



BRIGGS & STRATTON
CUSTOMER EDUCATION

ELECTRONIC FUEL INJECTION

SERVICE & DIAGNOSTICS



VANGUARD™ 810 EFI



BIG BLOCK™ EFI

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⚠ CAUTION

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

Proper service and repair are important to the safety of the service technician and the 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 specifically 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 unit will be jeopardized by the replacement part, service procedure or tool selected.

It is important to note that this manual contains various Cautions and Notices 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 unit or render it unsafe. It is also important to understand that these "Cautions" and "Notices" are not exhaustive, because it is impossible to warn of all the possible hazardous consequences that might result from failure to follow these instructions.

All information, illustrations and specifications contained in this manual are based on the latest product information available at the time of publication approval. The right is reserved to make changes at any time without notice.

Common Abbreviations

BARO	-	BAROMETRIC PRESSURE	IC	-	IGNITION CONTROL
BAT	-	BATTERY, BATTERY POSITIVE TERMINAL, BATTERY OR SYSTEM VOLTAGE	IGN	-	IGNITION
B+	-	BATTERY POSITIVE	INJ	-	INJECTOR
CAN	-	CONTROLLER AREA NETWORK	I/O	-	INPUT/OUTPUT
CKT	-	CIRCUIT	kPa	-	KILOPASCAL
CONN	-	CONNECTOR	KV	-	KILOVOLTS
CYL	-	CYLINDER	MAP	-	MANIFOLD ABSOLUTE PRESSURE
DEG	-	DEGREES	MAT	-	MANIFOLD AIR TEMPERATURE
DIAG	-	DIAGNOSTIC	MFI	-	MULTIPORT FUEL INJECTION
DLC	-	DATA LINK CONNECTOR	MIL	-	MALFUNCTION INDICATOR LAMP
DTC	-	DIAGNOSTIC TROUBLE CODE	MSEC	-	MILLISECOND
DVOM	-	DIGITAL VOLT OHMMETER	MPR	-	MAIN POWER RELAY
ECM	-	ENGINE CONTROL MODULE	N/C	-	NORMALLY CLOSED
EHT	-	ENGINE HEAD TEMPERATURE SENSOR	N/O	-	NORMALLY OPEN
EI	-	ELECTRONIC IGNITION	OBD	-	ON-BOARD DIAGNOSTIC
EFI	-	ELECTRONIC FUEL INJECTION	OPT	-	OPTIONAL
EMI	-	ELECTROMAGNETIC INTERFERENCE	PWM	-	PULSE WIDTH MODULATION
ENG	-	ENGINE	RAM	-	RANDOM ACCESS MEMORY
EOP	-	ENGINE OIL PRESSURE	REF HI	-	REFERENCE HIGH
EST	-	ELECTRONIC SPARK TIMING	REF LO	-	REFERENCE LOW
E-STOP-	-	EMERGENCY STOP	ROM	-	READ ONLY MEMORY
FMI	-	FAILURE MODE INDICATOR	SPN	-	SUSPECT PARAMETER NUMBER
GND	-	GROUND	SW	-	SWITCH
GOV	-	GOVERNOR	TAC	-	THROTTLE ACTUATOR CONTROL
GPH	-	GALLONS PER HOUR	TACH	-	TACHOMETER
O ₂	-	HEATED OXYGEN SENSOR	TERM	-	TERMINAL
HG	-	INCHES OF MERCURY	TP	-	THROTTLE POSITION
IAC	-	IDLE AIR CONTROL	TPS	-	THROTTLE POSITION SENSOR
			V	-	VOLTS
			VAC	-	VACUUM
			WOT	-	WIDE OPEN THROTTLE

Wire Color Abbreviations

ABBREVIATION	MAIN COLOR	TRACER COLOR
BLK	- BLACK	-
BLK/WHT	- BLACK	/ WHITE
BLU	- BLUE	-
BLU/BRN	- BLUE	/ BROWN
BLU/YEL	- BLUE	/ YELLOW
BRN	- BROWN	-
GRN	- GREEN	-
GRN/WHT	- GREEN	/ WHITE
GRY	- GREY	-
GRY/BLK	- GREY	/ BLK
LT.BLU	- LIGHT BLUE	-
LT.BLU/BLK	- LIGHT BLUE/	BLACK
LT.BLU/WHT	- LIGHT BLUE/	WHITE
LT.GRN	- LIGHT GREEN	-
ORG	- ORANGE	-
ORG/BLK	- ORANGE	/ BLACK
ORG/WHT	- ORANGE	/ WHITE
PNK	- PINK	-
PNK/BLK	- PINK	/ BLACK
RED	- RED	-
RED/WHT	- RED	/ WHITE
TAN	- TAN	-
TAN/BLK	- TAN	/ BLACK
VIO	- VIOLET	-
VIO/BLK	- VIOLET	/ BLACK
VIO/WHT	- VIOLET	/ WHITE
WHT	- WHITE	-
WHT/GRN	- WHITE	/ GRN
WHT/RED	- WHITE	/ RED
YEL	- YELLOW	-

General Diagnostic Aids

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). When a malfunction is detected by the ECM, a DTC is set and the Malfunction Indicator Lamp (MIL) is illuminated.

Malfunction Indicator Lamp (MIL)

The Malfunction Indicator Lamp (MIL) is designed to alert the operator that a problem has occurred and that the equipment should be taken for service as soon as reasonably possible. As a bulb and system check, the light will come "ON" with the key "ON," engine "OFF." When the engine is started, the light will turn "OFF." If the light remains "ON," the self-diagnostic system has detected a problem. If the problem goes away, the light will go out in most cases after 10 seconds, but a DTC will remain stored in the ECM. When the light remains "ON" while the engine is running, or when a malfunction is suspected due to an operational problem, the "On-Board Diagnostic (OBD) System Check" must be performed as the first step. These checks will expose malfunctions which may not be detected if other diagnostics are performed prematurely.

Diagnostic Trouble Codes DTC's

The Engine Control Module (ECM) monitors all engine operations against preset calibrated limits. When a component goes outside of its calibrated limits the ECM sets a DTC. The DTC will be stored in the ECM and the Malfunction Indicator Lamp (MIL) will illuminate. If the component goes back into it's normal operation window the MIL will shut off but the DTC will still be stored in the ECM under DTC history until it is cleared. If the MIL stays illuminated it indicates a current malfunction in the EFI system and should be serviced immediately.

Reading DTC's using only the MIL blink code.

To activate the MIL blink code follow these steps.

1. Verify the battery is above 12v.
2. Turn off the key switch for 10 seconds.
3. Turn the key ON then OFF, ON then OFF, Then back to the ON position but do not start the engine. Each On then OFF sequence must be done with less than 2.5 seconds in between.
4. If the steps are followed correctly the MIL will begin to blink or flash a series of times. Each series of flashes represents a number. Count the number of blinks and this will give you the Diagnostic Trouble Code(s) that have been set. The DTC(s) that are in the ECM's memory current and history will blink.

NOTE: It is a good technique to write the numbers down after each series has flashed.

5. The DTC's are four numbers long. There is a 1 second pause in between each MIL blink series. Four series of flashes will give you the four digit diagnostic trouble code. After the DTC(s) are blinked a two digit 61 will blink to indicate the DTC(s) have all been shown.
6. The code 61 will always be the last code to blink. If code 61 blinks immediately The ECM has not set any DTC's and the EFI system is operating properly.

Example of how to decipher the MIL blink codes with the end code

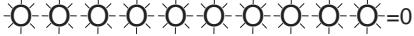
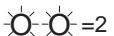
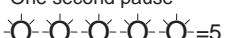
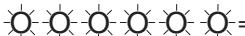
	One second pause	
	One second pause	
	One second pause	
	Three second pause	Diagnostic Trouble Code P0251
	One second pause	
		End Code 61

Figure 1-1 MIL blink code example.

Reading Diagnostic Trouble Codes (With out using the Mil blink code)

The provision for communicating with the ECM is the Data Link Connector (DLC) refer to figure 1-2. It is part of the engine wiring harness, and is a 6-pin connector, which is electrically connected to the ECM. The DTC's stored in the ECM's memory can be retrieved through a hand-held diagnostic code reader plugged into the DLC, or a PC based software program designed to interface with the ECM data stream.

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." This is the starting point for the diagnostic procedures. The OBD system check will lead to a diagnostic table in the Diagnosis section to correct the problem.
2. Is there a DTC stored? If a DTC is stored, go directly to that DTC table number in the Diagnosis section.

Using the Tiny Scan tool to read DTC's

Connect the Tiny Scan tool to the Diagnostic Link Connector (DLC). Once connected turn the ignition "ON" Engine "OFF." Once the ignition is on the Tiny Scan will read all diagnostic trouble codes (DTC's.) If for some reason the Tiny Scan cannot connect to the ECM to read the DTC's it will display no-C which means no communication.

After the DTC's have been read, the unit will show how many DTC's were read. For example dc-4 means that 4 DTC's were read. Pressing the select button will cycle and show each DTC. After the last DTC is read it will take you to the cleared code screen, hold the button until the screen says hold and continue to hold it down until it changes to clr (clear). Pressing the button again will rescan for persistent DTC's. It is helpful to write down each DTC as it is shown to help with further diagnostics when they are needed.

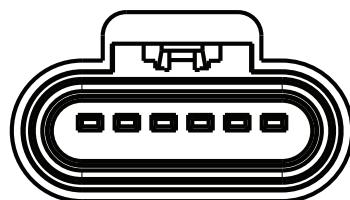


Figure 1-2 Data Link Connector (DLC)

Technician Assistant Diagnostic Software

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 Technician Assistant Diagnostic Software 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. The Technician Assistant Diagnostic Software does not make the use of diagnostic tables unnecessary, nor do they indicate exactly where the problem is in a particular circuit.

Technician Assistant Diagnostic Software With Intermittents

Intermittents are problems that occur in irregular intervals. The system may function normally most of the time then occasionally have problems that seem to fix themselves. This a good example of an intermittent problem.

The Technician Assistant Diagnostic Software provides the ability to perform a "wiggle test" on wiring harnesses or components with the engine not running, while observing the display.

The Technician Assistant Diagnostic Software can be plugged in and observed while operating under the condition when the MIL turns "ON" or the engine operation is poor. If the problem seems to be related to certain parameters that can be checked on the Technician Assistant Diagnostic Software, they should be checked during operation with engine running. If there does not seem to be any correlation between the problem and any specific circuit, the Technician Assistant Diagnostic Software 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 Technician Assistant Diagnostic Software 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 engine may uncover the problem.

The Technician Assistant Diagnostic Software has the ability to save time in diagnosis and prevent the replacement of good parts. The key to using the Technician Assistant Diagnostic Software successfully for diagnosis lies in the technician's ability to understand the system they are trying to diagnose, as well as an understanding of the Technician Assistant Diagnostic Software 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."

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 calibratable length of time, a DTC will be stored. The MIL will be illuminated and a calibrated default value will replace the sensor value to restore engine performance.

Clearing Diagnostic Trouble Codes

The following procedure will instruct you on the method for clearing codes from the ECM's fault code memory.

Before you clear codes it is advisable to record the codes by writing them on a piece of paper or in your service notebook. Since you may want to remember which codes were set at a later time, writing them down will be a

good diagnostic aid.

1. Connect your code reader, or PC to the 6 pin diagnostic link connector (DLC) located on the wiring harness. You will need to remove the cap from this connector to access the connector.
2. Turn the ignition key to the on position (key on), Engine off.
3. Select the "clear codes" or the "clear DTC's" function
4. Clear DTC's
5. Turn Ignition OFF (key off) for at least 20 seconds.
6. Turn ignition ON and reread DTC's. If DTC's are still present, check "Notice" below and repeat procedure following from step 2.

NOTICE: When clearing DTC's with the use of a code reader, the ignition must be cycled to the OFF position or the DTC's will NOT clear.

Non-Scan Diagnosis of operating concerns (No DTC's Set)

If Operating concerns still exist 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 EFI 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 engine 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 may go undetected by the ECM and may result in an operation concern.

A good example of this would be if the Engine Head Temperature (EHT) Sensor was reading incorrectly and indicating to the ECM that Engine Head Temperature was at 20°F, but the actual temperature was at 150°F. This would cause the ECM to deliver more fuel than what was actually needed by the engine. This would result in an overly rich condition, causing rough running. This condition would not have caused a DTC to set, as the ECM interprets this within the operating "window".

To identify a sensor that is out of range, you could unplug the sensor electrical connector while the engine is running. After a short period of time, 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 variation is observed, the DTC table for that particular sensor should be followed to correct the problem.

NOTICE: Be sure to clear each DTC after disconnecting and reconnecting each sensor. Failure to do so may result in a misdiagnosis of the operation concern.

Battery Disconnect Caution

⚠ Caution: Before servicing any electrical component, the ignition key must be in the OFF or LOCK position and all electrical loads must be OFF, unless instructed otherwise in the procedures. As a further precaution, you may want to disconnect the battery cables from the battery terminals.

This will help ensure that there will not be any accidental short-to-ground connections. Failure to follow these precautions may cause personal injury and/or damage to the equipment or its components.

Special Tool and Equipment

	Fuel Pressure Gauge Service Tool Part # 19627		Spark Tester Service Tool Part # 19368
	Digital Volt Ohmmeter Extech Ma220 Service Tool Part #19602		Test Light (Source Locally)
	Diagnostic Cable # 19628		Back Probe Wire Set Service Tool Part # 19625
	Noid Light Service Tool Part # 19623		Tiny Scan Code reader Service Tool Part # 19626
	BIG BLOCK™ Fuel PSI Test Adapter # 19624		

Service Precautions

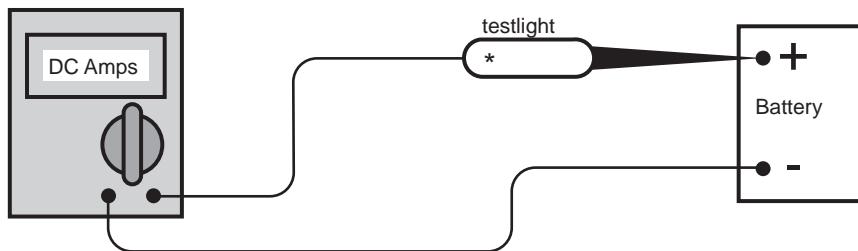
Service Precautions

The following requirements must be observed when working on 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 equipment's electrical system.
6. Ensure that all cable harnesses are connected solidly 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 equipment, disconnect the battery leads and the ECM connectors.
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 Digital Volt Ohmmeter (DVOM) must use a digital meter with a rating of 10 megohm 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 Volt Ohmmeter DVOM) in series with the test light being tested, and power the test light ammeter circuit with the battery.



If the ammeter indicates **less** than 3/10 amp (.3A) current flow, the test light is **safe** to use.
 If the ammeter indicates **more** than 3/10 (.3A) current flow, the test light is **not safe** to use.

Figure 1-3Test Light Amperage Draw Test

General Circuit Testing

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.

Wiring Connector Service

Most connectors on the engine wiring harness 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 sensor 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.

Probing Electrical Connectors

Back probe

Back probing connectors if done properly is a safe and effective way to check and verify the wiring harness. To back probe a terminal, slide the metal pin side of the back probe adaptor in between the wire and the seal on the back side of the connector. Push the back probe adaptor gently into the connector until it stops. DO NOT force the back probe adaptor into the connector or it may damage the terminal.

Important:

- Back probe connector terminals only when required in diagnostic procedures.
- Back probing can be a source of damage to connector terminals. Use care in order to avoid deforming the terminal, either by forcing the back probe too far into the cavity or by using too large of a back probe. .
- After back probing any connector, inspect for terminal damage. If terminal damage is suspected, test for proper terminal contact.

Do not disconnect the connector and probe the terminals from the harness side (front) of the connector.

Notice: Do not insert test equipment probes into the mating side (front) of any connector or fuse block terminal. The diameter of the test probes will deform most terminals. A deformed terminal can cause a poor connection, which can result in system failures. Do not use paper clips or other substitutes as they can damage terminals and cause incorrect measurements.

Testing for Intermittent and Poor Connections

Most intermittent conditions are caused by faulty electrical connections or wiring. Inspect for the

General Circuit Testing

following items:

- Wiring broken inside the insulation
- Poor connection between the male and female terminal at a connection.
- Poor terminal to wire connection—Some conditions which fall under this description are poor crimps, poor solder joints, crimping over the wire insulation rather than the wire itself and corrosion in the wire to terminal contact area, etc.
- Wire insulation which is rubbed through, this causes an intermittent short as the bare area touches other wiring or parts of the engine.

Troubleshooting with a Digital Volt

Ohmmeter Test Probe Notice

A DVOM should be used instead of a test lamp in order to test for voltage in high impedance circuits. While a test lamp shows whether voltage is present, a DVOM indicates how much voltage is present.

The ohmmeter function on a DVOM shows how much resistance exists between 2 points along a circuit. Low resistance in a circuit means good continuity.

Important: Disconnect the power feed from the suspect circuit when measuring resistance with a DVOM. This prevents incorrect readings. A DVOM applies such a small voltage to measure resistance that the presence of any other voltages can upset the resistance reading.

Diodes and solid state components in a circuit can cause a DVOM to display a false reading. To find out if a component is affecting a measurement take a reading once, then reverse the leads and take a second reading. If the readings differ the solid state component is affecting the measurement.

Troubleshooting with a Test Light

A test lamp can simply and quickly test a low impedance (low resistance) circuit for voltage.

To properly operate a test light use the following procedure.

1. Attach 1 lead to ground.
2. Touch the other lead to various points along the circuit where voltage should be present.
3. When the bulb illuminates, there is voltage

at the point being tested.

Troubleshooting using a Noid Light

A noid light can simply and quickly test the fuel injector circuit and the Ignition coil circuit for voltage.

To properly operate a noid light use the following procedure.

1. Verify the noid light you are using has the correct terminals on it so it doesn't misshape the connector terminals it's being plugged into.
2. Plug the noid light into the circuit to be tested.
3. Start or turn over the engine. If the noid light blinks there is voltage at the point being tested.

Measuring Voltage

Notice: Refer to Test Probe Notice

The following procedure measures the voltage at a selected point in a circuit.

1. Disconnect the electrical harness connector for the circuit being tested, if necessary.
2. Enable the circuit and/or system being tested. Use the following methods:
 - Ignition ON Engine OFF.
 - Ignition ON Engine ON.
 - Turn on the circuit and/or system with a scan tool in Output Controls.
 - Turn on the switch for the circuit and/or system being tested.
3. Select the V (AC) or V (DC) position on the DVOM.
4. Connect the positive lead of the DVOM to the point of the circuit to be tested.
5. Connect the negative lead of the DVOM to a good ground.
6. The DVOM displays the voltage measured at that point.

Introduction to Wiring

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 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.

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.

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 equipment 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.

On-Board 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 as shown in Figure 1-4.

Use care when probing a connector or replacing a connector terminal. It is possible to short between adjacent 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.

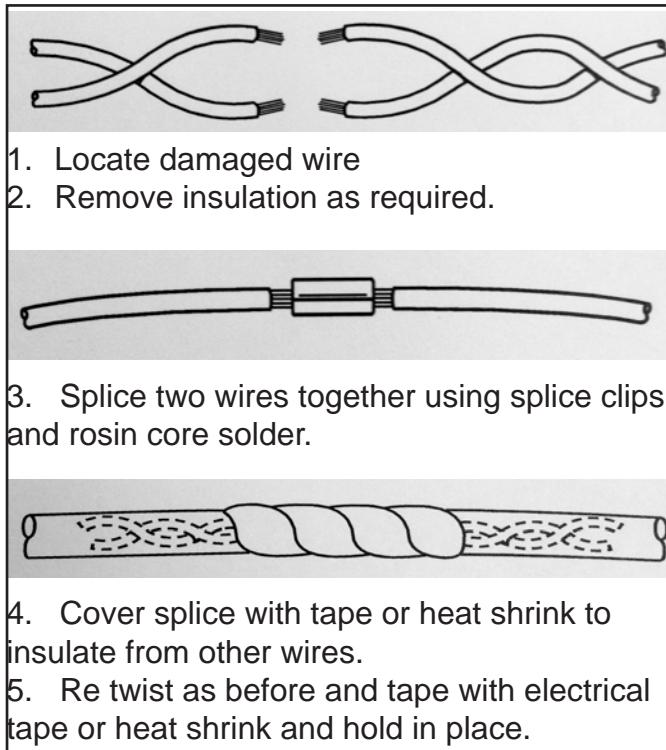


Figure 1-4 Wire Splicing Procedure

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Model 490000 (810 Vanguard) EFI component Locator

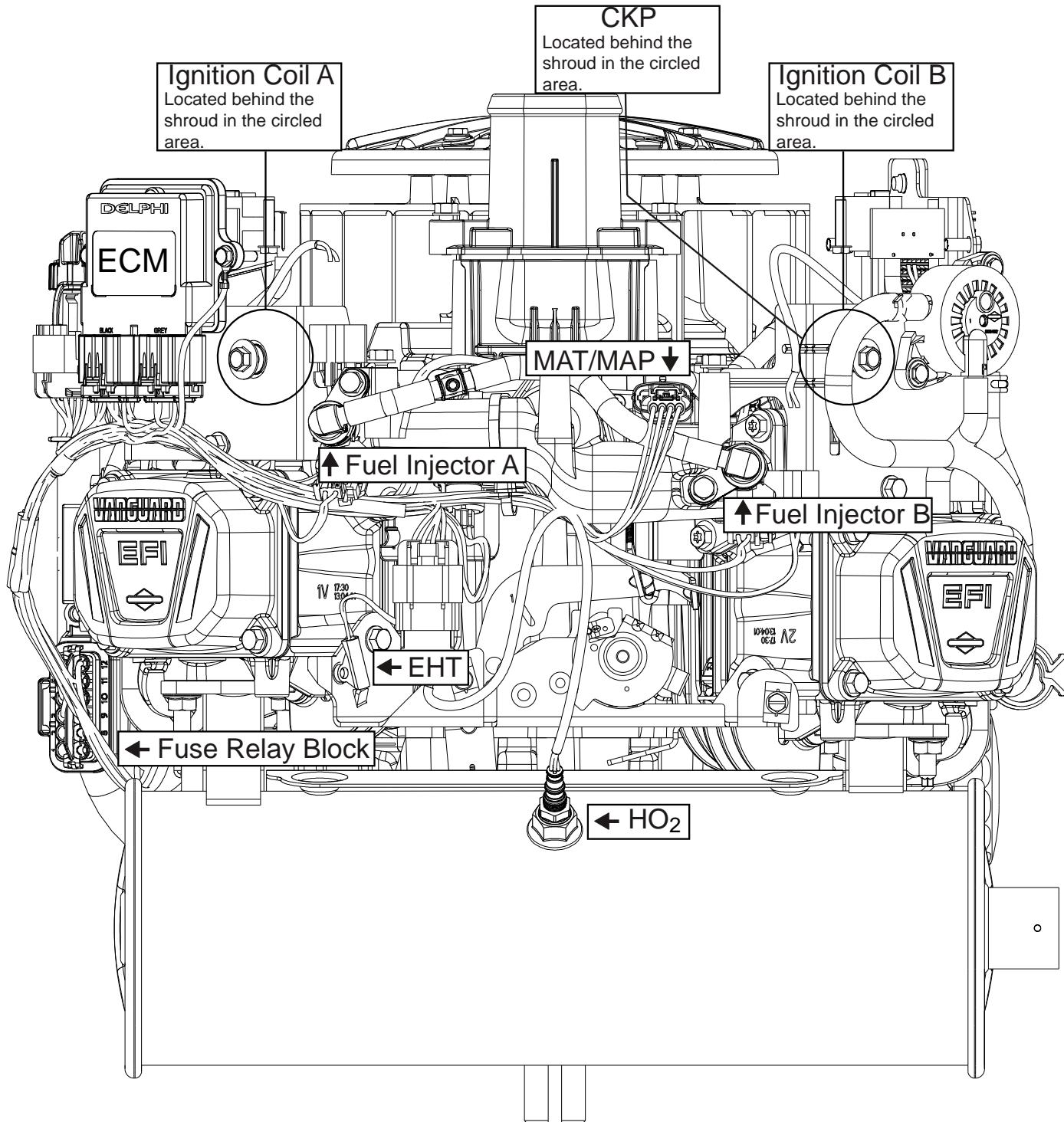


Figure 1-5 Model 490000 Component locator
(Some shrouds have been removed for better component visual aid.)

Model 610000 (Big Block) component Locator

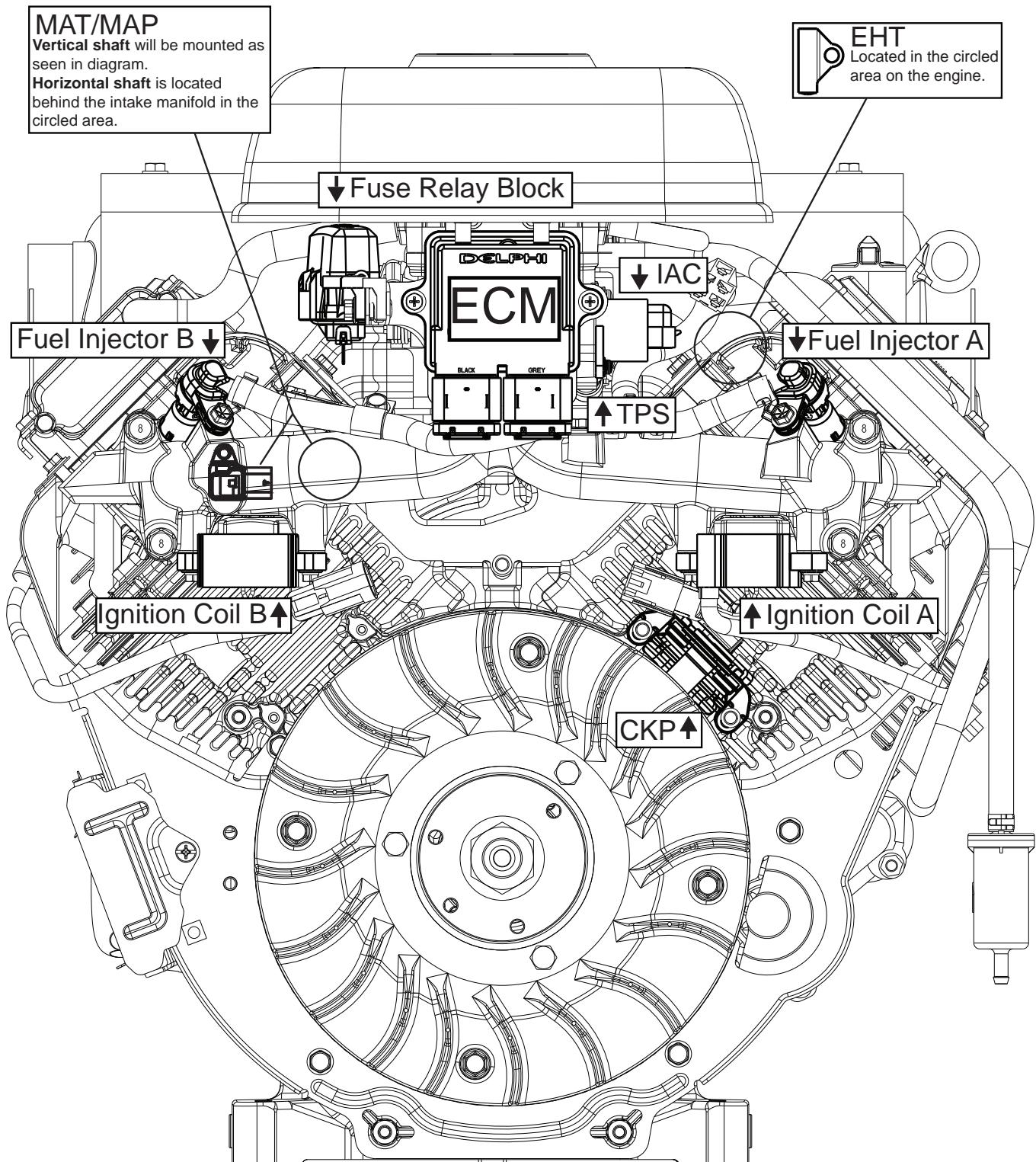


Figure 1-6 Model 610000 Component locator
(Some shrouds have been removed for better component visual aid.)

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General Description

Purpose

The function of the fuel metering system is to deliver the correct amount of fuel to the engine under all operating conditions. Fuel is delivered to the engine by individual fuel injectors mounted in the intake manifold near each cylinder.

Modes Of Operation

The ECM looks at inputs from several sensors to determine how much fuel to deliver to 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

On the 490000 Model when the ignition switch is turned to the crank position, the ECM turns the fuel pump "ON." On the 610000 Model when the ignition switch is turned to the crank position, the ECM sends a ground signal to the fuel pump relay. The ground signal powers up the relay. The fuel pump relay then sends B+ to the fuel pump(s). The ECM then checks the MAP sensor or barometric pressure and determines the proper air/fuel ratio for starting. The ECM controls the amount of fuel delivered in the starting mode by changing how long the injectors are turned "ON" and "OFF." This is done by "pulsing" the injectors for very short times.

Run Mode

During the cranking event, once the engine passes a 300 RPM threshold, the engine is said to be in the RUN mode. The ECM will calculate the desired air/fuel ratio based on these ECM inputs: RPM, EHT sensor and MAP. Higher engine loads (MAP input) and colder Engine Head Temperatures (EHT input) require more fuel, or a richer air/fuel ratio.

Acceleration Mode

The ECM looks at rapid changes in TPS (if equipped) and MAP, and provides extra fuel by increasing the injector pulse width.

Fuel Cutoff Mode

No fuel is delivered by the injector when the ignition is "OFF," to prevent dieseling. Also, in-

jector pulses are not delivered if the ECM does not receive reference pulses from the crank position sensor, which means the engine is not running.

Closed Loop Fuel Control

The ECM monitors the EHT and oxygen sensor. The ECM needs to monitor the exhaust stream to adjust the air/fuel ratio so that the engine will operate at peak efficiency. Measuring the amount of oxygen remaining after combustion is a means to indicate the air/fuel ratio. A richer mixture will consume more oxygen during combustion than a leaner mixture. The oxygen sensor or air/fuel ratio sensor measures the amount of oxygen remaining after the combustion in the exhaust stream. Using this information and information from the other sensors on the EFI system the ECM will control the injection duration to achieve the ideal air/fuel ratio.

NOTE: The engine operation often requires different air/fuel ratios for starting, maximum power and maximum fuel economy.

Fuel Pump Electrical Circuit model 490000

When the ignition switch is turned "ON," the ECM turns the fuel pump "ON" for two seconds causing the fuel pump to pressurize the fuel system.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump "ON" causing the fuel pump to run.

If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts "OFF" the fuel pump, causing the fuel pump to stop.

Fuel Pump Electrical Circuit model 610000 (Big Block)

When the ignition switch is turned "ON," the ECM turns the fuel pump relay "ON" for two seconds causing the fuel pump to pressurize the fuel system.

When the ignition switch is turned to the crank position, the ECM turns the fuel pump relay "ON" causing the fuel pump to run.

If the ECM does not receive ignition reference pulses (engine cranking or running), it shuts

Fuel Metering System Components (If Equipped)

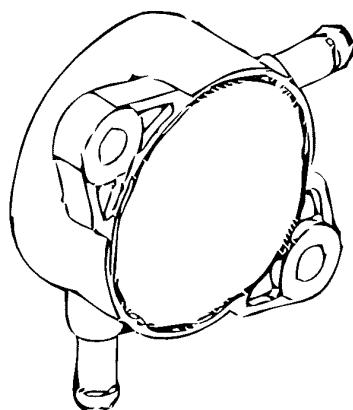


Figure 2-1 Mechanical Diaphragm Fuel Pump

"OFF" the fuel pump relay, causing the fuel pump to stop.

Fuel Injectors

The injector assembly is a solenoid like operated device, controlled by the ECM, that meters pressurized fuel to a single engine cylinder. The ECM energizes the injector, which opens a pintle valve, allowing fuel to flow past the pintle valve, and through a recessed flow director plate. The director plate has machined holes that control the fuel flow, generating a conical spray pattern of finely atomized fuel at the injector tip. Fuel can be directed at the intake valve, causing it to become further atomized and vaporized before entering the combustion chamber.

Fuel Rail Assembly

The fuel rails are either a specially formulated hard hose or a rubber flexible hose depending on the application. An O-ring equipped quick-disconnect device is located on the fuel module. To remove the fuel line squeeze the two tabs together and gently pull back on the fitting to disconnect it from the fuel fitting.

Fuel Supply Components (Pump-on engine)
The fuel supply is stored in the fuel tank. On the model 490000 (810 Vanguard) a mechanical diaphragm pump (figure 2-1) is located on the plastic shroud near cylinder 2. It uses crank case pressure to operate a diaphragm style pump to pull fuel from the fuel tanks and through an in line filter. The diaphragm pump then pushes the fuel to the electrical fuel

pump module that is located on the side of the engine. The fuel pump module (figure 2-8) has an electric pump and a fuel regulator inside it to maintain a constant pressure of 39 psi through the fuel rail to the fuel injectors.

On the marine model 610000 the electric lift pump will be located somewhere in the fuel line between the remote fuel tank and the fuel pump module. The electric diaphragm (figure 2-6) pump pulls fuel from the fuel tank through an in-line filter then pushes it through a second in-line filter and supplies the fuel pump module. The fuel pump module (figure 2-8) has an internal fuel regulator inside it to maintain a constant fuel pressure to the fuel injectors.

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.

ECM Function

The ECM supplies either 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 may not illuminate when connected to the circuit. In some cases, an ordinary voltmeter will not give an accurate reading because its resistance is too low. Therefore, a digital voltmeter Extech Ma220 (Part number 19602) should be used. The ECM controls output circuits such as the injectors, relays, etc. by controlling the ground or power feed circuit.

Throttle Position Sensor (TPS) If equipped
The Throttle Position Sensor (TPS) is a potentiometer connected to the throttle shaft on the

throttle body. By monitoring the voltage on the signal line, the ECM calculates throttle position. As the throttle valve angle is changed, the TPS signal also changes, at a closed throttle position, the output of the TPS is low. As the throttle valve opens, the voltage output increases so that at Wide Open Throttle (WOT) the output voltage should be above 4 volts. (The TPS is not used on all models.)

In-Line Fuel Filter.

On the model 490000 (810 Vanguard) the fuel filter is located on the fuel line in between the fuel tanks and the mechanical lift pump.

On the marine model 610000 (Big Block) there are two in-line filters. One is located before the electric lift pump and one after the electric lift pump. To replace the filters remove both hose clamps one on either end.

⚠Caution: The line may be pressurized. Cover the line with a shop towel to eliminate any fuel discharge. Wear safety glasses at all times.

Always replace with a new fuel filter. Most filters will have a direction arrow on the filter. Make sure it is pointing towards the fuel line going to the engine.

Fuel Control On-Board Service

- The following is general information required when working on the fuel system.
- Always keep a dry chemical fire extinguisher near the work area.
- 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 to the repair.
- Observe all notices and cautions.

Fuel Pressure Relief Procedure

⚠Caution:

- Make sure you are wearing proper eye protection.
- Make sure there are no open flame or potential ignition devices in the area that you are working.
- Collect any fuel in an approved container and dispose of it properly.

Tool Required:

Fuel Pressure Gauge (Service Tool Part #19627)

1. Disconnect negative battery cable to avoid possible fuel discharge if an accidental attempt is made to start the engine.
2. Loosen fuel filler cap to relieve any tank vapor pressure.
3. Connect the fuel pressure gauge to the fuel pressure test port (Schrader valve.) Wrap a shop towel around fitting while connecting the gauge to avoid any spillage.
4. Install bleed hose to the fuel pressure gauge then put the other end of the hose into an approved container and open valve to bleed system pressure. Fuel connections are now safe for servicing.
5. Drain any fuel remaining in the gauge into an approved container.

Fuel Rail Assembly

The fuel rails should be removed as an assembly with the injectors attached.

Notice:

- Use care in removing the fuel rail assembly to prevent damage to the injector electrical connector terminals and the injector spray tips.
- Prevent dirt and other contaminants from entering open lines and passages. Fittings should be capped and holes plugged during servicing.

Clean

- Before removal, the fuel rail assembly may be cleaned with a spray type engine cleaner, following package instructions. **Do Not** soak fuel rails in liquid cleaning solvent.

⚠ Caution: Safety glasses must be worn when using compressed air as flying dirt particles may cause eye injury.

- Where injectors fit into intake manifold, use low pressure compressed air to remove any debris from around injectors before removing.

Remove or Disconnect

🔥 Caution: To reduce the risk of fire and Personal injury, relieve the fuel system pressure before servicing the fuel system components.

1. Remove the negative battery cable.
2. Remove the air box.
3. Remove the plastic upper engine shroud.
4. Disconnect the fuel pump(s) and fuel injector electrical connectors.
5. Remove the band clamps and the fuel injector caps that attach the fuel rail to the intake manifold and fuel injectors.
6. Remove the fuel injectors and the fuel rail together.
7. Squeeze the two tabs together on the quick disconnect fitting and pull away from the pump.

Install or Connect

Note: When replacing the fuel rail the entire assembly should be replaced.

1. Push the quick disconnect fitting back on the fuel pump module. Push firmly until you feel it fully seat. Give the connector a gentle tug to insure that it is properly seated.
2. Install Fuel injectors and the fuel rail together.
3. Connect the fuel pump(s) and fuel injector electrical connectors.
4. Install the plastic upper engine shroud.
5. Install the air box.
6. Hook up the negative battery terminal.

Inspect

Turn ignition switch to the “ON” position for 2 seconds, then turn to the “OFF” position for 10 seconds. Turn the ignition switch back to the “ON” position and check for fuel leaks.

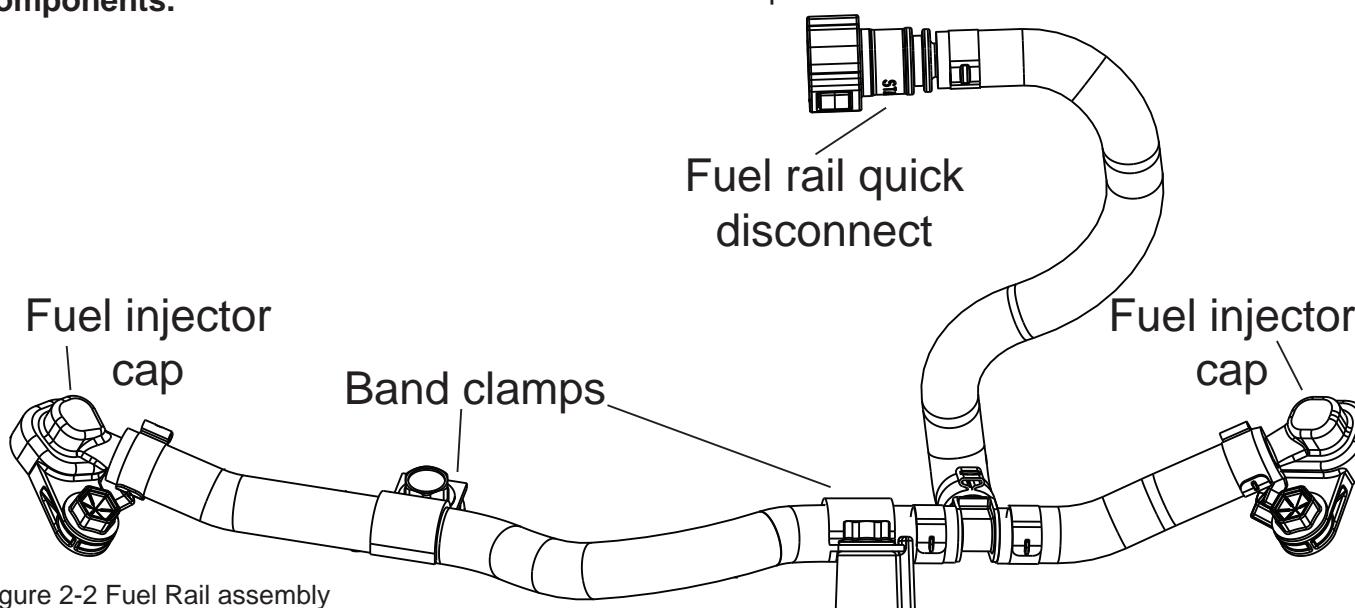


Figure 2-2 Fuel Rail assembly

Fuel Injectors

Notice: Use care in removing injectors to prevent damage to the injector electrical connector pins or the injector spray tips. The fuel injector is serviced as a complete assembly only. Since it is an electrical component, **Do Not** immerse it in any cleaner.

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.

Remove or Disconnect

1. Remove the negative battery cable.
2. Relieve the fuel pressure.
- Refer to the “Fuel Pressure Relief Procedure.”
3. Remove the fuel rail assembly following the procedures outlined in this section.

Disassemble

1. The injector will pull right out of the fuel rail.
2. Remove the bolt on each fuel injector cap that secures the fuel rail to the intake manifold and fuel injector.
3. Remove the injector O-ring seals from both ends of the injector and discard.

Clean and Inspect

Injector bores in fuel rail and intake manifold for nicks, burrs or corrosion damage. If severe, replace. Clean lightly with emery cloth in a radial motion.

Inspect injector O-ring seal grooves for nicks,

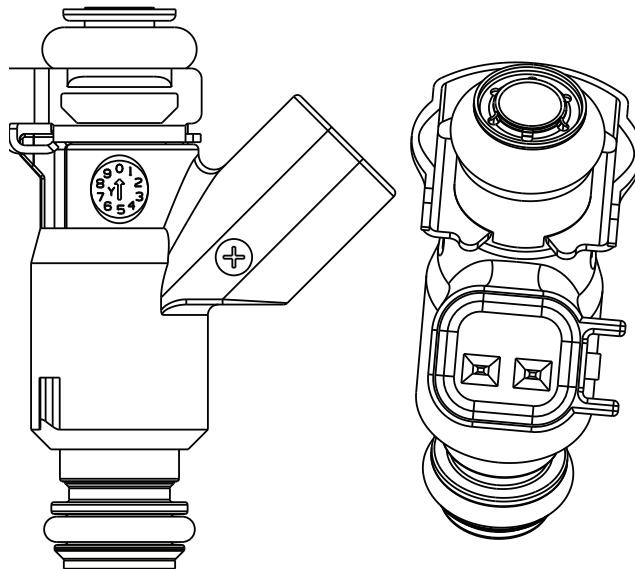


Figure 2-3 Fuel Injector side and top views.

burrs or corrosion. Replace injector if damaged. Clean with spray cleaner and wipe groove clean with lint free cloth.

- Do Not use abrasive materials or wire brush on injectors. They are plated with an anti-corrosive material.

Important

- When ordering individual replacement fuel injectors, be sure to order the identical part number that is inscribed on the old injector.

Assemble

1. Lubricate new injector O-ring seals with clean engine oil and install on injector.
2. EFI fuel injector assembly into fuel rail injector socket with electrical connector facing outward.

Install or Connect

1. Install the fuel rail assembly following procedures outlined in this section.
2. Connect the negative battery cable.

Inspect

- Turn ignition switch to the “ON” position for 2 seconds, then turn to the “OFF” position for 10 seconds. Turn the ignition switch back to the “ON” position and check for fuel leaks.

Diaphragm Lift Pump for Model 490000 (810 Vanguard)

⚠ Caution:

- Make sure you are wearing proper eye protection.
- Make sure there are no open flame or potential ignition devices in the area where you are working.
- Whenever you remove a hose or fitting, make sure to cover the area with a shop towel so as to minimize any fuel spray that may occur from residual pressure in the line.
- Collect any fuel in an approved container and dispose of it properly.
- Be careful not to get any debris in the fuel line or fuel pump.

Remove or Disconnect

1. Remove the negative battery cable.
2. Relieve fuel pressure.
- Refer to the "Fuel Pressure Relief Procedure" in this section.
3. Remove the two hose clamps that attach the two fuel lines to the pump.
4. Remove the 2 screws that attach it to the plastic shroud.
5. Gently pull the crankcase hose off.

Install or Connect

Note: Briggs & Stratton hose clamps should be replaced with factory components to ensure proper fitment and tensions.

1. Gently push the crank case hose on.
2. Mount the diaphragm pump using the two screws. The diaphragm lift pump should be installed in the same position as seen in figure 2-4 with the vent port and fuel inlet port pointing down.
3. Slide the inlet and outlet hose back on and clamp them down securely using hose clamps.
4. Slide the crank case vent hose back onto the pump.
5. Connect the negative battery terminal.

Inspect

Start or crank over the engine for 15 to 20 seconds. Check fuel line connections for leaks.

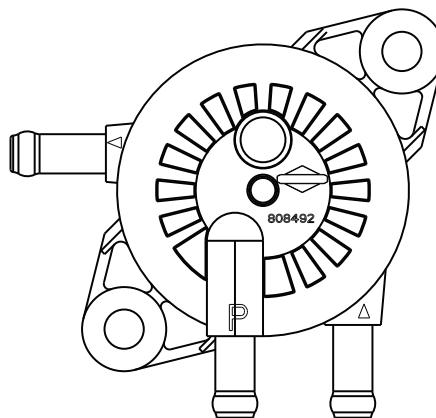


Figure 2-4 Mechanical Diaphragm Fuel Pump

Fuel Volume Testing

The purpose of this test is to verify that the proper amount of fuel is being delivered to the engine. In order to validate proper delivery volumes, a volumetric test may be performed. Since there are two different style pumps used on this system, there is a separate test procedure for each style pump.

To test the mechanical diaphragm style "lift" or feeder pump, use the following procedure to verify the proper volumetric output.

1. Carefully observe the safety precautions.
2. Disconnect the negative battery terminal.
3. Disconnect the fuel line on the **OUTPUT** side of the pump
4. With a volumetric measuring device with marked graduations (graduated cylinder or measuring cup), measure the volume of fuel discharged from the pump. To do this, re-connect the negative battery cable, start the engine and watch for fuel to discharge from the now disconnected hose. As soon as you begin to see fuel flow, start a stopwatch and continue to run for 30 seconds at 2200 RPM. After 30 seconds, turn off the engine. Refer to the specification chart for the approximate volume of fuel discharged.

Fuel pumping for 30 seconds	
Fuel Amount	237 ml
	0.5 pt
	0.25 qt
	1.0 cup

Note:

- The engine will run for a period of longer than the 30 second interval using fuel trapped in the electric pump reservoir.
- Volumetric measurements are only approximate. If you are within 10% of the specified measurement, the pump is likely functioning properly.
- If you are measuring the fuel with a measuring device that is placed **BELLOW** the fuel pump. The pump will gravity feed and give you a false reading.

Engine Cranks but will not start

If the engine cranks but will not start you may choose to perform a volumetric measurement test. Disconnect the **output** side of the fuel pump. Use a measuring device to measure the amount of fuel. Turn the engine over using the starter for 10 seconds. Compare your results to the chart below. Actual amounts will vary slightly.

Engine cranking for 10 seconds	
Fuel Amount	
	65 ml
	0.13 pt
	0.06 qt
	0.27 cup

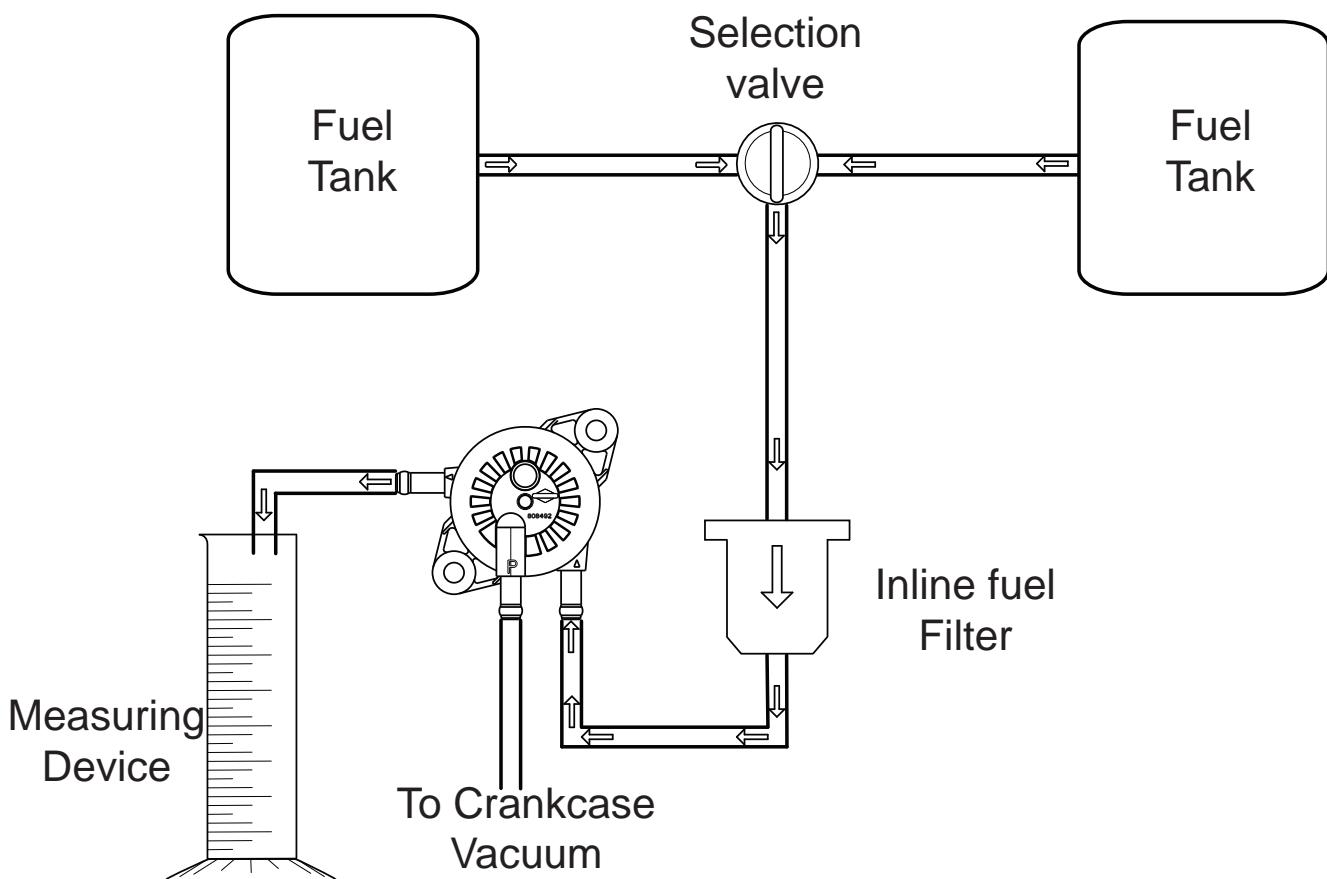


Figure 2-5 How to measure the flow rate of the diaphragm fuel pump.

Lift Pump For Model 610000 (Big Block)

⚠ Caution:

- Make sure you are wearing proper eye protection.
- Make sure there are no open flame or potential ignition devices in the area where you are working.
- Whenever you remove a hose or fitting, make sure to cover the area with a shop towel so as to minimize any fuel spray that may occur from residual pressure in the line.
- Be careful not to get any debris in the fuel line or fuel pump.

Remove or Disconnect

1. Remove the negative battery cable.
2. Disconnect the fuel pump from the wiring harness
3. Relieve fuel pressure.
- Refer to the "Fuel Pressure Relief Procedure", in this section.
4. Remove the screws that mount the lift pump.
5. Remove both hose clamps that attach the fuel line to the pump.

Install or Connect

Note: Briggs & Stratton hose clamps should be replaced with factory components to ensure proper fitment and tensions.

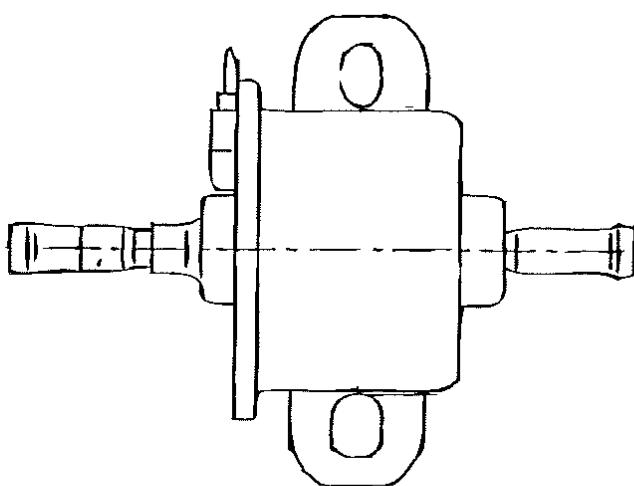


Figure 2-6 Model 610000 Fuel Lift Pump

1. Connect the inlet and outlet hoses and fasten them securely with hose clamps
2. Fasten the pump using 2 screws.
3. Connect the fuel pump electrical connector to the wiring harness.
4. Connect the negative battery terminal.

Inspect

Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

Testing

The purpose of this test is to verify that the proper amount of fuel is being delivered to the engine. In order to validate proper delivery volumes, a volumetric test may be performed. Since there are two different style pumps used on this system, there is a separate test procedure for each style pump.

To test the diaphragm style "lift" or electrical feeder pump, use the following procedure to verify the proper volumetric output.

1. Carefully observe the safety precautions.
2. Disconnect the negative battery terminal.
3. Disconnect the fuel line on the **OUTPUT** side of the pump
4. With a volumetric measuring device with marked graduations (graduated cylinder or measuring cup), measure the volume of fuel discharged from the pump. To do this, re-connect the negative battery cable.

NOTICE: The fuel pump will prime for 2 seconds when the ignition is keyed on.

Do not count that fuel in the measured amount. Start the engine and watch for fuel to discharge from the now disconnected hose.

- If the engine will not run, hook a fused jumper wire to the Deutch connector on the lift fuel pump. Hook the other side of the fused jumper wire to 12v B+.
5. As soon as you begin to see fuel flow, start a stopwatch and continue to run for 30 seconds. After 30 seconds, turn off the engine. Refer to the specification chart for the approximate volume of fuel discharged.

Note:

- The engine will run for a period of longer than the 30 second interval using fuel trapped in the electric pump reservoir.
- Volumetric measurements are only approximate. If you are within 10% of the specified measurement, the pump is likely functioning properly.
- If you are measuring the fuel with a measuring device that is placed **BELLOW** the fuel pump. The pump will gravity feed and give you a false reading.

Fuel pumping for 30 seconds	
Fuel Amount	
	478 ml
	1.0 pt
	0.5 qt
	2.0 cup

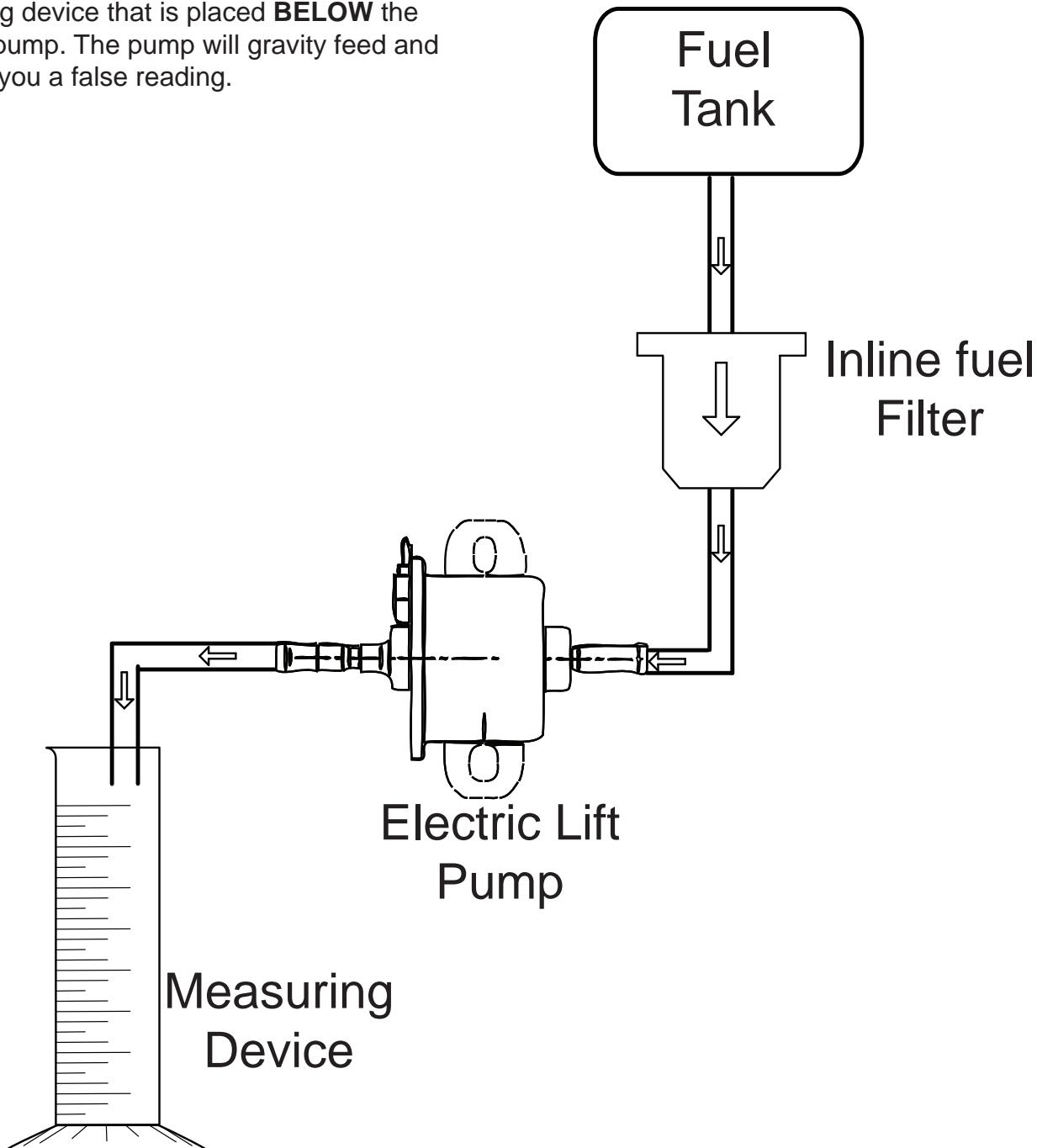


Figure 2-7 How to measure the flow rate of the electric lift fuel pump.

Fuel Pump Module For Models 490000 and 610000

⚠ Caution:

- Make sure you are wearing proper eye protection.
- Make sure there are no open flame or potential ignition devices in the area where you are working.
- Whenever you remove a hose or fitting, make sure to cover the area with a shop towel so as to minimize any fuel spray that may occur from residual pressure in the line.
- Collect any fuel in an approved container and dispose of it properly.
- Be careful not to get any debris in the fuel line or fuel pump.
- The electric lift pump is an electrical component, Do Not immerse it in any cleaners.

Remove or Disconnect

1. Remove the negative battery cable.
2. Disconnect the fuel pump module from the wiring harness.
3. Relieve fuel pressure.
- Refer to the "Fuel Pressure Relief Procedure."
4. Remove the fuel supply hose.
5. Remove the fuel rail assembly following the procedures outlined in this section.
6. Remove the mounting bolts

Install or Connect

1. Mount the pump using 3 bolts.
2. Mount the fuel rail.
3. Hook up the fuel supply line.
4. Hook the wiring harness into the fuel pump module.
5. Connect the negative battery terminal.

Inspect

Turn ignition switch to the "ON" position for 2 seconds, then turn to the "OFF" position for 10 seconds. Turn the ignition switch back to the "ON" position and check for fuel leaks.

Pressure Testing Procedure

1. Carefully observe the safety precautions
2. Ignition "OFF."

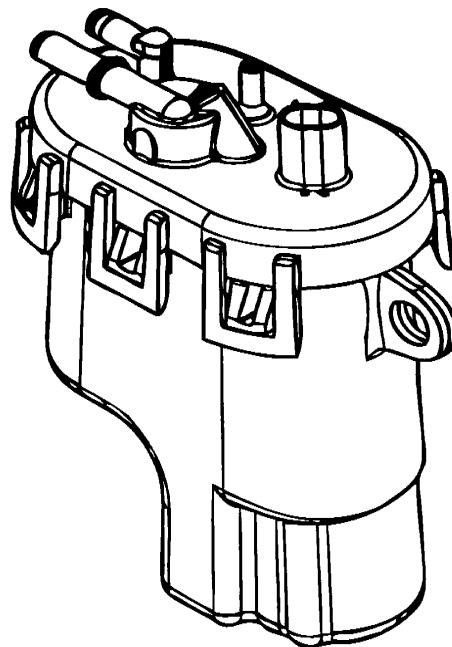


Figure 2-8 Fuel Pump Module

3. Relieve any residual fuel rail pressure.
4. Screw the fuel pressure gauge onto the fuel test port (Schrader valve.)
- Wrap a shop towel around the fitting as you're screwing it onto the test port to catch any fuel that may leak out.
5. Once the fitting is hand tightened "start the engine."

The fuel pressure gauge should hold a steady fuel pressure between 35 PSI and 43 PSI. This verifies the fuel pump module is working properly.

Throttle Body Assembly

The throttle body assembly repair procedures cover component replacement with the unit on the equipment. However, throttle body replacement requires that it be removed from the engine.

Clean

Important

- To clean the throttle body following disassembly, use a spray type cleaner that will not damage the material or components.. Use a shop towel to remove heavy deposits.
- An approved immersion cleaner may be used on disassembled metal parts **ONLY**.
- When cleaning a throttle body, extreme care should be taken not to allow solvents of any kind in or near the throttle position sensor or IAC motor if equipped..

Remove or Disconnect

1. Remove the negative battery cable.
2. Remove the air filter.
3. Remove the electrical connector from the throttle position sensor and the idle air control valve if equipped.
4. Remove the vacuum lines.
5. Remove the upper engine shroud.
6. Disconnect the throttle cable.
7. Remove the throttle body attaching bolts.
8. Remove the throttle body assembly and flange gasket.

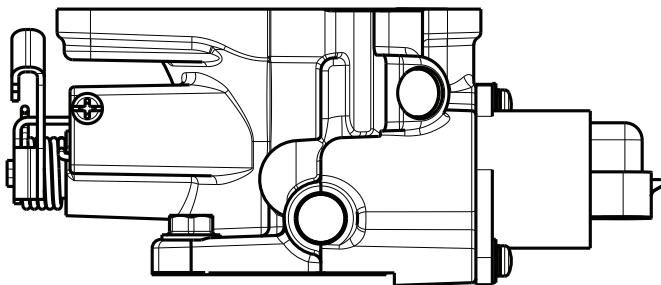


Figure 2-9 Throttle Body Side view (with IAC)

- Discard gasket.

Notice: Use care in cleaning old gasket material from machined aluminum surfaces as sharp tools may damage sealing surfaces.

Install or Connect

1. Install the throttle body assembly with new flange gasket.
2. Install the throttle body attaching bolts.
3. Connect the throttle cable..
4. Connect the vacuum lines.
5. Connect the electrical connector to the throttle position sensor and the idle air control valve if equipped..
6. Install the engines upper shroud.
7. Install the air filter.
8. Reconnect the negative battery cable.

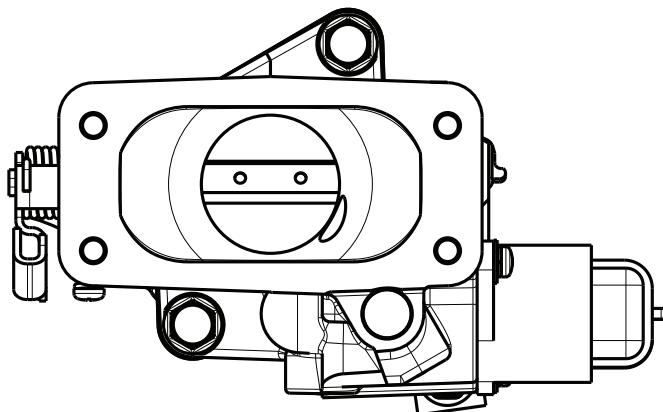


Figure 2-10 Throttle Body Top view (with IAC)

Fuel Flow Diagram (*typical for Lawn and Garden*) for Model 490000

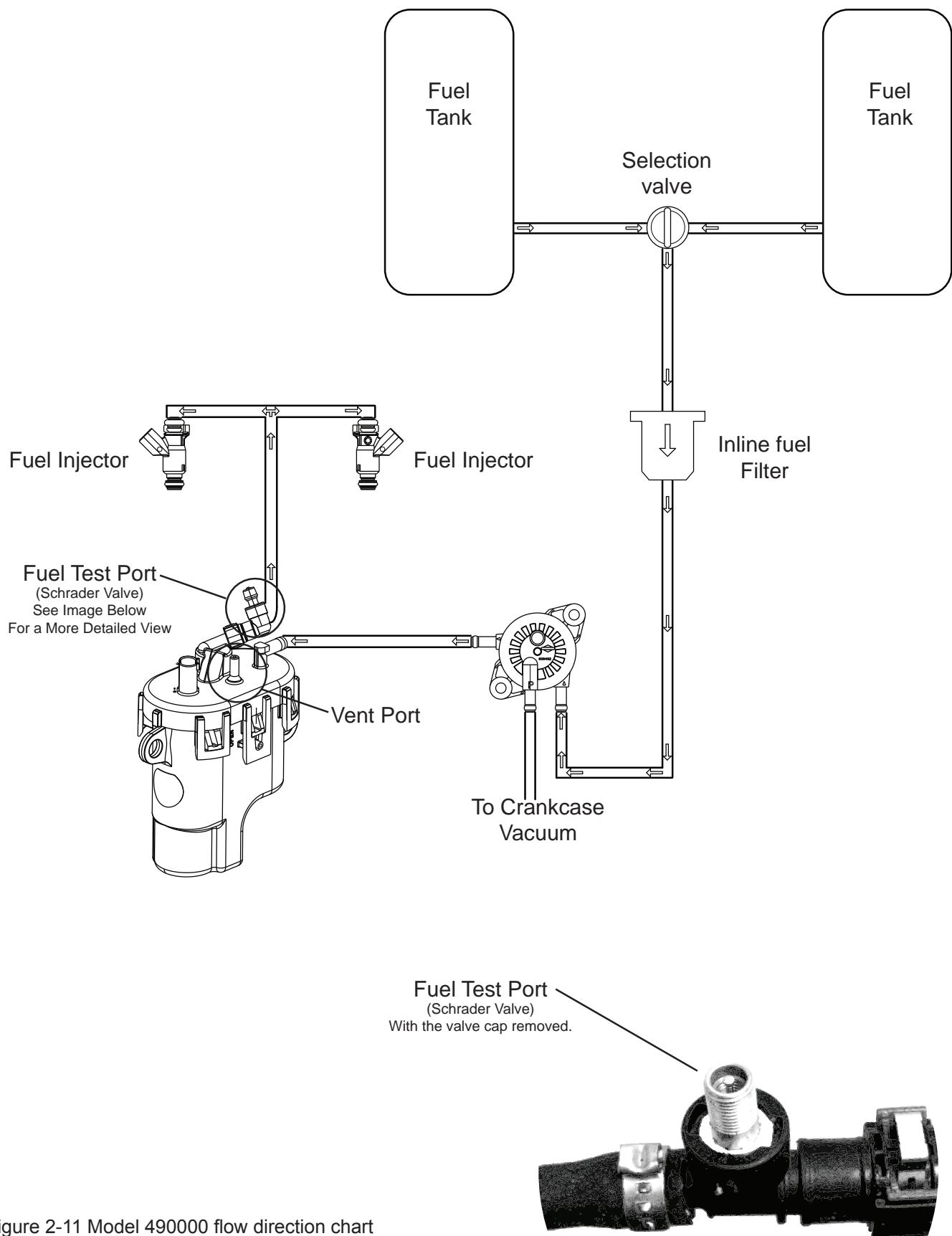


Figure 2-11 Model 490000 flow direction chart

Fuel Flow Diagram (*typical for Marine*) Model 610000 (Big Block)

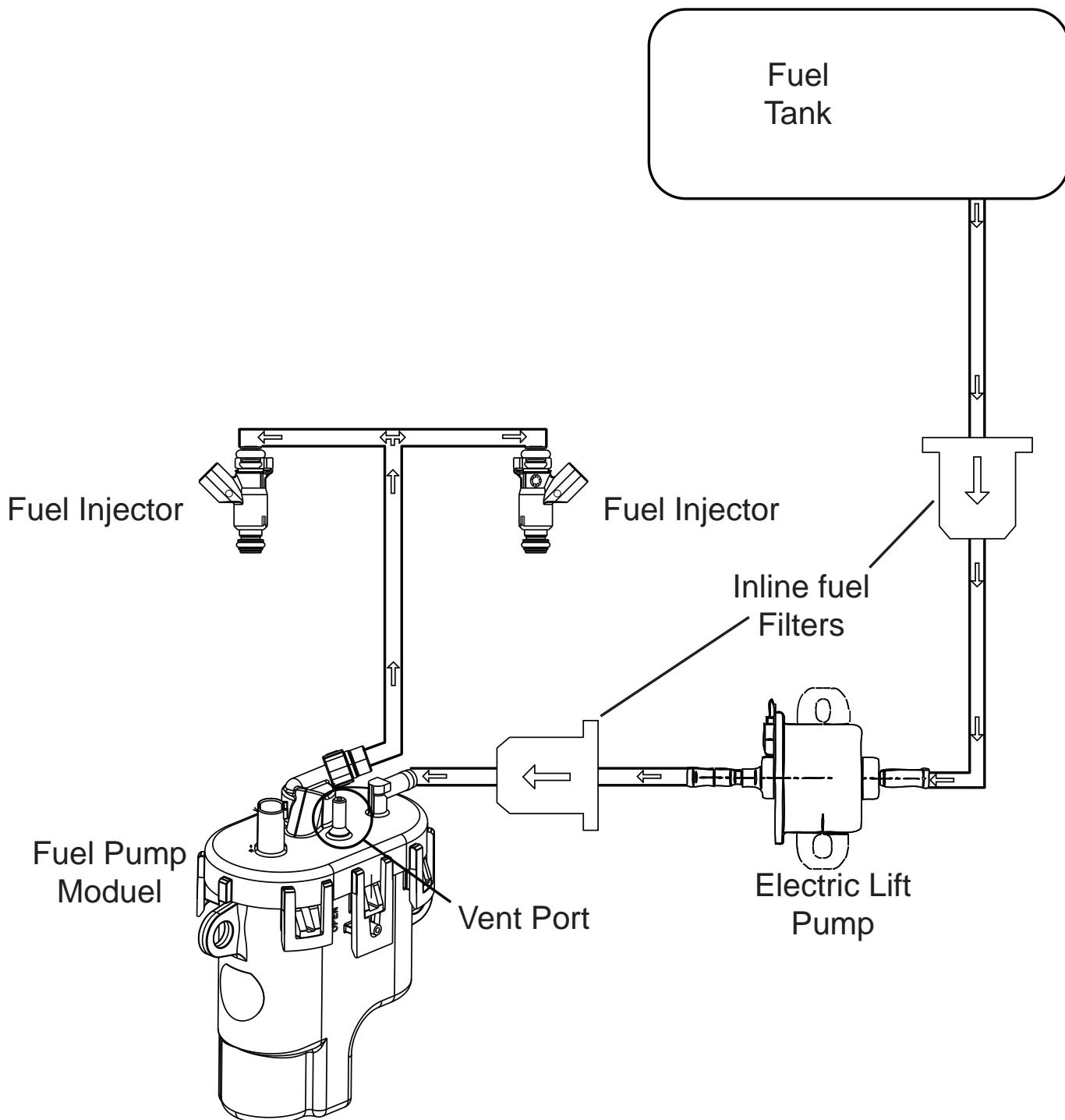


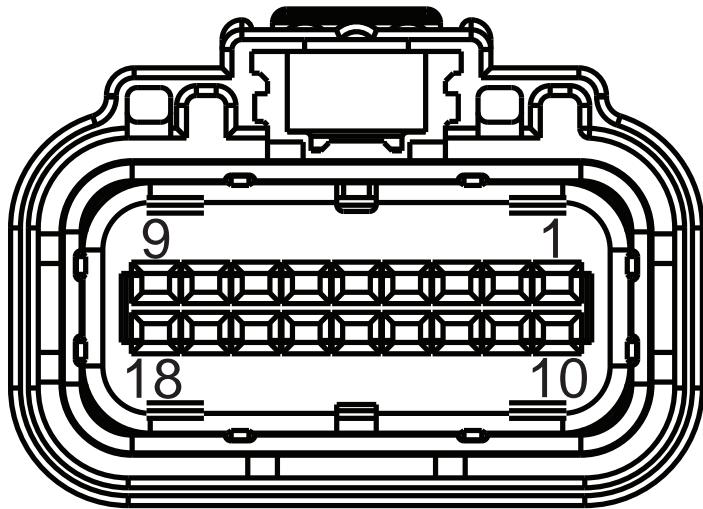
Figure 2-12 Model 610000 flow direction chart

Contents

Section 3 Diagnostic Trouble Codes

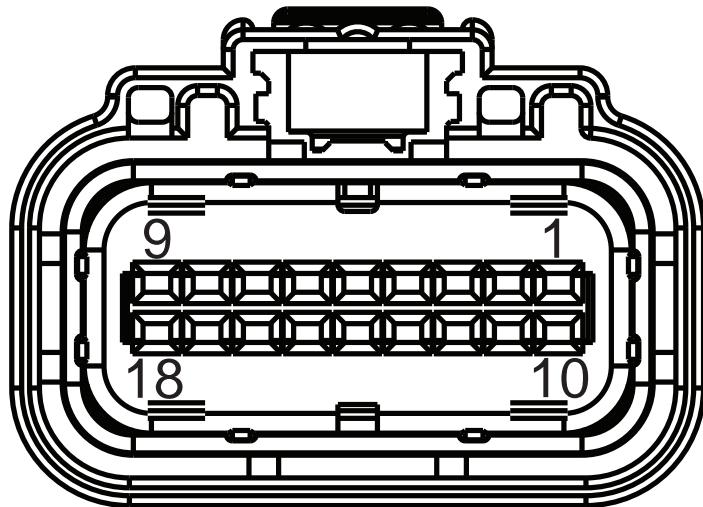
ECM Connector Pin-Out	2-3
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J1(Grey) ECM Connector



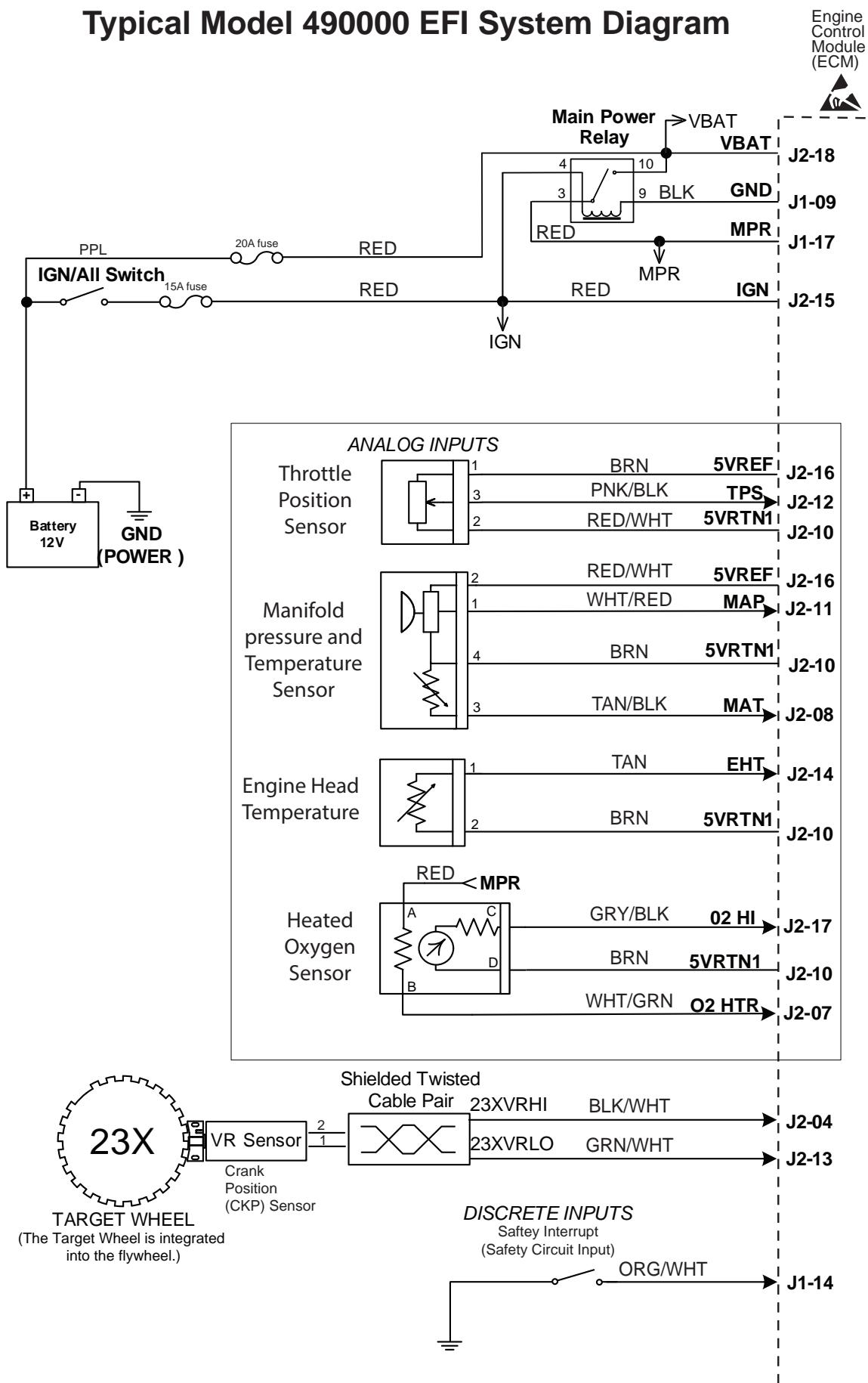
Connector/ Pin Number	Wire Color	Function
J1-1	BLU/BRN	IACAH1 (Idle Air Control A Hi) If equipped
J1-2	-	N/A (Not Applicable)
J1-3	ORG/BLK	MIL (Malfunction Indicator Light)
J1-4	-	N/A (Not Applicable)
J1-5	-	N/A (Not Applicable)
J1-6	-	TACHOMETER
J1-7	GRN	CANLo (Used only for Development ECM)
J1-8	YEL	CANHi (Used only for Development ECM)
J1-9	BLK	GROUND (Power)
J1-10	PPL/WHT	ESTCOILB (Engine Spark Timing Coil B)
J1-11	BLU/GRN	IACALO (Idle Air Control A Lo) If equipped
J1-12	BLU/GRY	IACBHI (Idle Air Control B Hi) If equipped
J1-13	BLU/RED	IACBLO (Idle Air Control B Lo) If equipped
J1-14	ORG/WHT	Safety Interrupt
J1-15	-	N/A (Not Applicable)
J1-16	-	N/A (Not Applicable)
J1-17	RED	MPR (Main Power Relay)
J1-18	-	N/A (Not Applicable)

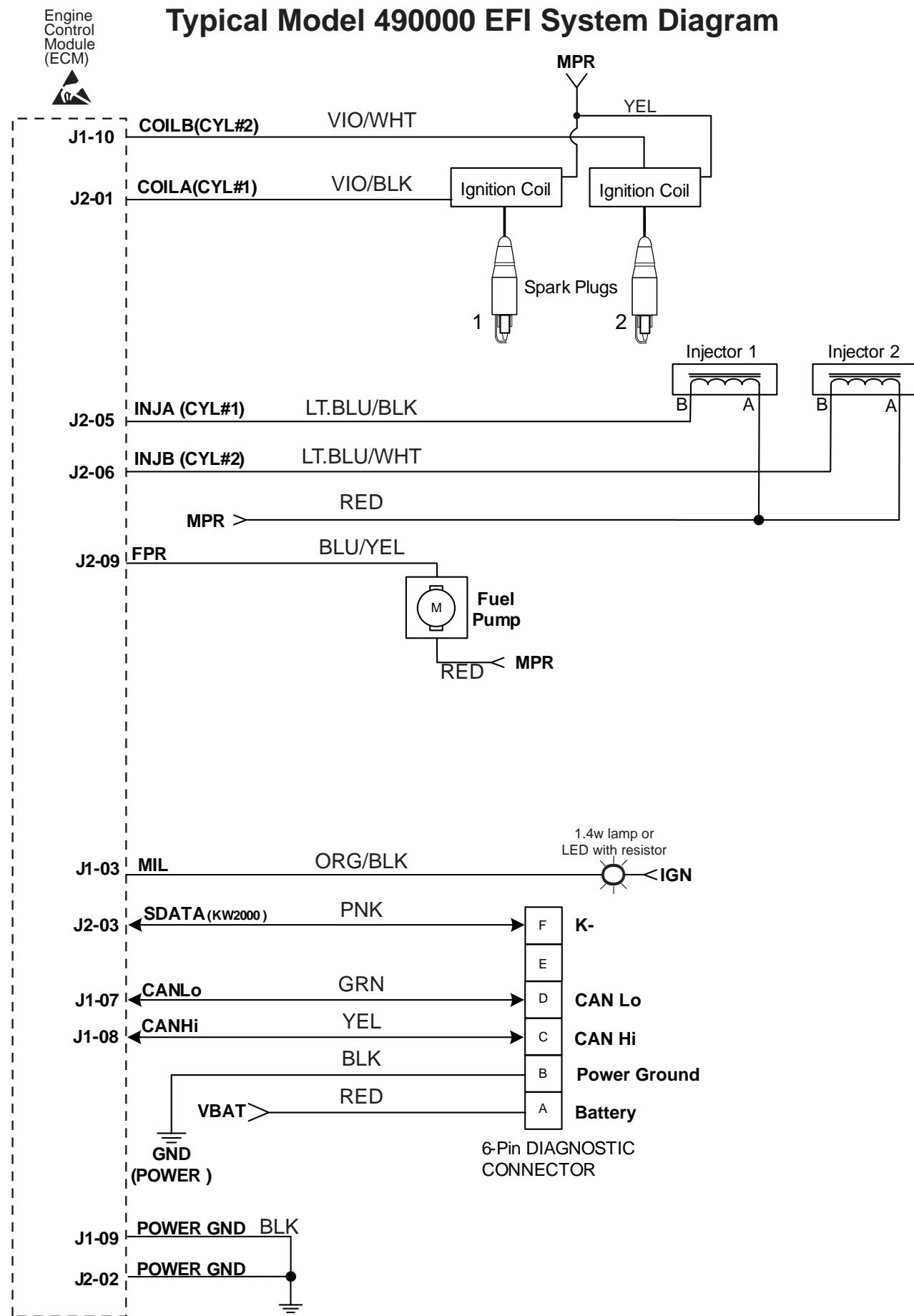
J2(Black) ECM Connector



Connector/ Pin Number	Wire Color	Function
J2-1	PPL/BLK	ESTCOILA (Engine Spark Timing Coil A)
J2-2	BLK	GROUND (Power)
J2-3	PNK	SDATA (Serial Data)
J2-4	BLK/WHT	Crank VR Hi (23X)
J2-5	LT. BLU/BLK	INJA (Injector A)
J2-6	LT. BLU/WHT	INJB (Injector B)
J2-7	WHT/GRN	O ₂ HTR (Oxygen Sensor Heater) If equipped
J2-8	TAN/BLK	MAT (Manifold Air Temperature)
J2-9	BLU/YEL	FPR (Fuel Pump Relay)
J2-10	BRN	5VRTN1 (5 Volt Return 1)
J2-11	WHT/RED	MAP (Manifold Absolute Pressure)
J2-12	PNK/BLK	TPS (Throttle Position Sensor) If equipped
J2-13	GRN/WHT	Crank VR Lo (23X)
J2-14	TAN	EHT (Engine Head Temperature Sensor)
J2-15	RED	IGN (Ignition)
J2-16	RED/WHT	5VREF (5 Volt Reference)
J2-17	GRY/BLK	O ₂ Hi (Oxygen Sensor)
J2-18	RED	VBAT (Voltage Battery)

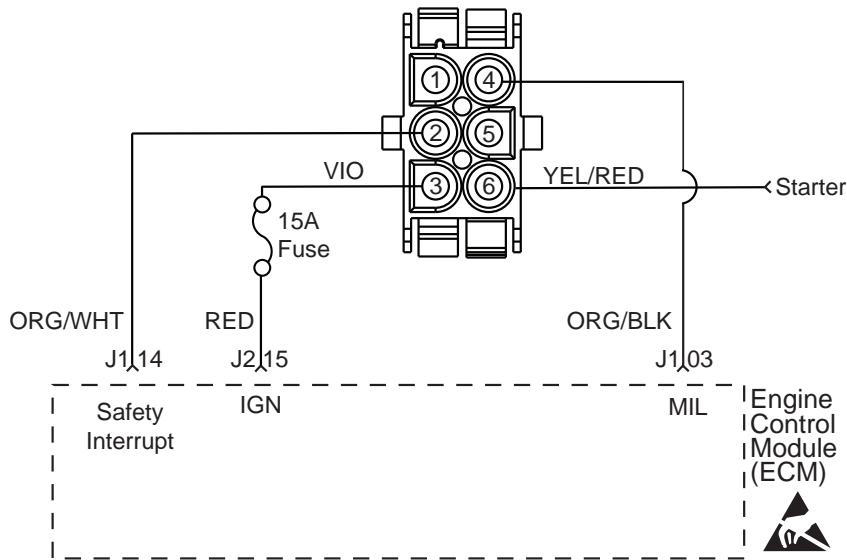
Typical Model 490000 EFI System Diagram



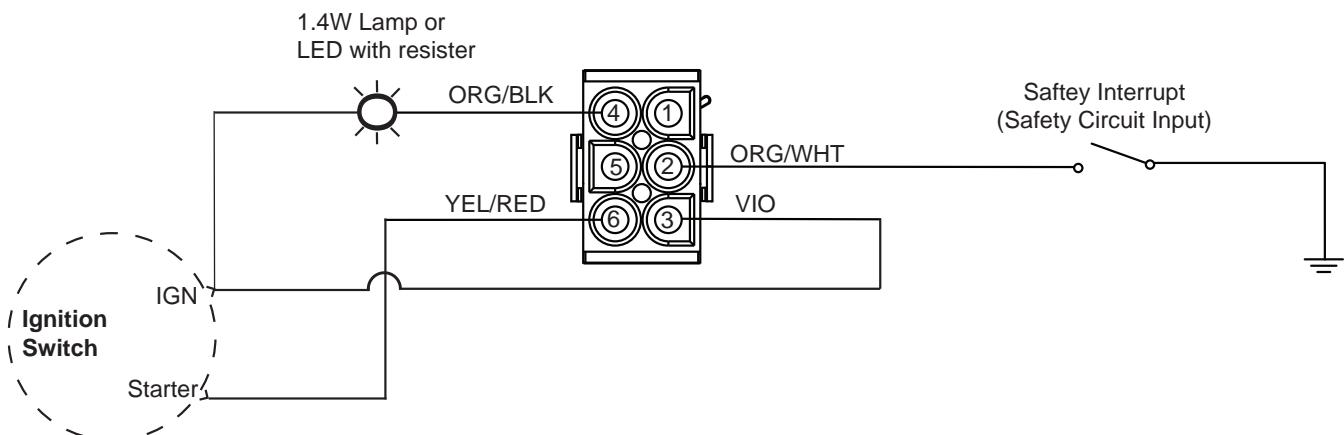


490000 Engine to Chassis Connector

Engine Connector

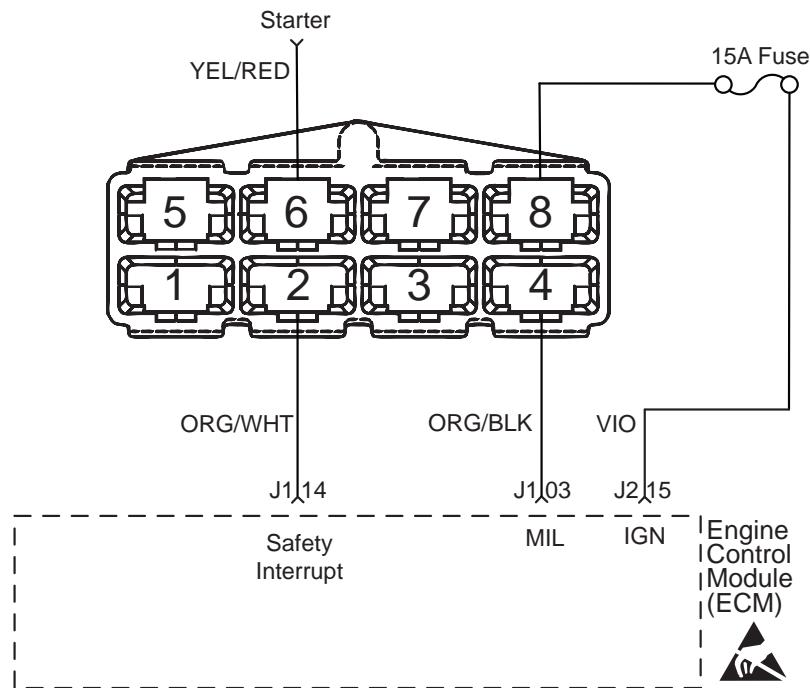


Chassis Connector

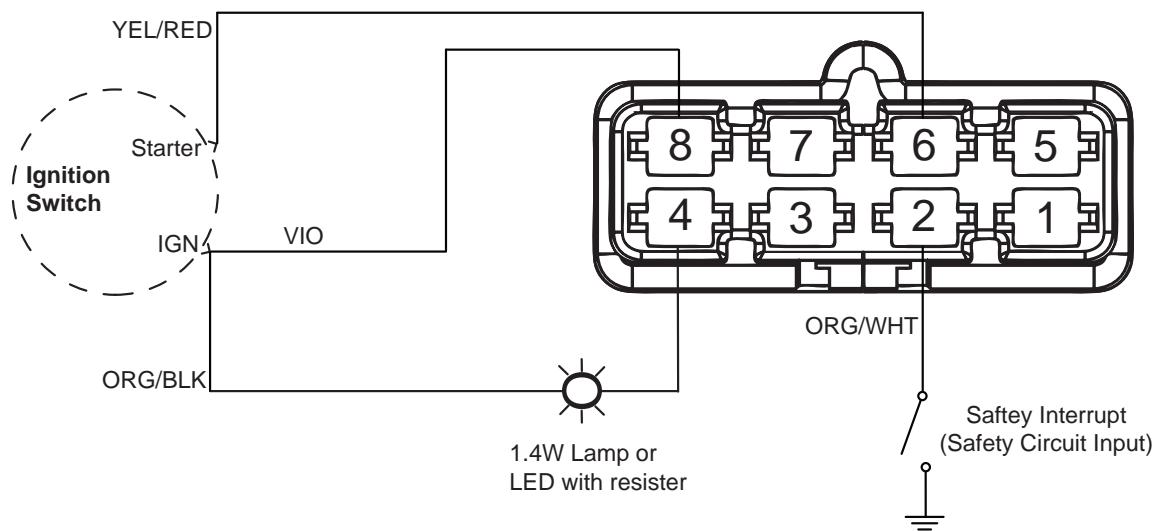


490000 8 way Engine to Chassis Connector

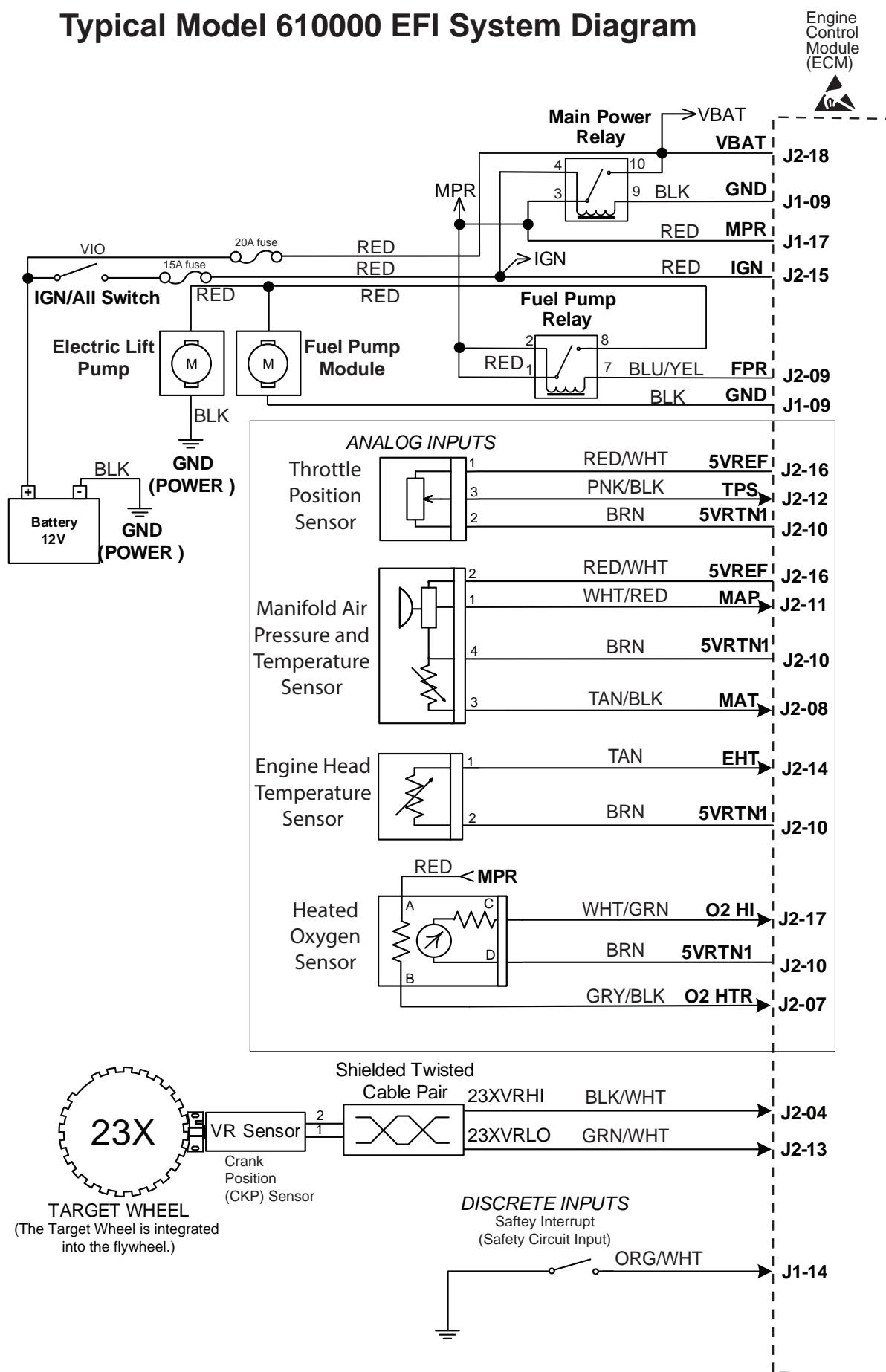
Engine Connector

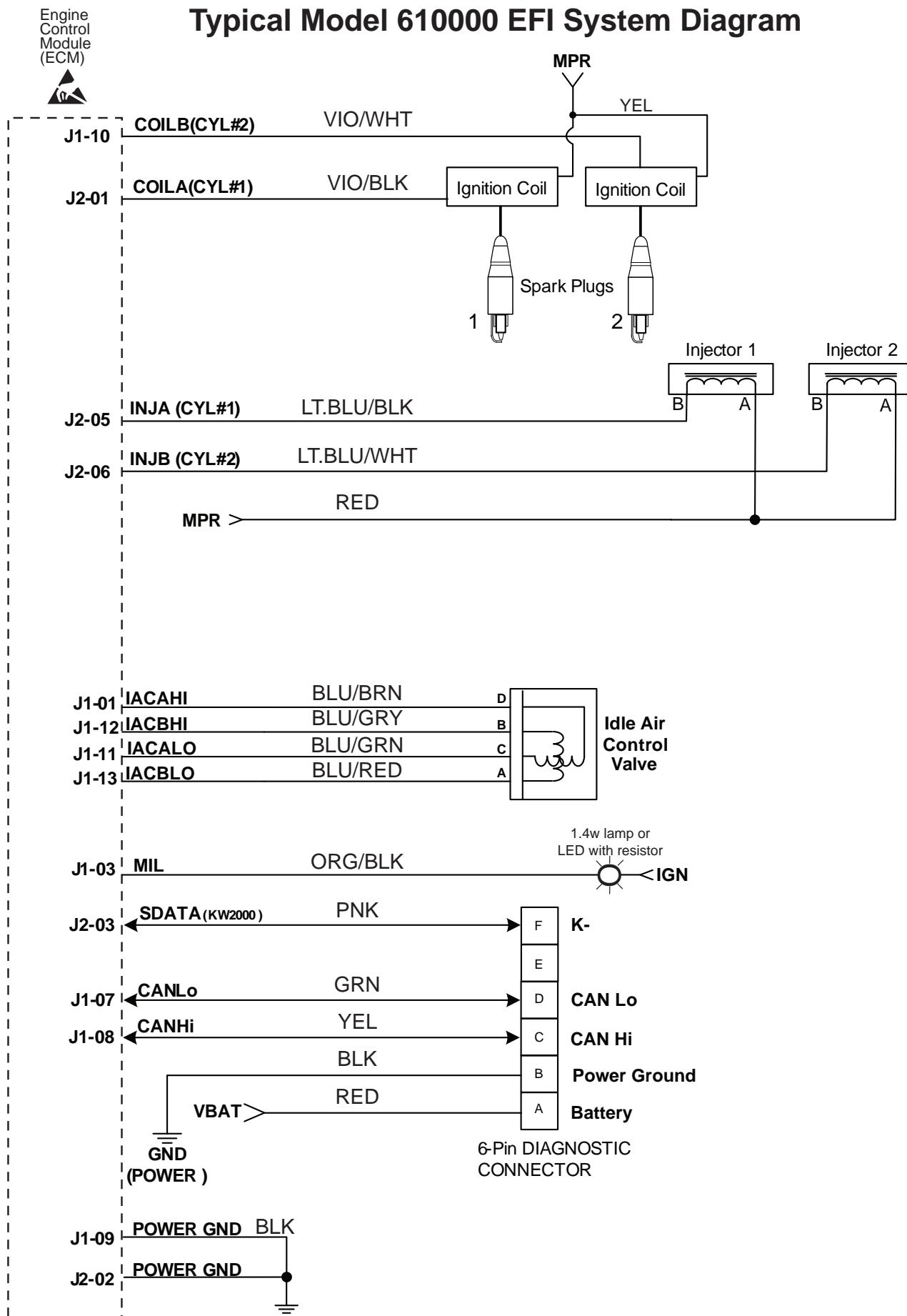


Chassis Connector



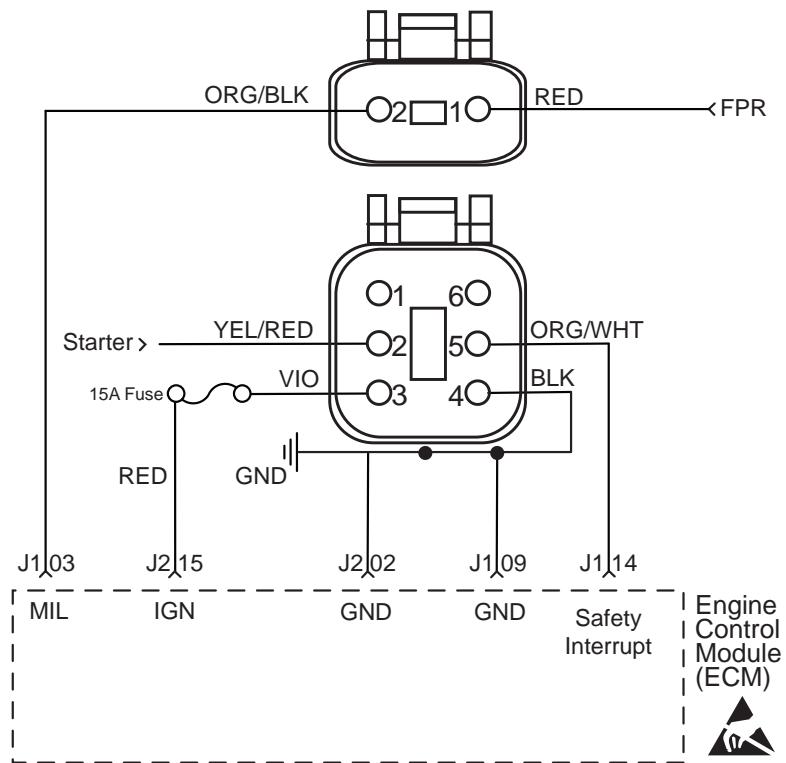
Typical Model 610000 EFI System Diagram



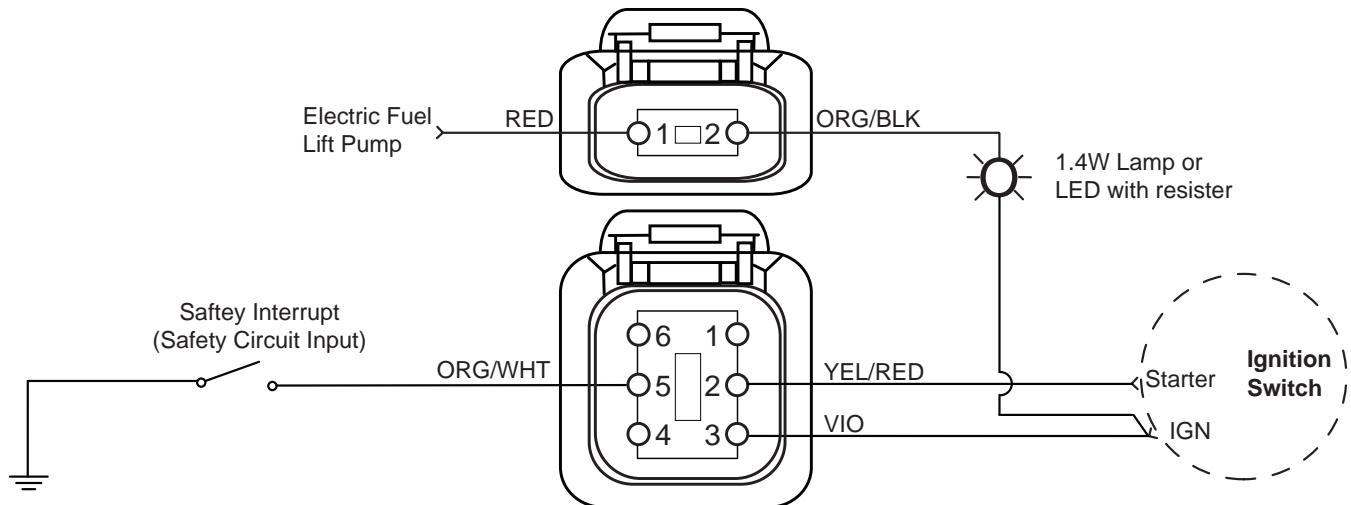


610000 Marine Engine to Chassis Connectors

Engine Connectors



Chassis Connectors



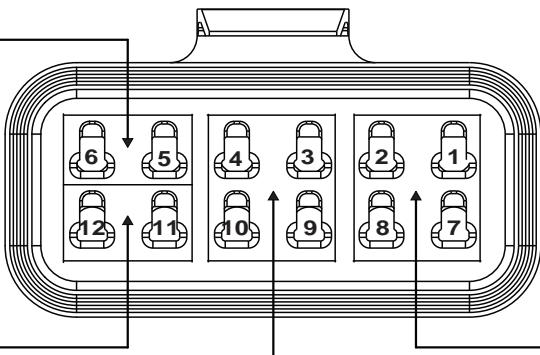
Pictorial view of the Fuse/Relay box and Component locations**Typical Fuse/Relay Box For 490000 and 610000**

20a Fuse

Battery

15a Fuse

Ignition



Main Power
Relay

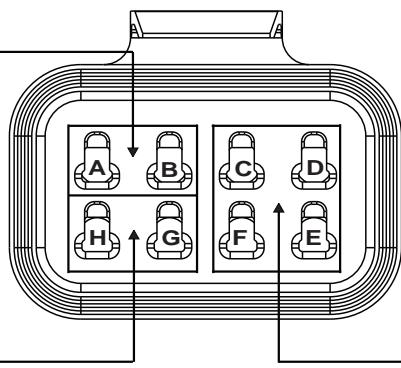
Fuel Pump
Relay

490000 Alternative Fuse/Relay Box

20a Fuse

Battery

15a Fuse
Ignition



Main Power
Relay

Diagnostic Trouble Codes (DTC)

System or Component	DTC Number	DTC Description
Oxygen Sensor Heater If equipped	P0031	HO ₂ S Heater Circuit High Voltage
	P0032	HO ₂ S Heater Circuit Low Voltage
Manifold Absolute Pressure sensor (MAP)	P0107	MAP Circuit Low Voltage or Open
	P0108	MAP Circuit High Voltage
Manifold Air Temperature Sensor (MAT)	P0112	MAT Circuit Low Voltage
	P0113	MAT Circuit High Voltage or Open
Engine Head Temperature (EHT) Sensor	P0117	Engine Head Temperature sensor Circuit Low Voltage
	P0118	Engine Head Temperature sensor Circuit High Voltage or Open
Throttle Position Sensor (TPS) If equipped	P0122	TPS Low Voltage or Open
	P0123	TPS High Voltage
Oxygen Sensor If equipped	P0131	O ₂ S 1 Circuit Low Voltage
	P0132	O ₂ S 1 Circuit High Voltage
PE System Lean	P0174	Lean Fuel Condition while in Power Enrichment
Fuel Injector A	P0201	Injector A Fault
Fuel Injector B	P0202	Injector B Fault
Fuel Pump Relay (FPR) If equipped	P0230	FPR Coil Circuit Low Voltage or Open
	P0232	FPR Coil Circuit High Voltage
Crankshaft Position Sensor (CKP)	P0336	CKP Sensor Noisy Signal
	P0337	CKP Sensor No Signal
Ignition Coil A	P0351	Cylinder A Ignition Coil Fault
Ignition Coil B	P0352	Cylinder B Ignition Coil Fault
Idle Control System If equipped	P0505	Idle Speed Control Error
System Voltage	P0562	System Voltage Low
	P0563	System Voltage High
MIL	P0650	MIL Circuit Malfunction
Safety Interrupt Sensor	P1500	Safety Interrupt Sensor Malfunction/Triggered

Verifying the ECM is Powering Up (Non-Scan Diagnostics)

Circuit Description

Every component associated with the EFI engine management system relies on the ECM. Therefore it is imperative that your diagnostic procedures include verification of power and grounds to the ECM. There are 4 terminals by which you can verify ECM operation. They are the battery "feed" terminal, the ignition-on terminal and two ground terminals. Be cautious

to actually remove and clean battery terminals. They may appear to be clean , but corrosion can coat the inner surfaces of the terminals and cause a poor connection to ground.

Note: When the ECM is powered up you may hear the fuel pump module prime for 2 seconds, this is not definitive enough to verify the ECM is getting the proper voltage.

Step	Action	Value(s)	Yes	No
1	1. Ignition "Off." 2. With a DVOM connected to a known good ground back probe terminal J2-18 of the ECM harness connector. Is the voltage within the specified value?	12.2-13.5v	Go to Step 2	Go to Step 5
2	1. Ignition "ON," Engine "OFF." 2. With a DVOM connected to a known good ground back probe terminal J2-15 of the ECM harness connector. Is the voltage within the specified value?	12.2-13.5v	Go to Step 3	Go to Step 6
3	1. Ignition "Off." 2. Using a DVOM connected to a known good ground take an Ohm reading by back probing terminal J2-02. Is the resistance less then the specified value?	2 Ohms	Go to Step 4	Go to Step 7
4	1. Ignition "Off." 2. Using a DVOM connected to a known good ground take an Ohm reading by back probing terminal J1-09. Is the resistance less then the specified value?	2 Ohms	System OK	Go to Step 7
5	Locate and repair open or short to ground in the Battery (B+) feed circuit. Is action complete?	-	Verify Repair	-
6	Locate and repair open or short to ground in the ignition feed circuit. Is action complete?	-	Verify Repair	-
7	Locate and repair open or short in the ECM ground circuit. Is action complete?	-	Verify Repair	-

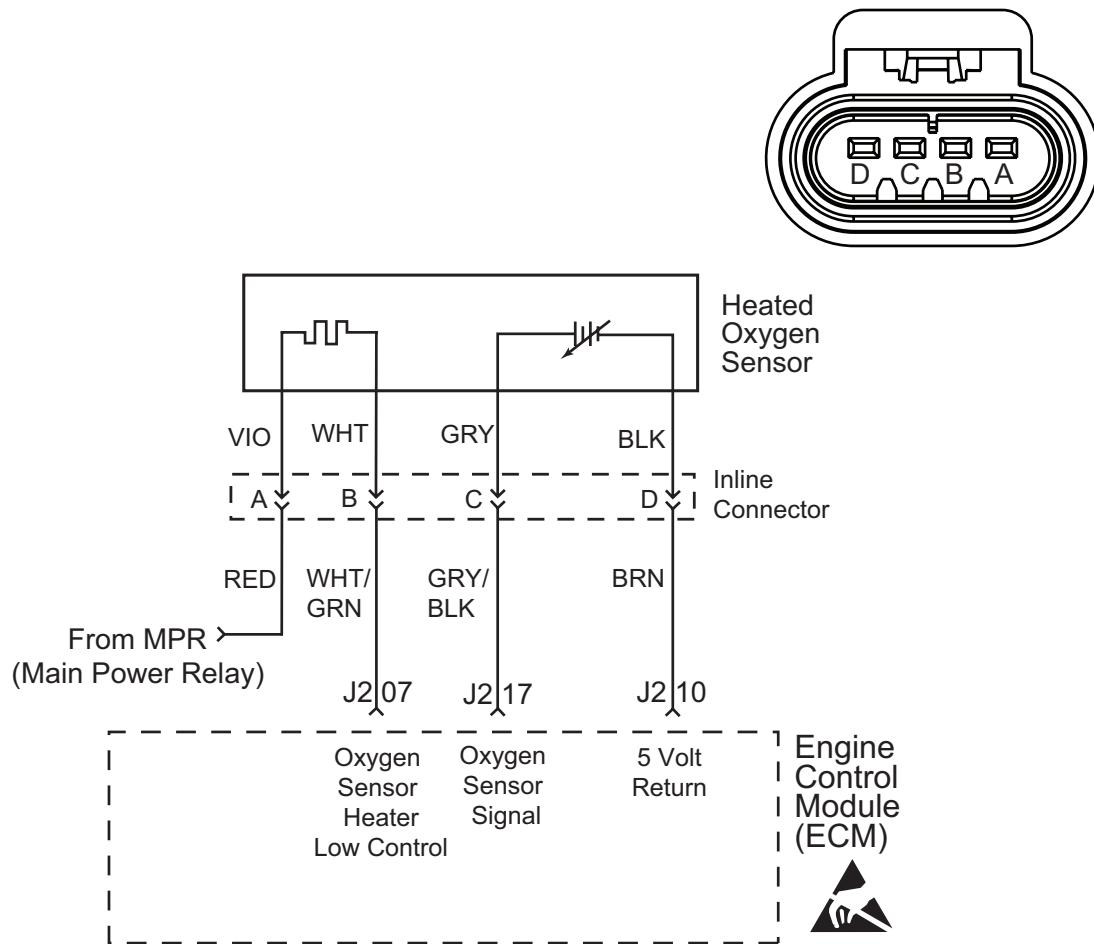
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Contents

Section 3a Diagnostic Trouble Codes

Non-Scan Diagnostics

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DTC P0031/P0032 Oxygen Sensor Heater if equipped (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 volt if the exhaust is lean.

The sensor behaves like an open circuit and produces no voltage when the exhaust temperature is below 360°C (600°F). An open oxygen sensor circuit or cold oxygen sensor causes an open loop operation.

The heater in the sensor provides a faster sensor warm-up. This allows the sensor to become active in a shorter period of time and remain active during a long extended idle.

DTC P0031 determines if the heated oxygen sensor has developed an open circuit. With an active DTC P0031 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

Diagnostic Aids

Check for the following conditions:

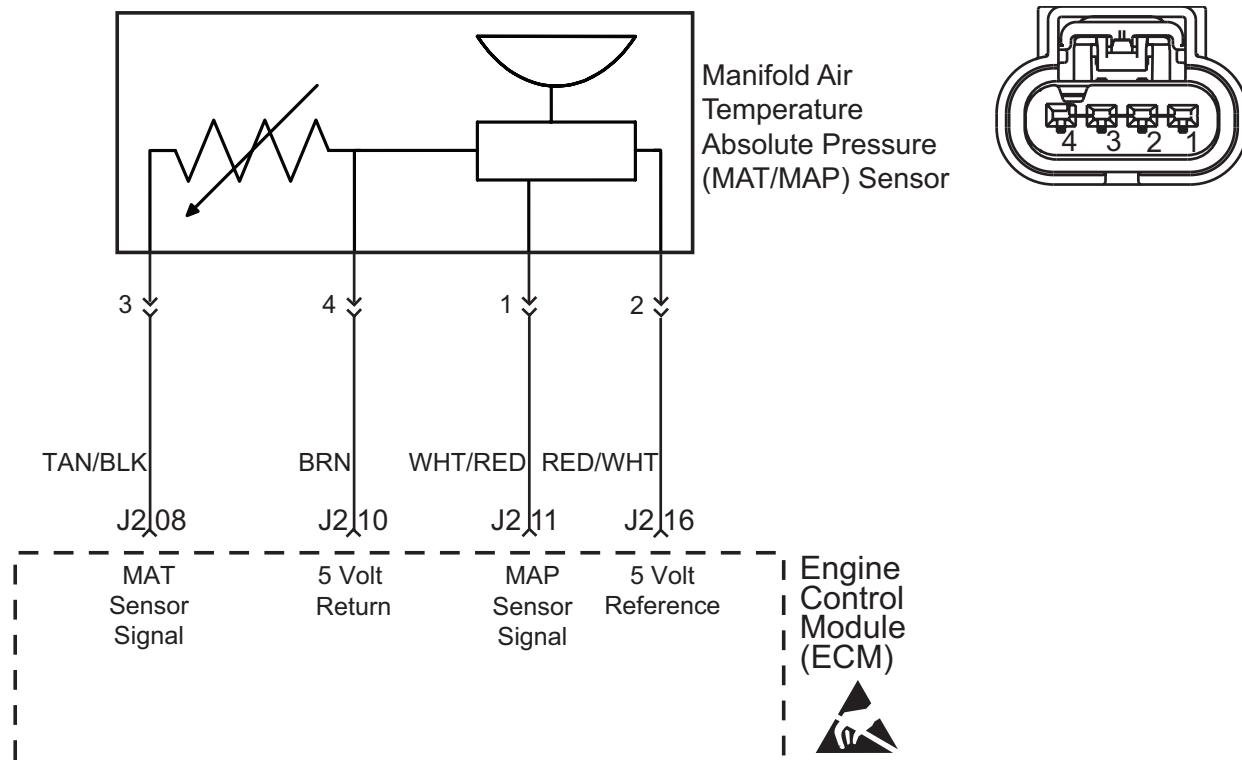
Poor connection in harness. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

For proper wire and connection repairs, refer to Wiring Repair.

After repairs, clear DTCs following "Clear DTCs Procedure." Failure to do so may result in DTCs not properly being cleared.

DTC P0031/P0032 Oxygen Sensor (HO_2) Heater (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Disconnect the HO_2 sensor electrical connector. 2. Ignition "ON," Engine "OFF." 3. With a test light connected to a known good ground, back probe terminal A of the harness connector. Does the test light illuminate brightly?	-	Go to Step 3	Go to Step 6
3	Using a DVOM back probe between terminals A and B of the HO_2 sensor harness connector. Is the voltage within the specified value?	12.2-13.5v	Go to Step 4	Go to Step 7
4	1. Ignition "ON," Engine "OFF." 2. Using a DVOM connected to a good ground and terminal J2-17 at the ECM. Is the voltage within the specified value?	4.20-4.95v	Go to Step 5	Go to Step 8
5	1. Ignition "ON," Engine "OFF." 2. Using a DVOM check the voltage between terminals C and D. Is the voltage within the specified value?	4.20-4.95v	Go to Step 10	Go to Step 9
6	Locate and repair open or short to ground in the ignition feed circuit for the HO_2 heater. Is action complete?	-	Verify Repair	-
7	Locate and repair open in the ground circuit for the HO_2 heater. Is action complete?	-	Verify Repair	-
8	Locate and repair open in the HO_2 sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 11
9	Locate and repair open in the HO_2 sensor ground circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 11
10	Repair faulty HO_2 sensor connections or replace faulty HO_2 sensor. Is action complete?	-	Verify Repair	-
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0107/P0108 Manifold Absolute Pressure (MAP) (Non-Scan Diagnostics)

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 0.5 volts at idle to 4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through the ECM terminal J2-16. The MAP sensor will send a voltage signal back to the ECM on terminal J2-11 according to the manifold pressure value on the terminal.

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 and connectors for damage.
- 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 barometric pressure and is referred to as BARO.

- If DTC P0107 is set, check for an open in ground circuit.
- If a MAP sensor circuit failure is present, the Throttle Position sensor (TPS) –if equipped– value will be used along with the MAP sensor default value.
- If the ground is bad in the ECM or the ground circuit has a bad connection this could cause multiple DTC's to be set.

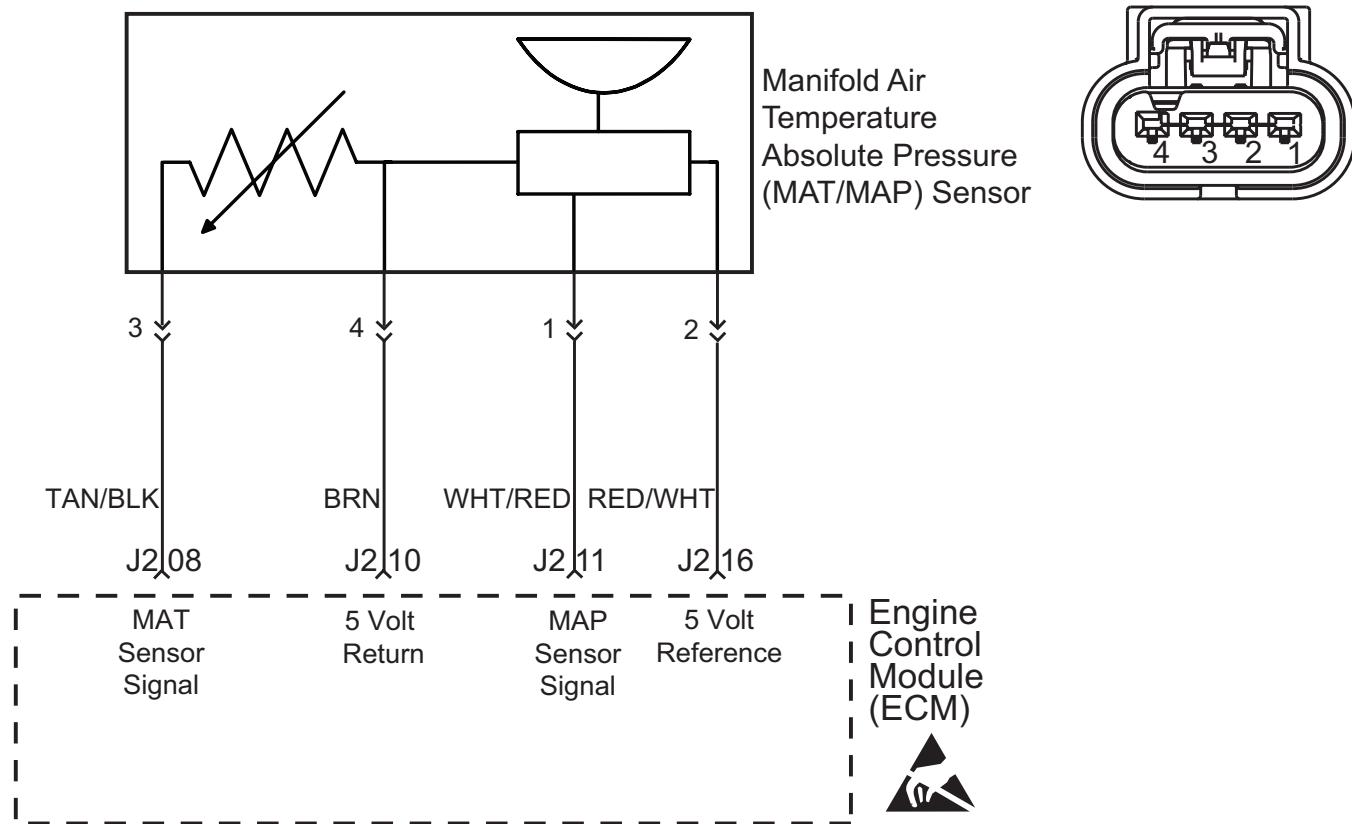
After repairs, clear DTC's following Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0107 Manifold Absolute Pressure (MAP) Sensor- Signal Voltage Low (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition OFF. 2. Disconnect MAP sensor harness connector. 3. Connect a jumper wire from harness terminal 1 to harness terminal 2. 4. Start engine and idle for 2 minutes or until code reader indicates a stored DTC. 5. Ignition “ON,” Engine “OFF.” Is DTC P0108 present?	-	Go to Step 4	Go to Step 3
3	1. Remove jumper wire from terminals 1 and 2. 2. Connect DVOM from harness terminal 2 to harness terminal 4. Is voltage reading above the specified value?	4.0v	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open or short to ground in the map sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
6	Locate and repair open or short to ground in 5v reference circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

**DTC P0108 Manifold Absolute Pressure (MAP) Sensor- Signal Voltage High
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect the MAP sensor harness connector. 3. Start the engine and idle for 2 minutes or until a DTC is indicated. 4. Ignition "ON," Engine "OFF." Is DTC P0107 present?	-	Go to Step 4	Go to Step 3
3	1. Disconnect the MAP sensor harness connector. 2. Ignition "ON," Engine "OFF." 3. Connect DVOM from harness terminals 2 and 4 at the sensor connector. Is voltage reading above the specified value?	4.0v	Go to Step 5	Go to Step 6
4	Check for plugged or leaking sensor vacuum fitting. Also locate and repair intermittent faulty connections. If OK, replace faulty MAP sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair short to voltage in the MAP sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
6	Locate and repair open in the sensor ground circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0112/P0113-Manifold Air Temperature (MAT) Sensor (Non-Scan Diagnostics)

Circuit Description

The Manifold Air Temperature (MAT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on the sensor circuit. When the engine is cold, the sensor (thermistor) resistance is high. As the engine warms up, the sensor resistance becomes lower.

Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

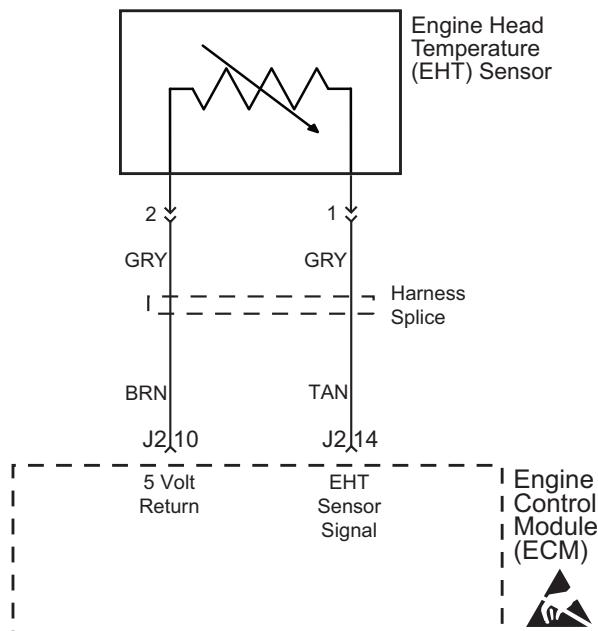
3. Inspect the wiring harness for damage.
4. If the harness appears to be OK, observe the MAT display on the code reader while moving connectors and wiring harnesses related to the MAT. A change in the MAT display will indicate the location of the fault.
5. If DTC P0113 is also set, check for an open ground.
6. After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

**DTC P0112 Manifold Air Temperature (MAT) Sensor Circuit -
Low Temp Indicated
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition “OFF.” 2. Disconnect the MAT sensor harness connector. 3. Ignition “ON,” Engine “OFF.” 4. Connect a DVOM by back probing terminals 3 and 4. Is voltage above the specified value?	4.0v	Go to Step 4	Go to Step 3
3	1. Ignition “OFF.” 2. Connect a DVOM to terminal 3 of the sensor connector and a known good ground. 3. Ignition “ON,” Engine “OFF.” Is voltage above the specified value?	4.0v	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty MAT sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open in the MAT sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
6	Locate and repair open in the sensor ground circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

**DTC P0113 Manifold Air Temperature (MAT) Sensor Circuit -
High Temp Indicated
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect the MAT sensor harness connector. 3. Ignition "ON," Engine "OFF." 4. Connect a DVOM by back probing terminals 3 and 4 at the sensor connector. Is the voltage above the specified value?	4.0v	Go to Step 3	Go to Step 4
3	Locate and repair intermittent faulty connections. If OK, replace faulty MAT sensor. Is action complete?	-	Verify Repair	-
4	Locate and repair short to ground in MAT signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0117/P0118 Engine Head Temperature (EHT) Sensor (Non-Scan Diagnostics)

Circuit Description

The Engine Head Temperature (EHT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on the sensor circuit. When the engine is cold, the sensor (thermistor) resistance is high. As the engine warms up, the sensor resistance becomes lower.

Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
3. After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.
4. To verify that the Thermistor is working properly check the approximate resistance value with an ohms tester using the table below as a guide. Connector J2 of the ECM must be disconnected before doing a resistance check.

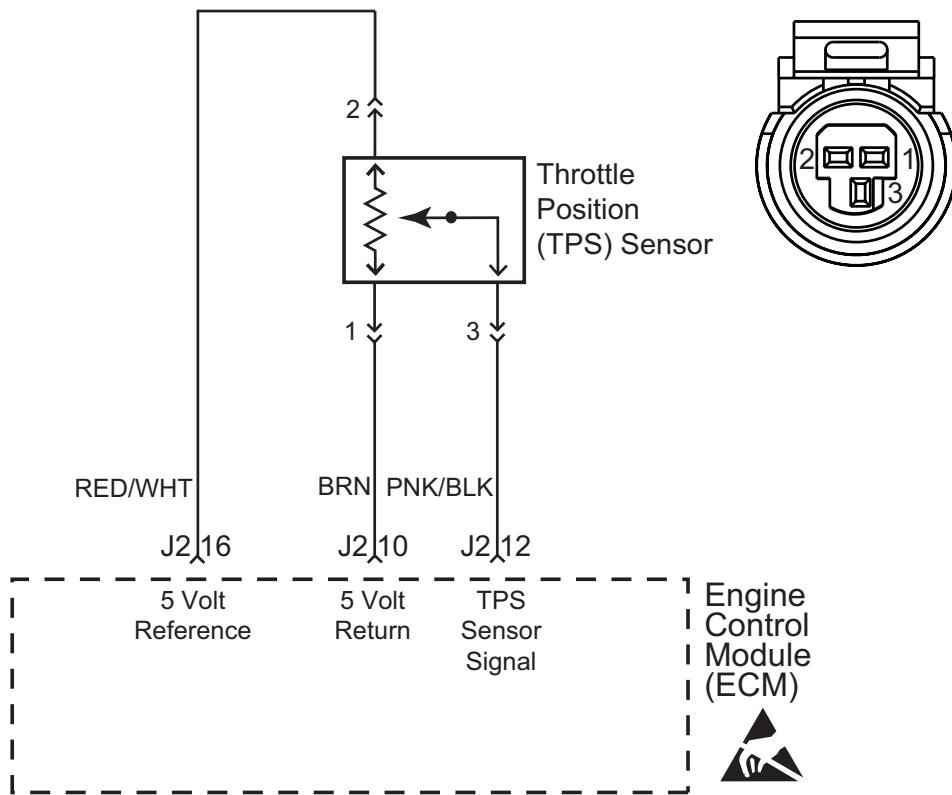
Temperature °C	Temperature °F	Resistance Ohms
-10	14	58,506
0	32	33,723
10	50	20,210
20	68	12,542
30	86	8,032
40	104	5,292
50	122	3,578
60	140	2,477
80	176	1,263
90	194	927
110	230	525
120	248	403
135	275	278
145	293	221
155	311	177

**DTC P0117 Engine Head Temperature (EHT) Sensor Circuit -
Low Temp Indicated
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "ON," Engine "OFF." 2. Connect the DVOM to terminals J2-10 and J2-14 in the ECM connector. Is voltage above the specified value?	1.5-4.5v	Go to Step 4	Go to Step 3
3	Connect a DVOM to terminal J2-14 and a known good ground. Is voltage above specified value?	4.0v	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty EHT sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open in the EHT sensor circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
6	Locate and repair open ground in the 5v return circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

**DTC P0118 Engine Head Temperature (EHT) Sensor Circuit -
High Temperature Indicated
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "ON," Engine "OFF." 2. Connect the DVOM to terminals J2-10 and J2-14 in the ECM connector. Is voltage above the specified value?	1.5-4.5v	Go to Step 3	Go to Step 4
3	Locate and repair intermittent faulty connections. If OK, replace faulty EHT sensor. Is action complete?	-	Verify Repair	-
4	Locate and repair short to ground in the EHT sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0122/P0123 Model 490000 Throttle Position Sensor (TPS) If equipped (Non-Scan Diagnostics)

Circuit Description

The Throttle Position Sensor (TPS) is a potentiometer connected to the throttle shaft on the throttle body. By monitoring the voltage on the signal line, the ECM calculates throttle position. As the throttle valve angle is changed, the TPS signal also changes. At a closed throttle position, the output of the TPS is low. As the throttle valve opens, the voltage output increases so that at Wide Open Throttle (WOT) the output voltage should be above 4 volts.

Diagnostic Aids

Check for the following conditions:

1. 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.
2. Damaged harness. Inspect the wiring harness and connectors for damage.
3. If the ground is bad in the ECM or has a

bad connection this could cause multiple DTC's to be thrown.

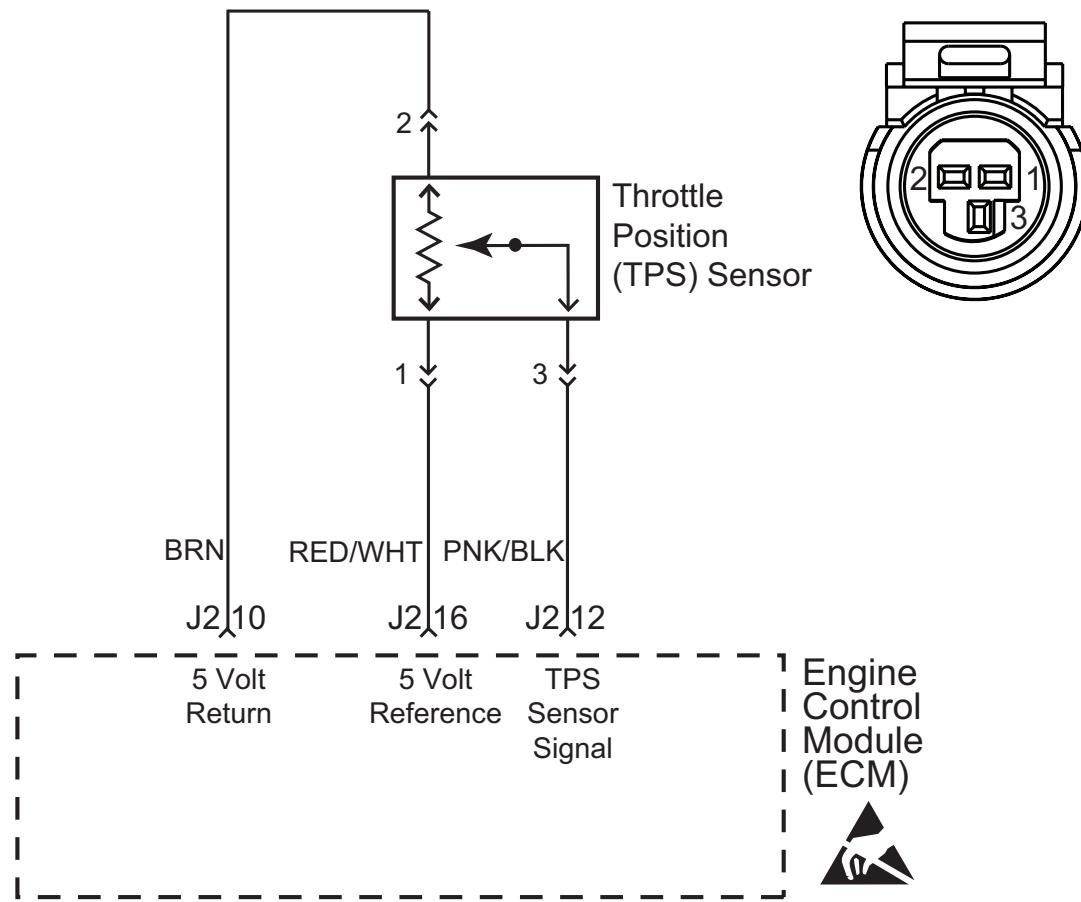
After repairs, clear DTC's following the Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0122 Model 490000 Throttle Position Sensor (TPS)
Circuit - Signal Voltage Low
(Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect TPS harness connector. 3. Connect a jumper wire from harness terminal 2 to harness terminal 3. 4. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 5. Ignition "ON," engine "OFF." Is DTC PO123 present?	-	Go to Step 4	Go to Step 3
3	1. Remove jumper wire from terminals 2 and 3. 2. Connect DVOM by back probing harness terminals 1 and 2 on the sensor connector. Is voltage reading above the specified value?	4.0v	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty TPS. Is action complete?	-	Verify repair	-
5	Locate and repair open or short to ground in the TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify repair	Go to Step 7
6	Locate and repair open or short to ground in the 5v reference circuit. Was a problem found?	-	Verify repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify repair	-

DTC P0123 Model 490000 Throttle Position Sensor (TPS)
Circuit - Signal Voltage High
(Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect TPS harness connector. 3. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 4. Ignition "ON," Engine "OFF." Is DTC PO122 present?	-	Go to Step 4	Go to Step 3
3	Disconnect the TPS harness connector. 5. Ignition "ON," Engine "OFF." 6. Connect DVOM from harness terminal 1 to harness terminal 2. Is voltage reading above the specified value?	4.0v	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty TPS. Is action complete?	-	Verify Repairs	-
5	Locate and repair open in the 5v return circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 7
6	Locate and repair short to voltage in the TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repairs	-



DTC P0122/P0123 Model 610000 Throttle Position Sensor (TPS) (Non-Scan Diagnostics)

Circuit Description

The Throttle Position Sensor (TPS) is a potentiometer connected to the throttle shaft on the throttle body. By monitoring the voltage on the signal line, the ECM calculates throttle position. As the throttle valve angle is changed, the TPS signal also changes. At a closed throttle position, the output of the TPS is low. As the throttle valve opens, the voltage output increases so that at Wide Open Throttle (WOT) the output voltage should be above 4 volts.

Diagnostic Aids

Check for the following conditions:

1. 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.
2. Damaged harness. Inspect the wiring harness and connectors for damage.
3. If the ground is bad in the ECM or has a

bad connection this could cause multiple DTC's to be thrown.

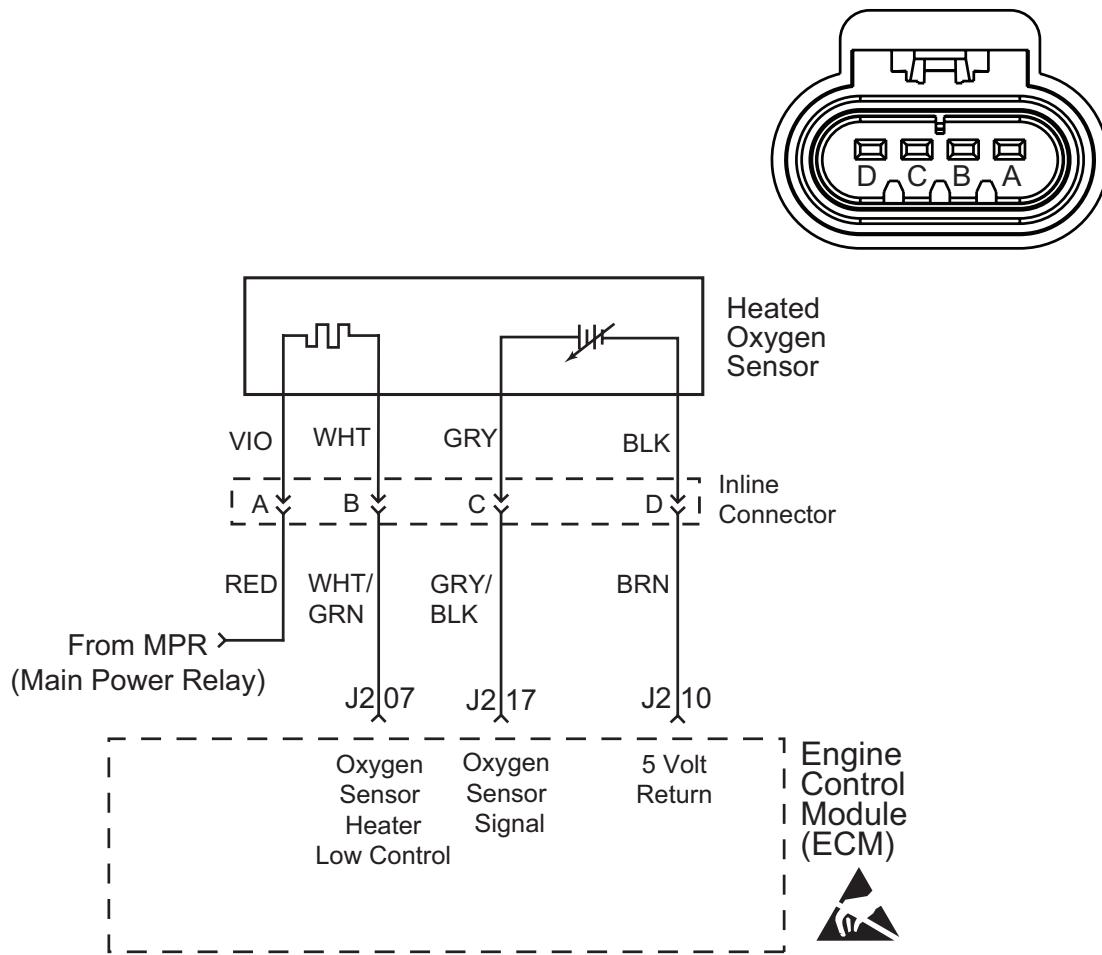
After repairs, clear DTC's following the Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0122 Model 610000 Throttle Position Sensor (TPS)
Circuit - Signal Voltage Low
(Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect TPS harness connector. 3. Connect a jumper wire from harness terminal 1 to harness terminal 3. 4. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 5. Ignition "ON," engine "OFF." Is DTC PO123 present?	-	Go to Step 4	Go to Step 3
3	1. Remove jumper wire from terminals 1 and 3. 2. Connect DVOM by back probing harness terminals 1 and 2 on the sensor connector. Is voltage reading above the specified value?	4.0v	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty TPS. Is action complete?	-	Verify repair	-
5	Locate and repair open or short to ground in the TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify repair	Go to Step 7
6	Locate and repair open or short to ground in the 5v reference circuit. Was a problem found?	-	Verify repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify repair	-

DTC P0123 Model 610000 Throttle Position Sensor (TPS)
Circuit - Signal Voltage High
(Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect TPS harness connector. 3. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 4. Ignition "ON," Engine "OFF." Is DTC P0122 present?	-	Go to Step 4	Go to Step 3
3	Disconnect the TPS harness connector. 5. Ignition "ON," Engine "OFF." 6. Connect DVOM from harness terminal 1 to harness terminal 2. Is voltage reading above the specified value?	4.0v	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty TPS. Is action complete?	-	Verify Repairs	-
5	Locate and repair open in the 5v return circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 7
6	Locate and repair short to voltage in the TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repairs	-



DTC P0131/P0132-Oxygen (HO_2) Sensor If equipped (Non-Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO_2) sensor(s) varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 volt if the exhaust is lean.

The sensor behaves like an open circuit and produces no voltage when the exhaust temperature is below 360°C (600°F). An open oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

The heater in the sensor provides for a faster sensor warm-up. This allows the sensor(s) to become active in a shorter period of time and remain active during a long extended idle.

DTC P0131 determines if the heated oxygen sensor has developed an open circuit. With an active DTC P0131 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

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.

For proper wire and connection repairs, refer to Wiring Repair. After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

**DTC P0131 Heated Oxygen Sensor Low Voltage-
Lean Exhaust indicated
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) system check performed?	-	Go to Step 2	Go to OBD System check
2	1. Run the Engine at normal operating temperature 2. Increase the engine speed to a specified value. 3. Using a DVOM check the voltage between terminal C and D by back probing the sensor connector. Is the HO ₂ sensor voltage displayed fixed less than the specified value.	2200 rpm 0.10v	Go to Step 3	Go to Step 4
3	1. Disconnect the HO ₂ sensor electrical connector. 2. Using a jumper wire, connect the HO ₂ sensors low circuit terminal B to a known good ground. 3. Ignition "ON," Engine "OFF." Is the voltage displayed on the DVOM within the specified value?	0.15-0.49v	Refer to Diagnostic Aids	Go to Step 5
4	If no additional DTC's are stored, refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	-	Go to Applicable DTC Table	-
5	Locate and repair short to ground in the HO ₂ sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to step 6
6	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify repair	-

**DTC P0132 Heated Oxygen Sensor High Voltage-Rich Exhaust indicated
(Non-Scan Diagnostics)**

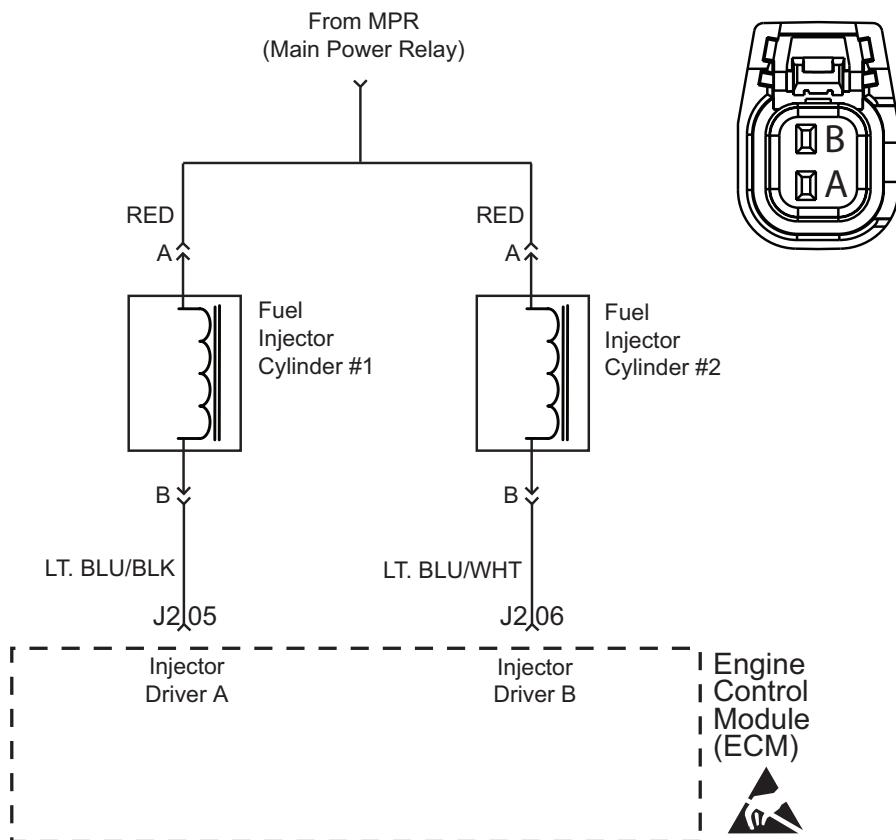
Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Run the engine at normal operating temperature. 2. Increase the engine speed to specified value. 3. Using a DVOM check the voltage between terminal C and D by back probing the harness connector. Is the voltage displayed above the specified value?	2200 RPM 0.90v	Go to Step 3	Go to Step 5
3	Ignition "ON," Engine "OFF." Is the voltage displayed above the specified value?	0.90v	Go to Step 4	Refer to Diagnostic Aids
4	1. Disconnect the HO ₂ sensor electrical connector. 2. Ignition "ON," Engine "OFF." 3. Connect DVOM to terminals C and D. Is the voltage displayed above the specified value?	0.90v	Go to Step 7	Go to Step 6
5	If any additional DTC's are stored, refer to those table(s) first.	-	Go to Applicable DTC Table	-
6	Repair faulty HO ₂ sensor connections or replace HO ₂ sensor. Is action complete?	-	Verify Repair	-
7	Locate and repair short to voltage on the HO ₂ sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 8
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC P0174 PE System Lean (Non-Scan Diagnostics)

The Power Enrichment (PE) mode is initiated in Higher load running conditions. The ECM uses the input from the Map sensor and Crank Position Sensor to know when to go into Power Enrichment (PE). PE fueling provides a performance benefit to enrich the engine for

optimal performance and to provide maximum power. This also prevents against excessive Exhaust valve and engine temperatures. If the DTC P0174 has been set the Engine is not receiving enough fuel.

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Check the fuel filter and fuel lines for debris and or a restriction. If a problem is found, repair as necessary. Was a problem found?		Verify Repair	Go To Step 3
3	Check the fuel pressure. If a problem is found, repair as necessary. Is the fuel pressure within the specified value?		Verify Repair	Go To Step 4
4	Verify the lift pump is operating properly and that the fuel filter is not clogged or restricted. If a problem is found, repair as necessary. Was a problem found?		Verify Repair	Go To Step 5
5	Check for vacuum and exhaust leaks. If a problem is found, repair as necessary. Was a leak found?	-	Verify Repair	Go To Step 6
6	If any additional DTC's are stored, refer to those table(s) first.	-	Go to Applicable DTC Table	Go To Step 7
7	Replace faulty fuel injector(s). Is action complete?	-	Verify Repair	Go To Step 8
8	Replace faulty HO ₂ Sensor. Is action complete?	-	Verify Repair	Contact Engine Manufacturer



DTC P0201/P0202 Fuel Injectors A and B (Non-Scan Diagnostics)

Circuit Description

The fault code will indicate which injector is in fault mode.

The Engine Control Module (ECM) controls fuel injector drivers that are located inside the ECM. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC will set. When a DTC is set it will only indicate which fuel injector(s) has a fault. The technician will have to diagnose if it is a fault in the ground circuit or ignition circuit.

Important: The ECM/fuel injector fuse also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground.

NOTE: If an ignition coil fault code is active it will turn off the fuel injector for the same cylinder(s) the ignition coil is related to.

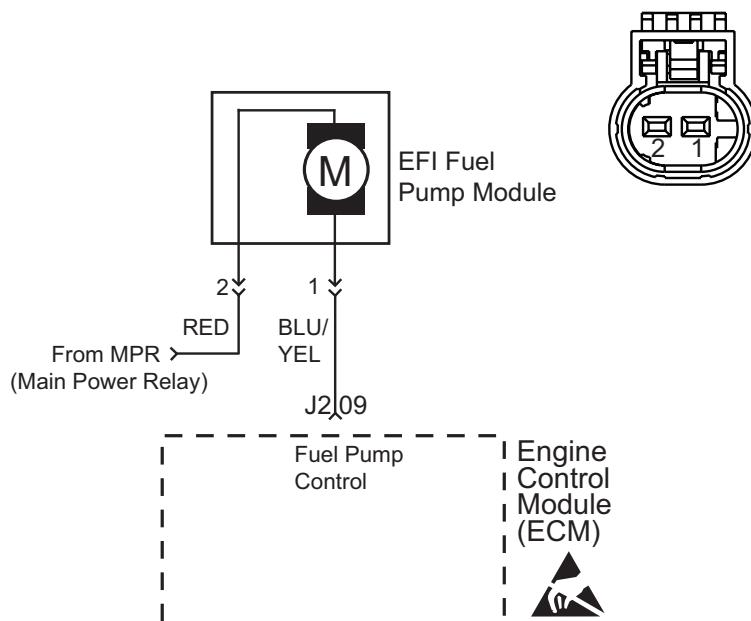
Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
 2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
 3. Inspect the wiring harness for damage.
 4. Check the fuse block for an open fuse.
- After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0201/ P0202 Fuel Injectors High, Low or Open (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Disconnect the appropriate harness connector for each fuel injector. 2. Ignition "ON," Engine "OFF." 3. Using a test lamp connected to a known good ground, back probe terminal A of each fuel injector at the harness connector. Does the test lamp illuminate on both harness connectors?	-	Go to Step 3	Go to Step 6
3	1. Connect the test lamp to B+, back probe terminal B of each fuel injector at the harness connector. 2. Attempt to start engine. Does the test lamp blink on both harness connectors?	-	Go to Step 4	Go to Step 5
4	1. Ignition "ON," Engine "OFF." 2. Connect the test lamp to B+, back probe terminal B of each fuel injector at the harness connector. DO NOT attempt to start the engine. Does the test lamp remain illuminated at all times on either of the ground circuits?	-	Go to Step 7	Go to Step 8
5	Locate and repair an open or short to voltage in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
6	Locate and repair an open or short to ground in the ignition (B+) circuit. Was a problem found?	-	Verify Repair	-
7	Locate and repair a short to ground in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
8	Repair faulty fuel injector connections or replace faulty fuel injector. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0230/P0232 Fuel Pump Relay (FPR) Model 490000 (Non-Scan Diagnostics)

Circuit Description

Certain engine models do not use a relay to operate the fuel pump. On these models the Engine Control Module (ECM) controls the fuel pump module with an internal switch called a driver. The primary function of the driver is to supply the ground to the fuel pump module. This driver has a fault line which the ECM monitors.

If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes causing the DTC to set.

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
- DTC's

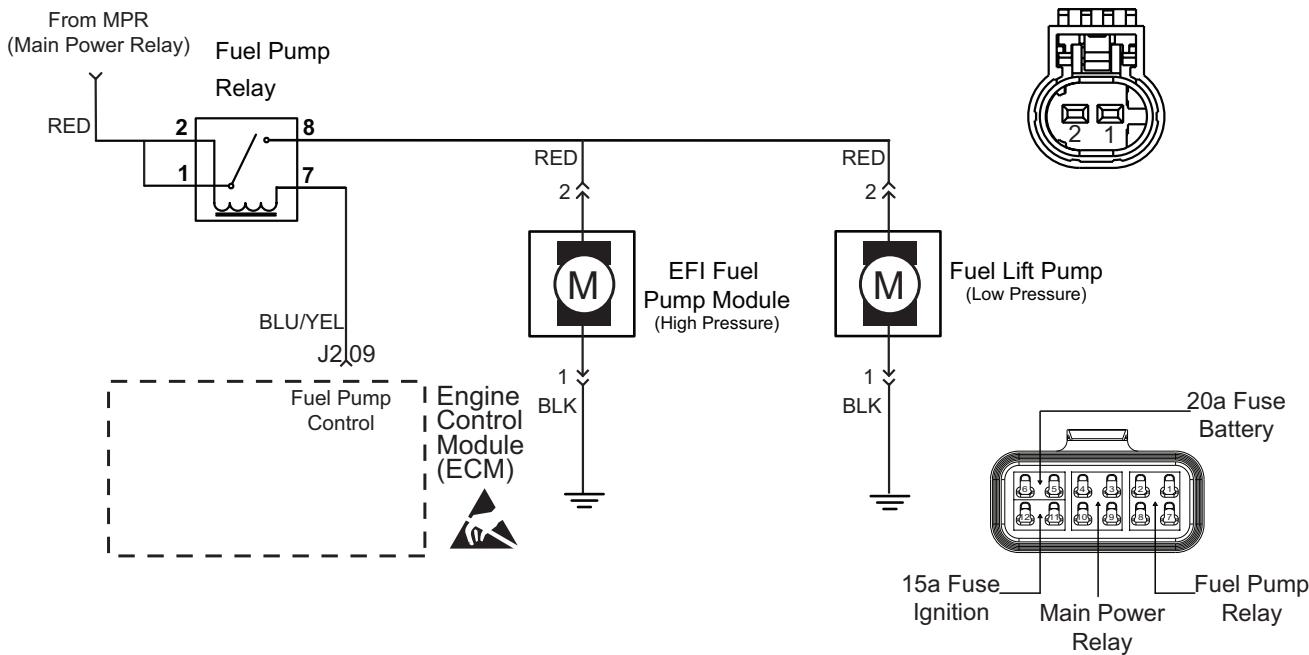
Diagnostic Aids

The following conditions may have caused the fuel pump fuse to malfunction:

1. The fuse is faulty
 2. There is an intermittent short in the fuel pump power feed circuit.
 3. The fuel pump has an intermittent internal problem.
 4. Poor connection at ECM.
 5. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
 6. Inspect the wiring harness and relay for damage.
 7. Check the fuse block for an open fuse.
- After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0230/P0232 Fuel Pump Relay (FPR) Model 490000 (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "ON," Engine "OFF." 2. Using a DVOM connected to a known good ground, back probe terminal 2 of the fuel pump module harness connector. Is the voltage displayed fixed above the specified value?	12.2-13.5v	Go to Step 3	Go to Step 5
3	1. Using a test light connected to a B+, back probe terminal 1 of the fuel pump module harness connector. 2. Attempt to start engine. Does the test lamp illuminate brightly while cranking?	-	Go to Step 6	Go to Step 4
4	Locate and repair an open or short to voltage in the fuel pump module ground circuit. Was a problem found?	-	Verify Repair	Go to Step 7
5	Locate and repair an open or short to ground in the fuel pump module ignition (B+) circuit. Was a problem found?	-	Verify Repair	-
6	Repair faulty fuel pump module connections or replace faulty fuel pump module. Is action complete?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0230/P0232 Model 610000 Fuel Pump Relay (FPR) (Non-Scan Diagnostics)

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pump module and the electric lift pump. The lift pump is a diaphragm style pump that transfers fuel from the tank to the fuel pump module. The fuel pump module and lift pump will remain ON as long as the ECM receives reference pulses from the crank sensor. If there are no reference pulses, the ECM turns the fuel pump relay OFF after about 2 seconds. This shuts off the fuel pumps. The fuel pump module delivers fuel to the fuel rail and injectors. The fuel pump module also has an internal fuel pressure regulator, that maintains a fuel pressure of 39 PSI or 270 KPA. 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
- DTC's

Diagnostic Aids

The following conditions may have caused the fuel pump fuse to malfunction:

1. The fuse is faulty
 2. There is an intermittent short in the fuel pump power feed circuit.
 3. The fuel pump has an intermittent internal problem.
 4. Poor connection at ECM.
 5. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
 6. Inspect the wiring harness and relay for damage.
 7. Check the fuel pump for an open fuse.
- After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0230/P0232 Fuel Pump Relay Driver Circuit High, Low or Open (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Check the fuel pump fuse. Is the fuse open?	-	Go to Step 9	Go to Step 3
3	1. Disconnect the fuel pump relay harness connector. 2. Ignition "ON," Engine "OFF." 3. Probe the fuel pump relay battery feed circuit at the harness connector with a test lamp connected to ground. Does the test lamp illuminate?	-	Go to Step 4	Go to Step 12
4	Probe the fuel pump relay ground circuit at the harness connector with a test lamp connected to B+. Refer to the thumbnail wiring schematic for the proper terminal identification. 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 ground. Refer to the thumbnail wiring diagram for the proper terminal identification. 2. Command the fuel pump on by turning the Ignition "ON," Engine "OFF." NOTE: When the ignition is turned on and the engine is not running the ECM will only power up the FPR for 2 seconds then shut off. Does the test lamp illuminate?	-	Go to Step 6	Go to Step 11
6	1. Ignition "ON." 2. Jumper the fuel pump relay battery feed circuit to the fuel pump load circuit at the harness connector using a fused jumper wire. 3. 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 connector at the fuel pump. 3. Probe the power feed circuit in the fuel pump harness connector with a test lamp connected to a known good ground. Does the test lamp illuminate?	-	Go to Step 8	Go to Step 14

**DTC P0230/P0232 Fuel Pump Relay Driver Circuit High,
Low or Open cont'd
(Non-Scan Diagnostics)**

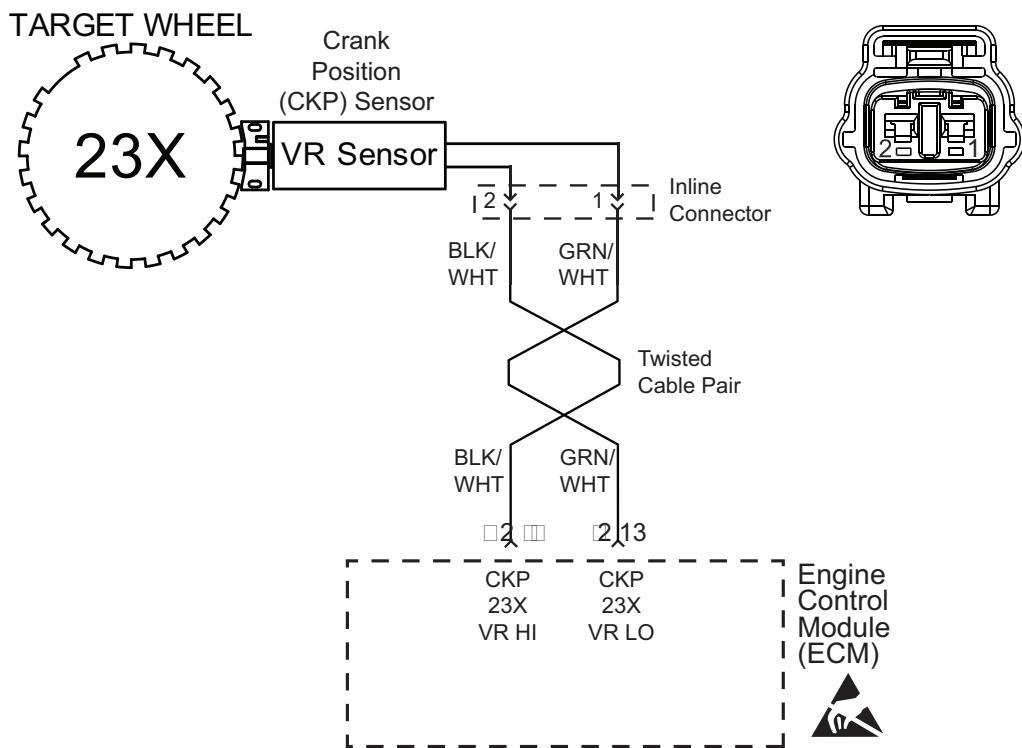
Step	Action	Value(s)	Yes	No
8	1. Leave the fused jumper wire connected. 2. Connect the test lamp between the battery feed circuit and the ground circuit in the fuel pump harness connector. Does the test lamp illuminate?	-	Go to Step 24	Go to Step 15
9	1. Ignition "OFF." 2. Remove the fuel pump fuse. 3. Disconnect the fuel pump harness connector at the fuel pump. 4. Probe the load circuit for the fuel pump relay at the harness connector with a test lamp connected to B+. Does the test lamp illuminate?	-	Go to Step 16	Go to Step 10
10	Probe the battery feed circuit for 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. Ignition "OFF." 2. Disconnect the ECM connector J2. 3. Measure the continuity of the fuel pump relay control circuit from the fuel pump relay harness connector to the ECM connector using the DVOM. Does the DVOM display the specified value or lower?	2 ohms	Go to Step 22	Go to Step 17
12	Repair the open or grounded battery feed circuit to the relay. Replace the fuel pump fuse if the fuse is open. Is the action complete?	-	Go to Step 25	-
13	Repair the open fuel pump relay ground circuit. Is the action complete?	-	Go to Step 25	-
14	Repair the open circuit between the fuel pump relay and the fuel pump. Is the action complete?	-	Go to Step 25	-
15	Repair the open fuel pump ground circuit. Is the action complete?	-	Go to Step 25	-
16	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 25	-

**DTC P0230/P0232 Fuel Pump Relay Driver Circuit High,
Low or Open cont'd
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
17	Repair the fuel pump relay control circuit. Is the action complete?	-	Go to Step 25	-
18	Inspect for poor connections at the relay harness connector. Did you find and correct the condition?	-	Go to Step 25	Go to Step 19
19	Replace the relay. Refer to Fuel Pump Relay Replacement. Is the action complete?	-	Go to Step 25	-
20	Repair the short to ground in the battery feed circuit to the fuel pump relay. Is the action complete?	-	Go to Step 25	-
21	1. Ignition "OFF." 2. Re-install the fuel pump relay. 3. Install a new fuse. 4. Connect the fuel pump harness to the fuel pump. 5. Command the fuel pump relay ON by turning the Ignition "ON," Engine "OFF." NOTE: When the ignition is turned on and the engine is not running the ECM will only power up the FPR for 2 seconds then shut off. Is the fuel pump fuse open?	-	Go to Step 23	Go to Diagnostic Aids
22	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Go to Step 25	Go to Step 22
23	1. Inspect the fuel pump harness for a short to ground. If you find a short, repair the circuit as necessary. Did you find and correct the condition?	-	Go to Step 25	-
24	1. Inspect for poor electrical connections at the fuel pump harness before replacing the fuel pump. 2. Replace the fuel pump. Is the action complete?	-	Go to Step 25	Go to Step 24
25	1. Select the Diagnostic Trouble Code (DTC) option and the Clear DTC Information option using the code reader. 2. Attempt to start the engine. Does the engine start and continue to operate?	-	Go to Step 26	-

**DTC P0230/P0232 Fuel Pump Relay Driver Circuit High,
Low or Open cont'd
(Non-Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
26	<p>1. Idle the engine until the normal operating temperature is reached.</p> <p>2. Select the Diagnostic Trouble Code (DTC) option.</p> <p>Are any DTCs displayed?</p>	-	Go to Applicable DTC table	System OK



DTC P0336/P0337 Crankshaft Position (CKP) Sensor (Non-Scan Diagnostics)

Modes of Operation

The crankshaft position (CKP) sensor works in conjunction with the 23X reluctor target wheel on the flywheel. Each tooth on the reluctor wheel is equally spaced with 1 tooth missing for the reference sync pulse. As the crankshaft rotates, the reluctor target wheel interrupts a magnetic field produced by a magnet internal to the sensor. The CKP sensor internal circuitry detects this interruption of the magnetic field, and produces an ON/OFF AC voltage of varying frequency. The frequency of the CKP sensor output signal is dependent upon crankshaft speed. The ECM uses each CKP output signal to determine crankshaft speed, and identify crankshaft position.

There is one normal mode of operation, with the spark under control of the ECM. If the CKP signal is lost the engine will not run. The ECM will not be able to determine which stroke the pistons are on. Diagnostic trouble codes are available to accurately diagnose the ignition system with the code reader.

Diagnostic Aids

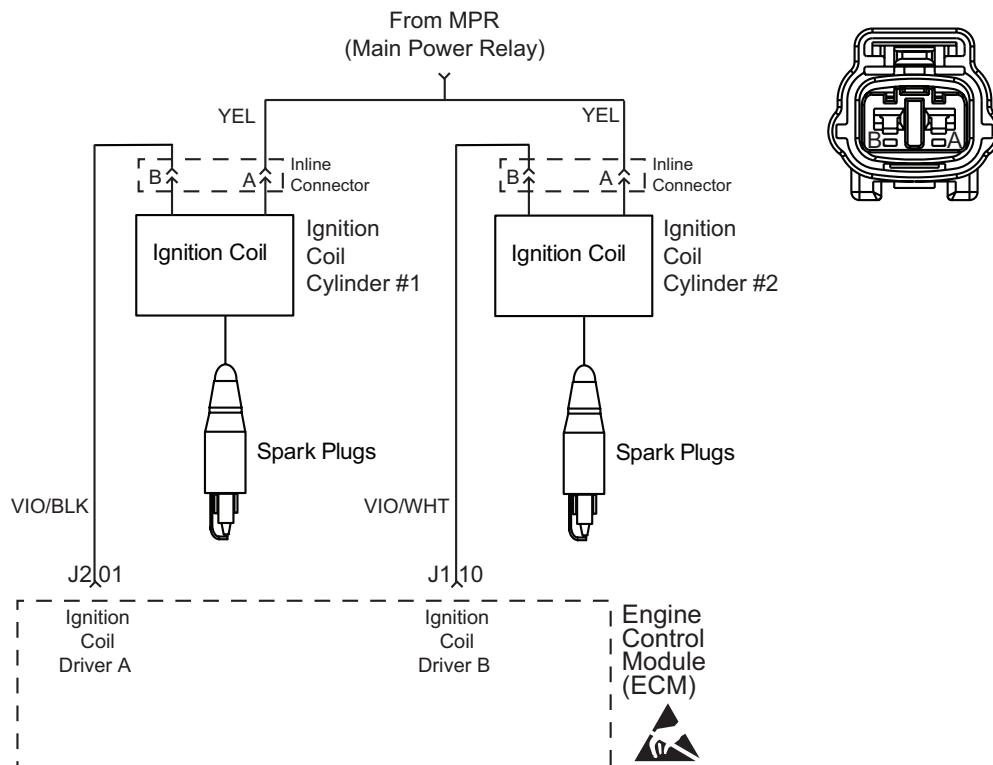
Check for the following conditions:

1. Verify that the Crank Position Sensor is gapped at .30 from the target wheel.
2. 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.
3. Damaged harness. Inspect the wiring harness for damage. If the ground is bad in the ECM or has a bad connection this could cause multiple DTC's to be thrown.

After repairs, clear DTC's following clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0336/P0337 Crankshaft Position (CKP) Sensor (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Did you perform the "On-Board Diagnostic" (OBD) System Check?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Back probe the ECM connector at terminals J2-04 and J2-13. 3. Using a DVOM set to AC voltage turn over the engine. Does the DVOM indicate that the CKP is giving off an AC voltage above the specified range?	0.95v	Go to Step 7	Go to Step 3
3	1. Ignition "OFF." 2. Back probe the CKP sensor connector at terminals 1 and 2. 3. Using a DVOM set to AC voltage turn over the engine. Does the DVOM indicate that the CKP is giving off an AC voltage above the specified range?	0.95v	Go to Step 4	Go to Step 5
4	Locate and repair short or open in the CKP circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	Verify the CKP is clean and mounted correctly. Was a problem found?	-	Verify Repair	Go to Step 6
6	Repair faulty CKP connections or replace faulty CKP. Is action complete?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0351/P0352 Ignition Coil A and B (Non-Scan Diagnostics)

Circuit Description

Each ignition coil has an ignition (B+ voltage) and a ground circuit. The engine control module (ECM) supplies an ignition control (IC) circuit and a low reference circuit. Each ignition coil contains a solid state driver module that is located inside the ECM. The ECM will command the IC circuit ON, which allows the current to flow through the primary coil windings for the appropriate time or dwell. When the ECM commands the IC circuit OFF, this will interrupt current flow through the primary coil windings. The magnetic field created by the primary coil windings will collapse across the secondary coil windings, which induces a high voltage across the spark plug electrodes. The primary coils are current limited to prevent overloading if the IC circuit is held ON for an extended time.

The fault code will indicate which coil is in fault.

When an ignition coil fault is set the ECM will also shut down the fuel injector for the same cylinder that the fault is set on. The engine will

continue to run on one cylinder if no fault is set for the opposite cylinder.

If there is no spark and a DTC has NOT set check the coil wire to the spark plug for good connectivity.

Important: The ECM/ignition coil fuse also supplies voltage to the fuel injectors. If the fuse is open, inspect all related circuits for a short to ground.

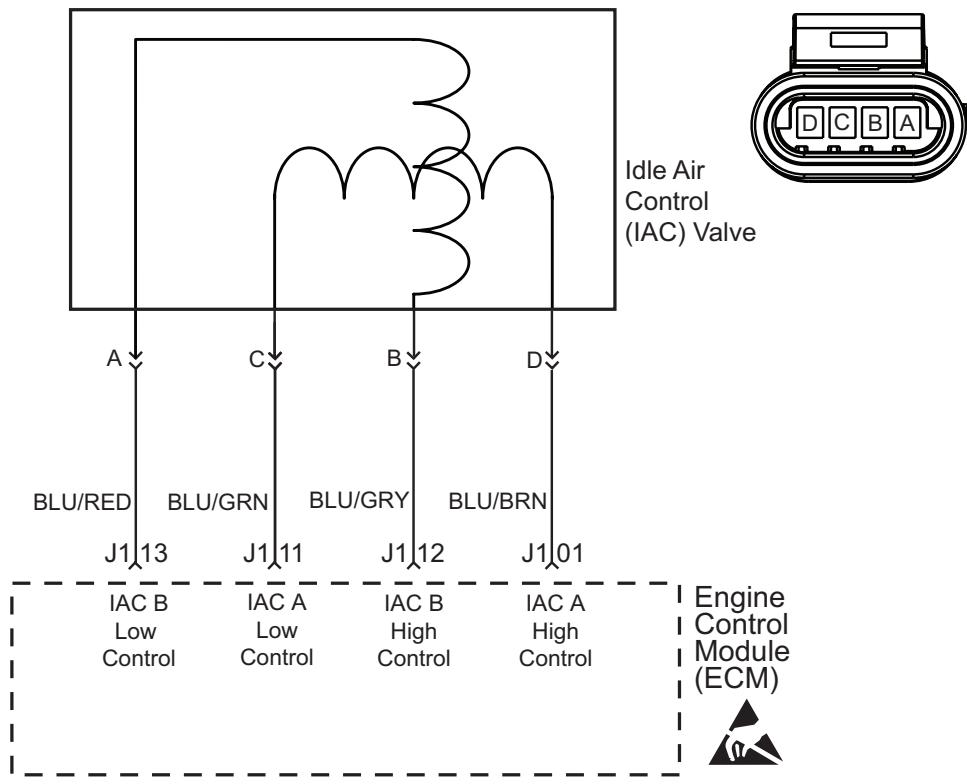
Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
 2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
 3. Inspect the wiring harness for damage.
 4. Check the fuse block for an open fuse.
- After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0351/P0352 Ignition coil(s) High, Low or Open (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Disconnect the appropriate harness connector for each Ignition coil. 2. Ignition “ON,” Engine “OFF.” 3. Using a test lamp connected to a known good ground, back probe terminal A of each ignition coil harness connector. Does the test lamp illuminate on both harness connectors?	-	Go to Step 3	Go to Step 6
3	1. Connect the test lamp to B+; back probe terminal B of each ignition coil harness connector. 2. Attempt to start engine. Does the test lamp blink on both harness connectors?	-	Go to Step 4	Go to Step 5
4	1. Ignition “ON,” Engine “OFF.” 2. Connect the test lamp to B+; back probe terminal B of each ignition coil harness connector. DO NOT attempt to start the engine. Does the test lamp remain illuminated at all times on either of the ground circuits?	-	Go to Step 7	Go to Step 8
5	Locate and repair an open or short to voltage in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
6	Locate and repair an open or short to ground in the ignition (B+) circuit. Was a problem found?	-	Verify Repair	-
7	Locate and repair short to ground in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
8	Repair faulty fuel injector connections or replace faulty fuel injector. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0505 Idle Air Control (IAC) Valve If equipped (Non-Scan Diagnostics)

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

Check for the following items:

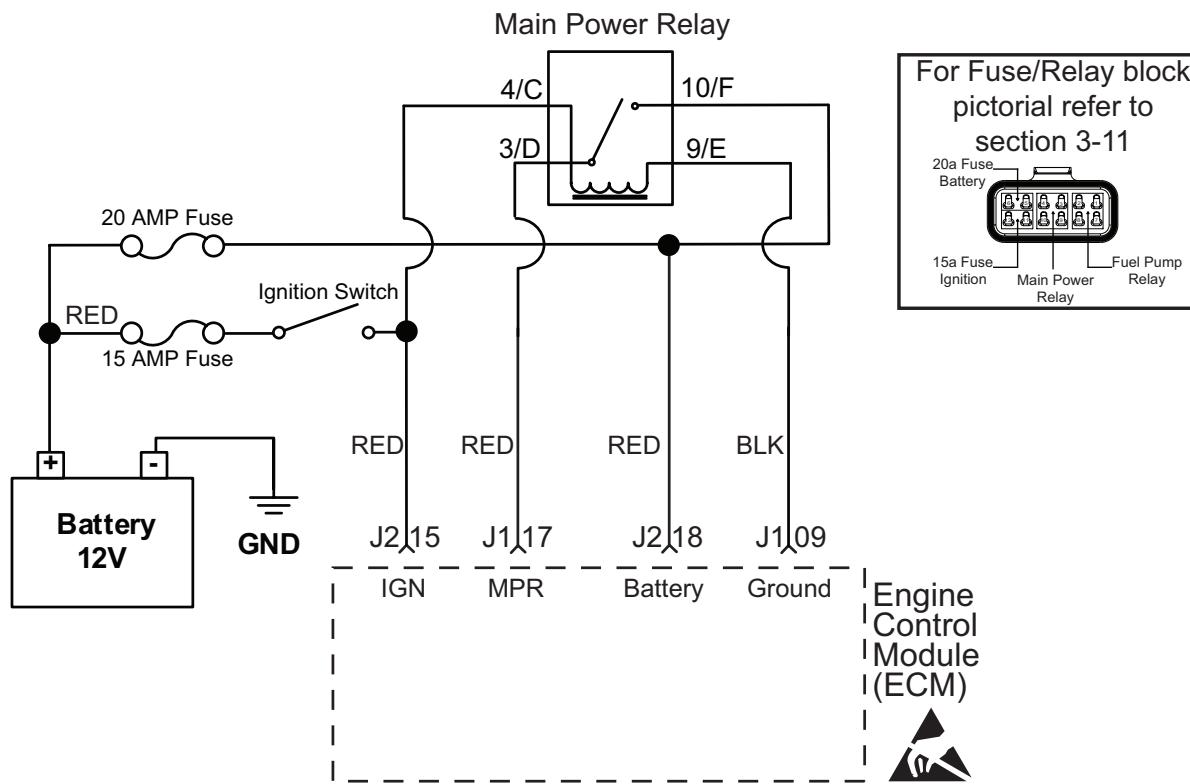
1. Poor connection or damaged harness.
Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
2. Check for vacuum leaks, disconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold.
3. Check for poor connections, opens or short to grounds in the IAC circuit. This may re-

sult in improper idle control.

4. 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.

DTC P0505 Idle Air Control (IAC) Valve Test (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Engine should be at normal operating temperature. 2. Start engine and allow idle to stabilize. 3. Record RPM. 4. Ignition “OFF” for 10 seconds. 5. Disconnect IAC harness connector. 6. Restart engine and record RPM. Is RPM higher than the first recorded RPM by more than the specified value?	200 RPM	Go to Step 3	Go to Step 4
3	1. Reinstall IAC harness connector. 2. Idle speed should gradually return within 75 RPM of the original recorded RPM within 30 seconds. Does RPM return to original recorded RPM?	-	Go to Step 5	Go to Step 4
4	1. Ignition “OFF” for 10 seconds. 2. Disconnect IAC harness connector. 3. Restart engine. 4. Using a test lamp connected to a known good ground, back probe each one of the four IAC harness terminals. Does the test lamp blink on all four terminals?	-	Go to Step 7	Go to Step 8
5	IAC circuit is functioning properly.	-	-	-
6	Locate and repair poor connection, open, or short to ground in the IAC circuit that did not blink. If a problem was found, repair as necessary. Was a problem found?	-	Go to OBD System Check	Go to Step 8
7	Check for poor IAC connections or replace the faulty IAC valve. Is action complete?	-	Go to OBD System Check	-
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Go to OBD System Check	-



DTC P0562/P0563 System Voltage (Non-Scan Diagnostics)

Circuit Description

The EFI system operates with a battery voltage from 9 to 16 volts. If the system voltage drops below 6.2 volts the ECM will reset. The Malfunction Indicator Light (MIL) will illuminate if the voltage is below 9 volts or above 16 volts for a specified amount of time during normal operation.

To determine the system voltage to the ECM, a voltage measurement can be taken at a terminal J2-18. If the voltage at terminal J2-18 is not within 0.01 volt of the measurement you get at the battery (measuring between the positive(+) and negative(-) posts of the battery with your DVOM), determine the fault associated with circuit J2-18.

Similarly, you should be able to measure battery voltage on terminal J2-15 with the ignition switch in the on position and the engine not running.

Refer to the diagram above to locate the two terminals on the ECM that provide battery voltage and ignition-on voltage.

To further diagnose system voltage faults, refer to Briggs & Stratton Intec V-Twin Cylinder OHV Repair Manual section 7.

Diagnostic Aids

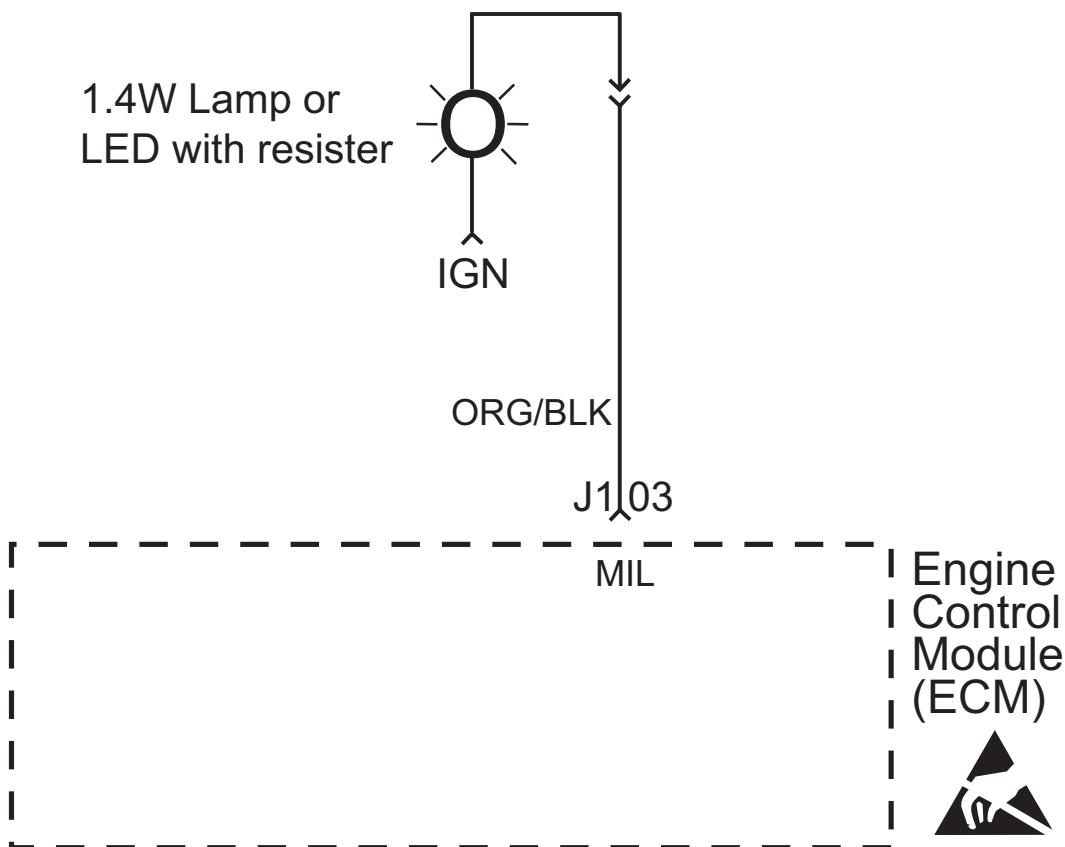
Check for the following conditions:

1. 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.
2. Damaged harness. Inspect the wiring harness and connectors for damage.

After repairs, clear DTC's following Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0562/P0563 System voltage (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Key “OFF” Engine “OFF.” 2. Check the battery for voltage with a DVOM. Is the battery within specified value?	12.2-13.5v	Go to Step 3	Go to Step 5
3	1. Ignition “OFF” Engine “OFF.” 2. Check if the ECM has battery voltage at ECM terminal J2-18 with a DVOM connected to a known good ground. Was the voltage within 0.5 of the battery voltage?	-	Go to Step 4	Go to Step 9
4	1. Ignition “ON” Engine “OFF.” 2. Check for ignition voltage at ECM terminal J2-15 with a DVOM connected to a known good ground. Was the voltage within 0.5v of the battery voltage?	-	Go to Step 5	Go to Step 10
5	Check charging system. Refer to Briggs & Stratton manual for intec V-Twin Cylinder OHV Repair Manual section 7 Is the charging system OK?	-	Go to Step 7	Go to Step 6
6	Locate and repair charging system. Refer to Briggs & Stratton manual for intec V-Twin Cylinder OHV Repair Manual section 7 Is action complete?	-	Verify Repair	-
7	Verify good continuity at the battery terminals. Repair if necessary.	-	Verify Repair	Go to Step 8
8	Replace battery. Is action complete?	-	Verify Repair	-
9	Locate and repair an open or short to ground in the battery feed circuit. Is action complete?	-	Verify Repair	-
10	Locate and repair an open or short to voltage in the ignition feed circuit. Is action complete?	-	Verify Repair	-



DTC P0650 Malfunction Indicator Lamp (MIL) Diagnosis (Non-Scan Diagnostics)

Circuit Description

The Malfunction Indicator Lamp (MIL) gets 12v B+ when the ignition is in the on or run position. The ECM sends a ground signal to illuminate the MIL when the ignition is on and the engine is NOT running. The ECM will also send the ground signal to activate the light if one or more of the malfunctions exists under the conditions listed in the DTC's table. If the malfunction clears, the lamp will go out and the Diagnostic Trouble Code (DTC) will be stored in the ECM. The amount of time after the malfunction occurs before the MIL illuminates is calibratable. (Instantly or up to several minutes).

Do not clear the DTC's unless directed by a diagnostic procedure. Clearing the DTC's may also clear valuable diagnostic information.

Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM. Inspect harness connectors for backed out terminals, im-

proper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

2. Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the Malfunction indicator Lamp (MIL) display while moving connectors and wiring harnesses related to the MIL. A change in the MIL display will indicate the location of the fault.

After repairs, clear DTC's following Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0650 Malfunction Indicator Light (MIL) Malfunction (Non-Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition “OFF.” 2. Using a test light hooked to a known good ground probe the Ignition side of the MIL. Does the test lamp illuminate brightly?	-	Go to Step 3	Go to Step 4
3	1. Ignition “On,” Engine “OFF.” 2. Using a test light connected to a known good ground probe the Ignition side of the MIL. Does the test lamp illuminate brightly?	-	Go to Step 5	Go to Step 4
4	Locate and repair an open or short to ground in the battery feed circuit. If a problem was found, repair as necessary Is action complete?	-	Verify repair	-
5	1. Ignition “OFF.” 2. Using a test light connected to B+ probe the ground side of the MIL. Does the test lamp illuminate brightly?	-	Go to Step 7	Go to Step 6
6	1. Ignition “On,” Engine “OFF.” 2. Using a test light connected to B+ back probe the terminal J1-03 of the ECM connector. Does the test lamp illuminate brightly?	-	Go to Step 8	Go to Step 9
7	Locate and repair poor connection or open in the ground circuit. If a problem was found, repair as necessary. Was a problem found?	-	Verify Repair	-
8	Repair faulty MIL connections or replace faulty MIL. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

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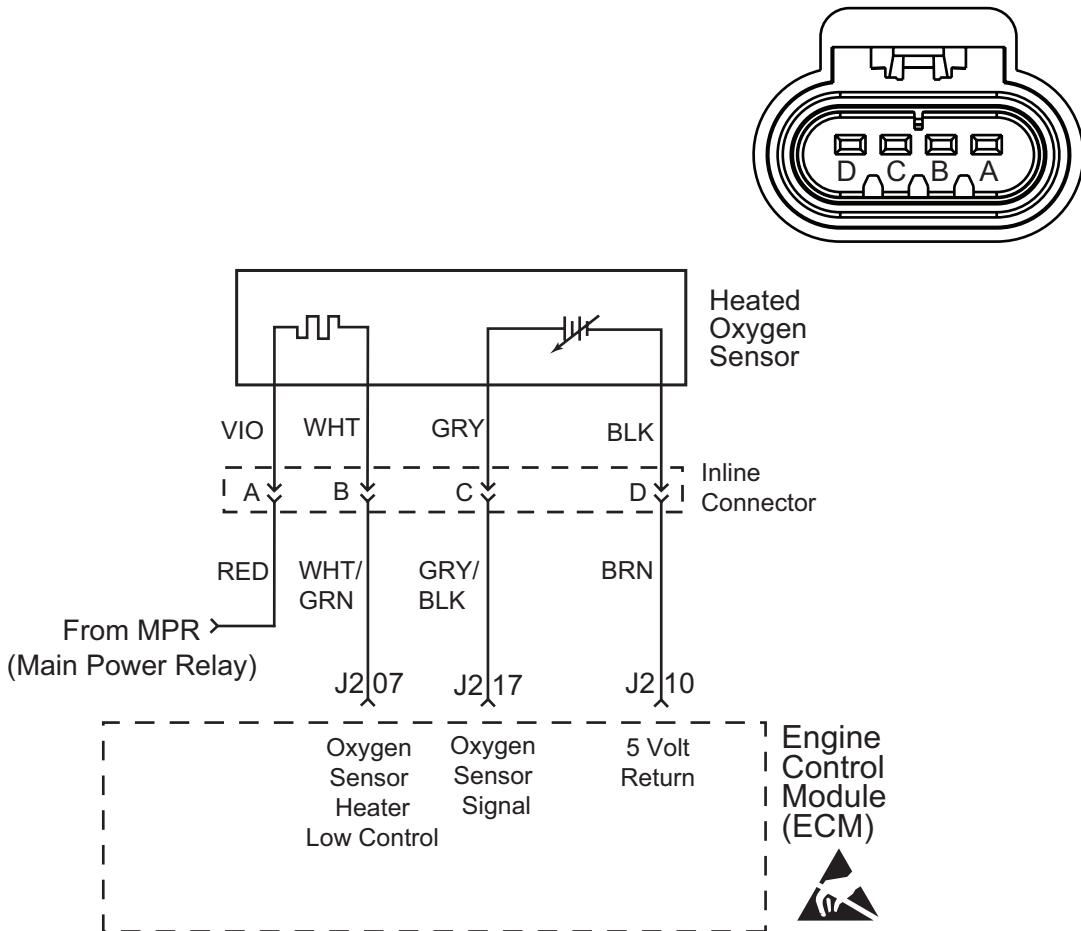
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DTC P0031/P0032 Oxygen Sensor Heater If equipped (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO_2) Sensor varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 volt if the exhaust is lean.

The sensor behaves like an open circuit and produces no voltage when the exhaust temperature is below 360°C (600°F). An open oxygen sensor circuit or cold oxygen sensor causes an open loop operation.

The heater in the sensor provides a faster sensor warm-up. This allows the sensor to become active in a shorter period of time and remain active during a long extended idle.

DTC P0031 determines if the heated oxygen sensor has developed an open circuit. With an active DTC P0031 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

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.

For proper wire and connection repairs, refer to Wiring Repair.

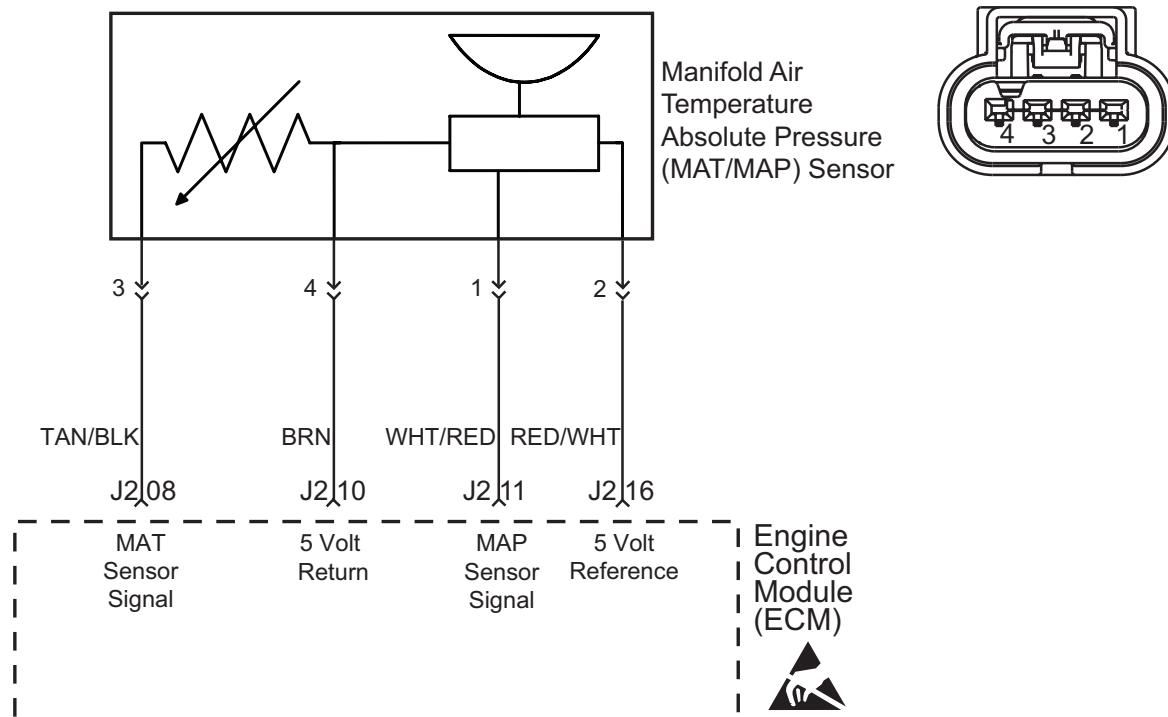
After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

**DTC P0031/P0032 Oxygen Sensor (HO_2) Heater -
Voltage High, Low or Open
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Disconnect the HO_2 sensor electrical connector. 2. Using a DVOM connected to a known good ground, and terminal J1-17 in the ECM harness connector. Does DVOM indicate a voltage within the specified value?	12.2-13.5v	Go to Step 3	Go to Step 8
3	Using a DVOM back probe the sensor connector at terminals A and B. Does DVOM indicate a voltage within the specified value?	12.2-13.5v	Go to Step 4	Go to Step 9
4	1. Reconnect the HO_2 sensor electrical connector. 2. Connect scan tool. 3. Run the engine at a normal operating temperature. 4. Run the engine above the specified value for at least two minutes. Does the scan tool indicate Closed Loop Fuel control?	2200 RPM	Go to Step 7	Go to Step 5
5	1. Ignition “OFF.” 2. Disconnect the HO_2 sensor electrical connector. 3. Install a jumper between the sensor connector terminals C and D. 4. Ignition “ON,” Engine “OFF.” Does the scan tool HO_2 sensor voltage display indicate a voltage less than the specified value?	0.1v	Go to Step 12	Go to Step 6
6	1. Ignition “OFF.” 2. Remove the jumper wire. 3. Ignition “ON,” Engine “OFF.” 4. Using a DVOM back probe sensor connector B. 5. Then probe B+(battery Positive) with the other lead wire from the DVOM. Does the voltage read within the specified range?	12.2-13.5v	Go to Step 10	Go to Step 11

**DTC P0031/P0032 Oxygen Sensor (HO_2) Heater - Voltage High,
Low or Open cont'd
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
7	If any additional DTC's are stored, refer to those table(s) first.	-	Go to Applicable DTC Table	-
8	Locate and repair open or short to ground in the ignition feed circuit for the HO_2 heater. Is action complete?	-	Verify Repair	-
9	Locate and repair open in the ground circuit for the HO_2 heater. Is action complete?	-	Verify Repair	-
10	Locate and repair open in the HO_2 sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 13
11	Locate and repair open in the HO_2 sensor ground circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 13
12	Check for faulty HO_2 sensor connections. If OK, replace HO_2 sensor. Is action complete?	-	Verify Repair	-
13	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0107/P0108 Manifold Absolute Pressure (MAP) (Scan Diagnostics)

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 0.5 volts at idle to 4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM will substitute a default MAP value.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through the ECM terminal J2-16. The MAP sensor will send a voltage signal back to the ECM on terminal J2-11 according to the manifold pressure value on the terminal.

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.

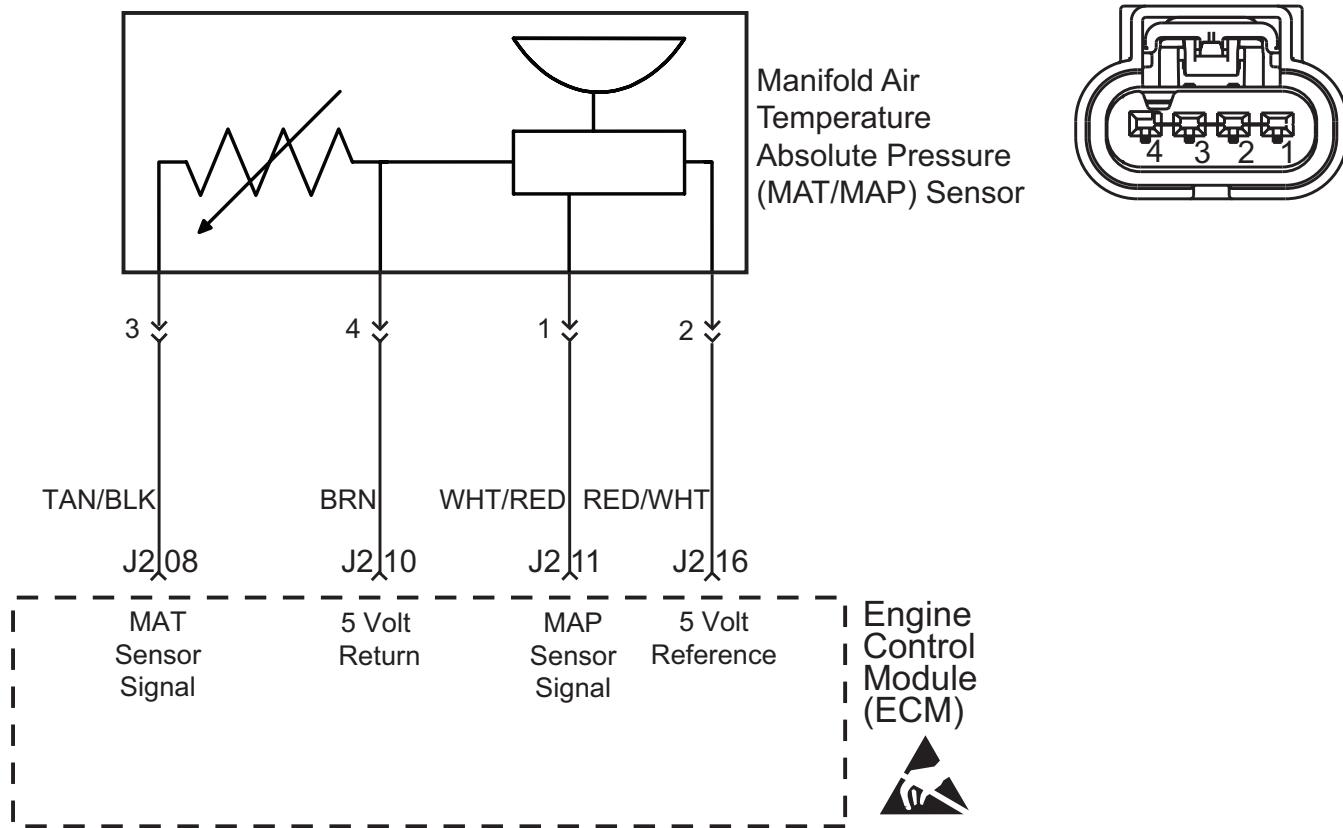
- With the ignition ON, engine OFF, the manifold pressure is equal to atmospheric pressure and the signal voltage will be high. This information is used by the ECM as an indication of barometric pressure and is referred to as BARO.
 - If DTC P0107 is set, check for an open in ground circuit.
 - If a MAP sensor circuit failure is present, the Throttle Position sensor (TPS) –if equipped– value will be used along with the MAP sensor default value.
 - If the ground is bad in the ECM or the ground circuit has a bad connection this could cause multiple DTC's to be set.
- After repairs, clear DTC's following Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0107 Manifold Absolute Pressure (MAP) Sensor-Signal Voltage Low (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Install a scan tool 2. Start the engine and allow Engine to idle. Does scan tool indicate MAP sensor voltage greater than the specified value?	1.0v	Go to Step 3	Go to Step 5
3	1. Ignition "OFF." 2. Disconnect MAP sensor harness connector. 3. Connect a jumper wire from harness terminal 1 to harness terminal 2. 4. Ignition "ON," Engine "OFF." Does scan tool indicate MAP sensor voltage greater than the specified value?	4.0v	Go to Step 7	Go to Step 4
4	1. Ignition "OFF." 2. Connect a DVOM from the harness terminal 2 to a known good ground. 3. Ignition "ON," Engine "OFF." Does DVOM indicate a voltage greater than the specified value?	4.0v	Go to Step 6	Go to Step 5
5	Locate and repair open or short to ground in 5 Volt reference circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 8
6	Locate and repair open or short to ground in Map sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 8
7	Check for plugged or leaking sensor vacuum fitting. If OK, repair faulty MAP sensor connections or replace MAP sensor. Is action complete?	-	Verify Repair	-
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC P0108 Manifold Absolute Pressure (MAP) Sensor-Signal Voltage High (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Install a scan tool 2. Start the engine and allow Engine to idle. Does scan tool indicate MAP sensor voltage greater than the specified value?	4.0v	Go to Step 3	Go to Step 5
3	1. Ignition "OFF." 2. Disconnect MAP sensor harness connector. 3. Ignition "ON," Engine "OFF." Does scan tool indicate MAP sensor voltage less than the specified value?	1.0v	Go to Step 4	Go to Step 6
4	1. Ignition "ON," Engine "OFF." 2. Connect a DVOM to terminals 2 and 4 by back probing the sensor connector. 3. Ignition "ON," Engine "OFF." Does DVOM indicate a voltage greater than the specified value?	4.0v	Go to Step 8	Go to Step 7
5	DTC P0108 is intermittent. Locate and repair intermittent faulty connections.	-	Verify Repair	-
6	Locate and repair short to voltage in the MAP Sensor Signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 9
7	Locate and repair open in the sensor ground circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 9
8	Check for plugged or leaking sensor vacuum fitting. If OK, repair faulty MAP sensor connections or replace MAP sensor. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0112/P0113 Manifold Air Temperature (MAT) Sensor (Scan Diagnostics)

Circuit Description

The Manifold Air Temperature (MAT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on the sensor circuit. When the engine is cold, the sensor (thermistor) resistance is high. As the engine warms up, the sensor resistance becomes lower.

Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
3. Inspect the wiring harness for damage.

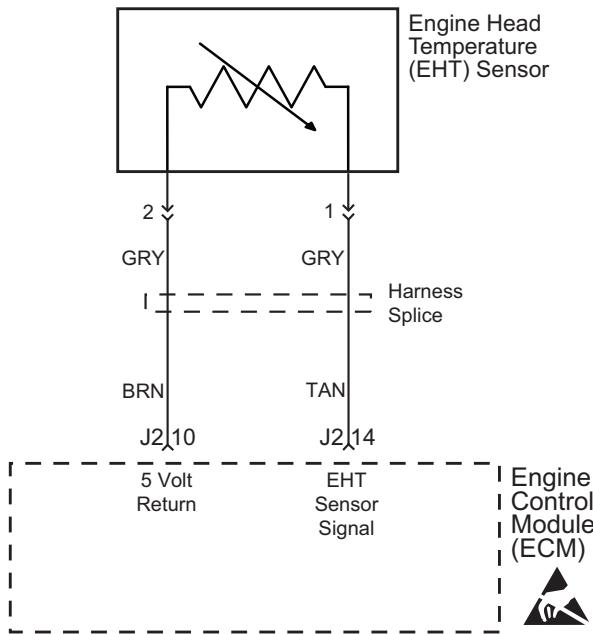
4. If the harness appears to be OK, observe the MAT display on the scan tool while moving connectors and wiring harnesses related to the MAT. A change in the MAT display will indicate the location of the fault.
5. If DTC P0113 is also set, check for an open ground.
6. After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

**DTC P0112 Manifold Air Temperature (MAT) Sensor Circuit -
Low Temp Indicated
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect the MAT sensor harness connector. 3. Ignition "ON," Engine "OFF." 4. Connect a DVOM by back probing terminals 3 and 4. Is voltage above the specified value?	4.0v	Go to Step 4	Go to Step 3
3	1. Connect a one lead from the DVOM to terminal 3. 2. Connect the other lead of the DVOM to a known good ground. Is voltage above the specified value?	4.0v	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty MAT sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open in the MAT sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
6	Locate and repair open in the sensor ground circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

**DTC P0113 Manifold Air Temperature (MAT) Sensor Circuit -
High Temp Indicated
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition “OFF.” 2. Disconnect the MAT sensor harness connector. 3. Ignition “ON,” Engine “OFF.” 4. Connect a DVOM by back probing terminals 3 and 4 at the sensor connector. Is the voltage above the specified value?	4.0v	Go to Step 3	Go to Step 4
3	Locate and repair intermittent faulty connections. If OK, replace faulty MAT sensor. Is action complete?	-	Verify Repair	-
4	Locate and repair short to ground in MAT signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0117/P0118 Engine Head Temperature (EHT) Sensor (Scan Diagnostics)

Circuit Description

The Engine Head Temperature (EHT) Sensor uses a thermistor to control the signal voltage to the ECM. The ECM applies 5 volts on the sensor circuit. When the engine is cold, the sensor (thermistor) resistance is high. As the engine warms up, the sensor resistance becomes lower.

Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
3. Inspect the wiring harness for damage.
4. If the harness appears to be OK, observe the EHT Sensor display on the scan tool while moving connectors and wiring harnesses related to the EHT Sensor. A change in the EHT Sensor display will indicate the location of the fault.
5. If DTC P0118 is also set, check for an open ground
6. After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

To verify that the Thermistor is working properly check the approximate resistance value with an ohms tester using the table below as a guide.

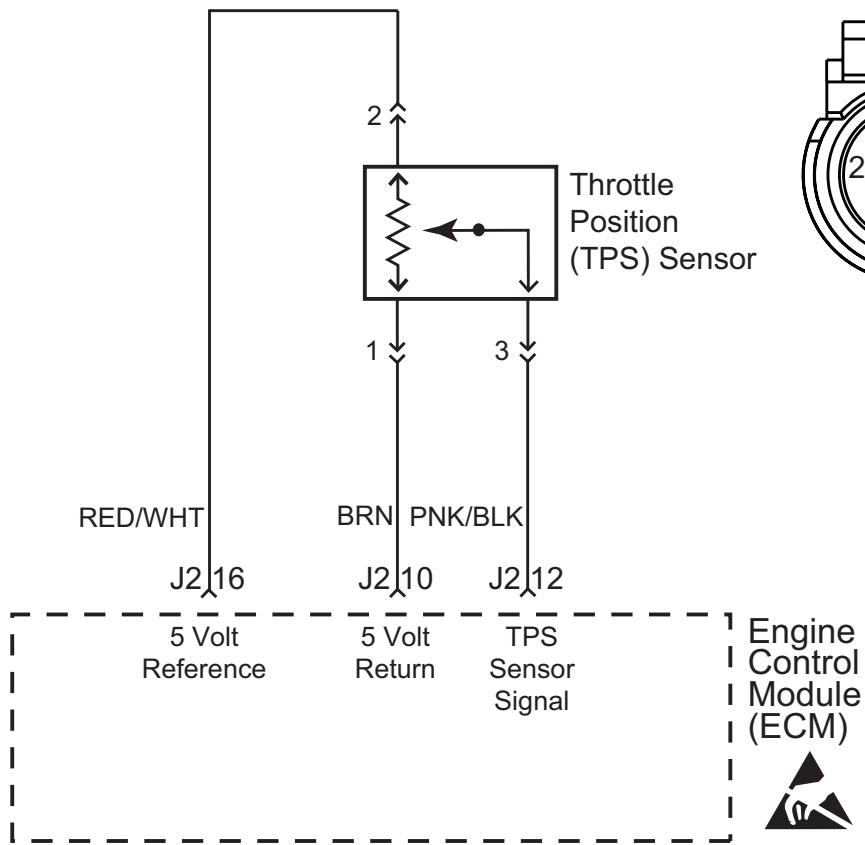
Temperature °C	Temperature °F	Resistance Ohms
-10	14	58,506
0	32	33,723
10	50	20,210
20	68	12,542
30	86	8,032
40	104	5,292
50	122	3,578
60	140	2,477
80	176	1,263
90	194	927
110	230	525
120	248	403
135	275	278
145	293	221
155	311	177
175	347	117
185.0	365.0	96.73

**DTC P0117 Engine Head Temperature (EHT) Sensor Circuit -
Low Temp Indicated
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "ON," Engine "OFF." 2. Connect the DVOM to terminals J2-10 and J2-14 in the ECM connector. Is voltage above the specified value?	1.5-4.5v	Go to Step 4	Go to Step 3
3	Connect a DVOM to terminal J2-14 and a known good ground. Is voltage above specified value?	4.0v	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty EHT sensor. Is action complete?	-	Verify Repair	-
5	Locate and repair open in the EHT sensor circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
6	Locate and repair open ground in the 5v return circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC P0118 Engine Head Temperature (EHT) Sensor Circuit - High Temp Indicated (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "ON," Engine "OFF." 2. Connect the DVOM to terminals J2-10 and J2-14 in the ECM connector. Is voltage within the specified value?	1.2-4.5V	Go to Step 3	Go to Step 4
3	Locate and repair intermittent faulty connections. If OK, replace faulty EHT sensor. Is action complete?	-	Verify Repair	-
4	Locate and repair short to ground in the EHT sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0122/P0123 Model 490000 Throttle Position Sensor (TPS) If equipped (Scan Diagnostics)

Circuit Description

The Throttle Position Sensor (TPS) is a potentiometer connected to the throttle shaft on the throttle body. By monitoring the voltage on the signal line, the ECM calculates throttle position. As the throttle valve angle is changed, the TPS signal also changes. At a closed throttle position, the output of the TPS is low. As the throttle valve opens, the voltage output increases so that at Wide Open Throttle (WOT) the output voltage should be above 4 volts.

Diagnostic Aids

Check for the following conditions:

1. 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.
2. 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.

3. If the ground is bad in the ECM or has a bad connection this could cause multiple DTC's to be thrown.

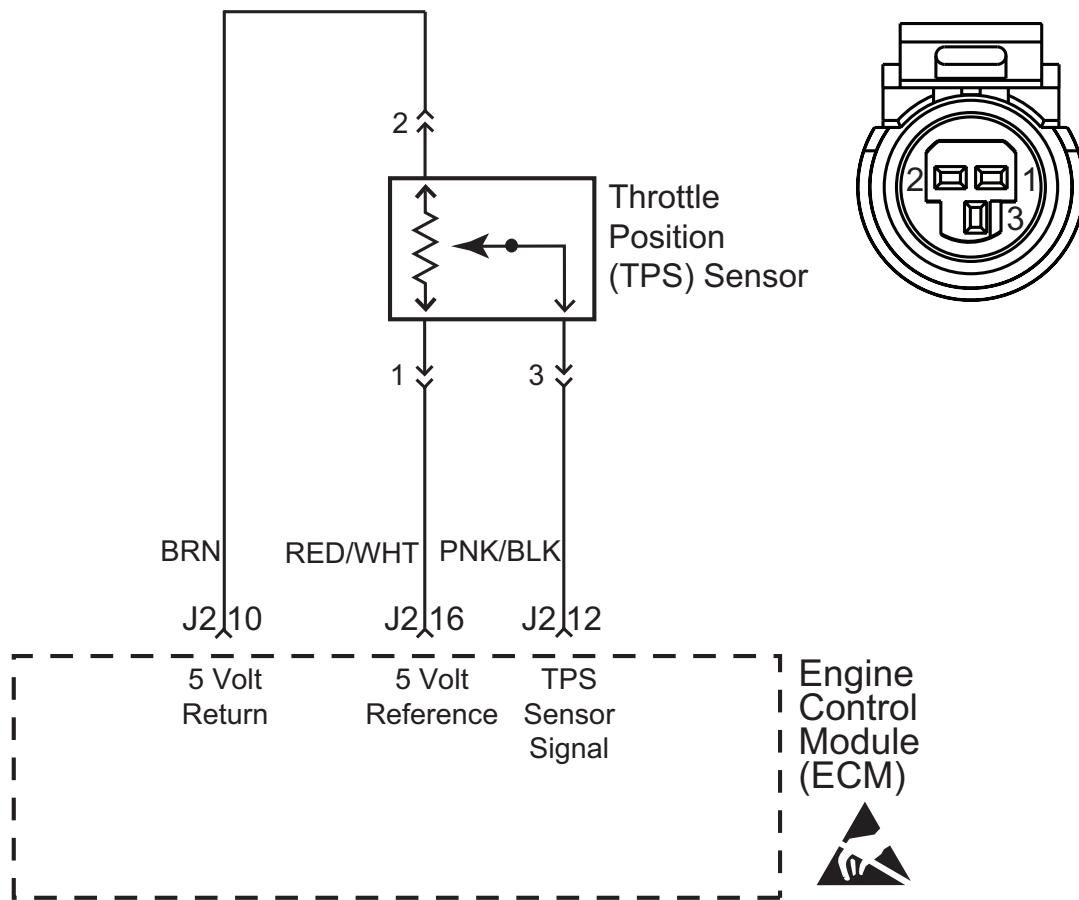
After repairs, clear DTC's following the Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

**DTC P0112 Model 490000 Throttle Position Sensor (TPS) Circuit -
Signal Voltage Low
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Ignition "ON," Engine "OFF." Does scan tool indicate TPS voltage less than the specified value?	0.36v	Go to Step 3	Go to Step 5
3	1. Ignition "OFF." 2. Disconnect the TPS harness connector. 3. Connect a jumper wire from harness terminal 2 to harness terminal 3. 4. Ignition "ON," Engine "OFF." Does the scan tool indicate a TPS voltage greater than the specified value?	4.0v	Go to Step 7	Go to Step 4
4	1. Ignition "OFF." 2. Connect a DVOM from the harness terminal 2 to a known good ground. 3. Ignition "ON," Engine "OFF." Does scan tool indicate a TPS voltage greater than the specified value?	4.0v	Go to Step 6	Go to Step 5
5	Locate and repair open or short to ground in the 5v reference circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 8
6	Locate and repair open or short to ground in TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 8
7	Repair faulty TPS connections or replace faulty TPS. Is action complete?	-	Verify Repair	-
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

**DTC P0123 Model 490000 Throttle Position Sensor (TPS) Circuit -
Signal Voltage High
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Throttle closed. 2. Ignition “ON,” Engine “OFF.” Does scan tool indicate TPS voltage greater than the specified value?	4.0v	Go to Step 3	Go to Step 5
3	1. Ignition “OFF.” 2. Disconnect TPS harness connector. 3. Ignition “ON,” Engine “OFF.” Does scan tool indicate a voltage less than the specified value?	0.36v	Go to Step 4	Go to Step 5
4	Connect DVOM from harness terminal 1 to harness terminal 2. Does DVOM indicate a voltage greater than the specified value?	4.0v	Go to Step 7	Go to Step 6
5	Locate and repair short to voltage in the TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 8
6	Locate and repair open in the sensor ground circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 8
7	Repair faulty TPS connections or replace faulty TPS. Is action complete?	-	Verify Repairs	-
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repairs	-



DTC P0122/P0123 Model 610000 Throttle Position Sensor (TPS) (Scan Diagnostics)

Circuit Description

The Throttle Position Sensor (TPS) is a potentiometer connected to the throttle shaft on the throttle body. By monitoring the voltage on the signal line, the ECM calculates throttle position. As the throttle valve angle is changed, the TPS signal also changes. At a closed throttle position, the output of the TPS is low. As the throttle valve opens, the voltage output increases so that at Wide Open Throttle (WOT) the output voltage should be above 4 volts.

Diagnostic Aids

Check for the following conditions:

1. 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.
2. Damaged harness. Inspect the wiring harness and connectors for damage.
3. If the ground is bad in the ECM or has a

bad connection this could cause multiple DTC's to be thrown.

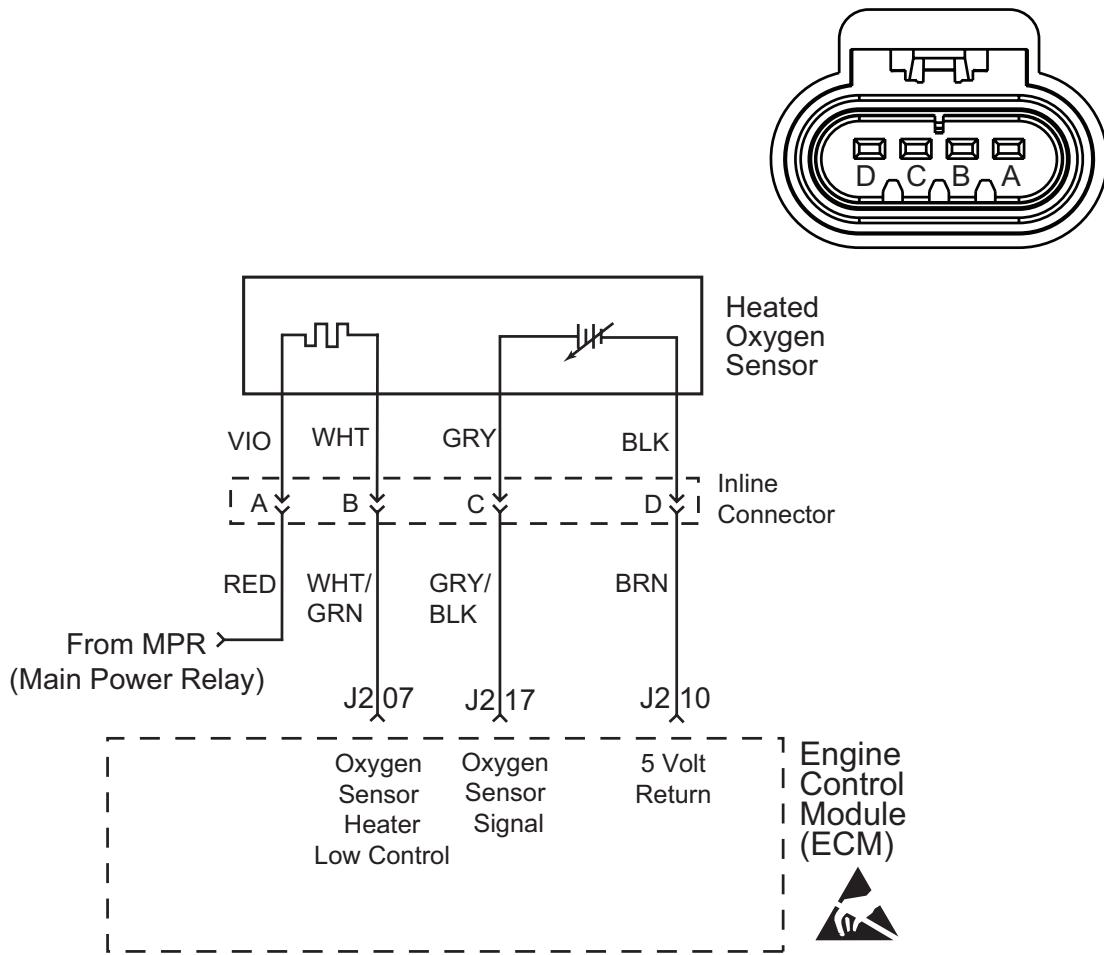
After repairs, clear DTC's following the Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0122 Model 610000 Throttle Position Sensor (TPS)
Circuit - Signal Voltage Low
(Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect TPS harness connector. 3. Connect a jumper wire from harness terminal 1 to harness terminal 3. 4. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 5. Ignition "ON," engine "OFF." Is DTC P0123 present?	-	Go to Step 4	Go to Step 3
3	1. Remove jumper wire from terminals 1 and 3. 2. Connect DVOM by back probing harness terminals 1 and 2 on the sensor connector. Is voltage reading above the specified value?	4.0v	Go to Step 5	Go to Step 6
4	Locate and repair intermittent faulty connections. If OK, replace faulty TPS. Is action complete?	-	Verify repair	-
5	Locate and repair open or short to ground in the TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify repair	Go to Step 7
6	Locate and repair open or short to ground in the 5v reference circuit. Was a problem found?	-	Verify repair	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify repair	-

DTC P0123 Model 610000 Throttle Position Sensor (TPS)
Circuit - Signal Voltage High
(Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "OFF." 2. Disconnect TPS harness connector. 3. Start engine and idle for 2 minutes or until DTC tool indicates a stored DTC. 4. Ignition "ON," Engine "OFF." Is DTC PO122 present?	-	Go to Step 4	Go to Step 3
3	Disconnect the TPS harness connector. 5. Ignition "ON," Engine "OFF." 6. Connect DVOM from harness terminal 1 to harness terminal 2. Is voltage reading above the specified value?	4.0v	Go to Step 6	Go to Step 5
4	Locate and repair intermittent faulty connections. If OK, replace faulty TPS. Is action complete?	-	Verify Repairs	-
5	Locate and repair open in the 5v return circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 7
6	Locate and repair short to voltage in the TPS signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repairs	Go to Step 7
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repairs	-



DTC P0131/P0132 Oxygen (HO₂) Sensor If equipped (Scan Diagnostics)

Circuit Description

The Heated Oxygen (HO₂) sensor(s) varies voltage within a range from about 1.0 volt if the exhaust is rich, down to about 0.1 volt if the exhaust is lean.

The sensor behaves like an open circuit and produces no voltage when the exhaust temperature is below 360° C (600°F). An open oxygen sensor circuit or cold oxygen sensor causes an Open Loop operation.

The heater in the sensor provides for a faster sensor warm-up. This allows the sensor(s) to become active in a shorter period of time and remain active during a long extended idle.

DTC P0131 determines if the heated oxygen sensor has developed an open circuit. With an active DTC P0131 set, the system operates in an Open Loop mode and the Malfunction Indicator Lamp (MIL) is turned on.

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.

For proper wire and connection repairs, refer to Wiring Repair. After repairs, clear DTC's following "Clear DTC's Procedure." Failure to do so may result in DTC's not properly being cleared.

**DTC P0131 Heated Oxygen Sensor Low Voltage-
Lean Exhaust indicated
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) system check performed?	-	Go to Step 2	Go to OBD System check
2	1. Connect scan tool. 2. Run the Engine at normal operating temperature. 3. Increase the engine speed to a specified value. Is the HO ₂ sensor voltage displayed less than the specified value.	2200 rpm 0.10v	Go to Step 3	Go to Step 4
3	Using a jumper wire, connect terminal B of the HO ₂ sensor to a known good ground. Wait 15 seconds for the voltage to settle. Does the scan tool HO ₂ sensor voltage display indicate a voltage within the specified value?	0.10-0.49v	Refer to Diagnostic Aids	Go to Step 5
4	If no additional DTC's are stored. Refer to the Diagnostic Aids. If any additional DTC's are stored, refer to those table(s) first.	-	Go to Applicable DTC Table	-
5	Locate and repair short to ground in the HO ₂ sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to step 6
6	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify repair	-

**DTC P0132 Heated Oxygen Sensor High Voltage-Rich Exhaust indicated
(Scan Diagnostics)**

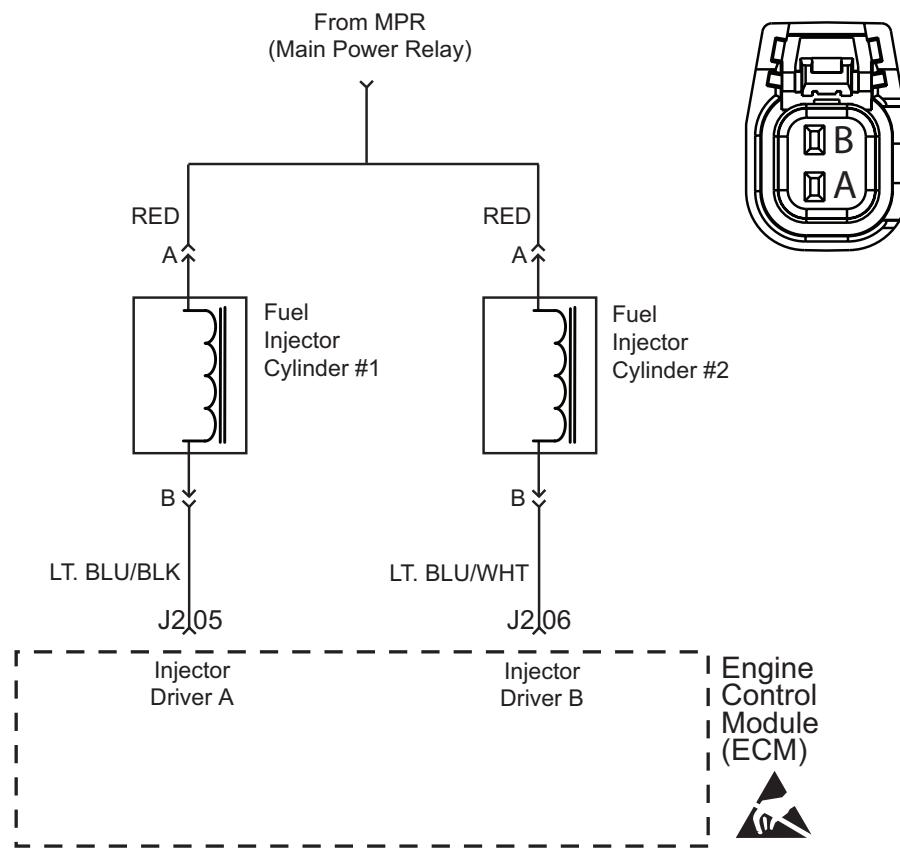
Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Connect scan tool. 2. Run the engine at normal operating temperature. 3. Increase the engine speed to specified value. Does the scan tool HO ₂ Sensor voltage display indicate a voltage above the specified value?	2200 RPM 0.900v	Go to Step 3	Go to Step 5
3	Ignition “ON,” Engine “OFF.” Does the scan tool HO ₂ Sensor voltage display indicate a voltage above the specified value?	0.900v	Go to Step 4	Refer to Diagnostic Aids
4	1. Disconnect the HO ₂ sensor electrical connector. 2. Ignition “ON,” Engine “OFF.” Does the scan tool HO ₂ Sensor voltage display indicate a voltage above the specified value?	0.900v	Go to Step 6	Go to Step 7
5	If any additional DTC’s are stored, refer to those table(s) first.	-	Go to Applicable DTC Table	-
6	Repair faulty HO ₂ sensor connections or replace HO ₂ sensor. Is action complete?	-	Verify Repair	-
7	Locate and repair short to voltage on the HO ₂ sensor signal circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 8
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

DTC P0174 PE System Lean (Non-Scan Diagnostics)

The Power Enrichment (PE) mode is initiated in Higher load running conditions. The ECM uses the input from the Map sensor and Crank Position Sensor to know when to go into Power Enrichment (PE). PE fueling provides a performance benefit to enrich the engine for

optimal performance and to provide maximum power. This also prevents against excessive Exhaust valve and engine temperatures. If the DTC P0174 has been set the Engine is not receiving enough fuel.

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Check the fuel filter and fuel lines for debris and or a restriction. If a problem is found, repair as necessary. Was a problem found?		Verify Repair	Go To Step 3
3	Check the fuel pressure. If a problem is found, repair as necessary. Is the fuel pressure within the specified value?		Verify Repair	Go To Step 4
4	Verify the lift pump is operating properly and that the fuel filter is not clogged or restricted. If a problem is found, repair as necessary. Was a problem found?		Verify Repair	Go To Step 5
5	Check for vacuum and exhaust leaks. If a problem is found, repair as necessary. Was a leak found?	-	Verify Repair	Go To Step 6
6	If any additional DTC's are stored, refer to those table(s) first.	-	Go to Applicable DTC Table	Go To Step 7
7	Replace faulty fuel injector(s). Is action complete?	-	Verify Repair	Go To Step 8
8	Replace faulty HO ₂ Sensor. Is action complete?	-	Verify Repair	Contact Engine Manufacturer



DTC P0201/P0202 Fuel Injectors A and B (Scan Diagnostics)

Circuit Description

The fault code will indicate which injector is in fault mode.

The Engine Control Module (ECM) controls fuel injector drivers that are located inside the ECM. An ignition voltage is supplied to the fuel injectors. The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. If the ECM detects an incorrect voltage for the commanded state of the driver, a fuel injector control DTC will set. When a DTC is set it will only indicate which fuel injector(s) has a fault. The technician will have to diagnose if it is a fault in the ground circuit or ignition circuit.

Important: The ECM/fuel injector fuse also supplies voltage to the ignition coils. If the fuse is open, inspect all related circuits for a short to ground.

NOTE: If an ignition coil fault code is active it will turn off the fuel injector for the same cylinder(s) the ignition coil is related to.

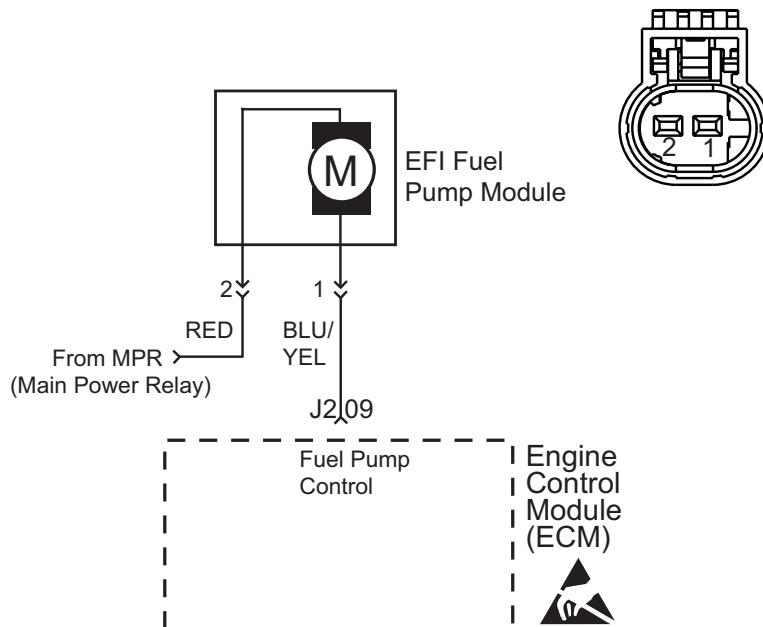
Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
 2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
 3. Inspect the wiring harness for damage.
 4. Check the fuse block for an open fuse.
- After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0201/ P0202 Fuel Injectors High, Low or Open (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Disconnect the appropriate harness connector for each fuel injector. 2. Ignition "ON," Engine "OFF." 3. Using a test lamp connected to a known good ground, back probe terminal A of each fuel injector at the harness connector. Does the test lamp illuminate on both harness connectors?	-	Go to Step 3	Go to Step 6
3	1. Connect the test lamp to B+, back probe terminal B of each fuel injector at the harness connector. 2. Attempt to start engine. Does the test lamp blink on both harness connectors?	-	Go to Step 4	Go to Step 5
4	1. Ignition "ON," Engine "OFF." 2. Connect the test lamp to B+, back probe terminal B of each fuel injector at the harness connector. DO NOT attempt to start the engine. Does the test lamp remain illuminated at all times on either of the ground circuits?	-	Go to Step 7	Go to Step 8
5	Locate and repair an open or short to voltage in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
6	Locate and repair an open or short to ground in the ignition (B+) circuit. Was a problem found?	-	Verify Repair	-
7	Locate and repair a short to ground in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
8	Repair faulty fuel injector connections or replace faulty fuel injector. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0230/P0232 Model 490000 Fuel Pump Relay (FPR) (Scan Diagnostics)

Circuit Description

Certain engine models do not use a relay to operate the fuel pump. On these models the Engine Control Module (ECM) controls the fuel pump module with an internal switch called a driver. The primary function of the driver is to supply the ground to the fuel pump module. This driver has a fault line which the ECM monitors.

If the fault detection circuit senses a voltage other than what the ECM expects, the fault line status changes causing the DTC to set.

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
- DTC's

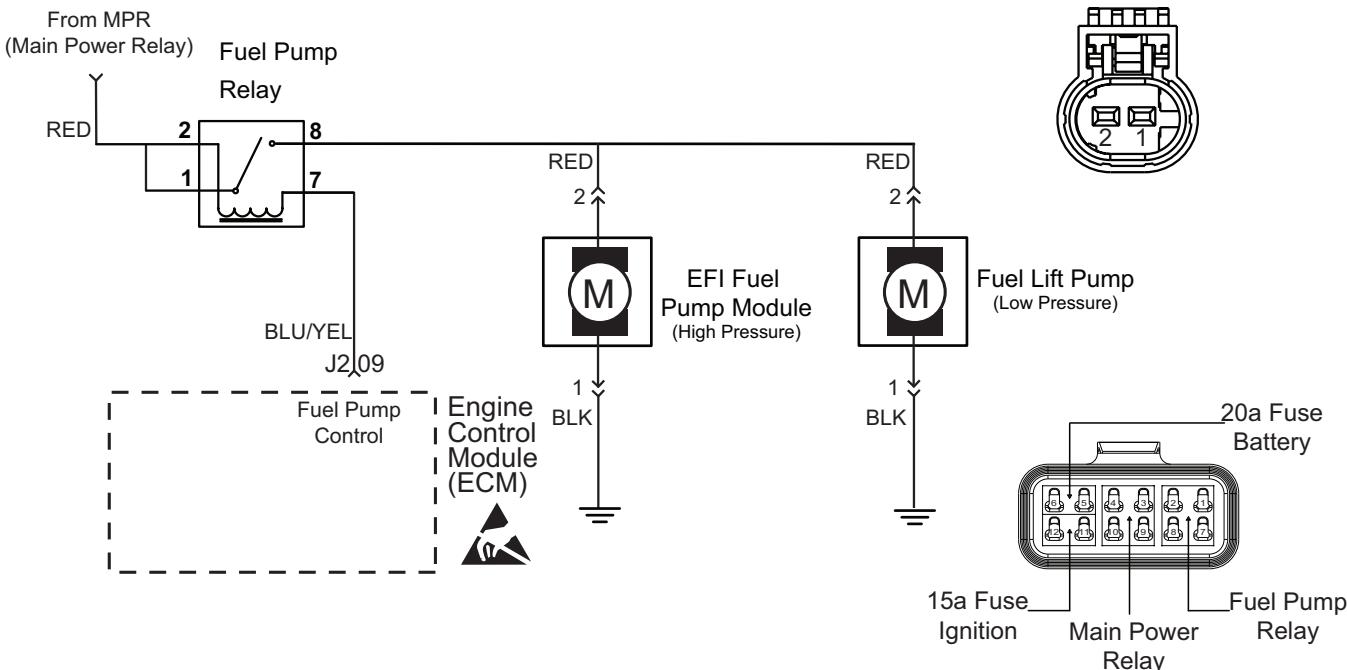
Diagnostic Aids

The following conditions may have caused the fuel pump fuse to malfunction:

1. The fuse is faulty
 2. There is an intermittent short in the fuel pump power feed circuit.
 3. The fuel pump has an intermittent internal problem.
 4. Poor connection at ECM.
 5. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
 6. Inspect the wiring harness and relay for damage.
 7. Check the fuse block for an open fuse.
- After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0230/P0232-Fuel Pump Relay (FPR) model 49000 (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "ON," Engine "OFF." 2. Using a DVOM connected to a known good ground, back probe terminal 2 of the fuel pump module harness connector. Is the voltage displayed above the specified value?	12.0-13.5V	Go to Step 3	Go to Step 5
3	1. Using a test light connected to a B+, back probe terminal 1 of the fuel pump module harness connector. 2. Attempt to start engine. Does the test lamp illuminate brightly while cranking?	-	Go to Step 6	Go to Step 4
4	Locate and repair an open or short to voltage in the fuel pump module ground circuit. Was a problem found?	-	Verify Repair	Go to Step 7
5	Locate and repair an open or short to ground in the fuel pump module ignition (B+) circuit. Was a problem found?	-	Verify Repair	-
6	Repair faulty fuel pump module connections or replace faulty fuel pump module. Is action complete?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0230/P0232 Model 610000 Fuel Pump Relay FPR (Scan Diagnostics)

Circuit Description

When the ignition switch is ON, the ECM activates the electric fuel pump module and the electric lift pump. The lift pump is a diaphragm style pump that transfers fuel from the tank to the fuel pump module. The fuel pump module and lift pump will remain ON as long as the ECM receives reference pulses from the crank sensor. If there are no reference pulses, the ECM turns the fuel pump relay OFF after about 2 seconds. This shuts off the fuel pumps. The fuel pump module delivers fuel to the fuel rail and injectors. The fuel pump module also has an internal fuel pressure regulator, that maintains a fuel pressure of 39 PSI or 270 KPA. 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
- DTC's

Diagnostic Aids

The following conditions may have caused the fuel pump fuse to malfunction:

1. The fuse is faulty
2. There is an intermittent short in the fuel pump power feed circuit.
3. The fuel pump has an intermittent internal problem.
4. Poor connection at ECM.
5. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
6. Inspect the wiring harness and relay for damage.
7. Check the fuse block for an open fuse.

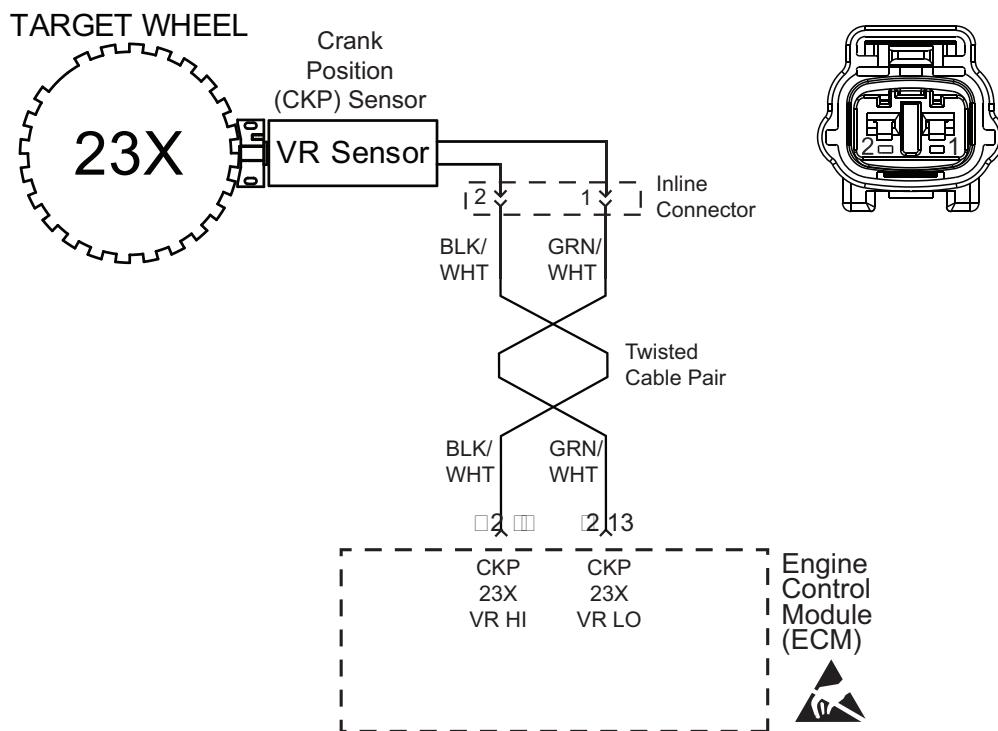
After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

**DTC P0230/P0232 Fuel Pump Relay Driver Circuit
High, Low or Open
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition "ON," Engine "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 connector J2(Black). 3. Install a 5 amp fused jumper wire from a known good ground to the control circuit at the ECM harness connector (J2-09). 4. Ignition "ON," Engine "OFF." Important: Replace the relay if the DVOM goes to 0 during the current draw test. 5. Using a DVOM on 40 amp scale, measure the current from the relay control circuit in the ECM harness connector to ground for 2 minutes. 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 DVOM, measure the resistance from the relay control circuit in the ECM harness connector to ground. Does the DVOM display infinite resistance or OL?	-	Go to Step 10	Go to Step 8
5	1. Ignition "OFF." 2. Disconnect the fuel pump relay connector. 3. Connect a test lamp between the fuel pump relay control circuit and the fuel pump relay ignition feed circuit, on the coil side of the relay, at the fuel pump relay harness connector. 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 10	Go to Step 6

**DTC P0230/P0232 Fuel Pump Relay Driver Circuit
High, Low or Open cont'd
(Scan Diagnostics)**

Step	Action	Value(s)	Yes	No
6	Using a test lamp connected to 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 9
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 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 11	Go to Step 8
8	Repair the faulty relay control circuit. Is action complete?	-	Verify Repair	-
9	Repair the faulty relay ignition feed circuit. Is action complete?	-	Verify Repair	-
10	Repair faulty relay connections or replace faulty relay. Is action complete?	-	Verify Repair	-
11	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0336/P0337 Crankshaft Position (CKP) Sensor (Scan Diagnostics)

Modes of Operation

The crankshaft position (CKP) sensor works in conjunction with the 23X reluctor target wheel on the flywheel. Each tooth on the reluctor wheel is equally spaced with 1 tooth missing for the reference sync pulse. As the crankshaft rotates, the reluctor target wheel interrupts a magnetic field produced by a magnet internal to the sensor. The CKP sensor internal circuitry detects this interruption of the magnetic field, and produces an ON/OFF AC voltage of varying frequency. The frequency of the CKP sensor output signal is dependent upon crankshaft speed. The ECM uses each CKP output signal to determine crankshaft speed, and identify crankshaft position.

There is one normal mode of operation, with the spark under control of the ECM. If the CKP signal is lost the engine will not run. The ECM will not be able to determine which stroke the pistons are on. Diagnostic trouble codes are available to accurately diagnose the ignition system with the scan tool.

Diagnostic Aids

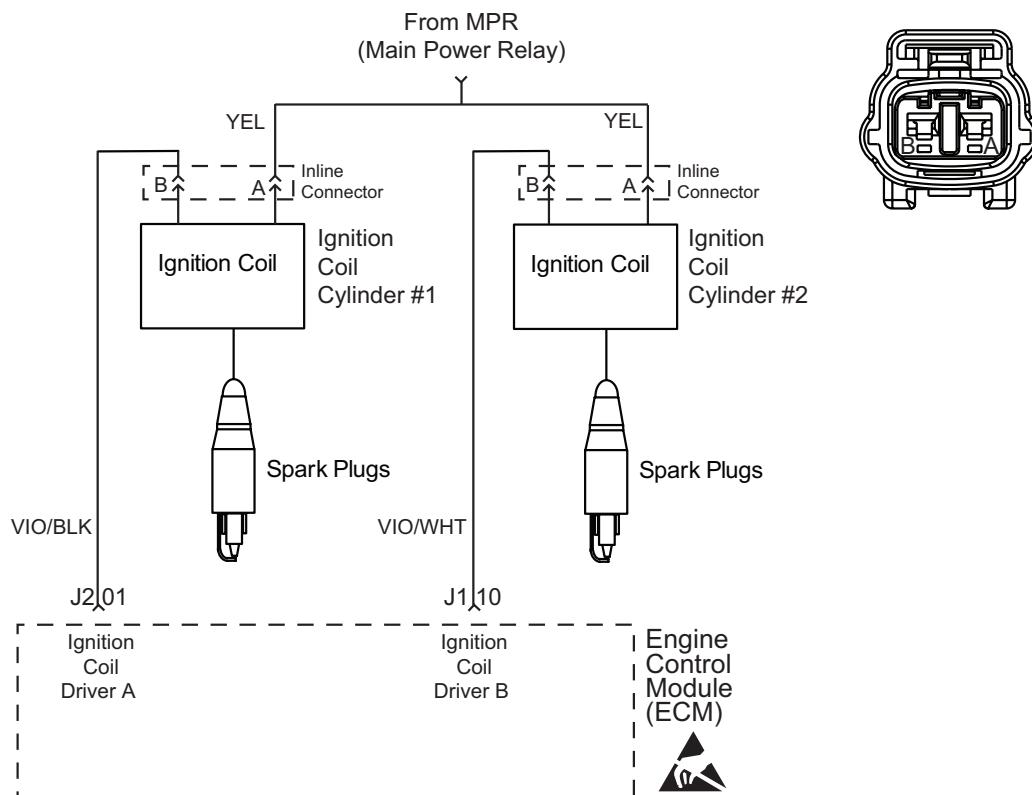
Check for the following conditions:

1. Verify that the Crank Position Sensor is gapped at .30 from the target wheel.
2. 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.
3. Damaged harness. Inspect the wiring harness for damage. If the ground is bad in the ECM or has a bad connection this could cause multiple DTC's to be thrown.

After repairs, clear DTC's following clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0336/P0337 Crankshaft Position (CKP) Sensor (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Did you perform the "On-Board Diagnostic" (OBD) System Check?	-	Go to Step 2	Go to OBD System Check
2	<p>1. Ignition "OFF."</p> <p>2. Back probe the ECM connector at terminals J2-04 and J2-13.</p> <p>3. Using a DVOM set to AC voltage turn over the engine. Disconnect the ignition coils to stop it from running while your turning the engine over with the starter.</p> <p>Does the DVOM indicate that the CKP is giving off an AC voltage above the specified value?</p>	0.95v	Go to Step 7	Go to Step 3
3	<p>1. Ignition "OFF."</p> <p>2. Back probe the CKP sensor connector at terminals 1 and 2.</p> <p>3. Using a DVOM set to AC voltage turn over the engine.</p> <p>Does the DVOM indicate that the CKP is giving off an AC voltage above the specified value?</p>	0.95v	Go to Step 4	Go to Step 5
4	Locate and repair short or open in the CKP circuit. If a problem is found, repair as necessary. Was a problem found?	-	Verify Repair	Go to Step 5
5	Verify the CKP is clean and mounted correctly. Was a problem found?	-	Verify Repair	Go to Step 6
6	Repair faulty CKP connections or replace faulty CKP. Is action complete?	-	Verify Repair	-
7	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0351/P0352 Ignition Coil A and B (Scan Diagnostics)

Circuit Description

Each ignition coil has an ignition (B+ voltage) and a ground circuit. The engine control module (ECM) supplies an ignition control (IC) circuit and a low reference circuit. Each ignition coil contains a solid state driver module that is located inside the ECM. The ECM will command the IC circuit ON, which allows the current to flow through the primary coil windings for the appropriate time or dwell. When the ECM commands the IC circuit OFF, this will interrupt current flow through the primary coil windings. The magnetic field created by the primary coil windings will collapse across the secondary coil windings, which induces a high voltage across the spark plug electrodes. The primary coils are current limited to prevent overloading if the IC circuit is held ON for an extended time.

The fault code will indicate which coil is in fault.

When an ignition coil fault is set the ECM will also shut down the fuel injector for the same cylinder that the fault is set on. The engine will

continue to run on one cylinder if no fault is set for the opposite cylinder.

If there is no spark and a DTC has NOT set check the coil wire to the spark plug for good connectivity.

Important: The ECM/ignition coil fuse also supplies voltage to the fuel injectors. If the fuse is open, inspect all related circuits for a short to ground.

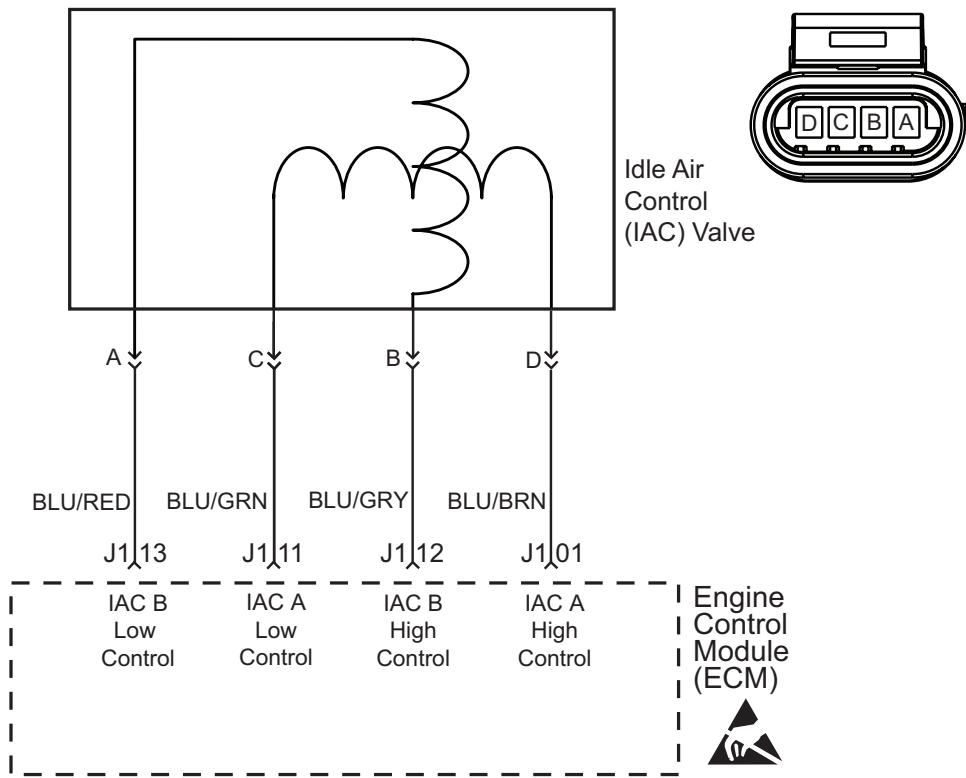
Diagnostic Aids

Check for the following conditions:

1. Poor connection at ECM.
 2. Inspect the wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.
 3. Inspect the wiring harness for damage.
 4. Check the fuse block for an open fuse.
- After repairs, clear DTC's following Clearing DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0351/P0352 Ignition coil(s) High, Low or Open (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Disconnect the appropriate harness connector for each fuel injector. 2. Ignition "ON," Engine "OFF." 3. Using a test lamp connected to a known good ground, back probe terminal A of each ignition coil harness connector. Does the test lamp illuminate on both harness connectors?	-	Go to Step 3	Go to Step 6
3	1. Connect the test lamp to B+; back probe terminal B of each ignition coil harness connector. 2. Attempt to start engine. Does the test lamp blink on both harness connectors?	-	Go to Step 4	Go to Step 5
4	1. Ignition "ON," Engine "OFF." 2. Connect the test lamp to B+; back probe terminal B of each ignition coil harness connector. DO NOT attempt to start the engine. Does the test lamp remain illuminated at all times on either of the ground circuits?	-	Go to Step 7	Go to Step 8
5	Locate and repair an open or short to voltage in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
6	Locate and repair an open or short to ground in the ignition (B+) circuit. Was a problem found?	-	Verify Repair	-
7	Locate and repair a short to ground in the ground circuit. Was a problem found?	-	Verify Repair	Go to Step 9
8	Repair faulty fuel injector connections or replace faulty fuel injector. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-



DTC P0505 Idle Air Control (IAC) Valve If equipped (Scan Diagnostics)

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

Check for the following items:

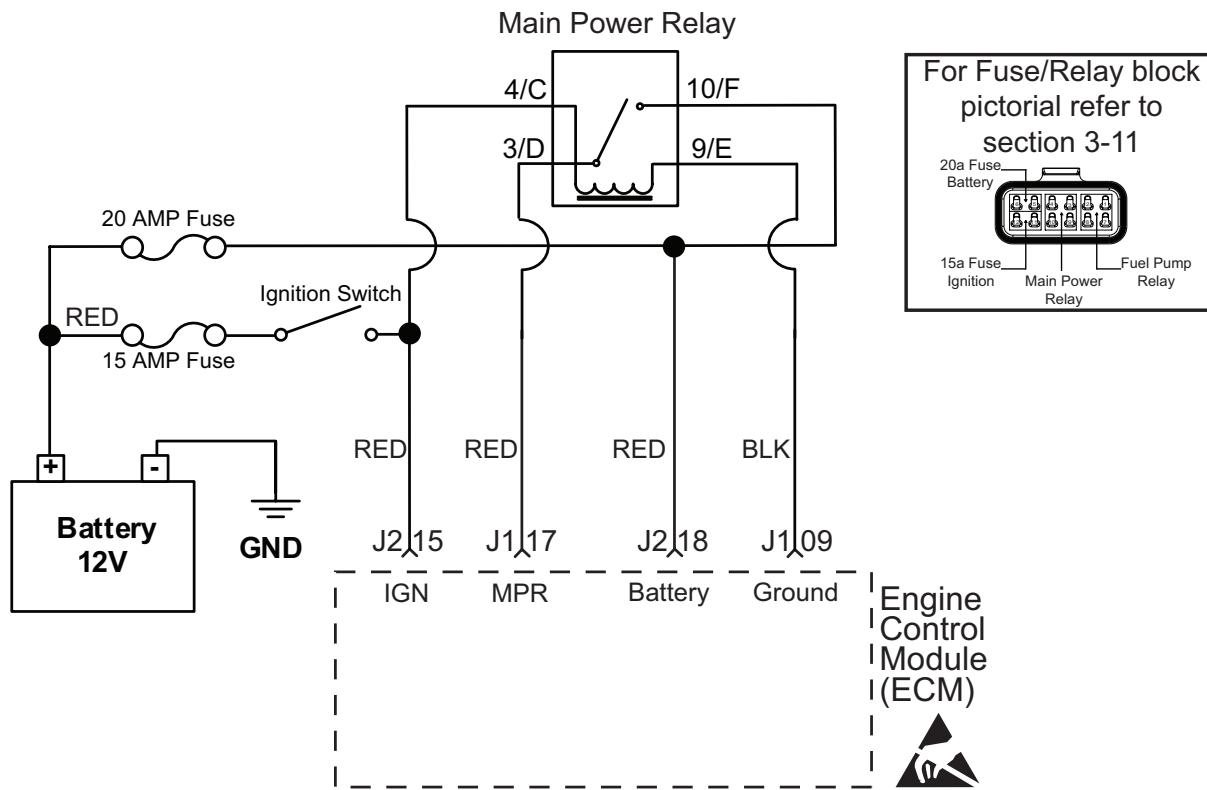
1. Poor connection or damaged harness.
Inspect the ECM harness and connectors for improper mating, broken locks, improperly formed or damaged terminals, poor terminal to wire connection and damaged harness.
2. Check for vacuum leaks, disconnected or brittle vacuum hoses, cuts, etc. Examine manifold and throttle body gaskets for proper seal. Check for cracked intake manifold.
3. Check for poor connections, opens or short to grounds in the IAC circuit. This may re-

sult in improper idle control.

4. 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.

DTC P0505 Idle Air Control (IAC) Valve Test (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Engine should be at normal operating temperature. 2. Start engine and allow idle to stabilize. 3. Record RPM. 4. Ignition “OFF” for 10 seconds. 5. Disconnect IAC harness connector. 6. Restart engine and record RPM. Is RPM higher than the first recorded RPM by more than the specified value?	200 RPM	Go to Step 3	Go to Step 4
3	1. Reinstall IAC harness connector. 2. Idle speed should gradually return within 75 RPM of the original recorded RPM within 30 seconds. Does RPM return to original recorded RPM?	-	Go to Step 5	Go to Step 4
4	1. Ignition “OFF” for 10 seconds. 2. Disconnect IAC harness connector. 3. Restart engine. 4. Using a test lamp connected to a known good ground, back probe each one of the four IAC harness terminals. Does the test lamp blink on all four terminals?	-	Go to Step 7	Go to Step 8
5	IAC circuit is functioning properly.	-	-	-
6	Locate and repair poor connection, open, or short to ground in the IAC circuit that did not blink. If a problem was found, repair as necessary. Was a problem found?	-	Go to OBD System Check	Go to Step 8
7	Check for poor IAC connections or replace the faulty IAC valve. Is action complete?	-	Go to OBD System Check	-
8	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Go to OBD System Check	-



DTC P0562/P0563 System Voltage (Scan Diagnostics)

Circuit Description

The EFI system operates with a battery voltage from 9 to 16 volts. If the system voltage drops below 6.2 volts the ECM will reset. The Malfunction Indicator Light (MIL) will illuminate if the voltage is below 9 volts or above 16 volts for a specified amount of time during normal operation.

To determine the system voltage to the ECM, a voltage measurement can be taken at a terminal J2-18. If the voltage at terminal J2-18 is not within 0.01 volt of the measurement you get at the battery (measuring between the positive(+) and negative(-) posts of the battery with your DVOM), determine the fault associated with circuit J2-18.

Similarly, you should be able to measure battery voltage on terminal J2-15 with the ignition switch in the on position and the engine not running.

Refer to the diagram above to locate the two terminals on the ECM that provide battery voltage and ignition-on voltage.

To further diagnose system voltage faults, refer to Briggs & Stratton Intec V-Twin Cylinder OHV Repair Manual section 7.

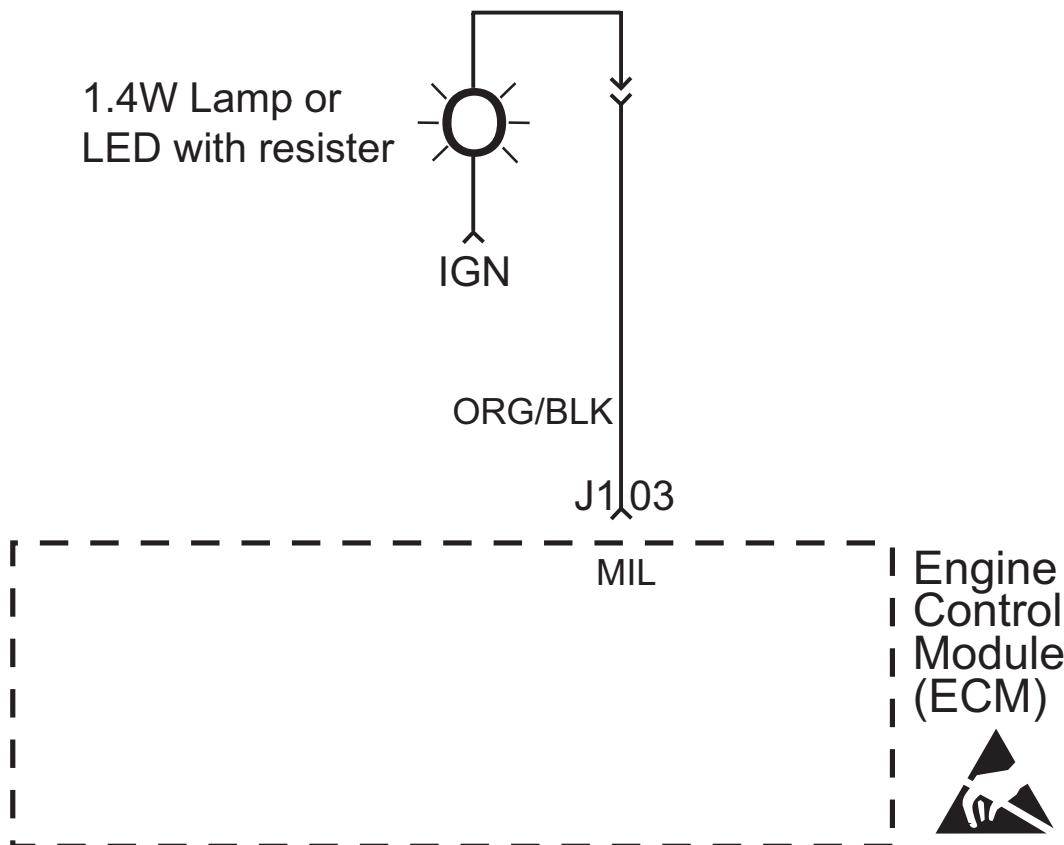
Diagnostic Aids

Check for the following conditions:

1. 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.
2. Damaged harness. Inspect the wiring harness and connectors for damage.
3. Check the fuse block for an open fuse. After repairs, clear DTC's following Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0562/P0563 System voltage (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Key “OFF” Engine “OFF.” 2. Check the battery for voltage with a DVOM. Is the battery within specified value?	12.2-13.5v	Go to Step 3	Go to Step 5
3	1. Ignition “OFF” Engine “OFF.” 2. Check if the ECM has battery voltage at ECM terminal J2-18 with a DVOM connected to a known good ground. Was the voltage within 0.3v of the battery voltage?	-	Go to Step 4	Go to Step 9
4	1. Ignition “ON” Engine “OFF.” 2. Check for ignition voltage at ECM terminal J2-15 with a DVOM connected to a known good ground. Was the voltage within 0.3v of the battery voltage?	-	Go to Step 5	Go to Step 10
5	Check charging system. Refer to Briggs & Stratton manual for intec V-Twin Cylinder OHV Repair Manual section 7 Is the charging system OK?	-	Go to Step 7	Go to Step 6
6	Locate and repair charging system. Refer to Briggs & Stratton manual for intec V-Twin Cylinder OHV Repair Manual section 7 Is action complete?	-	Verify Repair	-
7	Verify good continuity at the battery terminals. Repair if necessary.	-	Verify Repair	Go to Step 8
8	Replace battery. Is action complete?	-	Verify Repair	-
9	Locate and repair an open or short to ground in the battery feed circuit. Is action complete?	-	Verify Repair	-
10	Locate and repair an open or short to voltage in the ignition feed circuit. Is action complete?	-	Verify Repair	-



DTC P0650 Malfunction Indicator Lamp (MIL) Diagnosis (Scan Diagnostics)

Circuit Description

The Malfunction Indicator Lamp (MIL) gets 12v B+ when the ignition is in the on or run position. The ECM sends a ground signal to illuminate the MIL when the ignition is on and the engine is NOT running. The ECM will also send the ground signal to activate the light if one or more of the malfunctions exists under the conditions listed in the DTC's table. If the malfunction clears, the lamp will go out and the Diagnostic Trouble Code (DTC) will be stored in the ECM. The amount of time after the malfunction occurs before the MIL illuminates is calibratable. (Instantly or up to several minutes).

Do not clear the DTC's unless directed by a diagnostic procedure. Clearing the DTC's may also clear valuable diagnostic information.

Diagnostic Aids

Check for the following conditions:

- Poor connection at ECM. Inspect harness connectors for backed out terminals, im-

proper mating, broken locks, improperly formed or damaged terminals and poor terminal to wire connection.

2. Damaged harness. Inspect the wiring harness for damage. If the harness appears to be OK, observe the Malfunction indicator Lamp (MIL) display while moving connectors and wiring harnesses related to the MIL. A change in the MIL display will indicate the location of the fault.

After repairs, clear DTC's following Clear DTC's Procedure in the General Information section. Failure to do so may result in DTC's not properly being cleared.

DTC P0650 Malfunction Indicator Light (MIL) Malfunction (Scan Diagnostics)

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	1. Ignition “OFF.” 2. Using a test light hooked to a known good ground probe the Ignition side of the MIL. Does the test lamp Illuminate brightly?	-	Go to Step 3	Go to Step 4
3	1. Ignition “On,” Engine “OFF.” 2. Using a test light connected to a known good ground probe the Ignition side of the MIL. Does the test lamp Illuminate brightly?	-	Go to Step 5	Go to Step 4
4	Locate and repair an open or short to ground in the battery feed circuit. If a problem was found, repair as necessary Is action complete?	-	Verify repair	-
5	1. Ignition “OFF.” 2. Using a test light connected to B+ probe the ground side of the MIL. Does the test lamp Illuminate brightly?	-	Go to Step 7	Go to Step 6
6	1. Ignition “On,” Engine “OFF.” 2. Using a test light connected to B+ back probe the terminal J1-03 of the ECM connector. Does the test lamp Illuminate brightly?	-	Go to Step 8	Go to Step 9
7	Locate and repair poor connection or open in the ground circuit. If a problem was found, repair as necessary. Was a problem found?	-	Verify Repair	-
8	Repair faulty MIL connections or replace faulty MIL. Is action complete?	-	Verify Repair	-
9	Repair faulty ECM connections or replace faulty ECM. Is action complete?	-	Verify Repair	-

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Symptoms

Important Preliminary Checks

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.

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.
- Check thoroughly for any type of vacuum 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 for correct procedure.
- Moisture in primary or secondary ignition circuit connections.
- Salt corrosion on electrical connections and exposed throttle body linkages.

Intermittents

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. Many 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). The unit may be operated with a Digital Volt Ohmmeter 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.
- To check loss of DTC memory, disconnect MAP sensor and idle engine until the MIL comes ON. DTC P0107 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 P0107 from memory using "Clearing DTC Procedure" found in General Information section. 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 secondary ignition components shorted to ground, or an open ignition coil ground.
- Check for components internally shorted to ground such as starters, alternators or relays.

If problem has not been found go to ECM Connector Symptom Tables at the end of Symptoms section.

Engine Will NOT Crank

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Was the visual/physical check performed?	-	Go to Step 3	Go to Visual/Physical Check
3	<p>Check the battery following conditions.</p> <ul style="list-style-type: none"> • Loose or corroded terminals • Verify the battery voltage is within the specified range. <p>If a problem is found, repair as necessary. Will the engine crank over?</p>	12.2-13.5v	Symptom Fixed	Go to Step 4
4	<p>Verify the PTO clutch is not engaged. If the PTO clutch is engaged disengage it. Will the engine crank over?</p>	-	Symptom Fixed	Go to Step 5
5	<p>Verify the safety interrupt is NOT active or faulty (if equipped). If a problem is found, repair as necessary. Will the engine crank over?</p>	-	Symptom Fixed	Go to Step 6
6	<p>Verify the ignition switch is working properly. Refer to Intek V-Twin Cylinder OHV repair Manual Section 2. If a problem is found, repair as necessary. Will the engine crank over?</p>	-	Symptom Fixed	Go to Step 7
7	<p>Verify the starter is operating properly. Refer to Intek V-Twin Cylinder OHV repair Manual Section 6. Will the engine crank over?</p>	-	Symptom Fixed	Go to Step 8
8	<p>1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following:</p> <ul style="list-style-type: none"> • Visual inspection. • Scan tool data/ Code reader data • All electrical connections within a suspected circuit and/or system. <p>Will the engine crank over?</p>	-	Symptom Fixed	Contact Engine Manufacturer

Engine Cranks But Will NOT Start

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Was the visual/physical check performed?	-	Go to Step 3	Go to Visual/Physical Check
3	Verify fuel in the tank(s). If a problem is found, repair as necessary. Does the engine start?	-	Symptom Fixed	Go to Step 4
4	Check fuel shut off valve (if equipped). If the valve is closed turn it to the open position. Does the engine start?	-	Symptom Fixed	Go to Step 5
5	Check the following fuel systems for debris, water, or contaminants. <ul style="list-style-type: none">• Fuel tanks• Fuel filter• Fuel lines• Fuel pumps If a problem is found, repair as necessary. Does the engine start?	-	Symptom Fixed	Go to Step 6
6	Verify the fuel pumps are operating properly with a fuel pressure test. Refer to section 2 page 10 for test procedure. If a problem is found, repair as necessary. Does the engine start?	35-43 PSI	Symptom Fixed	Go to Step 7
7	Verify the Safety interrupt Is NOT active or faulty. If a problem is found, repair as necessary. Does the engine start?	-	Symptom Fixed	Go to Step 8
8	Check the battery for the following conditions. <ul style="list-style-type: none">• Loose or corroded terminals• Verify the battery voltage is within the specified voltage range. If a problem is found, repair as necessary. Does the engine start and continue to run?	12.2-13.5v	Symptom Fixed	Go to Step 9
9	Verify that each cylinder is getting spark. Refer to Intek V-Twin Cylinder OHV repair Manual Section 2 for test procedure. If a problem is found, repair as necessary. Does the engine start?	-	Symptom Fixed	Go to Step 10

Engine Cranks But Will NOT Start cont'd

Step	Action	Value(s)	Yes	No
10	<p>Verify the ECM is powering up. Refer to section 3 for procedure. If a problem is found, repair as necessary.</p> <p>Does the engine start?</p>	-	Symptom Fixed	Go to Step 11
11	<p>Check the engine for the following mechanical problems:</p> <ul style="list-style-type: none"> • Low compression. • Leaking cylinder head gaskets. • Proper valve set up. <p>Refer to Intek V-Twin Cylinder OHV repair Manual Section for test procedures.</p> <p>If a problem is found, repair as necessary.</p> <p>Does the engine still have low power output?</p>	-	Symptom Fixed	Go to Step 12
12	<ol style="list-style-type: none"> 1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> • Visual inspection. • Scan tool data/ Code reader data • All electrical connections within a suspected circuit and/or system. <p>If a problem is found, repair as necessary.</p> <p>Does the engine start?</p>	-	Symptom Fixed	Contact Engine Manufacturer

Hard Start Symptoms

Definition: Engine cranks OK, but does not start for a long time. Does run, or may start but immediately dies.

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Was the visual/physical check performed?	-	Go to Step 3	Go to Visual/Physical Check
3	<p>Check the following fuel systems for debris, water, or contaminants.</p> <ul style="list-style-type: none"> • Fuel tanks • Fuel filter • Fuel lines • Fuel pumps <p>If a problem is found, repair as necessary. Does the engine start and continue to run?</p>	-	Symptom Fixed	Go to Step 4
4	<p>Check for proper fuel pressure. Refer to section 2 for the test procedure. If a problem is found, repair as necessary.</p> <p>Does the engine start and continue to run?</p>	35-43 PSI	Symptom Fixed	Go to Step 5
5	<p>Check the battery for the following conditions.</p> <ul style="list-style-type: none"> • Loose or corroded terminals • Verify that the battery voltage is within the specified range. <p>If a problem is found, repair as necessary. Does the engine start and continue to run?</p>	12.2-13.5v	Symptom Fixed	Go to Step 6
6	<p>Check for intermittent opens or shorts to ground in the MAP sensor circuit. If a problem is found, repair as necessary.</p> <p>Does the engine start and continue to run?</p>	-	Symptom Fixed	Go to Step 7
7	<ol style="list-style-type: none"> 1. Check for proper operation of the TPS (if equipped). 2. Verify the throttle linkage is not sticking, binding or worn causing the TPS voltage to be higher than normal. If a problem is found, repair as necessary. <p>Does the engine start and continue to run?</p>	-	Symptom Fixed	Go to Step 8
8	<p>Check for proper operation of the IAC (if equipped). If a problem is found, repair as necessary.</p> <p>Does the engine start and continue to run?</p>	-	Symptom Fixed	Go to Step 9

Hard Start Symptoms cont'd

Step	Action	Value(s)	Yes	No
9	<p>Check the engine for the following mechanical problems:</p> <ul style="list-style-type: none"> • Low compression. • Leaking cylinder head gaskets. • Proper valve set up. <p>Refer to Intek V-Twin Cylinder OHV repair Manual Section for test procedures.</p> <p>If a problem is found, repair as necessary.</p> <p>Does the engine still have low power output?</p>	-	Symptom Fixed	Go to Step 10
10	<ol style="list-style-type: none"> 1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none"> • Visual inspection. • Scan tool data/ Code reader data • All electrical connections within a suspected circuit and/or system. <p>If a problem is found, repair as necessary.</p> <p>Does the engine start and continue to run?</p>	-	Symptom Fixed	Contact Engine Manufacturer

Engine Has Low Power Output

Step	Action	Value(s)	Yes	No
1	Was the "On-Board Diagnostic" (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Was the visual/physical check performed?	-	Go to Step 3	Go to Visual/Physical Check
3	<p>Check the following fuel systems for debris, water, or contaminants.</p> <ul style="list-style-type: none"> • Fuel tanks • Fuel filter • Fuel lines • Fuel pumps <p>If a problem is found, repair as necessary. Does the engine still have low power output?</p>		Go to Step 4	Symptom Fixed
4	<p>Check for proper fuel pressure. Refer to section 2 for the test procedure. If a problem is found, repair as necessary. Does the engine start and continue to run?</p>	35-43 PSI	Go to Step 5	Symptom Fixed
5	<p>Verify the crankcase oil is at the correct level. If a problem is found, repair as necessary. Does the engine still have low power output?</p>	-	Go to Step 5	Symptom Fixed
6	<p>Verify that the air filter doesn't need replaced. If a problem is found, repair as necessary. Does the engine still have low power output?</p>	-	Go to Step 6	Symptom Fixed
7	<p>Verify the engine doesn't have a greater engine load on it than is intended for its application? Check for the following;</p> <ul style="list-style-type: none"> • Damaged drive belt. • For mowers verify the blades are not restricted by debris. • Faulty pulley bearing(s). <p>Does the engine still have low power output?</p>	-	Go to Step 7	Symptom Fixed
8	<p>Check the spark plugs for the following conditions.</p> <ul style="list-style-type: none"> • Verify they are gapped properly. • Verify they are not gas fouled. • Verify they are not excessively worn. <p>If a problem is found, repair as necessary. Does the engine still have low power output?</p>	--	Go to Step 8	Symptom Fixed
9	<p>Verify the exhaust is not restricted. If a problem is found, repair as necessary. Does the engine still have low power output?</p>	-	Go to Step 9	Symptom Fixed

Engine Has Low Power Output cont'd

Step	Action	Value(s)	Yes	No
10	<p>Check the engine for the following mechanical problems:</p> <ul style="list-style-type: none">• Low compression.• Leaking cylinder head gaskets.• Proper valve set up. <p>Refer to Intek V-Twin Cylinder OHV repair Manual Section for test procedures.</p> <p>If a problem is found, repair as necessary.</p> <p>Does the engine still have low power output?</p>	-	Go to Step 10	Symptom Fixed
11	<ol style="list-style-type: none">1. Review all diagnostic procedures within this table.2. If all procedures have been completed and no malfunctions have been found, review/inspect the following:<ul style="list-style-type: none">• Visual inspection.• Scan tool data/Code reader data• All electrical connections within a suspected circuit and/or system. <p>If a problem is found, repair as necessary.</p> <p>Does the engine still have low power output?</p>	-	Contact Engine Manufacturer	Symptom Fixed

Engine Hunting and Surging

Step	Action	Value(s)	Yes	No
1	Was the “On-Board Diagnostic” (OBD) System checked?	-	Go to Step 2	Go to OBD System Check
2	Was the visual/physical check performed?	-	Go to Step 3	Go to Visual/Physical Check
3	<p>Check the following fuel systems for debris, water, or contaminants.</p> <ul style="list-style-type: none"> • Fuel tanks • Fuel filter • Fuel lines • Fuel pumps <p>If a problem is found, repair as necessary. Is the engine still hunting and surging?</p>	-	Go to Step 4	Symptoms Fixed
4	<p>Check for proper fuel pressure. Refer to section 2 for the test procedure. If a problem is found, repair as necessary. Does the engine start and continue to run?</p>	35-43 PSI	Go to Step 5	Symptoms Fixed
5	<p>Check the battery for the following conditions.</p> <ul style="list-style-type: none"> • Loose or corroded terminals • Verify the battery voltage is within the specified range. <p>If a problem is found, repair as necessary.</p>	12.2-13.5v	Go to Step 6	Symptoms Fixed
6	<p>Verify the crankcase oil is at the correct level. If a problem is found, repair as necessary. Is the engine still hunting and surging?</p>	-	Go to Step 7	Symptoms Fixed
7	<p>Verify that the air filter doesn't need replaced. If a problem is found, repair as necessary. Is the engine still hunting and surging?</p>	-	Go to Step 8	Symptoms Fixed
8	<p>Verify the governor is set up properly. Refer to Intek V-Twin Cylinder OHV repair Manual Section 4. If a problem is found, repair as necessary. Is the engine still hunting and surging?</p>	-	Go to Step 9	Symptoms Fixed
9	<p>Inspect the governor link spring for damage or improper installation. If a problem is found, repair as necessary. Is the engine still hunting and surging?</p>	-	Go to Step 10	Symptoms Fixed
10	<p>Disconnect the governor spring, check for binding or uneven resistance in the governor arm travel from stop to stop. If a problem is found, repair as necessary. Is the engine still hunting and surging?</p>	-	Go to Step 11	Symptoms Fixed

Engine Hunting and Surging cont'd

Step	Action	Value(s)	Yes	No
11	Inspect the governor spring and controls for damage or improper installation. If a problem is found, repair as necessary. Is the engine still hunting and surging?	-	Go to Step 12	Symptoms Fixed
12	Replace the governor spring or controls. If a problem is found, repair as necessary. Is the engine still hunting and surging?	-	Go to Step 13	Symptoms Fixed
13	1. Review all diagnostic procedures within this table. 2. If all procedures have been completed and no malfunctions have been found, review/inspect the following: <ul style="list-style-type: none">• Visual inspection.• Scan tool data/ Code reader data• All electrical connections within a suspected circuit and/or system. If a problem is found, repair as necessary. Is the engine still hunting and surging?	-	Contact Engine Manufacturer	Symptoms Fixed

ECM Connector J1

Connector/ Pin Number	Function	Wire Color	Possible Symptom From Faulty Circuit
J1-1	IACAH1 (Idle Air Control A Hi) If equipped	BLU/BRN	Rough, Unstable, or Incorrect Idle
J1-2	N/A (Not Applicable)	-	
J1-3	MIL (Malfunction Indicator Light)	ORG/BLK	MIL Inoperative
J1-4	N/A (Not Applicable)	-	
J1-5	N/A (Not Applicable)	-	
J1-6	N/A (Not Applicable)	-	
J1-7	CANLO (Used only for Development ECM)	GRN	No Can Signal
J1-8	CANHi (Used only for Development ECM)	YEL	No Can Signal
J1-9	GROUND (Power)	BLK	An open ground or high resistance ground may cause any or all symptoms
J1-10	ESTCOILB (Engine Spark Timing Coil B)	PPL/WHT	Rough Idle, Lack of Power, Stalling
J1-11	IACALO (Idle Air Control A Lo) If equipped	BLU/GRN	Rough, Unstable, or Incorrect Idle
J1-12	IACBHI (Idle Air Control B Hi) If equipped	BLU/GRY	Rough, Unstable, or Incorrect Idle
J1-13	IACBLO (Idle Air Control B Lo) If equipped	BLU/RED	Rough, Unstable, or Incorrect Idle
J1-14	Safety Interrupt	ORG/ WHT	No Start
J1-15	N/A (Not Applicable)	-	
J1-16	N/A (Not Applicable)	-	
J1-17	MPR (Main Power Relay)	RED	An open B+ circuit or high resistance in the B+ circuit may cause any or all symptoms
J1-18	N/A (Not Applicable)	-	

ECM Connector J2

Connector/ Pin Number	Function	Wire Color	Possible Symptom From Faulty Circuit
J2-1	ESTCOILA (Engine Spark Timing Coil A)	PPL/BLK	Rough Idle, Lack of Power, Stalling
J2-2	GROUND (Power)	BLK	An open ground or high resistance ground may cause any or all symptoms.
J2-3	SDATA (Serial Data)	PNK	No Serial Data
J2-4	Crank VR Hi (23X)	BLK/WHT	No Start
J2-5	INJA (Injector A)	LT.BLU/ BLK	Rough Idle, Lack of Power, Stalling
J2-6	INJB (Injector B)	LT. BLU/ WHT	Rough Idle, Lack of Power, Stalling
J2-7	HO ₂ HTR (Oxygen Sensor Heater) If equipped	GRY/BLK	Lack of Power, Surge, Rough Idle, Exhaust Odor
J2-8	MAT (Manifold Air Temperature)	TAN/BLK	Rough Idle
J2-9	FPR (Fuel Pump Relay)	BLU/YEL	No Start
J2-10	5VRTN1 (5 Volt Return 1)	BRN	Lack of Performance, Stalling, Exhaust Odor, Improper Idle
J2-11	MAP (Manifold Absolute Pressure)	WHT/RED	Poor Performance, Surge, Poor Fuel Economy, Exhaust Odor
J2-12	TPS (Throttle Position Sensor) If equipped	PNK/BLK	Poor fuel Economy, Surge, Exhaust Odor
J2-13	Crank VR Lo (23X)	GRN/ WHT	No Start
J2-14	EHT (Engine Head Temperature Sensor)	TAN	Poor Performance, Exhaust Odor, Rough Idle
J2-15	IGN (Ignition)	RED	No Start, MIL Inoperative
J2-16	5VREF (5 Volt Reference)	RED/WHT	Lack of Power, Surge, Rough Idle, Exhaust Odor
J2-17	HO ₂ HI (Oxygen Sensor)	WHT/ GRN	Lack of Power, Surge, Rough Idle, Exhaust Odor
J2-18	VBAT (Voltage Battery)	RED	No Start

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the PowerPortal

Printed in the U.S.A.

BRIGGSandSTRATTON.com • ThePowerPortal.com



CE8182-8/14

BRIGGS & STRATTON
CORPORATION

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POST OFFICE BOX 702
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