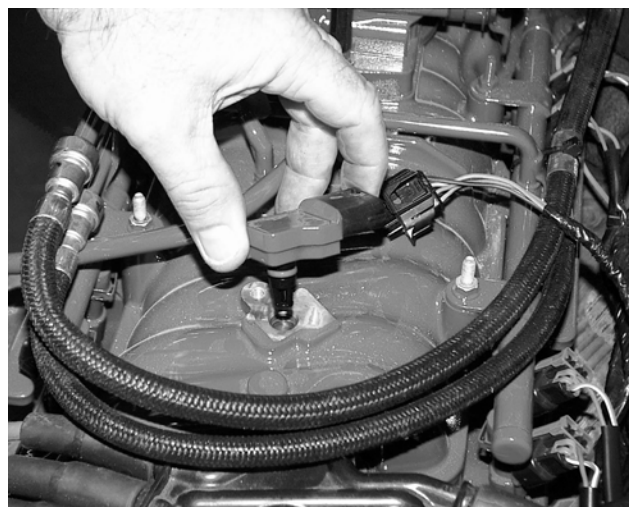
\PIC22584

5. Disconnect the MAP/MAT sensor harness connector.



PIC22585

6. Remove screw holding MAP sensor.



PIC22586

⚠ Caution!

Do not rotate or pry on the MAP/MAT sensor when removing. Damage to the MAP/MAT sensor or the intake manifold may result.

7. Remove the MAP sensor by pulling straight up with a slight rocking motion.
8. Remove the MAP/MAT sensor o-ring.
9. Discard the MAP/MAT sensor o-ring.

⚠ Caution!

Never reuse an o-ring. Always install a new O-ring when removing or replacing the MAP sensor.

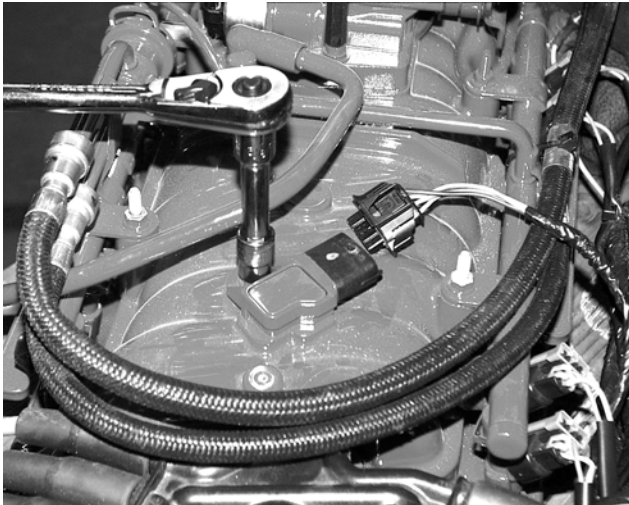
Inspection

1. Inspect for carbon that insulates the MAT portion of the sensor. If the sensor has large amounts of carbon, replace sensor, cleaning may damage sensor and provide unreliable data to the ECM.

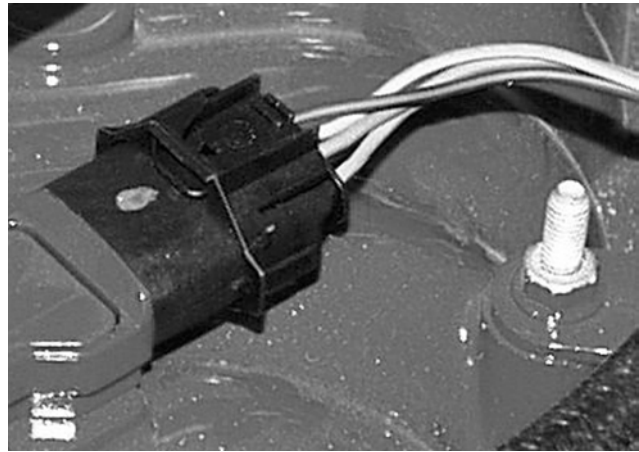
Installation



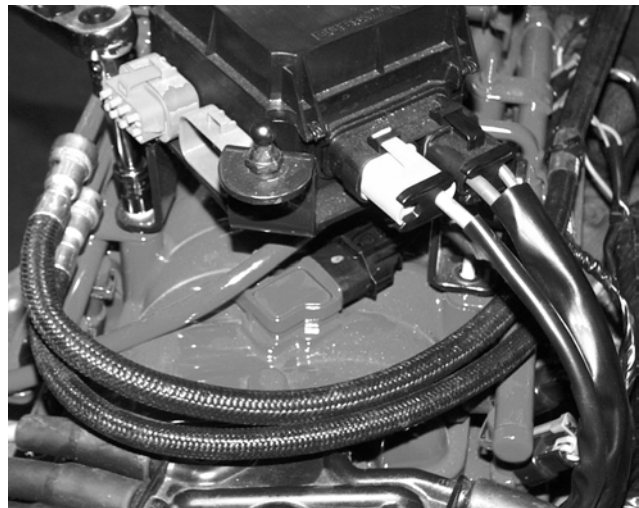
1. Install the new MAP sensor o-ring on the MAP sensor.
2. Install the MAP sensor.



3. Install and tighten the MAP Sensor screw. to 12 N•m (106 lb. in.)



3. Connect the MAP sensor harness connector.

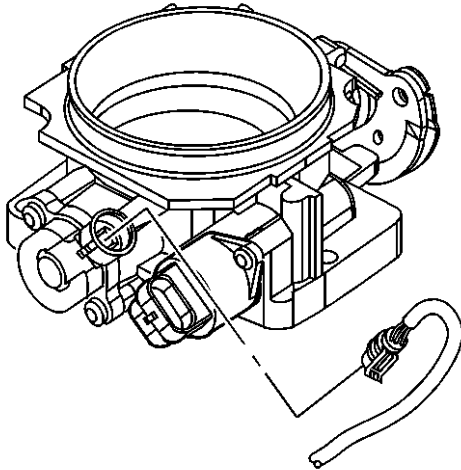


4. Install the fuse box on the studs.
5. Install and tighten the retaining nuts to 12 N•m (106 lb. in.)
6. Reconnect any wires that were removed.
7. Install the engine cover.

Throttle Position (TP) Sensor

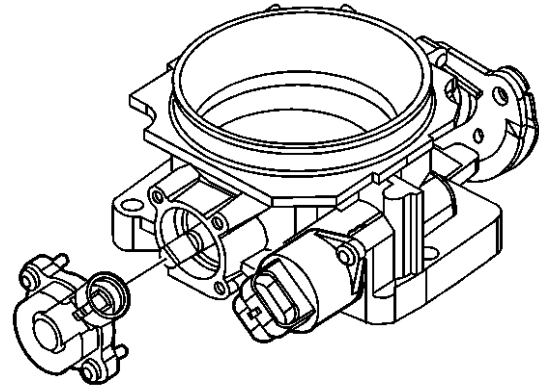
Removal

1. Remove the engine cover.



2. Disconnect the throttle position (TP) sensor harness connector.

12885

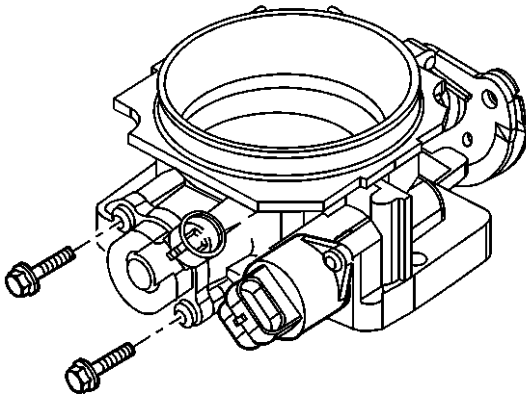


10936

NOTE! The TP sensor is an electrical component. Do not soak the TP sensor in any liquid cleaner or solvent, as damage may result.

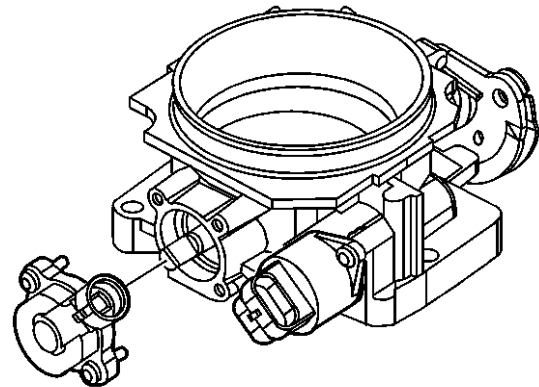
4. Remove the TP sensor and gasket from the throttle body assembly.

Installation



10935

3. Remove the mounting bolts from the TP sensor.



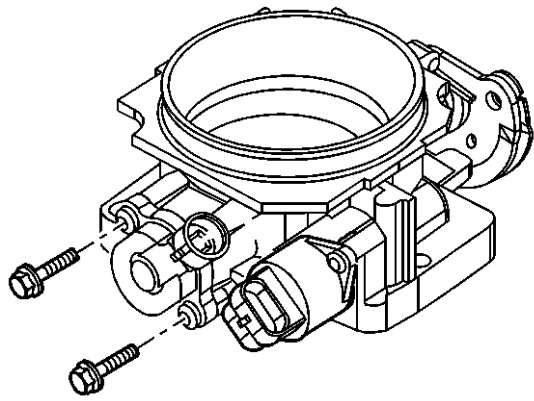
10936

1. With the throttle valve closed, install the TP sensor on the throttle shaft. Rotate the TP sensor counter-clockwise in order to align the mounting holes.

Idle Air Control (IAC) Valve

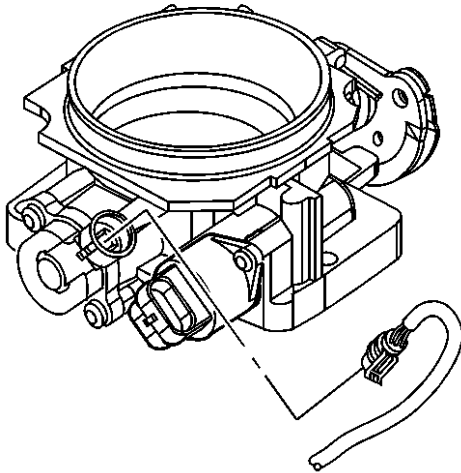
Removal

1. Turn OFF the ignition.
2. Remove the engine cover.



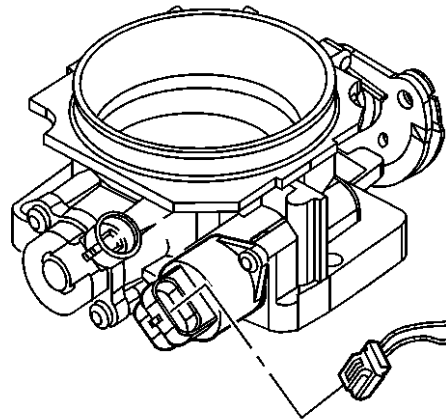
10935

2. Install the TP sensor mounting bolts. Tighten the bolts to 2 N•m (18 lb in).



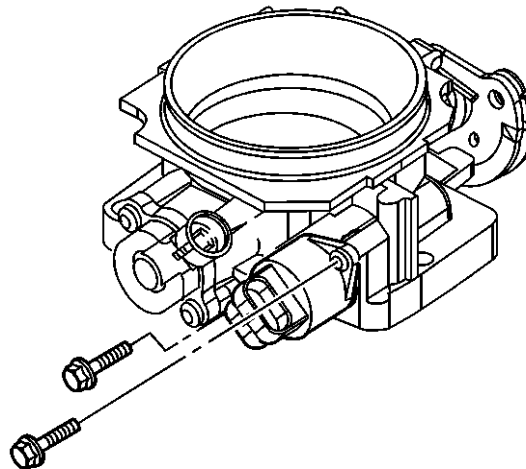
12885

3. Connect the TP sensor harness connector.
4. Install the engine cover.



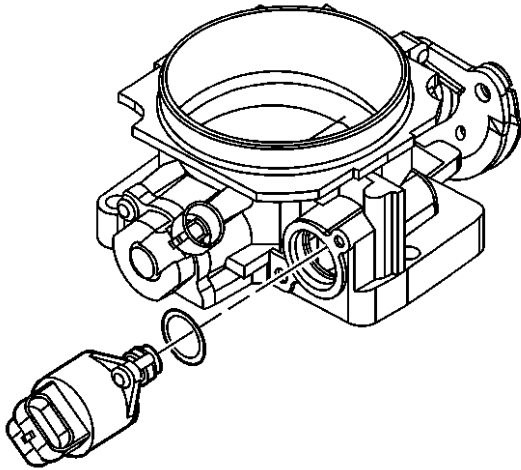
12886

3. Disconnect the harness connector from the idle air control (IAC) valve.



12909

4. Remove the IAC valve attaching fasteners.



12910

NOTE! If the IAC valve has been in service: DO NOT push or pull on the IAC valve pintle. The force required to move the pintle may damage the threads on the worm drive. Also, DO NOT soak the IAC valve in any liquid cleaner or solvent, as damage may result.

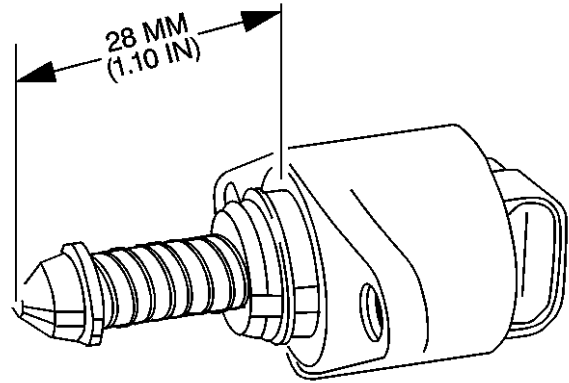
5. Remove the IAC valve assembly.
6. Remove the O-ring.

Cleaning and Inspection

1. Clean the IAC valve O-ring sealing surface, the pintle valve seat, and the air passage.
 - a) Use a carburetor cleaner and a parts cleaning brush in order to remove any carbon deposits. Follow the instructions on the container.
 - b) Do not use a cleaner that contains methylethyl ketone. MEK is an extremely strong solvent and not necessary for this type of deposit.
 - c) Shiny spots on the pintle or seat are normal and do not indicate misalignment or a bent pintle shaft.
 - d) If the air passage has heavy deposits, remove the throttle body for a complete cleaning. Refer to *Throttle Body Assembly* and to *Throttle Body Cleaning Procedure*.
2. Inspect the IAC valve O-ring for cuts, cracks, or distortion. Replace the O-ring if damaged.

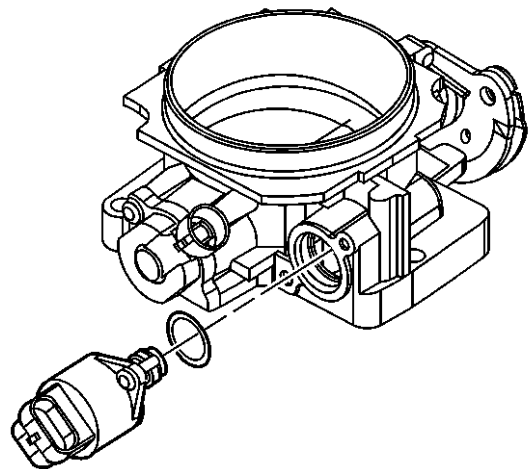
Installation

Important: If you are installing a new IAC valve, replace the valve with an identical part. The IAC valve pintle shape and diameter are designed for the specific application.



17065

1. Measure the distance between tip of the IAC valve pintle and the mounting flange. If the distance is more than 28 mm (1.10 in), use finger pressure in order to slowly retract the pintle. The force required to retract the pintle of a new valve will not cause damage to the valve.



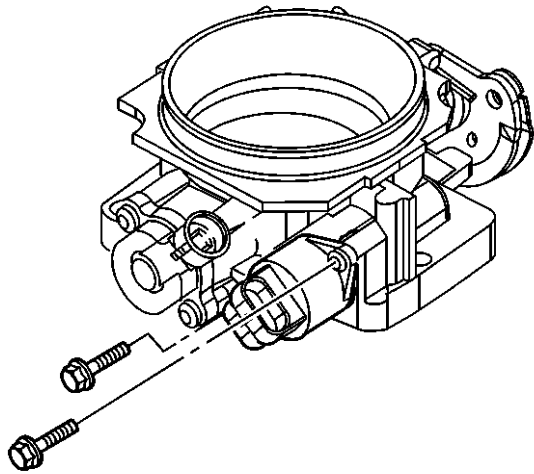
12910

2. Lubricate the IAC valve O-ring with clean engine oil.
3. Install the IAC valve assembly.

Throttle Body Assembly

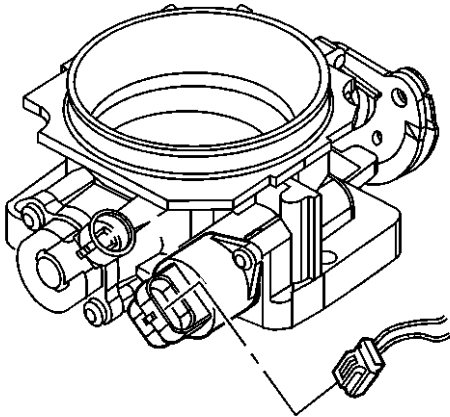
Removal

1. Disconnect the negative battery cable.
2. Remove the engine cover.
3. Remove the flame arrestor and gasket (if applicable).
4. Remove the throttle linkage.



12909

4. Install the attaching fasteners. Tighten the IAC valve fasteners to 3 N•m (27 lb in).

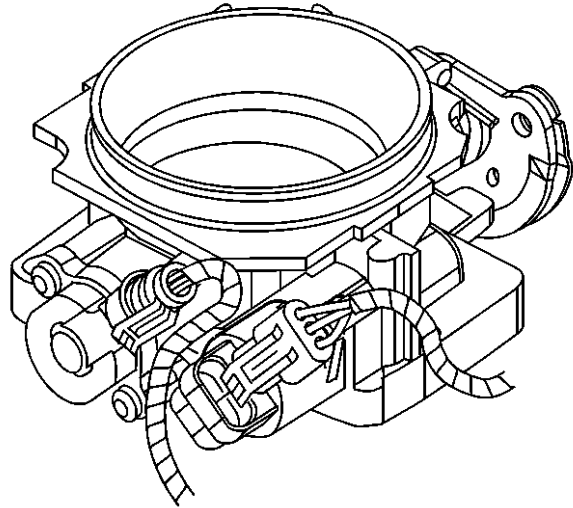


12886

5. Connect the IAC harness connector.
6. Install the engine cover.
7. Reset the IAC valve pintle position.

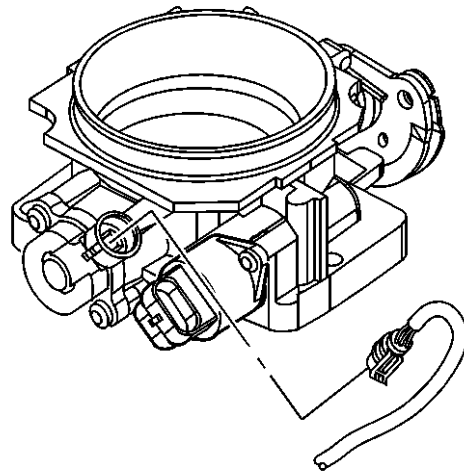
IAC Valve Reset Procedure

1. Turn ON the ignition for 5 seconds, leaving the engine OFF.
2. Turn OFF the ignition for 10 seconds.
3. Start the engine.
4. Check for the proper idle speed.



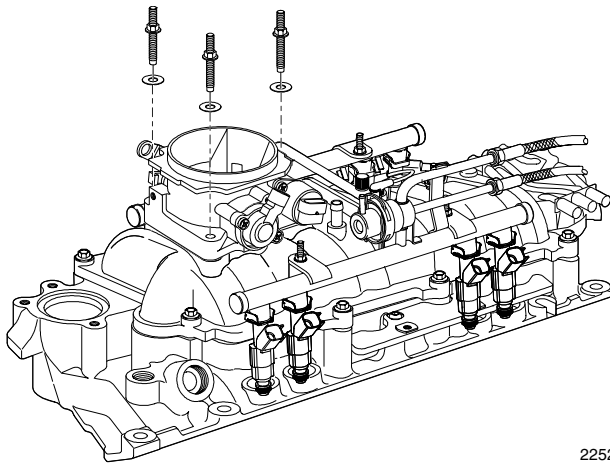
312513

5. Disconnect the (IAC) valve harness connector.



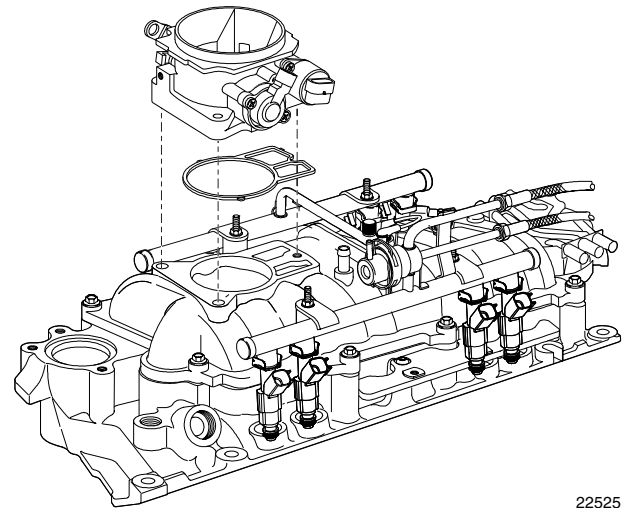
12885

6. Disconnect the (TP) sensor harness connector.



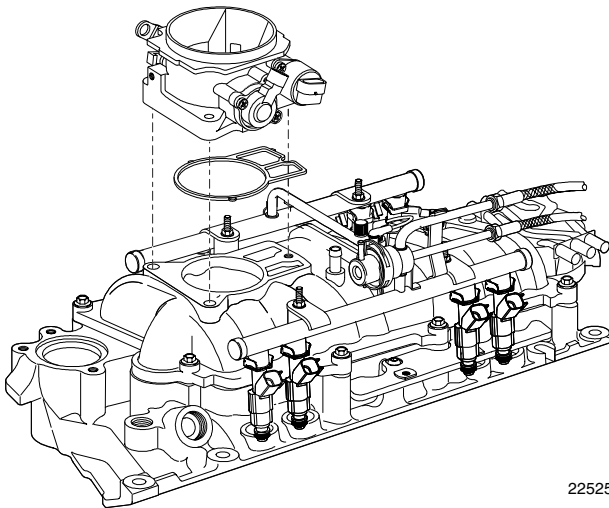
22524

7. Remove the throttle body retaining studs.



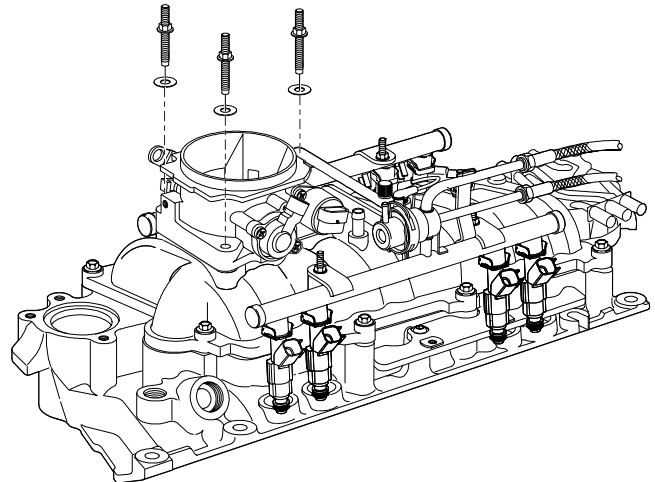
22525

2. Install the throttle body assembly with a new seal.



22525

8. Remove the throttle body assembly.
9. Discard the throttle body seal.



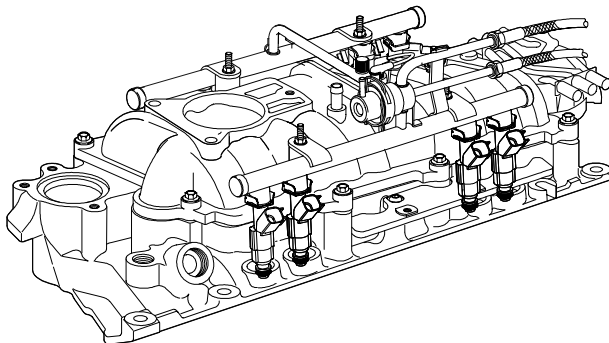
22524

3. Install the throttle body assembly retaining studs. Tighten the studs to 9 N•m (80 lb in).

Installation

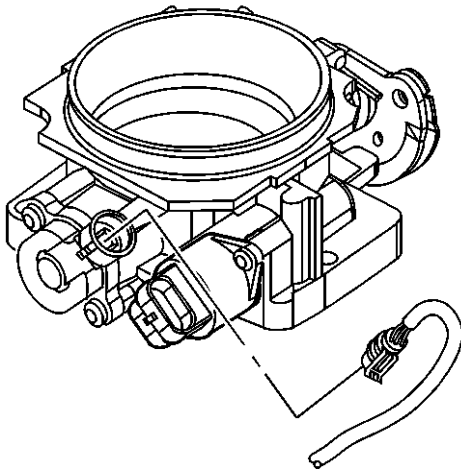
 **Caution!**

Wear Safety Glasses



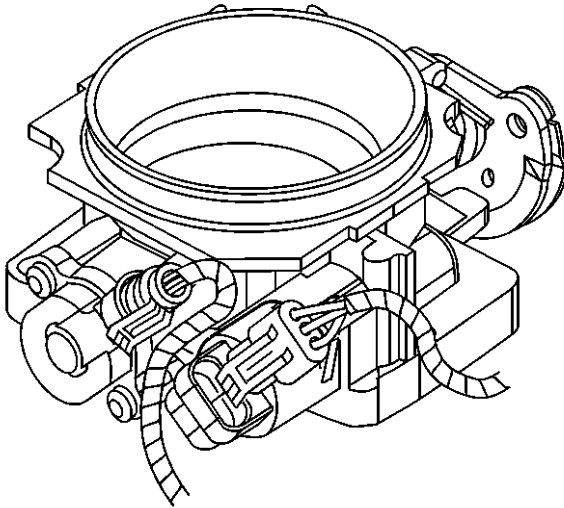
2526

1. Clean the gasket surface on the intake manifold.



12885

4. Connect the TP sensor harness connector.



312513

5. Connect the IAC valve harness connector.
6. Reconnect the throttle linkage.
7. Install the flame arrestor.
8. Install the the engine cover.
9. Connect the negative battery cable.

Throttle Body Cleaning Procedure

1. Inspect the throttle body bore and the throttle valve plate for deposits. You must open the throttle valve in order to inspect all of the surfaces.

⚠ Caution!

Do not subject a throttle body assembly which contains the following components to an immersion cleaner or a strong solvent:

- Throttle position (TP) sensor
- Idle air control (IAC) valve
- Sealed throttle shaft bearings

The cleaners will damaged the electric components or sensors.

The cleaners will damage some of these components that contain seals or O-rings.

Solvents can wash away or break down the grease used on non-serviceable throttle shaft bearings.

Never use a wire brush or scraper to clean the throttle body. A wire brush or sharp tools may damage the throttle body components.

⚠ Caution!

Do not use a cleaner that contains methyl ethyl ketone. This extremely strong solvent may damage components and is not necessary for this type of cleaning.

2. Clean the throttle body bore and the throttle valve plate using a clean shop towel with GM Top Engine Cleaner, P/N 1052626 or an equivalent product.
3. If the deposits are excessive, remove and disassemble the throttle body for cleaning. Refer to the following procedures:
 - Throttle Body Assembly
 - Throttle Position (TP) Sensor
 - Idle Air Control (IAC) Valve
4. After disassembly, clean the throttle body using a parts cleaning brush. DO NOT immerse the throttle body in any cleaning solvent.
5. If you removed and disassembled the throttle body for cleaning, assemble and install the throttle body. Refer to the following procedures:
 - Throttle Body Assembly
 - Throttle Position (TP) Sensor
 - Idle Air Control (IAC) Valve

Fuel Pressure Relief Procedure

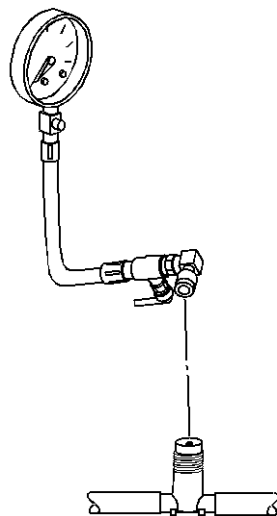
⚠ Caution!

To reduce the risk of fire and personal injury, relieve fuel system pressure before servicing fuel system components. After relieving fuel pressure, a small amount of fuel may be released when servicing fuel lines or connections. To reduce the chance of personal injury, cover fuel line fittings with a shop towel before disconnecting to catch any fuel that may leak out. Place the towel in an approved container when disconnection is completed.

The following is general information required when working on the fuel system:

- Always keep a dry chemical fire extinguisher near the work area.
- Do not replace fuel pipe with fuel hose.
- Always bleed off fuel pressure before servicing any fuel system components.
- Do not do any repairs on the fuel system until you have read the instructions and checked the figures relating the repair.
- Observe all notices and cautions.

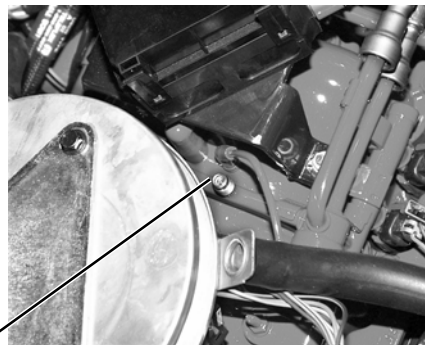
Tools Required



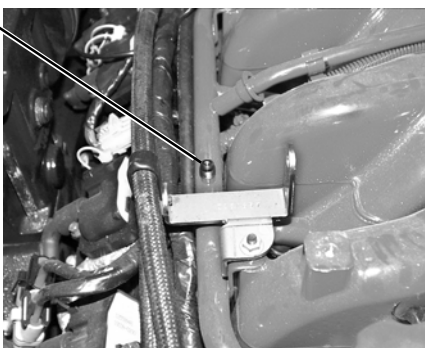
180378

VP Part no 3855353 Fuel Pressure Gauge

1. Turn the ignition OFF.
2. Disconnect the negative battery cable in order to avoid possible fuel discharge if an accidental attempt is made to start the engine.
3. Remove dust cover from the schrader valve (1).



PIC22529



PIC22530

4. Connect the fuel pressure gauge to the fuel pressure valve. Wrap a shop towel around the fitting while connecting the gauge in order to avoid spillage.
5. Install the bleed hose of the gauge into an approved container.
6. Open the valve on the gauge to bleed the system pressure. The fuel connections are now safe for servicing.
7. Drain any fuel remaining in the gauge into an approved container.

Quick Connect Fitting(s) Service

Tools Required

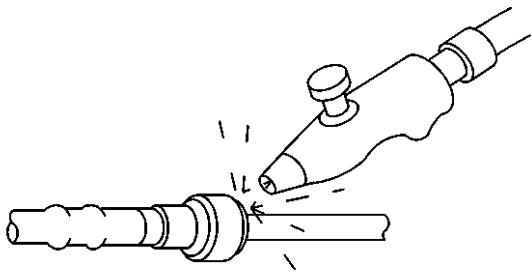
VP Part no 885384 Fuel Line Quick Connect Separator

Removal

1. Relieve the fuel system pressure before servicing any fuel system connection. Refer to *Fuel Pressure Relief Procedure*.
2. Remove the retainer from the quick-connect fitting.

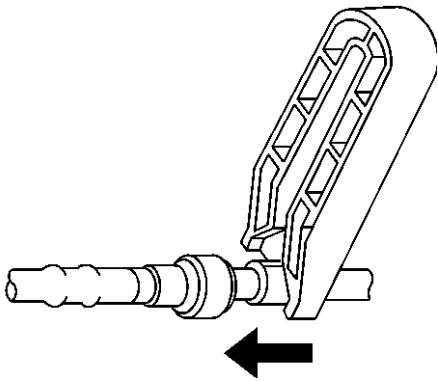
⚠ Caution!

Wear safety glasses to avoid eye damage.



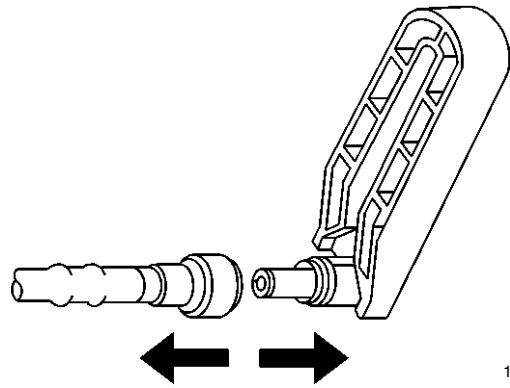
12776

3. Blow dirt out of the fitting using compressed air.



12780

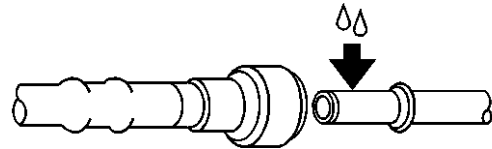
4. Choose the correct tool from the tool set for the size of the fitting. Insert the tool into the female connector, then push inward in order to release the locking tabs.



12782

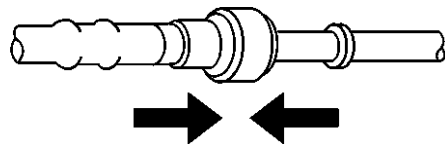
5. Pull the connection apart.
6. Use a clean shop towel in order to wipe off the male pipe end.
7. Inspect both ends of the fitting for dirt and burrs. Clean or replace the components as required.

Installation



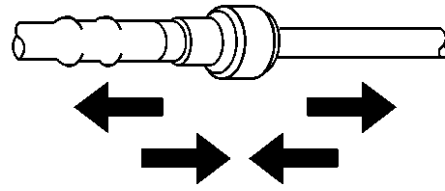
12784

1. Apply a few drops of clean engine oil to the male pipe end.



12786

2. Push both sides of the fitting together in order to snap the retaining tabs into place.

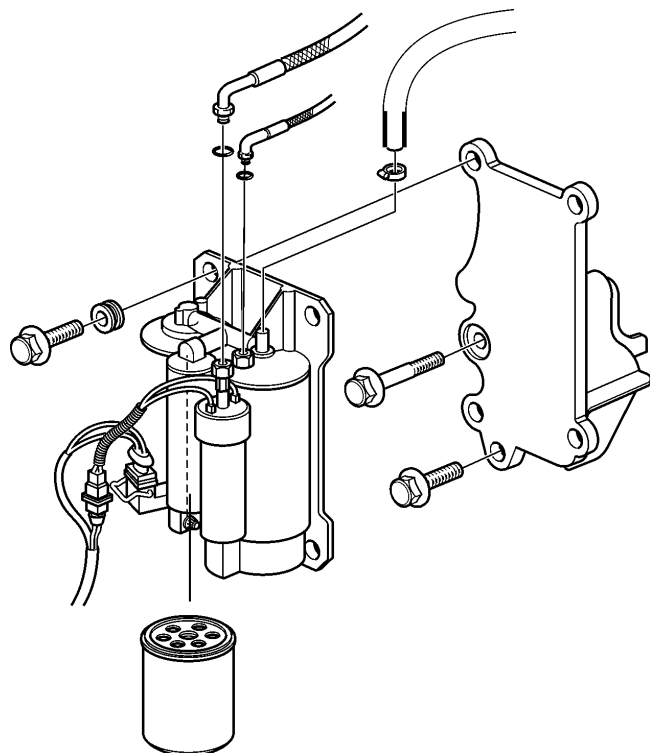


12787

3. Once installed, pull on both sides of the fitting in order to make sure the connection is secure.
4. Install the retainer to the quick-connect fitting.

Fuel Pump

NOTE! The fuel pumps on this Volvo Penta engine are not serviceable. The entire fuel cell must be replaced if either or both fuel pumps fail.



17970A

Removal

1. Disconnect negative battery cable.
2. Relieve the fuel system pressure before servicing any fuel system component. Refer to *Fuel Pressure Relief Procedure*.
3. Clean all the fuel fitting connections and the surrounding areas before disconnecting the fuel pipes in order to avoid possible contamination of the fuel system.
4. Disconnect the threaded fittings from the fuel cell.
5. Cap the fuel pipes in order to prevent possible fuel system contamination.
6. Disconnect the fuel pump electrical connectors.
7. Disconnect the cooling lines to the fuel cell.
8. Remove the fuel filter and dispose of it in an approved manner.
9. Remove the 4 retaining screws and retain for installation on the new fuel cell.
10. Remove the fuel cell.

Installation

⚠ Caution!

Make sure to replace the fuel cell with the identical part number.

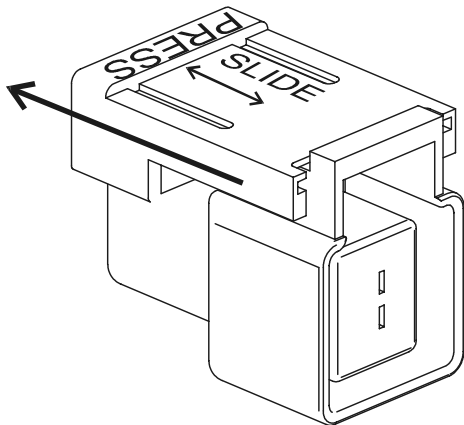
1. Install the fuel cell.
2. Reconnect the fuel pump electrical connectors.
3. Remove the caps from the fuel pipes.
4. Install new O-rings on the fuel lines. Reconnect the threaded fittings into the fuel pump. Tighten the fittings to 25 N•m (18 lb ft).
5. Reconnect the cooling lines.
6. If a fuel filter does not come installed on the new fuel cell, install a new fuel filter.
7. Connect the negative battery cable.
8. Inspect for leaks.
 - a) Turn the ignition ON for 2 seconds.
 - b) Turn the ignition OFF for 10 seconds.
 - c) Turn the ignition ON.
 - d) Inspect for fuel leaks.
9. Connect fuel pressure gauge to the high pressure schrader valve on the fuel rail.
10. Start engine and let idle. Check high pressure fuel pump for correct pressure.
11. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.
12. Disconnect Fuel Pressure gauge and install schrader valve dust cover.

Fuel Rail Assembly

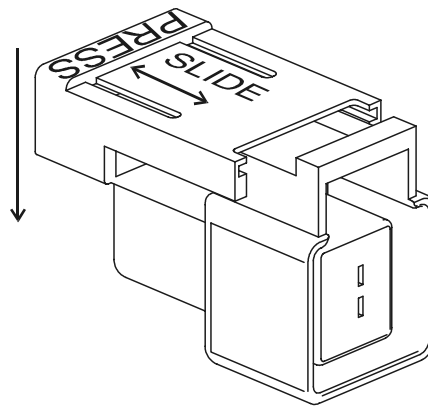
Removal

An eight digit identification number is located on the fuel rail assembly. Refer to this model identification number if servicing or part replacement is required.

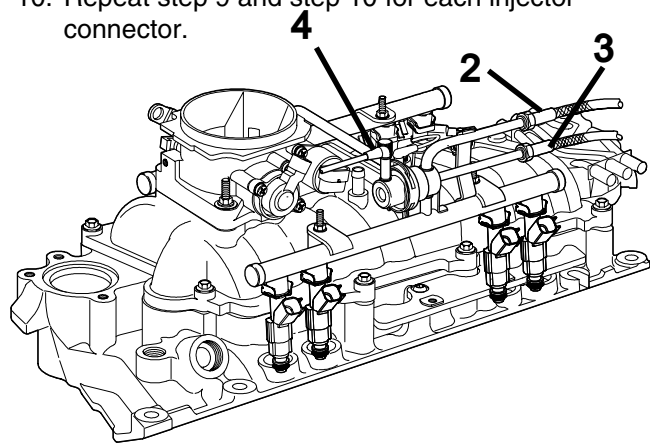
1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.
2. Remove the engine cover.
3. Before removal, clean the fuel rail assembly with a spray type engine cleaner, if necessary. Do not soak fuel rails in liquid cleaning solvent.
4. Disconnect the TP sensor harness connector.
5. Disconnect the IAC valve harness connector.
6. Remove the upper engine wiring harness bracket studs and position the upper engine wire harness aside.
7. Identify the connectors to their corresponding injectors to ensure correct injector firing order after re-assembly.



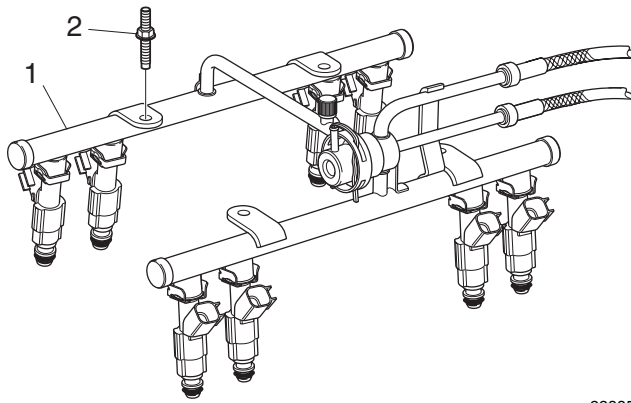
8. Slide the top portion of the injector connector up until it clicks. There should be a click when the slide reaches the end of its stroke. Do not pull the top portion of the connector past the stop tabs.



9. Press the tab on the upper portion of the injector connector in order to release the connector from the injector.
10. Repeat step 9 and step 10 for each injector connector.

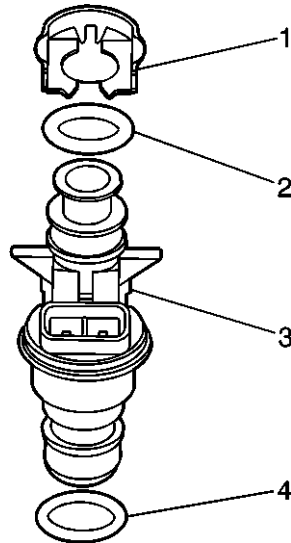


11. Disconnect the fuel feed and return pipes (2), (3) from the fuel rail.
12. Disconnect the fuel pressure regulator vacuum line (4).



22885

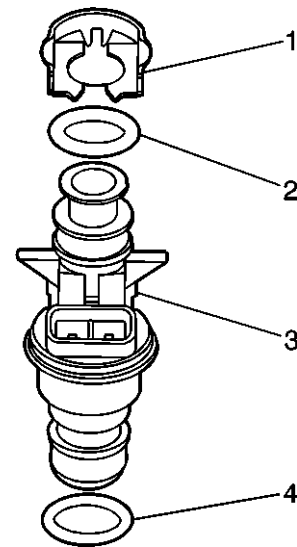
14. Remove the fuel rail attaching bolts (2).
15. Remove the fuel rail assembly (1).



351185

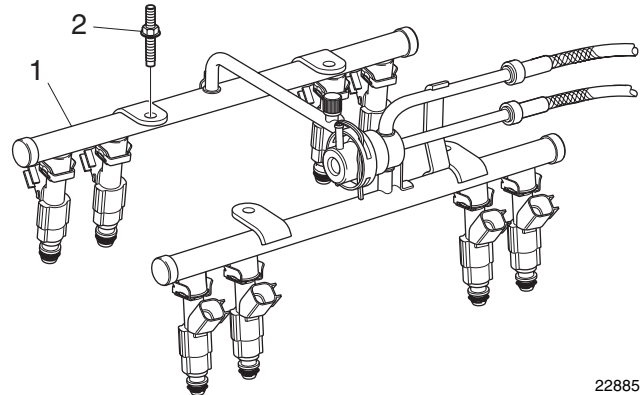
16. Remove the injector lower O-ring seal (4) from the spray tip end of each injector (3).
17. Discard the O-ring seals.

Installation



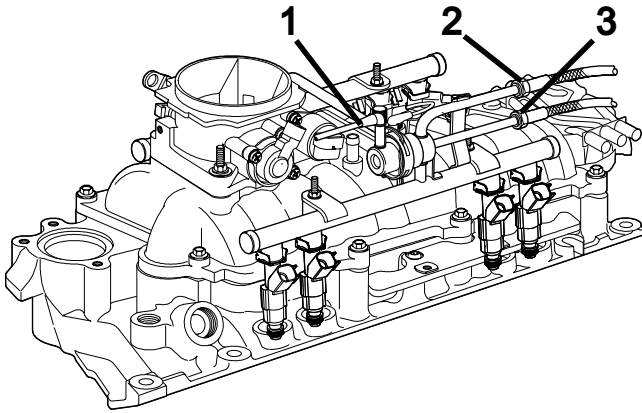
351185

1. Lubricate the new lower injector O-ring seals (4) with clean engine oil.
2. Install the new O-ring seals (4) on the spray tip end of each injector (3).



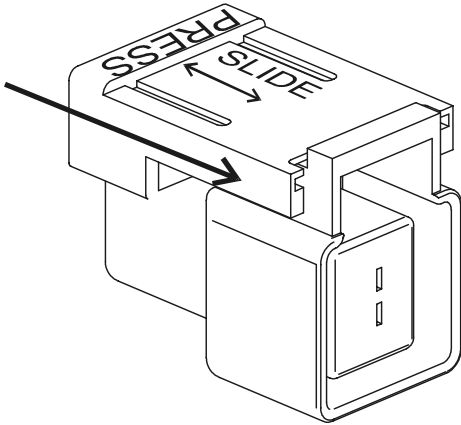
22885

3. Install the fuel rail assembly (1) to the intake manifold.
4. Apply a 5 mm (0.020 in) band of Volvo Penta 8701528 or Loctite® 243 threadlock to the threads of the fuel rail attaching bolts.
5. Install the fuel rail attaching bolts (2). Tighten the fuel rail attaching bolts to 12 N•m (106 lb in).



22527

6. Connect the fuel pressure regulator vacuum line (1).
7. Connect the fuel feed and return pipes (2), (3) to the fuel rail.



22533

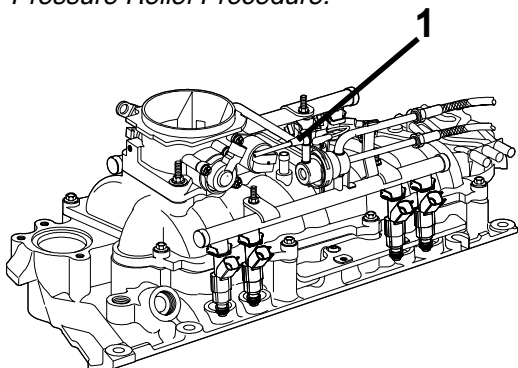
8. Connect the injector electrical connectors as follows:
 - a) Install each connector on the proper injector in order to ensure correct injector firing order. Slide the tab stop down to lock the connector onto the injector.
 - b) Rotate the injectors as required in order to avoid stretching the wire harness.

9. Install the upper engine wire harness bracket.
10. Install the retainer studs to the upper engine wire harness. Tighten the nut to 10 N•m (89 lb in).
11. Reconnect the TP sensor harness connector.
12. Reconnect the IAC valve harness connector.
13. Connect the negative battery cable.
14. Inspect for leaks.
 - a) Turn the ignition ON for 2 seconds.
 - b) Turn the ignition OFF for 10 seconds.
 - c) Turn the ignition ON.
 - d) Inspect for fuel leaks.
15. Install the engine cover. Tighten the bolts 10 N•m (89 lb in).

Fuel Pressure Regulator

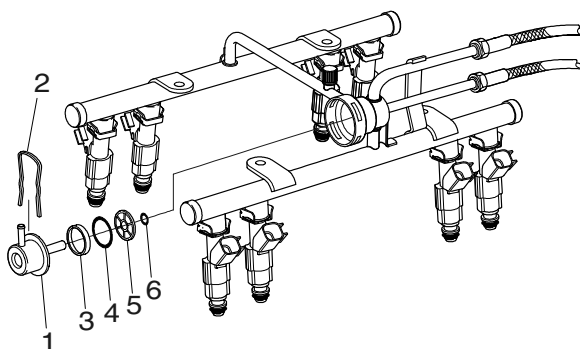
Removal

1. Relieve the fuel system pressure. Refer to *Fuel Pressure Relief Procedure*.



22527

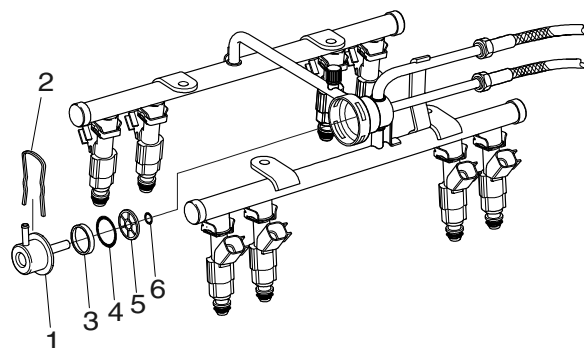
2. Disconnect the fuel pressure regulator vacuum line (1).
3. Clean any dirt from the fuel pressure regulator retainer and the surrounding area.



22528

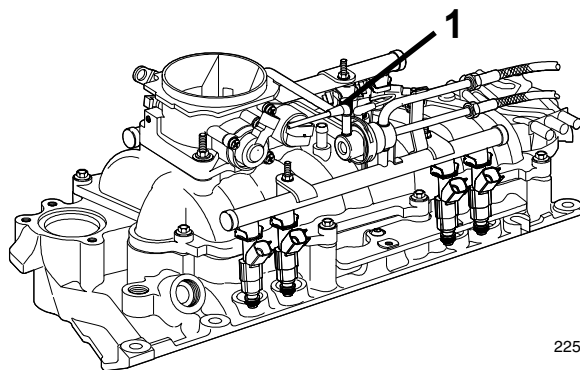
4. Remove the fuel pressure regulator retainer (2).
5. Remove the fuel pressure regulator (1) from the fuel pressure regulator housing.

Installation



22528

1. Install the backup ring (3) on the fuel pressure regulator (1).
2. Install the new large O-ring (4) on the fuel pressure regulator.
3. Install the regulator filter (5) on the fuel pressure regulator.
4. Install the new small O-ring (6) on the fuel pressure regulator.
5. Lubricate the fuel pressure regulator large O-ring and the small O-ring with clean engine oil.
6. Push the fuel pressure regulator into the regulator housing on the fuel rail.
7. Install a new fuel pressure regulator retainer (2).



22527

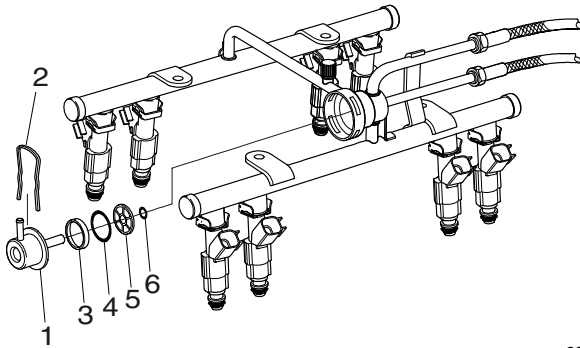
8. Connect the fuel pressure regulator vacuum line (1).
9. Connect the negative battery cable.
10. Inspect for leaks.
 - a) Turn the ignition ON for 2 seconds.
 - b) Turn the ignition OFF for 10 seconds.
 - c) Turn the ignition ON.
 - d) Inspect for fuel leaks.
11. Install the engine cover.

Fuel Injector

Removal

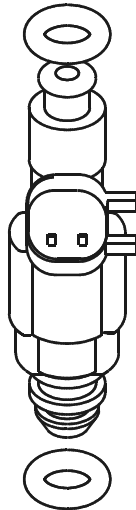
Important: The engine oil may be contaminated with fuel if the fuel injectors are leaking.

1. Remove the fuel rail assembly. Refer to *Fuel Rail Assembly*.



22528

2. Remove the injector retainer clip (2).
3. Insert the fork of J 43013, the fuel injector assembly removal tool, between the fuel rail pod and the 3 protruding retaining clip ledges. Use a prying motion while inserting the tool in order to force the injector out of the fuel rail pod.

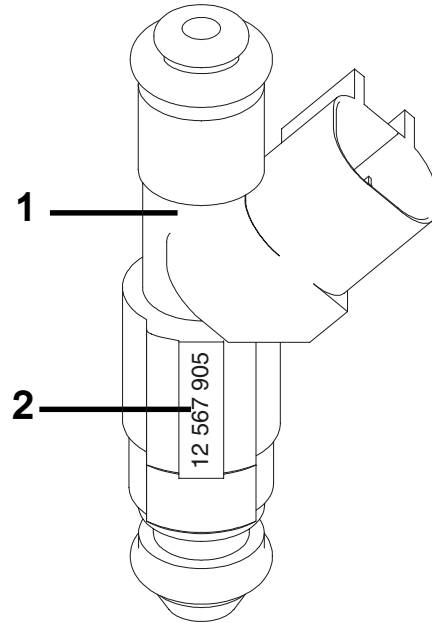


22540

4. Discard the injector retainer clip.
5. Remove the injector O-ring seals from both ends of the injector. Discard the O-ring seals.

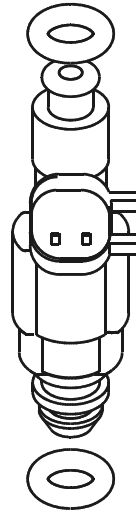
Installation

Important: When ordering new fuel injectors, be sure to order the correct injector for the application being serviced.



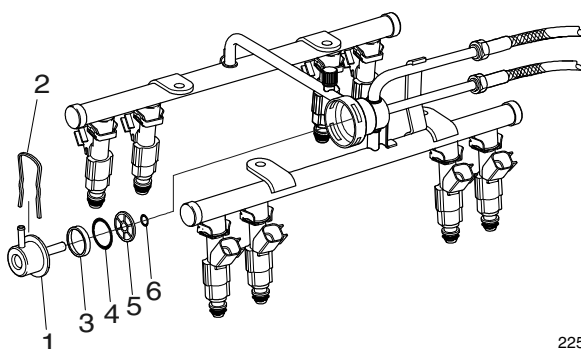
22541

The fuel injector assembly (1) is stamped with a part number identification (2). The Injector for the 4.3, 5.0 and 5.7 are the same. The injector for the 8.1 liter engines are different and should not be mixed together.



22540

1. Lubricate the new O-ring seals with clean engine oil.
2. Install the new injector O-ring seals on the injector.
3. Install a new retainer clip on the injector.



22528

4. Push the fuel injector into the fuel rail injector socket with the electrical connector facing outwards. The retainer clip locks on to a flange on the fuel rail injector socket.
5. Install the fuel rail assembly. Refer to *Fuel Rail Assembly*.

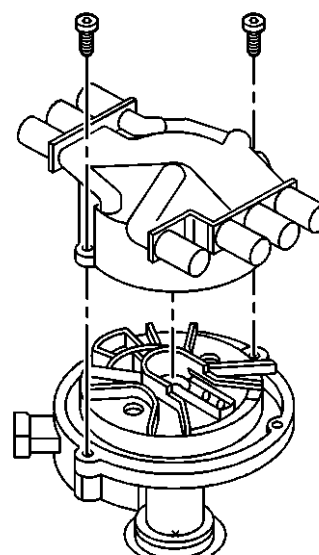
Distributor

Removal

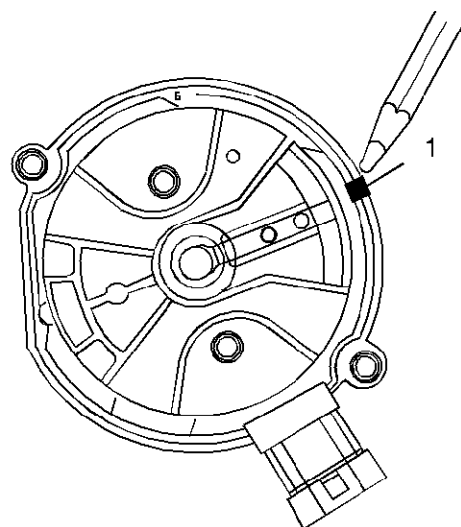
If the malfunction indicator lamp (MIL) turns on and DTC 81 sets after installing the distributor, this indicates an incorrectly installed distributor.

Engine damage or distributor damage may occur.

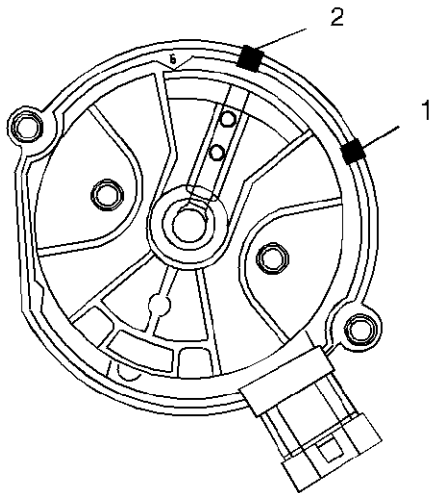
1. Turn OFF the ignition.
2. Remove the engine cover.
3. Remove the flame arrestor.
4. Remove the spark plug wires from the distributor cap.
 - Twist each spark plug 1/2 turn.
 - Pull only on the wire boot in order to remove the wire from the distributor cap.
5. Remove the electrical connector from the base of the distributor.



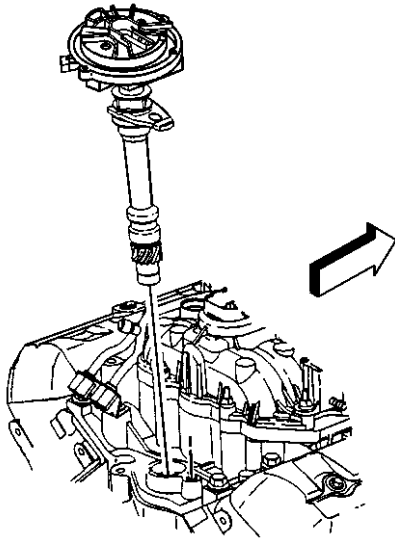
6. Remove the 2 screws that retain the distributor cap to the housing.
7. Discard the screws.
8. Remove the distributor cap from the housing.



9. Use a grease pencil in order to mark the position of the rotor in relation to the distributor housing (1).
10. Mark the distributor housing and the intake manifold with the grease pencil.

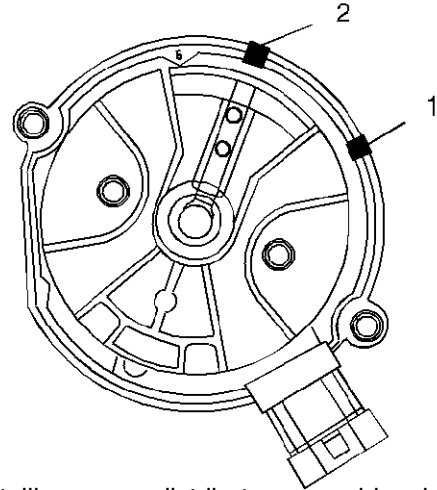


11. As the distributor is being removed from the engine, watch the rotor move in a counter-clockwise direction about 42 degrees. This will appear as slightly more than one clock position.
12. Note the position of the rotor segment.
13. Place a second mark on the base of the distributor (2). This will aid in achieving the proper rotor alignment during the distributor installation.

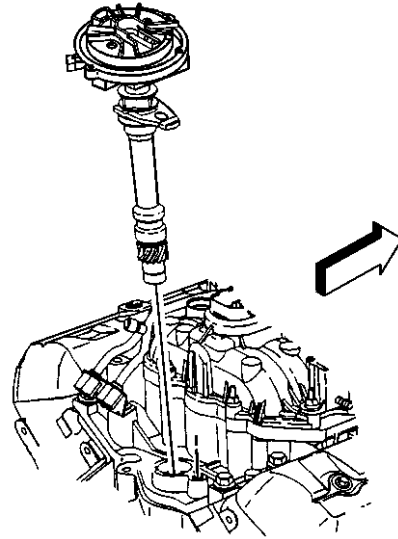


14. Remove the mounting clamp hold-down bolt.
15. Remove the distributor.

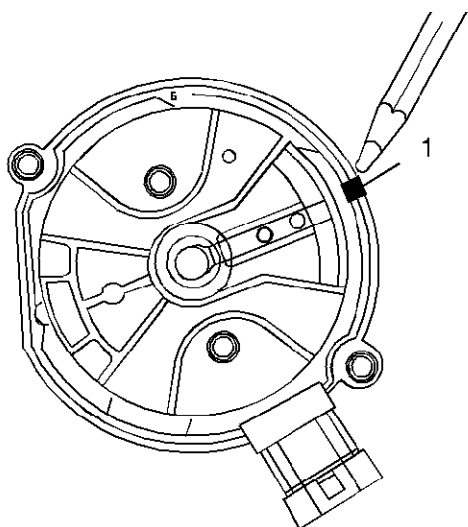
Installation



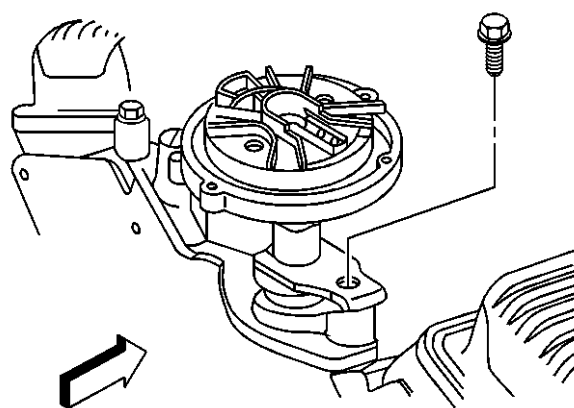
1. If installing a new distributor assembly, place 2 marks on the new distributor housing in the same location as the marks on the original housing.
2. Remove the new distributor cap, if necessary.
3. Align the rotor with the second mark (2).



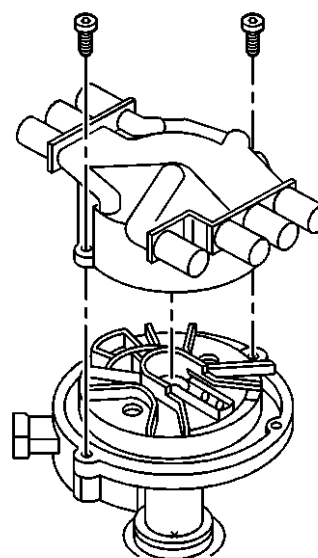
4. Guide the distributor into the engine.
5. Align the hole in the distributor hold-down base over the mounting hole in the intake manifold.



6. As the distributor is being installed, observe the rotor moving in a clockwise direction about 42 degrees.
7. Once the distributor is completely seated, the rotor segment should be aligned with the mark on the distributor base (1).
 - a) If the rotor segment is not aligned with the mark, the driven gear teeth and the camshaft have meshed one or more teeth out of alignment.
 - b) In order to correct this condition, remove and reinstall the distributor.



8. Install the distributor mounting clamp bolt. Tighten the bolt to 25 N•m (18 lb ft).



9. Install the distributor cap.
10. Install the new distributor cap screws. Tighten the screws to 2.4 N•m (21 lb in).
11. Install the electrical connector to the distributor.
12. Install the spark plug wires to the distributor cap.
13. Install the ignition coil wire to the distributor cap.

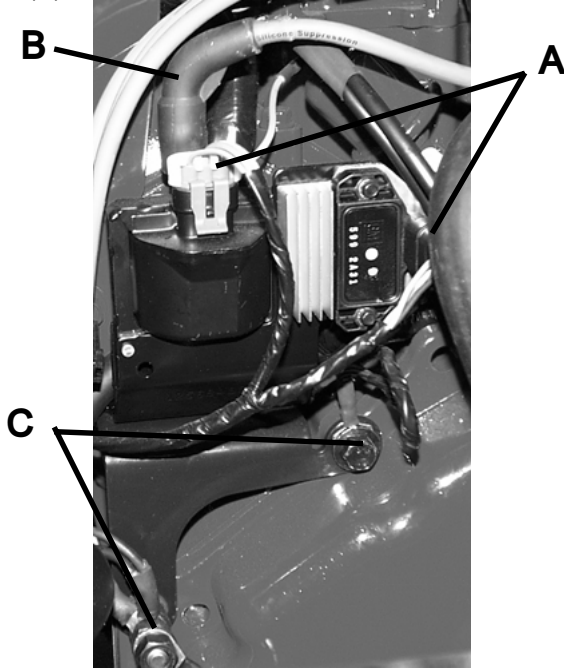
Important: If the malfunction indicator lamp illuminates after installing the distributor and DTC 81 is set, the distributor has been installed incorrectly.

14. Install the engine cover.

Ignition Coil

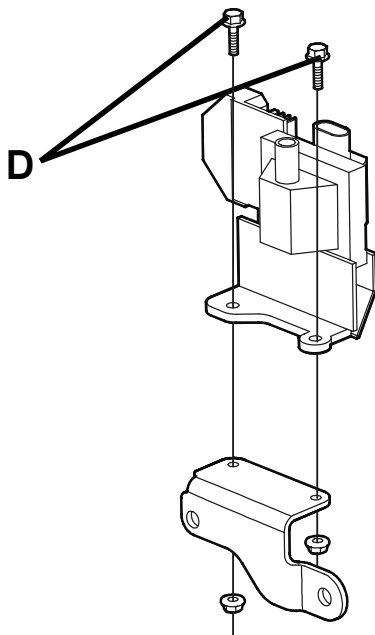
Removal

1. Remove the engine cover.
2. Disconnect the electrical connectors (A).
3. Remove the ignition coil wire to the distributor (B).



PIC22572

4. Remove the nut and bolt holding the bracket and the ignition coil to the flywheel housing (C).
5. Remove the bracket and the ignition coil.



22542

6. Remove the two screws and nuts (D) holding the ignition coil to the bracket.
7. Remove the ignition coil from the bracket.

Installation

1. Install the ignition coil to the bracket with the 2 screws. 7-9 N•m (5-7 lb.ft.)
2. Install the ignition coil and the bracket to the intake manifold with studs. Tighten the nut and screw to 34-39 N•m (20-25 lb.ft.)
3. Install the ignition coil wire (B).

DANGER!

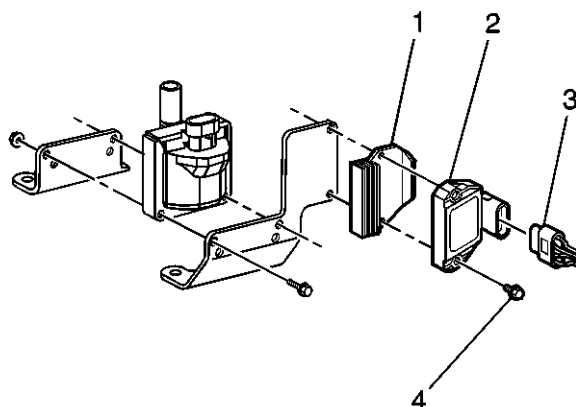
The wire must not touch anything like the steering or exhaust system. Chafing the insulation will cause a short to ground and sparking in the engine compartment. This could cause fire or an explosion if gas fumes are present

4. Install the electrical connectors.
5. Install the engine cover.

Ignition Control Module

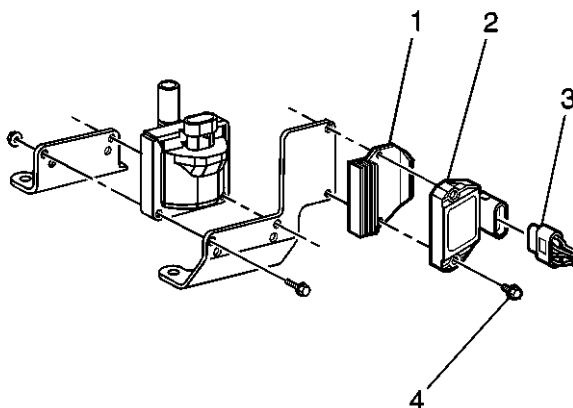
Removal

1. Remove the engine cover.



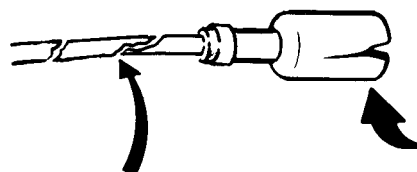
2. Disconnect the electrical connector (3).
3. Remove the screws (4) holding the ignition control module (2) and the heat sink (1) to the bracket.
4. Remove the ignition control module and the heat sink.

Installation



1. Install the ignition control module (2) and the heat sink (1) on the bracket with the screws (4). Tighten the screws to 3.5 N•m (31 lb in).
2. Reconnect the electrical connectors (3).
3. Install the engine cover.

Spark Plug Wire Inspection



22820

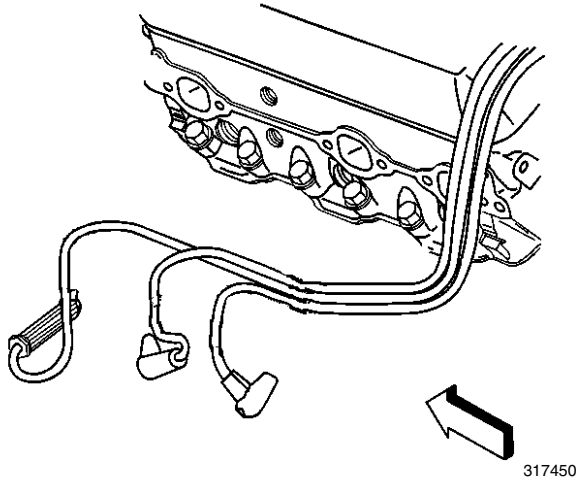
Spark plug wire integrity is vital for safe and proper engine operation. A thorough inspection will be necessary to accurately identify conditions that may affect engine operation. Inspect for the following conditions:

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 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 on a terminal, replace the wire and the component connected to the wire.

Spark Plug Wire

Removal

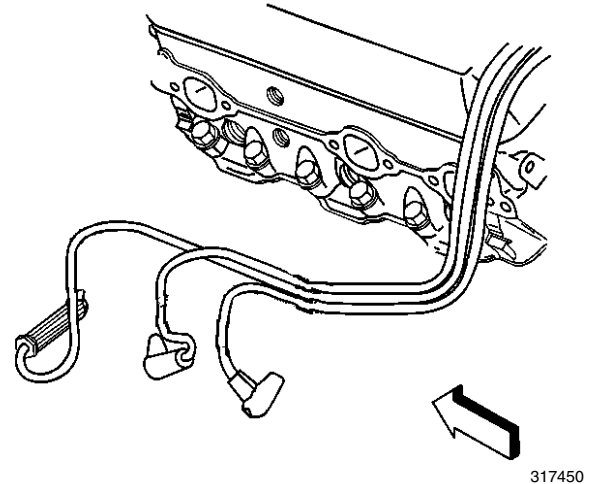


1. Disconnect the spark plug wire at each spark plug as follows:
 - a) Twist the boots 1/2 turn before removing the boots.
 - b) Pull only on the boot or use a tool designed for this purpose in order to remove the wire from each spark plug.
2. Disconnect the spark plug wire from the distributor as follows:
 - a) Twist each spark plug boot 1/2 turn.
 - b) Pull only on the boot or use a tool designed for this purpose in order to remove the wires from the distributor.

Installation

⚠ Caution!

If the boot to wire movement has occurred, the boot will give a false visual impression of being fully seated. Ensure that the boots have been properly assembled by pushing sideways on the installed boots. Failure to properly seat the terminal onto the spark plug will lead to wire core erosion and result in an engine misfire or crossfire condition, and possible internal damage to the engine.



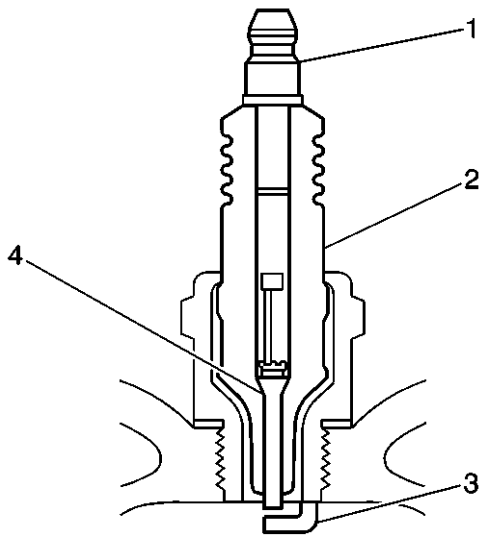
1. Install the spark plug wires at the distributor.
2. Install the spark plug wire to each spark plug.
3. Inspect the wires for proper installation as follows:
 - a) Push sideways on each boot in order to inspect the seating.
 - b) Reinstall any loose boot.
 - c) Wire routings must be kept intact during service and followed exactly when wires have been disconnected or when replacement of the wires is necessary. Failure to route the wires properly can lead to radio ignition noise and crossfiring of the plugs, or shorting of the leads to the ground.
 - d) Any time the spark plug wires or boots are installed on the spark plugs, new dielectric grease needs to be applied inside the boot.

Spark Plug Inspection

Spark Plug Usage

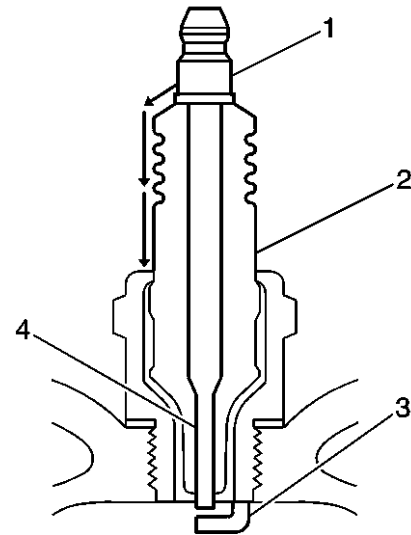
1. Ensure that the correct spark plug is installed. An incorrect spark plug causes driveability conditions.
2. Ensure that the spark plug has the correct heat range. An incorrect heat range causes the following conditions:
 - a) Spark plug fouling - Colder plug
 - b) Pre-ignition causing spark plug and/or engine damage - Hotter plug

Spark Plug Inspection



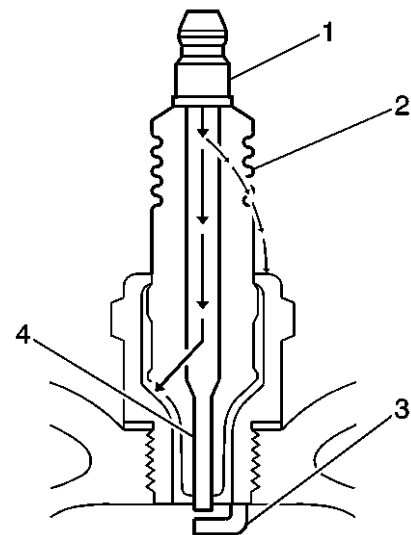
622530

1. Inspect the terminal post (1) for damage as follows:
 - a) Inspect for a bent or broken terminal post (1).
 - b) Test for a loose terminal post (1) by twisting and pulling the post. The terminal post (1) should NOT move.



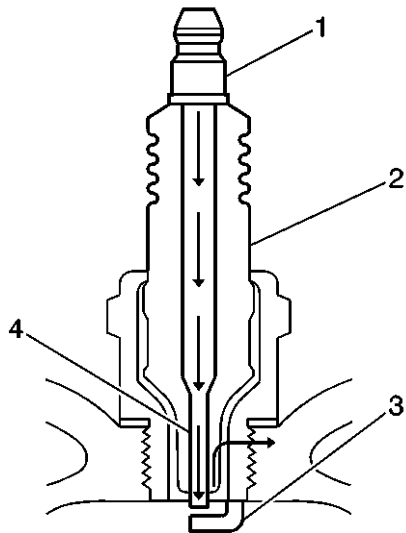
622530

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:
 - a) Inspect the spark plug boot for damage.
 - b) 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.



622530

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).



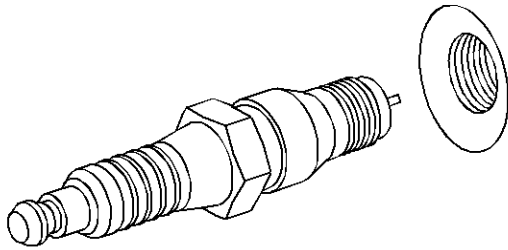
622527

Spark Plug Visual Inspection

1. Normal operation - Brown to grayish-tan with small amounts of white powdery deposits are normal combustion by-products from fuels with additives.
 2. Carbon Fouled - Dry, fluffy black carbon, or soot caused by the following conditions:
 - a) Rich fuel mixtures
 - Leaking fuel injectors
 - Excessive fuel pressure
 - Restricted air filter element
 - Incorrect combustion
 - b) Reduced ignition system voltage output
 - Weak coils
 - Worn ignition wires
 - Incorrect spark plug gap
 - c) Excessive idling or slow speeds under light loads can keep spark plug temperatures so low that normal combustion deposits may not burn off.
 3. 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.
4. Inspect for evidence of improper arcing as follows:
 - a) 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.
 - b) Inspect for the correct spark plug torque. Refer to *Ignition System Specifications*. Insufficient torque can prevent correct spark plug operation. An over torqued spark plug, causes the insulator (2) to crack.
 - c) Inspect for signs of tracking that occurred near the insulator tip instead of the center electrode (4).
 - d) Inspect for a broken or worn side electrode (3).
 - e) 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.
 - f) Inspect for bridged electrodes (3, 4). Deposits on the electrodes (3, 4) reduce or eliminates the gap.
 - g) Inspect for worn or missing platinum pads on the electrodes (3, 4), if equipped.
 - h) 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.

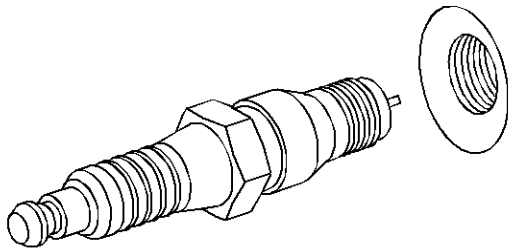
Spark Plug Replacement

Removal



1. Remove the spark plug wires. Refer to *Spark Plug Wire*.
2. Loosen each spark plug 1 or 2 turns.
3. Brush or air blast away any dirt from around the spark plugs.
4. Remove the spark plugs 1 at a time. Place each plug in a tray marked with the corresponding cylinder numbers.

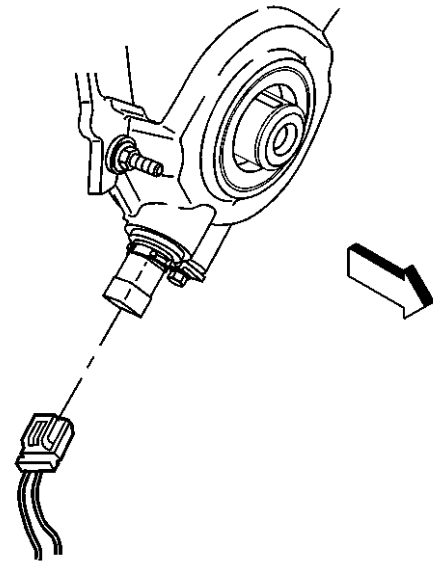
Installation



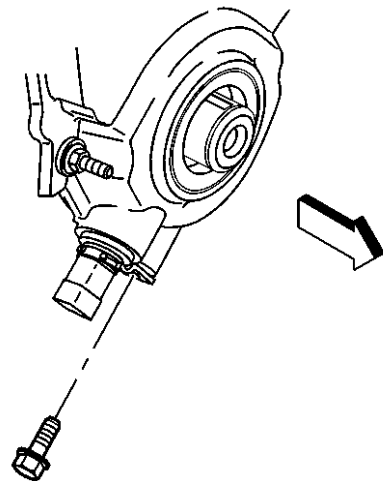
1. Properly position each spark plug washer.
2. Inspect each spark plug gap. Adjust each plug as needed for a Spark plug gap of 1.524 mm (0.060 in).
3. Hand start the spark plugs in the corresponding cylinders.
4. Tighten the spark plugs as follows:
 - a) For used heads tighten the spark plugs to 15 N•m (11 lb ft).
 - b) For new aluminum heads tighten the spark plugs to 20 N•m (15 lb ft).
 - c) For new iron heads tighten the spark plugs to 30 N•m (22 lb ft).
5. Install the spark plug wires. Refer to *Spark Plug Wire*.

Crankshaft Position (CKP) Sensor

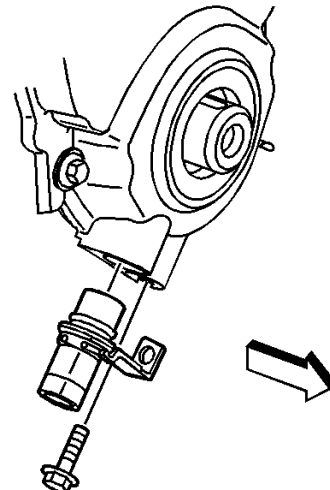
Removal



1. Disconnect the CKP sensor harness connector.



2. Remove the CKP sensor mounting bolt.



3. Remove the CKP sensor.

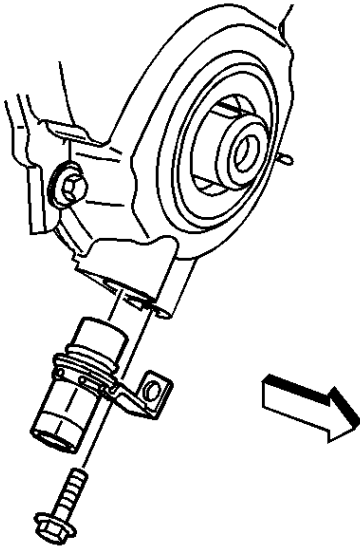
Installation

NOTE! When installing the CKP sensor, make sure the sensor is fully seated before tightening the mounting bolt. A poorly seated CKP sensor may perform erratically and may set false DTCs.



Caution!

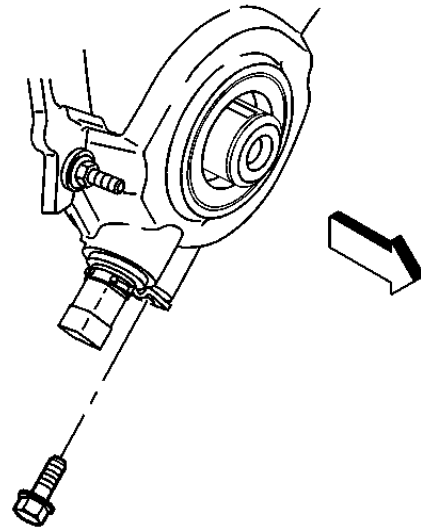
Do not reuse the original O-ring.



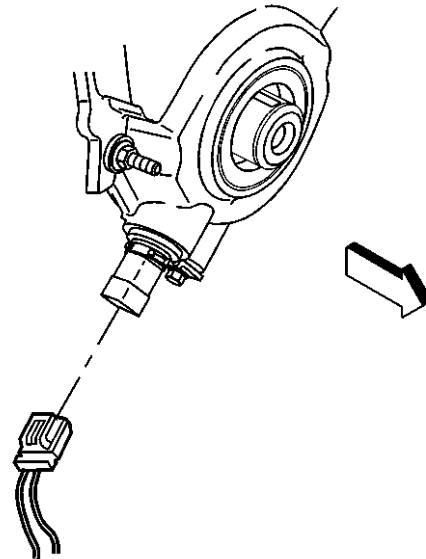
1. Replace the CKP sensor O-ring.
2. Lubricate the O-ring with clean engine oil before installing the CKP sensor.

NOTE! Make sure the CKP sensor mounting surface is clean and free of burrs.

3. Install the CKP sensor.



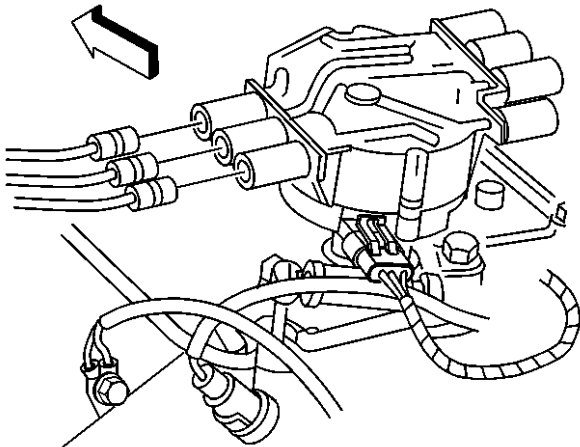
4. Install the CKP sensor mounting bolt. Tighten the CKP sensor mounting bolt to 9 N•m (80 lb in).



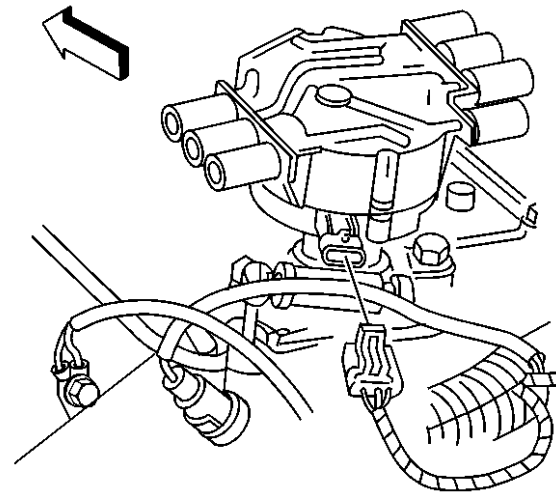
5. Connect the CKP sensor harness connector.

Camshaft Position (CMP) Sensor Removal

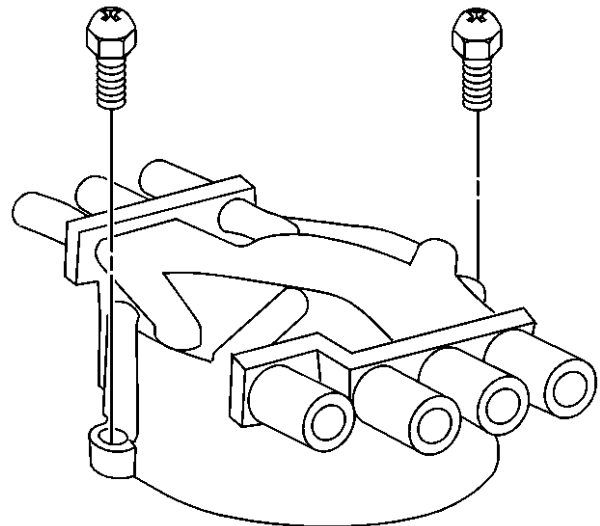
1. Remove the engine cover.



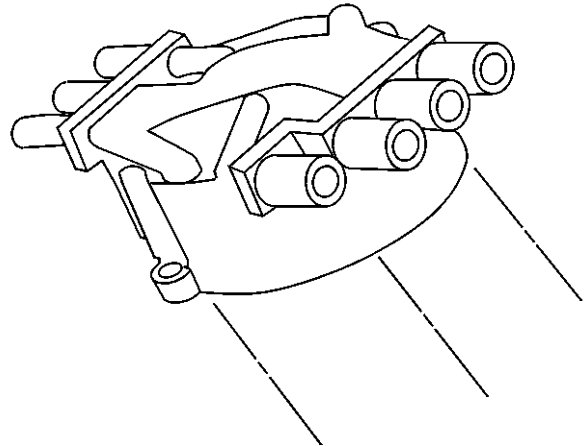
2. Disconnect the spark plug wires and ignition coil wire from the distributor. Refer to *Spark Plug Wire*.



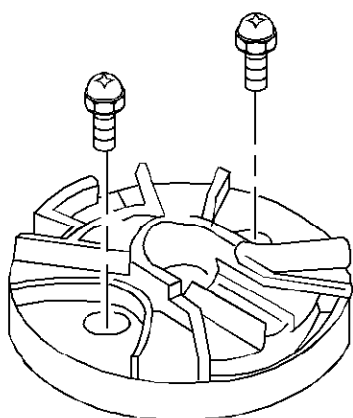
3. Disconnect the camshaft position (CMP) sensor harness connector from the distributor.



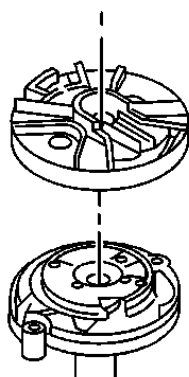
4. Remove the distributor cap screws.



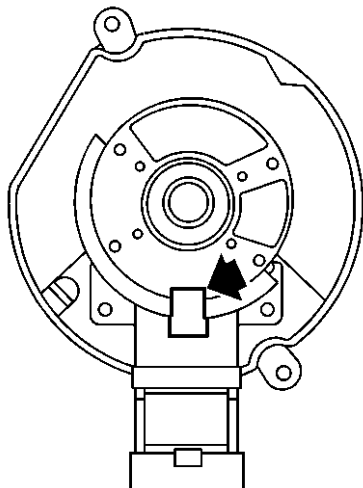
5. Remove the distributor cap.



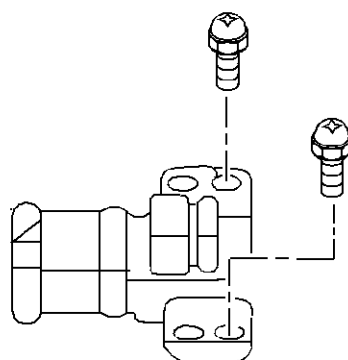
6. Remove the rotor screws.



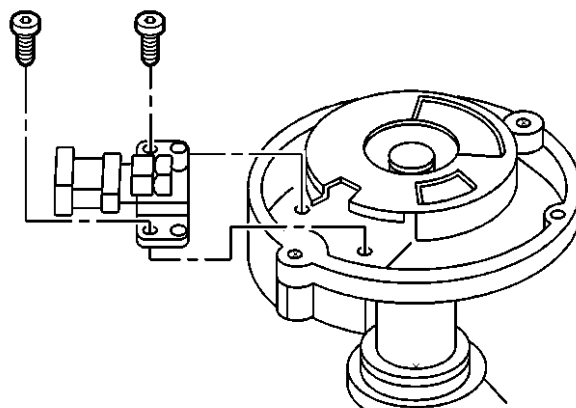
7. Remove the rotor.



8. Align the square slot in the reluctor wheel with the CMP sensor.



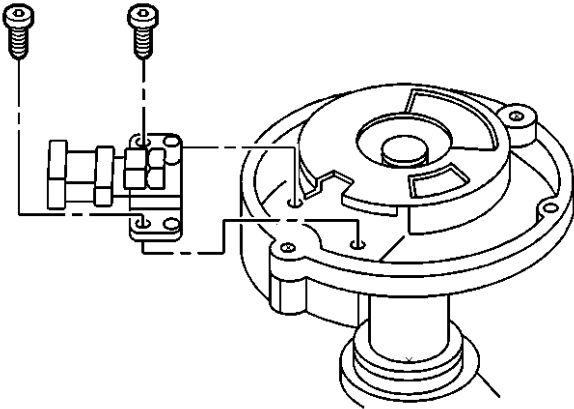
9. Remove the CMP screws.



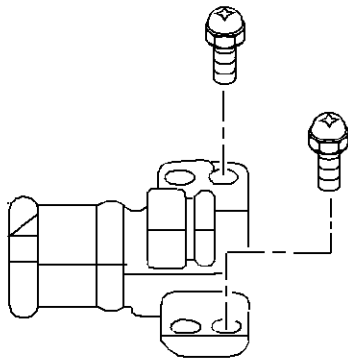
10. Remove the CMP sensor.

Installation

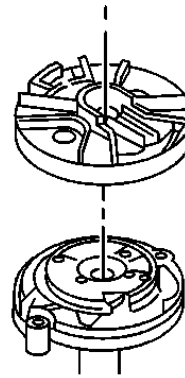
Important: Do not use the old cap, CMP sensor, and rotor screws. Use the replacement screws that have been coated with a thread locking compound.



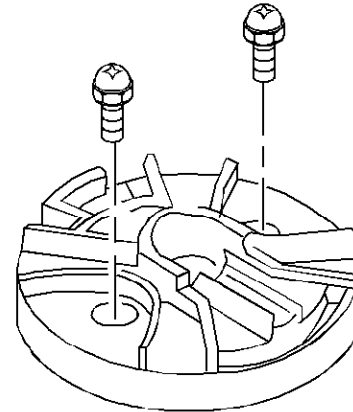
1. Insert the CMP sensor through the reluctor wheel slot



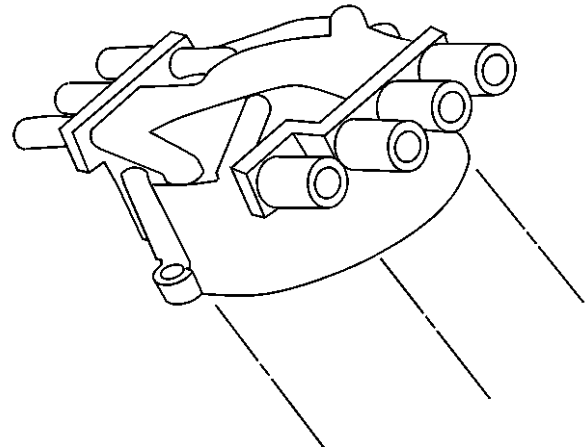
2. Install new CMP mounting screws. Tighten the bolts to 2.2 N•m (19 lb in).



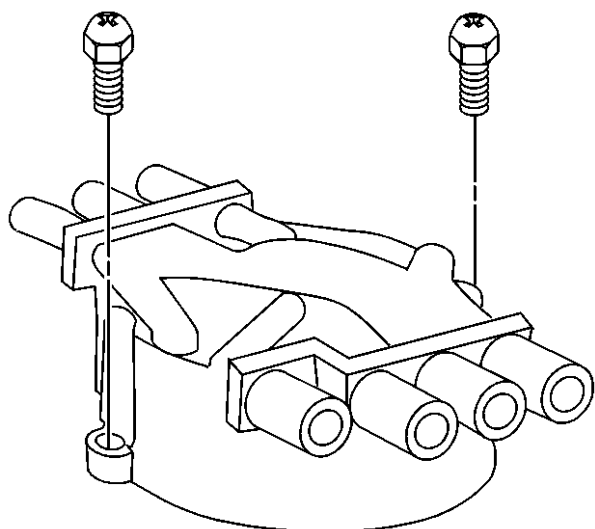
3. Install the rotor onto the reluctor wheel.



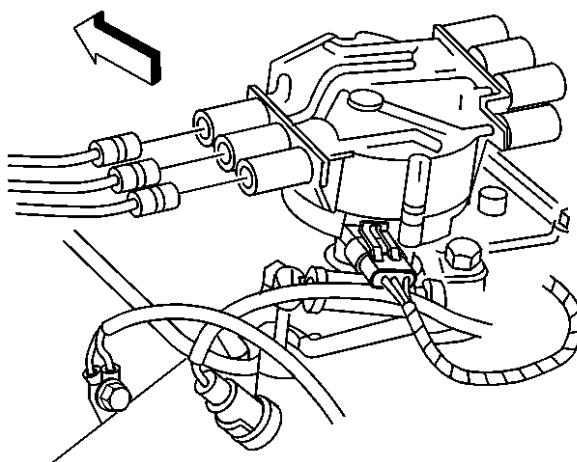
4. Install new rotor screws. Tighten the screws to 2 N•m (18 lb in).



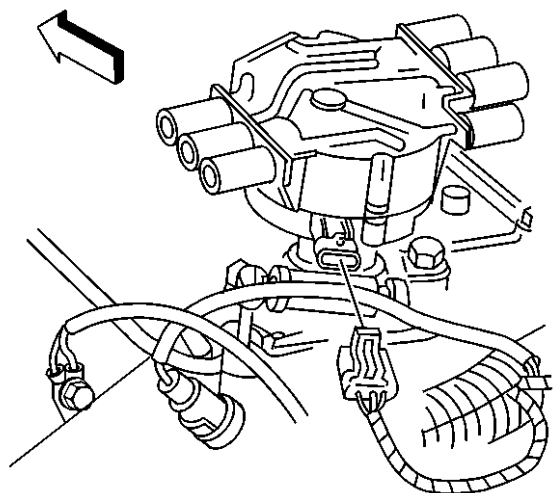
5. Install the distributor cap.



6. Install new distributor cap screws. Tighten the screws to 2.4 N•m (21 lb in).



8. Connect the spark plug wires and ignition coil wire. Refer to Spark Plug Wire.
9. Install the engine cover.

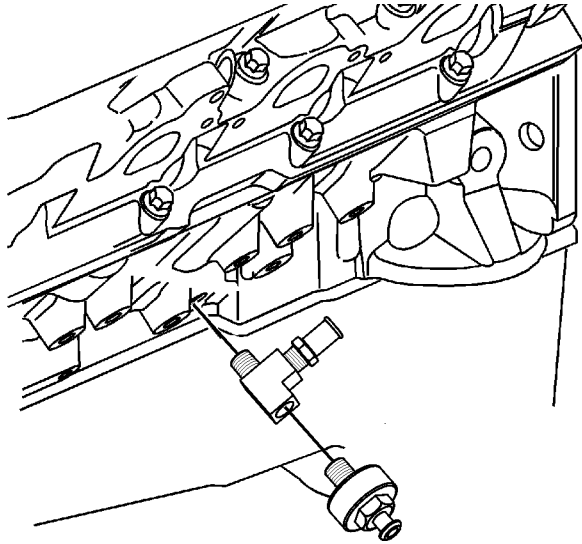


7. Connect the CMP sensor harness connector.

Knock Sensor (KS)

Removal

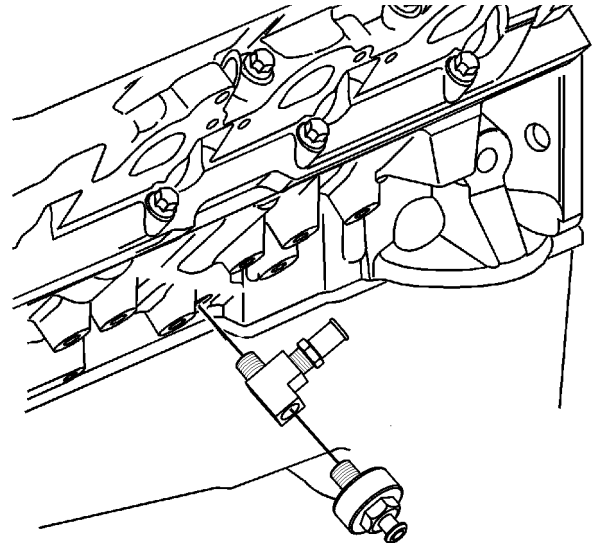
1. Disconnect the negative battery cable.
2. Remove the engine cover.



3. Disconnect the knock sensor harness connector.
4. Remove the knock sensor from drain tee.

Installation

NOTE! Refer to Component Fastener Tightening Notice in Cautions and Notices.



1. Install the knock sensor in drain tee.
2. Tighten the sensor to 18 N•m (13 lb. ft.)
3. Connect the knock sensor harness connector.
4. Connect the negative battery cable.

Temperature vs. Resistance IAT and ECT

°C	°F	Ohms	°C	°F	Ohms
100	212	177	25	77	2796
90	194	241	20	68	3520
80	176	332	15	59	4450
70	158	467	10	50	5670
60	140	667	5	41	7280
50	122	973	0	32	9420
45	133	1188	-5	23	12300
40	104	1459	-10	14	16180
35	95	1802	-15	5	21450
30	86	2238	-20	-4	28680
25	77	2796	-30	-22	52700
20	68	3520	-40	-40	100700

TBL22552

Ignition System Specifications

Application	Specifications	
	Metric	English
Firing Order	1-8-4-3-6-5-7-2	
Spark Plug Wire Resistance	10,000 Ohms	
Spark Plug Torque	15 N•m	11 lb. ft
Spark Plug Gap	1.52 mm	.060 in.
Spark Plug Type	Volvo Penta Part no. 3861326 AC TJ14R-P15	

TBL22553

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Camshaft Position Sensor (CMP)	25 N•m	18 lb. ft.
Crankshaft Position Sensor Bolt (CKP)	25 N•m	18 lb.ft.
Engine Control Module (ECM) Mounting Screws	10-14 N•m	88-142 lb. in.
Engine Coolant Temperature Sensor (ECT)	17 N•m	13 lb. in.
Fuel Rail Attachment Bolts	10 N•m	89 lb. in.
Idle Air Control (IAC) Valve Attaching Screws	2 M•m	18 lb. in.
Ignition Coil Attachment Bolts (bracket to flywheel housing bracket)	12 N•m	106 lb. in.
Knock Sensor	17 N•m	13 lb. ft.
Throttle Body Attaching bolts	9 N•m	80 lb. in.
Throttle Position(TP) Sensor Attaching Screws	2 N•m	18 lb. in

TBL22554

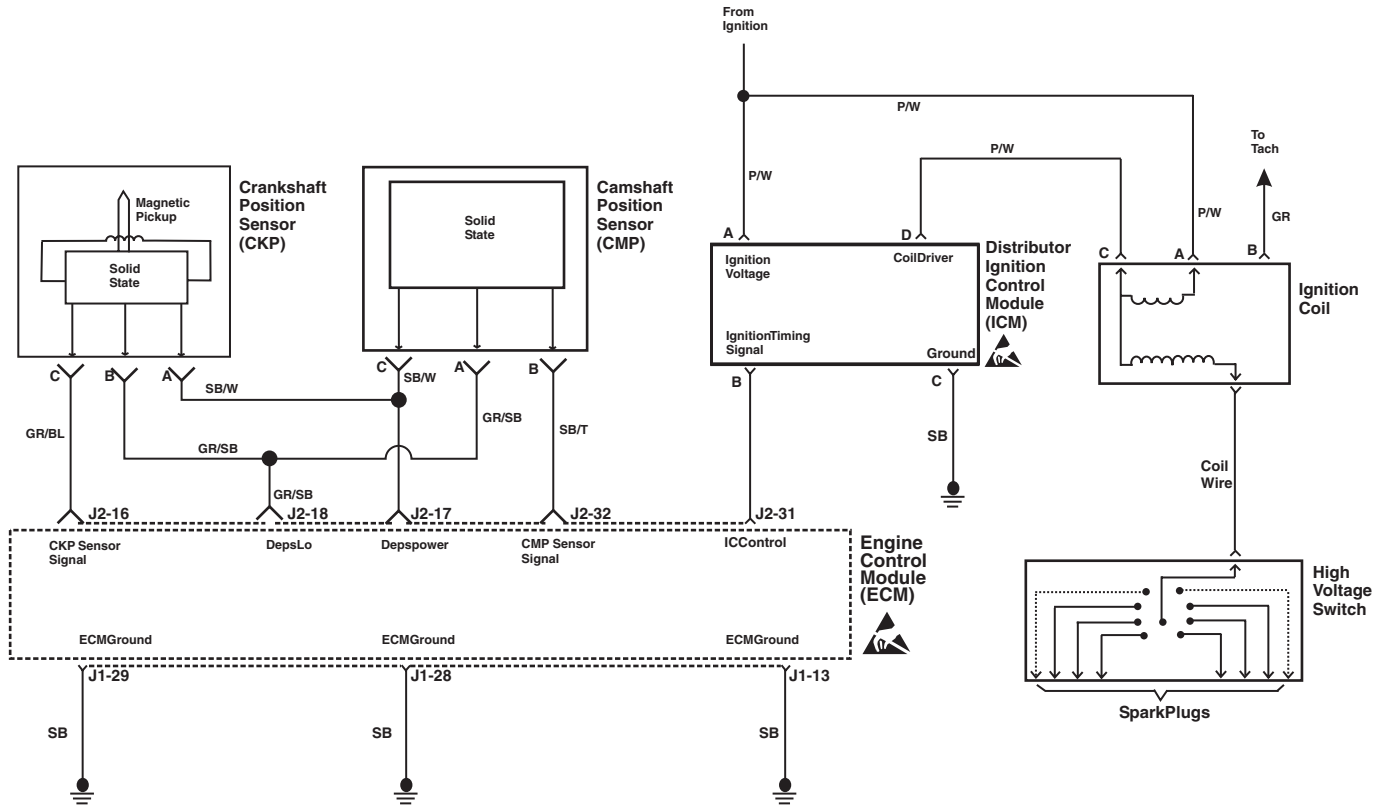
Notes

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Electronic Ignition System - General



22710

System Description

This system includes the distributor, the camshaft position (CMP) sensor, the ignition control (IC) module, the secondary wires, the spark plugs, the knock sensors (KS), and the crankshaft position (CKP) sensor. The ignition system is controlled by the engine control module (ECM). The ECM monitors the information from various engine sensors, computes the desired spark timing, and controls the dwell and firing of the ignition coil via IC line to the IC module.

Test Description

Important: The battery should be fully charged prior to any tests.

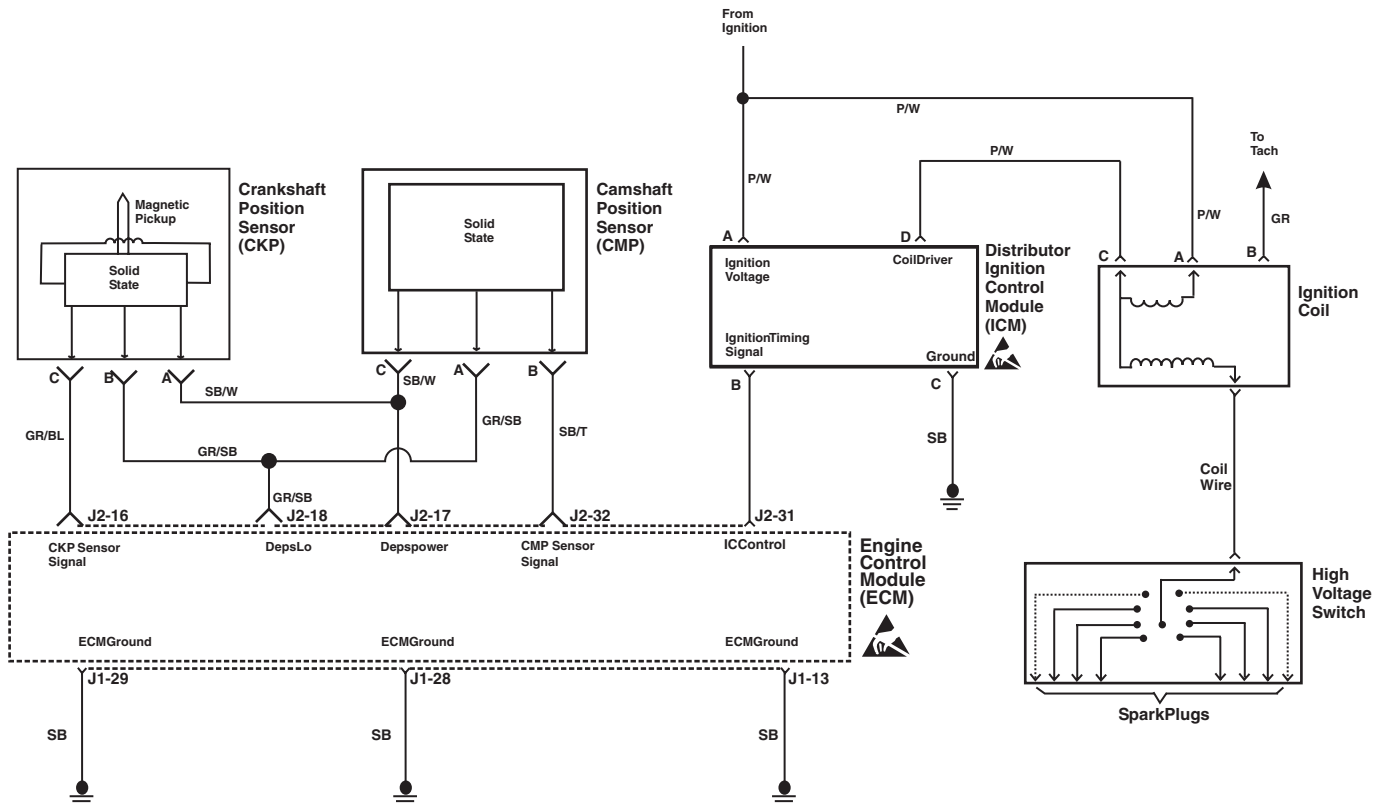
The numbers below refer to the step numbers on the diagnostic table.

3. This step checks for proper spark output. This check can be used in case of an ignition miss, because the system may provide enough voltage to run the engine but not enough to operate a spark plug under heavy load.
4. This test separates the distributor cap, rotor, and ignition wires from the ignition coil in order to help identify a secondary ignition system problem.
6. This test checks the ignition control module (ICM), connections, and wiring.
12. This test begins to determine if the ECM is providing a signal to the ICM. If the ECM is not providing a signal to the ignition control module, the problem exists between the ignition control module and the ECM.
14. This test checks for a basic engine mechanical problem.

Electronic Ignition System - General

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Crank the engine. 2. Observe the Engine Speed parameter with the scan tool. Does the scan tool display engine RPM?	—	Go to Step 3	Go to Step 19
3	1. Check the spark plug wires for open circuits, cracks, or improper seating of terminals at the spark plugs, distributor, and ignition coil before proceeding with the test. 2. Check spark at the plug with approved Spark Tester or equivalent while cranking. If there is no spark on one wire, check a second wire. A few sparks then nothing is considered no spark. Does spark occur on all cylinders?	—	Go to Intermittent Conditions	Go to Step 4
4	1. Remove the coil wire from the distributor cap. 2. Insert the Spark Tester into the coil wire and clamp the tester onto a ground. 3. Crank the engine. Does spark occur?	—	Go to Step 13	Go to Step 5
5	1. Measure the coil wire resistance. Does the resistance measure approximately the specified value?	1,000 ohm/in.	Go to Step 6	Go to Step 32
6	1. Disconnect the ignition coil harness connector. 2. Probe the harness ignition coil driver circuit (PIN C) with a test lamp connected to battery positive voltage. 3. Crank the engine. Does the test lamp flash while cranking the engine?	—	Go to Step 8	Go to Step 7
7	1. Turn OFF the ignition. 2. Probe the harness ignition coil driver circuit (PIN C) with a test lamp connected to battery positive voltage. Does the test lamp illuminate?	—	Go to Step 29	Go to Step 9
8	1. Turn ON the ignition, with the engine OFF. 2. Measure the coil ignition voltage (PIN A) with a DMM connected to a ground. Does the voltage measure above the specified value?	10.0	Go to Step 22	Go to Step 18
9	1. Turn OFF the ignition. 2. Check for an open circuit between the ignition coil and the ICM. Did you find the condition?	—	Go to Step 28	Go to Step 10
10	1. Turn ON the ignition, with the engine OFF. 2. Measure the coil ignition voltage (PIN A) at the ICM harness connector with a DMM connected to a ground. Does the voltage measure above the specified value?	—	Go to Step 11	Go to Step 20
11	1. Probe the ICM harness connector ground circuit (PIN C) with a test lamp connected to battery positive voltage. Does the test lamp illuminate?	—	Go to Step 12	Go to Step 24

Electronic Ignition System - General cont.



22710

System Description

This system includes the distributor, the camshaft position (CMP) sensor, the ignition control (IC) module, the secondary wires, the spark plugs, the knock sensors (KS), and the crankshaft position (CKP) sensor. The ignition system is controlled by the engine control module (ECM). The ECM monitors the information from various engine sensors, computes the desired spark timing, and controls the dwell and firing of the ignition coil via IC line to the IC module.

Test Description

Important: The battery should be fully charged prior to any tests.

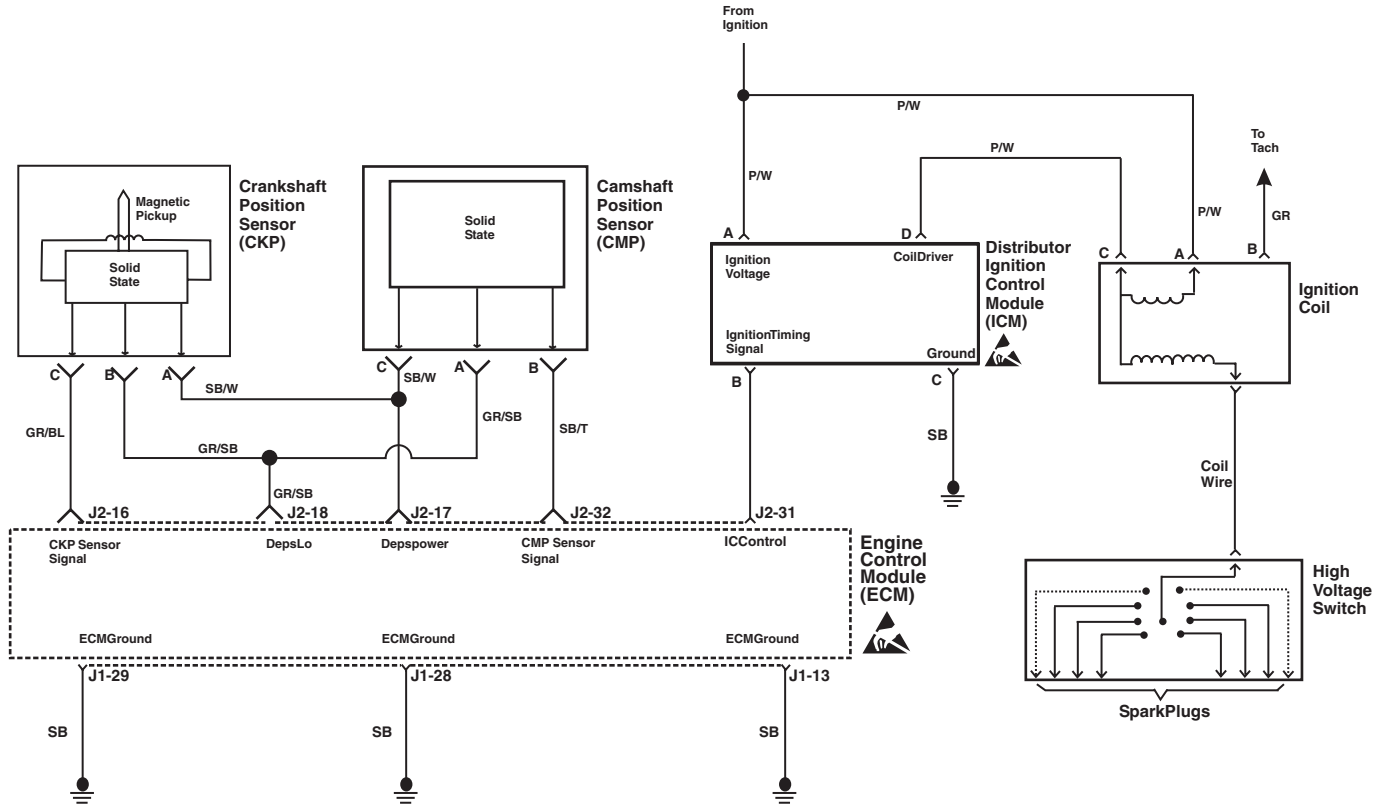
The numbers below refer to the step numbers on the diagnostic table.

3. This step checks for proper spark output. This check can be used in case of an ignition miss, because the system may provide enough voltage to run the engine but not enough to operate a spark plug under heavy load.
4. This test separates the distributor cap, rotor, and ignition wires from the ignition coil in order to help identify a secondary ignition system problem.
6. This test checks the ignition control module (ICM), connections, and wiring.
12. This test begins to determine if the ECM is providing a signal to the ICM. If the ECM is not providing a signal to the ignition control module, the problem exists between the ignition control module and the ECM.
14. This test checks for a basic engine mechanical problem.

Electronic Ignition System - General cont.

Step	Action	Value	Yes	No
12	1. Probe the IC timing control circuit (PIN B) with a DMM set to the AC scale connected to a ground. 2. Crank the engine. 3. Observe the voltage while the engine is being cranked. Does the voltage measure within the specified values?	1.0-4.0	Go to Step 21	Go to Step 15
13	1. Remove the distributor cap. 2. Check the cap for the following conditions: • Cracks • Moisture • Carbon tracks • Physical damage Did you find any of these conditions?	—	Go to Step 34	Go to Step 14
14	1. Crank the engine. 2. Observe the distributor rotor while the engine is being cranked. Did the distributor rotor turn?	—	Go to Step 33	Go to Diagnostic Starting Point in <i>Engine Manual</i>
15	1. Turn OFF the ignition 2. Disconnect the ECM. 3. Check the ignition timing control circuit for an open between the ECM and the ICM. Did you find the condition?	—	Go to Step 25	Go to Step 16
16	1. Probe the ignition timing control circuit at the ECM (PIN 31) with a test lamp connected to battery voltage. Does the test lamp illuminate?	—	Go to Step 26	Go to Step 17
17	1. Turn ON the ignition, with the engine OFF. 2. Probe the ignition timing control circuit (PIN 31) at the ECM with a test lamp connected to a ground. Does the test lamp illuminate?	—	Go to Step 27	Go to Step 23
18	1. Check for an open or shorted to ground ignition voltage circuit at the ignition coil. 2. Repair as necessary. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
19	1. Check for a short to ground on the CKP or CMP depower circuit. 2. Repair as necessary. Refer to Wiring Repairs in Wiring Systems. Did you find and correct the condition?	—	Go to Step 37	Go to Step 23
20	1. Check for an open or a short to ground on the ignition voltage circuit at the ICM. 2. Repair as necessary. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
21	1. Check for a poor ICM connection. Did you find a problem?	—	Go to Step 30	Go to Step 35
22	1. Check for a poor coil connection. Did you find a problem?	—	Go to Step 30	Go to Step 31

Electronic Ignition System - General cont.



22710

System Description

This system includes the distributor, the camshaft position (CMP) sensor, the ignition control (IC) module, the secondary wires, the spark plugs, the knock sensors (KS), and the crankshaft position (CKP) sensor. The ignition system is controlled by the engine control module (ECM). The ECM monitors the information from various engine sensors, computes the desired spark timing, and controls the dwell and firing of the ignition coil via IC line to the IC module.

Test Description

Important: The battery should be fully charged prior to any tests.

The numbers below refer to the step numbers on the diagnostic table.

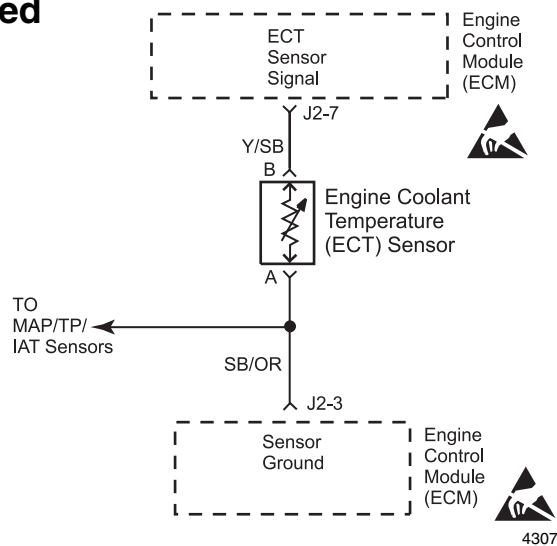
3. This step checks for proper spark output. This check can be used in case of an ignition miss, because the system may provide enough voltage to run the engine but not enough to operate a spark plug under heavy load.
4. This test separates the distributor cap, rotor, and ignition wires from the ignition coil in order to help identify a secondary ignition system problem.
6. This test checks the ignition control module (ICM), connections, and wiring.
12. This test begins to determine if the ECM is providing a signal to the ICM. If the ECM is not providing a signal to the ignition control module, the problem exists between the ignition control module and the ECM.
14. This test checks for a basic engine mechanical problem.

Electronic Ignition System - General cont.

Step	Action	Value	Yes	No
23	1. Check for a poor ECM connection. Did you find a problem?	—	Go to Step 30	Go to Step 36
24	1. Repair the open ICM ground circuit. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
25	1. Repair the open ignition timing control circuit. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
26	1. Repair the grounded ignition timing control circuit. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
27	1. Repair the short to voltage in the ignition timing control circuit. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
28	1. Repair the open in the coil driver circuit between the ignition coil and the ICM. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
29	1. Repair the short to ground in the coil driver circuit between the ignition coil and the ICM. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
30	1. Repair the circuit as necessary. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 37	—
31	1. Replace the ignition coil. Refer to Ignition Coil Replacement. Did you complete the replacement?	—	Go to Step 37	—
32	1. Replace the coil wire. Refer to Spark Plug Replacement. Did you complete the replacement?	—	Go to Step 37	—
33	1. Replace the distributor rotor. Refer to Distributor Overhaul. Did you complete the replacement?	—	Go to Step 37	—
34	1. Replace the distributor cap. Refer to Distributor Overhaul. Did you complete the replacement?	—	Go to Step 37	—
35	1. Replace the IC module. Refer to Ignition Control Module Replacement. Did you complete the replacement?	—	Go to Step 37	—
36	1. Replace the ECM. Refer to Engine Control Module Replacement. Did you complete the replacement?	—	Go to Step 37	—
37	1. Operate the vessel within the conditions under which the original symptom was noted. Does the system now operate properly?	—	System OK	Go to Step 1

22734B

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temperature Indicated



Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to the sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table. At normal operating temperature (85°C - 95°C or 185°F - 203°F), the voltage will measure about 1.5-2.0 volts.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- If DTC 33 is also set, check for open ground on J2-3.

After repairs, clear DTC’s following “Clear DTC’s Procedure”. Failure to do so may result in DTC’s not properly being cleared.

Test Description

2. DTC 14 will set if signal voltage indicates a coolant temperature below -30°C (-22°F).
3. This test simulates a DTC 15. If the ECM recognizes the low voltage signal and displays a high temperature, the ECM and wiring are OK.

Engine Coolant Temperature (ECT) Sensor table

C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 14 - Engine Coolant Temperature (ECT) Sensor Circuit - Low Temperature Indicated

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, leave engine OFF. Does the scan tool display a coolant temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect the ECT sensor harness connector. 3. Connect a jumper wire from harness terminal "A" to harness terminal "B". 4. Turn ignition ON, leaving engine OFF. Does scan tool display a coolant temperature above the specified value?	130°C (266°F)	Go to Step 6	Go to Step 5
4	DIC 14 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair open in 5 volt reference circuit J2-7 to terminal "B" ECT harness connector or ground circuit J2-3 to terminal "A" ECT harness connector. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22725

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated

Circuit Description

The Engine Coolant Temperature (ECT) sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts from J2-7 to pin B on the ECT sensor. When the engine coolant is cold, the sensor (thermistor) resistance is high. As the engine coolant warms up, the sensor resistance becomes less. See engine coolant temperature sensor table. At normal operating temperature (70°C - 73°C or 157°F - 163°F), the voltage will measure about 1.36 volts.

Diagnostic Aids

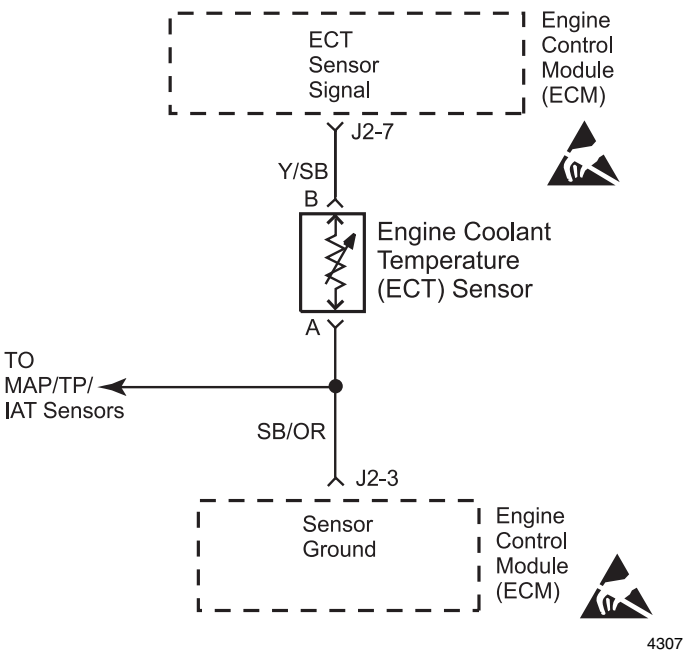
Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the ECT display on the scan tool while moving connectors and wiring harnesses related to the ECT sensor. A change in the ECT display will indicate the location of the fault.
- The scan tool displays engine coolant temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display a ECT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” coolant sensor. After engine is started, the temperature should rise steadily and then stabilize at operating temperature when the thermostat opens.
- Check harness routing for a potential short to ground between J2-7 and ECT harness connector “B”.

After repairs, clear DTC’s following “Clear DTC’s Procedure”. Failure to do so may result in DTC’s not properly being cleared.

Test Description

2. DTC 15 will set if signal voltage indicates a coolant temperature above 130°C or 266°F.
3. This test simulates a DTC 14. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.



Engine Coolant Temperature (ECT) Sensor table

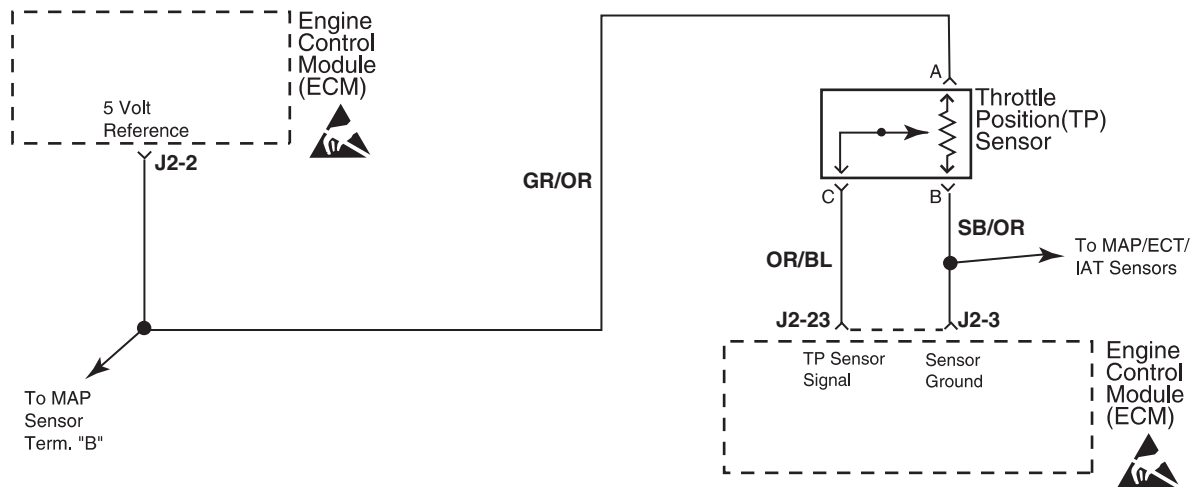
C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 15 - Engine Coolant Temperature (ECT) Sensor Circuit - High Temp Indicated

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, engine OFF. Does the scan tool display a coolant temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect ECT sensor harness connector. 3. Turn ignition ON, engine OFF. Does scan tool display a coolant temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 15 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair short to ground between J2-7 and pin "B" ECT harness connector. Was a problem found?	—	Verify Repair	Go to Step 7
6	Repair faulty ECT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22726

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High



4308

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor from pin J2-2 to TP sensor connector terminal A. Terminal B to pin J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, to pin J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to

the TP sensor. A change in the TP sensor display will indicate the location of the fault.

- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition "ON", engine "OFF", throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

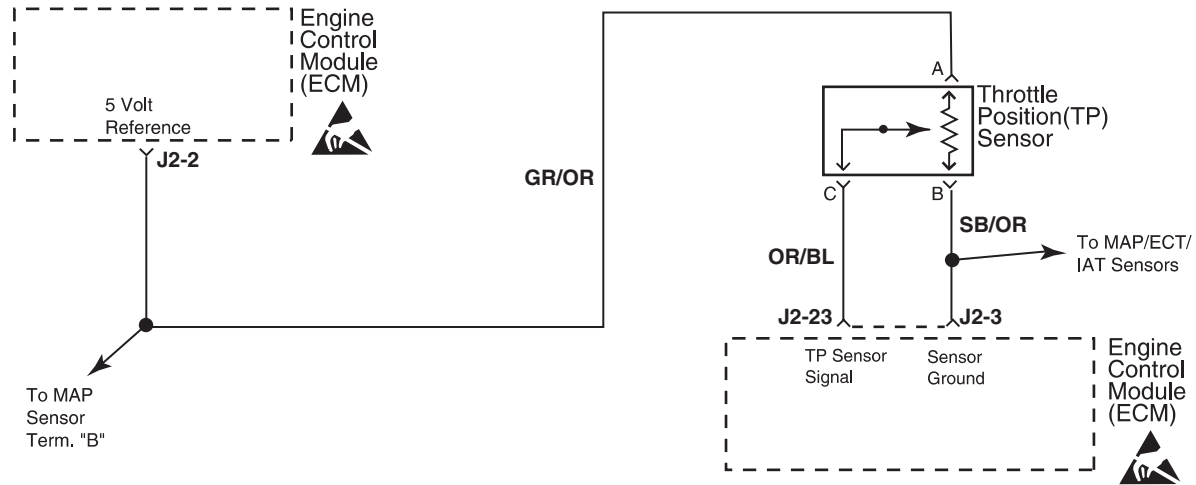
2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 22. If the ECM recognizes the low voltage signal, the ECM and wiring are OK.
4. Using DVOM from harness terminal "A" harness terminal "B" checks the sensor ground circuit. A faulty sensor ground will cause a DTC 21.

DTC 21 - Throttle Position (TP) Sensor Circuit - Signal Voltage High

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, engine OFF. Does scan tool indicate TP sensor voltage greater than specified value?	4 volts	Go to Step 3	Go to Step 5
3	1. Turn ignition OFF. 2. Disconnect TP sensor harness connector. 3. Turn ignition ON, engine OFF. Does the Digital Volt-Ohm Meter indicate a voltage less than the specified value?	.36 volt	Go to Step 4	Go to Step 6
4	Connect Digital Volt-Ohm Meter from harness terminal "A" to harness connector terminal "B". Does Digital Volt-Ohm Meter indicate a voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 7
5	DTC 21 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
6	Locate and repair short to voltage in circuit between J2-23 and terminal "C" TP harness connector. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
7	Locate and repair open in ground circuit between J2-3 and terminal "B" TP harness connector. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	—	Verify Repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22727

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low



4308

Circuit Description

The Throttle Position (TP) sensor is a potentiometer that provides a voltage signal that changes relative to the throttle blade. Signal voltage should vary from about .7 volt at idle to about 4.8 volts at Wide Open Throttle (WOT).

The TP sensor signal is one of the most important inputs used by the ECM for fuel control and for IAC control.

The ECM supplies a 5 volt signal to the sensor through J2-2 to Pin A on the TP sensor. Pin B to J2-3 is the TP sensor ground circuit. The TP sensor will send a voltage signal back to the ECM, from Pin C to J2-23, according to where the throttle blades are positioned.

Diagnostic Aids

Check for the following conditions:

- **Poor connection at ECM.** Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- **Damaged harness.** Inspect the wiring harness for damage. If the harness appears to be OK, observe the TP sensor display on the scan tool while moving connectors and wiring harnesses related to the TP sensor. A change in the TP sensor display will indicate the location of the fault.

- The scan tool reads throttle position in voltage and percentage relative to the throttle blade opening. With ignition "ON", engine "OFF", throttle blades closed (idle), the voltage should be 0.3-0.9 volts. The voltage should steadily increase as the throttle is moved toward Wide Open Throttle (WOT).
- If DTC 34 is also set, check for a short to ground in the 5 volt reference circuit.
- If a TP sensor circuit failure is present, the MAP sensor default value will be used along with the TP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

2. With the throttle closed, the TP sensor voltage should read 0.3-0.9 volt. If it does not, check the throttle cable adjustment or for bent or binding linkage.
3. This test simulates a DTC 21. If the ECM recognizes the high signal voltage, the ECM and wiring are OK.
4. This test checks for the 5 volt reference.

DTC 22 - Throttle Position (TP) Sensor Circuit - Signal Voltage Low

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Turn ignition ON, engine OFF. Does scan tool indicate TP sensor voltage less than the specified value?	.36 volts	Go to Step 3	Go to Step 5
3	1. Turn ignition OFF. 2. Disconnect TP sensor harness connector. 3. Connect a jumper wire between harness terminal "A" and harness terminal "C". 4. Turn ignition ON, engine OFF. Does the scan tool indicate TP sensor voltage greater than the specified value?	4 volts	Go to Step 8	Go to Step 4
4	1. Turn ignition OFF. 2. Connect Digital Volt-Ohm Meter from harness terminal "A" to a known good engine ground. 3. Turn ignition ON, engine OFF. Does DVOM indicate a voltage greater than the specified value?	4 volts	Go to Step 7	Go to Step 6
5	DTC 22 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	—	—
6	Locate and repair open or short to ground in circuit between J2-2 and harness connector "A". Also check the circuit to the MAP sensor for a short to ground. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
7	Locate and repair open or short to ground in TP sensor signal circuit between J2-23 and harness connector "C". If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 9
8	Replace faulty TP sensor. Is action complete?	—	Verify Repair	—
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

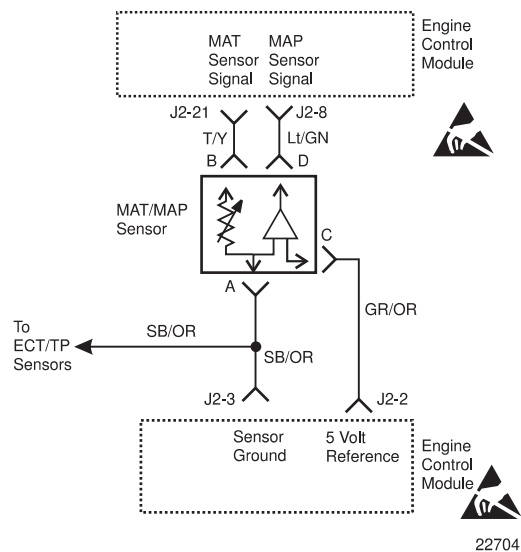
22728

DTC 23 - manifold Air Temperature (MAT) Sensor Circuit - Low Temp Indicated

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Turn ignition ON, engine OFF. Does the scan tool display an intake air temperature less than the specified value?	-30°C (-22°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect MAT sensor harness connector. 3. Connect a jumper wire between the MAT harness connector terminals "A" and "B". 4. Turn ignition ON, engine OFF. Does the scan tool display a coolant temperature above the specified value	130°C (266°F)	Go to Step 6	Go to Step 5
4	DTC 23 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair open in the MAT sensor signal circuit (J2-21 to MAT harness terminal "A") or the MAT sensor ground circuit (J2-3 to MAT harness terminal "B"). Was a problem found and corrected?	—	Verify Repair	Go to Step 7
6	Repair faulty MAT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22729

DTC 25 - Manifold Air Temperature (MAT) Sensor Circuit - High Temp Indicated



Circuit Description

The Manifold Air Temperature (MAT)/Manifold Air Pressure (MAP) is a combined sensor. The MAT part of the sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts to the sensor. When the intake air temperature is cold, the sensor (thermistor) resistance is high. As the intake air temperature warms up, the sensor resistance becomes less. See *Manifold Air Temperature Sensor* table.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAT display on the scan tool while moving connectors and wiring harnesses related to the MAT sensor. A change in the MAT display will indicate the location of the fault.
- The scan tool displays manifold air temperature in degrees Celsius and Fahrenheit. If the engine is cold (not running within 8 hours), the scan tool should display an MAT sensor value within a few degrees of outside air temperature. This may help aid in diagnosing a “shifted” MAT sensor.
- Check harness routing for a potential short to ground in the MAT sensor signal circuit (J2-21 to MAT harness connector terminal “A”).

After repairs, clear DTC’s following “Clear DTC’s Procedure”. Failure to do so may result in DTC’s not properly being cleared.

Test Description

2. DTC 25 will set if signal voltage indicates an intake air temperature above 130°C or 266°F.
3. This test simulates a DTC 23. If the ECM recognizes the high voltage signal and displays a low temperature, the ECM and wiring are OK.

Manifold Air Temperature Sensor Table

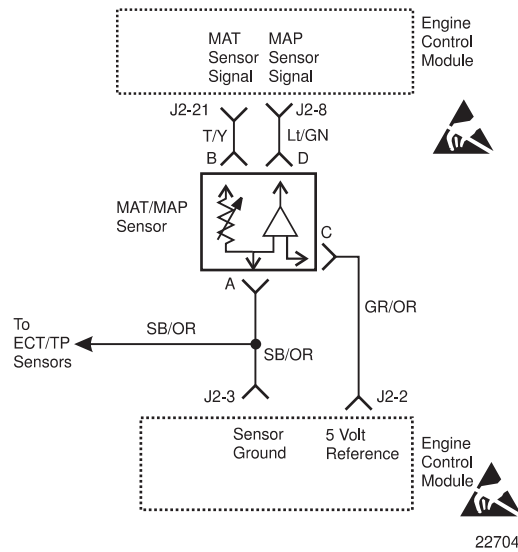
C°	F°	Ohms
Temperature vs. Resistance Values (Approx)		
100	212	177
90	194	241
80	176	332
70	158	467
60	140	667
50	122	973
45	113	1188
40	104	1459
35	95	1802
30	86	2238
25	77	2796
20	68	3520
15	59	4450
10	50	5670
5	41	7280
0	32	9420
-5	23	12300
-10	14	16180
-15	5	21450
-20	-4	28680
-30	-22	52700
-40	-40	100700

DTC 25 - Manifold Air Temperature (MAT) Sensor Circuit - High Temp Indicated

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Ignition ON, engine OFF. Does scan tool display intake air temperature greater than the specified value?	130°C (266°F)	Go to Step 3	Go to Step 4
3	1. Turn ignition OFF. 2. Disconnect MAT sensor harness connector. 3. Turn ignition ON, engine OFF. Does scan tool display an intake air temperature below the specified value?	-30°C (-22°F)	Go to Step 6	Go to Step 5
4	DTC 25 is intermittent. Locate and repair faulty connections. Refer to Diagnostic Aids.	—	Verify Repair	—
5	Locate and repair short to ground in the MAT sensor signal circuit (J2-21 to MAT harness connector terminal "A"). Was a problem found and corrected?	—	Verify Repair	—
6	Repair faulty MAT sensor. Is action complete?	—	Verify Repair	—
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22730

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High



Circuit Description

The Manifold Absolute Pressure (MAP)/ Manifold Air Temperature (MAT) sensor is a combined sensor. The MAP part of the sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as signal voltage that will vary from about 1.0-1.5 volts at idle to about 4.0-4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value that will vary with RPM.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through pin J2-2 and terminal "2" of the MAP sensor harness connector. Terminal "1" in the is the ground circuit for the MAP sensor and connects to pin J2-3 of the ECM. The MAP signal terminal "4" sends a voltage signal back to the ECM according to what the manifold pressure is.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the MAP sensor display on the scan tool while moving connectors and wiring harnesses related to the MAP sensor. A change in the MAP sensor display will indicate the location of the fault.
- If the idle is rough or unstable, refer to *Symptoms* Section for items which may cause an unstable

idle.

- With the ignition "ON", engine "OFF", the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of altitude and is referred to as BARO. Comparison of this BARO reading, with a known good MAP sensor, is a good way to check the accuracy of a "suspect" sensor. Reading should be the same, plus or minus 0.4 volt.
- If DTC 14 is also set, check for open in ground in the sensor ground circuit (J2-3 to MAP harness connector terminal "B").
- If a MAP sensor circuit failure is present, the TP sensor default value will be used along with the MAP sensor default value.

After repairs, clear DTC's following "Clear DTC's Procedure". Failure to do so may result in DTC's not properly being cleared.

Test Description

2. This step will determine if there is an adequate vacuum supply to the MAP sensor. If the vacuum gauge reading is erratic, refer to the "Rough or Unstable Idle" symptom.
4. This step simulates a DTC 34. If the ECM recognizes the low signal voltage and sets a DTC 34, the ECM and wiring are OK.
5. This step checks for an open in ground in the sensor ground circuit.

DTC 33 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage High

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Install a vacuum gauge to a manifold vacuum source. 2. Start engine and raise to 1000 r/m in neutral. 3. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified	35.56 cm Hg 45.5 kPa (14 in. Hg)	Go to Step 3	Go to Step 6
3	1. Install a scan tool. 2. Start the engine and allow engine to idle. Does the scan tool indicate MAP sensor voltage greater than the specified value?	4 volts	Go to Step 4	Go to Step 7
4	1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. Does scan tool indicate MAP sensor voltage greater than the specified value?	1 volt	Go to Step 5	Go to Step 8
5	1. Turn the ignition OFF. 2. Connect Digital Multi-Meter (DMM) between MAP sensor harness terminal "A" and "C". 3. Turn ignition ON, engine OFF. Does the DMM indicate a voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 9
6	Repair low or unsteady vacuum problem. Is action complete?	—	Verify Repair	—
7	DTC 33 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	—	—
8	Locate and repair short to voltage in MAP sensor signal circuit (J2-8 to MAP harness connector terminal "B"). Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	Locate and repair open in MAP sensor ground circuit (J2-3 to MAP harness connector terminal "A"). Was a problem found and corrected?	—	Verify Repair	Go to Step 11
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

22731

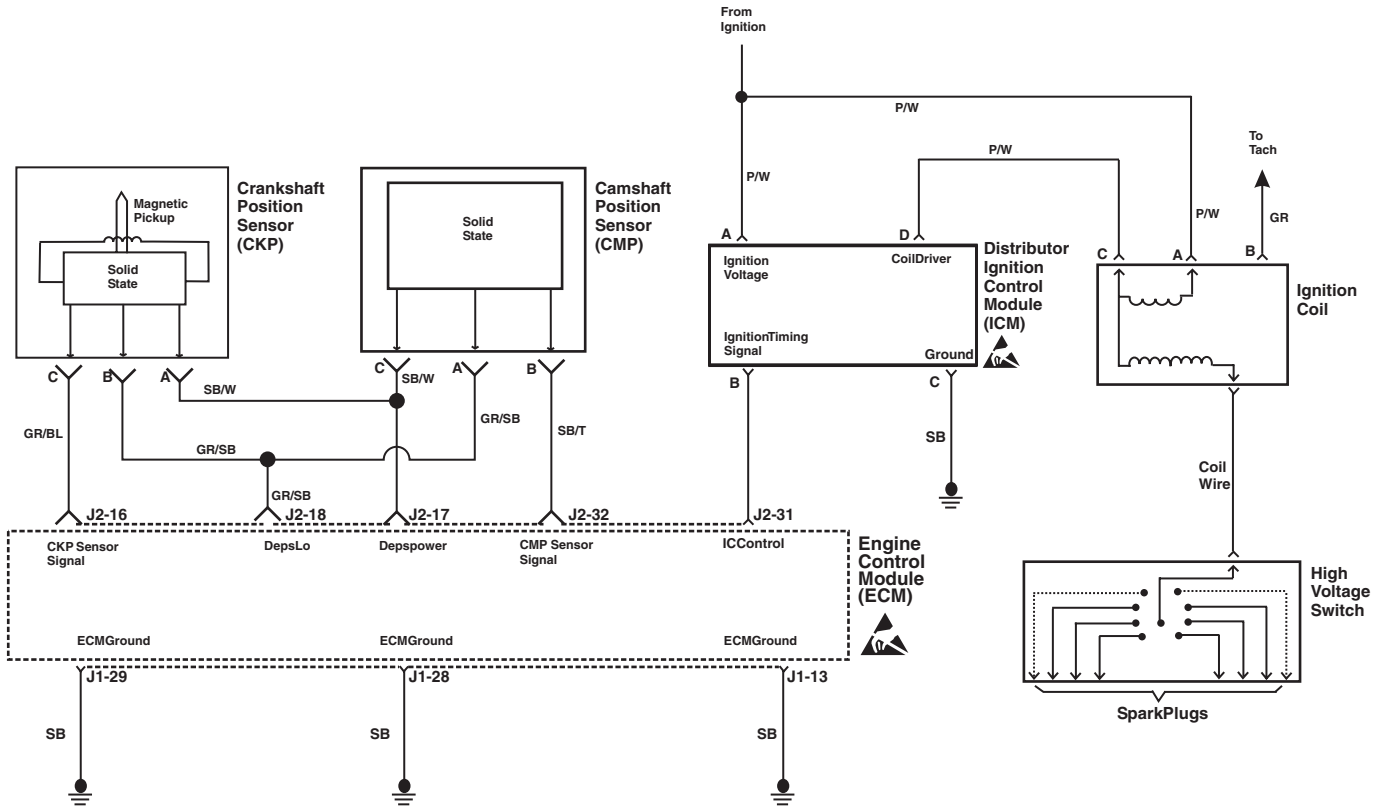
DTC 34 - Manifold Absolute Pressure (MAP) Sensor Circuit - Signal Voltage Low

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Turn ignition OFF. 2. Install vacuum gauge to a manifold vacuum source. 3. Start engine and raise to 1000 r/m in neutral. 4. The vacuum reading should be steady. Is the vacuum gauge reading steady and above the specified value?	35.5 cm Hg 45.5 kPa (14 in. Hg)	Go to Step 3	Go to Step 6
3	1. Install a scan tool. 2. Start the engine and allow to engine to Idle. Does scan tool indicate map sensor voltage less than the specified value?	1 volt	Go to Step 4	Go to Step 7
4	1. Turn the ignition OFF. 2. Disconnect MAP sensor harness connector. 3. Connect a jumper wire between MAP sensor harness connector terminals "B" and "C". 4. Turn ignition ON, engine OFF. Does the scan tool indicate MAP sensor voltage greater than the specified value?	4 volts	Go to Step 10	Go to Step 5
5	1. Turn OFF ignition. 2. Connect a Digital Multi-Meter between MAP sensor harness connector terminal "C" and a known good engine ground. 3. Turn ignition ON, engine OFF. Does the Digital Multi-Meter indicate a voltage greater than the specified value?	4 volts	Go to Step 9	Go to Step 8
6	Repair low or unsteady vacuum problem. Is action complete?	—	Verify Repair	—
7	DTC 34 is intermittent. Locate and repair intermittent faulty connections. Refer to Diagnostic Aids.	—	—	—
8	Locate and repair open or short to ground in 5 volt reference circuit J2-2 to MAP harness connector terminal "C". Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	Locate and repair open or short to ground in MAP sensor signal circuit J2-8 to MAP harness connector terminal "B". Was a problem found and corrected?	—	Verify Repair	—
10	Check for plugged or leaking sensor vacuum fitting. If OK, replace faulty MAP sensor. Is action complete?	—	Verify Repair	—
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	—	Verify Repair	—

DTC 41 - Enhanced Ignition system

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Clear the DTCs 2. Disconnect the injector harness connector. 3. Crank the engine for 15 seconds. Does DTC 41 set?	—	Go to Step 3	Go to Intermittent Conditions
3	1. Turn OFF the ignition. 2. Reconnect the injector harness connector. 3. Disconnect the ICM harness connector. 4. Probe the IC timing control circuit (PIN B) and a known good ground with a DMM set to the AC scale. 5. Crank the engine. 6. Observe the voltage. Does the voltage measure within the specified value?	1-4	Go to Step 4	Go to Step 6
4	1. Turn OFF the ignition. 2. Probe the IC ground circuit (PIN C) at the ICM connector with a test lamp connected to B+. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 11
5	1. Turn ON the ignition, with the engine OFF. 2. Probe the ignition voltage circuit (PIN A) at the ICM harness connector with a test lamp connected to ground. Does the test lamp illuminate?	—	Go to Step 9	Go to Step 14
6	1. Turn OFF the ignition. 2. Disconnect the ECM connector J2. 3. Probe the IC timing control circuit (PIN 31) at the ECM connector with a test lamp connected to B+ Does the test lamp illuminate?	—	Go to Step 12	Go to Step 7
7	1. Turn OFF the ignition. 2. Test for an open in the IC timing control circuit between the ECM and the ICM harness connector. Did you find and correct the condition?	—	Go to Step 17	Go to Step 8
8	1. Reconnect the ECM connector. 2. Turn ON the ignition, with the engine OFF. 3. Probe the IC timing control circuit (PIN B) at the ICM harness connector with a DMM set to the DC scale and connected to ground. Does the voltage measure more than the specified value?	1.0	Go to Step 12	Go to Step 10
9	1. Inspect for poor connections at the harness connector of the ICM. 2. Refer to Testing for Poor Connections. Did you find and correct the condition?	—	Go to Step 17	Go to Step 15
10	1. Inspect for poor connections at the harness connector of the ECM. 2. Refer to Testing for Poor Connections. Did you find and correct the condition?	—	Go to Step 17	Go to Step 16

DTC 41 - Enhanced Ignition System cont.



22710

Circuit Description

The enhanced ignition system uses the crankshaft position (CKP) sensor in order to provide a timing input to the control module. Ignition control (IC) spark timing for each cylinder is based on this input. The engine control module provides the ignition timing signal to the ignition control module (ICM) to control the ignition coil. Each timing pulse detected by the ICM allows the ICM 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. This diagnostic trouble code (DTC) will set if the Engine control module (ECM) detects an unusually high or low voltage on the ignition timing signal circuit.

Test Description

Number(s) below refer to the step number(s) on the diagnostic table:

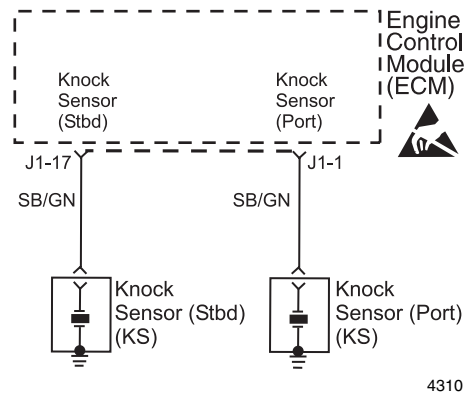
2. This step determines if the DTC is an intermittent.
3. This step checks if the IC timing signal from the PCM is available at the ignition control module.

DTC 41 - Enhanced Ignition System cont.

Step	Action	Value	Yes	No
11	1. Repair the open in the IC ground circuit. 2. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 17	—
12	1. Repair the short to ground in the IC timing control circuit. 2. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?		Go to Step 17	—
13	1. Repair the short to voltage in the IC timing control circuit. 2. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 17	—
14	1. Repair the open in the ignition voltage circuit. 2. Refer to Wiring Repairs in Wiring Systems. Did you complete the repair?	—	Go to Step 17	—
15	1. Replace the ICM. 2. Refer to ICM replacement. Did you complete the replacement?	—	Go to Step 17	—
16	1. Replace the ECM. 2. Refer to ECM replacement. Did you complete the replacement?	—	Go to Step 17	—
17	1. Use the scan tool in order to clear the DTCs. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. Idle the engine at the normal operating temperature.	—	Go to Step 18	—
18	1. Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to the applicable DTC table	System OK

22733A

DTC 44 - Knock Sensor (KS) 1 Circuit



NOTE! Some models may have only one knock sensor. Use knock sensor #1 for these models.

Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Proce-

dure". Failure to do so may result in DTC's not properly being cleared.

If the knock sensor wires are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

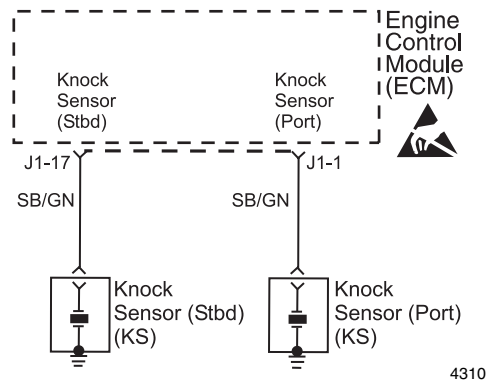
4. This step ensures the knock sensor is secured properly in the engine block.
5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) 1 Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the spark plug wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Check knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 parameter. 4. Disconnect "J1" harness from the ECM. 5. Connect a Digital Multi-Meter from "J1-17" (knock signal 1) to a known good engine ground near the knock sensor. Is the resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found and repaired?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor (s). Is the action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is the action complete?	—	Verify Repair	—

22743

DTC 44 - Knock Sensor (KS) 2 Circuit



NOTE! Some early models may have only one knock sensor. Use knock sensor #1 for these models.

Circuit Description

The ECM uses the Knock Sensor(s) in order to detect engine detonation. This detection allows the ECM to retard spark timing based on the KS signal coming into the ECM. DTC 44 will set only if the ECM does not see any activity on the KS signal circuit(s).

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
- Damaged harness. Inspect the wiring harness for damage.
- Loose Knock Sensor(s) in engine block.
- Poor connection at the Knock Sensor(s).

After repairs, clear DTC's following "Clear DTC's Proce-

dure". Failure to do so may result in DTC's not properly being cleared.

If the knock sensor wires are routed too close to secondary ignition wires, the ECM may see the interference as a knock signal, resulting in false timing retard.

Test Description

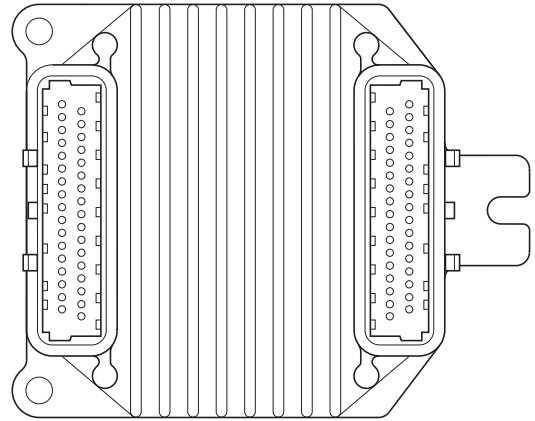
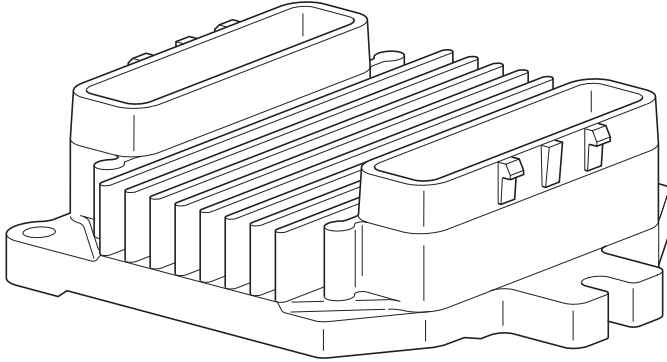
4. This step ensures the knock sensor is secured properly in the engine block.
5. Checks to see that the knock sensor circuit is within specifications.

DTC 44 - Knock Sensor (KS) 2 Circuit

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	Important! If you can hear the engine knock, repair the engine mechanical problem before proceeding with this diagnostic table. Check the KS signal circuits for incorrect routing near the spark plug wires. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 3
3	Check the KS signal circuits for any terminals not being fully seated or for incorrect installation. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 4
4	Check knock sensors for being loose in the engine block. If a problem is found, repair as necessary. Was a problem found?	—	Verify Repair	Go to Step 5
5	1. Install scan tool. 2. Select the option to view the data list. 3. Select to view the knock signal 1 parameter. 4. Disconnect "J1" harness from the ECM. 5. Connect a Digital Multi-Meter from "J1-1" (knock signal 2) to a known good engine ground near the knock sensor. Is the resistance between the specified value?	93-107K ohms	Go to Step 8	Go to Step 6
6	Locate and repair open or short to ground in the circuit that were out of range. If a problem is found, repair as necessary. Was a problem found and repaired?	—	Verify Repair	Go to Step 7
7	Inspect knock sensor terminal contacts. If OK, replace faulty knock sensor (s). Is the action complete?	—	Verify Repair	—
8	Replace faulty ECM connections or replace faulty ECM. Is the action complete?	—	Verify Repair	—

22744

DTC 51 - Calibration Checksum Failure



3004

Circuit Description

This test allows the ECM to check for a calibration failure by comparing the calibration value to a known value stored in the EEPROM.

This test is also used as a security measure to prevent improper use of calibration or changes to these calibrations that may alter the designed function of MEFI.

Diagnostic Aids

If DTC 51 failed more than once, but is intermittent, replace the ECM.

Test Description

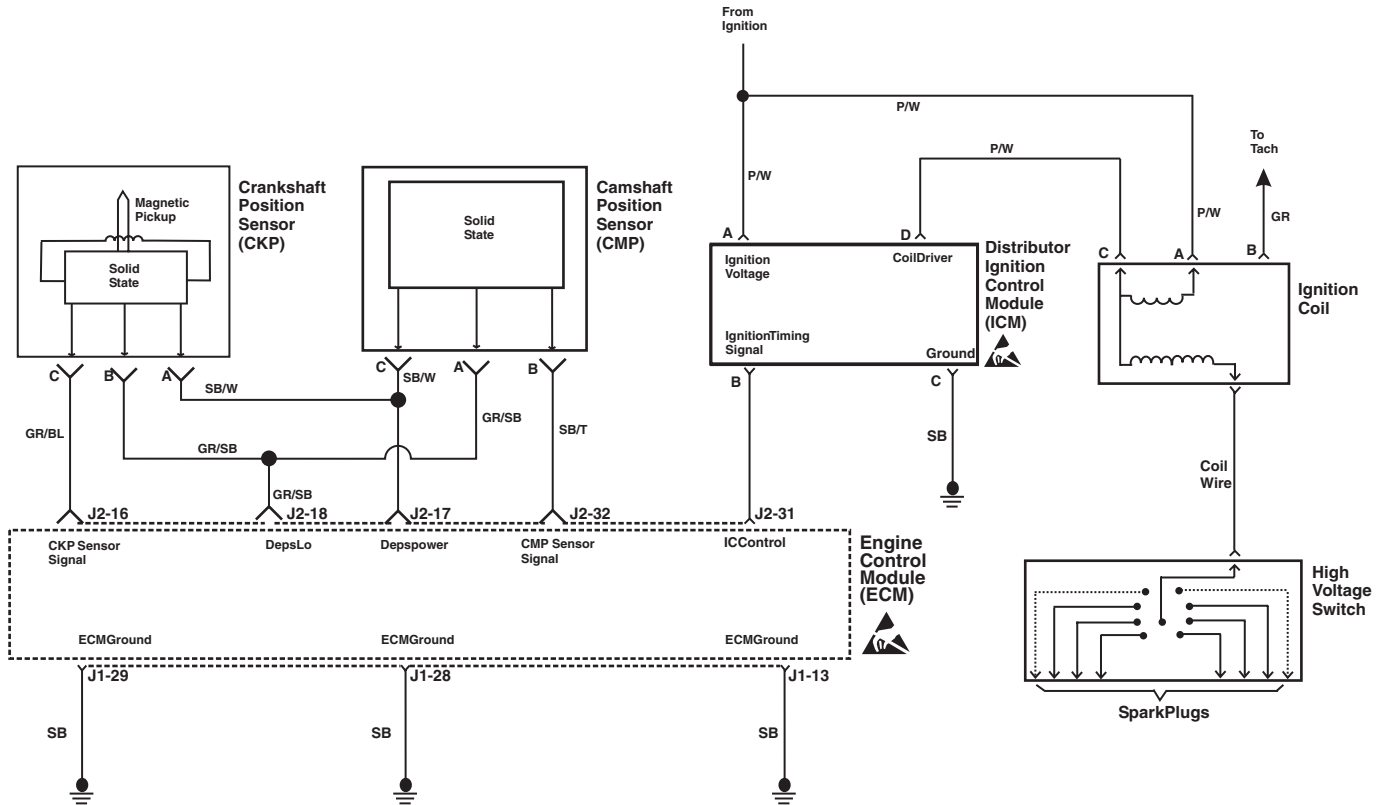
2. This step checks to see if the fault is present during diagnosis. If present, the ECM is not functioning properly and must be replaced or reprogrammed.

DTC 51 - Calibration Checksum Failure

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Install scan tool. 2. Ignition ON, engine OFF 3. Clear DTC 51. 4. Switch to Diagnostic Trouble Codes (DTC). Does DTC 51 reset?	—	Go to Step 3	Refer to Diagnostic Aids
3	Replace or reprogram faulty ECM and verify DTC does not reset. Is action complete?	—	Verify Repair	—

22745

DTC 81 - Crankshaft Position Sensor (CKP)



22710

Circuit Description

The crankshaft position (CKP) sensor signal indicates the crankshaft speed and position. The CKP sensor is connected directly to the engine control module (ECM), and consists of the following circuits:

The Digital Electronic Position Sensor Power (Depspower) circuit

The Digital Electronic Position Sensor Lo (Depslo) circuit

The Reference circuit

Conditions for Running the DTC

The camshaft position (CMP) sensor is transitioning.

Conditions for Setting the DTC

The PCM determines no signal from the CKP sensor for more than 30 seconds.

Diagnostic Aids

The following conditions may cause this DTC to set:

- Poor connection or poor terminal tension at the sensor
- Crankshaft reluctor wheel damage or improper installation
- Excessive air gap between the CKP sensor and the reluctor wheel.
- The engine running out of fuel
- Foreign material passing between the sensor and the reluctor wheel

Excess crankshaft end play causes the CKP sensor reluctor wheel to move out of alignment with the CKP sensor. This could result in any one of the following:

- A no start
- A start and stall
- Erratic performance

An intermittent condition.

Test Description

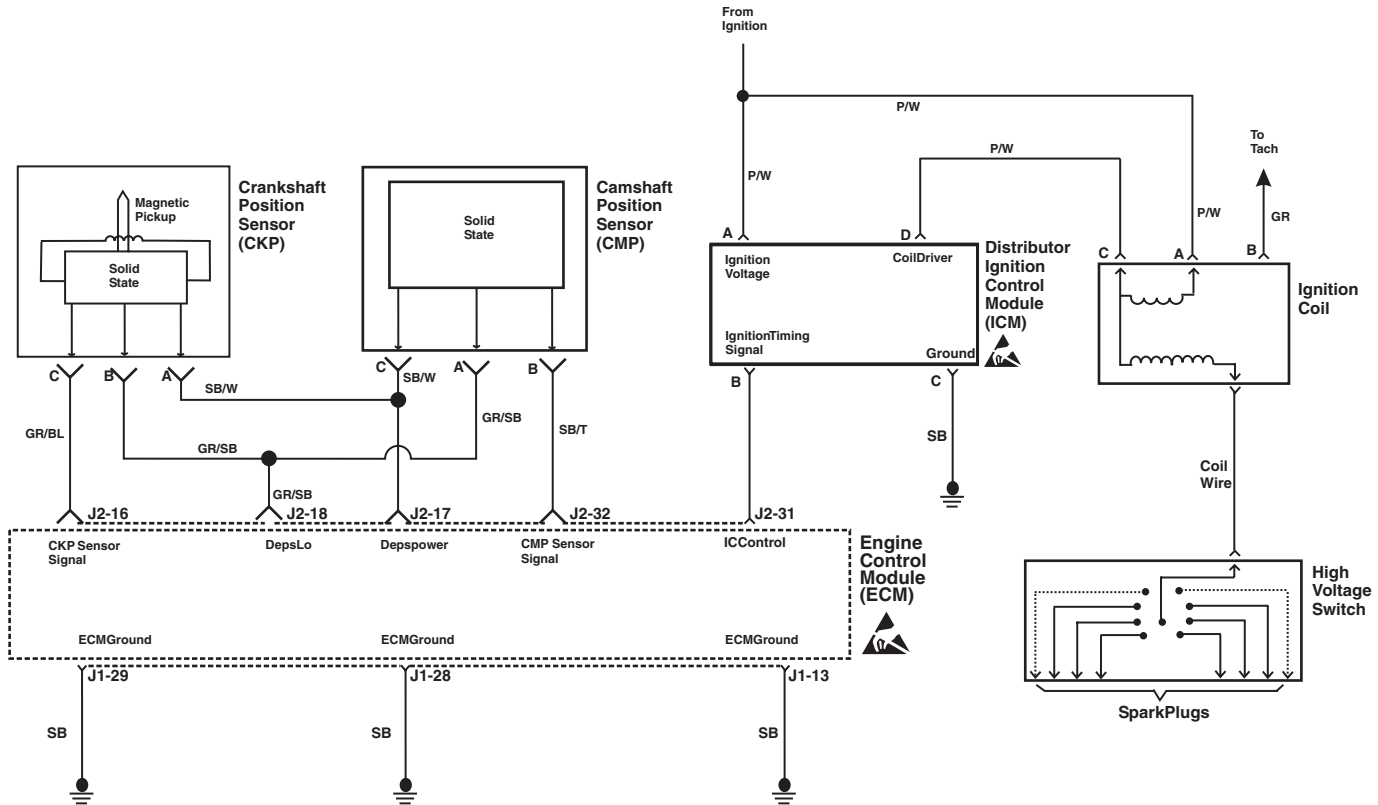
The numbers below refer to the step numbers on the diagnostic table.

3. This step determines if the fault is present.

DTC 81 - Crankshaft Position Sensor (CKP)

Step	Action	Value	Yes	No
1	Did you perform the Diagnostic System Check-Engine Controls?	—	Go to Step 2	Go to Diagnostic System Check-Engine Controls
2	Does the engine start and continue to run?	—	Go to Step 3	Go to Step 4
3	1. Start the engine. 2. Operate the vehicle within the Conditions for Running the DTC. Does the DTC fail this ignition?	—	Go to Step 4	Go to Diagnostic Aids
4	1. Important: An internally shorted CAM sensor can cause DTC 81 to set. Test this circuit for a short before proceeding with this diagnostic table. Turn ON the ignition, with the engine OFF. 2. Disconnect the CKP sensor harness connector. 3. Using the DMM, measure the voltage from the CKP sensor Depspower circuit and a good ground. Does the DMM display the specified value?	B+	Go to Step 5	Go to Step 7
5	1. Using the DMM, measure the voltage between the CKP sensor Depspower circuit and the CKP sensor Depslo circuit. Does the DMM display the specified value?	B+	Go to Step 6	Go to Step 8
6	1. Turn OFF the ignition. 2. Connect jumpers between the engine harness connector and the CKP sensor connector of the Depspower circuit and the Depslo circuit. 3. Connect a DMM set to the duty cycle position between the reference circuit of the CKP sensor and a good known ground. Select AC voltage and press the Hz button twice in order to display the duty cycle.	40-60%	Go to Step 9	Go to Step 10
7	1. Test for an open or short to ground in the CKP sensor Depspower circuit. 2. If you find an open or a short to ground, repair the circuit as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 16
8	1. Test for an open or a poor connection in the CKP sensor Depslo circuit. 2. If you find an open or poor connection, repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 14
9	1. Test the CKP sensor reference circuit for the following conditions: - An open - A short to ground or Depslo - A short to voltage or Depspower 2. Repair the circuit as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 11

DTC 81 - Crankshaft Position Sensor (CKP) cont.



22710

Circuit Description

The crankshaft position (CKP) sensor signal indicates the crankshaft speed and position. The CKP sensor is connected directly to the engine control module (ECM), and consists of the following circuits:

The Digital Electronic Position Sensor Power (Depspower) circuit

The Digital Electronic Position Sensor Lo (Depslo) circuit

The Reference circuit

Conditions for Running the DTC

The camshaft position (CMP) sensor is transitioning.

Conditions for Setting the DTC

The PCM determines no signal from the CKP sensor for more than 30 seconds.

Diagnostic Aids

The following conditions may cause this DTC to set:

- Poor connection or poor terminal tension at the sensor
- Crankshaft reluctor wheel damage or improper installation
- Excessive air gap between the CKP sensor and the reluctor wheel.
- The engine running out of fuel
- Foreign material passing between the sensor and the reluctor wheel

Excess crankshaft end play causes the CKP sensor reluctor wheel to move out of alignment with the CKP sensor. This could result in any one of the following:

- A no start
- A start and stall
- Erratic performance

An intermittent condition.

Test Description

The numbers below refer to the step numbers on the diagnostic table.

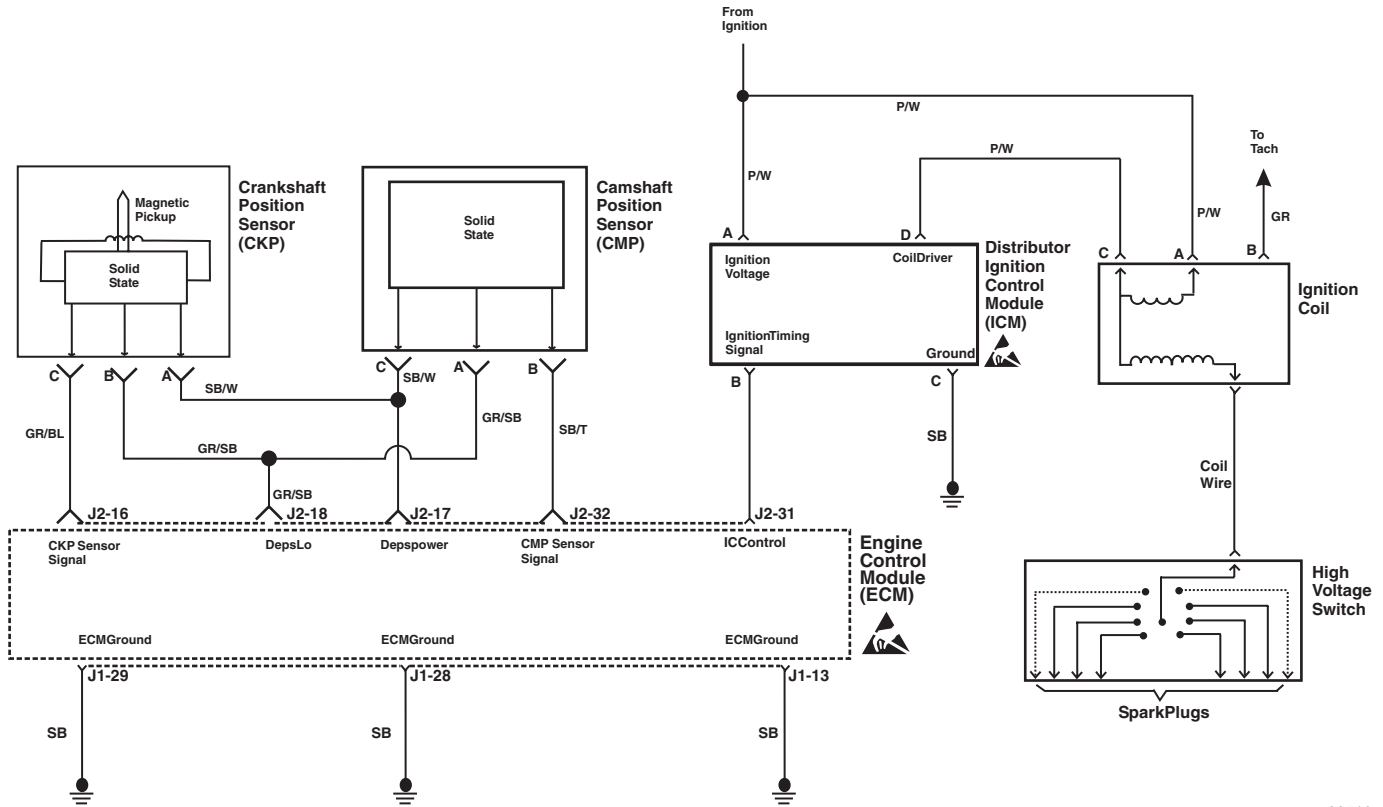
3. This step determines if the fault is present.

DTC 81 - Crankshaft Position Sensor (CKP) cont.

Step	Action	Value	Yes	No
10	1. Inspect for poor connections at the CKP sensor. 2. If you find a poor connection repair the condition as necessary. Did you find and correct the condition?	—	Go to Step 16	Go to Step 11
11	1. Remove the CKP sensor. 2. Visually inspect the CKP sensor for the following conditions: - Physical damage - Loose or improper installation - Wiring routed too closely to secondary ignition components 3. Repair the circuit as necessary. Did you find and correct the problem?	—	Go to Step 16	Go to Step 12
12	1. Inspect the CKP reluctor wheel for damage or looseness. 2. Refer to Diagnostic Aids in DTC 81. Did you find and correct the condition?	—	Go to Step 16	Go to Step 13
13	1. Replace the CKP sensor. Did you complete the repair?	—	Go to Step 16	—
14	1. Inspect for poor connections at the ECM. 2. If you find a poor connection, repair the condition as necessary. Did you complete the repair?	—	Go to Step 16	Go to Step 15
15	1. Replace the ECM. Did you complete the replacement?	—	Go to Step 16	—
16	1. Use the scan tool in order to clear the DTCs. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text. Does the DTC run and pass?	—	Go to Step 17	Go to Step 2
17	1. With a scan tool, observe the stored information. 2. Capture info. Does the scan tool display any DTC that you have not diagnosed?	—	Go to	System OK

22710A

DTC 81 - Camshaft Position Sensor (CMP)



22710

Circuit Description

The camshaft position (CMP) sensor is a sensor designed to detect changes in a magnetic field. The control module supplies the CMP sensor with the following:

- A Depspower
- A Depslo circuit
- A signal circuit

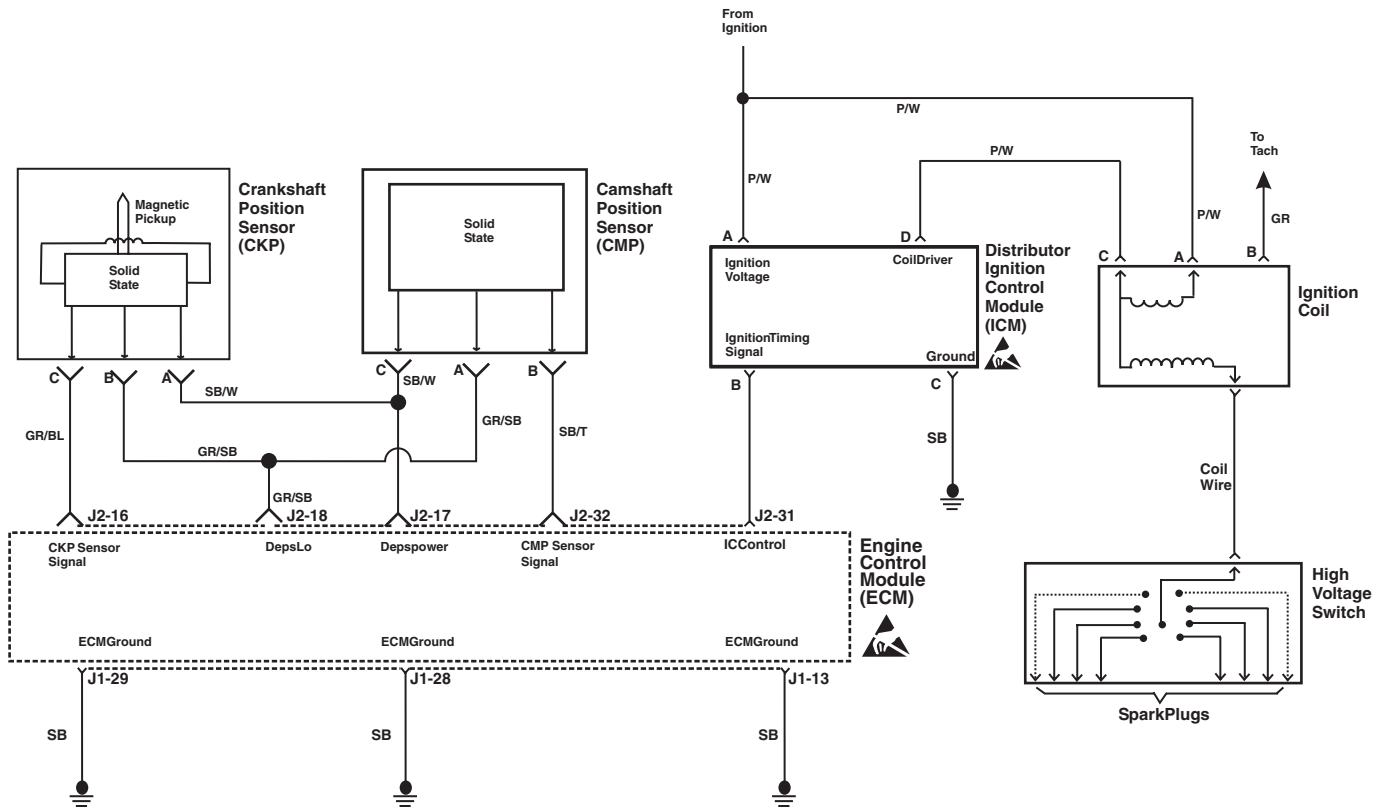
The CMP sensor produces a magnetic field whenever the ignition is ON. The CMP sensor is mounted near a reluctor wheel that is attached to the distributor shaft. When the distributor shaft rotates, or when the engine is cranking or running, the reluctor wheel changes the magnetic field. The CMP sensor converts each change

in the magnetic field into a PULSE. The number of teeth on the reluctor wheel determines how many pulses the CMP sensor detects per camshaft rotation. If the engine control module (ECM) does not detect the CMP signal while the engine is running, this diagnostic trouble code (DTC) will set.

DTC 81 - Camshaft Position Sensor (CMP)

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Turn OFF the ignition. 2. Disconnect the CMP sensor connector. 3. Turn ON the ignition, with the engine OFF. 4. Probe the Depspower circuit of the CMP sensor harness connector with a test lamp connected to ground. Does the test lamp illuminate?	—	Go to Step 4	Go to Step 3
3	1. Probe the Depspower circuit of the CMP sensor harness connector with a test lamp connected to battery voltage. Does the test lamp illuminate?	—	Go to Step 10	Go to Step 9
4	1. Probe the Depslo circuit of the CMP sensor harness connector with a test lamp connected to battery voltage. Does the test lamp illuminate?	—	Go to Step 5	Go to Step 11
5	1. Jumper the Depspower circuit from the CMP sensor to the CMP sensor harness connector using J 35616-A connector test adapter kit. 2. Jumper the Depslo circuit from the CMP sensor to the CMP sensor harness connector. 3. Set the DMM to the DC voltage scale and press the hertz button twice in order to locate the % scale. 4. Measure the Duty Cycle from the CMP sensor signal circuit of the CMP sensor to a good ground with a DMM. 5. Start the engine. Is the Duty Cycle within the specified value?	45-55%	Go to Step 6	Go to Step 15
6	1. Disconnect the ECM. 2. Measure the resistance of the CMP sensor signal circuit from the CMP sensor harness connector to the ECM harness connector with a DMM. Refer to <i>Circuit Testing</i> in Wiring Systems. Is the resistance above the specified value?	0-5 ohms	Go to Step 12	Go to Step 7
7	1. Connect the ECM connector. 2. Probe the signal circuit of the CMP sensor harness connector with a test lamp connected to battery voltage. Refer to <i>Probing Electrical Connectors</i> in Wiring Systems. Does the test lamp illuminate?	—	Go to Step 13	Go to Step 8
8	1. Probe the signal circuit of the CMP sensor harness connector with a test lamp connected to a good ground. Refer to <i>Probing Electrical Connectors</i> in Wiring Systems. Does the test lamp illuminate?	—	Go to Step 14	Go to Step 16
9	1. Test the Depspower circuit for an open or high resistance. Refer to <i>Circuit Testing and Wiring Repairs</i> in Wiring Systems. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
10	1. Test the Depspower circuit for a short ground. Refer to <i>Circuit Testing and Wiring Repairs</i> in Wiring Systems. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16

DTC 81 - Camshaft Position Sensor (CMP) cont.



22710

Circuit Description

The camshaft position (CMP) sensor is a sensor designed to detect changes in a magnetic field. The control module supplies the CMP sensor with the following:

- A Depspower
- A Depslo circuit
- A signal circuit

The CMP sensor produces a magnetic field whenever the ignition is ON. The CMP sensor is mounted near a reluctor wheel that is attached to the distributor shaft. When the distributor shaft rotates, or when the engine is cranking or running, the reluctor wheel changes the magnetic field. The CMP sensor converts each change

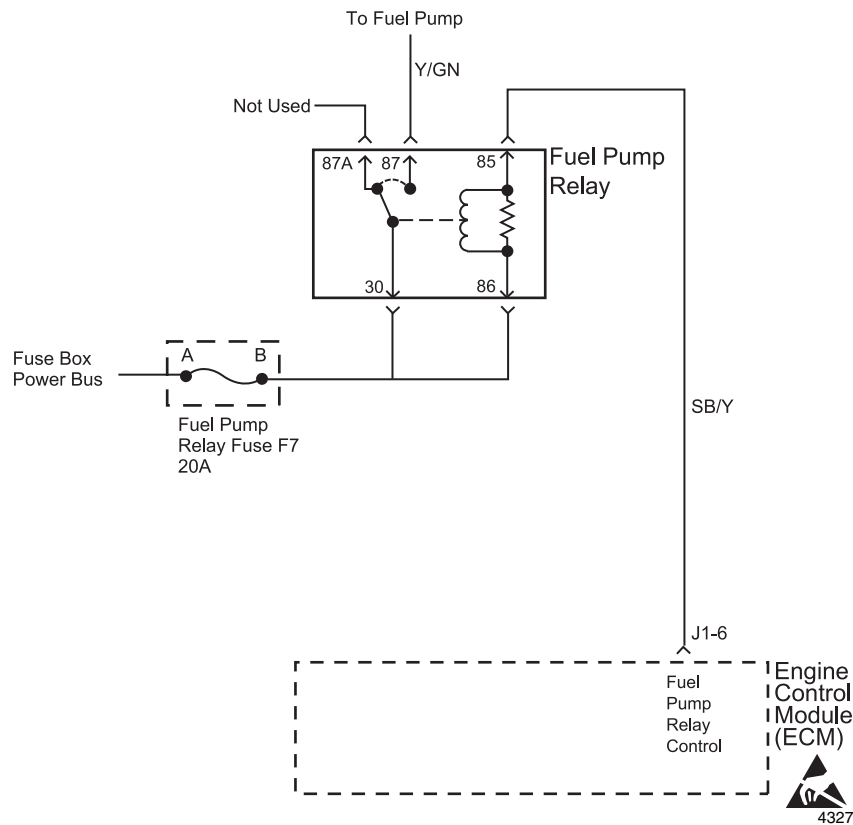
in the magnetic field into a PULSE. The number of teeth on the reluctor wheel determines how many pulses the CMP sensor detects per camshaft rotation. If the engine control module (ECM) does not detect the CMP signal while the engine is running, this diagnostic trouble code (DTC) will set.

DTC 81 - Camshaft Position Sensor (CMP) cont.

Step	Action	Value	Yes	No
11	1. Test the Depslo circuit for an open or high resistance. Refer to <i>Circuit Testing and Wiring Repairs</i> in Wiring Systems. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
12	1. Test the signal circuit for an open or high resistance. Refer to <i>Circuit Testing and Wiring Repairs</i> in Wiring Systems. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
13	1. Test the signal circuit for a short to ground. Refer to <i>Circuit Testing and Wiring Repairs</i> in Wiring Systems. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
14	1. Test the signal circuit for a short to voltage. Refer to <i>Circuit Testing and Wiring Repairs</i> in Wiring Systems. Did you find and correct the condition?	—	Go to Step 19	Go to Step 16
15	1. Test for an intermittent and for a poor connection at the CMP harness connector. If you find a poor connection, repair the connectors as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 17
16	1. Test for an intermittent and for a poor connection at the ECM harness connector. If you find a poor connection, repair the connectors as necessary. Did you find and correct the condition?	—	Go to Step 19	Go to Step 18
17	1. Replace the CMP sensor. Refer to CMP sensor Replacement. Did you complete the replacement?	—	Go to Step 19	Go to Step 8
18	1. Replace the ECM. Refer to ECM sensor Replacement. Did you complete the replacement?	—	Go to Step 19	Go to Step 16
19	1. Use the scan tool in order to clear the DTCs. 2. Turn OFF the ignition for 30 seconds. 3. Start the engine. 4. Operate the vehicle within the Conditions for Running the DTC. Does the DTC run and pass?	—	Go to Step 20	Go to Step 16
20	1. Select the Diagnostic Trouble Code (DTC) option. Does the scan tool display any DTCs that you have not diagnosed?	—	Go to DTC List	System OK

22735A

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open



Circuit Description

The Engine Control Module (ECM) controls the relay by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the controlled component. This driver has a fault line which the ECM monitors. When the ECM commands the relay ON, the voltage of the control circuit should be low, near 0 volts. When the ECM commands the relay OFF, the voltage should be high, near battery voltage. If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes causing a DTC to set.

The relay controls the high current flow to the fuel pumps. This allows the ECM driver to only have to control the relatively low current used by the relay.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

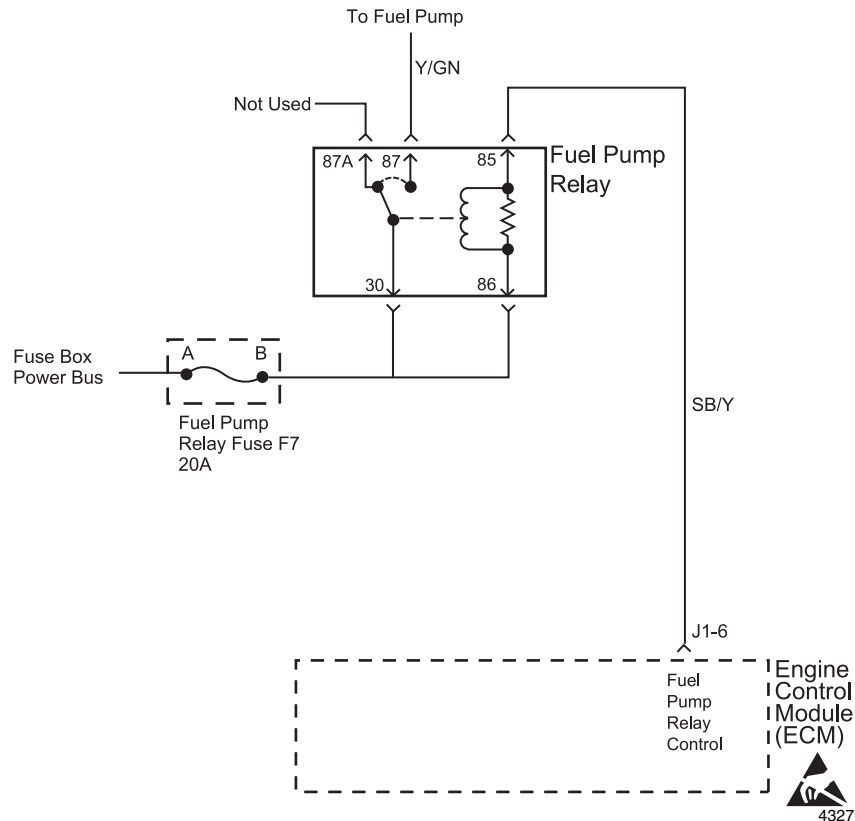
Test Description

2. Listen for an audible click when the relay operates. Command both the ON and OFF states. Repeat the commands if necessary.
3. This test can detect a partially shorted coil which would cause an excessive current flow. Leaving the circuit energized for 2 minutes allows the coil to warm up. When warm, the coil may open, and the current drops to 0, or the coil may short, and the current goes above 0.75 amp.
5. Identify and test the relay coil terminals in order to avoid improper diagnosis.
12. If no trouble is found in the control circuit or the connection at the ECM, the ECM may be faulty. However, this is an extremely unlikely failure.

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF. 2. Command the relay ON and OFF using the scan tool. Does the relay turn ON and OFF when commanded?	—	Go to Step 3	Go to Step 5
3	1. Ignition OFF 2. Disconnect the ECM J1 connector. 3. Install a 5 amp fused jumper wire from a known good engine ground to the control circuit at the ECM J1 connector pin J1-6. 4. Ignition ON, engine OFF. 5. Using a DMM on the 40 amp scale, measure the current from the relay control circuit in the ECM harness connector to ground for 2 minutes. Important! If the DMM goes to 0 during the current draw test, replace the relay. Does the current draw measure less than the specified value?	0.75A	Go to Diagnostic Aids	Go to Step 4
4	1. Ignition OFF. 2. Disconnect the fuel pump relay connector. 3. Using a DMM measure the resistance from the relay control circuit in the ECM harness connector to ground. Does the DMM display infinite resistance or OL?	—	Go to Step 12	Go to Step 10
5	1. Ignition OFF 2. Disconnect the fuel pump relay connector. 3. Connect a test lamp between the fuel pump relay control circuit(relay pin 85) and the fuel pump relay ignition feed circuit, on the coil side of the relay (relay pin 86), at the fuel pump relay socket in the fuse box. 4. Ignition ON, engine OFF. 5. Using a scan tool, command the relay ON and OFF. Does the test lamp turn ON and OFF when commanded?	—	Go to Step 8	Go to Step 6
6	Using a test lamp connected to a known good engine ground, probe the ignition feed circuit, on the coil side of the fuel pump relay harness connector. Is the test lamp illuminated?	—	Go to Step 7	Go to Step 11
7	1. Ignition OFF. 2. Reconnect the relay. 3. Disconnect the ECM connector J2 4. Ignition ON, engine OFF. 5. Using a fused jumper wire connected to a known good engine ground, momentarily probe the relay control circuit in the ECM harness connector. Does the relay turn ON when the circuit is grounded and OFF when the circuit is opened?	—	Go to Step 9	Go to Step 10

22751

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open cont.**Circuit Description**

The Engine Control Module (ECM) controls the relay by grounding the control circuit via an internal switch called a driver. The primary function of the driver is to supply the ground for the controlled component. This driver has a fault line which the ECM monitors. When the ECM commands the relay ON, the voltage of the control circuit should be low, near 0 volts. When the ECM commands the relay OFF, the voltage should be high, near battery voltage. If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes causing a DTC to set.

The relay controls the high current flow to the fuel pumps. This allows the ECM driver to only have to control the relatively low current used by the relay.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

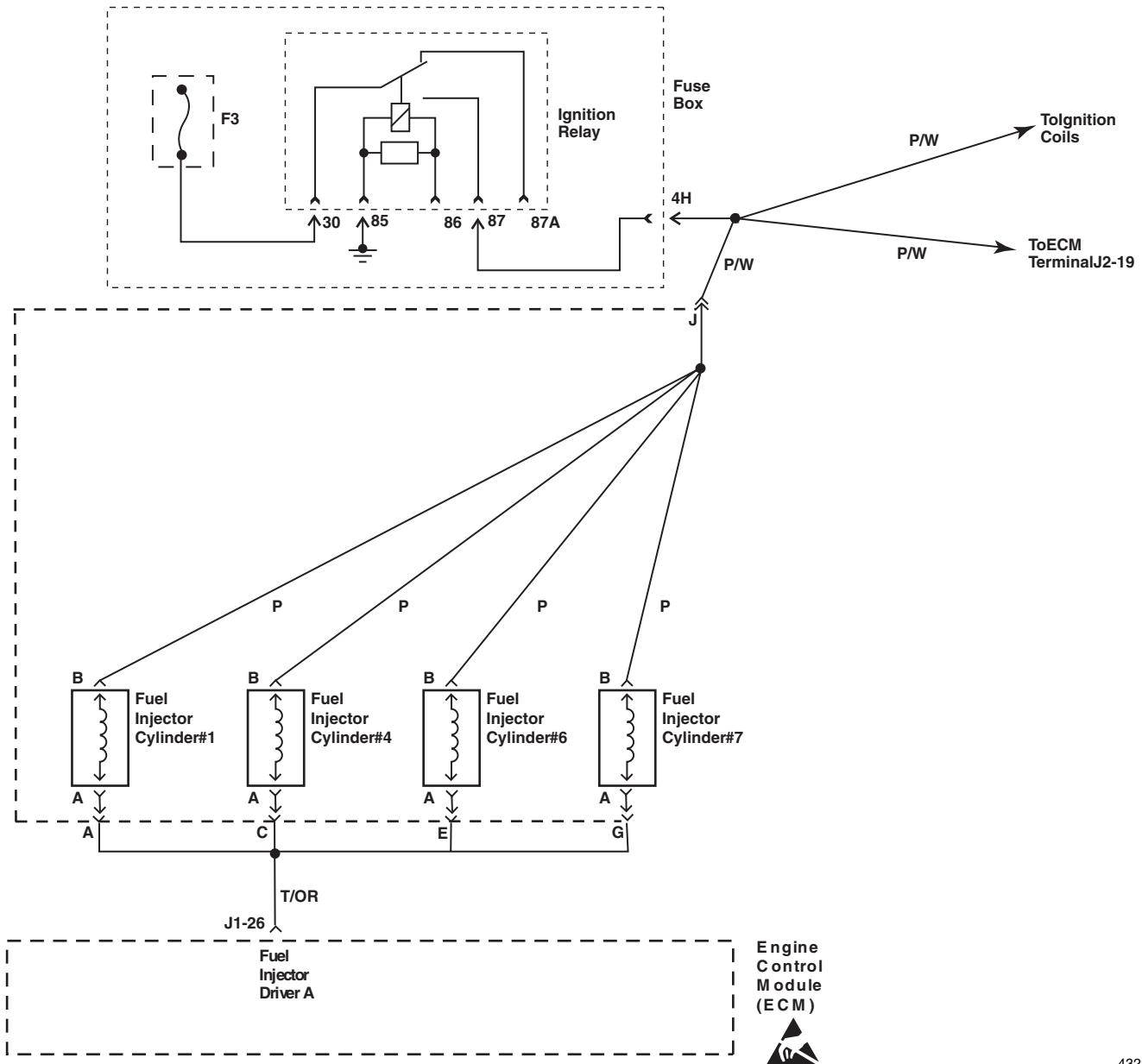
2. Listen for an audible click when the relay operates. Command both the ON and OFF states. Repeat the commands if necessary.
3. This test can detect a partially shorted coil which would cause an excessive current flow. Leaving the circuit energized for 2 minutes allows the coil to warm up. When warm, the coil may open, and the current drops to 0, or the coil may short, and the current goes above 0.75 amp.
5. Identify and test the relay coil terminals in order to avoid improper diagnosis.
12. If no trouble is found in the control circuit or the connection at the ECM, the ECM may be faulty. However, this is an extremely unlikely failure.

DTC 81 - Fuel Pump Relay Driver Circuit High, Low or Open cont.

Step	Action	Value	Yes	No
8	Locate and repair faulty connections at the relay. Was a problem found and repaired	—	Verify Repair	Go to Step 12
9	Locate and repair faulty connections at the ECM. Was a problem found and corrected?	—	Verify Repair	Go to Step 13
10	Repair the faulty connections at the ECM.	—	—	—
11	Repair the faulty ignition feed circuit.	—	—	—
12	Replace the faulty relay	—	—	—
13	Replace the ECM	—	—	—

22752

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open



4328A

Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)* or *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35*

Degrees C (50-95 Degrees F).

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

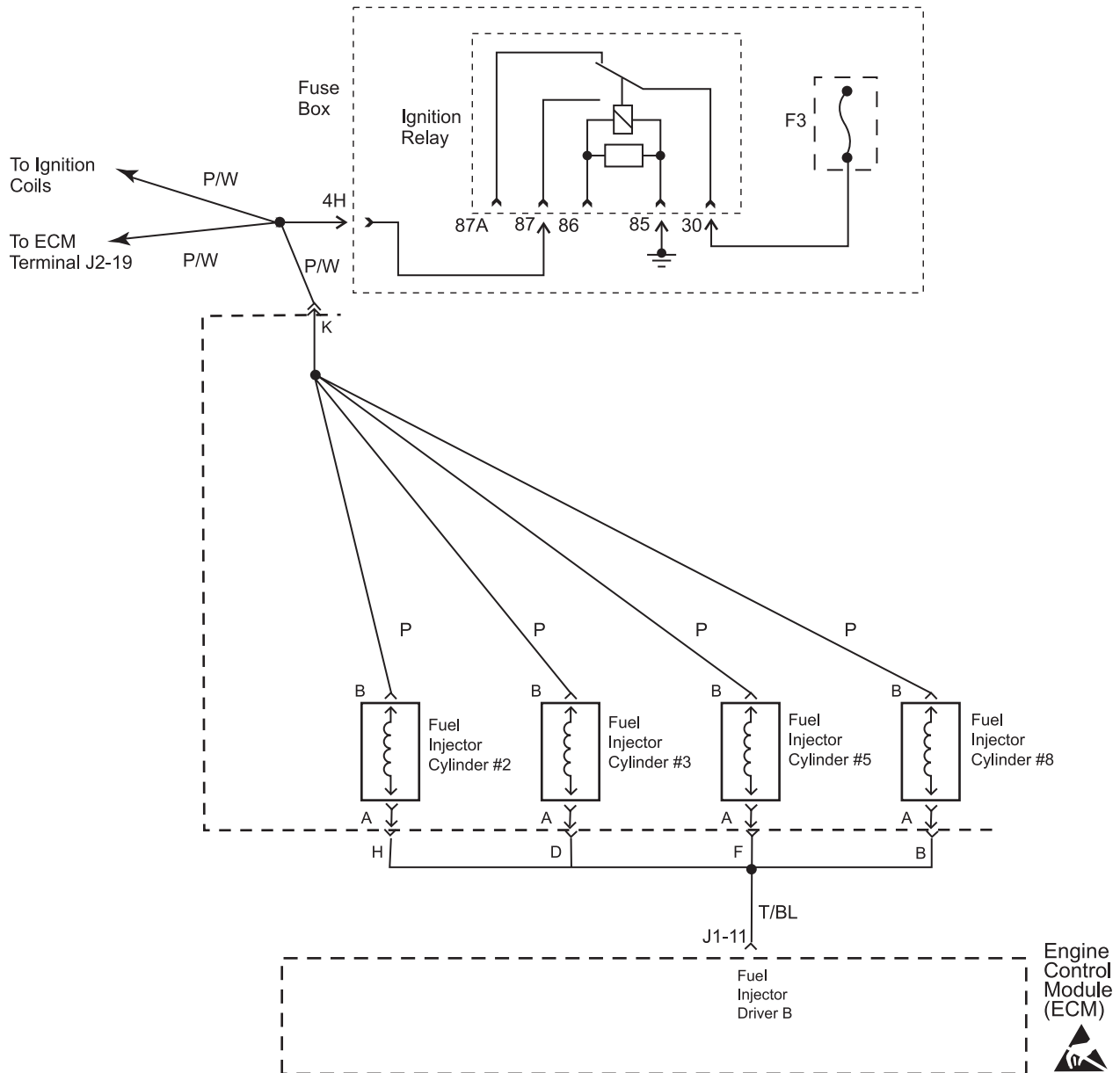
Test Description

- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply circuit is indicated. The ECM/INJ fuse also supplies voltage to the ignition coils. If the fuse is open, inspect the circuits to the ignition coils for a short to ground.
- This test verifies that the ECM is able to control the fuel injector. If the test lamp blinks, then the ECM and

DTC 81 - Fuel Injector Driver A Circuit High, Low or Open

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to <i>Step 2</i>	Go to OBD System Check
2	1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Ignition ON, engine OFF. 3. Using a test lamp connected to a known good engine ground, probe the ignition voltage circuits for each fuel injector on the harness connector. Does the test lamp illuminate in all four circuits?	—	Go to <i>Step 3</i>	Go to Step 8
3	1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors 2. Start the engine. Does the test lamp blink on all four injector harness connections?	—	Go to <i>Step 7</i>	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	—	Go to Step 6	Go to Step 5
5	1. Locate and repair open or short to ground or short to voltage in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 8
6	1. Locate and repair a short to ground in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
7	1. Locate and repair poor connections at the harness connector for the fuel injector. Was a problem found and corrected?	—	Verify Repair	Go to Step 10
8	1. Locate and repair poor connections at the harness connector of the ECM. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	1. Repair an open or short to ground in the fuel injector ignition voltage circuit. Important! The ECM/INJ fuse (F3) also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground. Was a problem found and corrected?	—	Verify Repair	—
10	1. Replace the fuel injector. Is action complete?	—	Verify Repair	—
11	1. Replace the ECM. Is action complete?	—	Verify Repair	—

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open



4329

Circuit Description

The Engine Control Module (ECM) enables the fuel injector drivers. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector driver by grounding the control circuit via a solid state device called a driver. The ECM monitors the status of each driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC sets.

Diagnostic Aids

Performing the Fuel Injector Coil test may help isolate an intermittent condition. Refer to *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Between 10-35 Degrees C (50-95 Degrees F)* or *Fuel Injector Coil Test - Engine Coolant Temperature (ECT) Outside 10-35 Degrees C (50-95 Degrees F)*.

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

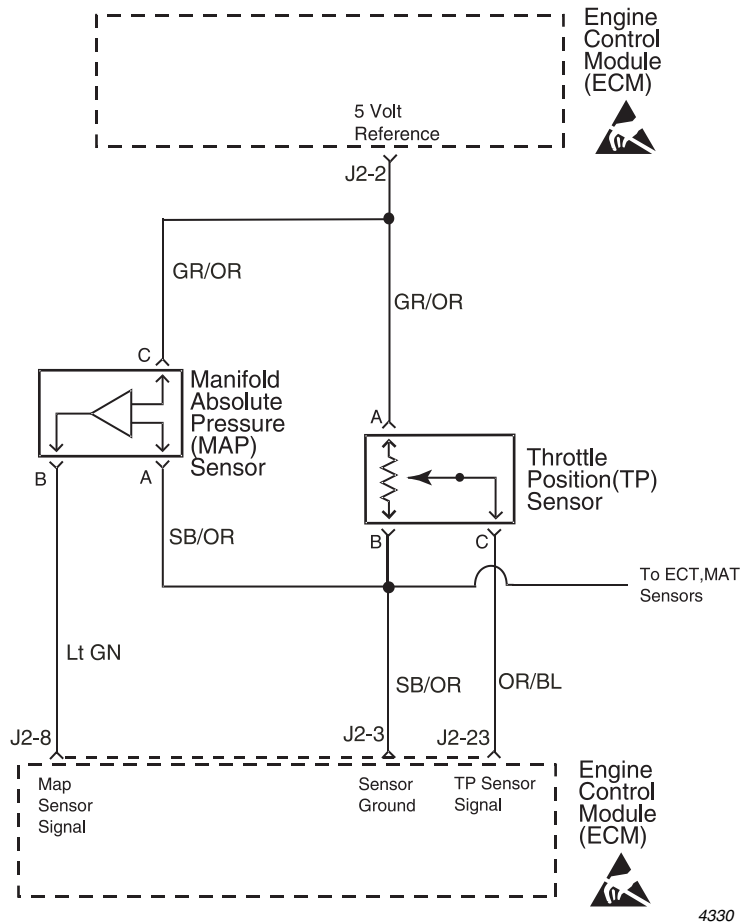
- This step tests for voltage at the fuel injector harness connector. The ECM/INJ fuse supplies power to the coil side of the fuel injector harness connector. If the fuse is open, a short to ground on the fuel injector B+ supply.

DTC 81 - Fuel Injector Driver B Circuit High, Low or Open

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to <i>Step 2</i>	Go to OBD System Check
2	1. Disconnect the appropriate harness connectors of the four fuel injectors. 2. Ignition ON, engine OFF. 3. Using a test lamp connected to a known good engine ground, probe the ignition voltage circuits for each fuel injector on the harness connector. Does the test lamp illuminate in all four circuits?	—	Go to <i>Step 3</i>	Go to Step 8
3	1. Connect the fuel injector test lamp J 34730-2C between the control circuit and the ignition voltage circuit of the fuel injector harness connector. Repeat for all four fuel injectors 2. Start the engine. Does the test lamp blink on all four injector harness connections?	—	Go to <i>Step 7</i>	Go to Step 4
4	Does the test lamp remain illuminated at all times on any of the four fuel injector harness connectors?	—	Go to Step 6	Go to Step 5
5	1. Locate and repair open or short to ground or short to voltage in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 8
6	1. Locate and repair a short to ground in the fuel injector control circuit. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
7	1. Locate and repair poor connections at the harness connector for the fuel injector. Was a problem found and corrected?	—	Verify Repair	Go to Step 10
8	1. Locate and repair poor connections at the harness connector of the ECM. Was a problem found and corrected?	—	Verify Repair	Go to Step 11
9	1. Repair an open or short to ground in the fuel injector ignition voltage circuit. Important! The ECM/INJ fuse (F3) also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground. Was a problem found and corrected?	—	Verify Repair	—
10	1. Replace the fuel injector. Is action complete?	—	Verify Repair	—
11	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22754

DTC 81 - 5 Volt Reference Circuit Out of Range



Circuit Description

The Engine Control Module (ECM) uses a common 5 volt reference circuit as a sensor feed. This circuit supplies 5 volts to the Manifold Absolute Pressure (MAP) sensor and the Throttle Position (TP) sensor. The ECM monitors the voltage on the 5 volt reference circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

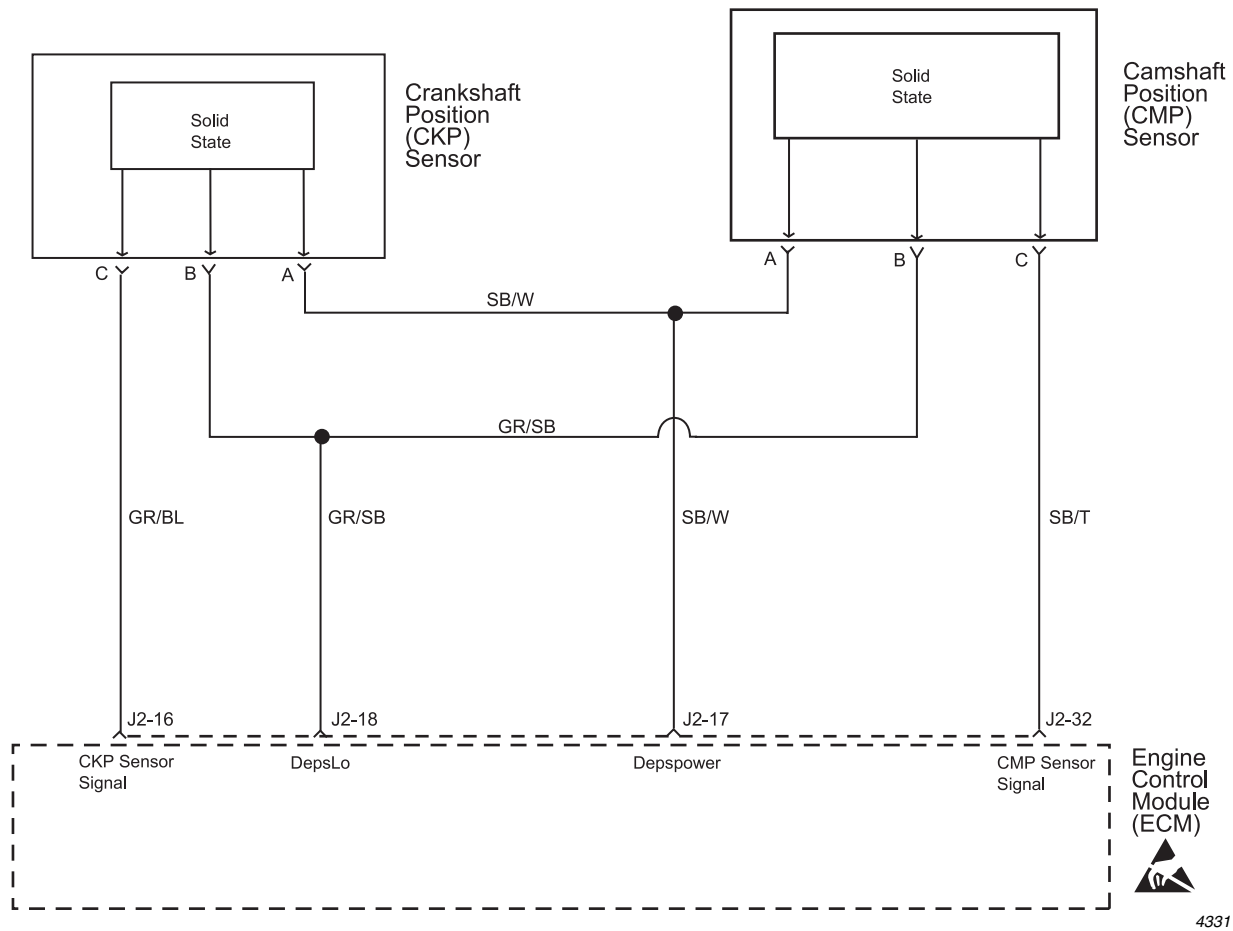
3. The 5 volt reference circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

DTC 81 - 5 Volt Reference Circuit Out of Range

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to <i>Step 2</i>	Go to OBD System Check
2	1. Disconnect the ECM harness connector J2 2. Ignition ON, engine OFF. 3. Using a Digital Multi-Meter connected to a known good engine ground, probe the other lead of the Digital Multi-Meter to the 5 volt reference circuit (J2-2) at the ECM harness connector. Does the circuit measure more than the specified value?	5.1 volts	Go to <i>Step 6</i>	Go to Step 3
3	Before proceeding, remove the following fuses: - F3 - F7 1. Disconnect the MAP sensor and the TP sensor harness connectors 2. Using a Digital Multi-Meter, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
4	1. Ignition OFF. 2. Disconnect the ECM connector J2. 3. Using a test lamp connected to B+, probe the 5 volt reference circuit (J2-2) at the ECM harness connector. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 5
5	1. Using a Digital Multi-Meter, test the continuity from the 5 volt reference circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
6	1. Locate and repair a short to voltage on the 5 volt reference circuit. Is action complete?	—	Verify Repair	—
7	1. Locate and repair short between the 5 volt reference circuit and the ECM circuit that had continuity. Is action complete?	—	Verify Repair	—
8	1. Locate and repair short to ground on the 5 volt reference circuit. Is action complete?	—	Verify Repair	—
9	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22755

DTC 81 - Depspower Circuit Out of Range



4331

Circuit Description

The Engine Control Module (ECM) uses a dedicated 5 volt reference circuit for the Crankshaft Position (CKP) sensor and the Camshaft Position (CMP) sensor. This circuit supplies 5 volts to only the CKP and the CMP sensor circuits. This circuit is referred to as Depspower. The ECM monitors the voltage on the Depspower circuit. This DTC sets if the voltage is out of range.

Diagnostic Aids

If the condition is suspected to be intermittent, refer to *Intermittent Conditions*.

Test Description

3. The Depspower circuit may be shorted to another ECM circuit. The shorted circuit may not be apparent when the ECM harness connector is disconnected.

DTC 81 - Depspower Circuit Out of Range

Step	Action	Value	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	—	Go to Step 2	Go to OBD System Check
2	1. Disconnect the ECM harness connector J2. 2. Ignition ON, engine OFF. 3. Using a Digital Multi-Meter connected to a known good engine ground, probe the other lead of the Digital Multi-Meter to the Depspower circuit (J2-17) at the ECM harness connector. Does the circuit measure more than the specified value?	5.1 volts	Go to Step 6	Go to Step 3
3	Before proceeding, remove the following fuses: - F3 - F7 1. Disconnect the CKP sensor and the CMP sensor harness connectors. 2. Using a Digital Multi-Meter, test the continuity from the Depspower circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
4	1. Ignition OFF. 2. Disconnect the ECM connector J2. 3. Using a test lamp connected to B+, probe Depspower circuit (J2-17) at the ECM harness connector. Does the test lamp illuminate?	—	Go to Step 8	Go to Step 5
5	1. Using a Digital Multi-Meter, test the continuity from Depspower circuit to all other ECM circuits at the ECM J2 harness connector. Do any of the circuits indicate a resistance within the specified range?	0-2 ohms	Go to Step 7	Go to Step 9
6	1. Locate and repair a short to voltage on the Depspower circuit. Is action complete?	—	Verify Repair	—
7	1. Locate and repair short between the Depspower circuit and the ECM circuit that had continuity. Is action complete?	—	Verify Repair	—
8	1. Locate and repair short to ground on the Depspower circuit. Is action complete?	—	Verify Repair	—
9	1. Replace the ECM. Is action complete?	—	Verify Repair	—

22756



Three grounding type switches and one thermistor detect conditions critical to engine longevity:

- When closed, the ECM responds by entering *ENGINE PROTECTION MODE* mode. An engine mounted warning horn or, If so equipped, a dash-mounted warning horn will also sound.

Test Description

1. Determines if warning horn is activated by ECM or if horn lead is grounded.
2. Determines if oil pressure or exhaust temperature switches are causing the problem.
3. Determines if ECT sensor is cause of problem.
4. Checks oil pressure J2-7 for an open circuit.
5. Checks oil pressure J2-7 for a grounded circuit.
6. Checks ECT sensor J2-3 for an open circuit.
7. Checks ECT sensor J2-3 for a grounded circuit.
8. Checks MAP sensor J2-3 for a grounded circuit.
Replace ECM if problem is not located in previous tests.
9. Check of warning horn circuit.

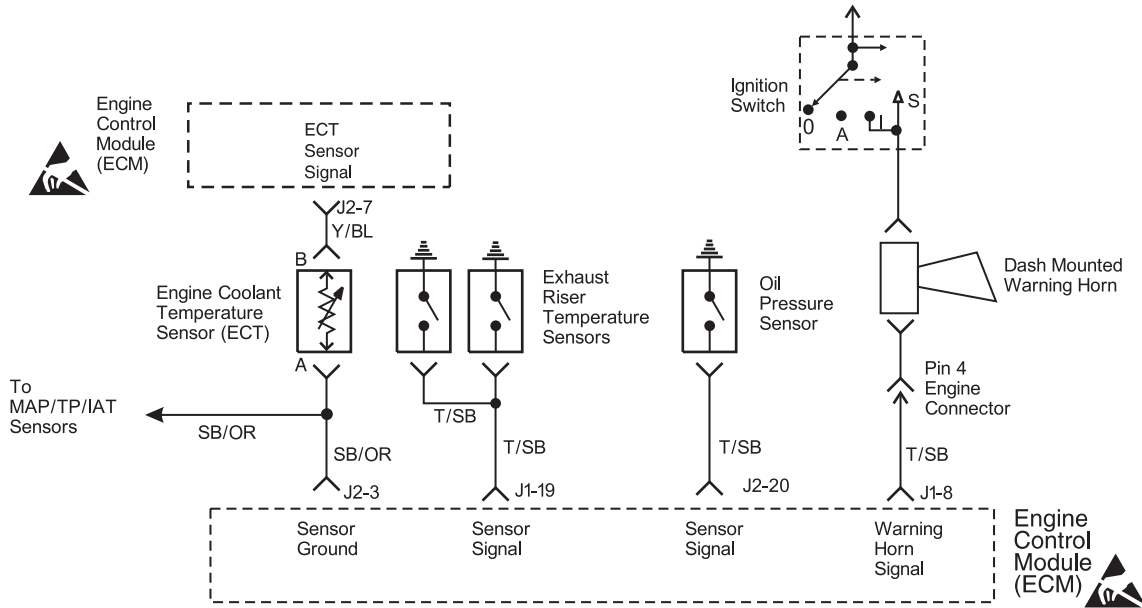
- Check engine crankcase oil level, add oil as necessary.
- See **Cooling System** section of **Engine** service manual for possible overheat causes.
- See appropriate engine section of **Engine** service manual for possible causes of loss of oil pressure.

An intermittent problem may be caused by a poor or corroded connection, a worn-through wire, a wire that's broken inside the insulation, or a defective switch.

Engine Protection Mode Circuit 4.3GXi-B, 5.0GXi-B, 5.7Gi-B, 5.7GXi-C

Step	Action	Value	Yes	No
1	1. Turn ignition off. 2. Remove connector at oil pressure switch. 3. Turn ignition on. If equipped, does audible warning horn sound? If not equipped, go to STEP 2.	—	Go to Step 9	Go to Step 2
2	1. Turn ignition off. 2. Leave oil pressure switch disconnected. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ?	—	Go to Step 3	Verify Repair
3	1. Turn ignition off. 2. Remove connector at ECT sensor. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ? NOTE: ECT sensor serves a dual function; it provides water temperature data to ECM for spark / fuel control, and warns of engine overheat to activate <i>Engine Protection Mode</i> circuit.	—	Go to Step 4	Verify Repair
4	1. Turn ignition off. 2. Remove J2 connector at ECM. 3. Using a DVOM, check resistance from terminal J2-7 to oil pressure switch connector terminal. Does ohmmeter read at or near zero (0)?	0	Go to Step 5	Verify Repair
5	1. Check resistance between ECM terminal J2-7 and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 6	Verify Repair
6	1. Using a DVOM, check resistance from terminal J2-3 to ECT connector terminal "A". Does ohmmeter read at or near zero (0)?	0	Go to Step 7	Verify Repair
7	1. Check resistance between ECT connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 8	Verify Repair
8	1. Remove connector at MAP sensor. 2. Check resistance between MAP connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Verify Repair	Verify Repair
9	1. Check of warning horn circuit only (engine otherwise responds correctly to <i>Engine Protection Mode</i> conditions). 2. Turn ignition off. Remove J2 connector at ECM. 3. Disconnect 10-way engine cable connector. 4. Using a DVOM, check circuit between J2-12 and Pin 4 for opens and grounds. Does circuit pass both tests?	—	Verify Repair	Verify Repair

Engine Protection Mode Circuit 4.3GXi-C/D, 5.0GXi-C/D, 5.7Gi-C/D, 5.7GXi-D/E



22680

Circuit Description

Three grounding type switches and one thermistor detect conditions critical to engine longevity:

- a water temperature thermistor (engine overheat)
- two temperature switches (exhaust overheat)
- an oil pressure switch (loss of pressure)

When closed, the ECM responds by entering **ENGINE PROTECTION MODE**. An engine mounted warning horn or, if so equipped, a dash-mounted warning horn will also sound.

This engine protection feature disables half the fuel injectors above 2500 RPM. If engine speed drops back to 1200 RPM, the system will reset and allow normal operation. Should the overheat or loss of oil pressure condition still exist, **ENGINE PROTECTION MODE** will again activate if engine speed exceeds 2500 RPM.

Test Description

1. Determines if warning horn is activated by ECM or if horn lead is grounded.
2. Determines if oil pressure or exhaust temperature switches are causing the problem.
3. Determines if ECT sensor is cause of problem.
4. Checks oil pressure J2-7 for an open circuit.
5. Checks oil pressure J2-7 for a grounded circuit.
6. Checks ECT sensor J2-3 for an open circuit.
7. Checks ECT sensor J2-3 for a grounded circuit.
8. Checks MAP sensor J2-3 for a grounded circuit.
Replace ECM if problem is not located in previous tests.
9. Check of warning horn circuit.

Diagnostic Aids

- Check engine crankcase oil level, add oil as necessary.
- See **Cooling System** section of **Engine** service manual for possible overheat causes.
- See appropriate engine section of **Engine** service manual for possible causes of loss of oil pressure.

If above diagnostics were performed, and no change in performance was made, refer to *Symptoms Section 4A*.

An intermittent problem may be caused by a poor or corroded connection, a worn-through wire, a wire that's broken inside the insulation, or a defective switch.

Engine Protection Mode Circuit 4.3GXi-C/D, 5.0GXi-C/D, 5.7Gi-C/D, 5.7GXi-D/E

Step	Action	Value	Yes	No
1	1. Turn ignition off. 2. Remove connector at oil pressure switch. 3. Turn ignition on. If equipped, does audible warning horn sound? If not equipped, go to STEP 2.	—	Go to Step 9	Go to Step 2
2	1. Turn ignition off. 2. Leave oil pressure switch disconnected. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ?	—	Go to Step 3	Verify Repair
3	1. Turn ignition off. 2. Remove connector at ECT sensor. 3. Start and operate engine above 2500 RPM. Does engine enter <i>Engine Protection Mode</i> ? NOTE: ECT sensor serves a dual function; it provides water temperature data to ECM for spark / fuel control, and warns of engine overheat to activate <i>Engine Protection Mode</i> circuit.	—	Go to Step 4	Verify Repair
4	1. Turn ignition off. 2. Remove J2 connector at ECM. 3. Using a DVOM, check resistance from terminal J2-7 to oil pressure switch connector terminal. Does ohmmeter read at or near zero (0)?	0	Go to Step 5	Verify Repair
5	1. Check resistance between ECM terminal J2-7 and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 6	Verify Repair
6	1. Using a DVOM, check resistance from terminal J2-3 to ECT connector terminal "A". Does ohmmeter read at or near zero (0)?	0	Go to Step 7	Verify Repair
7	1. Check resistance between ECT connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Go to Step 8	Verify Repair
8	1. Remove connector at MAP sensor. 2. Check resistance between MAP connector terminal "A" and a good engine ground. Does ohmmeter read infinity?	—	Verify Repair	Verify Repair
9	1. Check of warning horn circuit only (engine otherwise responds correctly to <i>Engine Protection Mode</i> conditions). 2. Turn ignition off. Remove J2 connector at ECM. 3. Disconnect 10-way engine cable connector. 4. Using a DVOM, check circuit between J2-12 and Pin 4 for opens and grounds. Does circuit pass both tests?	—	Verify Repair	Verify Repair

Notes

[illegible]

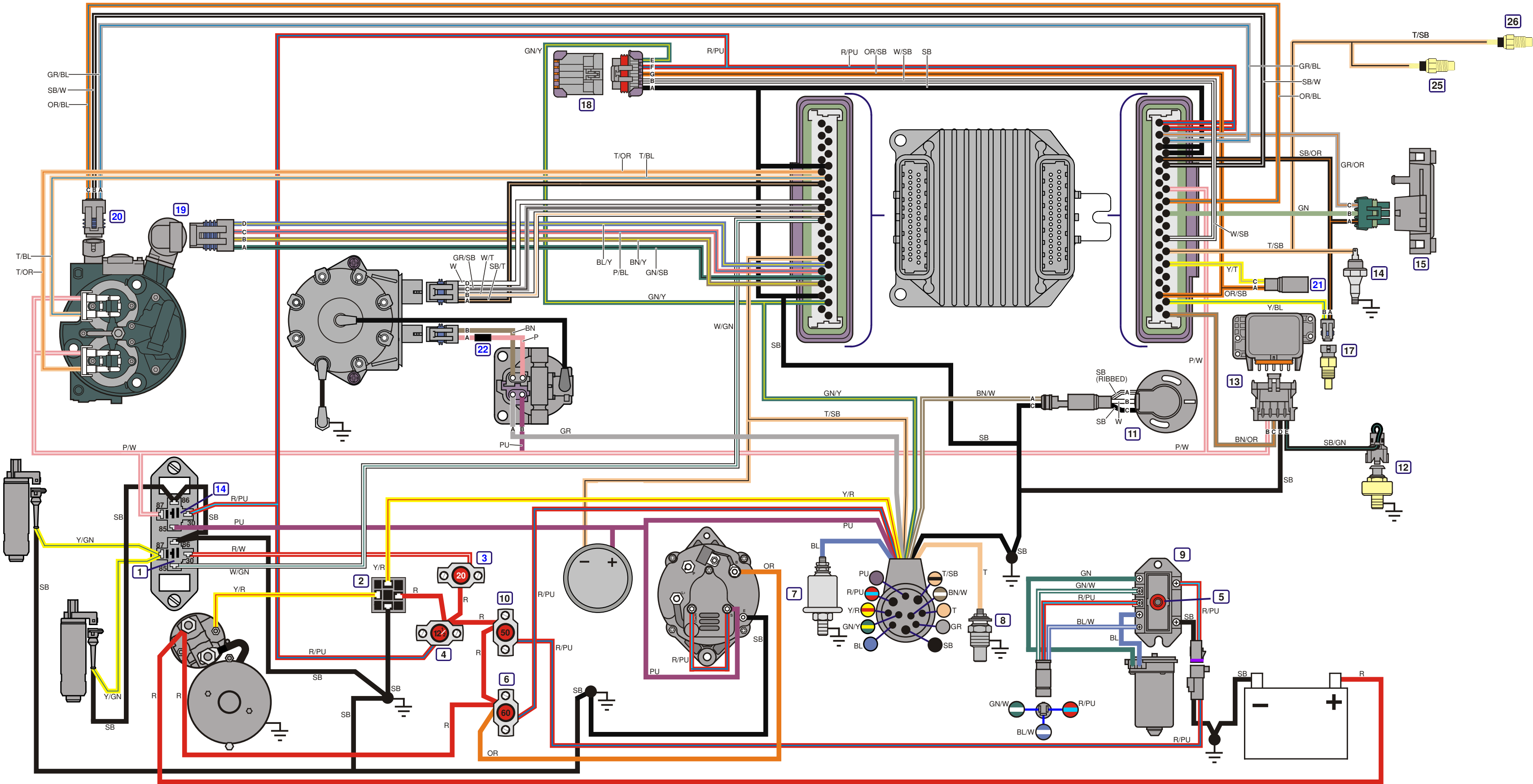
Engine Schematic

4.3GXi-A, 4.3OSi-A/B
5.0GXi-A, 5.0OSi-A/B
5.7Gi-A, 5.7OSi-A
5.7GXi-B, 5.7OSXi-A

Cable colors

BN = Brown
BL = Blue
GN = Green
GR = Grey
LBL = Light blue
LGN = Light green
OR = Orange
P = Pink
PU = Purple
R = Red
SB = Black
T = Tan
VO = Violet
W = White
Y = Yellow

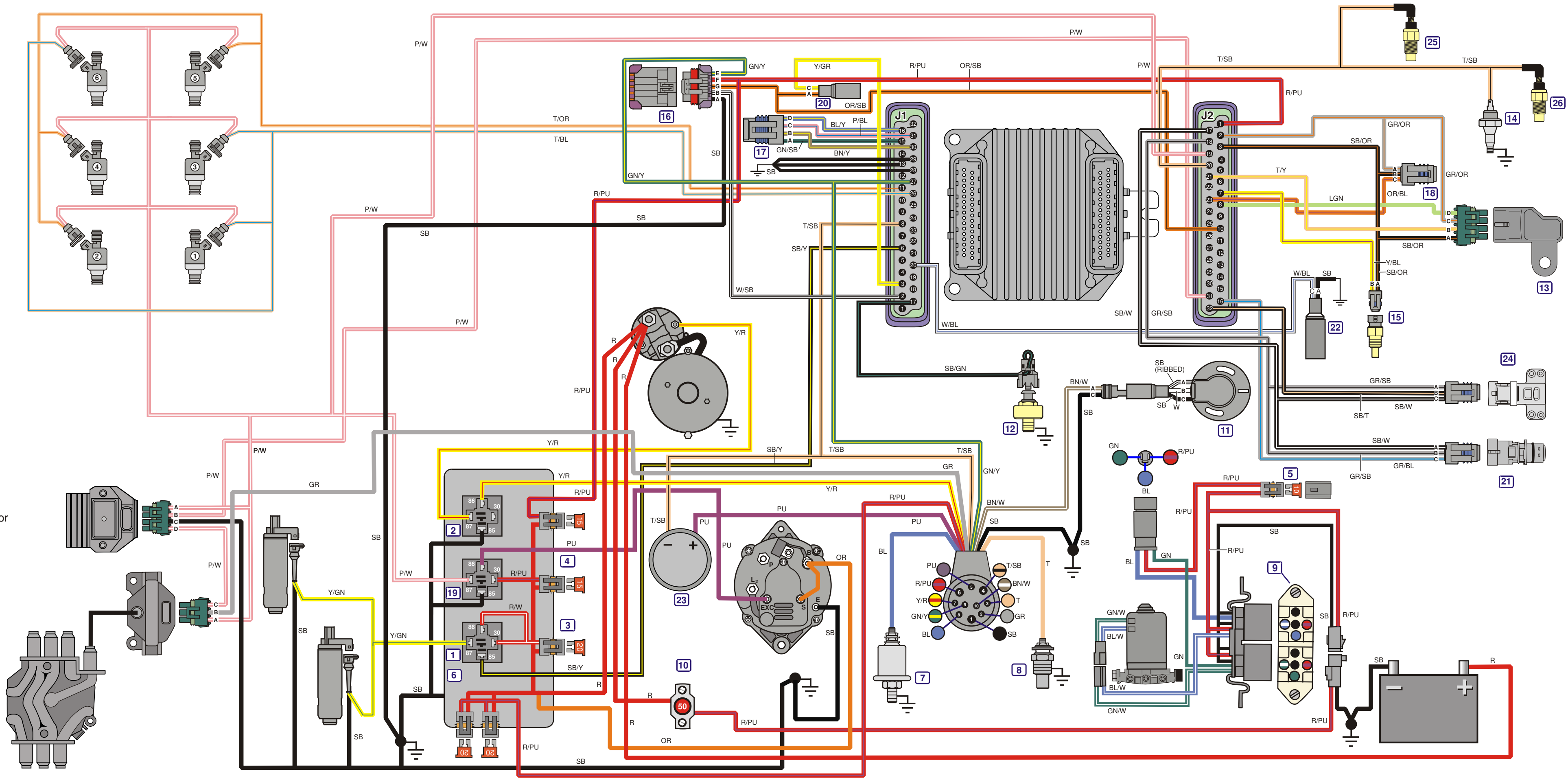
- 1 Relay, Fuel Pumps
- 2 Relay, Starter
- 3 20 Amp Fuse, Fuel Pumps
- 4 15 Amp Fuse, Ignition/Fuel
- 5 10 Amp Fuse, Trim/Tilt
- 6 40 Amp Fuse, Instrument Harness
- 7 Oil Pressure Transmitter
- 8 Water Temperature Transmitter Gauge
- 9 Relays, Trim Motor
- 10 50 Amp Circuit Breaker, Trim/Tilt
- 11 Trim Sender
- 12 Knock Sensor
- 13 Manifold Absolute Pressure (MAP) Sensor
- 14 Oil Pressure Switch
- 15 Coolant Temperature (CT) Sensor
- 16 Diagnostic Link Connector (DLC)
- 17 Idle Air Control (IAC) Motor
- 18 Throttle Position (TP) Sensor
- 19 Relay, Ignition/Fuel
- 20 Master/Slave Connector
- 21 Crank Sensor
- 22 Shift Interrupt Switch
- 23 Audible Alarm
- 24 Cam Sensor
- 25 Exhaust Temperature (Port)
- 26 Exhaust Temperature (Starboard)



4.3 GXi-B

BN = Brown
BL = Blue
GN = Green
GR = Grey
LBL = Light blue
LGN = Light green
OR = Orange
P = Pink
PU = Purple
R = Red
SB = Black
T = Tan
VO = Violet
W = White
Y = Yellow

- 1 Relay, Fuel Pumps
- 2 Relay, Starter
- 3 20 Amp Fuse, Fuel Pumps
- 4 15 Amp Fuse, Ignition/Fuel
- 5 10 Amp Fuse, Trim/Tilt
- 6 40 Amp Fuse, Instrument Harness
- 7 Oil Pressure Transmitter
- 8 Water Temperature Transmitter Gauge
- 9 Relays, Trim Motor
- 10 50 Amp Circuit Breaker, Trim/Tilt
- 11 Trim Sender
- 12 Knock Sensor
- 13 Manifold Absolute Pressure (MAP) Sensor
- 14 Oil Pressure Switch
- 15 Coolant Temperature (CT) Sensor
- 16 Diagnostic Link Connector (DLC)
- 17 Idle Air Control (IAC) Motor
- 18 Throttle Position (TP) Sensor
- 19 Relay, Ignition/Fuel
- 20 Master/Slave Connector
- 21 Crank Sensor
- 22 Shift Interrupt Switch
- 23 Audible Alarm
- 24 Cam Sensor
- 25 Exhaust Temperature (Port)
- 26 Exhaust Temperature (Starboard)



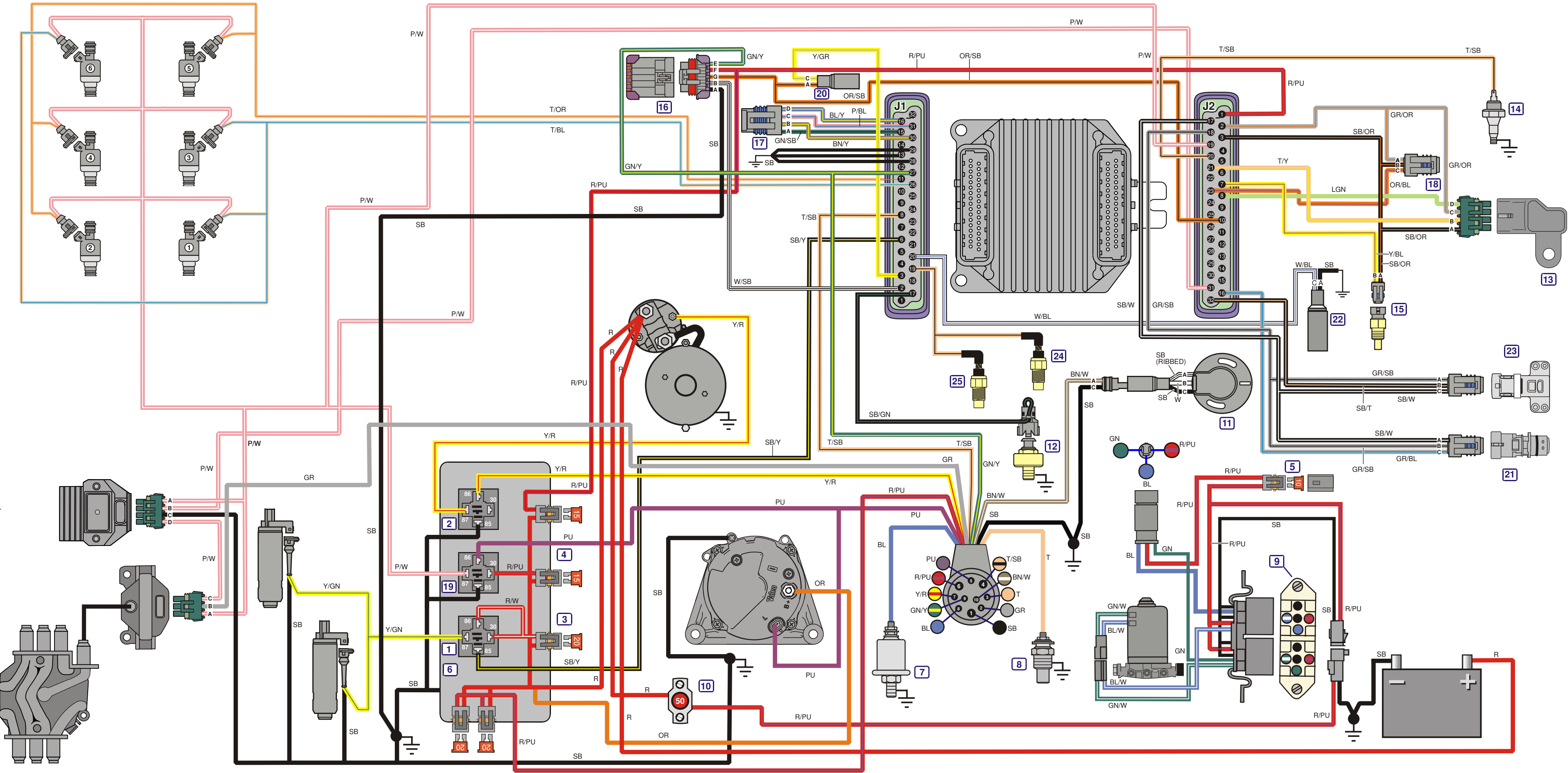
Engine Schematic

4.3 GXi-C/D

Cable colors

- BN = Brown
- BL = Blue
- GN = Green
- GR = Grey
- LBL = Light blue
- LGN = Light green
- OR = Orange
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Engine Schematic

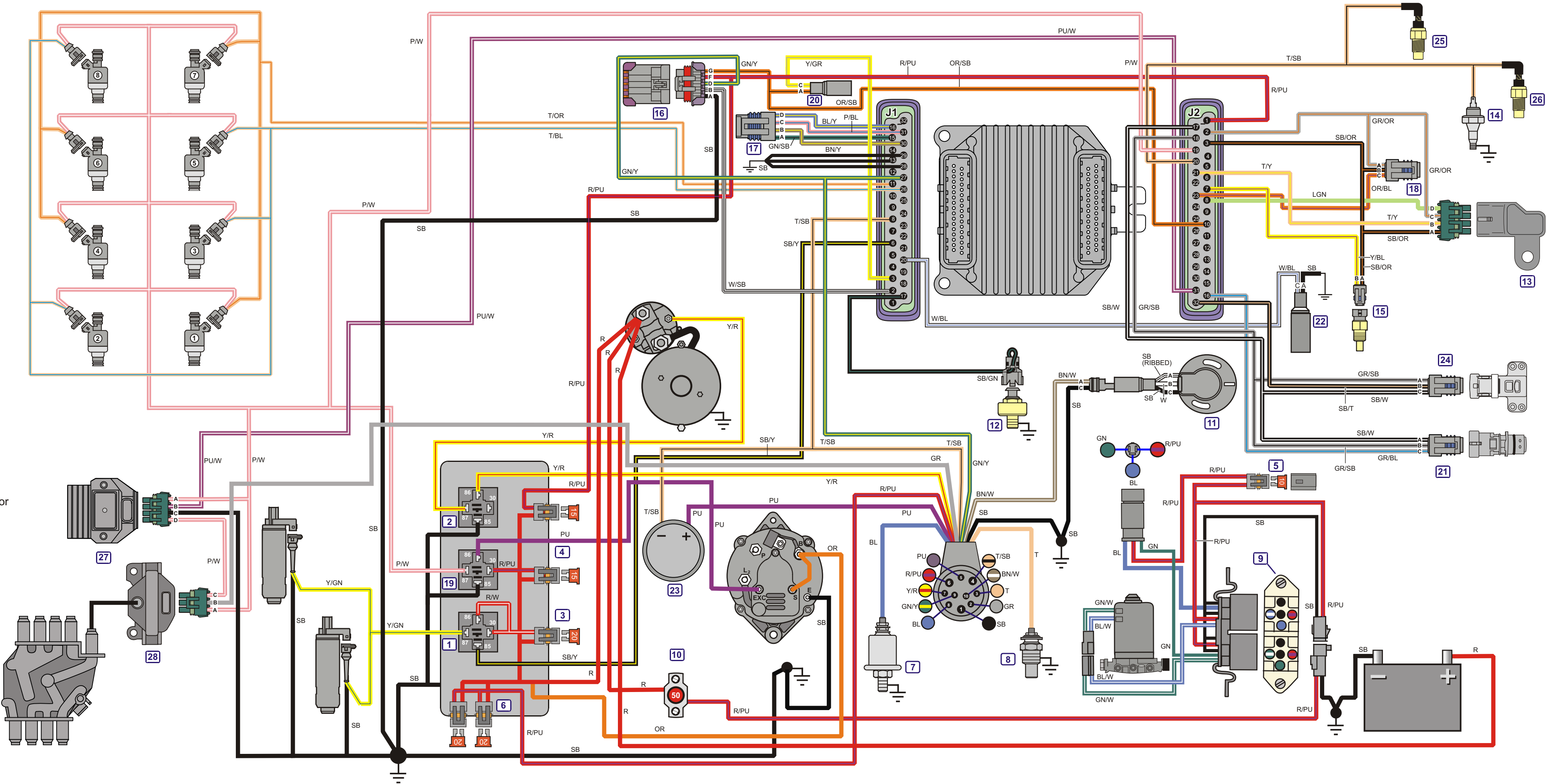
5.0GXi-B

5.7Gi-B, 5.7GXi-C

Cable colors

- BN = Brown
- BL = Blue
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- GR = Grey
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- 20 Master/Slave Connector
- 21 Crank Sensor
- 22 Shift Interrupt Switch
- 23 Audible Alarm
- 24 Cam Sensor
- 25 Exhaust Temperature (Port)
- 26 Exhaust Temperature (Starboard)
- 27 Ignition Control (IC) Module
- 28 Ignition Coil



Engine Schematic

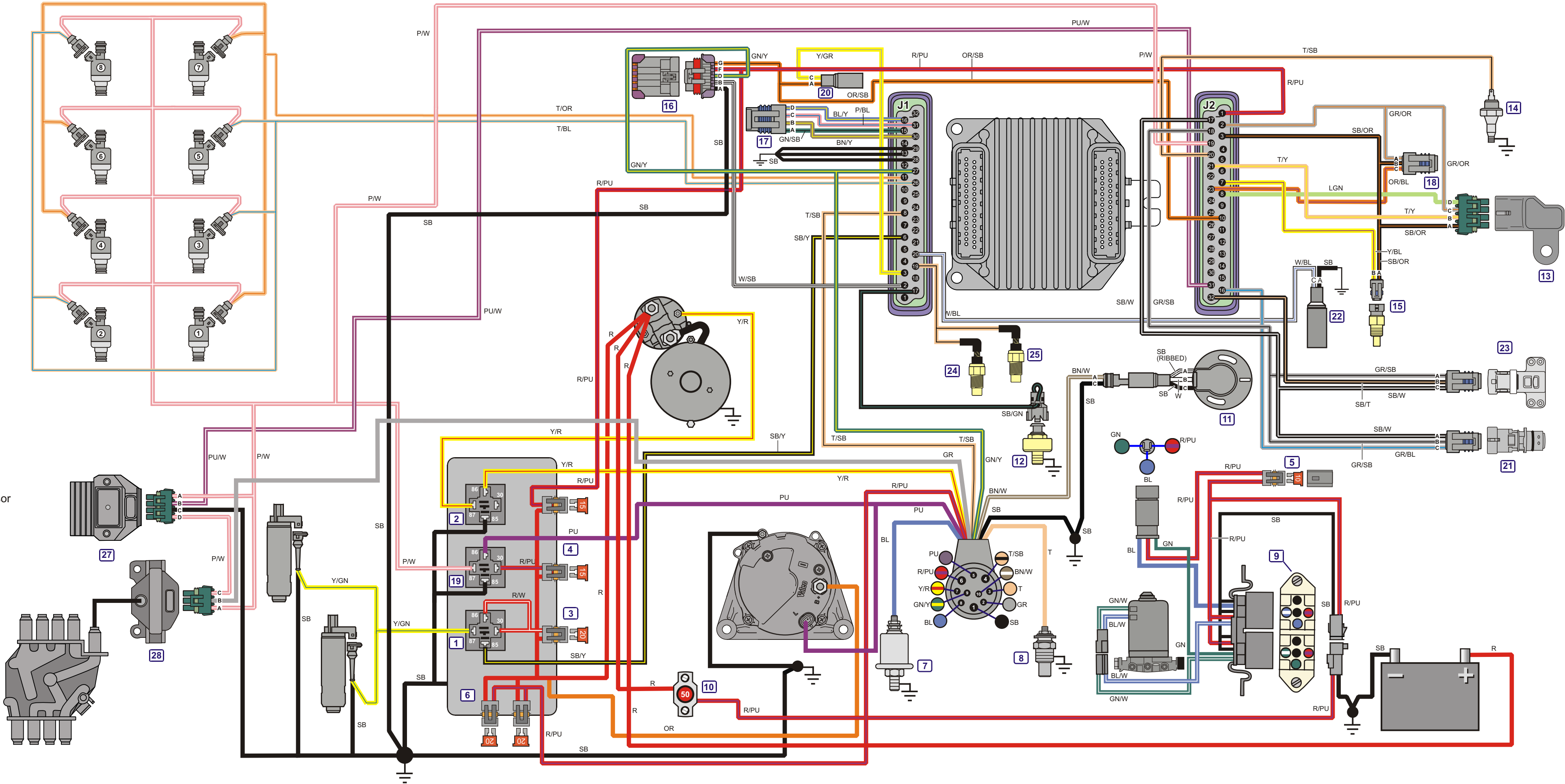
5.0GXi-C

5.7Gi-C, 5.7GXi-D

Cable colors

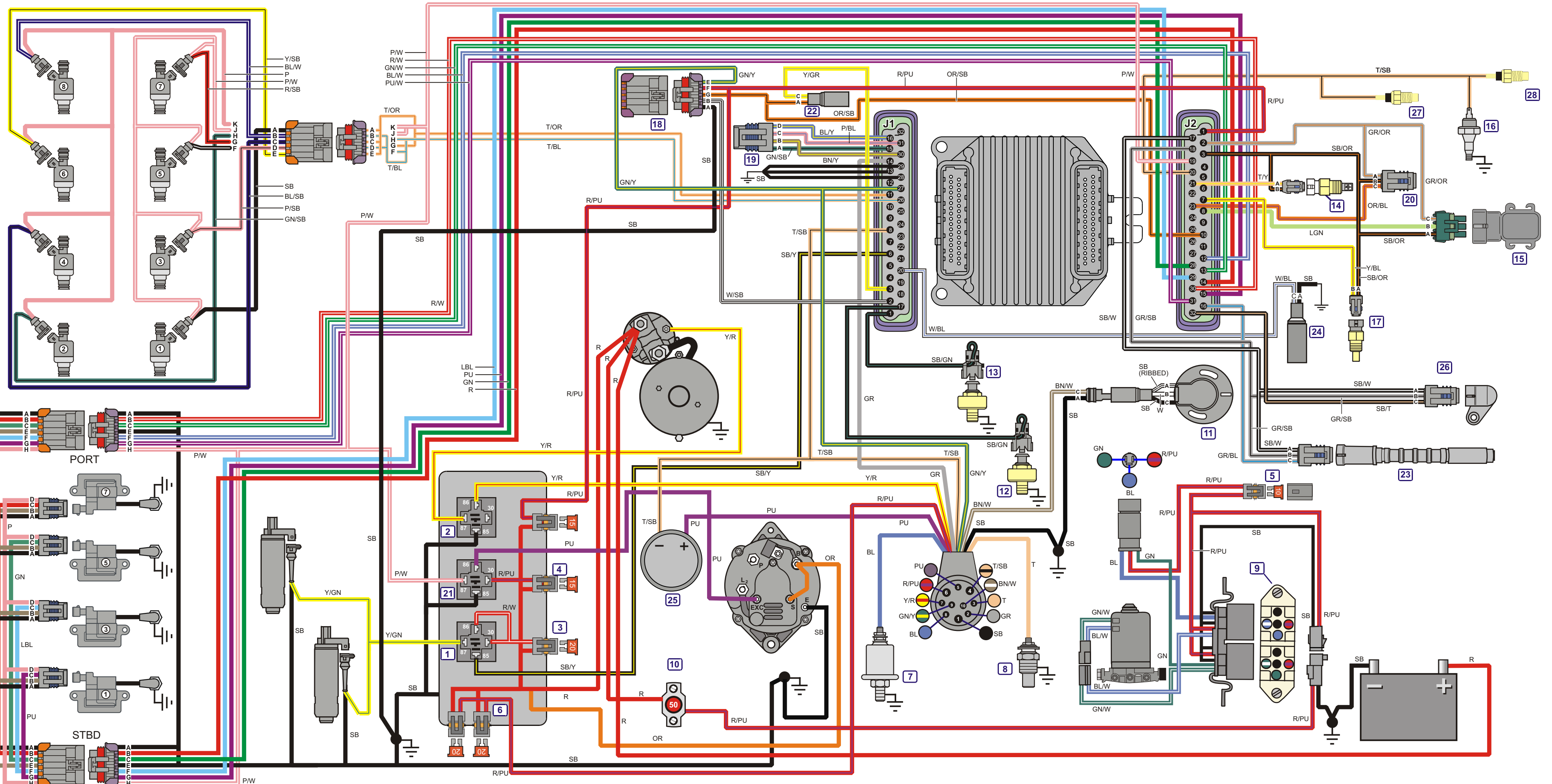
- BN = Brown
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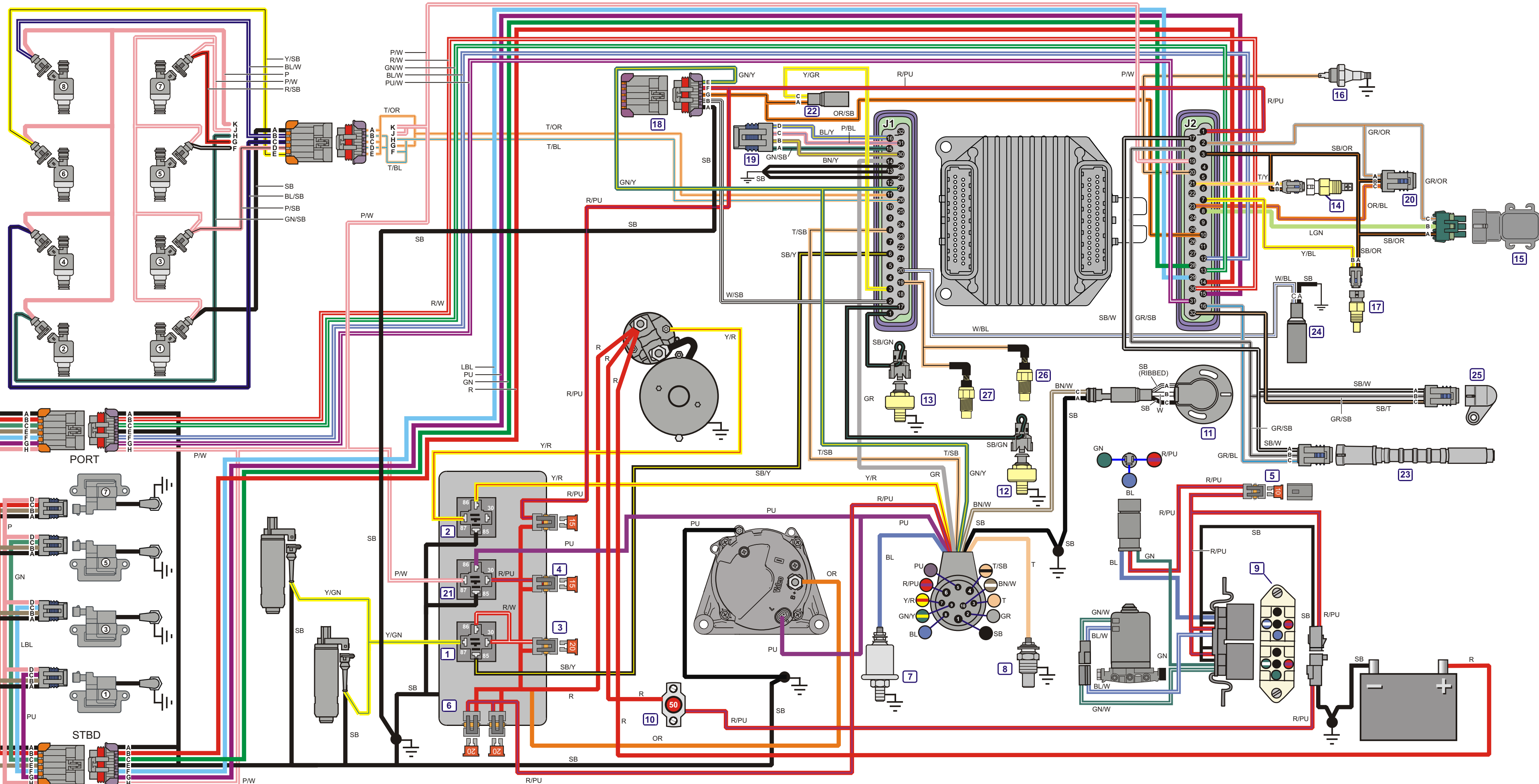
8.1Gi-B
8.1GXi-A

- [illegible]



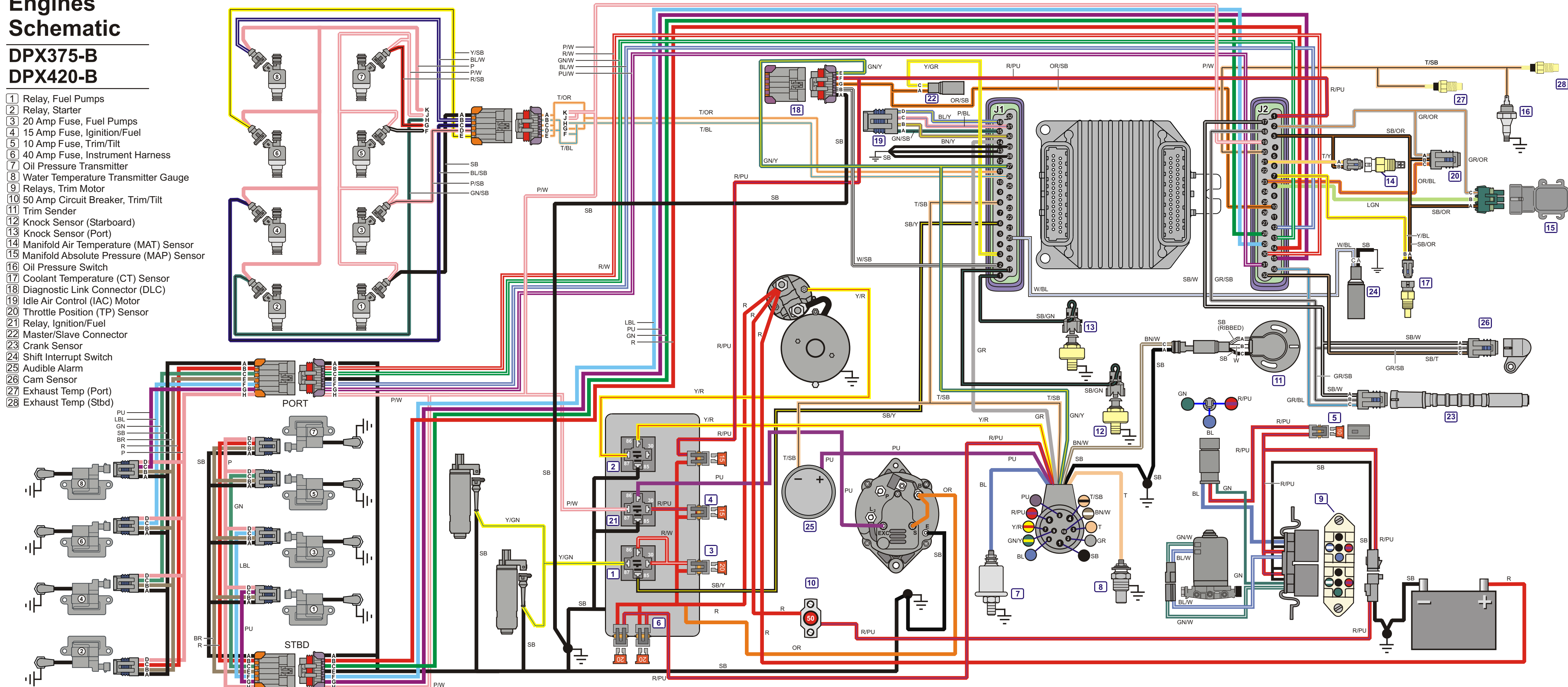
8.1Gi-C/D
8.1GXi-B/C

-
- Diagram illustrating the wiring of four relays (labeled 2, 4, 6, 8) to a common terminal block. The terminal block has four columns of terminals labeled D, C, B, and A. The wiring is as follows:
- Relay 8:** D to PU, C to LBL, B to GN, A to SB.
 - Relay 6:** D to SB, C to BR, B to R, A to P.
 - Relay 4:** D to PU, C to LBL, B to GN, A to SB.
 - Relay 2:** D to SB, C to BR, B to R, A to P.
- The diagram also shows a common ground connection for all relays.



DPX375-B
DPX420-B

-
- Wiring diagram for the 4-wire version of the 120VAC, 15A, 2500W electric heater. The diagram shows four heaters connected in parallel. Each heater has a 4-pin terminal block with terminals labeled D, C, B, and A. The wiring is as follows: Line (L) is connected to terminal D of all heaters. Neutral (N) is connected to terminal A of all heaters. Ground (G) is connected to the ground terminal of all heaters. The heater terminals are labeled 2, 4, 6, and 8. The heater specifications are 120VAC, 15A, 2500W. The heater is labeled 'HEATER'.



Safety Section

Part A

Marine Products and Safety of People Who Use Them	S-2
Sterndrive Shift System	S-3
Sterndrive Throttle Control System	S-4
Sterndrive Steering System	S-5
Sterndrive Fuel, Electrical System	S-7

Part B

Marine Products and Safety of People Who Fix Them	S-11
Handling Engines	S-11
Handling Lead Acid Batteries	S-12
Gasoline! Handle with Care	S-13
Hazardous Products	S-14

Part A - Marine Products and safety of People Who Use Them

Enjoyable boating is the goal of people who design and build marine products. To reach this goal, manufacturers are careful to make sure...

- Product User is informed. . .
- Products are safe and reliable. . .

It's up to you, the People who. . .

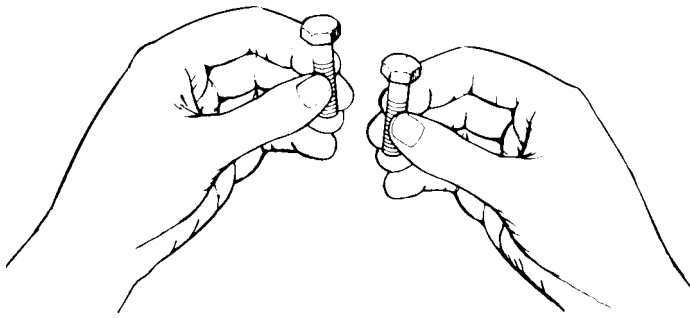
- Install accessories. . .
 - Service and Maintain the boat. . .
 - Service and maintain the sterndrive. . .
- . . . to keep the products safe and reliable.

This section talks about safe boating and how you can help keep it safe. Some things you may know . . . but others you may not.

First!

A word about fasteners . . . plain . . . special . . . all screws, nuts, washers and bolts.

Do Not Substitute Fasteners



They look the same, but . . . are they?

- The Same Size?
- The Same Strength?
- The Same Material?
- The Same Type?
- Standard or Metric Thread?

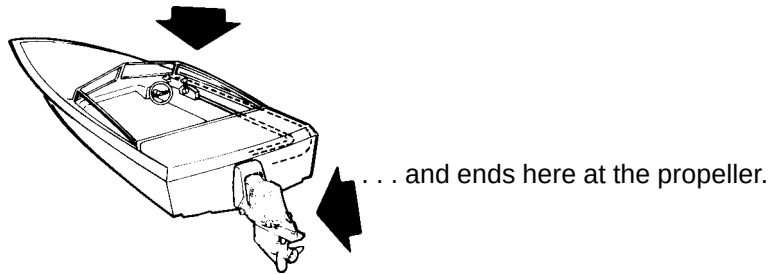
Don't substitute unless you know they are the same in all characteristics.

Second!

- Special locking screws and nuts are often used to attach steering, and remote control components to the sterndrive.
- When you remove any part from the sterndrive, keep track of special screws and nuts. Don't mix with other parts
- When reassembling the sterndrive, use only the special screws and nuts intended to hold steering, and control cables, plus related parts.
- Service with parts of known quality that meet Marine Industry (BIA/ABYC) Standard.

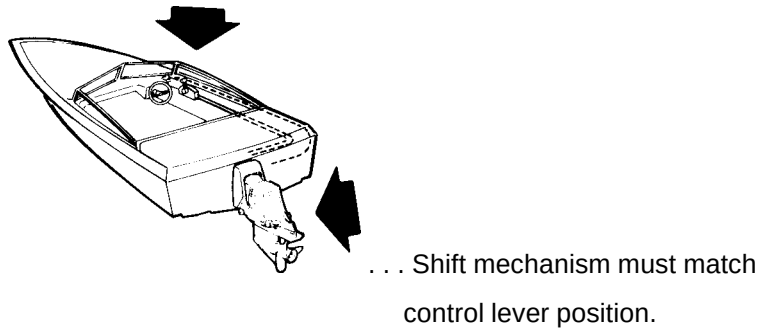
Sterndrive Shift System

The Shift System starts
here at the remote control lever . . .



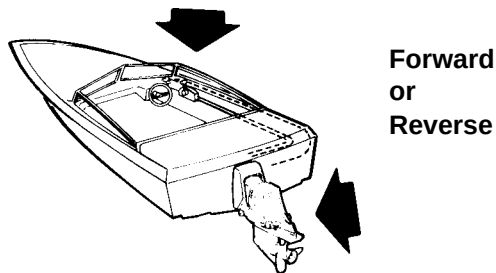
What's Most Important?

When the control lever is in Forward,
Neutral or Reverse position . .



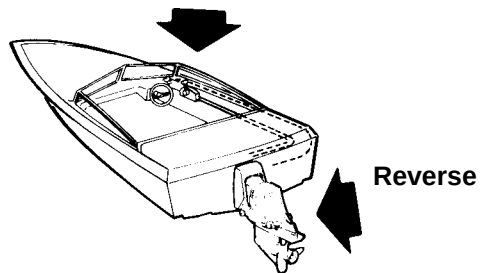
What Could Happen?

● If . . . Neutral



... Propeller is still powered (turning)
unknown to operator, or engine will
start in gear, boat will move unexpectedly.

● If . . . Forward



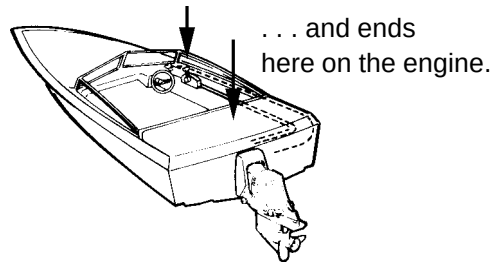
... boat will move opposite
to direction intended by operator.

How Can Loss of Shift Control be Minimized? In pre-delivery inspection and when servicing . . .

- Read, understand and follow manufacturers instructions.
- Closely follow the warnings marked with  . . .
- Assemble parts and make adjustments carefully . . .
- Test your work. Don't guess. Make sure propeller does what the operator wants and nothing else.

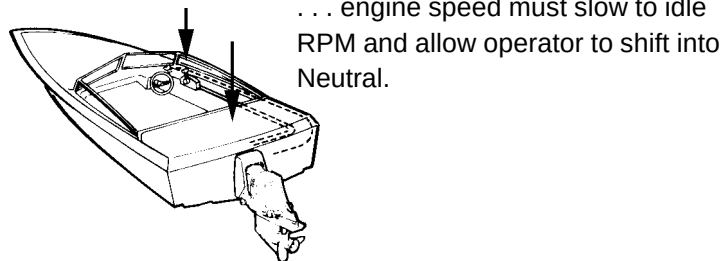
Sterndrive Throttle Control System

The throttle Control System starts here and the remote control lever . . .



What's Most Important?

When the control lever is moved from Forward (or Reverse) to Neutral . . .



Operator must be able to stop propeller.

What Could Happen?

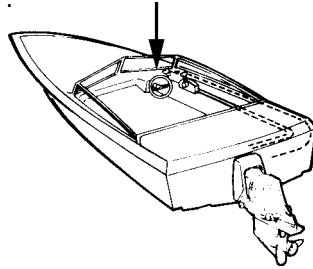
If operator cannot slow the engine to idle RPM and shift into neutral, (stop propeller), operator could panic and lose control of boat.

How Can Loss of Throttle Control be Minimized? In pre-delivery inspection and when servicing . . .

- Read, understand, and follow manufacturers instructions.
- Closely follow the warnings marked with  . . .
- Assemble parts and make adjustments carefully . . .
- Test your work. Don't guess. Make sure engine throttle response is smooth.
- Make sure full throttle operating RPM can be reached so operator won't overload engine

Sterndrive Steering System

The Steering System starts
here at the helm . . .



What's Most Important?

The Steering System . . .

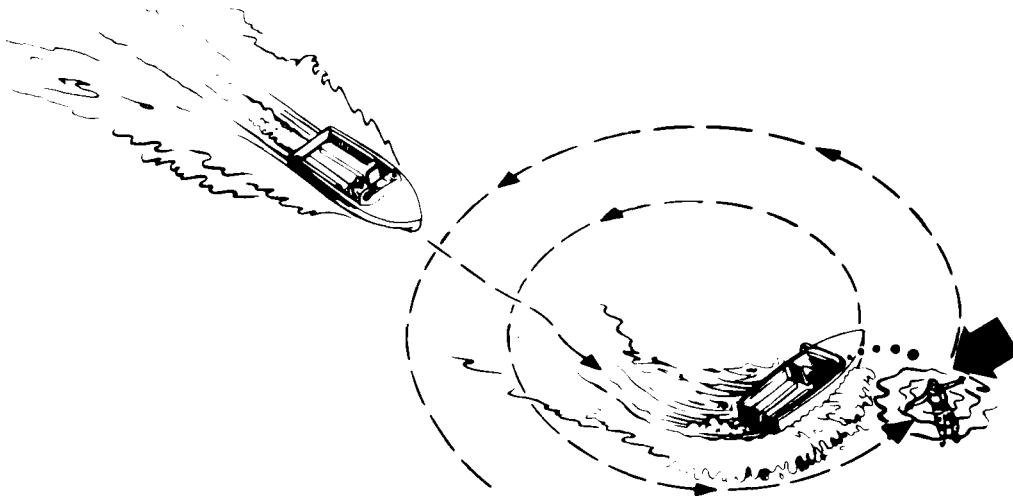
- must be installed properly
- must be adjusted properly
- must be lubricated

. . . and ends here at the propeller
on the sterndrive



What Could Happen?

- . . . if steering system comes apart, boat would turn suddenly and circle . . . passengers and/or operator may be thrown into water and could be hit.



- . . . if steering jams, operator may not be able to avoid obstacles. Operator could panic.
- . . . if steering is loose, operator may not be able to maintain a true course, and could result in loss of boat control.

How Can Loss of Steering Control be Minimized?

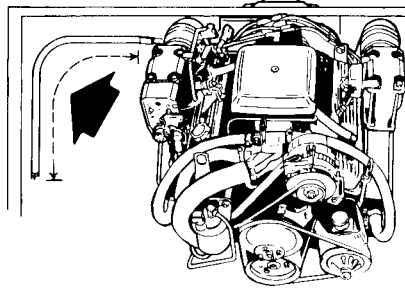
In pre-delivery inspection and when servicing

- use steering components which meet marine industry (BIA/ABYC) standards . . .
- Read, understand, and follow manufacturer's instructions.
- Assemble parts and make adjustments carefully . . .
- Closely follow the warnings marked with  . . .
- Keep parts moving freely . . . lubricate parts as soon as shown in manuals
- Use bolts, nuts, and washers supplied with steering attachment kits

When power assisted or mechanical steering systems are used, check to uncover possible trouble!

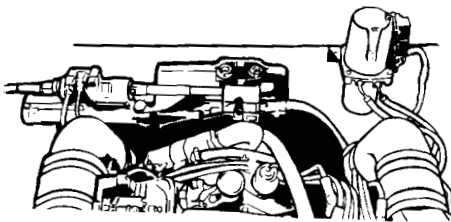
- Cable housing in this area must not be restricted

Why? Unit may go to full turn without turning steering wheel (Power assist models)

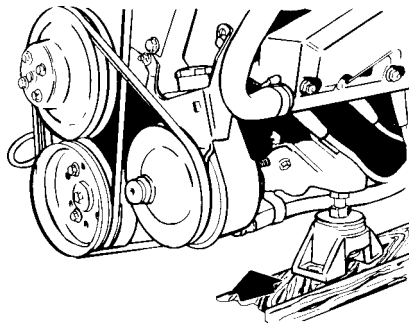


- Steering components must not bind

Why? Possible jamming of steering system.



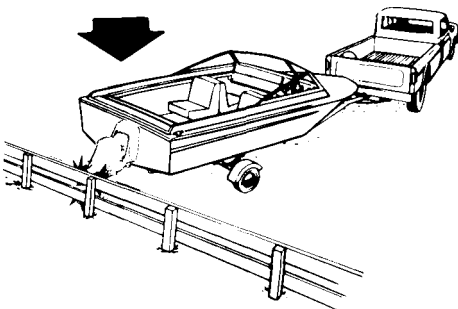
Power steering parts and push/pull cable must be free to move in order to actuate power steering valve when operator turns steering wheel



Engine stringer must not interfere with power steering pump and pulley

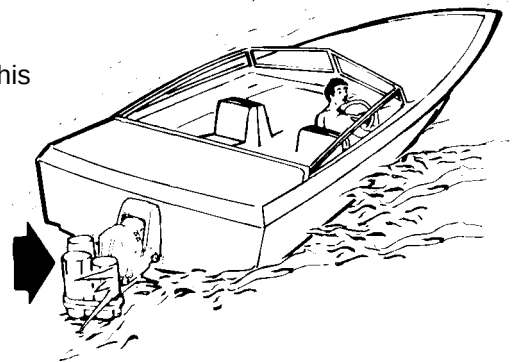
Maintain proper belt tension.

- Check for damaged parts . . . impacts to the sterndrive like this



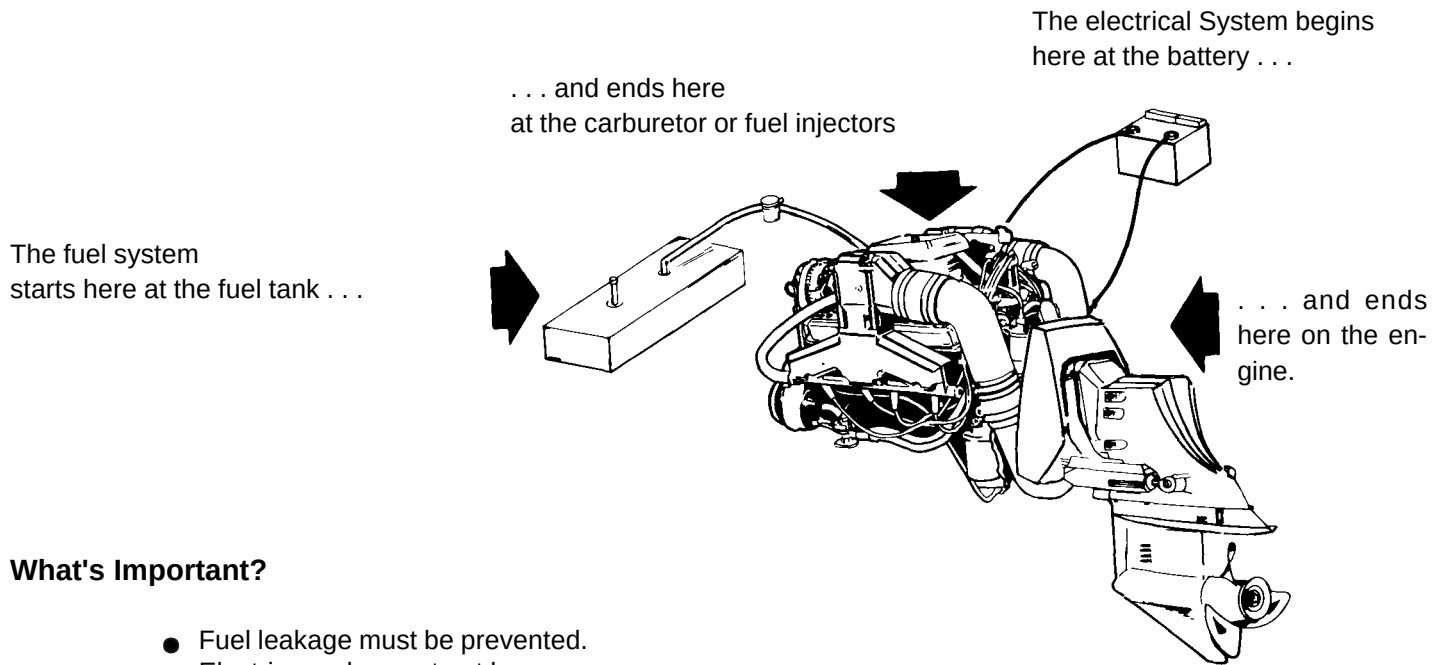
or this . . . or ???
can put stress on steering components. Look for . . .

- Cracked parts
- Bent parts
- Loose fasteners



Replace damaged parts. If weakened, parts could fail later . . . on the water . . . when least expected.

Sterndrive Fuel and Electrical Systems



What's Important?

- Fuel leakage must be prevented.
- Electric sparks must not happen.

What Could Happen?

Gasoline can explode and/ or burn easily:

- When boating, fuel leaking in the engine compartment could be ignited by a spark from a loose wire connection, or a damaged or deteriorated electrical component.

How Can Fire and Explosion Be Minimized?

- Read, understand and follow manufacturers instructions.
- Closely follow the warnings marked with  . . .
- Do not substitute fuel or electrical parts with other parts which may look the same. These parts are designed and manufactured to meet special U. S. Coast Guard safety regulations to prevent fire and explosion.

If you work on marine engines, you must understand these U.S. Coast Guard requirements. If you don't have them, write to . . .

. . . and ask for copies of:

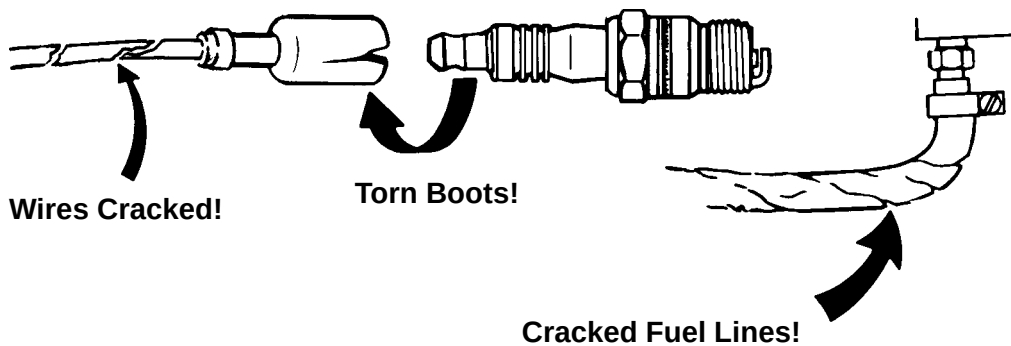
----- ----- -----	☐
National Technical Information Service Springfield, Virginia 22161	

(1) Electrical System Compliance Guideline (AD/A-049-638)

(2) Fuel System Compliance Guideline (AD/A-047-767)

These are concise guidelines - easy to read and understand. They explain what must be done to prevent fire and explosions.

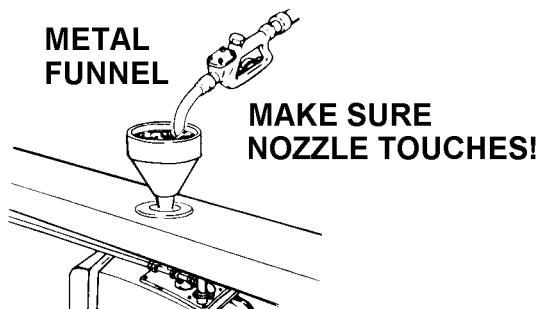
- Always use replacement parts specified by the manufacturer. They meet the U.S. Coast Guard requirements. Most automotive parts do not, especially electrical components that must meet ignition protection requirements of the U.S. Coast Guard regulations.
- When nonmetallic parts look to be in poor shape . . . replace them!



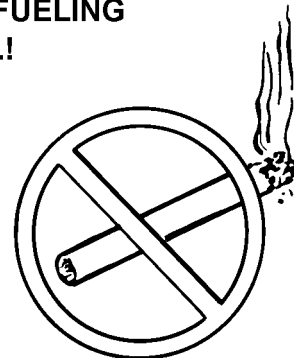
Using parts which meet U.S. Coast guard requirements is only half the job. The other half is your job . . .

It's time for replacement BEFORE sparks and/or fuel leaks occur.

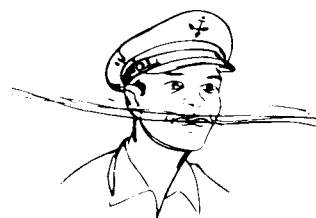
- Replace parts carefully. Make sure nuts and bolts are tight especially when they anchor electrical wires (to prevent sparking). If lock washers are specified - use them. No short cuts or missing parts with either of these CRITICAL safety related systems.
- When refueling, always ground fuel nozzle to the inlet fitting on the boat to prevent the buildup of electrostatic sparks. If you use a funnel, make sure it's metal and ground the fuel nozzle to the funnel.



**WHEN REFUELING
NEVER . . . !**



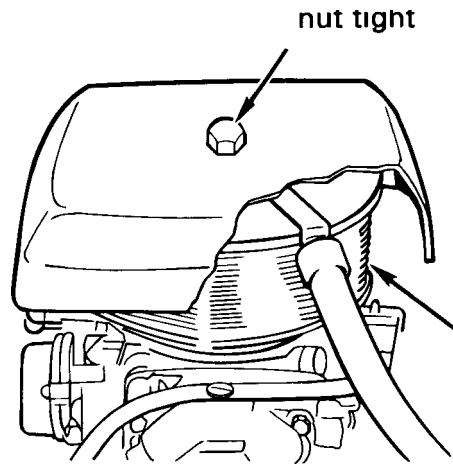
- If you smell gasoline in the engine compartment . . . find its source and stop the leakage.



- Follow "Starting Procedure" outlined in the operator's manual.

Always make sure there are no gasoline fumes in the engine compartment before starting the engine. Open the compartment and use your nose. Don't gamble.

- **Backfire flame arrestor** must be in place and securely attached to the air intake.



Do not alter the backfire flame arrestor.

If loose, damaged, or altered, an engine "backfire" may pass through the flame arrestor assembly into the engine compartment. If fumes are present in compartment, fire and explosion could result.

Summing Up

Now you know some things that can take the joy out of enjoyable boating.

No doubt about it . . . it takes time!

- Reading and understanding instructions.
- Reading and understanding warnings marked with  . . .
- Putting parts together correctly . . .
- Making correct adjustments . . .
- Testing you work.

and making sure

- Worn or damaged parts are replaced,
- Replaced parts are like originals . . . in every way.
- Customer is told of things which need attention . . .

But do you really want the alternative?

Part B - Marine Products and Safety of People* Who Fix Them

Part A talked about safe boating and how you, the mechanic, can help keep it safe for the boater. But what about you? Mechanics can be hurt while . . .

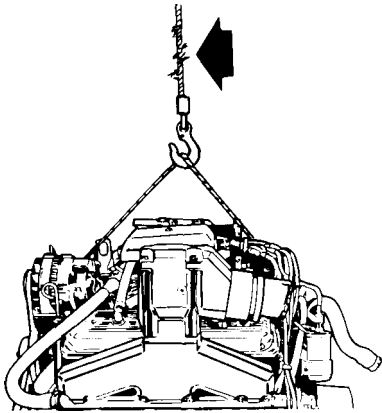
- Servicing boats
- Servicing sterndrives
- Troubleshooting problems
- Testing their work

Some items you'll know . . . others you may not.

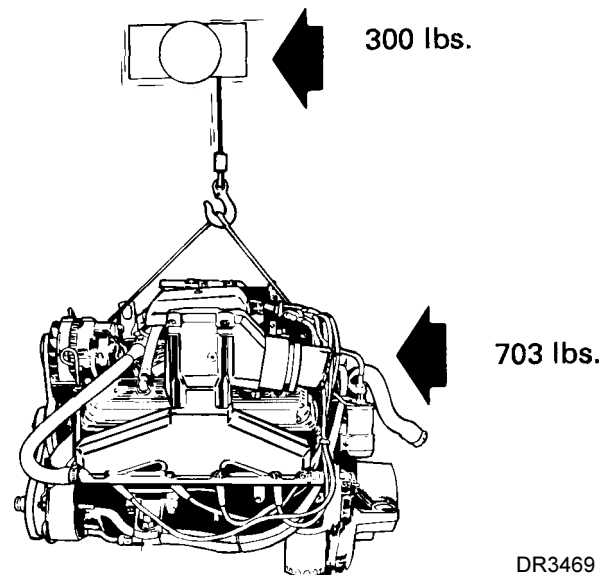
When Lifting Engines

If hoist is poor shape . . . or too small for the job

- Engine may drop suddenly



DR3471



DR3469

- Make sure shop aids have extra capacity — and keep them in good repair!

When Running Engine with Engine Compartment Cover Removed

The engine compartment cover is a guard. When you remove the cover / guard to work on the engine, remember:

- Loose clothing (open shirt sleeves, neckties), long hair, jewelry (rings, watches, bracelets), hands, arms, belts can be caught by moving belts or spinning pulleys
- Handle high voltage ignition components carefully. They can shock you and may cause you to recoil into moving parts.

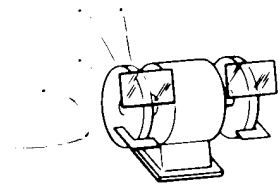
Two people working together on a running engine must look out for each other. Never, ever, hit the key to start the engine before signalling to your partner. (He may be leaning over the engine with his hands on a belt, or a "hot" electrical part, near the propeller, etc.)

*Mechanics, technicians, backyard do-it-yourselfers.

- Exhaust gasses of running engines contain carbon monoxide. . . you can't see it. . . you can't smell it. . . you can't taste it. . . but it's there whenever an engine runs. . . and it's deadly!

When you smell the other gasses in the exhaust, you are inhaling carbon monoxide. Run engines only in well ventilated areas.

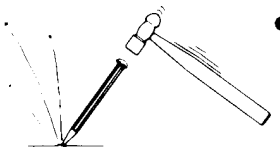
Eyes Need help



- Grinding



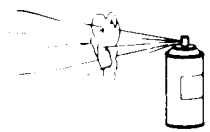
- End of Cables



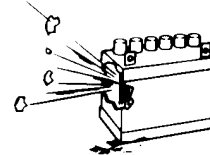
- Chiseling
(steel on steel)
(Tip: Use plastic or brass type hammers.
They don't chip off as easily as steel hammers.)



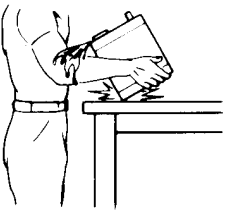
- Sprayed Cleaners, Paints



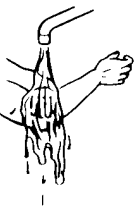
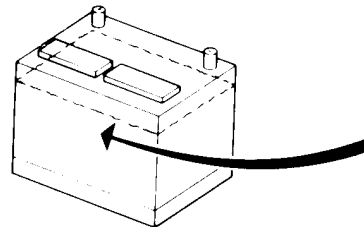
- Acid



Handling Lead Acid Batteries



- If spilled or splashed on any part of body..



Wash with lots of water. . .



- If solution gets into eyes. . . Wash. . . and see a Doctor, fast!

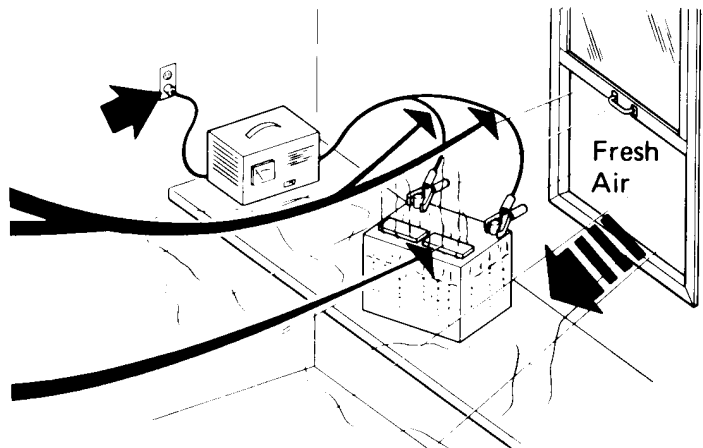


Charging Lead Acid Batteries

1 Attach and remove these cables with charger unplugged from 110 volt wall socket. (Prevents shocks if the charger is defective.)

2 Observe correct polarity when connecting these charger leads.

3 Always charge in a well ventilated area. Charging causes acid solution to give off hydrogen gas through the vents in the caps. . . Make sure vents are open. If clogged, pressure inside may build. . . battery may explode.



Battery gas is explosive!
While charging or discharging,
remember. . .

No Smoking
No Flames
No Sparks



Never yank cables off
battery posts. . . it's a sure
way to make lots of
sparks. . . surrounded by battery gas

Don't check battery condition
by placing metal objects
across posts.

You're sure to make sparks
and serious burns are
possible.

After Charging. . .

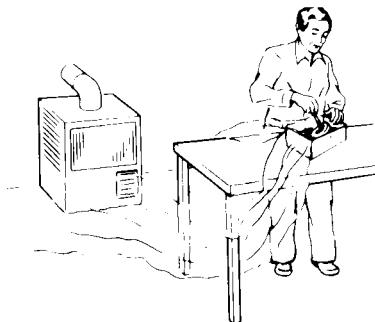


- Shut off charger
- Remove charger plug from wall socket
Then. . .
- Take charger cable off battery posts

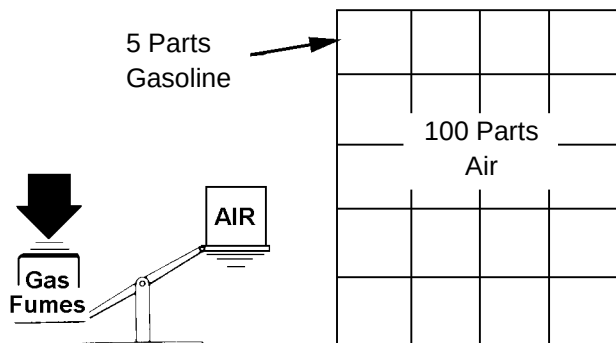
Gasoline! Handle With Care

- When you smell any odor of gasoline,
explosion is possible
- Gasoline fumes are heavier than air and will sink
to the lowest point in the boat or room,
and will stay there. . . waiting

- If the air around you is quiet . . . the pilot light in
the heater may
ignite the heavy fumes
before your nose ever
smells the fumes . .



Gasoline explodes easily and violently when
mixed with air



What Can you Do?

- Store properly . . .
- Fill portable tanks outside boat to prevent spillage in
boat
- Use fuel for fuel . . . not for a solvent
- If fumes are smelled (in shop, basement, garage), immediately:
 - Put out open flames, cigarettes, sparking devices
 - Wipe up spill or leak; get towels, rags outside fast
 - Check lowest area for fumes; open doors or win-
dows

Store in sturdy,
sealed gas can
. . . and . . .
keep outside

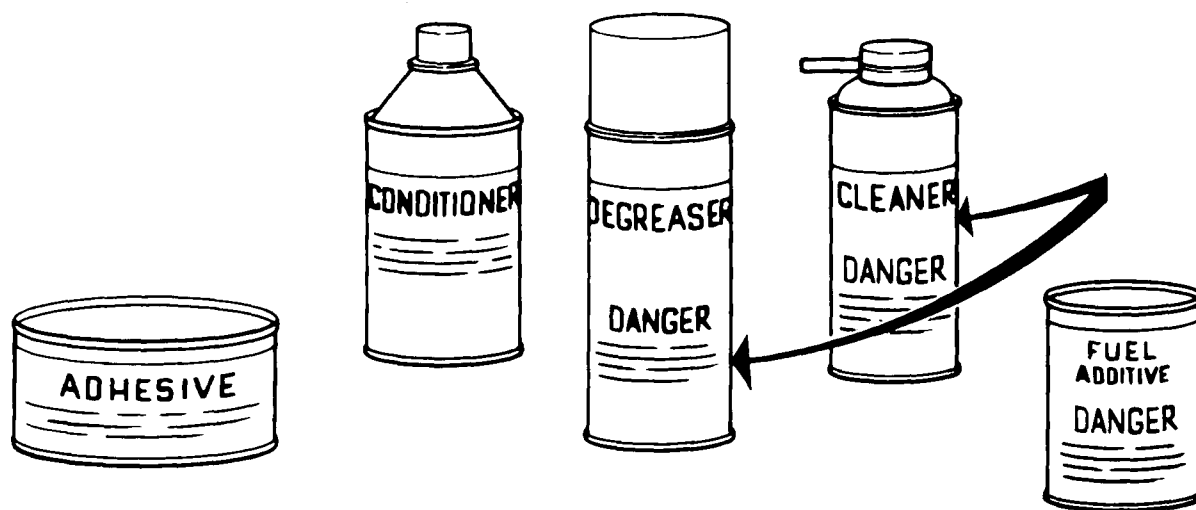


- Know items in and around repair area which can ignite gasoline fumes . . . Control them if fumes are smelled.

- Matches, cigarettes, torches, welders
- Electric motors (with unsealed cases)
- Electric generators (with unsealed cases)
- Light switches
- Appliance pilot lights (furnace, dryer, water heater)
- ??????????

How many of these are in your area?

Hazardous Products



Read the container label. It tells you . . .

- "How, and where, to use,"
- "How to give First Aid," and have "recommended" first aid materials on hand- should an emergency arise
- "How to dispose of can,"

Remember: Little children are very curious and will try to taste everything, so . . .

. . . ymmmmmmmmmmmm



Keep containers away from children

