



**ELECTRONIC FUEL  
INJECTION**

SERVICE & DIAGNOSTICS



**VANGUARD™ 810 EFI**



**BIG BLOCK™ EFI**



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## CAUTIONS

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.

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# Section 1

## Diagnostic Introduction

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## On-Board Diagnostic (OBD) System Check

The basic steps of any diagnosis are as follows:

1. Observe the Malfunction Indicator Lamp (MIL) with engine running. If MIL is illuminated, then current Diagnostic Trouble Codes (DTCs) are present.
2. Read DTC(s) using MIL, Tiny Scan Code Reader, or Electronic Technician Assistant (ETA) software.
3. To diagnose system problem(s), proceed to the applicable Diagnostic Table(s) in *Section 2: Troubleshooting DTCs*.
4. Once the problem is located and corrected through repair or replacement of faulty components, clear DTC(s) using the Tiny Scan Code Reader or the ETA software.  
**NOTE:** For information on the location or replacement of specific components, see *Section 5: Removal/Installation*.
5. Start and run engine to validate repairs. Observe MIL to verify that no DTCs are set.
6. If no DTCs are set, but engine performance issues exist, see *Section 4: Symptoms*.

### Diagnostic Trouble Codes (DTCs)

The ECM receives voltage signals from as many as five sensors. Each sensor functions within an established set of parameters, which can be viewed as its operating “window.”

When a malfunction or fault condition occurs, a change in the signal voltage alerts the ECM that the sensor is functioning outside its operating “window,” a DTC is set and stored in ECM memory, and the MIL is illuminated.

A default value temporarily replaces the erroneous sensor value to restore engine performance until the problem is corrected.

### Malfunction Indicator Lamp (MIL)

As a bulb and diagnostic system check, the MIL illuminates at Ignition ON, Engine OFF.

When the engine is started, the MIL is extinguished if no current fault condition exists.

If the MIL remains illuminated, it is an indication that a current DTC is stored. If the fault should correct itself, as in an intermittent condition, the MIL is extinguished after a ten second delay. The DTC remains stored in ECM memory as a historic code until cleared by the technician. The MIL does not indicate the existence of only historic codes.

### Data Link Connector (DLC)

The DLC provides for direct communication with the ECM. By plugging the Tiny Scan Code Reader or laptop (with ETA software loaded) into the 6-pin connector in the EFI wire harness, the DTCs stored in ECM memory can be read and cleared.

### Non-Scan Diagnostics

In the Non-Scan diagnostic mode, either the MIL or the Tiny Scan Code Reader is used to read DTCs. The technician then refers to the applicable Diagnostic Table to troubleshoot the problem. Those tables labeled *Non-Scan Diagnostics* must be used, as the data stream provided by the ECM is not available for analysis.

### Scan Diagnostics

In the more sophisticated diagnostic mode, the ETA software can facilitate the diagnosis of system problems through an expanded interface with the ECM. Through the use of data displays and menu selections, the technician has access to “live” data for analysis.

It is important to note that the software is not a stand-alone diagnostic tool for resolving DTCs, but must be used in conjunction with the Diagnostic Tables for the most efficient and effective diagnosis. Those tables that are applicable to users with access to the ETA software are labeled as *Scan Diagnostics*.



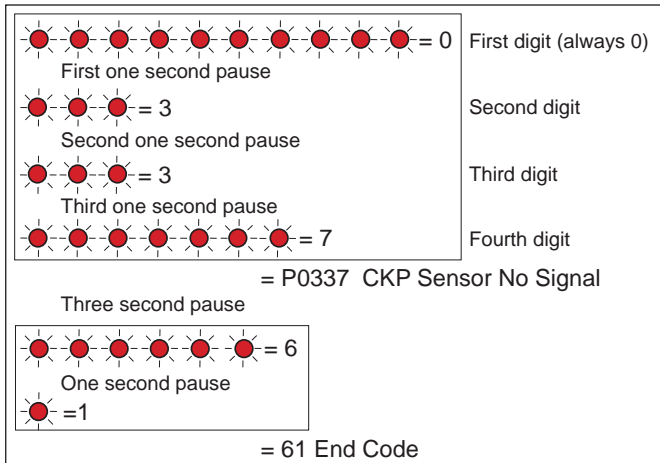


Figure 1-1 MIL Flash Sequence.

### Use MIL to Read DTCs

Proceed as follows:

1. Verify that battery voltage is above 12v.
2. Turn Ignition key OFF for ten seconds.
3. Turn Ignition key ON-OFF-ON-OFF-ON (but do not start the engine).

**NOTE:** No more than 2.5 seconds can elapse between each ON and OFF cycle or the routine is aborted.

4. When performed correctly, the MIL begins to flash the first of four digits.

**NOTE:** While each DTC actually begins with the letter “P,” only the numeric characters are flashed.

5. Also, the first digit of every DTC is zero, which is represented as a series of ten flashes before the first one second pause.
6. Count the number of flashes after the first one second pause to obtain the second digit of the DTC.
7. Count the number of flashes after the second one second pause to obtain the third digit, and then count the number of flashes after the third one second pause to obtain the fourth digit.

8. Write down each digit as it is displayed.
9. If there is more than one DTC, the next DTC begins to flash after a three second pause.
10. After all DTCs are reported, the number “61” is flashed to indicate this condition to the technician. The flashing sequence is then restarted and the technician may choose to verify the DTCs written down or exit the routine.

**NOTE:** If “61” is the first code flashed, then no active DTCs are set.

### Use Tiny Scan Code Reader to Read/Clear DTCs

Proceed as follows:

**NOTE:** Always follow steps 1-9 for an accurate report of current DTCs. Failure to do so may generate a report that includes historic codes.

1. Obtain Briggs & Stratton Tiny Scan Code Reader (Part No. 19626).
2. Connect code reader to DLC.
3. Turn Ignition ON, Engine OFF.

**NOTE:** If the Tiny Scan Code Reader cannot connect to the ECM, “no-C” is displayed, which stands for “no communication.” If communication is established, the



Figure 1-2 Data Link Connector (DLC).



tool displays the number of DTCs read. For example, “dc-0” means that no DTCs were found, while “dc-4” means that four DTCs are recorded.

4. Press the select button to cycle through the list of DTCs.
5. Once the last DTC is displayed, “CLr?” appears. Press and hold the select button until “Hold” changes to “Done,” which indicates that all DTCs have been “cleared” from ECM memory.
6. Turn Ignition OFF for a minimum of 20 seconds.
7. Turn Ignition ON, Engine OFF.
8. The tool displays the number of DTCs read.
9. Press the select button to cycle through the list of DTCs. Write down each DTC as it is displayed.

### Use Electronic Technician Assistant (ETA) to Read/Clear DTCs

Proceed as follows:

1. Obtain Interface Cable and laptop loaded with Briggs & Stratton Electronic Technician Assistant Diagnostic Software (Part No. 19628).
2. Connect Interface Cable between laptop and DLC.
3. Turn Ignition ON, Engine OFF.
4. To read current DTCs, proceed as follows:
  - a. Left click the green Online Icon in the Quick Access Tool Bar at the top of the screen to connect to the ECM.
  - b. Select **Fault Codes** ribbon.
  - c. Click **Current** to view current DTCs.

**NOTE:** Click **Historical** to view historic DTCs.

5. To clear DTCs, proceed as follows:
  - a. Click **Fault Codes** ribbon.
  - b. Left click **Clear**.
  - c. A pop up window displays the following message:

“Please Turn off the ECM and wait for this message to disappear.”
  - d. Turn Ignition OFF.
  - e. After at least five seconds has elapsed, turn Ignition ON. A pop up window displays the following message:

“1. Be certain the ignition switch has been turned off for at least 5 seconds.  
2. After 5 seconds, turn the ignition switch on to power up the ECM.  
3. After the ECM is powered up, click the OK button.”
  - f. Click **OK**.

**NOTE:** Clicking **Clear** erases both current and historic DTCs.

### Back Probing Connector Terminals

**NOTE:** Do not insert probes into terminals on the mating side of any connector. The diameter of the test probes can damage terminals.

1. Obtain Briggs & Stratton Back Probe Wire Set (Part No. 19625).
2. Carefully slide metal pin on probe between the rubber seal and wire insulation on the back side (wire end) of the connector.
3. Gently push the pin in until it stops. Stop pushing when the pin “bottoms out,” or when the plastic sheath is very close to the connector housing.

DO NOT force the pin into the connector as terminal and/or probe pin damage can occur. Probe travel may be stopped by contact with insulation or core crimps. Try again after removing and re-positioning probe pin.

**IMPORTANT:**

- Use care to avoid deforming connector terminals, either by forcing the probe too far into the cavity or by using a probe that is too large. If terminal damage is suspected, test for proper terminal contact.
- A deformed terminal can cause a poor connection resulting in intermittent problems or even complete component failure. Do not use paper clips or other substitute devices as they also can damage terminals.
- Do not probe through connector seals, wire insulation, secondary ignition wires, boots, etc. Damage can occur that is not readily apparent and tiny holes can result in water intrusion, which leads to corrosion and eventual component failure.

**Avoiding ECM Damage**

**⚠ CAUTION: A surge in voltage, current or both, is called a voltage spike. Voltage spikes can cause major damage to the ECM.**

1. To avoid ECM failure due to accidentally induced voltage spikes, always observe the following precautions:

- Do not start engine if battery cable connections are loose.
- Do not use a battery charger to start engine.
- Turn Ignition OFF before disconnecting and/or connecting battery cables.
- When disconnecting battery, always disconnect battery negative (-) cable first.
- When connecting battery, always connect battery positive (+) cable first.
- When charging battery, turn Ignition OFF and remove battery negative cable (black) from battery negative (-) terminal.

2. Do not spray water at or around ECM.

**NOTE:** See Figure 1-3. A pin hole centered under the adhesive label is used in manufacturing to determine the integrity of the potted seal. If the label peels or becomes torn, worn or abraded, exposure of the hole can allow water or moisture to intrude, leading to corrosion and eventual ECM failure.

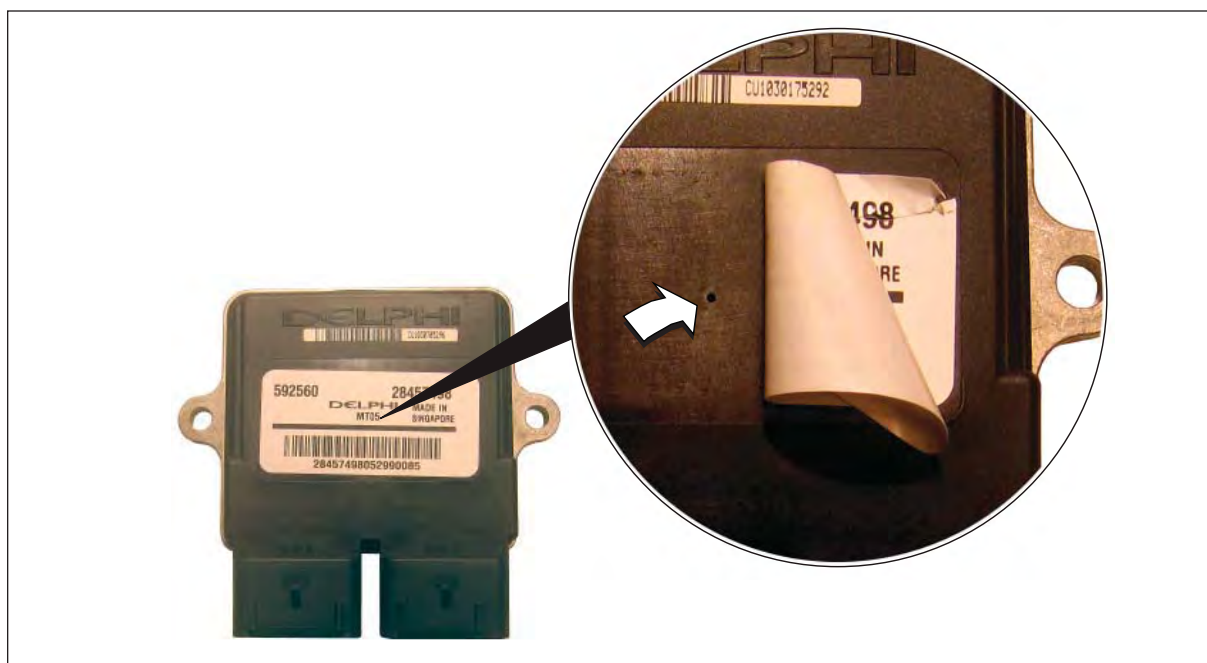


Figure 1-3 Protect ECM From Water Intrusion.

### Special Tools

The following special tools are required:

1. Briggs & Stratton Spark Tester (Part No. 19368).
2. Briggs & Stratton Digital Volt Ohmmeter Extech Ma220 (Part No. 19602).
3. Briggs & Stratton Noid Light (Part No. 19623).
4. Briggs & Stratton BIG BLOCK™ Fuel Pressure Test Adapter (Part No. 19624).
5. Briggs & Stratton Back Probe Wire Set (Part No. 19625).
6. Briggs & Stratton Tiny Scan Code Reader (Part No. 19626).
7. Briggs & Stratton Fuel Pressure Gauge (Part No. 19627).
8. Briggs & Stratton Electronic Technician Assistant Diagnostic Software and Interface Cable (Part No. 19628).



### Product Improvements/Field Upgrades

The following Service Bulletins provide information on product improvements recently introduced in production. Service kits are available for upgrading product in the field.

#### • Service Bulletin CSB-1030

For protection against voltage spikes on Model 610000 marine engines having the 20/50 amp charging system, install the Briggs & Stratton Capacitor Kit (Part No. 847148).

#### • Service Bulletin DSB-1053

To dampen vibration to the ECM/fuse block bracket, install Briggs & Stratton Service Kit (Part No. 847337), which includes a new fuse/relay block cover, ECM mounting bracket, rubber isolation mounts, and mounting hardware.

To access a bulletin, proceed as follows:

1. Go to [www.thepowerportal.com](http://www.thepowerportal.com).
2. Enter Login and Password.
3. From the home page, select the "Technical Information" tab.
4. Select "Service Bulletins."
5. Under "Keyword," type in the bulletin number.
6. Select "View."

## Section 2

# Troubleshooting DTCs

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## Diagnostic Trouble Codes (DTCs)

Component	DTC	Description
Oxygen (O <sub>2</sub> ) Sensor Heater	P0031	Signal Voltage Low
	P0032	Signal Voltage High
Manifold Absolute Pressure (MAP) Sensor	P0107	Signal Voltage Low or Open
	P0108	Signal Voltage High
Manifold Air Temperature (MAT) Sensor	P0112	Signal Voltage Low
	P0113	Signal Voltage High or Open
Engine Head Temperature (EHT) Sensor	P0117	Signal Voltage Low
	P0118	Signal Voltage High or Open
Throttle Position Sensor (TPS)	P0122	Signal Voltage Low or Open
	P0123	Signal Voltage High
Oxygen (O <sub>2</sub> ) Sensor	P0131	Signal Voltage Low
	P0132	Signal Voltage High
Power Enrichment (PE) Mode	P0174	Lean Fuel Condition
Cylinder 1 Fuel Injector	P0201	Cylinder 1 Fuel Injector Fault
Cylinder 2 Fuel Injector	P0202	Cylinder 2 Fuel Injector Fault
Fuel Pump Fault	P0230	Signal Voltage Low or Open
	P0232	Signal Voltage High
Crankshaft Position (CKP) Sensor	P0336	Signal Voltage Noisy
	P0337	Signal Voltage Absent
Cylinder 1 Ignition Coil	P0351	Cylinder 1 Ignition Coil Fault
Cylinder 2 Ignition Coil	P0352	Cylinder 2 Ignition Coil Fault
Idle Air Control (IAC)	P0505	IAC Malfunction
System Voltage	P0562	System Voltage Low
	P0563	System Voltage High
Malfunction Indicator Lamp (MIL)	P0650	MIL Circuit Malfunction

Component	Model 490000	Model 540000	Model 610000	
			Turf	Marine
IAC	-	-	-	*
HO <sub>2</sub> Sensor	*	*	*	-
TPS	-	-	-	*

\* = Equipped

## Model 490000 EFI Component Locations

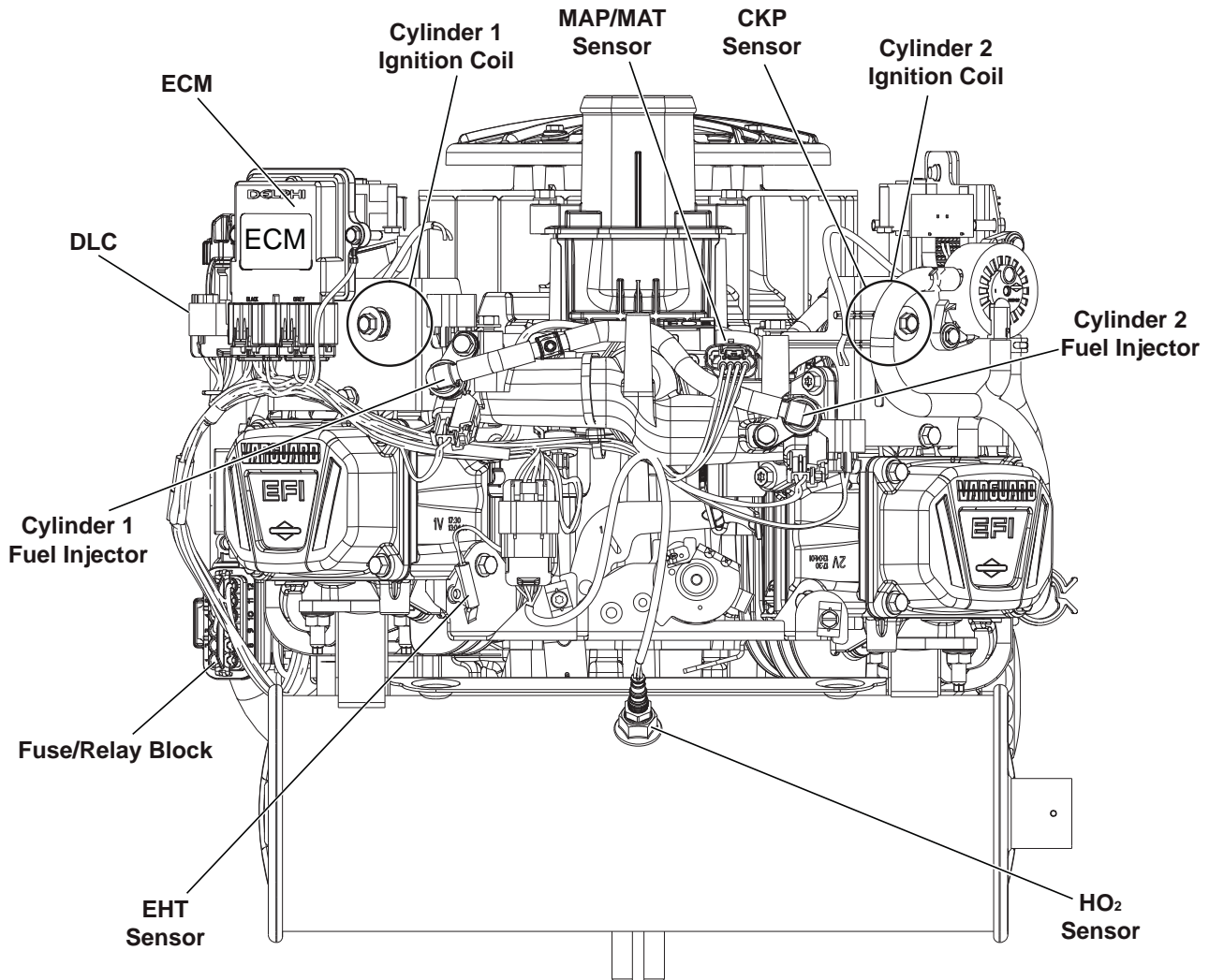


Figure 2-1 Model 490000 Components.  
(Static Guard, Decorative Cover, and Blower Housing Removed for Illustration Purposes.)

Disassembly Required for Back Probing Connector (x) or Replacing Component (o)				
To Access	Remove Air Cleaner Assembly	Remove Static Guard	Remove Decorative Cover	Remove Blower Housing
ECM				
MAP/MAT Sensor	xo	xo	xo	
Ignition Coil	o	o	o	o
Mechanical Diaphragm Fuel Pump				
Fuel Pump Module				
Fuel Injectors	o	o	o	
CKP Sensor	xo	xo	xo	xo
HO2 Sensor				
Fuse/Relay Block				

See Section 5: Removal/Installation for instructions.

 = Removal Not Required

## Models 540000/610000 EFI Component Locations

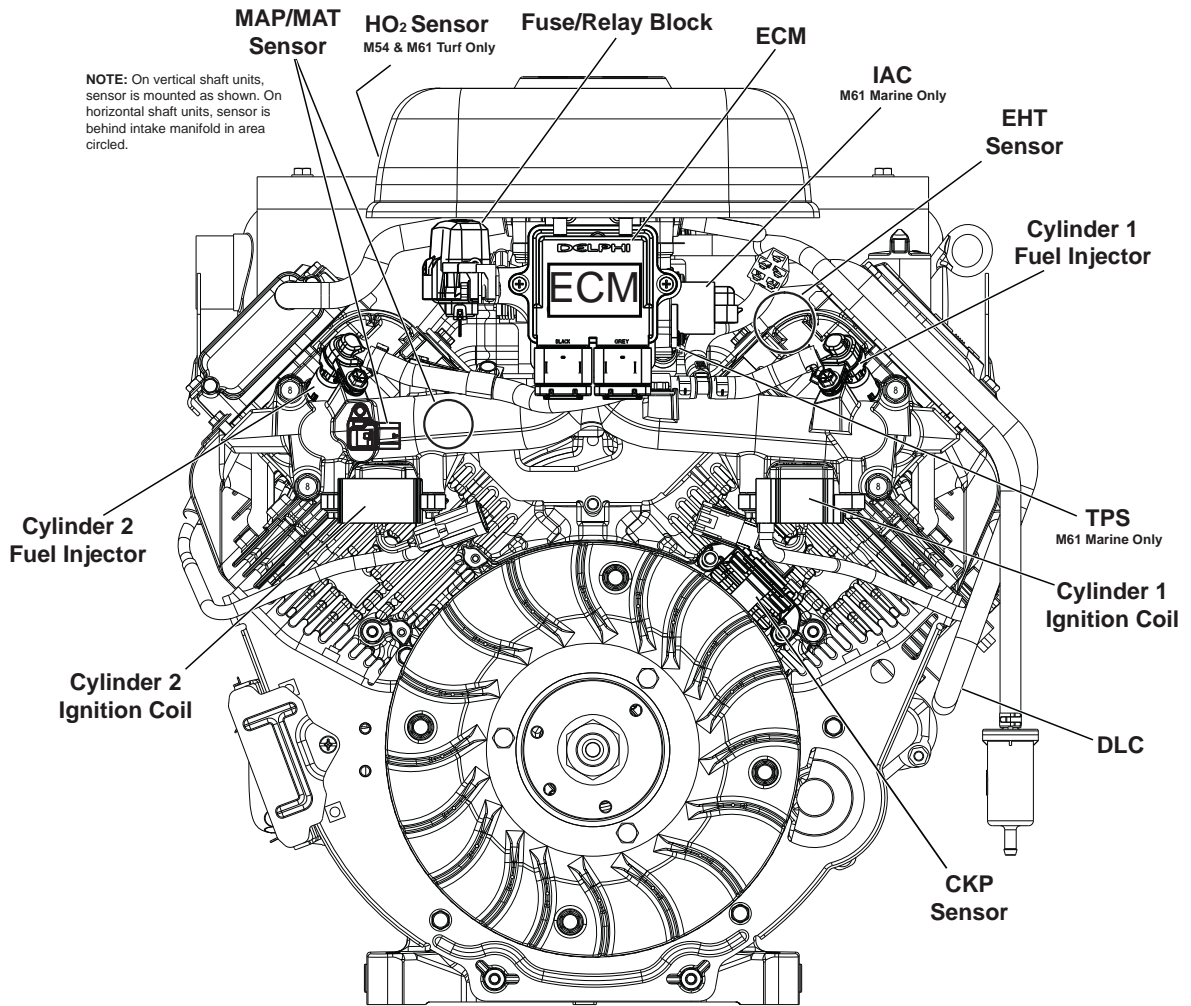



Figure 2-2 Models 540000/610000 Components.  
(Access Cover and Blower Housing Removed for Illustration Purposes.)

Disassembly Required for Back Probing Connector (x) or Replacing Component (o)				
To Access	Remove Access Cover	Remove Blower Housing	Remove Air Cleaner Assembly	Remove Throttle Body
ECM	xo			
MAP/MAT Sensor	xo	xo		
Ignition Coil	xo	xo		
Fuel Pump Module	xo		xo	
Fuel Injectors	xo	xo		
CKP Sensor	xo	xo		
TPS	xo		xo	o
IAC	xo		xo	
HO2 Sensor	xo		xo	
Fuse/Relay Block	xo			

See Section 5: Removal/Installation for instructions.

 = Removal Not Required

## Verify ECM Powers Up

### Circuit Description

Since all EFI components are dependent on proper operation of the ECM, any diagnosis must include checking ECM power and grounds.

Remove and clean battery terminals. While terminals may appear clean, corrosion on the

inner surfaces can cause a poor connection to ground.

**NOTE:** When the ECM is powered up, you may hear the fuel pump module prime for two seconds. This is not definitive proof that the ECM is getting proper voltage.

## Check ECM Power and Grounds Scan and Non-Scan Diagnostics (Page 1 of 2)

Step	Action	Yes	No
<b>1</b>	1. Turn Ignition OFF. 2. Back probe terminal J2-18 (Red wire) of ECM J2 (Black) connector. 3. Connect terminal J2-18 back probe to red meter test lead on DVOM. 4. Connect black meter test lead on DVOM to a known good ground. 5. Set DVOM to read volts DC. 6. Turn Ignition ON, Engine OFF. 7. Observe voltage on DVOM. 8. Is reading 12.2-14.5 volts DC?	Go to step 2.	Look for open or short to ground in battery (B+) feed circuit.  Perform visual and continuity check of 15 amp Ignition fuse (Blue).
<b>2</b>	1. Turn Ignition OFF. 2. Remove probe from terminal J2-18, and back probe terminal J2-15 (Red wire) of ECM J2 connector. 3. Connect terminal J2-15 back probe to red meter test lead on DVOM. 4. Connect black meter test lead on DVOM to a known good ground. 5. Turn Ignition ON, Engine OFF. 6. Observe voltage on DVOM. 7. Is reading 12.2-14.5 volts DC?	Go to step 3.	Look for open or short to ground in ignition feed circuit.
<b>3</b>	1. Turn Ignition OFF. 2. Remove probe from terminal J2-15, and back probe terminal J2-02 (Black wire) of ECM J2 connector. 3. Connect terminal J2-02 back probe to red meter test lead on DVOM. 4. Connect black meter test lead on DVOM to a known good ground. 5. Set DVOM to read resistance. 6. Observe reading on DVOM. 7. Is resistance 1.0 ohm or less?	Go to step 4.	Look for open or short in ECM ground circuit.

## Check ECM Power and Grounds Scan and Non-Scan Diagnostics (Page 2 of 2)

Step	Action	Yes	No
4	<ol style="list-style-type: none"> <li>1. Remove probe from terminal J2-02, and back probe terminal J1-09 (Black wire) of ECM J1 (Grey) connector.</li> <li>2. Connect terminal J1-09 back probe to red meter test lead on DVOM.</li> <li>3. Connect black meter test lead on DVOM to a known good ground.</li> <li>4. Observe reading on DVOM.</li> <li>5. Is resistance 1.0 ohm or less?</li> </ol>	System OK.	Look for open or short in ECM ground circuit.

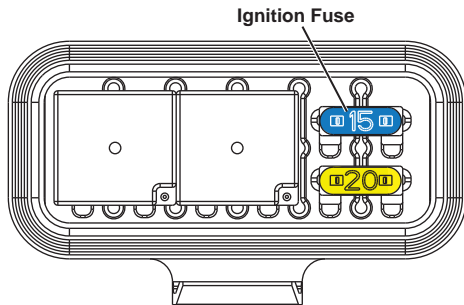


Figure 2-3 Fuse/Relay Block.

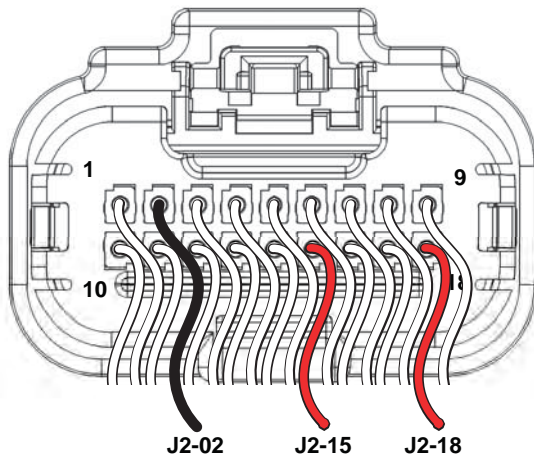


Figure 2-4 ECM J2 Connector (Black).

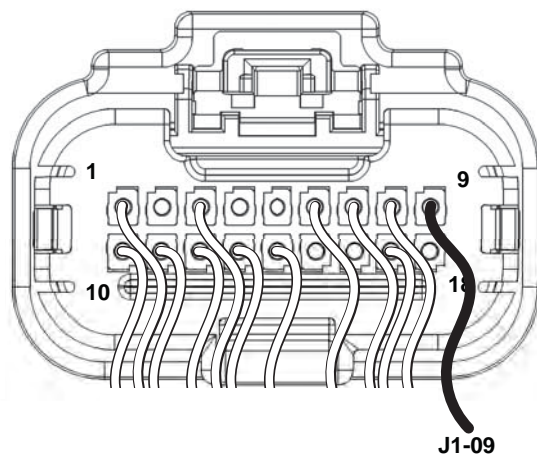
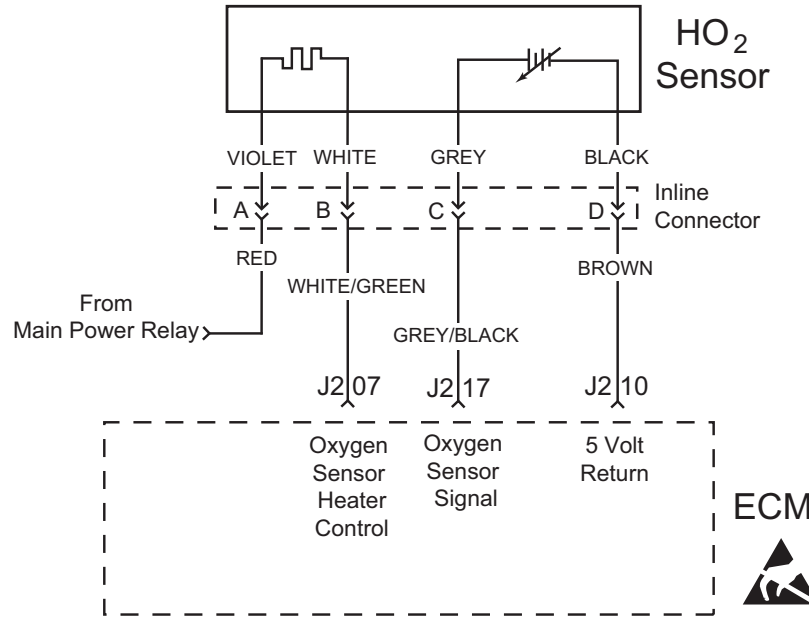


Figure 2-5 ECM J1 Connector (Grey).



## DTC P0031/P0032 Oxygen Sensor (HO<sub>2</sub>) Heater Signal Voltage Low or High

### Circuit Description

The HO<sub>2</sub> sensor voltage varies 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 600°F (360°C). An open sensor circuit or cold sensor causes an open loop operation.

The sensor heater provides for 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.

An active DTC P0031 indicates that the sensor has developed an open circuit and is operating in Open Loop mode. DTC P0032 indicates circuit resistance is low and voltage being returned to the ECM is too high.

### Diagnostic Aids

Check for the following conditions:

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

Always clear DTCs after performing repairs.



## DTC P0031 Oxygen Sensor (HO<sub>2</sub>) Heater Scan and Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect O<sub>2</sub> sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe (using fused patch cord) terminal A (Red wire) on engine side of O<sub>2</sub> sensor connector.</li> <li>3. Connect terminal A back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal D (Brown wire) on engine side of O<sub>2</sub> sensor connector.</li> <li>5. Connect terminal D back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine Off.</li> <li>8. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Go to step 3.	<p>Perform visual and continuity check of Main Power Relay and 20 amp Battery fuse (Yellow).</p> <p>Either there is no power from fuse block or not getting ground thru 5 volt return circuit.</p>
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal A, and back probe terminal B (White/Green wire) on engine side of O<sub>2</sub> sensor connector.</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Go to step 4.	Replace O <sub>2</sub> sensor.
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal B, and back probe ECM connector terminal J2-07 (White/Green wire).</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Both EFI wire harness and O <sub>2</sub> sensor are good.	Go to step 5.
<b>5</b>	Are both O <sub>2</sub> sensor and ECM J2 connectors fully mated?	Repair or replace EFI wire harness.	Connect connectors.

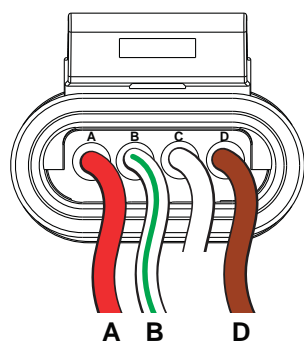


Figure 2-6 O<sub>2</sub> Sensor Connector.

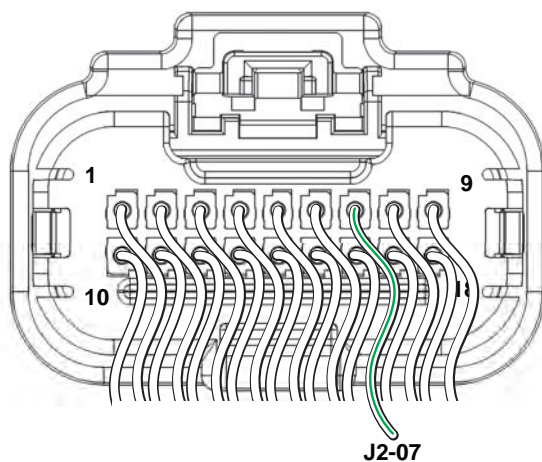


Figure 2-7 ECM J2 Connector (Black).

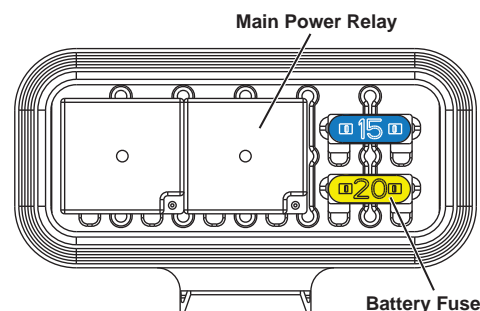


Figure 2-8 Fuse/Relay Block.

## DTC P0032 Oxygen Sensor (HO<sub>2</sub>) Heater Scan and Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect O<sub>2</sub> sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe (using fused patch cord) terminal B (White/Green wire) on engine side of O<sub>2</sub> sensor connector.</li> <li>3. Connect terminal B back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal D (Brown wire) on engine side of O<sub>2</sub> sensor connector.</li> <li>5. Connect terminal D back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Observe voltage on DVOM.</li> <li>9. Is reading 12.2-13.5 volts DC?</li> </ol>	Go to step 3.	Ensure probe connectivity.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Start and run engine.</li> <li>2. Observe voltage on DVOM.</li> <li>3. Within 15 seconds, does voltage reading drop to less than 100 millivolts?</li> </ol>	O <sub>2</sub> sensor OK. Clear codes and retest.	Replace O <sub>2</sub> sensor.

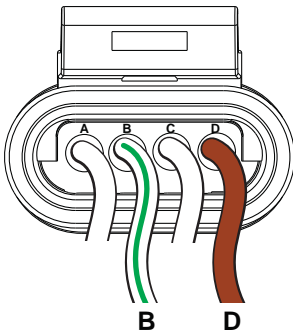
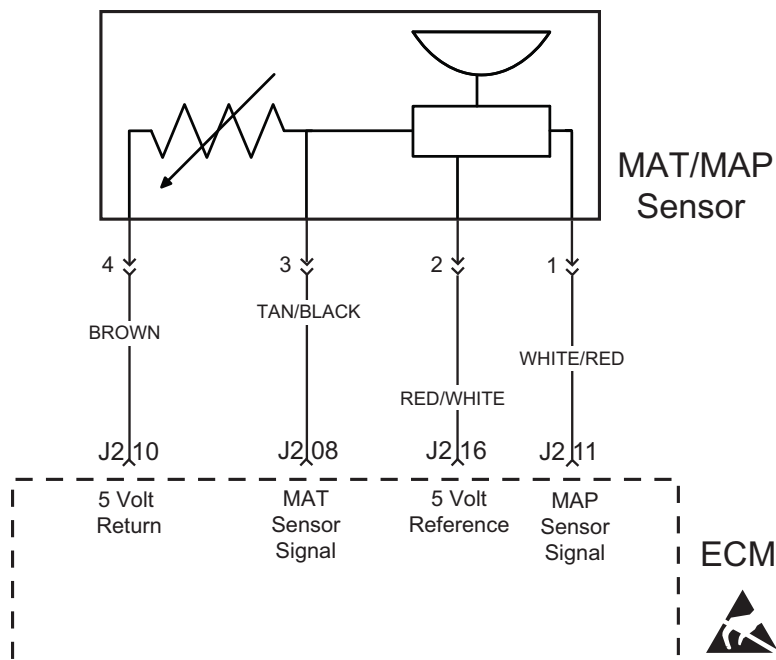


Figure 2-9 O<sub>2</sub> Sensor Connector.



## DTC P0107/P0108 Manifold Absolute Pressure (MAP) Sensor Signal Voltage Low, Open or High

### Circuit Description

The MAP sensor responds to changes in manifold pressure (vacuum). The ECM receives this information as a signal voltage that varies between about 0.5 volts at idle to 4.5 volts at Wide Open Throttle (WOT).

If the MAP sensor fails, the ECM substitutes a default MAP value.

The MAP sensor voltage of 5 volts is delivered to the MAP sensor through ECM terminal J2-16. The MAP sensor sends 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:

1. Poor ECM connection. Inspect wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
2. Damaged wire harness and/or connectors. If harness appears to be OK, shake or wiggle wire harness and/or connector with DVOM or ETA connected. Radical voltage changes or a change in the MAP sensor display can indicate the location of the fault condition.

Always clear DTCs after performing repairs.

## DTC P0107 Manifold Absolute Pressure (MAP) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>Pressure</b> heading, observe MAP Sensor Actual display with or without the engine running. 3. Is reading 0.5-4.5 volts DC?	MAP sensor circuit OK.	Go to step 2.
2	Is reading below 0.5 volts DC?	Go to DTC P0107 Non-Scan Diagnostics.	-

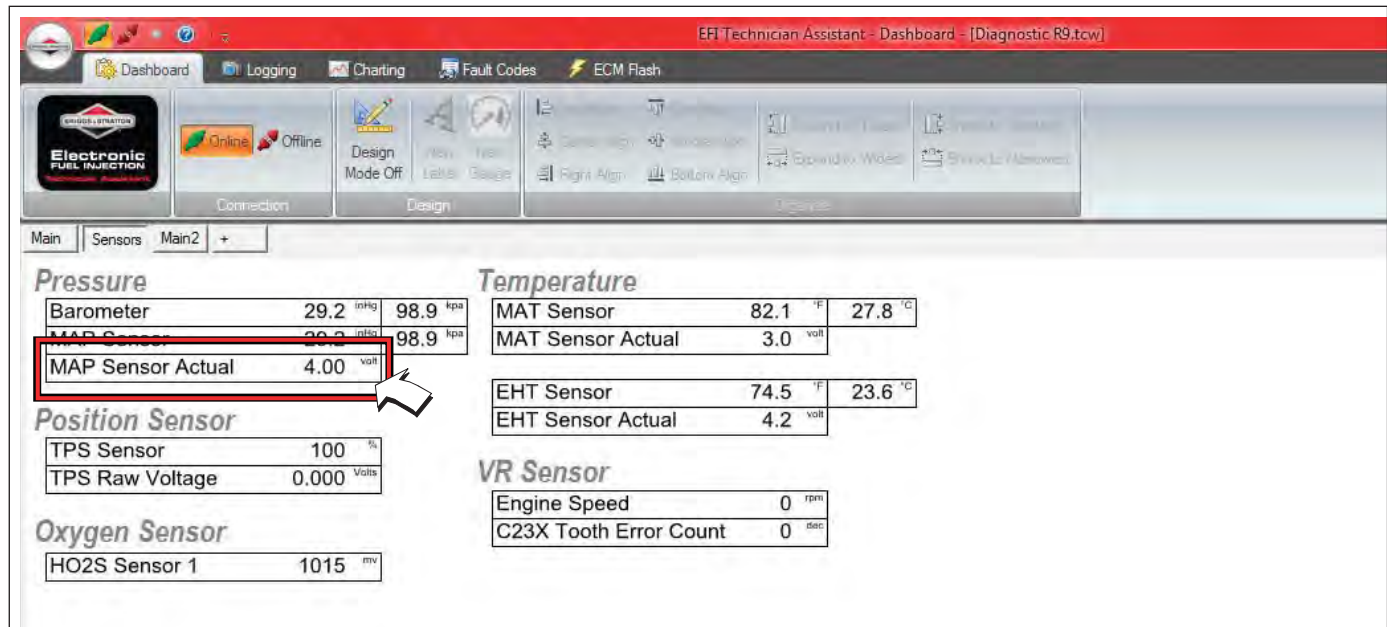


Figure 2-10 Check MAP Sensor Actual Display.

## DTC P0107 Manifold Absolute Pressure (MAP) Sensor Non-Scan Diagnostics (Page 1 of 2)

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect MAP sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 2 (Red/White wire) of MAP sensor connector.</li> <li>3. Connect terminal 2 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal 4 (Brown wire) of MAP sensor connector.</li> <li>5. Connect terminal 4 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Observe voltage on DVOM.</li> <li>9. Is reading 4.6-5.0 volts DC?</li> </ol>	Go to step 3.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 2, and back probe ECM connector terminal J2-16 (Red/White wire).</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Observe voltage on DVOM.</li> <li>5. Is reading 4.6-5.0 volts DC?</li> </ol>	Go to step 6.	Go to step 4.

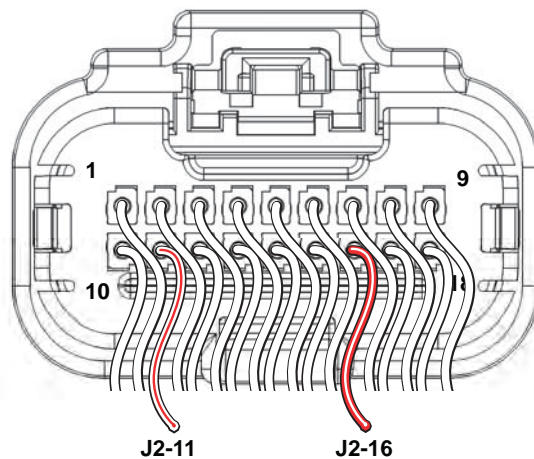
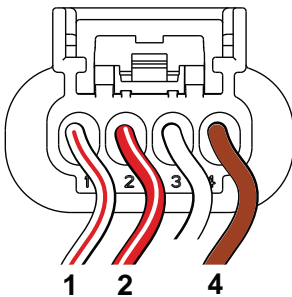


Figure 2-11 MAP Sensor Connector.

Figure 2-12 ECM J2 Connector (Black).

## DTC P0107 Manifold Absolute Pressure (MAP) Sensor Non-Scan Diagnostics (Page 2 of 2)

Step	Action	Yes	No
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal J2-16, and back probe terminal 1 (White/Red wire) of MAP sensor connector.</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Observe voltage on DVOM.</li> <li>5. Is reading 3.7-4.2 volts DC?</li> </ol>	MAP sensor OK.	Go to step 5.
<b>5</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 1, and back probe ECM connector terminal J2-11 (White/Red wire).</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Observe voltage on DVOM.</li> <li>5. Is reading 3.7-4.2 volts DC?</li> </ol>	EFI wire harness OK.  Replace MAP sensor.	Go to step 6.
<b>6</b>	<ol style="list-style-type: none"> <li>1. Not getting ground thru 5 volt return circuit.</li> <li>2. Are both MAP sensor and ECM J2 connectors fully mated?</li> </ol>	Repair or replace EFI wire harness.	Connect connectors.



## DTC P0108 Manifold Absolute Pressure (MAP) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>Pressure</b> heading, observe MAP Sensor Actual display with or without the engine running. 3. Is reading 0.5-4.5 volts DC?	MAP sensor circuit OK.	Go to step 2.
2	Is reading above 4.5 volts DC?	Go to DTC P0108 Non-Scan Diagnostics.	-

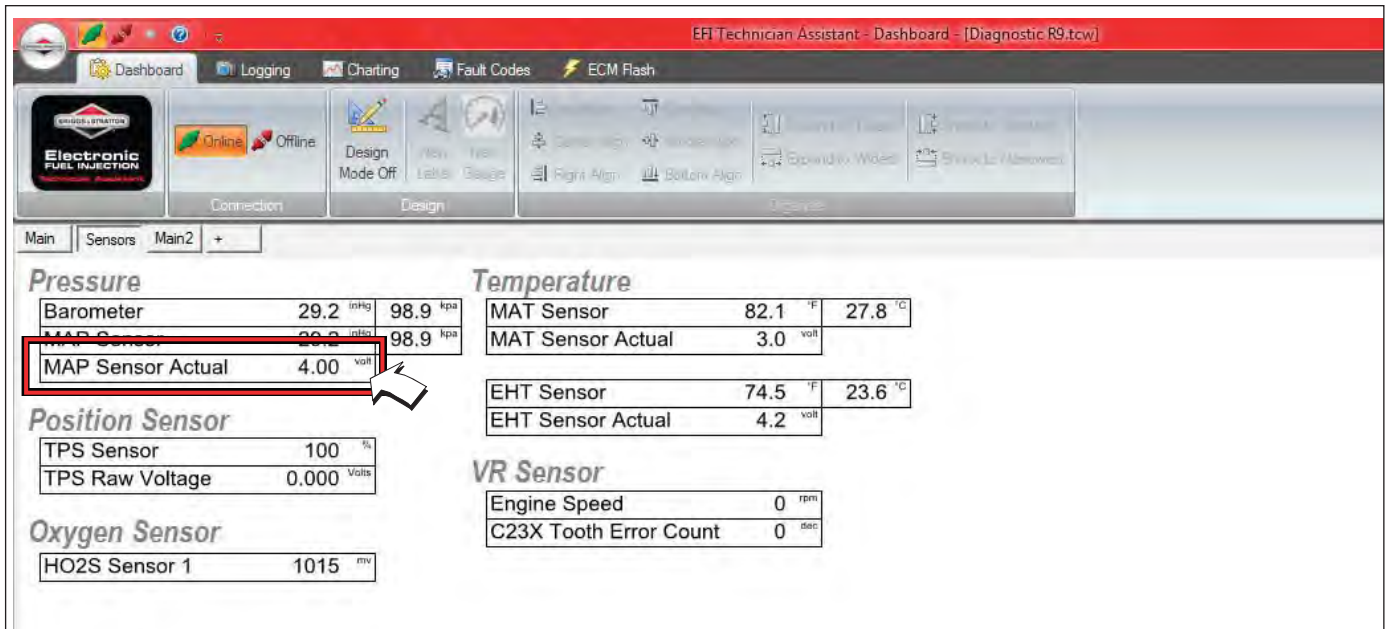


Figure 2-13 Check MAP Sensor Actual Display.

## DTC P0108 Manifold Absolute Pressure (MAP) Sensor Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect MAP sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 2 (Red/White wire) of MAP sensor connector.</li> <li>3. Connect terminal 2 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal 4 (Brown wire) of MAP sensor connector.</li> <li>5. Connect terminal 4 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Observe voltage on DVOM.</li> <li>9. Is reading 4.7-5.0 volts DC?</li> </ol>	Go to step 3.	-
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 2, and back probe terminal 1 (White/Red wire) of MAP sensor connector.</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Observe voltage on DVOM.</li> <li>5. Is reading 0.5-4.5 volts DC?</li> </ol>	EFI wire harness OK.	Reading is above 4.5 volts DC.  Replace MAP sensor.

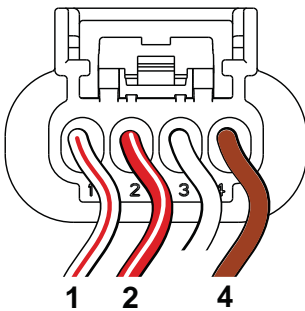
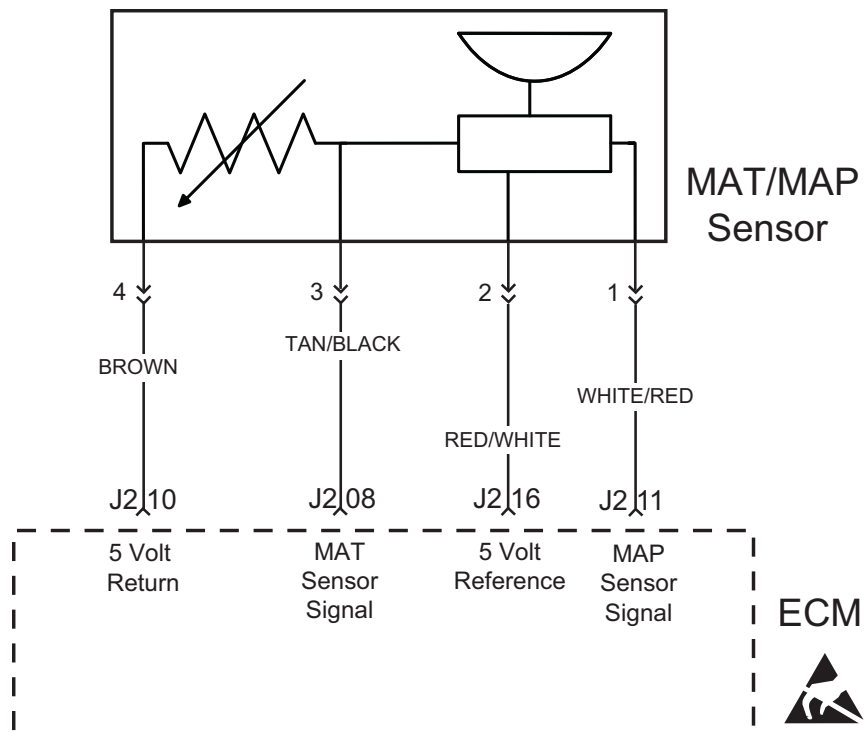


Figure 2-14 MAP Sensor Connector.



## DTC P0112/P0113 Manifold Air Temperature (MAT) Sensor Signal Voltage Low, High or Open

### Circuit Description

The MAT sensor uses a thermistor to control signal voltage to the ECM. The ECM applies 5 volts on the sensor circuit. Sensor resistance changes as ambient temperature changes, which in turn affects the voltage return to the ECM.

### Diagnostic Aids

Check for the following conditions:

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

3. Damaged wire harness and/or connectors. If harness appears to be OK, shake or wiggle wire harness and/or connector with DVOM or ETA connected. Radical voltage changes or a change in the MAT sensor display can indicate the location of the fault condition.

Always clear DTCs after performing repairs.

## DTC P0112 Manifold Air Temperature (MAT) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>Temperature</b> heading, observe MAT Sensor Actual display with or without the engine running. 3. Is reading 0.5-4.5 volts DC?	MAT sensor circuit OK.	Go to step 2.
2	Is reading below 0.5 volts DC?	Go to DTC P0112 Non-Scan Diagnostics.	-

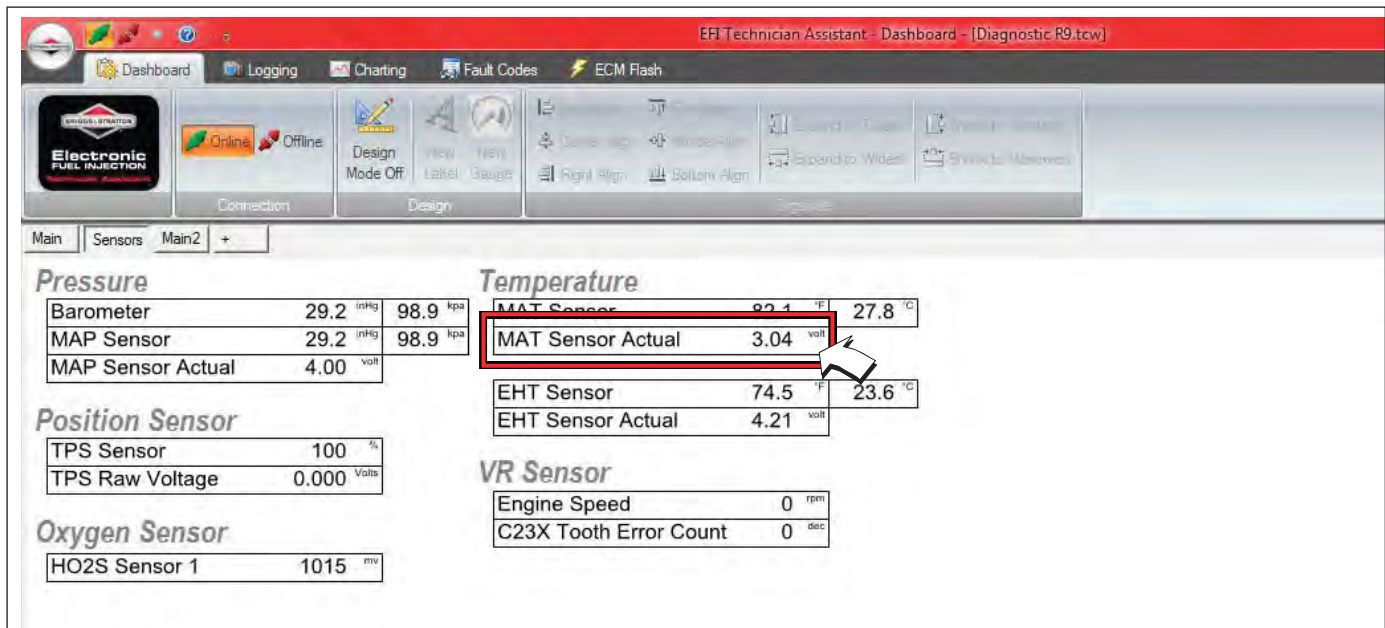


Figure 2-15 Check MAT Sensor Actual Display.

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

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect MAT sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 2 (Red/White wire) of MAT sensor connector.</li> <li>3. Connect terminal 2 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal 4 (Brown wire) of MAT sensor connector.</li> <li>5. Connect terminal 4 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Does DVOM read 4.7-5.0 volts DC?</li> </ol>	MAT sensor OK.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 2, and back probe terminal 3 (Tan/Black wire) of MAT sensor connector.</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Does DVOM read 0.5-4.5 volts DC?</li> </ol>	MAT sensor OK.	Reading is below 0.5 volts DC.  Replace MAT sensor.
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 3, and back probe ECM connector terminal J2-08 (Tan/Black wire).</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Does DVOM read 0.5-4.5 volts DC?</li> </ol>	MAT sensor circuit OK.	Go to step 5.
<b>5</b>	Are both MAT sensor and ECM J2 connectors fully mated?	Repair or replace EFI wire harness.	Connect connectors.

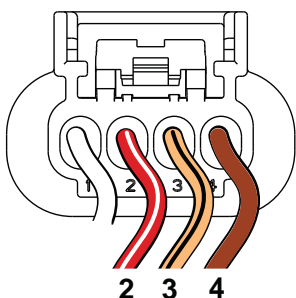


Figure 2-16 MAT Sensor Connector.

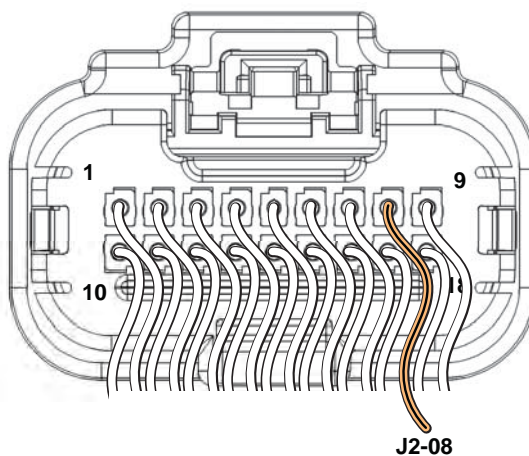


Figure 2-17 ECM J2 Connector (Black).

## DTC P0113 Manifold Air Temperature (MAT) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>Temperature</b> heading, observe MAT Sensor Actual display with or without the engine running. 3. Is reading 0.5-4.5 volts DC?	MAT sensor circuit OK.	Go to step 2.
2	Is reading above 4.5 volts DC?	Go to DTC P0113 Non-Scan Diagnostics.	-

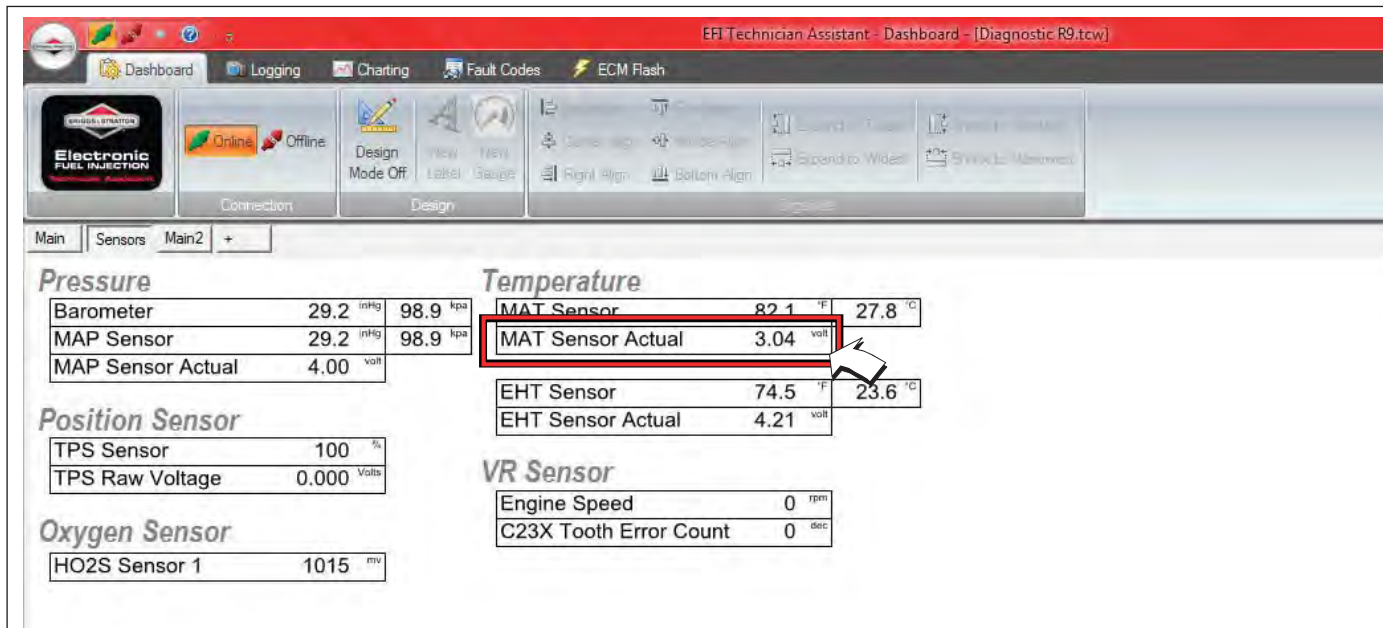


Figure 2-18 Check MAT Sensor Actual Display.



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

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect MAT sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 2 (Red/White wire) of MAT sensor connector.</li> <li>3. Connect terminal 2 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal 4 (Brown wire) of MAT sensor connector.</li> <li>5. Connect terminal 4 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Observe voltage on DVOM.</li> <li>9. Is reading 4.7-5.0 volts DC?</li> </ol>	MAT sensor OK.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 2, and back probe terminal 3 (Tan/Black wire) of MAT sensor connector.</li> <li>3. Turn Ignition ON, Engine OFF.</li> <li>4. Observe voltage on DVOM.</li> <li>5. Is reading 0.5-4.5 volts DC?</li> </ol>	MAT sensor OK.	Reading is above 4.5 volts DC.  Replace MAT sensor.

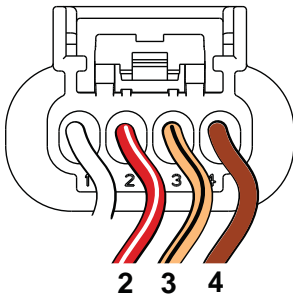
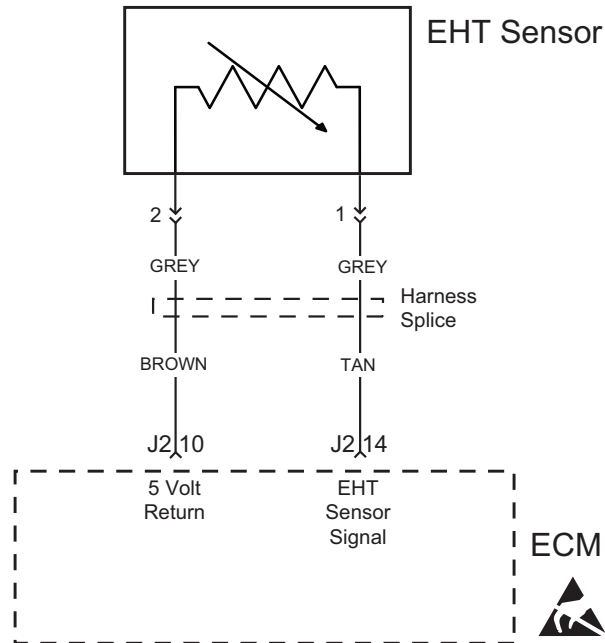


Figure 2-19 MAT Sensor Connector.



## DTC P0117/P0118 Engine Head Temperature (EHT) Sensor Signal Voltage Low, High or Open

### Circuit Description

The EHT sensor uses a thermistor to control signal voltage to the ECM. The ECM applies 5 volts on the sensor circuit. Sensor resistance changes as ambient temperature changes, which in turn affects the voltage return to the ECM.

### Diagnostic Aids

Check for the following conditions:

1. Poor ECM connection. Inspect wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
2. Damaged wire harness and/or connectors. If harness appears to be OK, shake or wiggle wire harness and/or connector with DVOM or ETA connected. Radical voltage changes or a change in the EHT sensor display can indicate the location of the fault condition.

Always clear DTCs after performing repairs.

## DTC P0117 Engine Head Temperature (EHT) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>Temperature</b> heading, observe EHT Sensor Actual display with or without the engine running. 3. Is reading 0.5-4.5 volts DC?	EHT sensor circuit OK.	Go to step 2.
2	Is reading below 0.5 volts DC?	Go to DTC P0117 Non-Scan Diagnostics.	-

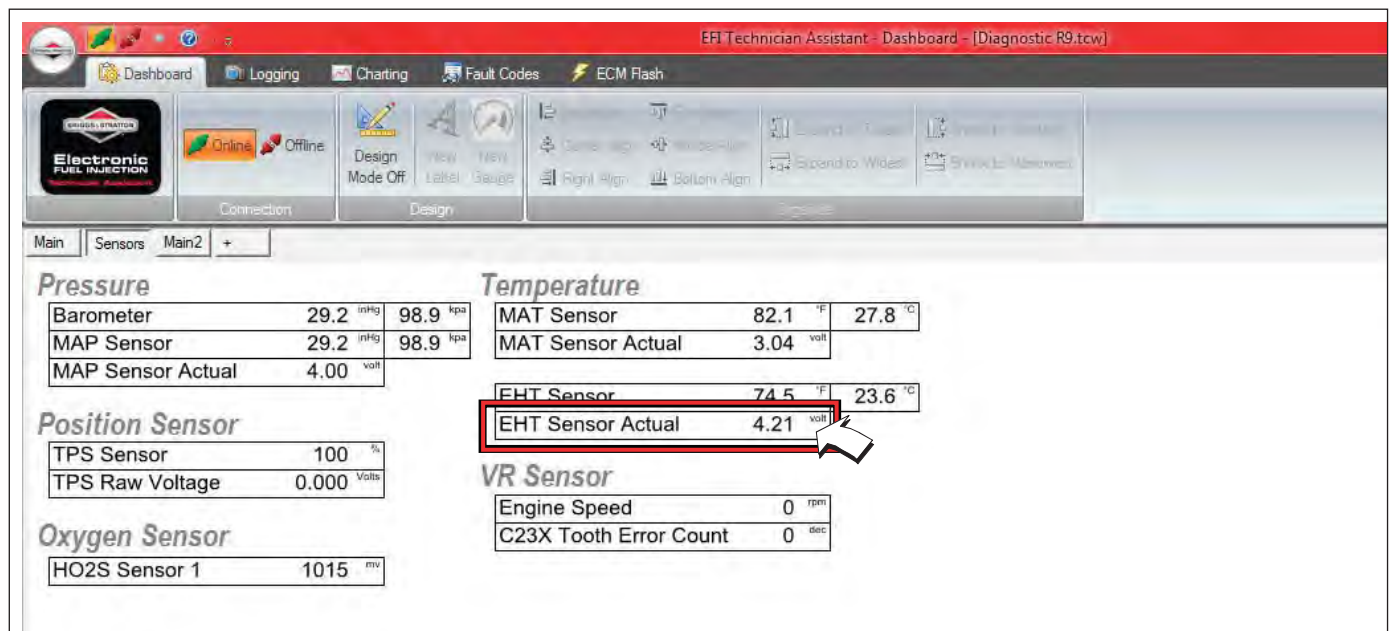


Figure 2-20 Check EHT Sensor Actual Display.

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

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect ECM J2 (Black) connector.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal J2-14 (Tan wire) of ECM connector.</li> <li>3. Connect terminal J2-14 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal J2-10 (Brown wire) of ECM connector.</li> <li>5. Connect terminal J2-10 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Observe voltage on DVOM.</li> <li>9. Is reading 0.5-4.5 volts DC?</li> </ol>	EHT sensor OK.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Reading is below 0.5 volts DC.</li> <li>2. Is ECM J2 connector fully mated?</li> </ol>	<p>EHT sensor is bad. Replace EFI wire harness.</p> <p><b>NOTE:</b> EHT sensor is an integral part of the EFI wire harness and is not sold separately.</p>	Connect connector.

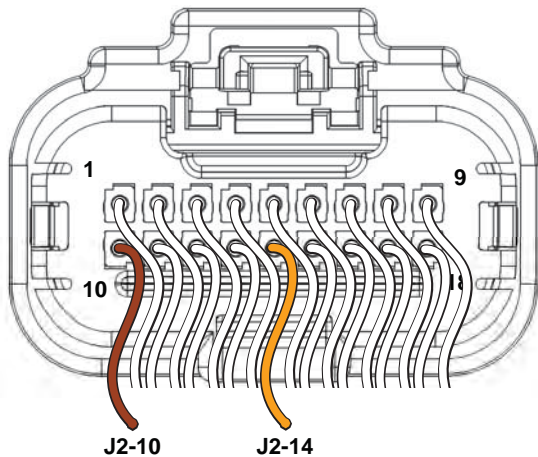


Figure 2-21 ECM J2 Connector (Black).

## DTC P0118 Engine Head Temperature (EHT) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>Temperature</b> heading, observe EHT Sensor Actual display with or without the engine running. 3. Is reading 0.5-4.5 volts DC?	EHT sensor circuit OK.	Go to step 2.
2	Is reading above 4.5 volts DC?	Go to DTC P0118 Non-Scan Diagnostics.	-

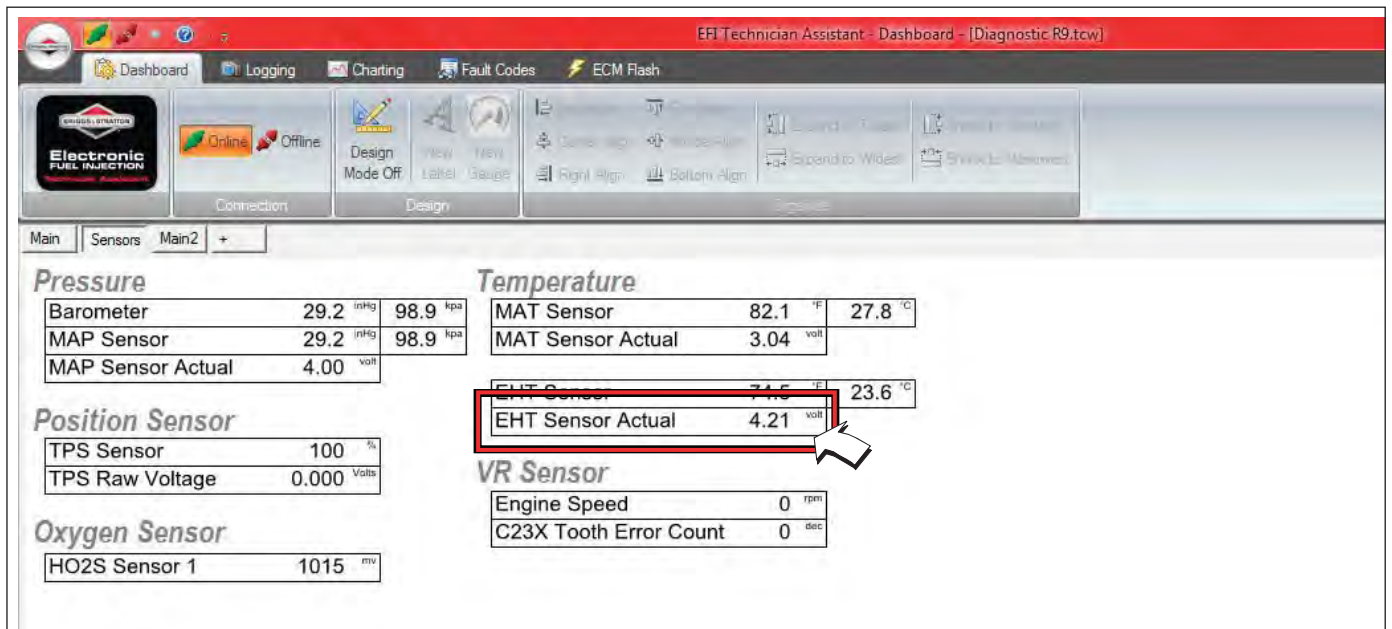


Figure 2-22 Check EHT Sensor Actual Display.

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

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect ECM J2 (Black) connector.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal J2-14 (Tan wire) of ECM connector.</li> <li>3. Connect terminal J2-14 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal J2-10 (Brown wire) of ECM connector.</li> <li>5. Connect terminal J2-10 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Observe voltage on DVOM.</li> <li>9. Is reading 0.5 - 4.5 volts DC?</li> </ol>	EHT sensor OK.	<p style="text-align: center;">Reading is above 4.5 volts DC. EHT sensor is bad.</p> <p style="text-align: center;">Replace EFI wire harness. <b>NOTE:</b> EHT sensor is an integral part of the EFI wire harness and is not sold separately.</p>

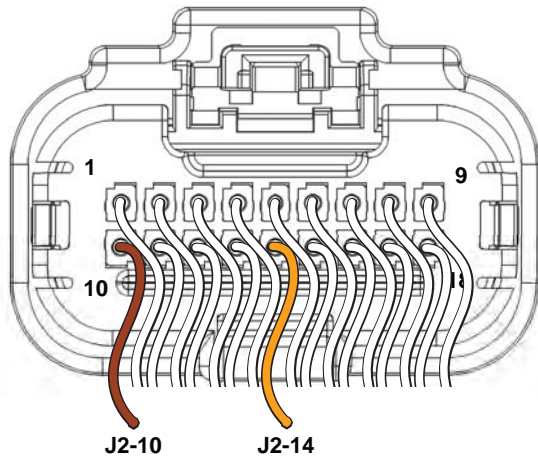
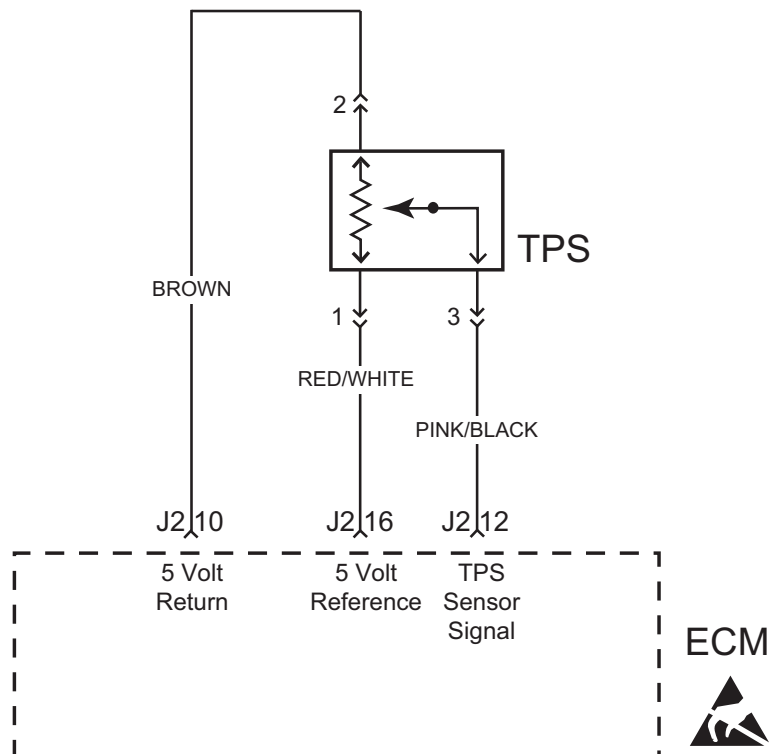


Figure 2-23 ECM J2 Connector (Black).



## DTC P0122/P0123 Throttle Position Sensor (TPS) Signal Voltage Low, Open or High

### Circuit Description

The TPS is a potentiometer connected to the throttle shaft on the throttle body. The ECM calculates throttle position by monitoring voltage on the signal circuit. As the throttle angle changes, the TPS signal also changes. At a closed throttle position, the voltage output of the TPS is low, but as the throttle opens, the voltage output increases.

### Diagnostic Aids

Check for the following conditions:

1. Poor ECM connection. Inspect wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
2. Damaged wire harness and/or connectors. If harness appears to be OK, shake or wiggle wire harness and/or connector with DVOM or ETA connected. Radical voltage changes or a change in the TPS display can indicate the location of the fault condition.

Always clear DTCs after performing repairs.



## DTC P0122 Throttle Position Sensor (TPS) Scan Diagnostics

Step	Action	Yes	No
1	<ol style="list-style-type: none"> <li>1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab.</li> <li>2. Under <b>Position Sensor</b> heading, observe TPS Raw Voltage display with or without the engine running.</li> <li>3. Is reading 0.5-4.5 volts DC?</li> </ol>	TPS circuit OK.	Go to step 2.
2	Is reading below 0.5 volts DC?	Go to DTC P0122 Non-Scan Diagnostics.	-

The screenshot shows the 'EHT Technician Assistant - Dashboard - [Diagnostic R9.tcw]' interface. The 'Sensors' tab is active, and the 'Position Sensor' section is expanded. The 'TPS Raw Voltage' is displayed as 0.723 Volts, which is circled in red with a white arrow pointing to it. Other sensor data is visible in the background.

Pressure		Temperature	
Barometer	29.2 inHg / 98.8 kpa	MAT Sensor	79.5 °F / 26.4 °C
MAP Sensor	29.5 inHg / 100. kpa	MAT Sensor Actual	3.10 volt
MAP Sensor Actual	4.00 volt	EHT Sensor	73.6 °F / 23.1 °C
		EHT Sensor Actual	4.22 volt
Position Sensor		VR Sensor	
TPS Raw Voltage	0.723 Volts	Engine Speed	0 rpm
		C23X Tooth Error Count	0 dec
Oxygen Sensor			
HO2S Sensor 1	1015 mv		

Figure 2-24 Check TPS Raw Voltage Display.

## DTC P0122 Throttle Position Sensor (TPS) Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect TPS and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 2 (Brown wire) of TPS connector.</li> <li>3. Connect terminal 2 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal 1 (Red/White wire) of TPS connector.</li> <li>5. Connect terminal 1 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Does DVOM read 4.7-5.0 volts DC?</li> </ol>	Go to step 3.	Go to step 5.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 2, and back probe terminal 3 (Pink/Black wire) of TPS connector.</li> <li>3. Start and run engine at idle speed.</li> <li>4. Does DVOM read 0.5-0.75 volts DC?</li> </ol>	Go to step 4.	Reset TPS. See <i>TPS Removal/Installation/Adjustment</i> in Section 5.
<b>4</b>	<ol style="list-style-type: none"> <li>1. Manually move throttle slowly and steadily toward Wide Open Throttle position while observing voltage on DVOM.</li> <li>2. Does voltage steadily increase from 0.73 +/- 0.02 volts?</li> </ol>	TPS OK.	Reading is below 0.5 volts DC. Reset or replace TPS. See <i>TPS Removal/Installation/Adjustment</i> in Section 5.
<b>5</b>	<ol style="list-style-type: none"> <li>1. Not getting ground thru 5 volt return circuit.</li> <li>2. Are both TPS and ECM J2 (Black) connectors fully mated?</li> </ol>	Repair or replace EFI wire harness.	Connect connectors.

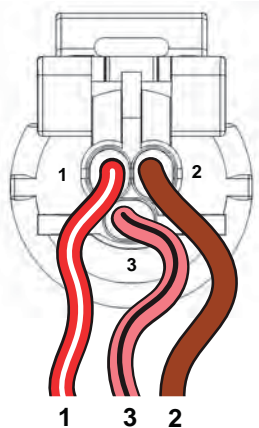


Figure 2-25 TPS Connector.

## DTC P0123 Throttle Position Sensor (TPS) Scan Diagnostics

Step	Action	Yes	No
1	<ol style="list-style-type: none"> <li>1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab.</li> <li>2. Under <b>Position Sensor</b> heading, observe TPS Raw Voltage display with or without the engine running.</li> <li>3. Is reading 0.5-4.5 volts DC?</li> </ol>	TPS circuit OK.	Go to step 2.
2	Is reading above 4.5 volts DC?	Go to DTC P0123 Non-Scan Diagnostics.	-

The screenshot shows the EFI Technician Assistant software interface. The 'Sensors' tab is active, and the 'Position Sensor' section is highlighted with a red box. A white arrow points to the 'TPS Raw Voltage' reading, which is 0.723 Volts. Other sensor readings are visible in the interface:

Pressure		Temperature	
Barometer	29.2 inHg / 98.8 kpa	MAT Sensor	79.5 °F / 26.4 °C
MAP Sensor	29.5 inHg / 100. kpa	MAT Sensor Actual	3.10 volt
MAP Sensor Actual	4.00 volt	EHT Sensor	73.6 °F / 23.1 °C
		EHT Sensor Actual	4.22 volt
Position Sensor		VR Sensor	
TPS Raw Voltage	0.723 Volts	Engine Speed	0 rpm
		C23X Tooth Error Count	0 dec
Oxygen Sensor			
HO2S Sensor 1	1015 mv		

Figure 2-26 Check TPS Raw Voltage Display.

## DTC P0123 Throttle Position Sensor (TPS) Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect TPS and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 2 (Brown wire) of TPS connector.</li> <li>3. Connect terminal 2 back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal 1 (Red/White wire) of TPS connector.</li> <li>5. Connect terminal 1 back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Does DVOM read 4.7-5.0 volts DC?</li> </ol>	Go to step 3.	Go to step 6.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal 2, and back probe terminal 3 (Pink/Black wire) of TPS connector.</li> <li>3. Start and run engine at idle speed.</li> <li>4. Does DVOM read 0.5-0.75 volts DC?</li> </ol>	Go to step 4.	Reset TPS. See <i>TPS Removal/Installation/Adjustment</i> in Section 5.
<b>4</b>	<ol style="list-style-type: none"> <li>1. Manually move throttle slowly and steadily toward Wide Open Throttle position while observing voltage on DVOM.</li> <li>2. Does voltage steadily increase from 0.73 +/- 0.02 volts?</li> </ol>	Go to step 5.	-
<b>5</b>	Does reading exceed 4.5 volts DC at any point?	Replace TPS.	-
<b>6</b>	<ol style="list-style-type: none"> <li>1. Not getting ground thru 5 volt return circuit.</li> <li>2. Are both TPS and ECM J2 (Black) connectors fully mated?</li> </ol>	Repair or replace EFI wire harness.	Connect connectors.

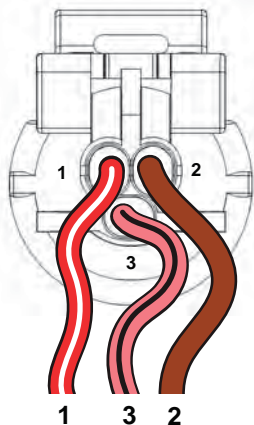
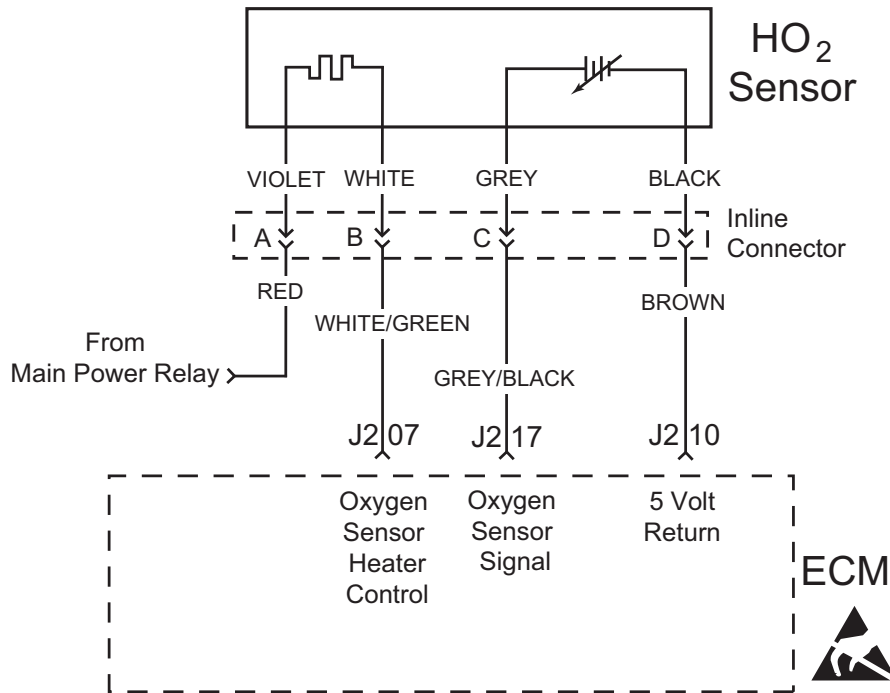


Figure 2-27 TPS Connector.



## DTC P0131/P0132 Heated Oxygen (HO<sub>2</sub>) Sensor Signal Voltage Low or High

### Circuit Description

The HO<sub>2</sub> sensor voltage varies 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 600°F (360°C). An open sensor circuit or cold sensor causes an open loop operation.

The sensor heater provides for 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.

An active DTC P0131 indicates that the sensor has developed an open circuit and is operating in Open Loop mode. DTC P0132 indicates circuit resistance is low and voltage being returned to the ECM is too high.

### Diagnostic Aids

Check for the following conditions:

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

Always clear DTCs after performing repairs.

## DTC P0131 Heated Oxygen (HO<sub>2</sub>) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Main</b> tab. 2. Observe HO2 Sensor display with or without the engine running. 3. Is reading 600-950 millivolts DC?	HO <sub>2</sub> sensor circuit OK.	Go to step 2.
2	Is reading below 600 millivolts DC?	Go to DTC P0131 Non-Scan Diagnostics.	-

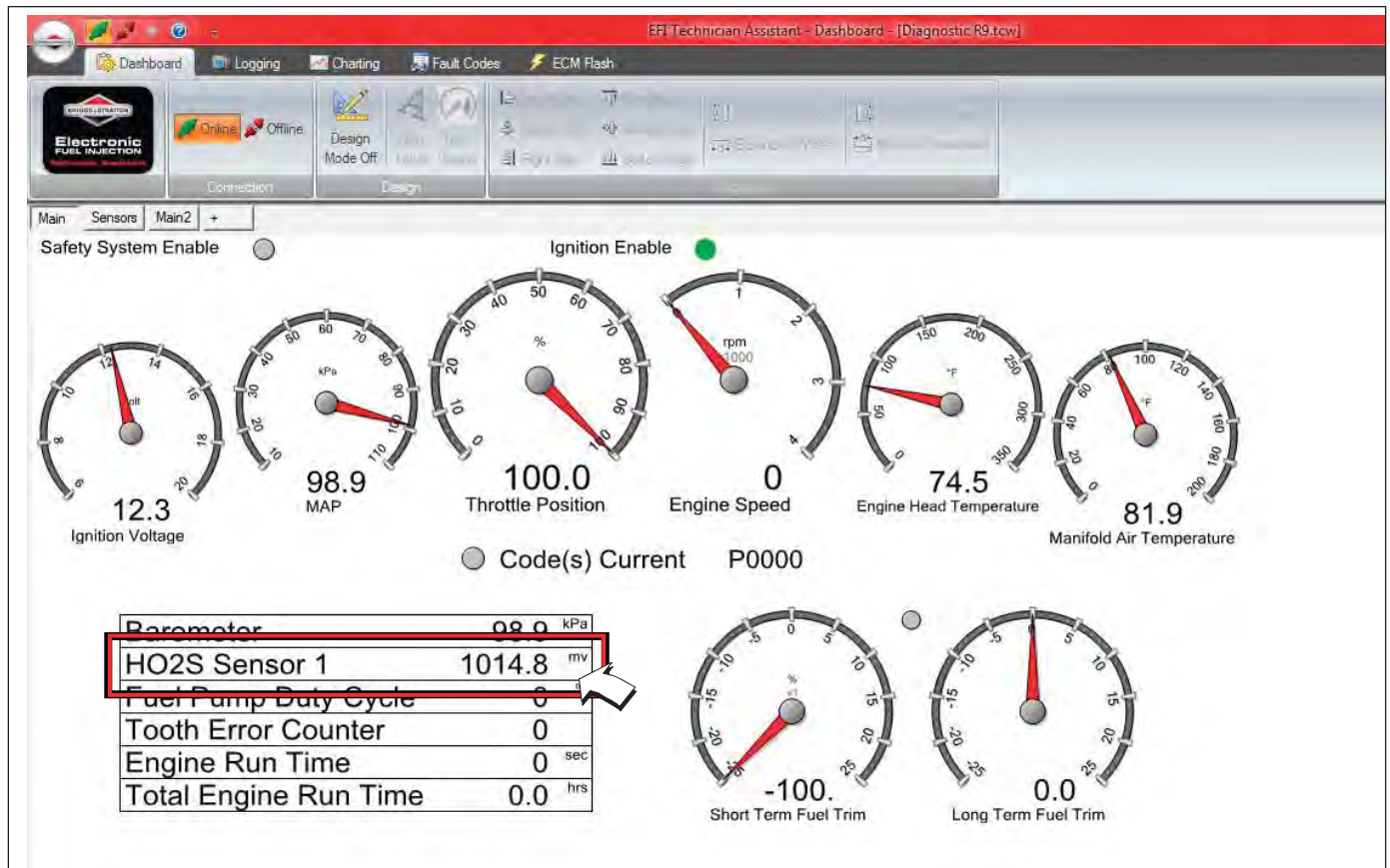


Figure 2-28 Check HO<sub>2</sub> Sensor Display.



## DTC P0131 Heated Oxygen (HO<sub>2</sub>) Sensor Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect HO<sub>2</sub> sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal C (Grey/Black wire) of HO<sub>2</sub> sensor connector.</li> <li>3. Connect terminal C back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal D (Brown wire) of HO<sub>2</sub> sensor connector.</li> <li>5. Connect terminal D back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Start and run engine for at least 2 minutes.</li> <li>8. With engine running, observe voltage on DVOM.</li> <li>9. Is reading 600 – 950 millivolts DC?</li> </ol>	HO <sub>2</sub> sensor OK.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal C, and back probe ECM connector terminal J2-17 (Grey/Black wire).</li> <li>3. Start and run engine.</li> <li>4. Observe voltage on DVOM.</li> <li>5. Is reading 600 – 950 millivolts DC?</li> </ol>	HO <sub>2</sub> sensor OK.	<p>Verify that both HO<sub>2</sub> sensor and ECM J2 (Black) connectors are fully mated.</p> <p><b>NOTE:</b> If reading is below 300 millivolts DC, inspect exhaust system for cracks or leaks between muffler and cylinder head (gaskets). If everything is OK, replace HO<sub>2</sub> sensor.</p>

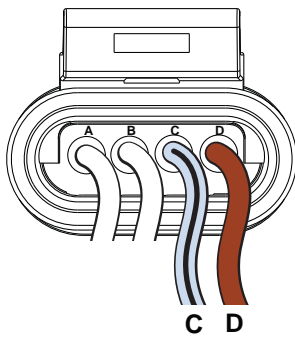


Figure 2-29 HO<sub>2</sub> Sensor Connector.

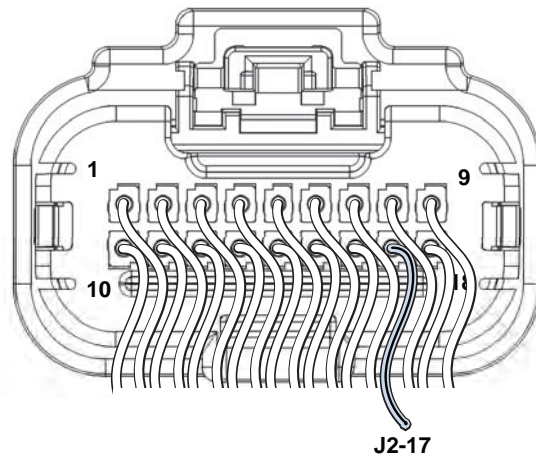


Figure 2-30 ECM J2 Connector (Black).



## DTC P0132 Heated Oxygen (HO<sub>2</sub>) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Main</b> tab. 2. Observe HO2 Sensor display with or without the engine running. 3. Is reading 600-950 millivolts DC?	HO <sub>2</sub> sensor circuit OK.	Go to step 2.
2	Is reading above 950 millivolts DC, but below 1014.8 millivolts DC?	Go to DTC P0132 Non-Scan Diagnostics.	-

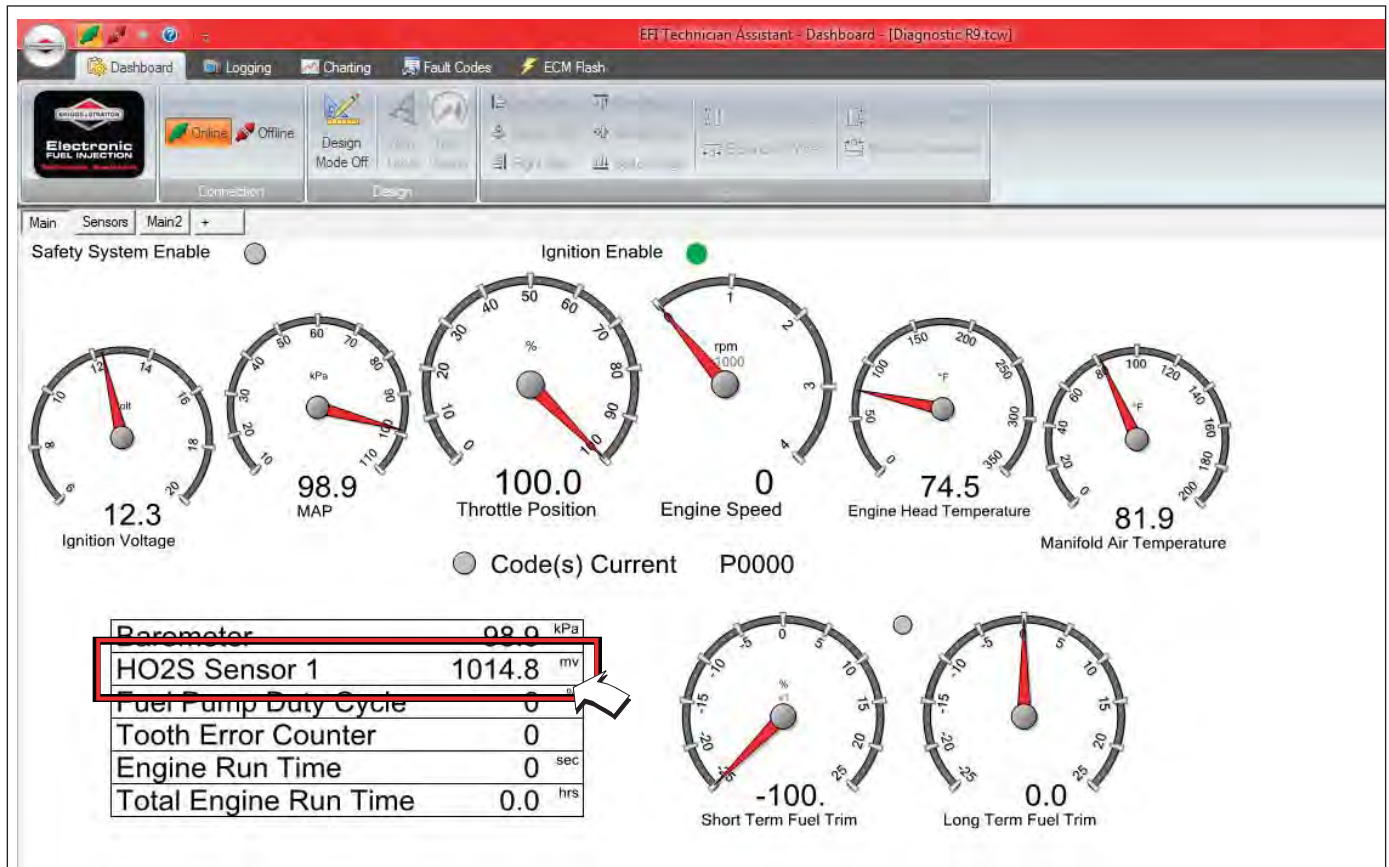


Figure 2-31 Check HO<sub>2</sub> Sensor Display.

## DTC P0132 Heated Oxygen (HO<sub>2</sub>) Sensor Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect HO<sub>2</sub> sensor and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal C (Grey/Black wire) of HO<sub>2</sub> sensor connector.</li> <li>3. Connect terminal C back probe to red meter test lead on DVOM.</li> <li>4. Back probe terminal D (Brown wire) of HO<sub>2</sub> sensor connector.</li> <li>5. Connect terminal D back probe to black meter test lead on DVOM.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Start and run engine for at least 2 minutes.</li> <li>8. With engine running, observe voltage on DVOM.</li> <li>9. Is reading 600 – 950 millivolts DC?</li> </ol>	HO <sub>2</sub> sensor OK.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal C, and back probe ECM connector terminal J2-17.</li> <li>3. Start and run engine.</li> <li>4. Observe voltage on DVOM.</li> <li>5. Is reading 600–950 millivolts DC?</li> </ol>	HO <sub>2</sub> sensor OK.	<p>Verify that both HO<sub>2</sub> sensor and ECM J2 connectors are fully mated.</p> <p><b>NOTE:</b> If reading is above 950 millivolts DC, replace HO<sub>2</sub> sensor or identify overly rich running condition.</p>

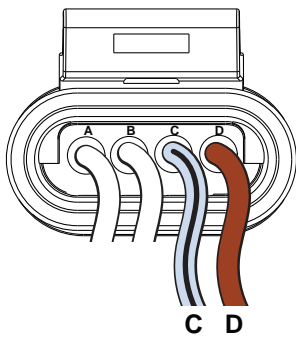


Figure 2-32 HO<sub>2</sub> Sensor Connector.

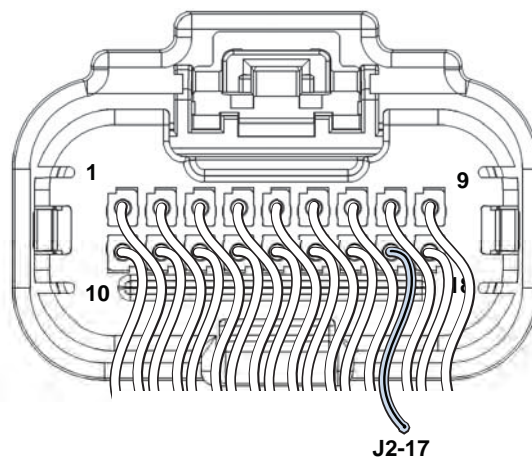


Figure 2-33 ECM J2 Connector (Black).

## DTC P0174 Power Enrichment (PE) Lean Fuel Condition Scan and Non-Scan Diagnostics

### Circuit Description

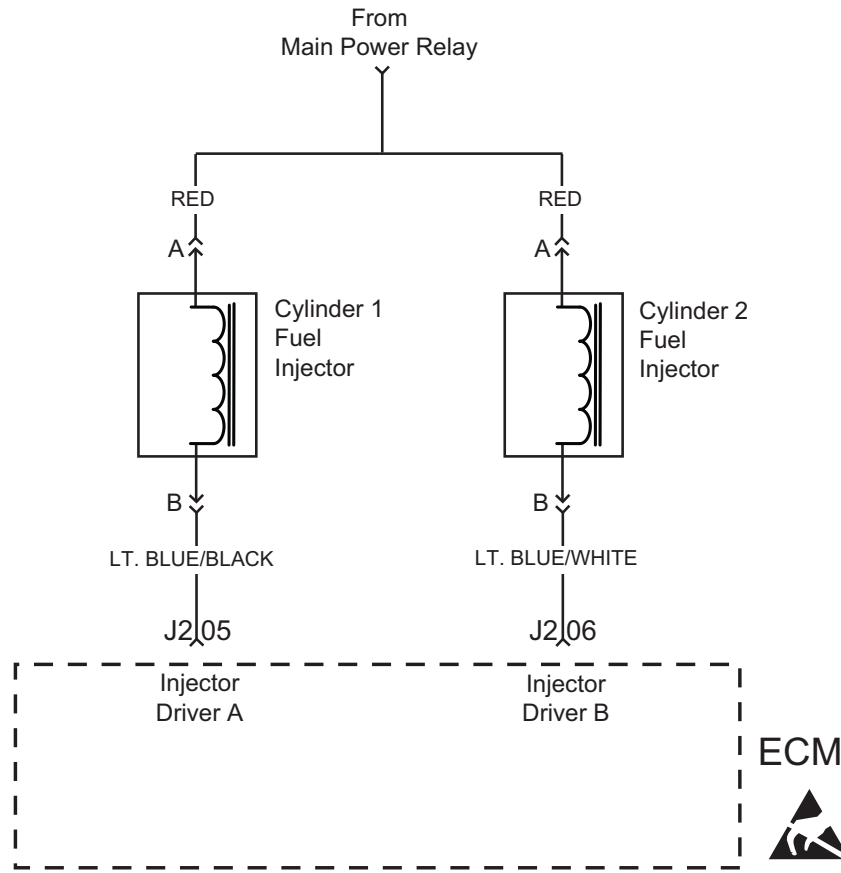
The PE mode is initiated in higher load running conditions. The ECM uses the MAP and CKP sensor inputs to know when to go into PE mode. PE fueling provides for optimal performance and maximum power. It also prevents against excessive exhaust valve and engine temperatures.

### Diagnostic Aids

If DTC P0174 is set, the ECM is detecting an overly lean condition under heavy load.

Always clear DTCs after performing repairs.

Step	Action	Yes	No
<b>1</b>	1. Check fuel filter and fuel lines for dirt, debris or other restriction. 2. Is a problem found?	Repair.	Go to step 2.
<b>2</b>	1. Check fuel pressure. 2. Is fuel pressure 38-43 psi (262-296 kPa)?	-	Go to step 3.
<b>3</b>	1. Verify that fuel filter is not clogged or restricted, and that fuel pump is operating properly (see <i>Mechanical Diaphragm Fuel Pump</i> or <i>Electric Lift Fuel Pump, Volumetric Test</i> , in Section 5). 2. Is a problem found?	Repair.	Go to step 4.
<b>4</b>	1. Check for vacuum and exhaust leaks. 2. Is a leak found?	Repair.	Go to step 5.
<b>5</b>	1. Check for faulty fuel injector(s). 2. Are faulty fuel injector(s) found?	Repair.	Go to step 6.
<b>6</b>	1. Replace faulty HO <sub>2</sub> sensor. 2. Is problem corrected?	-	Contact engine manufacturer.



## DTC P0201/P0202 Cylinder 1 or Cylinder 2 Fuel Injector Fault

### Circuit Description

The ECM controls each fuel injector by grounding the control circuit via a solid state device called a driver. If the ECM detects an unacceptable difference in resistance, a fuel injector control DTC is set.

Although the DTC indicates which fuel injector is faulty, the technician must determine if the fault is in the ground circuit or the +12v circuit from the MPR.

**NOTE:** If an ignition coil fault code is active, the fuel injector for the same cylinder is turned off.

### Diagnostic Aids

Check for the following conditions:

1. Poor ECM connection.
2. Inspect wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
3. Inspect wiring harness for damage.
4. Check fuse block for an open fuse.

Always clear DTCs after performing repairs.

## DTC P0201 Cylinder 1 Fuel Injector Fault

### Scan and Non-Scan Diagnostics

Step	Action	Yes	No
1	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect cylinder 1 fuel injector and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF. Clear codes.</li> <li>3. Turn Ignition OFF, and then back ON.</li> <li>4. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
2	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect fuel injector connector.</li> <li>3. Install Briggs &amp; Stratton Noid Light (Part No. 19623).</li> <li>4. Start and run engine.</li> <li>5. Does Noid Light flash?</li> </ol>	Replace fuel injector.	Go to step 3.
3	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove Noid Light and connect fuel injector connector.</li> <li>3. Back probe (using fused patch cord) terminal A (Red wire) of fuel injector connector.</li> <li>4. Connect terminal A back probe to red meter test lead on DVOM.</li> <li>5. Connect black meter test lead to a known good ground.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Go to step 4.	Reading is below 12.2 volts DC.  Perform visual and continuity check of Main Power Relay and 20 amp Battery fuse (Yellow).
4	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect fuel injector connector.</li> <li>3. Disconnect ECM J2 connector.</li> <li>4. Back probe terminal B (Lt. Blue/Black wire) of fuel injector connector.</li> <li>5. Connect terminal B back probe to red meter test lead on DVOM.</li> <li>6. Back probe terminal J2-05 (Lt. Blue/Black wire) of ECM J2 connector.</li> <li>7. Connect terminal J2-05 back probe to black meter test lead on DVOM.</li> <li>8. Set DVOM to read resistance.</li> <li>9. Does DVOM read less than 0.5 ohms?</li> </ol>	Control circuit is OK.	Reading is above 0.5 ohms. Check terminals for corrosion or replace EFI wire harness.  <b>NOTE:</b> If DTC still present after replacement of EFI wire harness, then replace ECM due to failed injector driver.

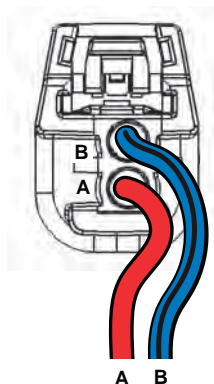


Figure 2-34 Cylinder 1 Fuel Injector Connector.

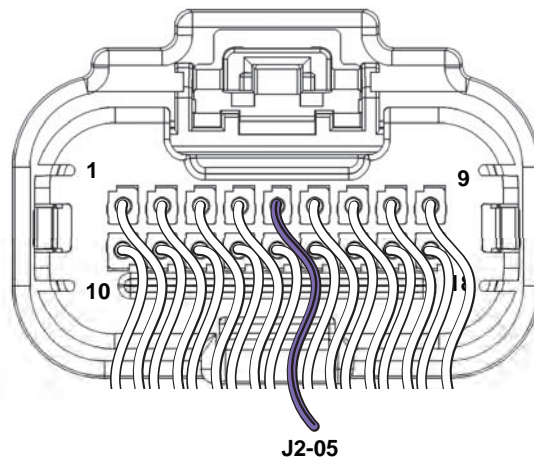


Figure 2-35 ECM J2 Connector (Black).

## DTC P0202 Cylinder 2 Fuel Injector Fault Scan and Non-Scan Diagnostics

Step	Action	Yes	No
1	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect cylinder 2 fuel injector and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF. Clear codes.</li> <li>3. Turn Ignition OFF, and then back ON.</li> <li>4. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
2	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect fuel injector connector.</li> <li>3. Install Briggs &amp; Stratton Noid Light (Part No. 19623).</li> <li>4. Start and run engine.</li> <li>5. Does Noid Light flash?</li> </ol>	Replace fuel injector.	Go to step 3.
3	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove Noid Light and connect fuel injector connector.</li> <li>3. Back probe (using fused patch cord) terminal A (Red wire) of fuel injector connector.</li> <li>4. Connect terminal A back probe to red meter test lead on DVOM.</li> <li>5. Connect black meter test lead to a known good ground.</li> <li>6. Set DVOM to read volts DC.</li> <li>7. Turn Ignition ON, Engine OFF.</li> <li>8. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Go to step 4.	<p style="text-align: center;">Reading is below 12.2 volts DC.</p> <p>Perform visual and continuity check of Main Power Relay and 20 amp Battery fuse (Yellow).</p>
4	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect fuel injector connector.</li> <li>3. Disconnect ECM J2 connector.</li> <li>4. Back probe terminal B (Lt. Blue/White wire) of fuel injector connector.</li> <li>5. Connect terminal B back probe to red meter test lead on DVOM.</li> <li>6. Back probe terminal J2-06 (Lt. Blue/ White wire) of ECM J2 connector.</li> <li>7. Connect terminal J2-06 back probe to black meter test lead on DVOM.</li> <li>8. Set DVOM to read resistance.</li> <li>9. Does DVOM read less than 0.5 ohms?</li> </ol>	Control circuit is OK.	<p>Reading is above 0.5 ohms. Check terminals for corrosion or replace EFI wire harness.</p> <p><b>NOTE:</b> If DTC still present after replacement of EFI wire harness, then replace ECM due to failed injector driver.</p>

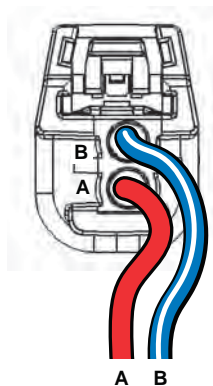


Figure 2-36 Cylinder 2 Fuel Injector Connector.

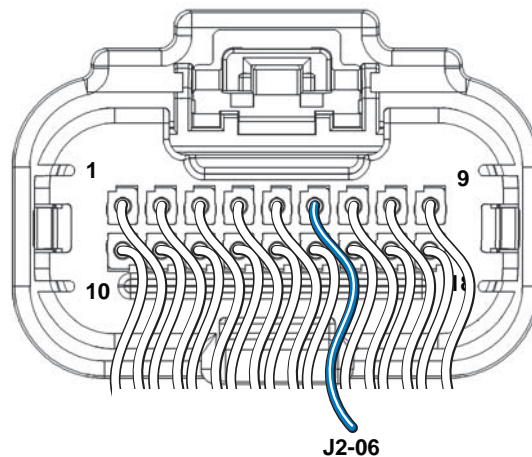
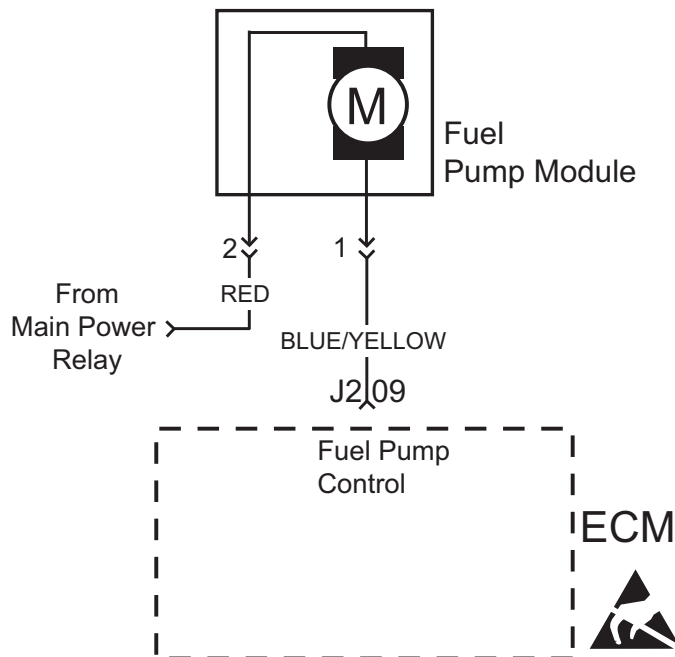


Figure 2-37 ECM J2 Connector (Black).





## DTC P0230/P0232 Fuel Pump Fault Signal Voltage Low, Open or High

### Circuit Description

The fuel pump is controlled by the ECM via the ground circuit of the fuel pump plug. If resistance is unacceptable in that circuit the fuel pump DTC is set.

- DTC 230 shows that the signal voltage is low, which indicates voltage is lost to the pump, high circuit resistance, or open connection.
- DTC 232 indicates that higher than expected voltage is seen on the circuit, which means that the fuel pump is not providing enough resistance or is turning too slowly.

When the ignition switch is turned ON, the ECM activates the electric fuel pump module. The fuel pump module remains ON as long as the ECM receives reference pulses from the CKP 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 fuel injectors.

### Diagnostic Aids

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

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

Always clear DTCs after performing repairs.



## DTC P0230 Fuel Pump Fault Scan and Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect fuel pump module and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF, and then back ON.</li> <li>2. Does fuel pump run for 2 seconds?</li> </ol>	Fuel pump module OK.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 2 (Red wire) of fuel pump module connector.</li> <li>3. Connect terminal 2 back probe to red meter test lead on DVOM.</li> <li>4. Connect black meter test lead on DVOM to a known good ground.</li> <li>5. Set DVOM to read volts DC.</li> <li>6. Turn Ignition ON, Engine OFF.</li> <li>7. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Go to step 4.	Perform visual and continuity check of Main Power Relay and 20 amp Battery fuse (Yellow).
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect fuel pump module connector.</li> <li>3. Remove probe from terminal 2, and back probe terminal 1 (Blue/Yellow wire) of fuel pump module connector.</li> <li>4. Connect terminal 1 back probe to red meter test lead on DVOM.</li> <li>5. Disconnect ECM J2 connector.</li> <li>6. Back probe terminal J2-09 (Blue/Yellow wire) of ECM J2 connector.</li> <li>7. Connect terminal J2-09 back probe to black meter test lead on DVOM.</li> <li>8. Set DVOM to read resistance.</li> <li>9. Does DVOM read 0.5 ohm or less?</li> </ol>	Replace fuel pump module.	Resistance reading is above 0.5 ohm.  Check terminals for corrosion or replace EFI wire harness.

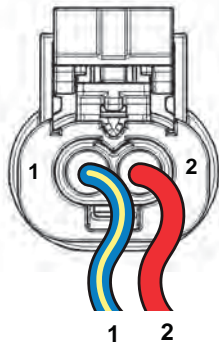


Figure 2-38 Fuel Pump Module Connector.

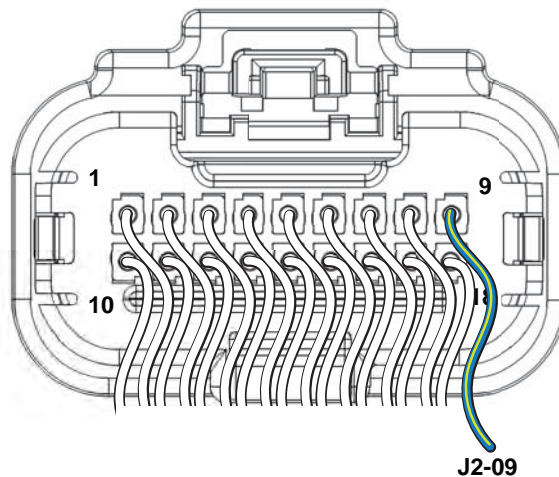


Figure 2-39 ECM J2 Connector (Black).

### DTC P0232 Fuel Pump Fault Scan and Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect fuel pump module connector.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal 1 (Blue/Yellow wire) of fuel pump module connector.</li> <li>3. Connect terminal 1 back probe to red meter test lead on DVOM.</li> <li>4. Connect black meter test lead on DVOM to a known good ground.</li> <li>5. Set DVOM to read volts DC.</li> <li>6. Attempt to start engine while observing voltage on DVOM.</li> <li>7. Is reading below 1.0 volts DC? <b>NOTE:</b> It is OK if engine starts.</li> </ol>	System performing OK.	Reading is above 1.0 volts DC.  Replace fuel pump module.

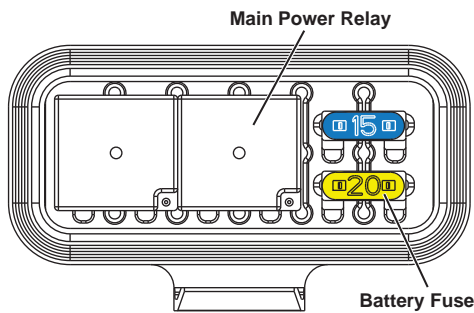


Figure 2-40 Fuse/Relay Block.

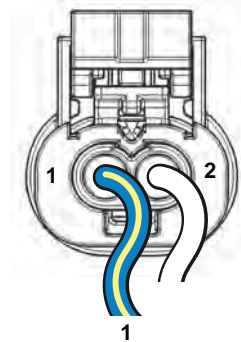
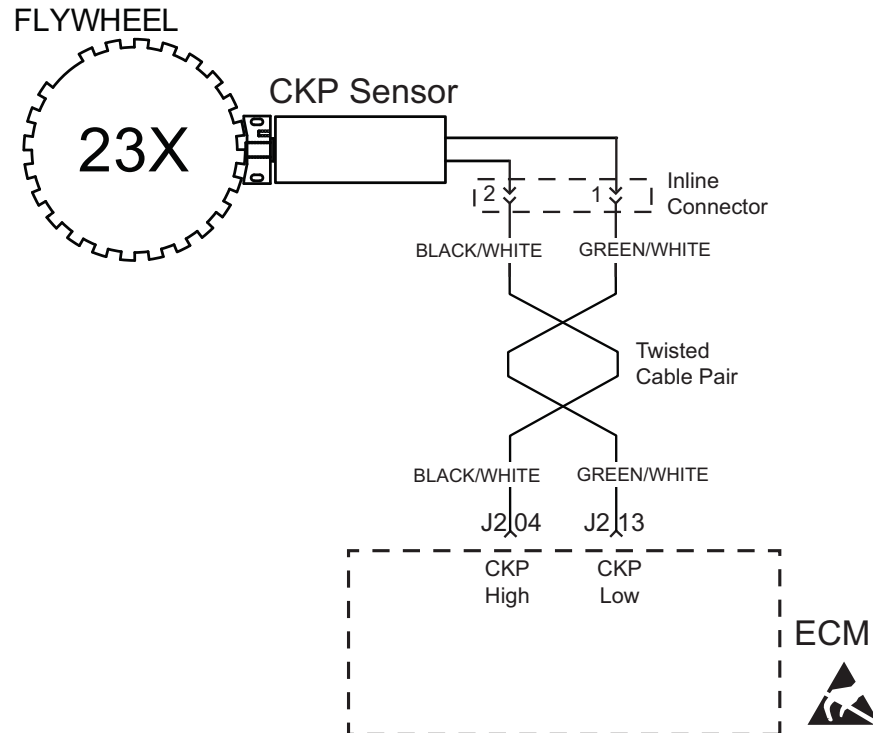


Figure 2-41 Fuel Pump Module Connector.



## DTC P0336/P0337 Crankshaft Position (CKP) Sensor Signal Voltage Noisy or Absent

### Modes of Operation

The 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 an internal sensor magnet. The CKP sensor internal circuitry detects this interruption, 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 sensor output signal to determine crankshaft speed and identify crankshaft position.

With the spark under control of the ECM, the engine will not run if the CKP sensor signal is lost. The ECM will not be able to determine which stroke the pistons are on.

### Diagnostic Aids

Check for the following conditions:

1. Verify that the CKP sensor is gapped at 0.030 inches (0.76 mm) from the target wheel.
2. Poor ECM connection. Inspect harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.

Always clear DTCs after performing repairs.

## DTC P0336 Crankshaft Position (CKP) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>VR Sensor</b> heading, observe the Tooth Error Count with or without the engine running. 3. Is reading below 20?	CKP sensor circuit OK.	Go to step 2.
2	Is reading 20 or above?	Go to DTC P0336 Non-Scan Diagnostics.	-

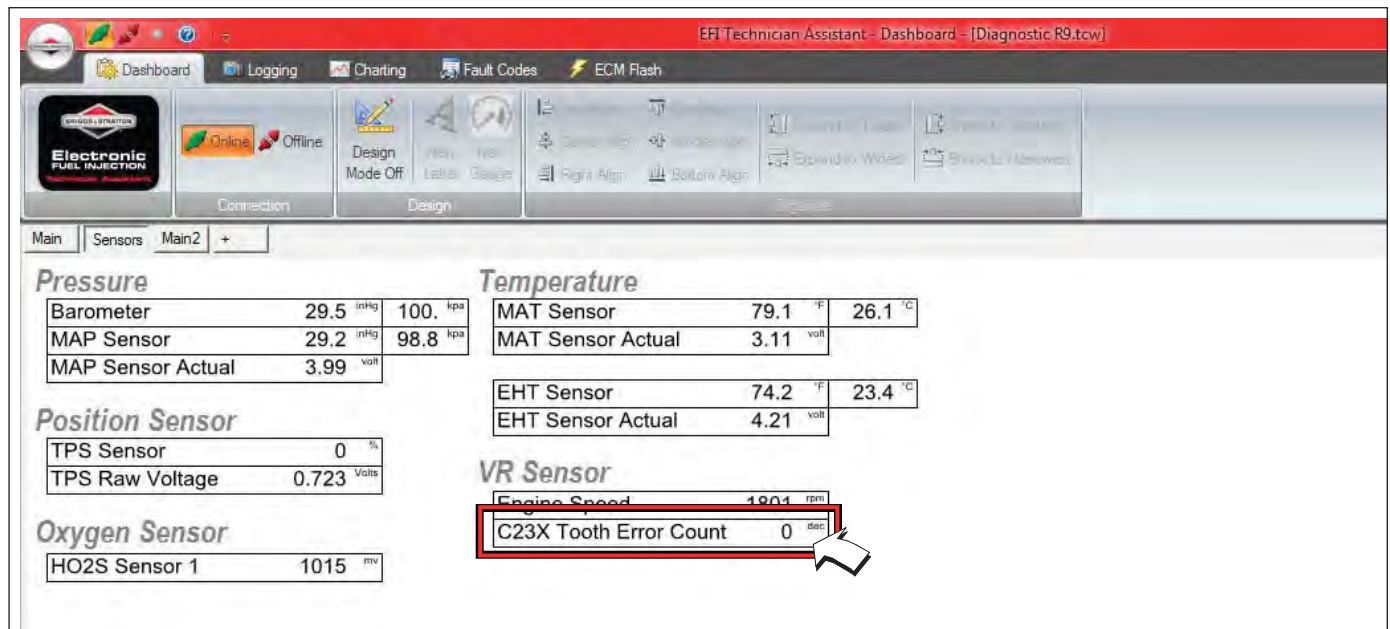


Figure 2-42 Check C23X Tooth Error Count Display.

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

Step	Action	Yes	No
1	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect CKP sensor connector.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
2	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Check CKP sensor air gap.</li> <li>3. Is CKP sensor air gap set at 0.030 inches (0.76 mm)?</li> </ol> <p><b>NOTE:</b> If air gap is too large, engine will likely backfire during cranking.</p>	Go to step 3.	Adjust as necessary.
3	<ol style="list-style-type: none"> <li>1. Obtain two Briggs &amp; Stratton Spark Testers (Part No. 19368).</li> <li>2. Install spark testers in line with high tension leads and spark plugs.</li> <li>3. Look for spark in tester windows while cranking engine.</li> <li>4. Is spark observed?</li> </ol>	Go to step 4.	Repair or replace spark plugs and/or high tension lead/ignition coil.
4	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Check valve lash adjustment.</li> <li>3. Is valve lash within specification?</li> </ol>	Go to step 5.	Adjust as necessary.
5	<ol style="list-style-type: none"> <li>1. Replace CKP sensor.</li> <li>2. Is problem corrected?</li> </ol>	-	Repair or replace EFI wire harness.



Figure 2-43 Spark Tester (Part No. 19368).

## DTC P0337 Crankshaft Position (CKP) Sensor Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Sensors</b> tab. 2. Under <b>VR Sensor</b> heading, observe Engine Speed display while cranking. 3. Is reading above zero?	CKP sensor circuit OK.	Go to DTC P0337 Non-Scan Diagnostics.

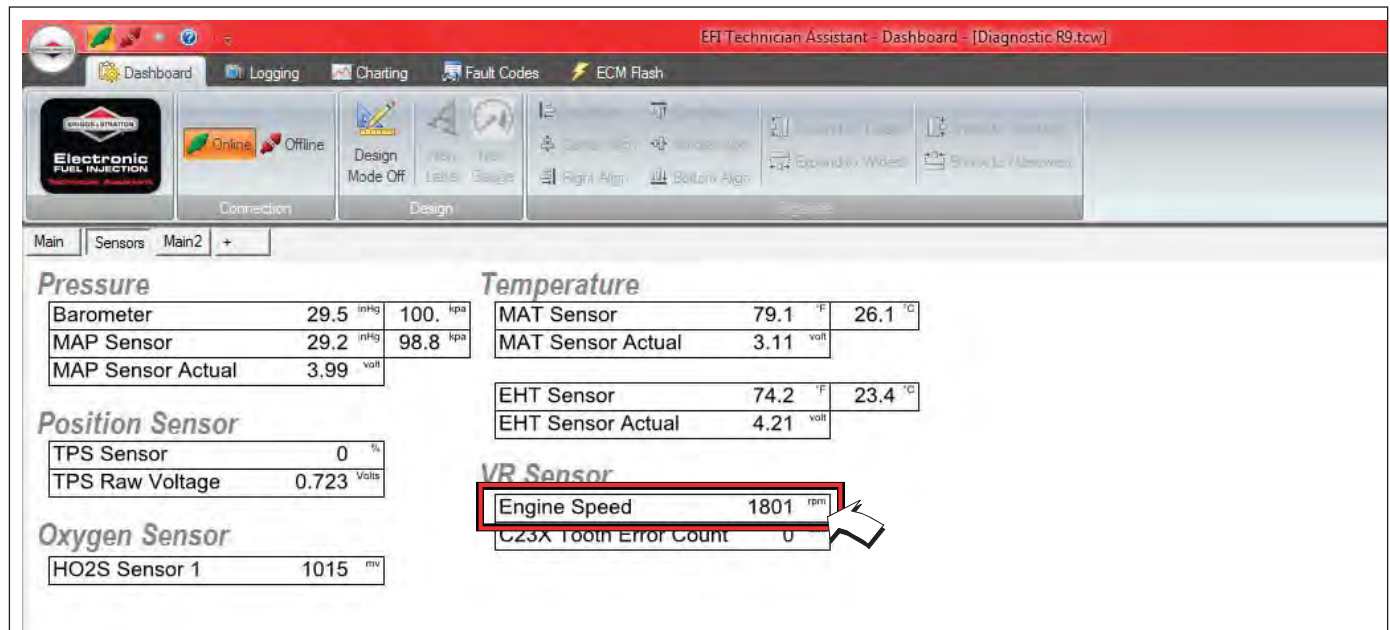


Figure 2-44 Check Engine Speed Display.



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

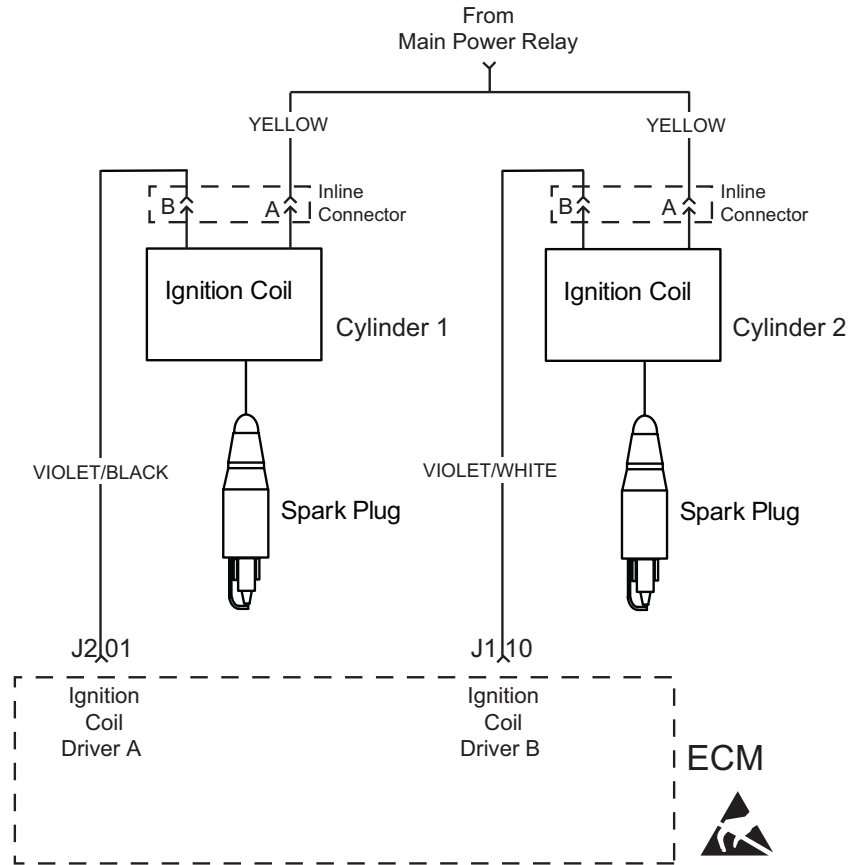
Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect CKP sensor connector.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect cylinder 1 fuel injector connector.</li> <li>3. Install Briggs &amp; Stratton Noid Light (Part No. 19623).</li> <li>4. Observe Noid Light while cranking engine.</li> <li>5. Does Noid Light flash?</li> </ol>	Go to step 3.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Obtain two Briggs &amp; Stratton Spark Testers (Part No. 19368).</li> <li>3. Install spark testers in line with high tension leads and spark plugs.</li> <li>4. Look for spark in tester windows while cranking engine.</li> <li>5. Is spark observed?</li> </ol>	Check CKP sensor connections.	Go to step 4.
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Replace CKP sensor.</li> <li>3. Is problem corrected?</li> </ol>	-	Repair or replace EFI wire harness.



Figure 2-45 Noid Light (Part No. 19623).



Figure 2-46 Spark Tester (Part No. 19368).



## DTC P0351/P0352 Cylinder 1 or Cylinder 2 Ignition Coil Fault

### Circuit Description

Each ignition coil has an ignition (B+ voltage) and a ground circuit. The ECM controls the ignition coil by completing the ground circuit as needed.

The DTCs indicate which ignition coil is faulty.

When an ignition coil fault is set, the ECM also shuts down the fuel injector for the same cylinder. The engine continues to run on one cylinder if no fault is set for the opposite cylinder.

### Diagnostic Aids

Check for the following conditions:

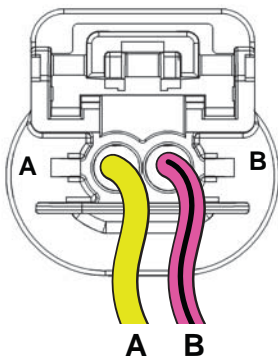
1. Poor ECM connection.
2. Inspect wire harness connectors for backed out terminals, improper mating, broken locks, improperly formed or damaged terminals, and poor terminal to wire connection.
3. Inspect wire harness for damage.
4. Check fuse block for an open fuse.

Always clear DTCs after performing repairs.

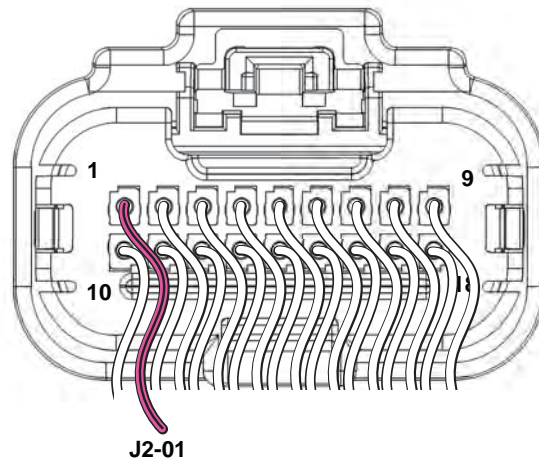
## DTC P0351 Cylinder 1 Ignition Coil Fault

### Scan and Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect cylinder 1 ignition coil and ECM J2 (Black) connectors.</li> <li>2. Turn Ignition ON, Engine OFF. Clear codes.</li> <li>3. Turn Ignition OFF, and then back ON.</li> <li>4. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect ignition coil connector.</li> <li>3. Install Briggs &amp; Stratton Noid Light (Part No. 19623).</li> <li>4. Observe Noid Light while cranking engine.</li> <li>5. Does Noid Light flash (but very dimly)?</li> </ol>	Circuit OK. Replace ignition coil.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe (using fused patch cord) terminal A (Yellow wire) of ignition coil connector.</li> <li>3. Connect terminal A back probe to red meter test lead on DVOM.</li> <li>4. Connect black meter test lead on DVOM to a known good ground.</li> <li>5. Set DVOM to read volts DC.</li> <li>6. Turn Ignition ON, Engine OFF.</li> <li>7. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Go to step 4.	<p style="text-align: center;">Reading is below 12.2 volts DC.</p> <p>Perform visual and continuity check of Main Power Relay and 20 amp Battery fuse (Yellow).</p>
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal A, and back probe terminal B (Violet/Black wire) of ignition coil connector.</li> <li>3. Connect terminal B back probe to red meter test lead on DVOM.</li> <li>4. Disconnect ECM J2 connector.</li> <li>5. Back probe terminal J2-01 (Violet/Black wire) of ECM J2 connector.</li> <li>6. Connect terminal J2-01 back probe to black meter test lead on DVOM.</li> <li>7. Set DVOM to read resistance.</li> <li>8. Does DVOM read 0.5 ohms or less?</li> </ol>	Replace ignition coil.	<p style="text-align: center;">Resistance reading is above 0.5 ohms.</p> <p>Repair or replace EFI wire harness.</p>



**A B**



**J2-01**

Figure 2-47 Cylinder 1 Ignition Coil Connector.

Figure 2-48 ECM J2 Connector (Black).

## DTC P0352 Cylinder 2 Ignition Coil Fault

### Scan and Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect cylinder 2 ignition coil and ECM J1 (Grey) connectors.</li> <li>2. Turn Ignition ON, Engine OFF. Clear codes.</li> <li>3. Turn Ignition OFF, and then back ON.</li> <li>4. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Disconnect ignition coil connector.</li> <li>3. Install Briggs &amp; Stratton Noid Light (Part No. 19623).</li> <li>4. Observe Noid Light while cranking engine.</li> <li>5. Does Noid Light flash (but very dimly)?</li> </ol>	Circuit OK. Replace ignition coil.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe (using fused patch cord) terminal A (Yellow wire) of ignition coil connector.</li> <li>3. Connect terminal A back probe to red meter test lead on DVOM.</li> <li>4. Connect black meter test lead on DVOM to a known good ground.</li> <li>5. Set DVOM to read volts DC.</li> <li>6. Turn Ignition ON, Engine OFF.</li> <li>7. Does DVOM read 12.2-13.5 volts DC?</li> </ol>	Go to step 4.	<p style="text-align: center;">Reading is below 12.2 volts DC.</p> <p>Perform visual and continuity check of Main Power Relay and 20 amp Battery fuse (Yellow).</p>
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Remove probe from terminal A, and back probe terminal B (Violet/White wire) of ignition coil connector.</li> <li>3. Connect terminal B back probe to red meter test lead on DVOM.</li> <li>4. Disconnect ECM J1 connector</li> <li>5. Back probe terminal J1-10 (Violet/White wire) of ECM J1 connector.</li> <li>6. Connect terminal J1-10 back probe to black meter test lead on DVOM.</li> <li>7. Set DVOM to read resistance.</li> <li>8. Does DVOM read 0.5 ohms or less?</li> </ol>	Replace ignition coil.	<p style="text-align: center;">Resistance reading is above 0.5 ohms.</p> <p>Repair or replace EFI wire harness.</p>

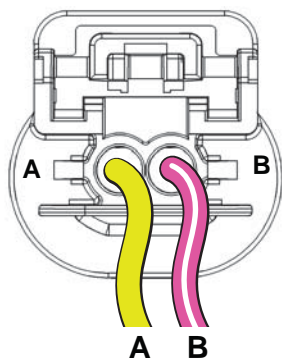


Figure 2-49 Cylinder 2 Ignition Coil Connector.

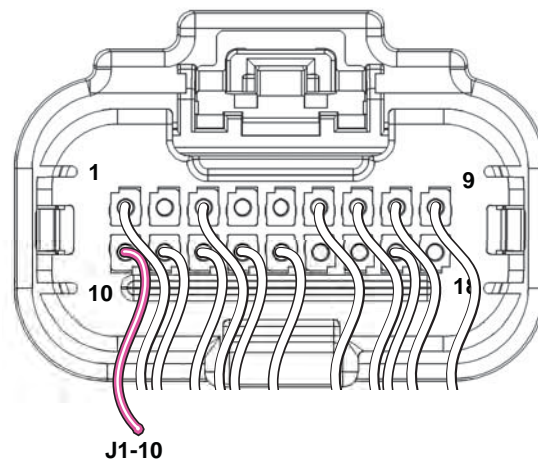
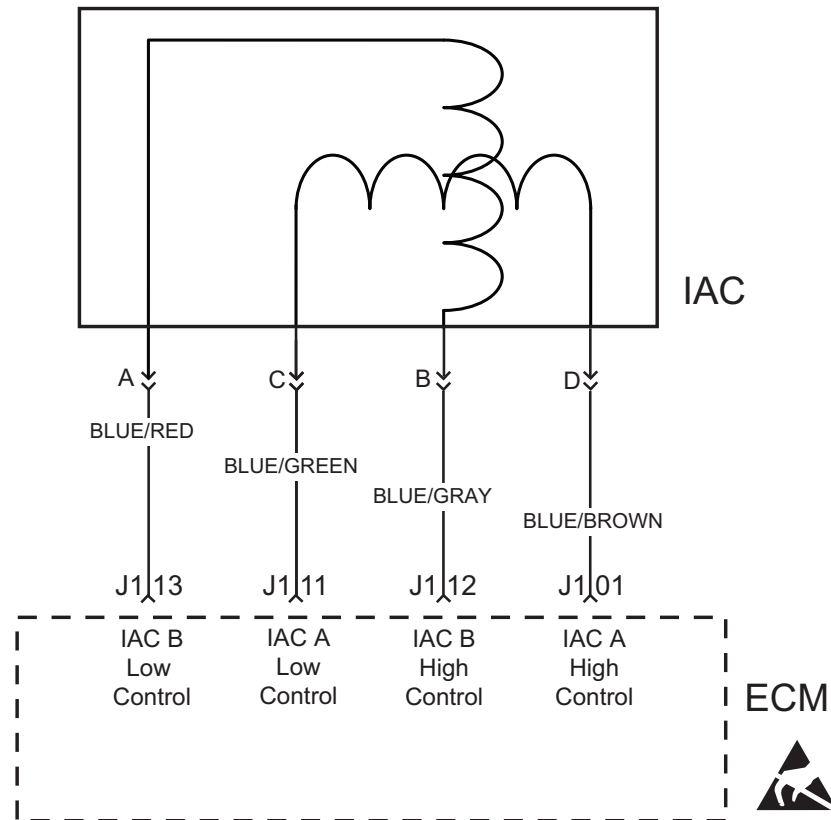


Figure 2-50 ECM J1 Connector (Grey).



## DTC P0505 Idle Air Control (IAC) Malfunction

### Circuit Description

The ECM controls idle speed to a calibrated RPM based on sensor inputs and actual engine RPM. The ECM uses four circuits to move the 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.
4. Check for a stuck IAC valve that will not respond to the ECM, a throttle stop screw that has been tampered with, or a damaged throttle body or linkage.

Always clear DTCs after performing repairs.

## DTC P0505 Idle Air Control (IAC) Malfunction Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Main</b> tab. 2. Observe Engine Speed display while idling. 3. Is reading 750-950 RPM?  <b>NOTE:</b> Cold engine temperatures and low battery voltages can cause high engine idle speeds. For example, at -18° F. (-28° C.), idle speed can be as high as 1350 RPM, while low battery voltages at normal engine operating temperatures can cause the engine idle speed to reach 1200 RPM.	IAC circuit OK.	Go to DTC P0505 Non-Scan Diagnostics.

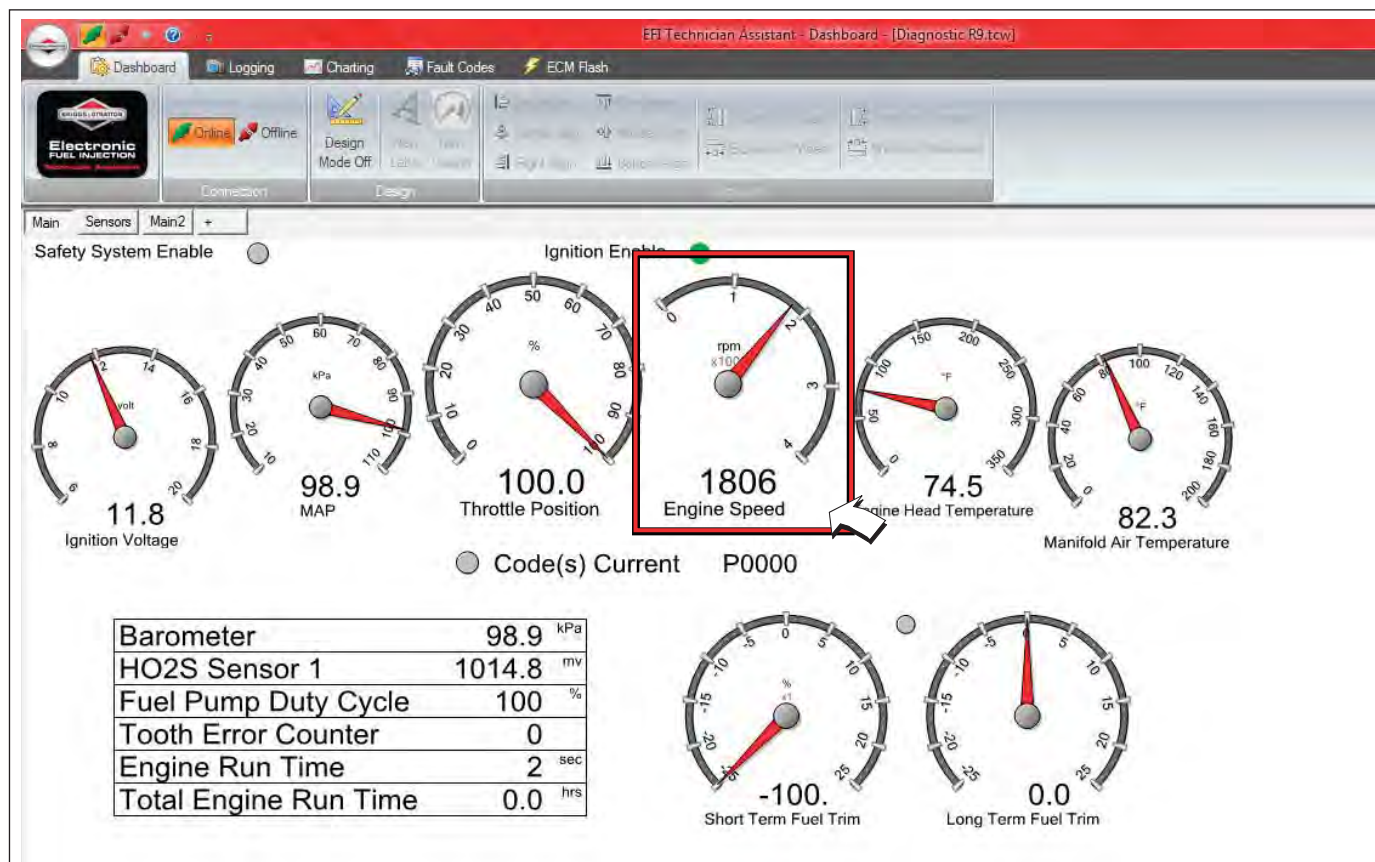


Figure 2-51 Check Engine Speed Display.



## DTC P0505 Idle Air Control (IAC) Malfunction Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	1. Disconnect and reconnect IAC and TPS connectors. 2. Turn Ignition ON, Engine OFF. 3. Clear codes. 4. Turn Ignition OFF, and then back ON. 5. Does DTC return?	Go to step 2.	Problem corrected.
<b>2</b>	1. Start engine and allow it to warm up for 5 minutes. 2. When engine idle speed is stabilized, use tachometer to record RPM. 3. Is tachometer reading 750-950 RPM? <b>NOTE:</b> Cold engine temperatures and low battery voltages can cause high engine idle speeds. For example, at -18° F. (-28° C.), idle speed can be as high as 1350 RPM, while low battery voltages at normal engine operating temperatures can cause the engine idle speed to reach 1200 RPM.	Look for intermittent conditions.	Go to step 3.
<b>3</b>	1. Turn Ignition OFF. 2. Back probe terminal 3 (Pink/Black wire) of TPS connector. 3. Connect terminal 3 back probe to red meter test lead on DVOM. 4. Connect black meter test lead on DVOM to a known good ground. 5. Set DVOM to read volts DC. 6. Start engine and run at idle speed. 7. Does DVOM read 0.5-0.75 volts DC?	Go to step 4.	Reset TPS. See <i>TPS Removal/Installation/Adjustment</i> in Section 5.
<b>4</b>	1. Turn Ignition OFF. 2. Remove IAC from throttle body and inspect for stuck pintel or carbon build up in IAC port. 3. Are either of these conditions found?	Clean or repair as necessary. Return to step 2 and repeat test procedure.	Inspect for intake tract leaks after the throttle body.

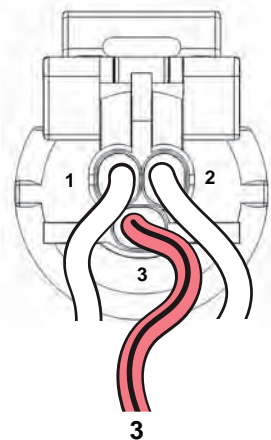
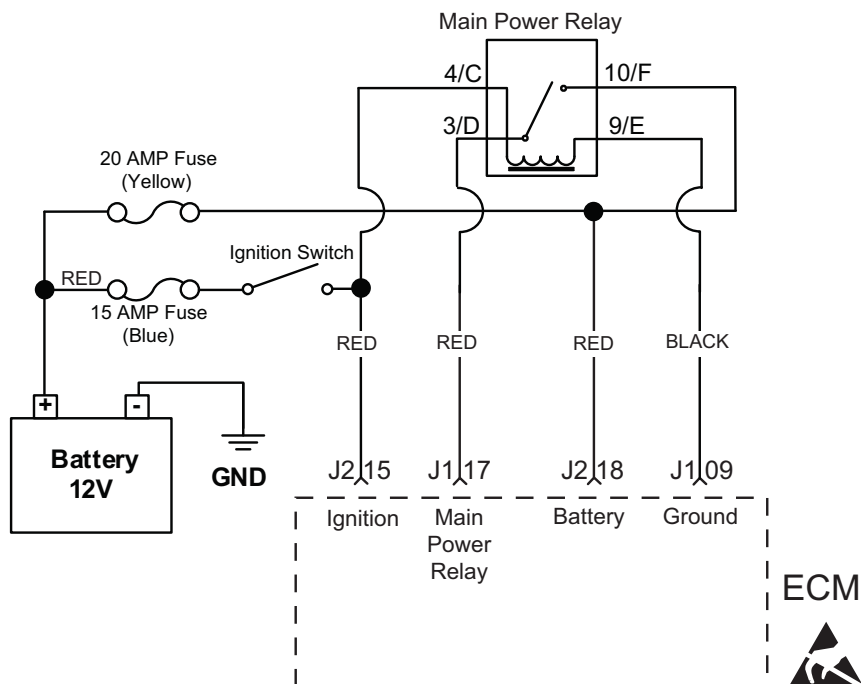


Figure 2-52 TPS Connector.





## DTC P0562/P0563 System Voltage Low or High

### Circuit Description

The EFI system operates with a battery voltage of 9-16 volts. If the system voltage drops below 6.2 volts the ECM will reset. During normal operation, the MIL is illuminated if the voltage is below 9 volts (setting P0562) or above 16 volts (setting P0563) for a specified amount of time.

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

Similarly, you should be able to measure battery voltage at terminal J2-15 with Ignition ON, Engine OFF.

To further diagnose system voltage faults, see Section 7 of the Briggs & Stratton Intek V-Twin Cylinder OHV Repair Manual.

### Diagnostic Aids

Check for the following conditions:

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

Always clear DTCs after performing repairs.

## DTC P0562 System Voltage Low Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Main2</b> tab. 2. Observe Ignition Voltage display with or without the engine running. 3. Is reading 9.0-15.0 volts DC?	System voltage OK.	Go to step 2.
2	Is reading below 9.0 volts DC?	Go to DTC P0562 Non-Scan Diagnostics.	-

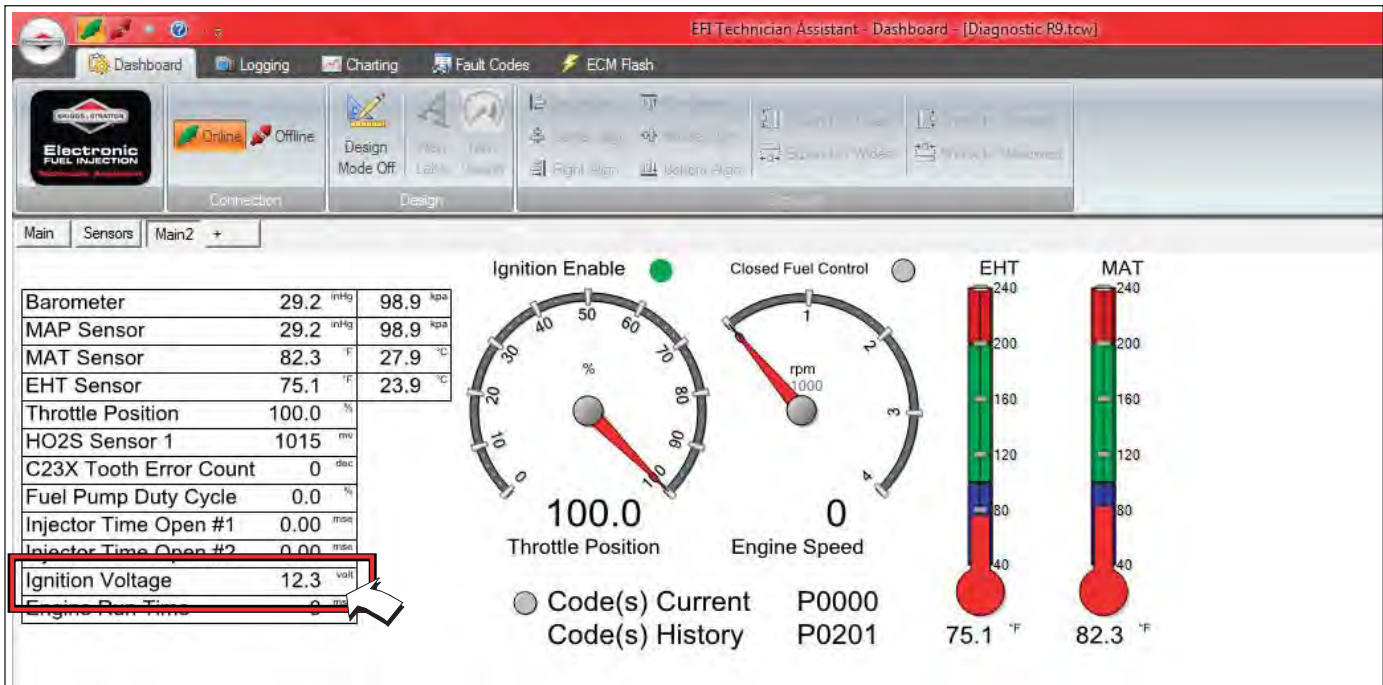


Figure 2-53 Check Ignition Voltage Display.

## DTC P0562 System Voltage Low Non-Scan Diagnostics (Page 1 of 2)

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect ECM J2 (Black) connector.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Connect red meter test lead on DVOM to battery positive (+) post.</li> <li>3. Connect black meter test lead on DVOM to battery negative (-) post.</li> <li>4. Set DVOM to read volts DC.</li> <li>5. Does DVOM read 12.2-14.5 volts DC?</li> </ol>	Go to step 3.	Go to step 5.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Back probe terminal J2-18 (Red wire) of ECM J2 connector.</li> <li>2. Connect terminal J2-18 back probe to red meter test lead on DVOM.</li> <li>3. Connect black meter test lead on DVOM to a known good ground.</li> <li>4. Turn Ignition ON, Engine OFF.</li> <li>5. Observe voltage on DVOM.</li> <li>6. Is reading within 0.5 volts of battery voltage?</li> </ol>	Go to step 4.	Go to step 8.
<b>4</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Back probe terminal J2-15 (Red wire) of ECM J2 connector.</li> <li>3. Connect terminal J2-15 back probe to red meter test lead on DVOM.</li> <li>4. Connect black meter test lead on DVOM to a known good ground.</li> <li>5. Turn Ignition ON, Engine OFF.</li> <li>6. Observe voltage on DVOM.</li> <li>7. Is voltage within 0.5 volt of battery voltage?</li> </ol>	Go to step 5.	Go to step 9.

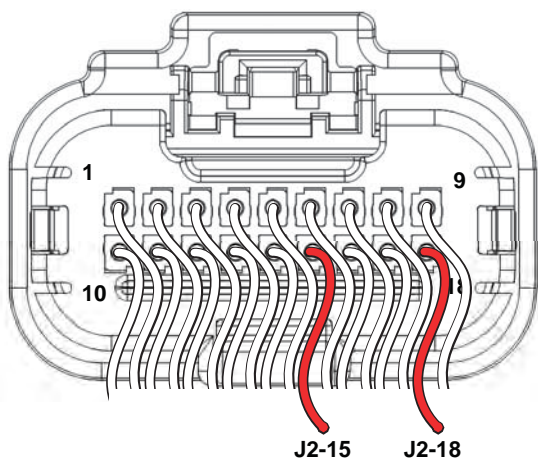


Figure 2-54 ECM J2 Connector (Black).

## DTC P0562 System Voltage Low Non-Scan Diagnostics (Page 2 of 2)

Step	Action	Yes	No
<b>5</b>	1. Check charging system. See the Briggs & Stratton Intek V-Twin Cylinder OHV Repair Manual. 2. Is charging system OK?	Go to step 7.	Go to step 6.
<b>6</b>	Repair charging system. See the Briggs & Stratton Intek V-Twin Cylinder OHV Repair Manual.	-	-
<b>7</b>	1. Check battery and cables for damage, corrosion, and loose connections. 2. Is a problem found?	Repair as necessary.	Replace battery.
<b>8</b>	1. Disconnect ECM J2 connector. 2. Back probe terminal J2-18 (Red wire) of ECM J2 connector. 3. Connect terminal J2-18 back probe to red meter test lead on DVOM. 4. Connect black meter test lead on DVOM to B+. 5. Set DVOM to read resistance. 6. Observe reading on DVOM. 7. Is resistance 0.5 ohms or less?	-	Repair as necessary.
<b>9</b>	1. Disconnect ECM J2 connector. 2. Back probe terminal J2-15 (Red wire) of ECM J2 connector. 3. Connect terminal J2-15 back probe to red meter test lead on DVOM. 4. Connect black meter test lead on DVOM to B+. 5. Set DVOM to read resistance. 6. Observe reading on DVOM. 7. Is resistance 0.5 ohms or less?	-	Repair as necessary.

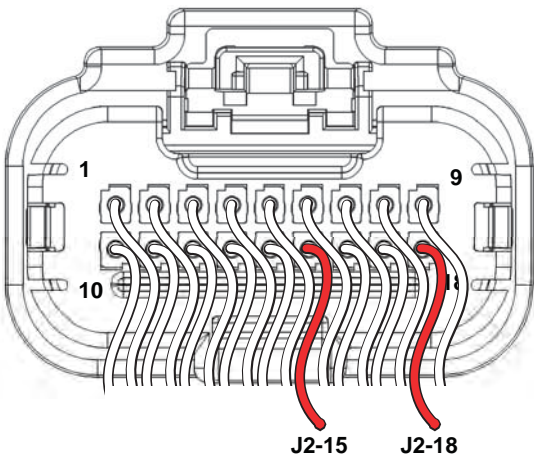


Figure 2-55 ECM J2 Connector (Black).

## DTC P0563 System Voltage High Scan Diagnostics

Step	Action	Yes	No
1	1. Select the <b>Dashboard</b> ribbon and then the <b>Main2</b> tab. 2. Observe Ignition Voltage display with or without the engine running. 3. Is reading 9.0-15.0 volts DC?	System voltage OK.	Go to step 2.
2	Is reading above 15.0 volts DC?	Go to DTC P0563 Non-Scan Diagnostics.	-

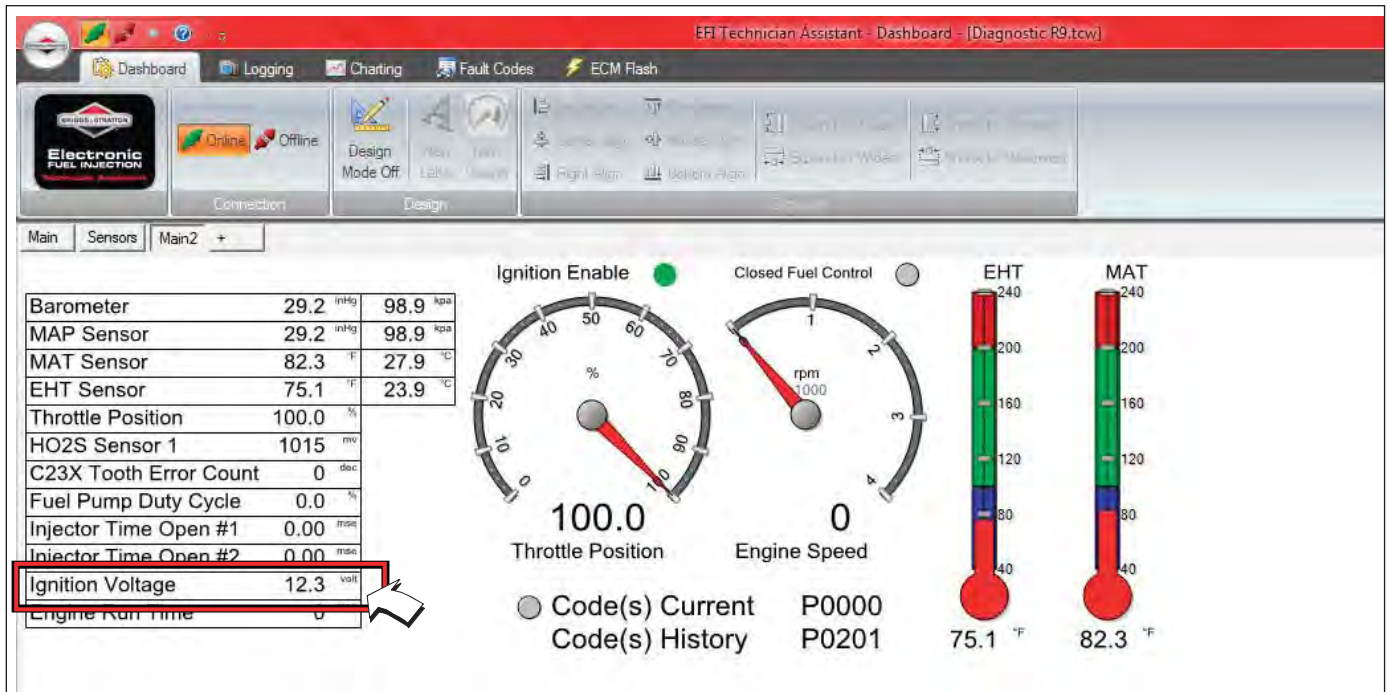
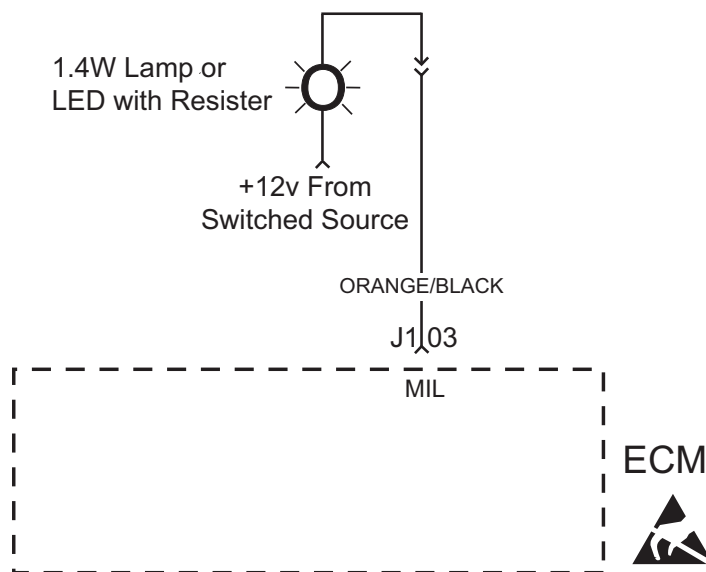


Figure 2-56 Check Ignition Voltage Display.

## DTC P0563 System Voltage High Non-Scan Diagnostics

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Connect red meter test lead on DVOM to battery positive (+) post.</li> <li>2. Connect black meter test lead on DVOM to battery negative (-) post.</li> <li>3. Set DVOM to read volts DC.</li> <li>4. Start and run engine at full speed (3600 RPM).</li> <li>5. Observe voltage on DVOM.</li> <li>6. Is reading 12.2-14.5 volts DC?</li> </ol>	System is OK.	Reading is above 15 volts. Check charging system. See the Briggs & Stratton Intek V-Twin Cylinder OHV Repair Manual.



## DTC P0650 Malfunction Indicator Lamp (MIL) Malfunction

### Circuit Description

The MIL gets 12v B+ when the ignition is in the ON or RUN position. The ECM completes a ground signal to illuminate the MIL with Ignition ON, Engine OFF. The ECM also completes the ground signal to activate the lamp if a DTC is set. If the malfunction clears, the lamp is extinguished and the DTC is stored in the ECM as a historic code.

### Diagnostic Aids

Check for the following conditions:

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

Always clear DTCs after performing repairs.



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

Step	Action	Yes	No
1	<ol style="list-style-type: none"> <li>1. Select the <b>Dashboard</b> ribbon and then the <b>Main</b> tab.</li> <li>2. Observe the Code(s) Current display.</li> <li>3. Does the display indicate that a current code exists?</li> </ol>	Go to step 3.	Go to step 2.
2	<ol style="list-style-type: none"> <li>1. Disconnect MAP sensor connector, ignition coil connector, or any other connector that will set a DTC. Start and run engine.</li> <li>2. Does the Code(s) Current display indicate that a current code exists?</li> </ol>	Go to step 3.	-
3	Is MIL illuminated?	System OK.	Go to DTC P0650 Non-Scan Diagnostics.

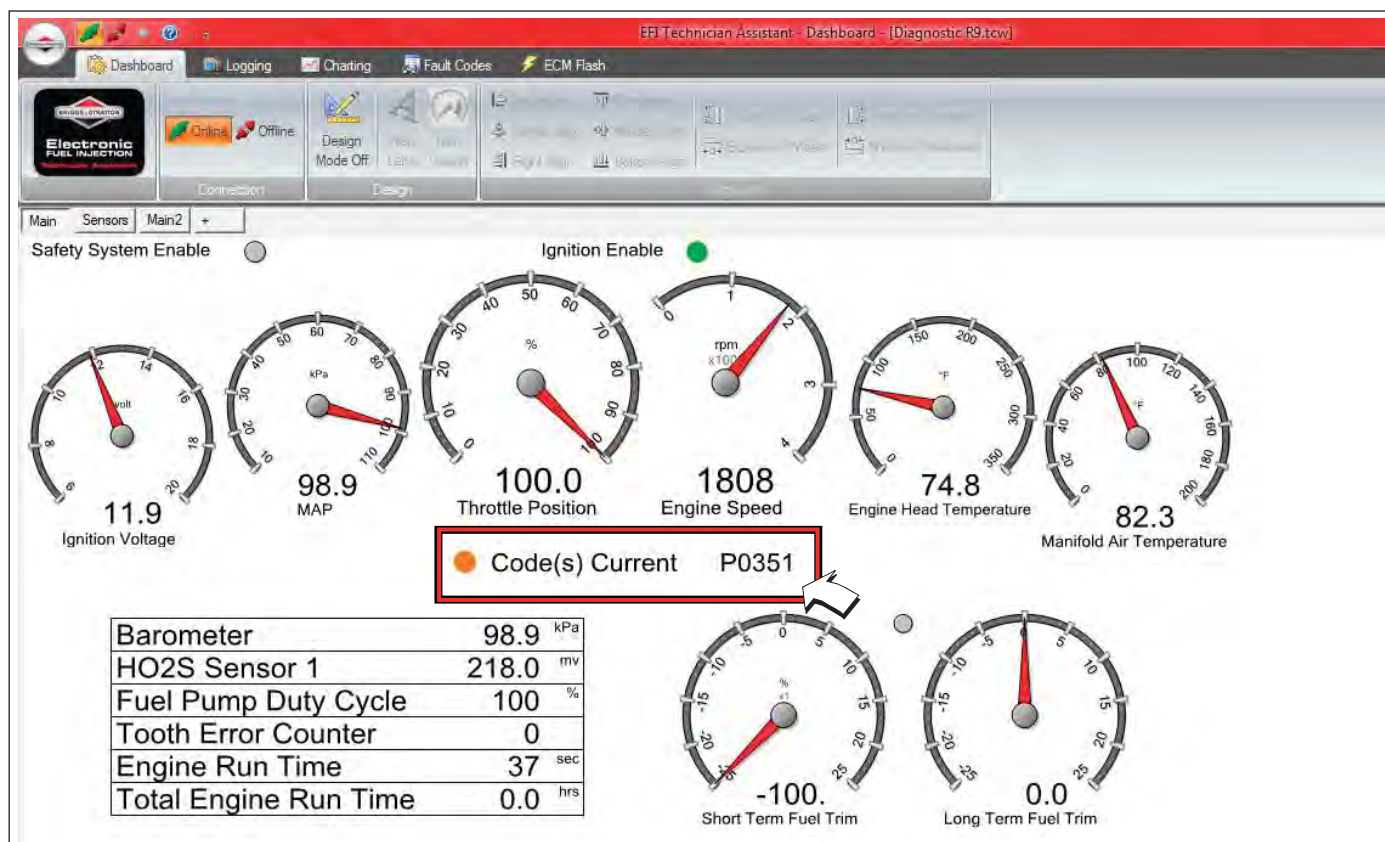


Figure 2-57 Check Code(s) Current Display.

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

Step	Action	Yes	No
<b>1</b>	<ol style="list-style-type: none"> <li>1. Disconnect and reconnect ECM J1 (Grey) connector.</li> <li>2. Turn Ignition ON, Engine OFF.</li> <li>3. Clear codes.</li> <li>4. Turn Ignition OFF, and then back ON.</li> <li>5. Does DTC return?</li> </ol>	Go to step 2.	Problem corrected.
<b>2</b>	<ol style="list-style-type: none"> <li>1. Turn Ignition OFF.</li> <li>2. Connect red meter test lead on DVOM to ignition side of MIL.</li> <li>3. Connect black meter test lead on DVOM to a known good ground.</li> <li>4. Set DVOM to read volts DC.</li> <li>5. Turn Ignition ON, Engine OFF.</li> <li>6. Observe voltage on DVOM.</li> <li>7. Is reading 12.2-14.5 volts DC?</li> </ol>	Go to step 4.	Go to step 3.
<b>3</b>	<ol style="list-style-type: none"> <li>1. Identify and locate voltage interruption between MIL and B+.</li> <li>2. Is interruption found?</li> </ol>	Repair as necessary.	Go to step 5.
<b>4</b>	<ol style="list-style-type: none"> <li>1. Check continuity of MIL.</li> <li>2. Is continuity good?</li> </ol>	Go to step 5.	Repair faulty MIL connections or replace faulty MIL.
<b>5</b>	<ol style="list-style-type: none"> <li>1. Back probe terminal J1-03 (Orange/Black wire) of ECM J1 connector.</li> <li>2. Connect terminal J1-03 back probe to red meter test lead on DVOM.</li> <li>3. Connect black meter test lead on DVOM to ignition side of MIL.</li> <li>4. Set DVOM to read resistance.</li> <li>5. Observe reading on DVOM.</li> <li>6. Is resistance 0.5 ohms or less?</li> </ol>	Repair faulty ECM connections or replace faulty ECM.	-

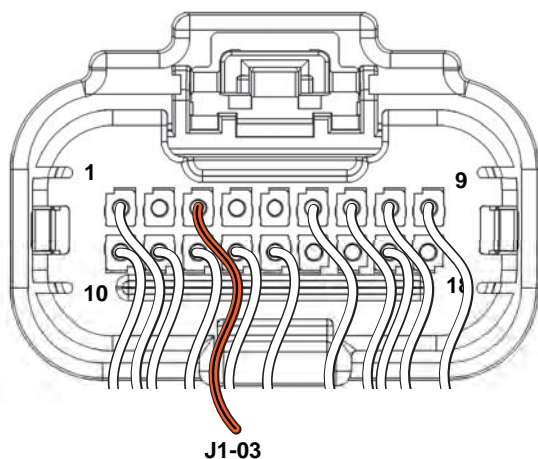


Figure 2-58 ECM J1 Connector (Grey).

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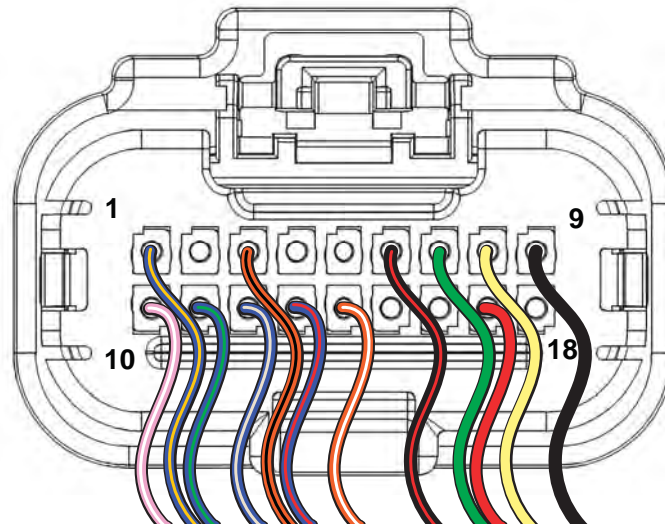
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## Section 3

### Wire Schematics and Pin-Outs

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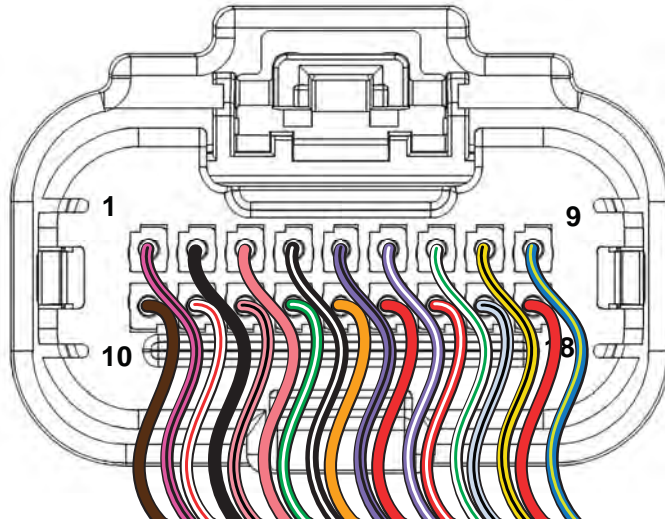
## ECM Connector J1 (Grey) Pin-Out



Connector-Pin Number	Wire Color	Function
J1-01	Blue/Brown	IAC HIGH "A" * Idle Air Control A High
J1-02	NOT USED	
J1-03	Orange/Black	MIL Malfunction Indicator Lamp
J1-04	NOT USED	
J1-05		
J1-06	Black/Red	Tachometer
J1-07	Green	CAN LOW Used for ECM Development only
J1-08	Yellow	CAN High Used only for ECM Development only
J1-09	Black	GROUND Power
J1-10	Violet/White	IGN COIL CYL 2 Engine Spark Timing Ignition Coil Cylinder 2
J1-11	Blue/Green	IAC LOW "A" * Idle Air Control A Low
J1-12	Blue/Grey	IAC HIGH "B" * Idle Air Control B High
J1-13	Blue/Red	IAC LOW "B" * Idle Air Control B Low
J1-14	Orange/White	Safety Interrupt Circuit
J1-15	NOT USED	
J1-16		
J1-17	Red	MPR Main Power Relay
J1-18	NOT USED	

\* If Equipped  
(See Table at Bottom of Page 11)

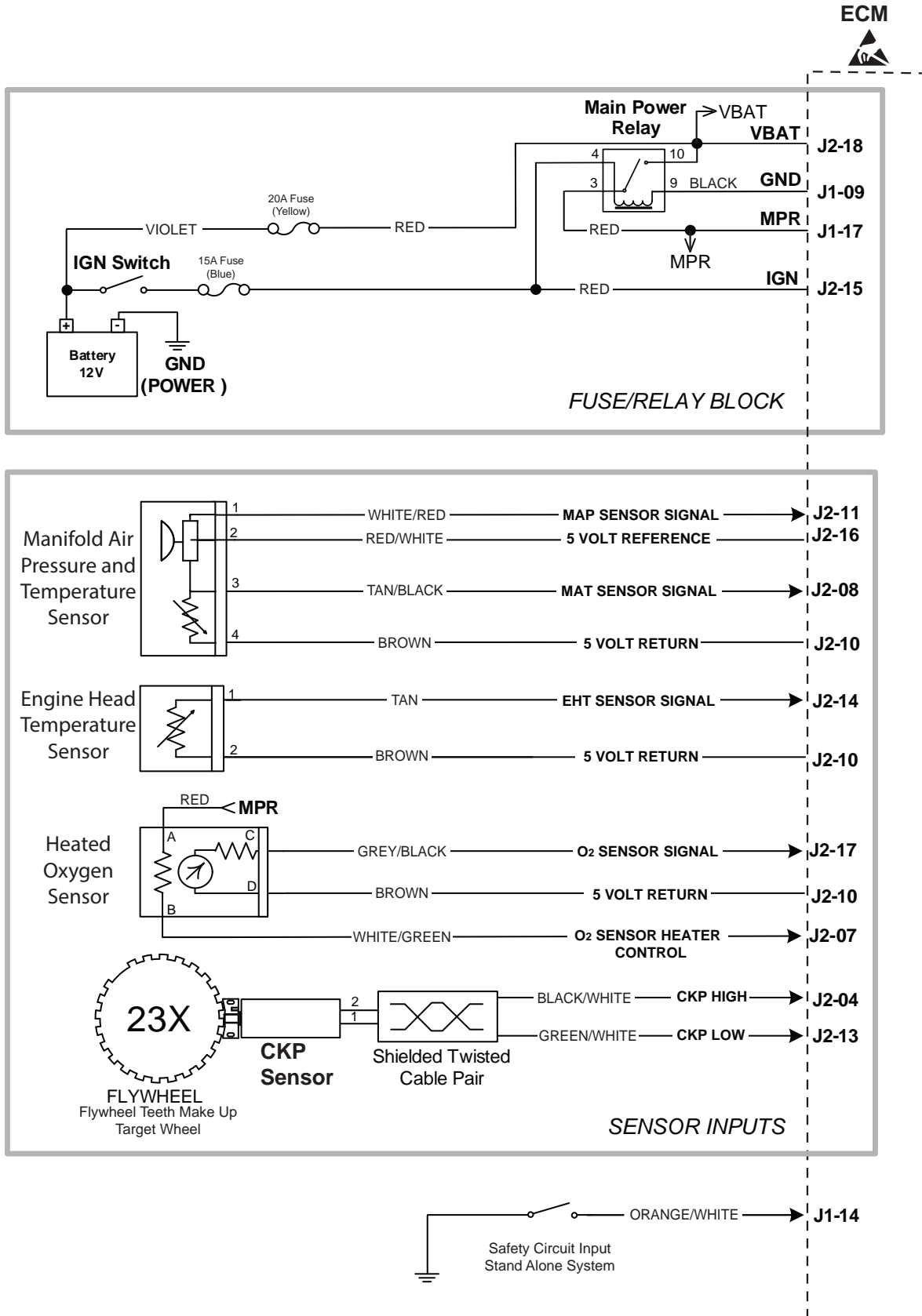
## ECM Connector J2 (Black) Pin-Out



Connector-Pin Number	Wire Color	Function
J2-01	Violet/Black	IGN COIL CYL 1 Engine Spark Timing Ignition Coil Cylinder 1
J2-02	Black	GROUND Power
J2-03	Pink	K-LINE Serial Data Diagnostic Communication
J2-04	Black/White	CKP High 23X
J2-05	Lt.Blue/Black	FUEL INJ CYL 1 Fuel Injector Cylinder 1
J2-06	Lt. Blue/White	FUEL INJ CYL 2 Fuel Injector Cylinder 2
J2-07	White/Green	HO <sub>2</sub> S HEATER CONTROL * Oxygen Sensor Heater
J2-08	Tan/Black	MAT Manifold Air Temperature Sensor
J2-09	Blue/Yellow	HIGH PRESSURE FUEL PUMP MODULE Fuel Pump
J2-10	Brown	5V RETURN 5 Volt Return
J2-11	White/Red	MAP Manifold Absolute Pressure Sensor
J2-12	Pink/Black	TPS * Throttle Position Sensor
J2-13	Green/White	CKP Low 23X
J2-14	Tan	EHT Engine Head Temperature Sensor
J2-15	Red	IGN Ignition
J2-16	Red/White	5V REFERENCE 5 Volt Reference
J2-17	Grey/Black	HO <sub>2</sub> S SIGNAL Oxygen Sensor Signal
J2-18	Red	VOLTAGE INPUT +12V Voltage Battery
HOT AT ALL TIMES WITH BATTERY CONNECTED !!!		

\* If Equipped  
(See Table at Bottom of Page 11)

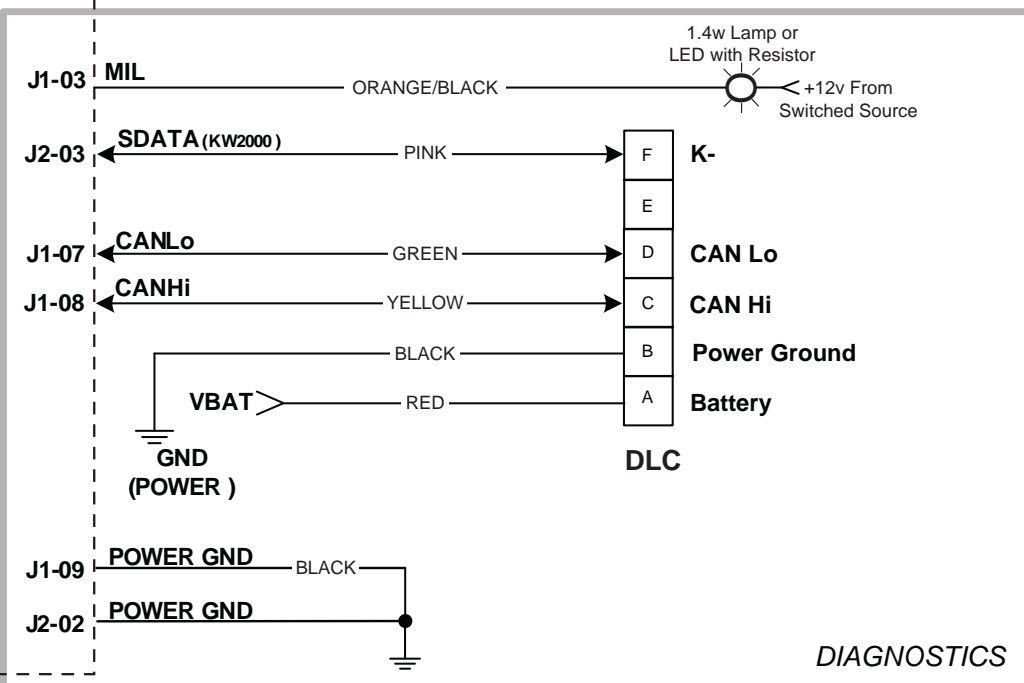
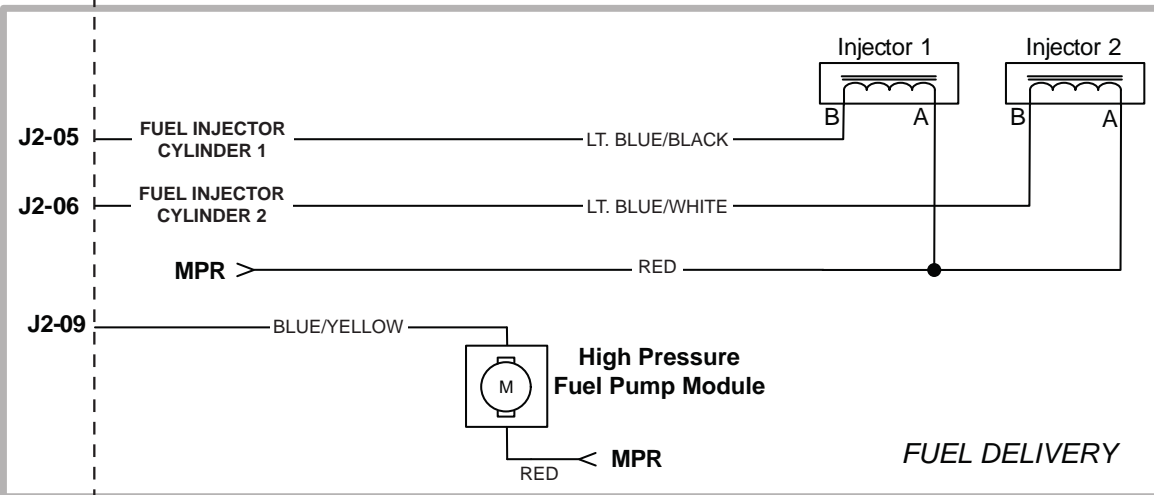
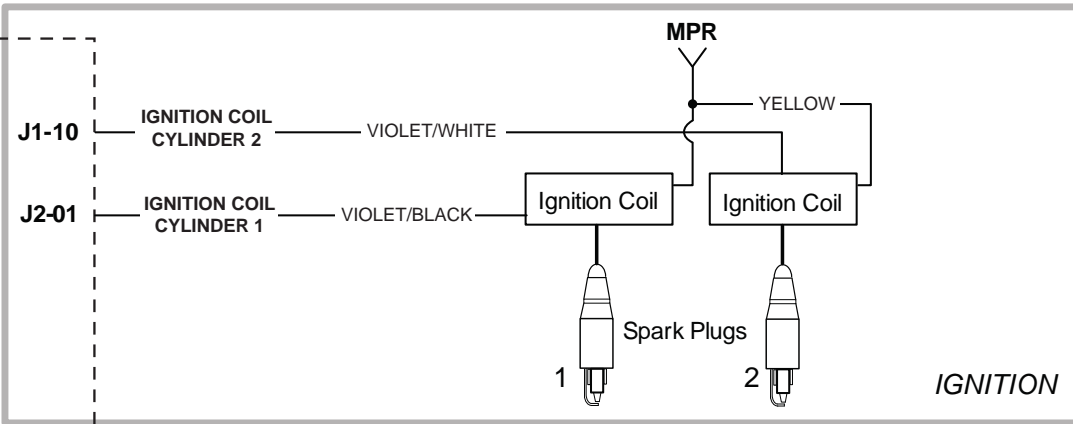
# Model 490000 EFI Electrical Schematic (Page 1 of 2)





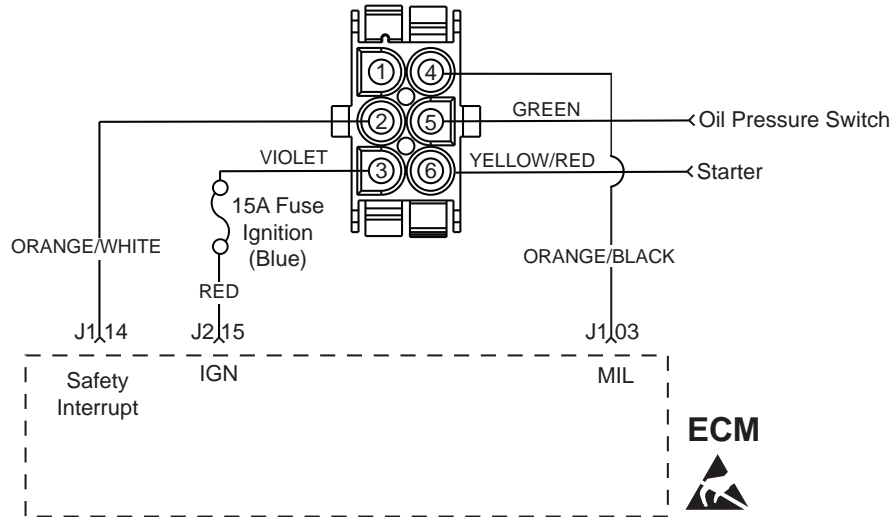
## Model 490000 EFI Electrical Schematic (Page 2 of 2)

ECM

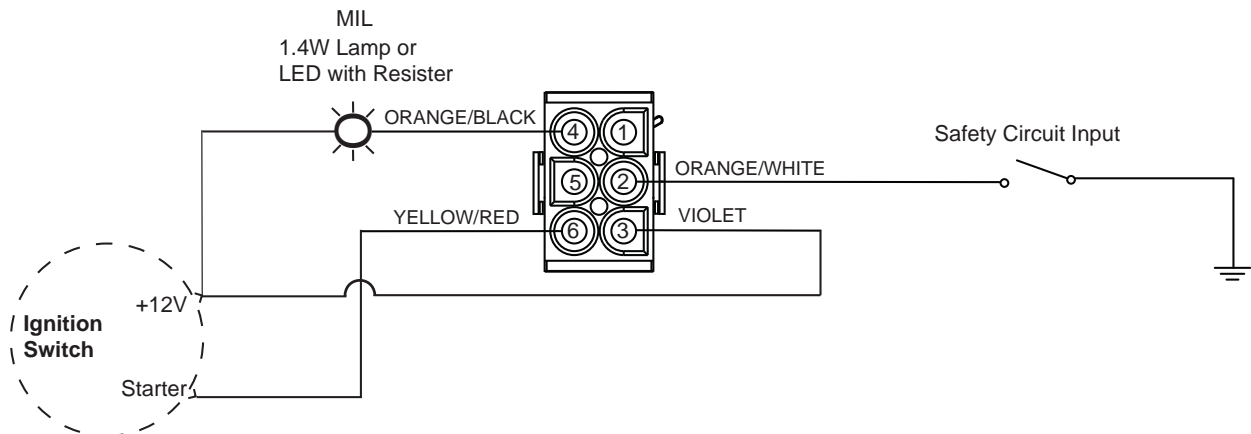


# Model 490000 Engine to Chassis 6-Place Connector Pin-Out (Standard)

## Engine Connector

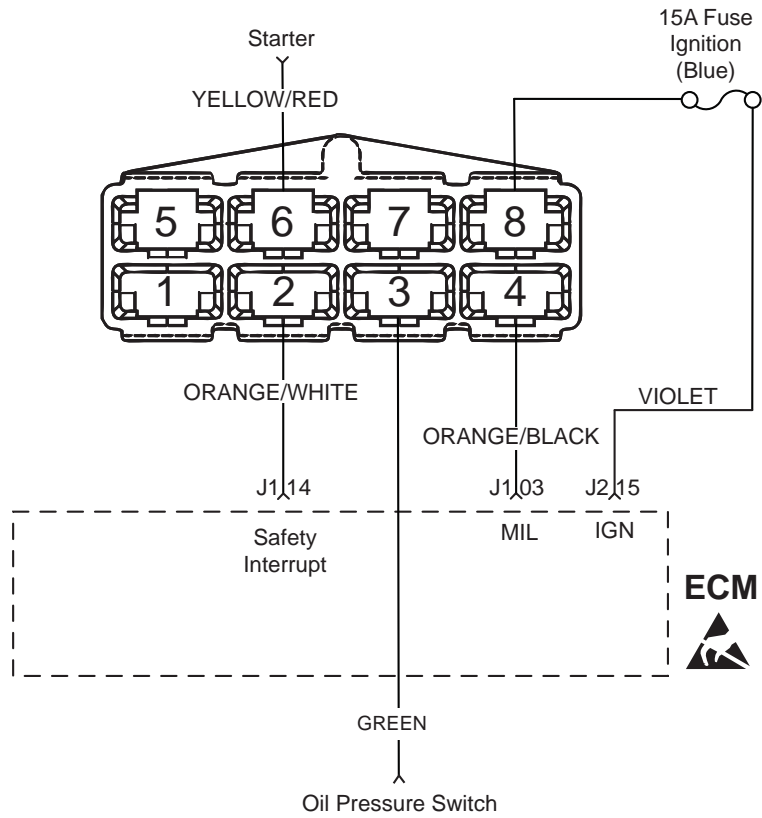


## Chassis Connector (Equipment Side)

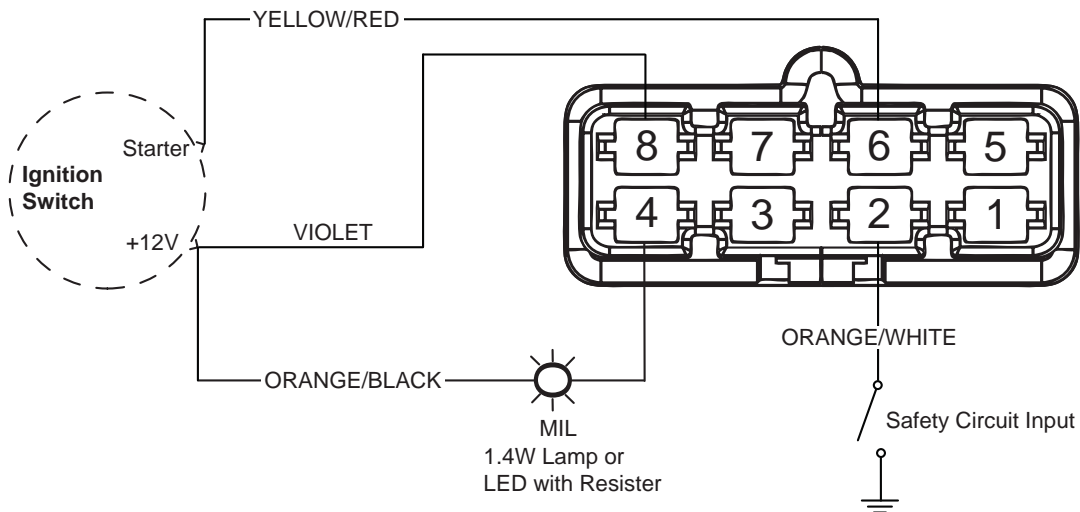


## Model 490000 Engine to Chassis 8-Place Connector Pin-Out (Optional)

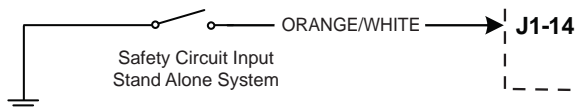
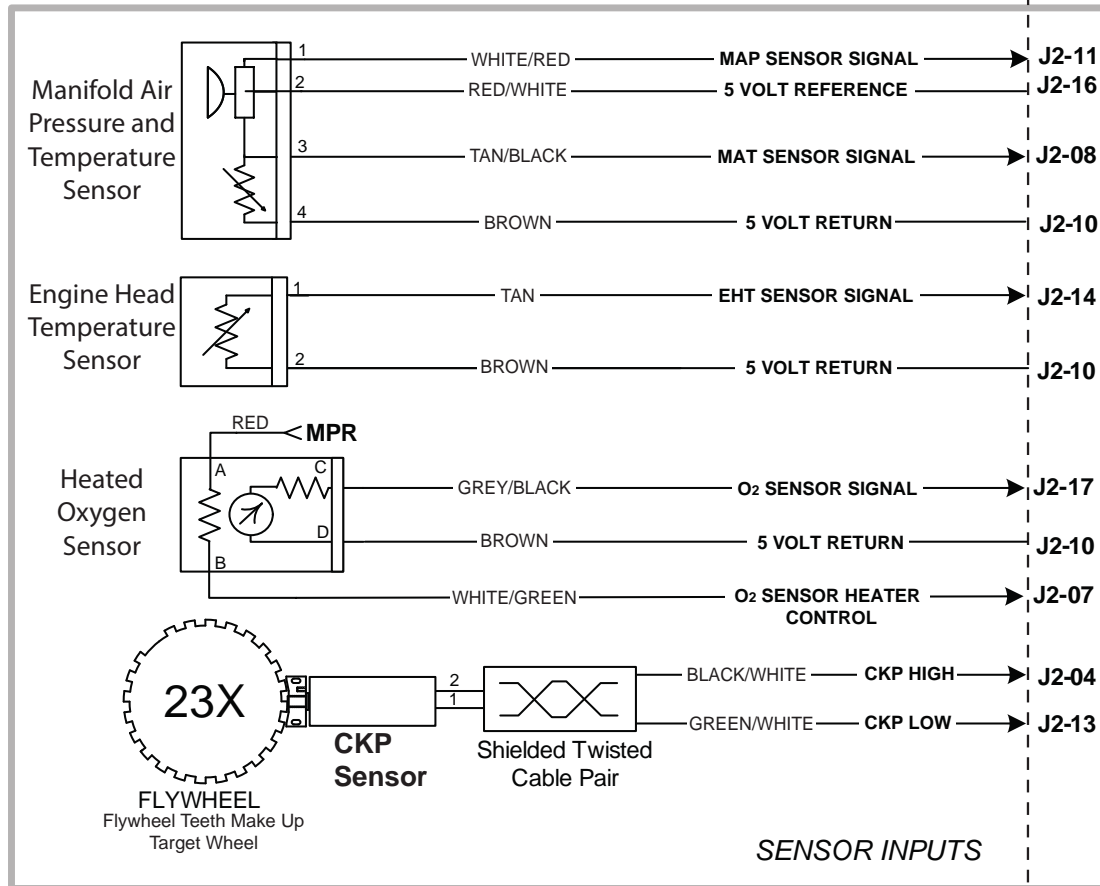
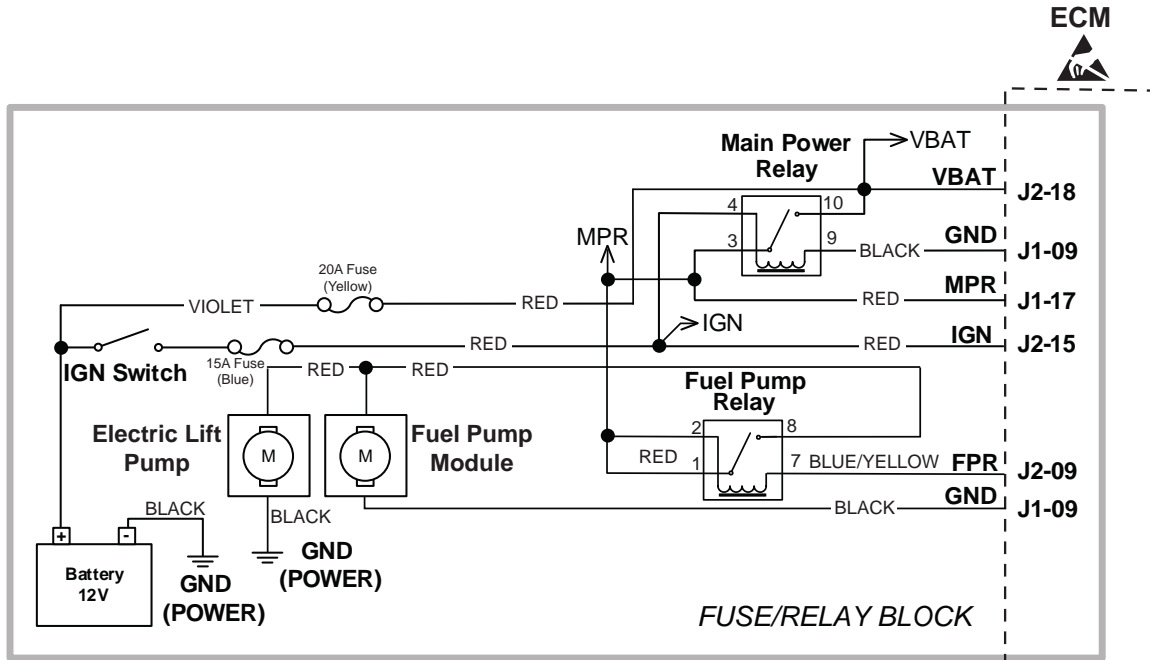
### Engine Connector



### Chassis Connector (Equipment Side)

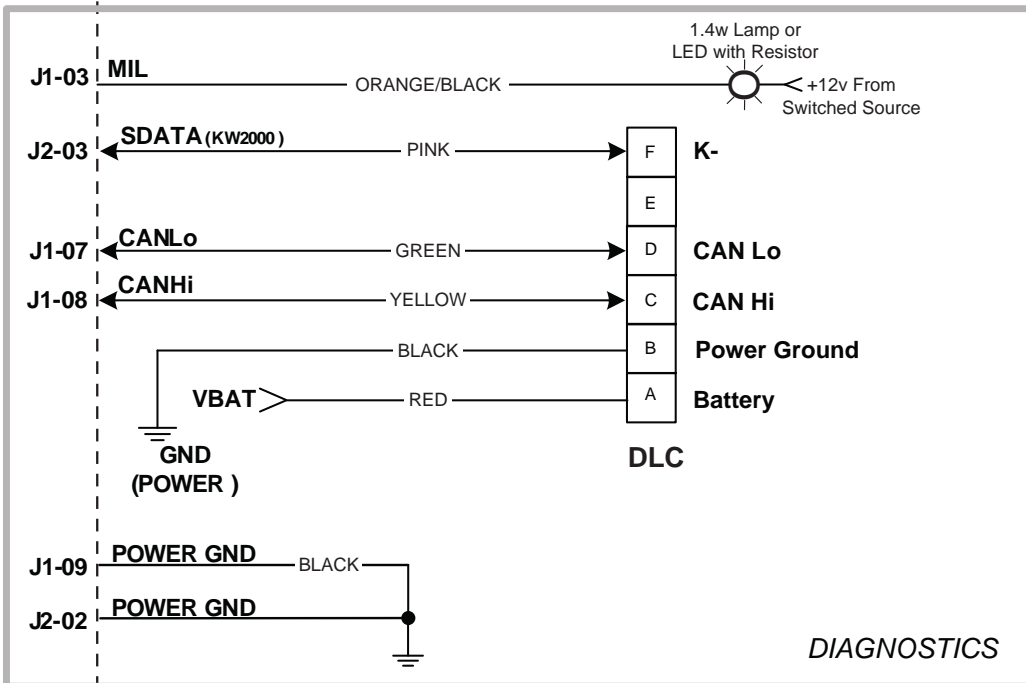
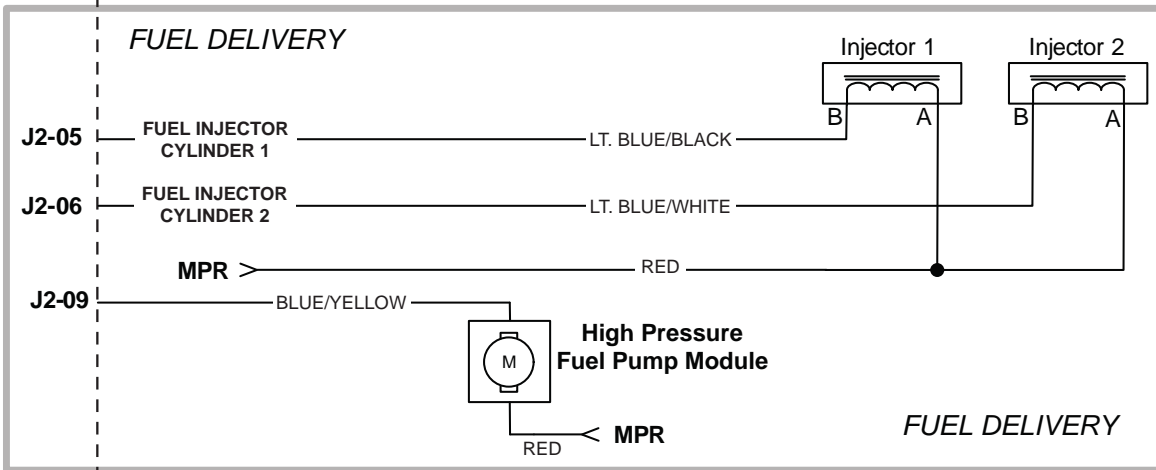
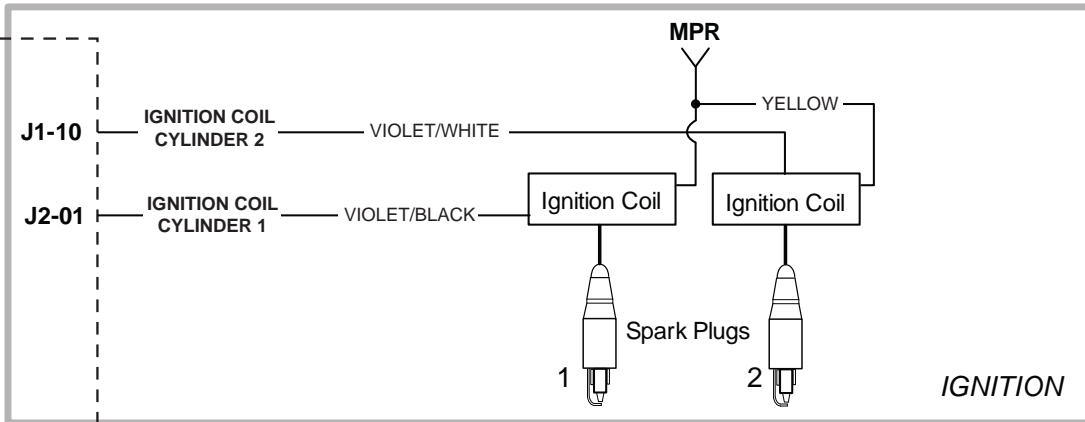


# Models 540000/610000 Turf EFI Electrical Schematic (Page 1 of 2)



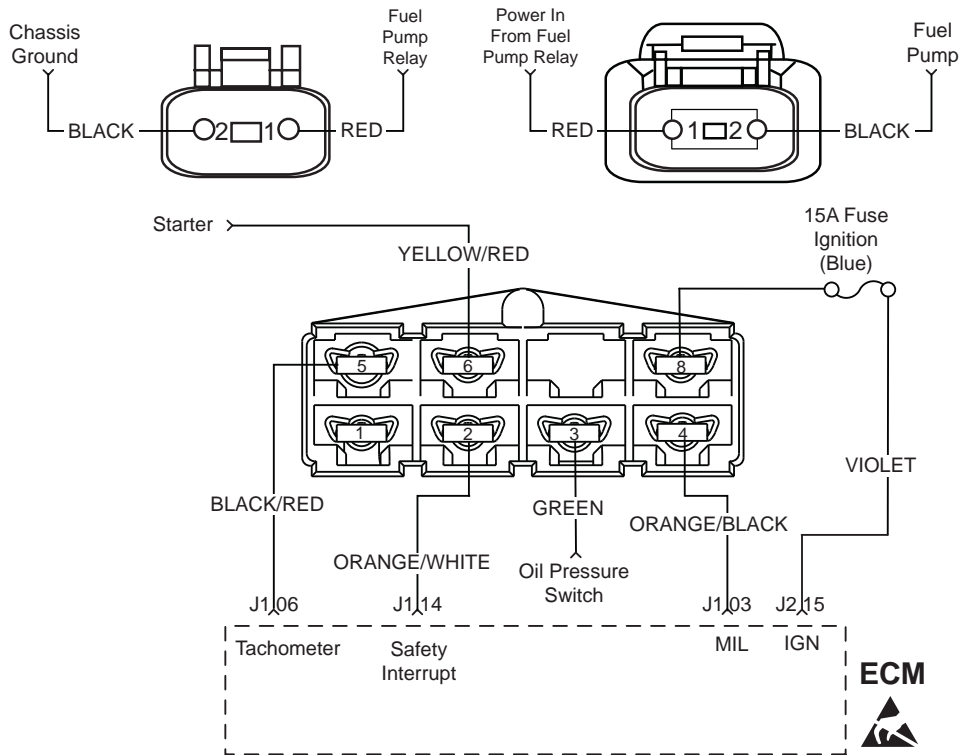
## Models 540000/610000 Turf EFI Electrical Schematic (Page 2 of 2)

ECM

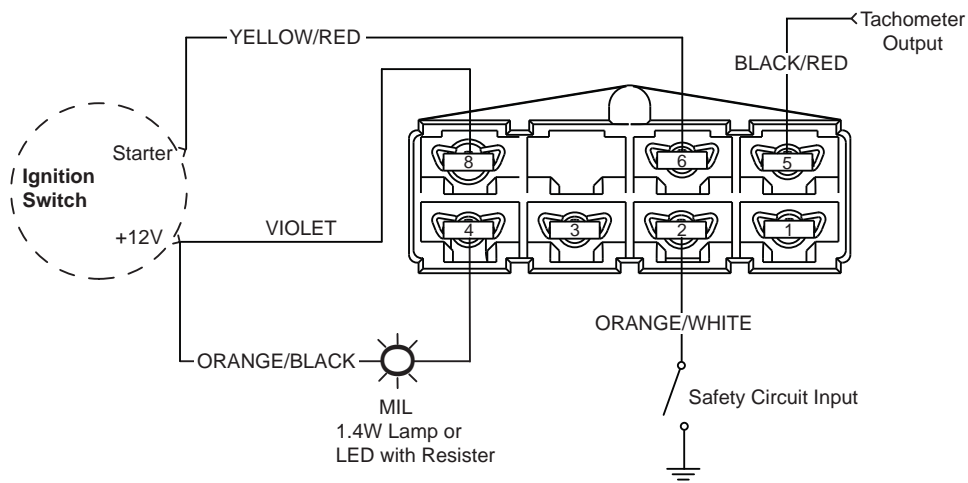


# Models 540000/610000 Turf Engine to Chassis 8-Place and 2-Place Connector Pin-Outs (Option 1)

## Engine Connectors

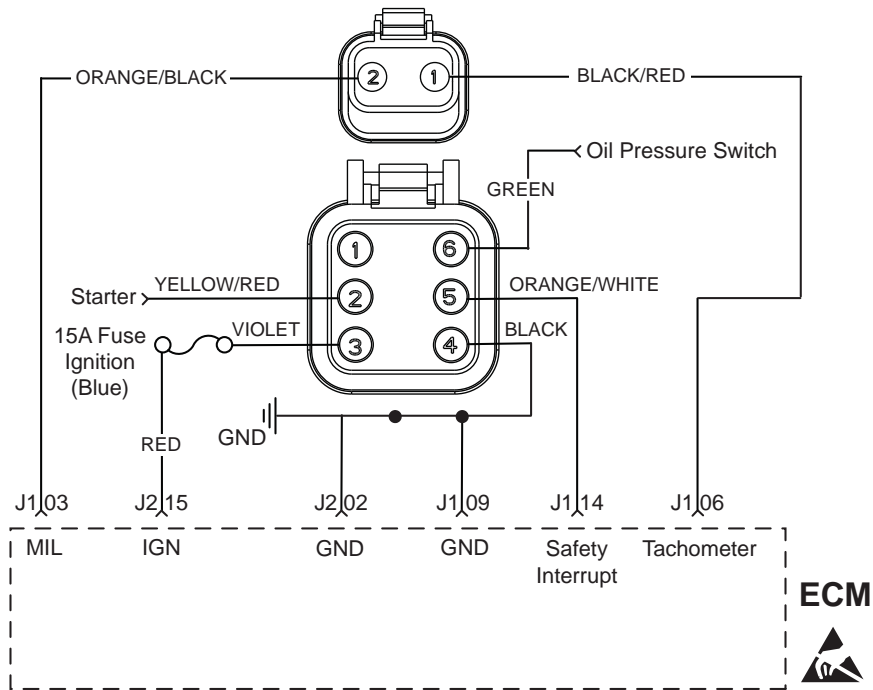


## Chassis Connector (Equipment Side)

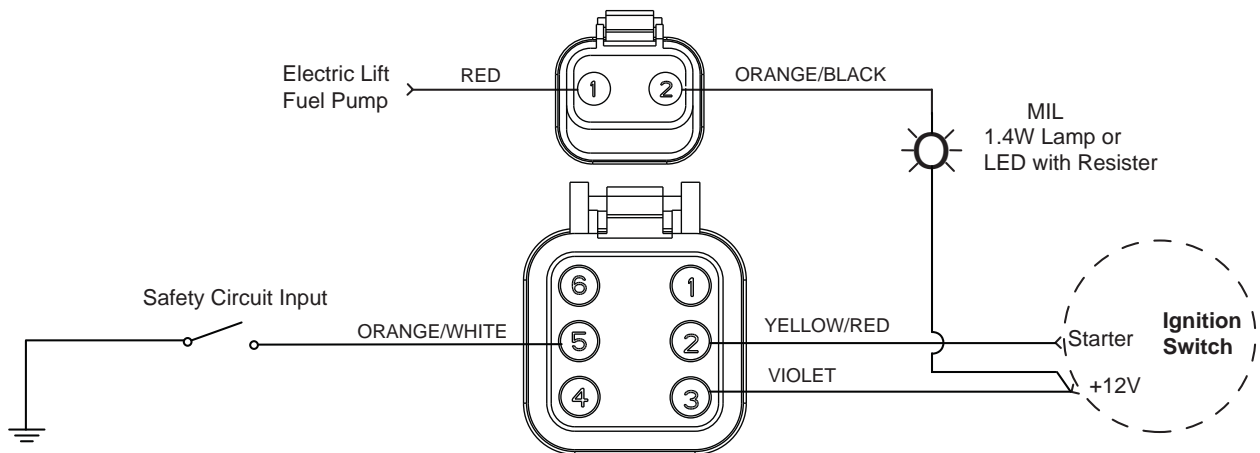


## Models 540000/610000 Turf Engine to Chassis 6-Place and 2-Place Connector Pin-Outs (Option 2)

### Engine Connectors

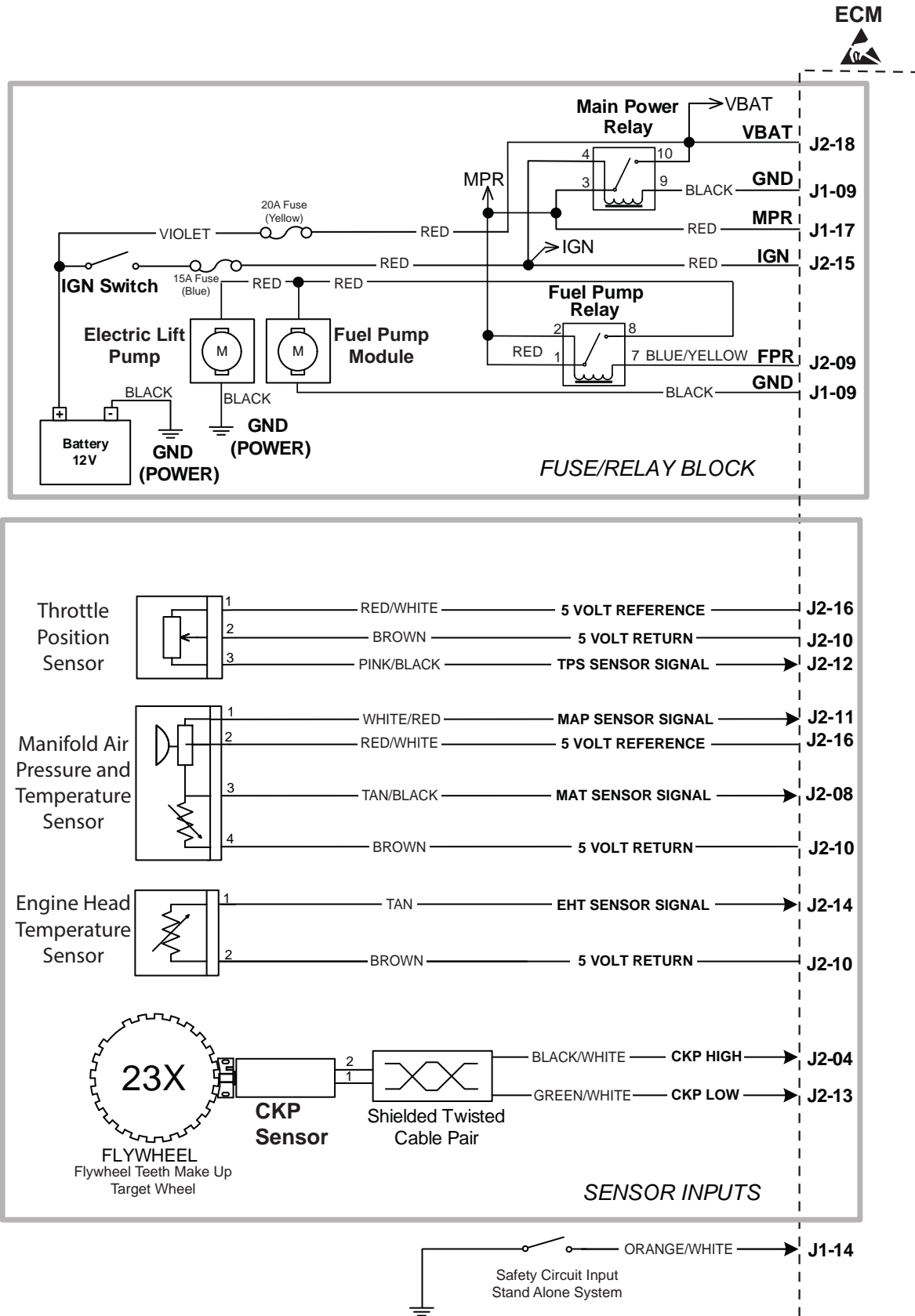


### Chassis Connectors (Equipment Side)



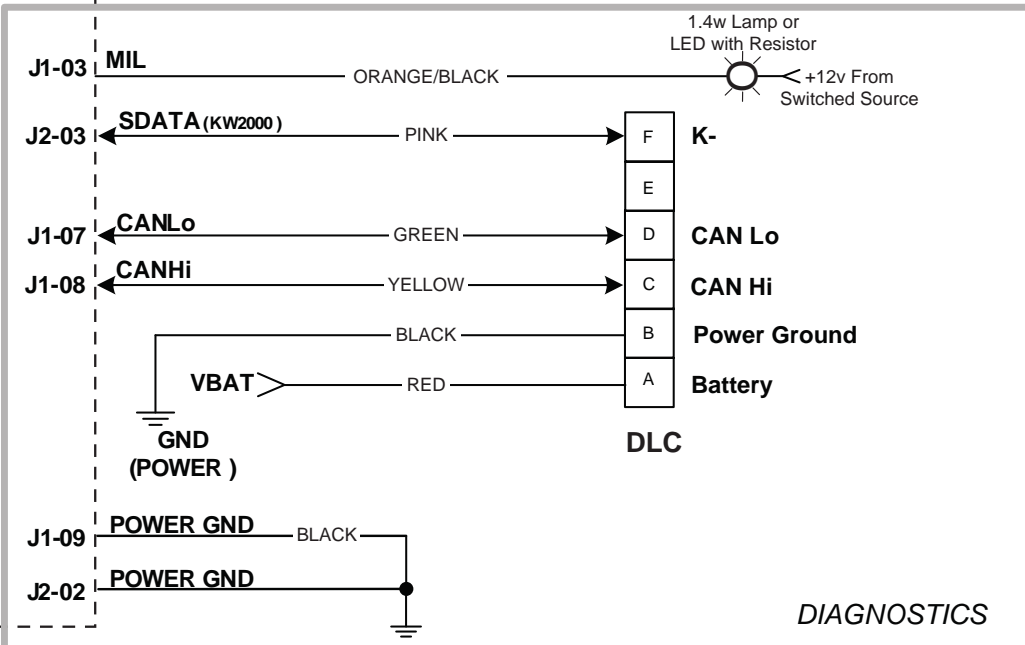
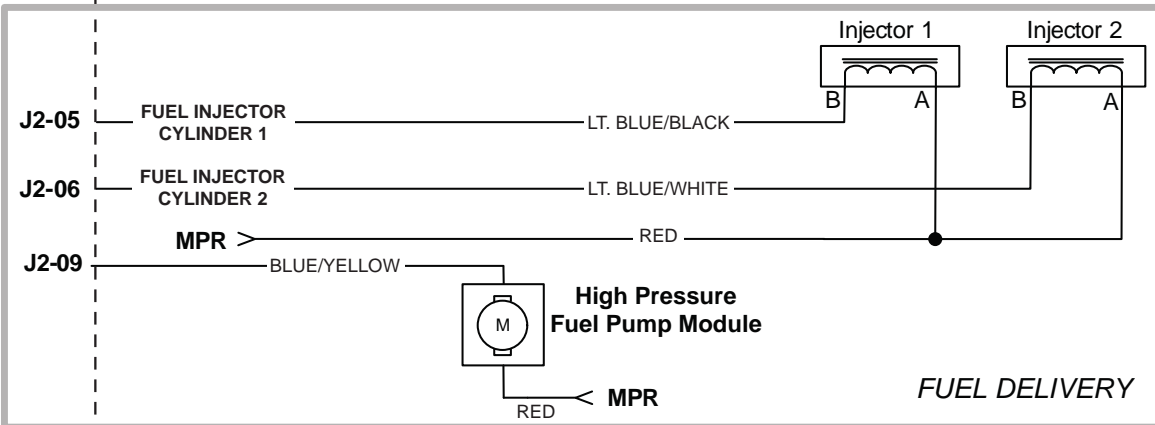
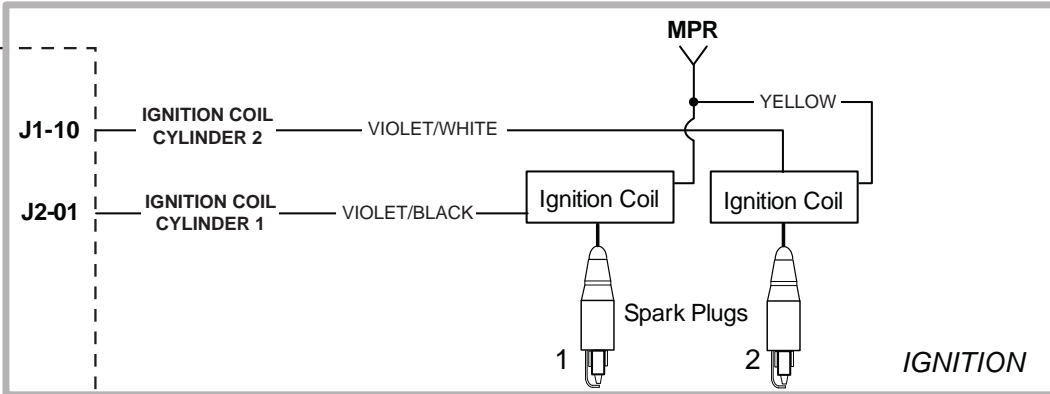


# Model 610000 Marine EFI Electrical Schematic (Page 1 of 2)



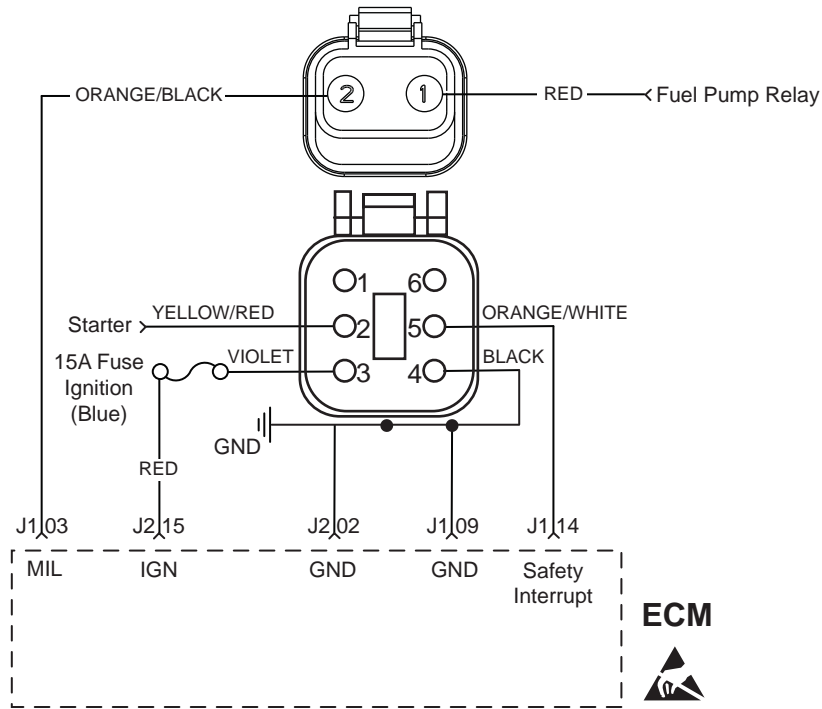
## Model 610000 Marine EFI Electrical Schematic (Page 2 of 2)

ECM

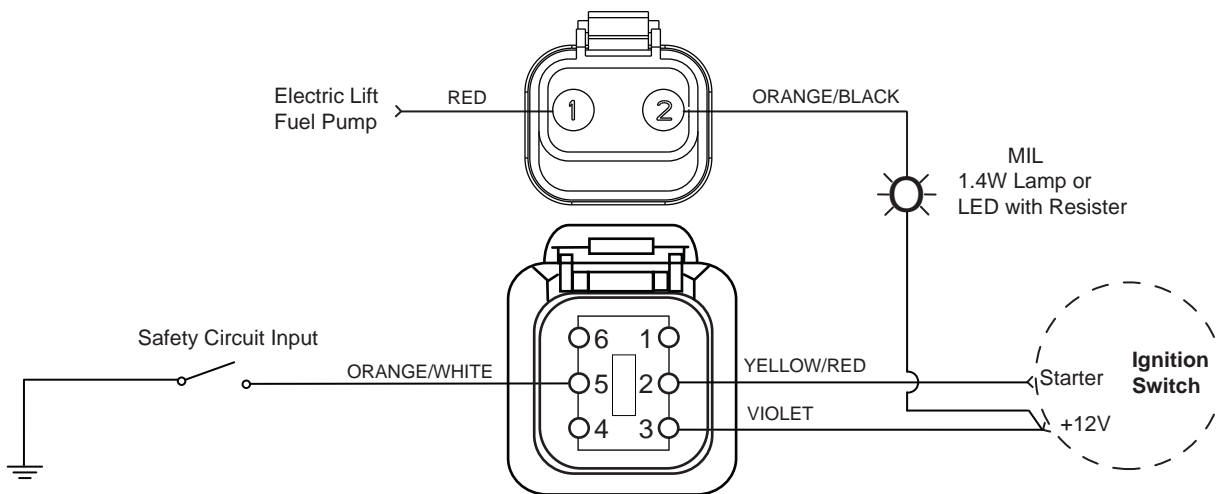


# Model 61000 Marine Engine to Chassis 6-Place and 2-Place Connector Pin-Outs

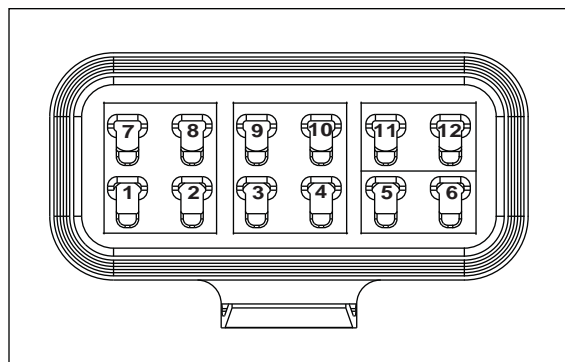
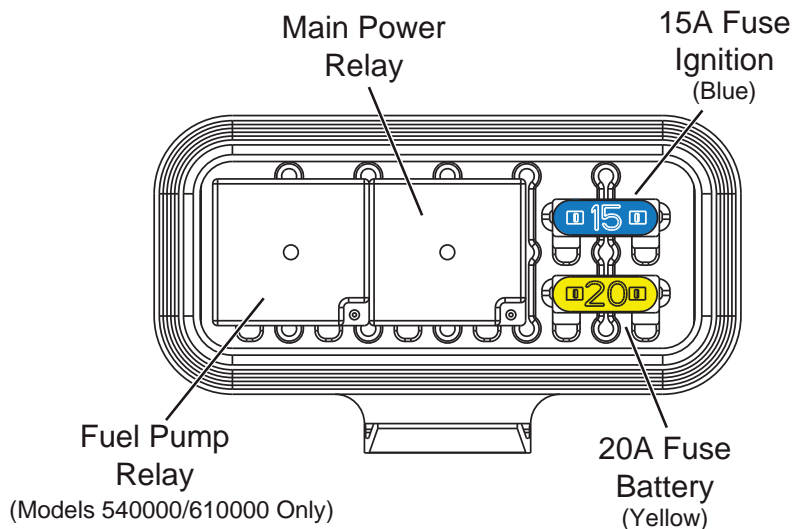
## Engine Connectors



## Chassis Connectors (Equipment Side)



### Models 490000/540000/610000 Fuse/Relay Block



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## Section 4

### Symptoms

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## Introduction

### Verify Customer Complaint

Verify customer complaint and then move to the Diagnostic Table that best describes the problem.

- Engine does not crank.
- Engine cranks but does not start.
- Engine exhibits hard start symptoms.
- Engine power output low.
- Engine hunts and surges.

### Perform Visual Check

Each Diagnostic Table contains an instruction to perform a careful visual check. This check should always include the following:

- Verify that ECM grounds and sensor connections are clean, tight and in their proper location.
- Thoroughly check for any type of vacuum leak or restriction.
- Look for air leaks at the throttle body mounting and intake manifold sealing surfaces.
- Inspect ignition wires for cracks, hardness, improper routing and carbon tracking.
- Inspect wires for kinks, cuts, burns, abraded insulation, and other damage.
- Look for moisture in primary or secondary ignition circuit connections.
- Look for salt corrosion on electrical connections and exposed throttle body linkages.

Check electrical connectors for the following:

- Poor mating of connector halves, or a terminal not fully seated in the connector body (backed out or loose).
- Improperly formed or damaged terminals and/or connectors.
- Improper contact tension of connector pin and socket terminals in the problem circuit.
- Poor terminal to wire connection (both core and insulation crimps).

### Intermittents

**IMPORTANT:** Intermittents may not cause the MIL to illuminate or set a DTC. DO NOT use the DTC Tables to diagnose intermittent problems. The fault condition must be present to locate the problem. Many intermittent problems are caused by faulty electrical connections or wiring.

The engine may be operated with a DVOM connected to the suspect circuit. If an abnormal voltage is observed when a malfunction occurs, it is a good indication that there is a fault in the circuit. A scan tool also may be used to help detect intermittents.

### Check DTC Memory Loss

Disconnect MAP sensor and idle engine until MIL is illuminated. DTC P0107 should be set and stored in ECM memory when the ignition is turned OFF. If it is not, then the ECM is faulty. After performing this test, be sure to clear the DTC from memory.

An intermittent MIL with no stored DTC may be caused by one or more of the following conditions:

- Ignition coil is shorted to ground and arcing is present at ignition wires or plugs.
- MIL wire to ECM is shorted to ground.
- Poor ECM grounds.
- An electrical system interference caused by a sharp electrical surge. The problem normally occurs when the faulty component is operated.
- Secondary ignition components are shorted to ground, or there is an open in the ignition coil ground.
- Engine components, such as starters, alternators or relays, are internally shorted to ground.



## Engine Does Not Crank

Step	Action	Yes	No
1	Perform OBD System Check. Are any DTCs found?	Go to applicable DTC Table.	Go to step 2.
2	Perform a careful visual check. Is a problem found?	Repair	Go to step 3.
3	Check battery as follows: <ul style="list-style-type: none"> <li>• Look for loose or corroded terminals.</li> <li>• Verify battery voltage is 12.2-13.5 volts.</li> </ul> Is a problem found?	Repair	Go to step 4.
4	Verify PTO clutch is not engaged. Is PTO clutch engaged?	Disengage PTO clutch.	Go to step 5.
5	Verify safety interrupt is NOT active or faulty, if equipped. Is a problem found?	Repair	Go to step 6.
6	Verify ignition switch is working properly. See Section 2 of the Intek V-Twin Cylinder OHV Repair Manual. Is a problem found?	Repair	Go to step 7.
7	Verify starter is operating properly. See Section 6 of the Intek V-Twin Cylinder OHV Repair Manual. Is a problem found?	Repair	Go to step 8.
8	Review diagnostic procedures in this table. If all steps have been completed and no problems have been found, proceed as follows: <ul style="list-style-type: none"> <li>• Repeat visual check.</li> <li>• Review Scan tool/Code reader data.</li> <li>• Check all electrical connections within the suspect circuit and/or system.</li> </ul> Is a problem found?	Repair	Go to step 9.
9	Carefully review data under <i>ECM Connector Symptoms</i> , page 100. Is a problem found?	Repair	Contact engine manufacturer.

## Engine Cranks But Does Not Start (Page 1 of 2)

Step	Action	Yes	No
1	Perform OBD System Check. Are any DTCs found?	Go to applicable DTC Table.	Go to step 2.
2	Perform a careful visual check. * Is a problem found?	Repair	Go to step 3.
3	Verify fuel in tank(s). Is there insufficient fuel in tank(s)?	Add fuel.	Go to step 4.
4	Check fuel shut off valve, if equipped. Is fuel shut off valve closed?	Open fuel shut off valve.	Go to step 5.
5	Check the following fuel system components for dirt, water, or other contaminants. <ul style="list-style-type: none"> <li>• Fuel tanks</li> <li>• Fuel filter</li> <li>• Fuel lines</li> <li>• Fuel pumps</li> </ul> Is a problem found?	Repair	Go to step 6.
6	Verify that fuel pressure is 38-43 psi (262-296 kPa). See page 104 for test procedure. Is a problem found?	Repair	Go to step 7.
7	Verify safety interrupt is NOT active or faulty. Is a problem found?	Repair	Go to step 8.
8	Check battery as follows: <ul style="list-style-type: none"> <li>• Look for loose or corroded terminals.</li> <li>• Verify battery voltage is 12.2-13.5 volts.</li> </ul> Is a problem found?	Repair	Go to step 9.
9	Verify that each cylinder is getting spark. See Intek V-Twin Cylinder OHV Repair Manual. Is a problem found?	Repair	Go to step 10.
10	Verify ECM powers up. See page 14 for test procedure. Is a problem found?	Repair	Go to step 11.

\* **NOTE:** Verify that the fuel pump primes for approximately two seconds when the ECM is powered up. If fuel pump primes for only 1/2 second, then the Safety Circuit is the likely problem.

## Engine Cranks But Does Not Start (Page 2 of 2)

Step	Action	Yes	No
<b>11</b>	Check engine for the following mechanical problems: <ul style="list-style-type: none"> <li>• Low compression.</li> <li>• Leaking cylinder head gaskets.</li> <li>• Proper valve set up.</li> </ul> See Intek V-Twin Cylinder OHV Repair Manual. Is a problem found?	Repair	Go to step 12.
<b>12</b>	Review diagnostic procedures in this table. If all steps have been completed and no problems have been found, proceed as follows: <ul style="list-style-type: none"> <li>• Repeat visual check.</li> <li>• Review Scan tool/Code reader data.</li> <li>• Check all electrical connections within the suspect circuit and/or system.</li> </ul> Is a problem found?	Repair	Go to step 13.
<b>13</b>	Carefully review data under <i>ECM Connector Symptoms</i> , page 100. Is a problem found?	Repair	Contact engine manufacturer.

## Engine Exhibits Hard Start Symptoms (Page 1 of 2)

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

Step	Action	Yes	No
1	Perform OBD System Check. Are any DTCs found?	Go to applicable DTC Table.	Go to step 2.
2	Perform a careful visual check. Is a problem found?	Repair	Go to step 3.
3	Check the following fuel system components for dirt, water, or other contaminants. <ul style="list-style-type: none"> <li>• Fuel tanks</li> <li>• Fuel filter</li> <li>• Fuel lines</li> <li>• Fuel pumps</li> </ul> Is a problem found?	Repair	Go to step 4.
4	Verify that fuel pressure is 38-43 psi (262-296 kPa). See page 104 for test procedure. Is a problem found?	Repair	Go to step 5.
5	Check battery as follows: <ul style="list-style-type: none"> <li>• Look for loose or corroded terminals.</li> <li>• Verify that battery voltage is 12.2-13.5 volts.</li> </ul> Is a problem found?	Repair	Go to step 6.
6	Check for intermittent opens or shorts to ground in MAP sensor circuit. Is a problem found?	Repair	Go to step 7.
7	1. Check for proper TPS operation, if equipped. 2. Verify that throttle linkage is not sticking, binding or worn causing high TPS voltage. Is a problem found?	Repair	Go to step 8.
8	Check for proper IAC operation, if equipped. Is a problem found?	Repair	Go to step 9.

## Engine Exhibits Hard Start Symptoms (Page 2 of 2)

Step	Action	Yes	No
9	<p>Check engine for the following mechanical problems:</p> <ul style="list-style-type: none"> <li>• Low compression.</li> <li>• Leaking cylinder head gaskets.</li> <li>• Proper valve set up.</li> </ul> <p>See Intek V-Twin Cylinder OHV Repair Manual.</p> <p>Is a problem found?</p>	Repair	Go to step 10.
10	<p>Review diagnostic procedures in this table. If all steps have been completed and no problems have been found, proceed as follows:</p> <ul style="list-style-type: none"> <li>• Repeat visual check.</li> <li>• Review Scan tool/Code reader data.</li> <li>• Check all electrical connections within the suspect circuit and/or system.</li> </ul> <p>Is a problem found?</p>	Repair	Go to step 11.
11	<p>Carefully review data under <i>ECM Connector Symptoms</i>, page 100.</p> <p>Is a problem found?</p>	Repair	Contact engine manufacturer.

## Engine Power Output Low (Page 1 of 2)

Step	Action	Yes	No
1	Perform OBD System Check. Are any DTCs found?	Go to applicable DTC Table.	Go to step 2.
2	Perform a careful visual check. Is a problem found?	Repair	Go to step 3.
3	Check the following fuel system components for dirt, water, or other contaminants. <ul style="list-style-type: none"> <li>• Fuel tanks</li> <li>• Fuel filter</li> <li>• Fuel lines</li> <li>• Fuel pumps</li> </ul> Is a problem found?	Repair	Go to step 4.
4	Verify that fuel pressure is 38-43 psi (262-296 kPa). See page 104 for test procedure. Is a problem found?	Repair	Go to step 5.
5	Verify crankcase oil is at the correct level. Is a problem found?	Add crankcase oil.	Go to step 6.
6	Verify air filter element is clean and dry. Is a problem found?	Replace air filter element.	Go to step 7.
7	Verify engine is not supporting a greater load than intended for its application? Check for the following: <ul style="list-style-type: none"> <li>• Damaged drive belt.</li> <li>• For mowers, verify blades are not restricted by debris.</li> <li>• Faulty pulley bearing(s).</li> </ul> Is a problem found?	Repair	Go to step 8.
8	Verify spark plugs are: <ul style="list-style-type: none"> <li>• Gapped properly.</li> <li>• Not gas fouled.</li> <li>• Not excessively worn.</li> </ul> Is a problem found?	Repair	Go to step 9.
9	Verify exhaust is not restricted. Is a problem found?	Repair	Go to step 10.

## Engine Power Output Low (Page 2 of 2)

Step	Action	Yes	No
10	Check engine for the following mechanical problems: <ul style="list-style-type: none"> <li>• Low compression.</li> <li>• Leaking cylinder head gaskets.</li> <li>• Proper valve set up.</li> </ul> See Intek V-Twin Cylinder OHV Repair Manual. Is a problem found?	Repair	Go to step 11.
11	Review diagnostic procedures in this table. If all steps have been completed and no problems have been found, proceed as follows: <ul style="list-style-type: none"> <li>• Repeat visual check.</li> <li>• Review Scan tool/Code reader data.</li> <li>• Check all electrical connections within the suspect circuit and/or system.</li> </ul> Is a problem found?	Repair	Go to step 12.
12	Carefully review data under <i>ECM Connector Symptoms</i> , page 100. Is a problem found?	Repair	Contact engine manufacturer.



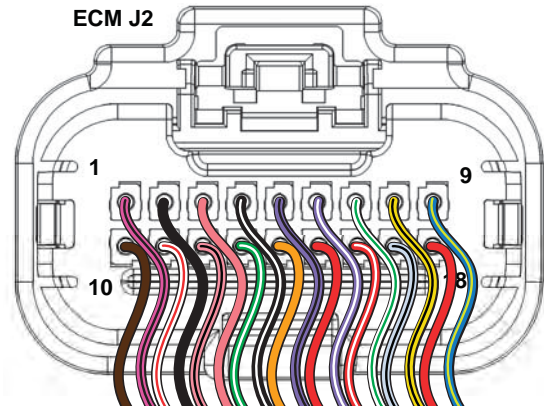
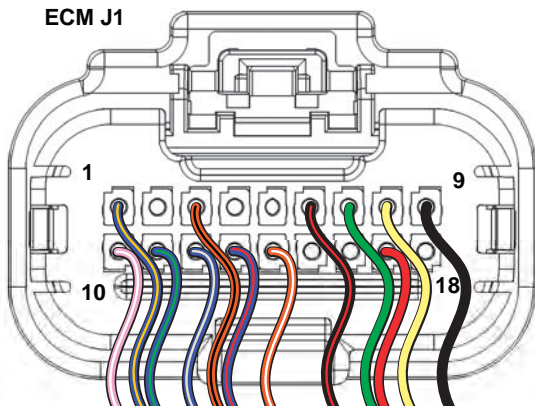
## Engine Hunts and Surges (Page 1 of 2)

Step	Action	Yes	No
1	Perform OBD System Check. Are any DTCs found?	Go to applicable DTC Table.	Go to step 2.
2	Perform a careful visual check. Is a problem found?	Repair	Go to step 3.
3	Check the following fuel system components for dirt, water, or other contaminants. <ul style="list-style-type: none"> <li>• Fuel tanks</li> <li>• Fuel filter</li> <li>• Fuel lines</li> <li>• Fuel pumps</li> </ul> Is a problem found?	Repair	Go to step 4.
4	Verify that fuel pressure is 38-43 psi (262-296 kPa). See page 104 for test procedure. Is a problem found?	Repair	Go to step 5.
5	Check battery as follows: <ul style="list-style-type: none"> <li>• Look for loose or corroded terminals.</li> <li>• Verify that battery voltage is 12.2-13.5 volts.</li> </ul> Is a problem found?	Repair	Go to step 6.
6	Verify crankcase oil is at the correct level. Is a problem found?	Add crankcase oil.	Go to step 7.
7	Verify air filter element is clean and dry. Is a problem found?	Replace air filter element.	Go to step 8.
8	Verify governor is set up properly. See Section 4 of the Intek V-Twin Cylinder OHV Repair Manual. Is a problem found?	Repair	Go to step 9.
9	Inspect governor link spring for damage or improper installation. Is a problem found?	Repair	Go to step 10.
10	Disconnect governor spring, and check for binding or uneven resistance in the governor arm travel from stop to stop. Is a problem found?	Repair	Go to step 11.

## Engine Hunts and Surges (Page 2 of 2)


Step	Action	Yes	No
11	Inspect governor spring and controls for damage or improper installation. Is a problem found?	Repair	Go to step 12.
12	Review diagnostic procedures in this table. If all steps have been completed and no problems have been found, proceed as follows: <ul style="list-style-type: none"> <li>• Repeat visual check.</li> <li>• Review Scan tool/Code reader data.</li> <li>• Check all electrical connections within the suspect circuit and/or system.</li> </ul> Is a problem found?	Repair	Go to step 13.
13	Carefully review data under <i>ECM Connector Symptoms</i> , page 100. Is a problem found?	Repair	Contact engine manufacturer.

## ECM Connector Symptoms



ECM Connector J1 (Grey)			
Connector-Pin Number	Function	Wire Color	Possible Symptom From Faulty Circuit
J1-01	IAC HIGH "A" * Idle Air Control A High	Blue/Brown	Rough, unstable, or incorrect idle
J1-02	NOT USED		
J1-03	MIL Malfunction Indicator Lamp	Orange/Black	MIL inoperative
J1-04	NOT USED		
J1-05			
J1-06	Tachometer	Black/Red	Tachometer inoperative
J1-07	CAN Low Used only for ECM Development	Green	No Can Signal
J1-08	CAN High Used only for ECM Development	Yellow	No Can Signal
J1-09	GROUND Power	Black	An open ground or high resistance ground may cause any or all symptoms
J1-10	IGN COIL CYL 2 Engine Spark Timing Coil Cylinder 2	Violet/White	Rough idle, lack of power, stalling
J1-11	IAC LOW "A" * Idle Air Control A Low	Blue/Green	Rough, unstable, or incorrect idle
J1-12	IAC HIGH "B" * Idle Air Control B High	Blue/Grey	Rough, unstable, or incorrect idle
J1-13	IAC LOW "B" * Idle Air Control B Low	Blue/Red	Rough, unstable, or incorrect idle
J1-14	Safety Interrupt Circuit	Orange/White	No start
J1-15	NOT USED		
J1-16			
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	NOT USED		

\* If Equipped  
(See Table at Bottom of Page 11)

<b>ECM Connector J2 (Black)</b>			
<b>Connector-Pin Number</b>	<b>Function</b>	<b>Wire Color</b>	<b>Possible Symptom From Faulty Circuit</b>
J2-01	IGN COIL CYL 1 Engine Spark Timing Coil Cylinder 1	Violet/Black	Rough idle, lack of power, stalling
J2-02	GROUND Power	Black	An open ground or high resistance ground may cause any or all symptoms
J2-03	K-LINE Serial Data Diagnostic Communication	Pink	No diagnostic data
J2-04	CKP High 23X	Black/White	No start
J2-05	FUEL INJ CYL 1 Fuel Injector Cylinder 1	Lt.Blue/Black	Rough idle, lack of power, stalling
J2-06	FUEL INJ CYL 2 Fuel Injector Cylinder 2	Lt. Blue/White	Rough idle, lack of power, stalling
J2-07	HO <sub>2</sub> HEATER CONTROL* Oxygen Sensor Heater	White/Green	Lack of power, surge, rough idle, exhaust odor
J2-08	MAT Manifold Air Temperature Sensor	Tan/Black	Rough idle
J2-09	HIGH PRESSURE FUEL PUMP MODULE Fuel Pump	Blue/Yellow	No start
J2-10	5V RETURN 5 Volt Return	Brown	Lack of performance, stalling, exhaust odor
J2-11	MAP Manifold Absolute Pressure Sensor	White/Red	Poor performance, surge, poor fuel economy, exhaust odor
J2-12	TPS * Throttle Position Sensor	Pink/Black	Rough idle
J2-13	CKP Low 23X	Green/White	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	5V REFERENCE 5 Volt Reference	Red/White	Lack of power, surge, rough idle, exhaust odor
J2-17	HO <sub>2</sub> SIGNAL Oxygen Sensor Signal	Grey/Black	Lack of power, surge, rough idle, exhaust odor
J2-18	VOLTAGE INPUT +12V Voltage Battery	Red	No start
	 HOT AT ALL TIMES WITH BATTERY CONNECTED !!!		

\* If Equipped  
(See Table at Bottom of Page 11)

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## Section 5

### Removal/Installation

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## Safety Precautions

Always observe the following safety precautions before removing any fuel system components.

### CAUTION:

- Wear proper eye protection.
- Relieve fuel system pressure.
- Be sure there is no open flame or potential ignition sources in the area.
- When removing a fuel hose or fitting, cover with a shop towel to catch any fuel leakage.
- Collect any fuel and/or shop towels in approved containers and dispose of properly.
- Exercise care to keep dirt and debris out of fuel lines and fuel pump.
- Keep a dry chemical fire extinguisher on hand in case of emergencies.

### Check/Relieve Fuel System Pressure for Model 490000

 **CAUTION:** The fuel in the fuel rail is under high pressure. To avoid an uncontrolled discharge or spray of fuel, and to reduce the risk of fire and personal injury, always relieve fuel system pressure before servicing.

Proceed as follows:

**NOTE:** Perform all steps if checking fuel system pressure. If only relieving fuel system pressure, perform steps 1-5 and 9-11.

1. Turn Ignition OFF.
2. Loosen fuel filler cap to relieve fuel tank pressure. Tighten filler cap after loosening.
3. Obtain Briggs & Stratton Fuel Pressure Gauge (Part No. 19627).

4. Locate fuel pressure test port (Schrader valve) on fuel pump module to fuel rail connector.

5. Remove protective cap from Schrader valve and install fuel pressure gauge.

**NOTE:** A small amount of gasoline may drain from the Schrader valve when the gauge is installed. Wrap a shop towel around the valve fitting to catch any fuel leakage.

6. Turn Ignition ON to pressurize fuel system.

7. Note the reading of the fuel pressure gauge. Fuel pressure should remain steady at 38-43 psi (262-296 kPa).

8. Turn Ignition OFF.


9. Position the clear bleed tube in an approved container and press the pressure relief button on the gauge assembly to relieve fuel system pressure. Fully depress and hold the pressure relief button until pointer on the dial face is resting on the stop pin.

10. Remove fuel pressure gauge from Schrader valve.

**NOTE:** A small amount of gasoline may drain from the Schrader valve when the gauge is removed. Wrap a shop towel around the valve fitting to catch any fuel leakage.

11. Install protective cap on Schrader valve.

### Check/Relieve Fuel System Pressure for Models 540000/610000

 **CAUTION:** The fuel in the fuel rail is under high pressure. To avoid an uncontrolled discharge or spray of fuel, and to reduce the risk of fire and personal injury, always relieve fuel system pressure before servicing.



Proceed as follows:

**NOTE:** Perform all steps if checking fuel system pressure. If only relieving fuel system pressure, perform steps 1-7.

1. Turn Ignition OFF.
2. Loosen fuel filler cap to relieve fuel tank pressure. Tighten filler cap after loosening.
3. Remove access cover. See *Access Cover/Blower Housing, Removal*, steps 1-3, page 119.
4. Remove air cleaner assembly. See *Air Cleaner Assembly, Removal*, page 123.
5. Pull out grey secondary lock and press to disconnect fuel pump module connector.
6. Turn Ignition ON, Engine ON.
7. Start and run engine until it stalls. If it does not start, crank engine a few times to relieve fuel system pressure.
8. Obtain the following tools:
  - Briggs & Stratton Fuel Pressure Gauge (Part No. 19627).
  - Briggs & Stratton BIG BLOCK Fuel Pressure Test Adapter (Part No. 19624).
9. Squeeze two tabs on quick disconnect fitting to release fuel rail from fuel outlet port of fuel pump module.

**NOTE:** Wrap shop towel around fitting to catch any fuel leakage.

10. Install fuel pressure test adapter between fuel rail and fuel pump module.
11. Remove protective cap from Schrader valve on fuel pressure test adapter and install fuel pressure gauge.
12. Connect fuel pump module connector. Push in grey secondary lock to secure.
13. Turn Ignition ON to pressurize fuel system.
14. Note the reading of the fuel pressure gauge. Fuel pressure should remain steady at 38-43 psi (262-296 kPa).
15. Turn Ignition OFF.
16. Position the clear bleed tube in an approved container and press the pressure relief button on the gauge assembly to relieve fuel system pressure. Fully depress and hold the pressure relief button until pointer on the dial face is resting on the stop pin.
17. Remove fuel pressure gauge from Schrader valve on fuel pressure test adapter.

**NOTE:** A small amount of gasoline may drain from the Schrader valve when the gauge is removed. Wrap a shop towel around the valve fitting to catch any fuel leakage.
18. Install protective cap on Schrader valve.
19. Remove fuel pressure test adapter between fuel rail and fuel pump module.
20. Firmly push quick disconnect fitting on fuel rail onto fuel outlet port of fuel pump module. Gently tug on fitting to verify that it is properly seated and secure.
21. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the ignition switch back to ON and check for fuel leaks.
22. Install air cleaner assembly. See *Air Cleaner Assembly, Installation*, page 124.
23. Install access cover. See *Access Cover/Blower Housing, Installation*, steps 7-10, page 119.

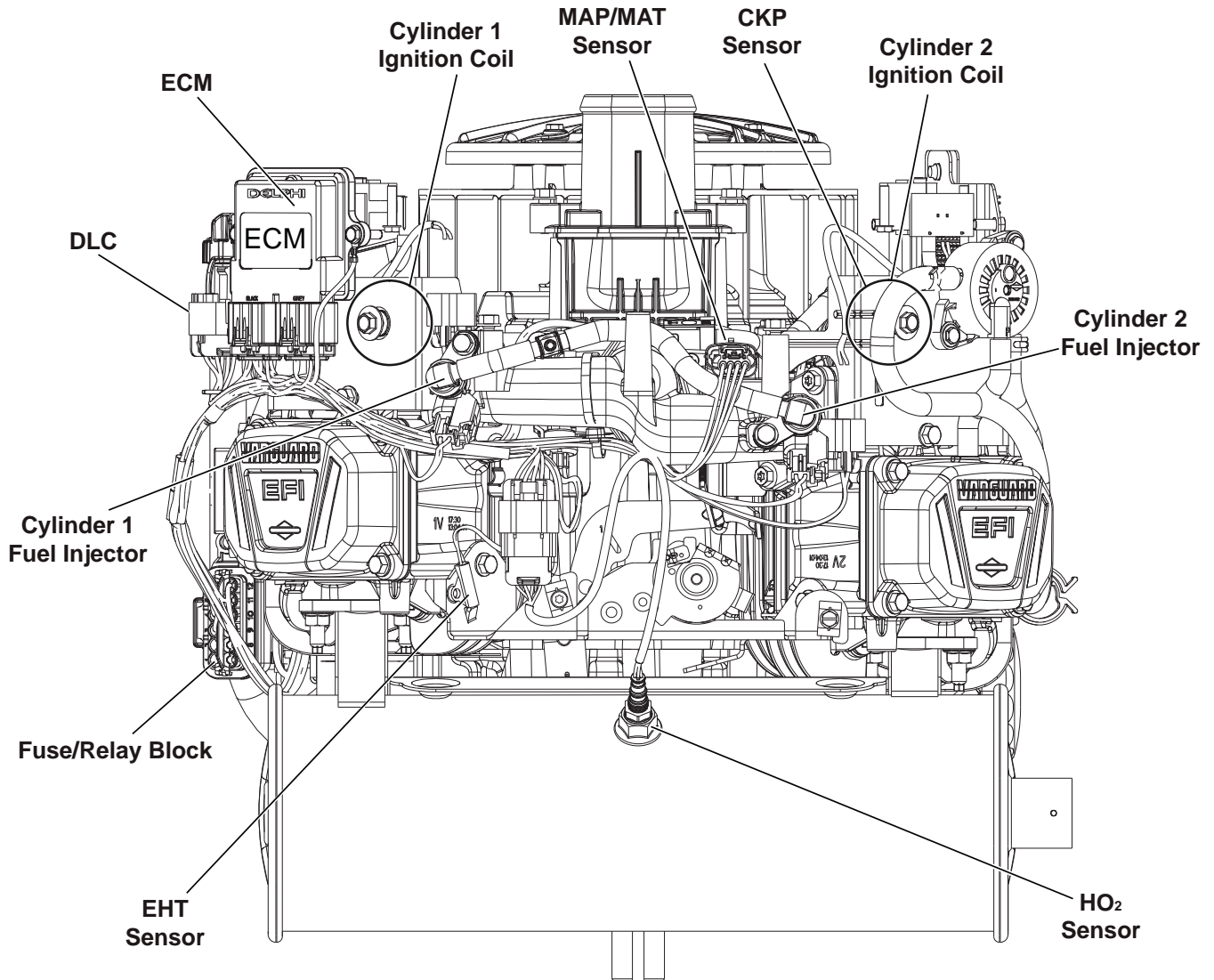


Figure 5-1 Model 490000 Components.  
 (Static Guard, Decorative Cover, and Blower Housing Removed for Illustration Purposes.)

## Model 490000 Fuel System Components

### Air Cleaner Assembly/Static Guard/ Decorative Cover/Blower Housing

#### Removal

1. See Figure 5-2. Remove air cleaner (A) as follows:
  - a. Rotate screw to loosen band clamp at air inlet elbow end of air hose. Remove air hose from air inlet elbow.
  - b. Remove two screws to release retaining strap from upper air cleaner bracket.
  - c. Remove air cleaner with retaining strap.
2. Remove six hex flange screws to release static guard (B).
3. Remove four hex flange screws to release decorative cover (C) from upper air cleaner bracket.
4. Remove four hex flange screws to release fan guard (D) from blower housing.
5. Remove two hex flange screws to release blower housing (E) from upper air cleaner bracket.
6. Remove two hex flange screws to release ECM bracket and ECM ground wire ring terminal from blower housing.

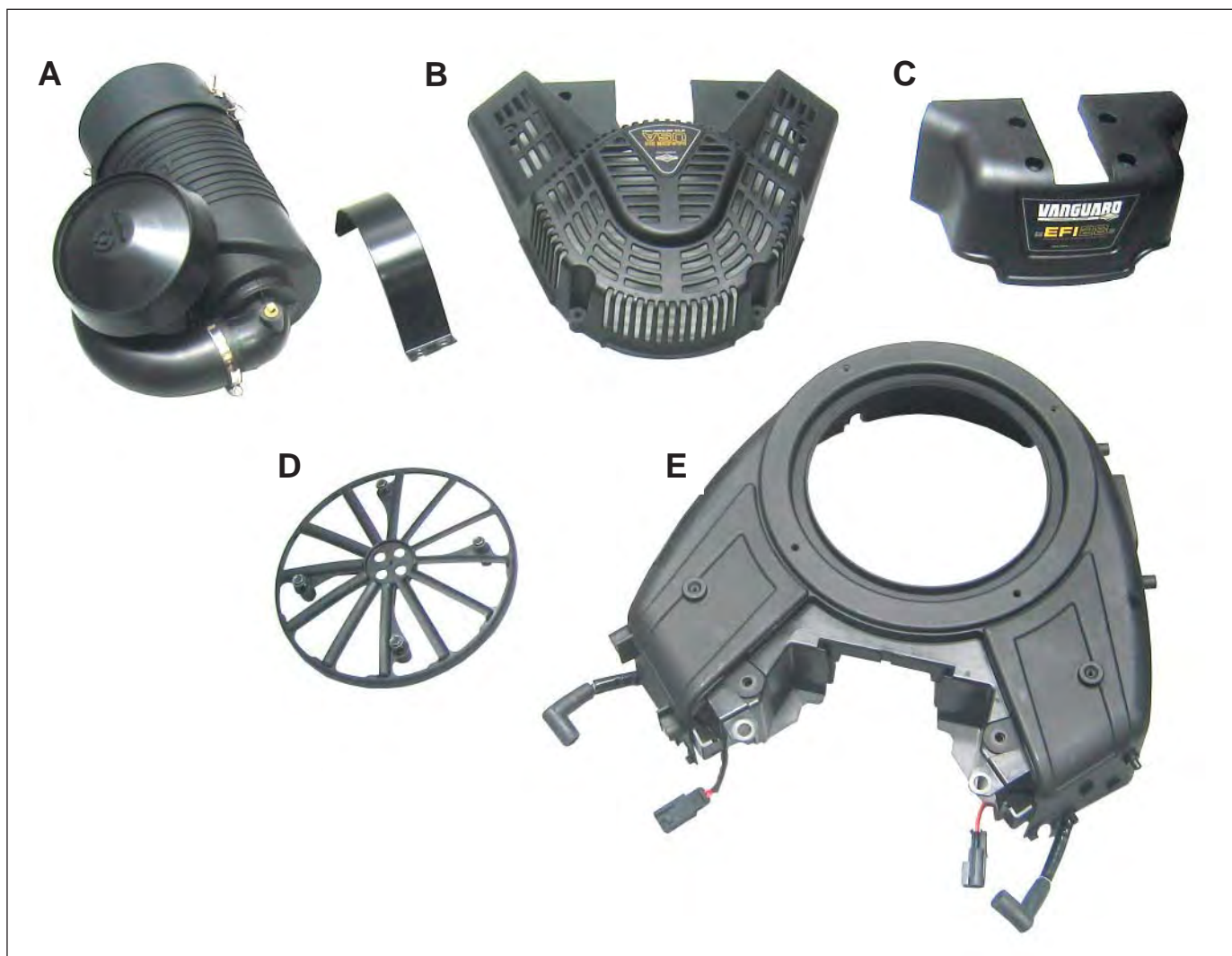


Figure 5-2 Remove Air Cleaner, Static Guard, Decorative Cover, Fan Guard, and Blower Housing

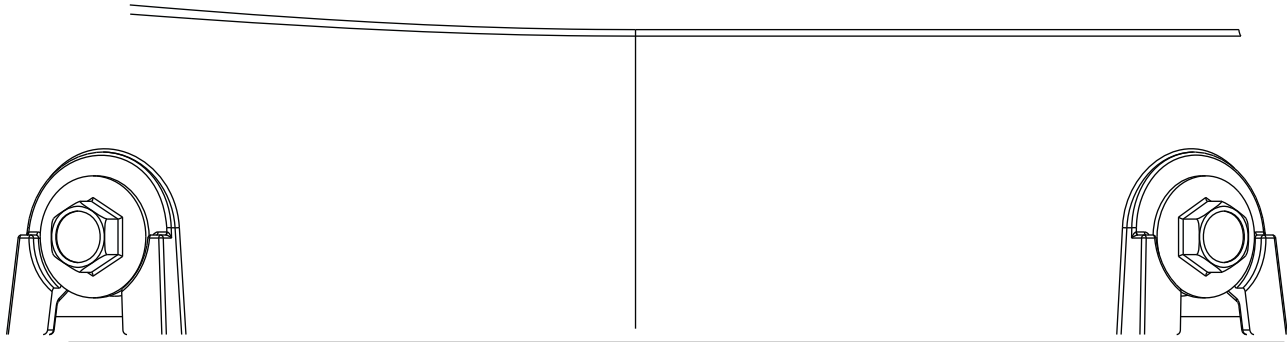


Figure 5-3 Verify Alignment of All Six Blower Housing Screws Before Tightening.

7. Remove two hex flange screws to release mechanical diaphragm fuel pump bracket from blower housing.
8. Remove four hex flange screws to release oil cooler bracket from blower housing.
9. Disconnect ignition coil connectors.
10. Push ignition coil conduit and connectors through openings to inboard side of blower housing.
11. Remove high tension leads from spark plug terminals.
12. Loosen four alignment screws at rear of blower housing.
13. Loosen two alignment screws at front of blower housing.
14. Raise blower housing to remove from engine.
4. Verify high tension leads are routed through slots on each side or damage will occur when blower housing is tightened.
5. Apply downward pressure to front of blower housing and hand tighten front two alignment screws.
6. Apply downward pressure to rear of blower housing and hand tighten the remaining four alignment screws.

**NOTE:** To be sure that blower housing is properly aligned, verify that washer head of each screw appears as shown in Figure 5-3.

### Installation

1. Push ignition coil connectors and conduit through openings to outboard side of blower housing.
2. Hand start six blower housing alignment screws, if not installed.
3. Place blower housing (E) into position on engine aligning slots with six alignment screws.
7. Alternately tighten six alignment screws to 75-95 in-lbs (9-11 Nm) using a crosswise pattern.
8. Install two hex flange screws to fasten blower housing to upper air cleaner bracket. Alternately tighten screws to 75-95 in-lbs (9-11 Nm).
9. Install high tension leads onto spark plug terminals.
10. Connect ignition coil connectors.
11. Install four hex flange screws to fasten oil cooler bracket to blower housing. Alternately tighten screws to 25-35 in-lbs (3-4 Nm) using a crosswise pattern.

12. Install two hex flange screws to fasten mechanical diaphragm fuel pump bracket to blower housing. Alternately tighten screws to 12-16 in-lbs (1-2 Nm).
13. Install two hex flange screws to fasten ECM bracket and ECM ground wire ring terminal to blower housing. Alternately tighten screws to 25-35 in-lbs (3-4 Nm).
14. Install four hex flange screws to fasten fan guard (D) to blower housing. Alternately tighten screws to 40-48 in-lbs (5 Nm) using a crosswise pattern.
15. Install four hex flange screws to fasten decorative cover (C) to upper air cleaner bracket. Alternately tighten screws to 50-70 in-lbs (6-8 Nm) using a crosswise pattern.
16. See Figure 5-2. Install six hex flange screws to fasten static guard (B) to blower housing. Alternately tighten screws to 25-35 in-lbs (3-4 Nm) using a crosswise pattern.
17. Install air cleaner (A) as follows:
  - a. Place air cleaner on upper air cleaner bracket.
  - b. Install two screws to fasten retaining strap to upper air cleaner bracket. Alternately tighten screws to 75-95 in-lbs (9-11 Nm).
  - c. Position band clamp on free end of air hose.
  - d. Install air hose onto air inlet elbow and tighten band clamp screw to 10-20 in-lbs (1-2 Nm).

### ECM

#### Removal

1. Remove two hex flange screws to release ECM bracket from blower housing.
2. Disconnect J1 and J2 connectors from ECM.

#### Installation

1. Connect J1 and J2 connectors to **new** ECM.
 

**NOTE:** The words BLACK and GREY are molded into the ECM housing to ensure proper installation of J1 (Grey) and J2 (Black) connectors.
2. Slide hex flange screw through inside ECM bracket flange and ground wire ring terminal. Start screw into inside boss on blower housing.
3. Install second Phillips screw on opposite side, and alternately tighten screws to 25-35 in-lbs (3-4 Nm).

### MAP/MAT Sensor

#### Removal

1. Remove air cleaner assembly, static guard and decorative cover. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Removal*, steps 1-3.
2. Pull out red secondary lock and press to disconnect MAP/MAT sensor connector.
3. Remove screw to release sensor bracket from threaded boss on intake manifold.
4. Remove sensor from intake manifold.

#### Installation

1. Lightly lubricate O-ring of **new** sensor.
2. Install sensor into intake manifold.
3. Install screw to fasten sensor bracket to threaded boss on intake manifold. Tighten screw to 50-60 in-lbs (6-7 Nm).
4. Connect MAP/MAT sensor connector. Push in red secondary lock to secure.



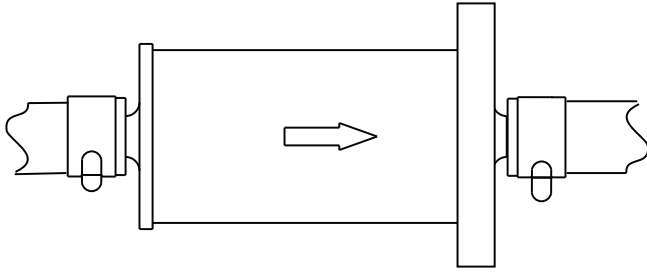


Figure 5-4 Point Arrow in Direction of Fuel Flow.

5. Install decorative cover, static guard, and air cleaner assembly. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Installation*, steps 15-17.

### Ignition Coil

#### Removal

1. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Removal*.
2. Remove two hex flange screws to release ignition coil from blower housing.

#### Installation

1. Install two hex flange screws to fasten **new** ignition coil to blower housing. Alternately tighten screws to 20-35 in-lbs (3-4 Nm).
2. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Installation*.

### Fuel Filter

#### Removal

1. See *Safety Precautions, Relieve Fuel System Pressure*.
2. Squeeze hose clip and remove fuel inlet hose from fuel filter fitting.

**NOTE:** Wrap shop towel around fuel filter fittings to catch any fuel leakage.

3. Squeeze hose clip and remove fuel outlet hose from fuel filter fitting.

#### Installation

1. With the arrow pointing in the direction of fuel flow, install **new** fuel filter between fuel inlet and outlet hoses. See Figure 5-4.
2. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the ignition switch back to ON and check for fuel leaks.

### Mechanical Diaphragm Fuel Pump

#### Removal

1. Squeeze hose clip at fuel inlet port (A) and remove hose from fuel filter. See Figure 5-5.
- NOTE:** Wrap shop towel around fittings to catch any fuel leakage.
2. Squeeze hose clip at fuel outlet port (B) and remove hose to fuel pump module.
3. Gently pull crankcase vacuum hose from pulse line fitting (C).
4. Remove two hex flange screws to release fuel pump from blower housing.

#### Installation

1. Orient **new** fuel pump with the crankcase vacuum and fuel inlet ports pointing down.

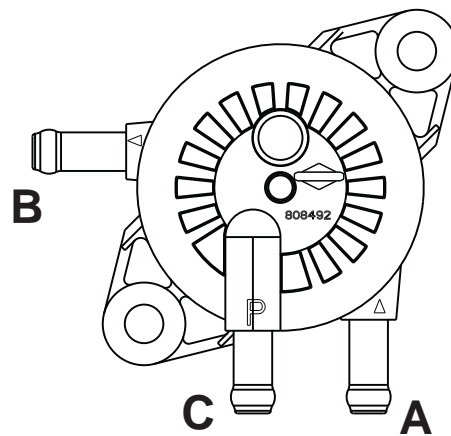


Figure 5-5 Mechanical Diaphragm Fuel Pump.

2. Install two hex flange screws to secure fuel pump to blower housing. Alternately tighten screws to 12-16 in-lbs (1-2 Nm).
3. Squeeze hose clip and install hose from fuel filter onto fuel inlet port (A).
4. Squeeze hose clip and install hose to fuel pump module onto fuel outlet port (B).
5. Gently push crankcase vacuum hose onto pulse line fitting (C). Be sure hose is not twisted after installation.
6. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the ignition switch back to ON and check for fuel leaks.

### Fuel Pump Module

#### Removal

1. See *Safety Precautions, Relieve Fuel System Pressure*.
  2. Squeeze clip and remove EVAP tube (to elbow fitting on cylinder 2 heat shield) from top of fuel pump module (A). See Figure 5-6.
  3. Remove three hex screws to release fuel pump module from bracket.
  4. Pull out grey secondary lock and press to disconnect fuel pump module connector (B).
  5. Squeeze two tabs on quick disconnect fitting to release fuel rail from fuel outlet port (C).
- NOTE:** Wrap shop towel around fittings to catch any fuel leakage.
6. Squeeze clip at fuel inlet port (D) and remove hose from mechanical diaphragm fuel pump.

**NOTE:** Fuel pump module may contain a small quantity of fuel. Hold fuel pump module with inlet and outlet fittings pointing upward until fuel can be drained into a suitable container.

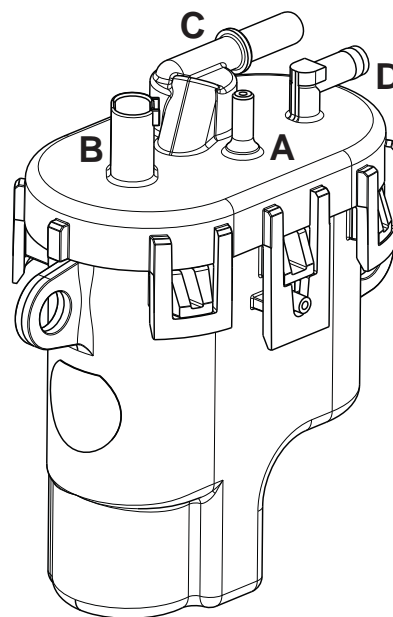


Figure 5-6 Fuel Pump Module.

#### Installation

1. Squeeze clip and install hose from mechanical diaphragm fuel pump onto fuel inlet port (D).
2. Firmly push quick disconnect fitting on fuel rail onto fuel outlet port (C). Gently tug on fitting to verify that it is properly seated and secure.
3. Connect fuel pump module connector (B). Push in grey secondary lock to secure.
4. Squeeze clip and install EVAP tube (to elbow fitting on cylinder 2 heat shield) at top of fuel pump module (A).
5. Install three hex screws to fasten fuel pump module to bracket. Alternately tighten screws to 60-70 in-lbs (7-8 Nm).
6. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the ignition switch back to ON and check for fuel leaks.



## Fuel Rail/Fuel Injectors

### Removal

1. See *Safety Precautions, Relieve Fuel System Pressure.*
2. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Removal.*
3. Remove EFI wire harness retaining clip from fuel rail. See A of Figure 5-7.
4. Remove fuel rail retaining clip from hole in CKP sensor bracket. Remove fuel rail retaining clip from fuel rail. See B of Figure 5-7.
5. Pull out green secondary lock and press to disconnect fuel injector connectors.
6. Remove two hex flange screws to release fuel injector cap flanges from intake manifold.
7. Remove retaining clips to release fuel injector caps from fuel injectors. Note orientation of the retaining clips prior to removal.
8. Remove fuel injectors from intake manifold.
9. Squeeze two tabs on quick disconnect fitting to release fuel rail from fuel pump module.

**NOTE:** Wrap shop towel around fitting to catch any fuel leakage.

### Installation

1. Lightly lubricate fuel injector O-rings with clean engine oil.
2. Install fuel injectors into intake manifold.
3. Install retaining clips to secure fuel injector caps to fuel injectors. Orient retaining clips as noted during removal. Be sure retaining clips are fully engaged.
4. Install two hex flange screws to fasten fuel injector cap flanges to intake manifold. Tighten screws to 50-60 in-lbs (6-7 Nm).

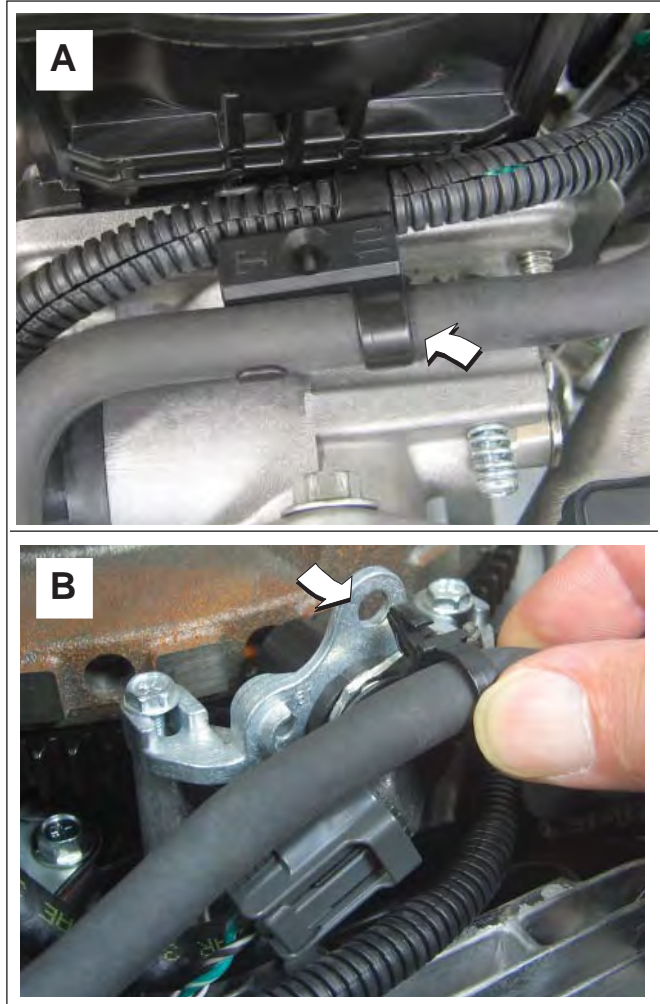


Figure 5-7 Remove/Install Fuel Rail From Clips.

5. Connect fuel injector connectors. Push in green secondary locks to secure.
6. Install EFI wire harness retaining clip onto fuel rail.
7. Install fuel rail retaining clip onto fuel rail. Install fuel rail retaining clip into hole in CKP sensor bracket.
8. Route quick disconnect fitting on fuel rail through opening in cylinder 2 heat shield to fuel pump module.
9. Firmly push quick disconnect fitting onto fuel pump module. Gently tug on fitting to verify that it is properly seated and secure.
10. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the

ignition switch back to ON and check for fuel leaks.

11. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Installation*.

### CKP Sensor

#### Removal

1. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Removal*.
2. Remove fuel rail retaining clip from hole in CKP sensor bracket.
3. Remove two hex flange screws to release CKP sensor bracket from cylinder mounting bosses.
4. Disconnect CKP sensor connector.

#### Installation

1. Start two hex flange screws to fasten CKP sensor bracket to cylinder mounting bosses. Alternately tighten screws until snug.
2. On side opposite connector, install mounting plate in groove of CKP sensor housing.
3. Insert CKP sensor into bracket. Align hole in mounting plate with hole stamped "49" on bracket. Install TORX screw and tighten to 25-35 in-lbs (3-4 Nm).
4. Loosen two bracket screws and adjust as necessary until gap between CKP sensor and flywheel tooth is 0.030 inches (0.76 mm). See Figure 5-8.
5. Alternately tighten CKP sensor bracket screws to 20-30 in-lbs (2-3 Nm).
6. Connect CKP sensor connector.
7. Install fuel rail retaining clip into hole in CKP sensor bracket.



Figure 5-8 Adjust CKP Sensor Gap.

8. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Installation*.

### EHT Sensor

**NOTE:** The EHT sensor is an integral part of the EFI wire harness and is not sold separately. Replace EFI wire harness if EHT sensor is bad.

### EFI Wire Harness

#### Removal

1. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Removal*.
2. Remove flywheel. Proceed as follows:
  - a. Using an air impact wrench or breaker bar, loosen flywheel nut.
  - b. Remove four hex flange screws to release fan from flywheel.
  - c. Unthread flywheel nut from crankshaft taper and then thread back on a couple turns.
  - d. Obtain flywheel puller (Part No. 19621).
  - e. Using the larger holes in the puller tool, and with the open side facing upward, place tool over crankshaft taper seating it on the flywheel nut.



Figure 5-9 Install Flywheel Puller (Part No. 19621).

- f. Install hex nut on each of two puller screws. Insert puller screws through holes in puller tool, and then thread into flywheel an equal number of turns.
  - g. Rotate hex nuts until contact is made with the puller tool. Verify that the puller tool is square. See Figure 5-9.
  - h. Holding screws to prevent rotation, alternately turn each hex nut in small increments until the flywheel is free.
  - i. Remove flywheel from crankshaft.
- ⚠ CAUTION: Keep fingers away from inside edge of flywheel during removal. Starter magnets are powerful and may pull the flywheel in with sufficient force to cause hand injury.**
- j. Remove screws to release puller tool from flywheel.
3. Remove four TORX screws to release backplate (and oil fill tube flange) from cylinder mounting bosses.
  4. See A of Figure 5-10. Proceed as follows:
    - Disconnect 6-place (or 8-place) engine to chassis connector.

- Disconnect starter solenoid ring and spade terminals.
  - Remove hex flange screw to release ground wire ring terminal from cylinder boss.
  - Remove two hex flange screws to release starter motor from cylinder 1.
  - Disconnect voltage regulator connector.
  - Remove hex flange screw to release fuse/relay block cover and voltage regulator bottom flange from cylinder 1 heat shield.
  - Disconnect ECM J1 and J2 connectors. Disconnect ECM ground wire ring terminal.
5. See B of Figure 5-10. Proceed as follows:
    - Remove TORX screw to release EHT sensor bracket from cylinder 1.

**NOTE:** Ignition coil connectors are disconnected during blower housing removal.

    - Disconnect fuel injector connectors.
    - Disconnect HO<sub>2</sub> sensor connector.
    - Disconnect MAP/MAT sensor connector.
    - Remove EFI wire harness from retaining clip on fuel rail (centered at front of intake elbow).
    - Cut cable strap to release EFI wire harness from intake manifold.
  6. See C of Figure 5-10. Proceed as follows:
    - Disconnect CKP sensor connector.
    - Disconnect fuel pump module connector.
    - Disconnect oil pressure switch connector. Release wire from hose clip on cylinder 2 heat shield.

7. Remove EFI wire harness from engine.

### Installation

1. Position **new** EFI wire harness on engine separating conduit and connectors into three groups as shown in Figure 5-10. Proceed as follows:

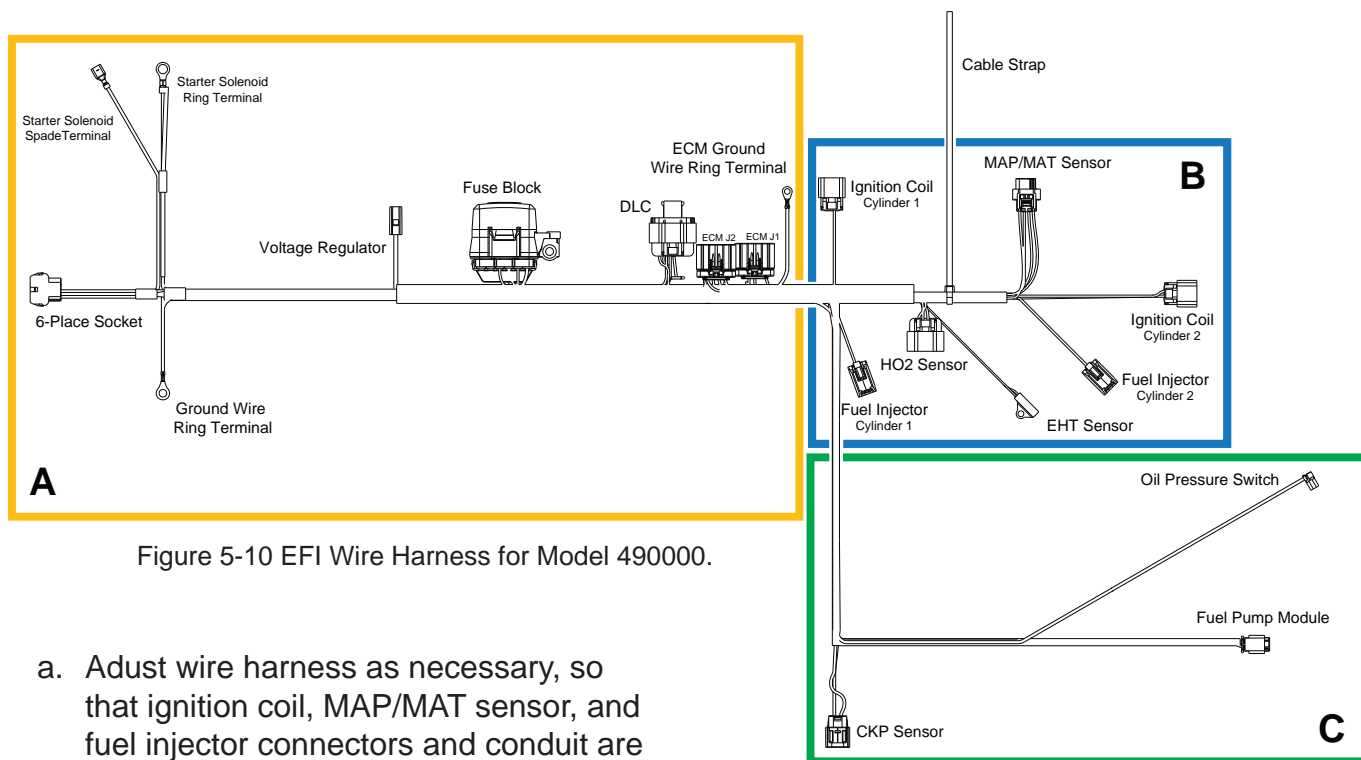


Figure 5-10 EFI Wire Harness for Model 490000.

- a. Adjust wire harness as necessary, so that ignition coil, MAP/MAT sensor, and fuel injector connectors and conduit are positioned below the fuel rail.
  - b. Draw out harness until ECM J1 and J2 connectors are seated at top of cylinder 1 valve cover and fuse/relay block is next to voltage regulator.
  - c. Draw out harness, so that 6-place (or 8-place) engine to chassis connector, starter solenoid ring and spade terminals, and ground wire ring terminal run under cylinder 1 heat shield to area of starter motor and oil fill tube.
  - d. Feed CKP sensor, fuel pump module, and oil pressure switch connectors and conduit under intake manifold (at point of cylinder 1 fuel injector), and then up between fuel rail and air intake elbow to outboard side of CKP sensor bracket.
  - e. Route fuel pump module and oil pressure switch connectors and conduit through opening at back of cylinder 2 heat shield to area of fuel pump module.
2. See C of Figure 5-10. Proceed as follows:
    - Connect CKP sensor connector.
    - Connect fuel pump module connector. Push in grey secondary lock to secure.
    - Route oil pressure switch sensor wire behind fuel pump module bracket, and then capture in hose clip on cylinder 2 heat shield. See Figure 5-11. Connect electrical connector to oil pressure switch installed in oil filter mount.
  3. See B of Figure 5-10. Proceed as follows:
    - Install EFI wire harness into retaining clip on fuel rail (centered at front of intake elbow).
    - Connect MAP/MAT sensor connector. Push in red secondary lock to secure.
    - Connect fuel injector connectors. Push in green secondary locks to secure.
    - Connect HO<sub>2</sub> sensor connector.





Figure 5-11 Capture Oil Pressure Switch Wire in Clip.

- Install cable strap to secure EFI wire harness to intake manifold.

**NOTE:** Ignition coil connectors are connected during blower housing installation.

- Orient EHT sensor with end rotated against tab on cylinder 1. Install TORX screw and tighten to 20-40 in-lbs (2-5 Nm).

4. See A of Figure 5-10. Proceed as follows:

- Connect ECM J1 and J2 connectors.

**NOTE:** ECM ground wire ring terminal is connected during blower housing installation.

- Install hex flange screw to fasten fuse/relay block cover and voltage regulator bottom flange to cylinder 1 heat shield. Tighten screw to 40-50 in-lbs (5-6 Nm).
- Connect voltage regulator connector.
- Keeping 6-place (or 8-place) engine to chassis connector, starter solenoid ring and spade terminals, and ground wire ring terminal on inboard side, install two hex flange screws to fasten starter motor to cylinder 1.

- Seat starter motor by alternately tightening screws to 50 in-lbs (6 Nm), and then final tighten screws to 145-165 in-lbs (16-19 Nm).

**NOTE:** Exercise care to avoid pinching, kinking or otherwise damaging wires as starter motor is installed.

- Keeping 6-place (or 8-place) engine to chassis connector, starter solenoid ring and spade terminals, and ground wire ring terminal on inboard side of oil fill tube, install four TORX screws to fasten backplate (and oil fill tube flange) to cylinder mounting bosses.

- Alternately tighten backplate screws to 90-110 in-lbs (10-12 Nm) using a crosswise pattern.

**NOTE:** Exercise care to avoid pinching, kinking or otherwise damaging wires as backplate and oil fill tube is installed.

- Connect starter solenoid ring and spade terminals.
- Install hex flange screw to fasten ground wire ring terminal to cylinder boss. Tighten screw to 22-35 in-lbs (3-4 Nm). See Figure 5-12.

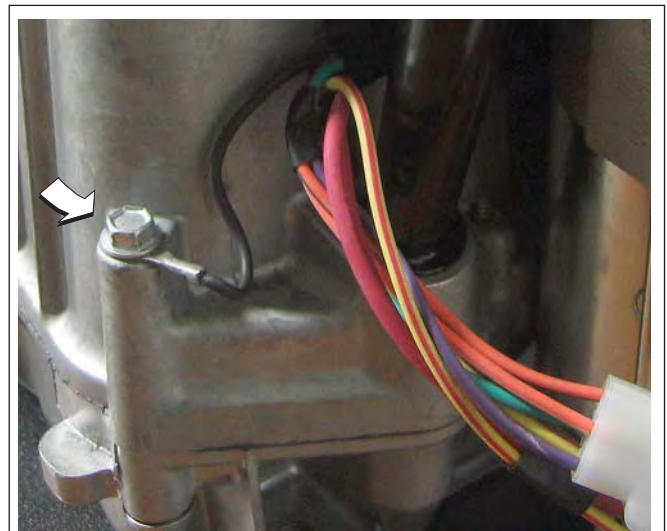


Figure 5-12 Fasten Ground Wire Ring Terminal to Boss.

- Connect 6-place (or 8-place) engine to chassis connector.

5. Install flywheel. Proceed as follows:

**⚠ CAUTION: Keep fingers away from inside edge of flywheel during installation. Stator magnets are powerful and may pull the flywheel in with sufficient force to cause hand injury.**

- a. Install flywheel onto crankshaft taper aligning crankshaft and flywheel keyways. Install key.
  - b. Install flywheel washer onto crankshaft taper with the dome side up.
  - c. Install flywheel nut onto crankshaft taper and tighten to 120-140 ft-lbs (163-190 Nm).
  - d. Install four hex flange screws to fasten fan to flywheel. Alternately tighten screws to 75-95 in-lbs (9-11 Nm).
6. See *Air Cleaner Assembly/Static Guard/Decorative Cover/Blower Housing, Installation*.

## HO<sub>2</sub> Sensor

### Removal

1. Disconnect HO<sub>2</sub> sensor connector.
2. Rotate sensor body hex CCW to release sensor from muffler. See Figure 5-13.

### Installation

1. Rotate sensor body hex CW to secure sensor to muffler. Tighten to 146-173 in-lbs (16-19 Nm).
2. Routing sensor cable conduit inboard of EFI wire harness, connect HO<sub>2</sub> sensor connector.



Figure 5-13 HO<sub>2</sub> Sensor.

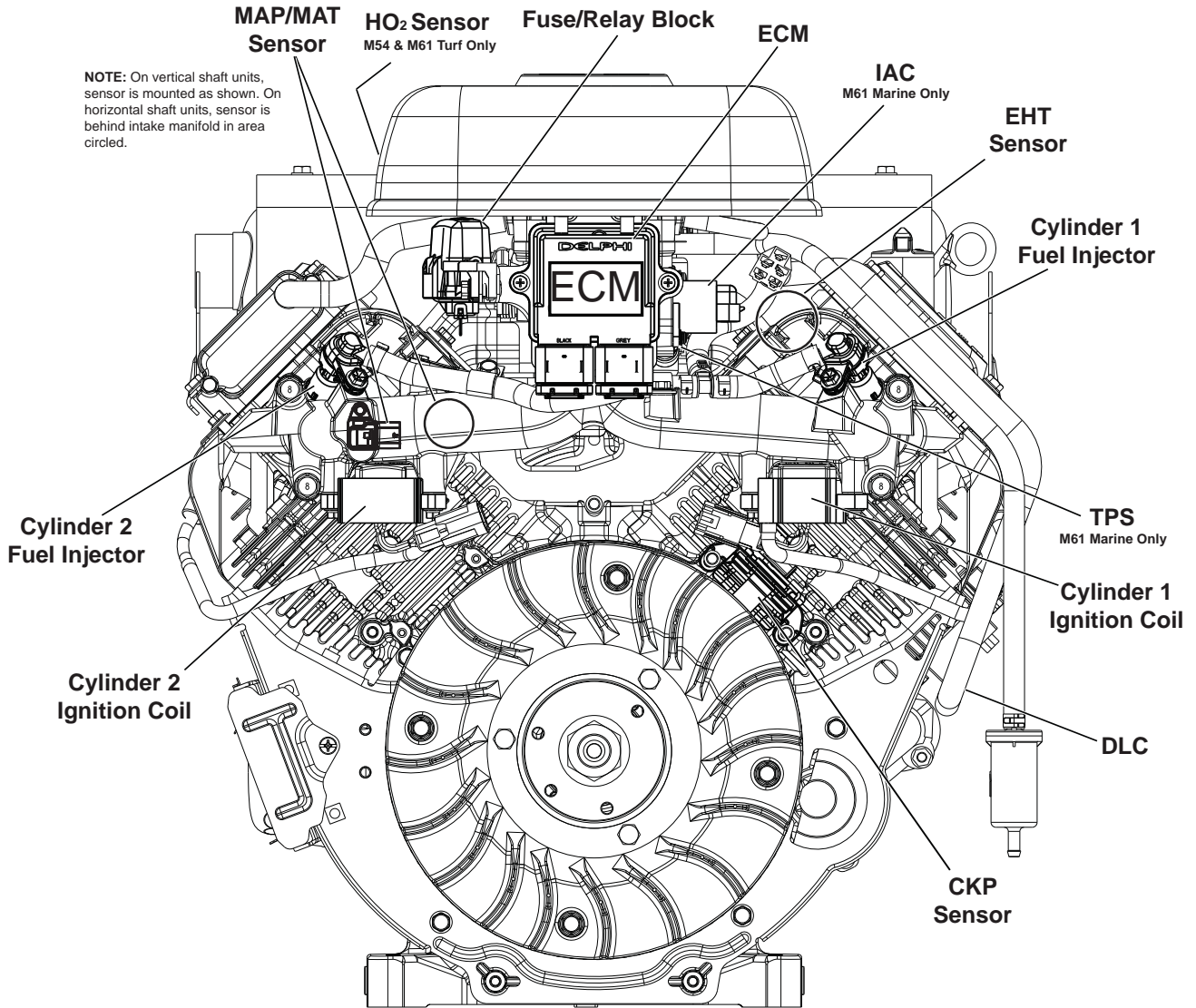


Figure 5-14 Models 540000/610000 Components.  
(Access Cover and Blower Housing Removed for Illustration Purposes.)



## Models 540000/610000 Fuel System Components

### Access Cover/Blower Housing

#### Removal

1. Remove two Phillips screws (1-2) to release access cover from blower housing. See Figure 5-15.
2. Lift access cover straight up to release tongues from grooves in blower housing.
3. If equipped, disconnect tachometer/hourmeter/MIL connector at back of access cover.
4. Remove four hex flange screws (3-6) from coupling nuts to release wire guard.
5. Remove hex flange screw (7) to release oil cooler bracket from blower housing.
6. Remove hex flange screws (8-9) to release left and right side air guides and blower housing from intake manifold.
7. Remove four coupling nuts (3-6). Lift blower housing straight up to disengage from posts.

#### Installation

1. Place blower housing into position engaging holes with four posts.
2. Verify high tension leads are routed through slots on each side or damage will occur when blower housing is tightened.
3. Install coupling nuts on posts (3-6). Alternately tighten coupling nuts to 78-96 in-lbs (9-11 Nm) using a crosswise pattern.
4. Install two hex flange screws (8-9) to fasten left and right side air guides and blower housing to intake manifold. Tighten screws to 78-96 in-lbs (9-11 Nm).
5. Install hex flange screw (7) to fasten oil cooler bracket to blower housing. Tighten

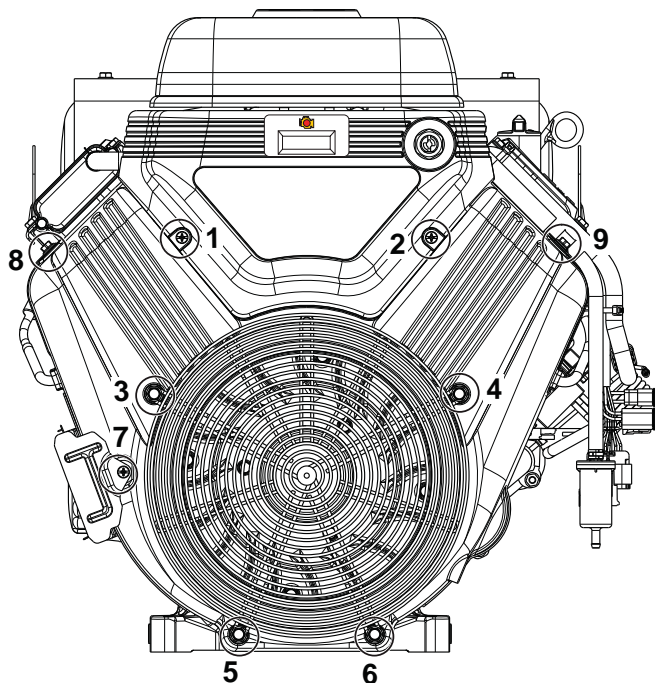


Figure 5-15 Remove Access Cover/Blower Housing.

- screw to 35-43 in-lbs (4-5 Nm).
6. Install four hex flange screws (3-6) to fasten wire guard to coupling nuts. Tighten screws to 78-96 in-lbs (9-11 Nm).
7. If equipped, connect tachometer/hourmeter/MIL connector at back of access cover.
8. Lower access cover straight down to engage tongues in grooves of blower housing.
9. Verify IAC connector wire harness conduit is routed through groove or damage will occur when access cover is tightened.
10. Install two Phillips screws (1-2) to fasten access cover to blower housing. Tighten screws to 35-43 in-lbs (4-5 Nm).

#### ECM

**NOTE:** A product improvement to dampen vibration to the ECM/fuse block bracket was recently introduced in production. A Briggs & Stratton Service Kit (Part No. 847337) to up-

grade product in the field includes a new fuse/relay block cover, ECM mounting bracket, rubber isolation mounts, and mounting hardware. See Service Bulletin DSB-1053 for details.

### Removal

1. Remove access cover. See *Access Cover/Blower Housing, Removal*, steps 1-3.
2. Remove two Phillips screws to release ECM from ECM/fuse block bracket.
3. Disconnect J1 and J2 connectors from ECM.

### Installation

1. Connect J1 and J2 connectors to **new** ECM.  
**NOTE:** The words BLACK and GREY are molded into the ECM housing to ensure proper installation of J1 (Grey) and J2 (Black) connectors.
2. Slide Phillips screw through ECM flange (Grey ECM J1 connector side) and ground wire ring terminal. Start screw into ECM/fuse block bracket.
3. Install second Phillips screw on opposite side, and alternately tighten screws to 35-52 in-lbs (4-6 Nm).
4. See *Access Cover/Blower Housing, Installation*, steps 7-10.

### MAP/MAT Sensor

#### Removal

1. See *Access Cover/Blower Housing, Removal*.
2. Pull out red secondary lock and press to disconnect MAP/MAT sensor connector.
3. Remove hex flange screw to release sensor flange from intake manifold.
4. Remove sensor from intake manifold.

#### Installation

1. Lightly lubricate O-ring of **new** MAP/MAT sensor.
2. Install sensor into intake manifold aligning hole in flange with hole in intake manifold.
3. Install hex flange screw and tighten to 78-96 in-lbs (9-11 Nm).
4. Connect MAP/MAT sensor connector. Push in red secondary lock to secure.
5. See *Access Cover/Blower Housing, Installation*.

### Ignition Coil

#### Removal

1. See *Access Cover/Blower Housing, Removal*.
2. Remove two hex flange screws to release ignition coil from intake manifold mounting bosses.  
**NOTE:** Do not cut cable strap on inside mounting boss. Cable strap is installed on ignition coil socket connector and is used for EFI wire harness retention.
3. Disconnect ignition coil connector.
4. Remove high tension lead from spark plug terminal.



Figure 5-16 Ignition Coil Assembly.

### Installation

1. Loop cable strap on ignition coil wire harness socket connector around inside mounting boss on intake manifold.
2. Connect ignition coil connector.
3. Install two hex flange screws to fasten ignition coil to intake manifold mounting bosses. Alternately tighten screws to 35-52 in-lbs (4-6 Nm).
4. Install high tension lead onto spark plug terminal.
5. See *Access Cover/Blower Housing, Installation*.

### Fuel Filter

#### Removal

1. See *Safety Precautions, Relieve Fuel System Pressure*.
2. Squeeze hose clip and remove fuel inlet hose from fuel filter fitting.
 

**NOTE:** Wrap shop towel around fuel filter fittings to catch any fuel leakage.
3. Squeeze hose clip and remove fuel outlet hose from fuel filter fitting.

#### Installation

1. With the arrow pointing in the direction of fuel flow, install **new** fuel filter between fuel inlet and outlet hoses. See Figure 5-17.
2. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the ignition switch back to ON and check for fuel leaks.

### Fuel Pump Module

#### Removal

1. See *Safety Precautions, Relieve Fuel System Pressure*.
2. Remove access cover. See *Access Cover/Blower Housing, Removal*, steps 1-3.

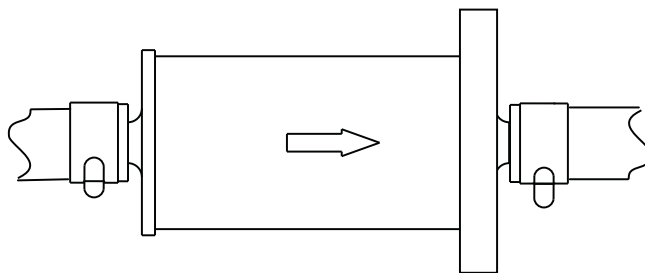


Figure 5-17 Point Arrow in Direction of Fuel Flow.

3. See *Air Cleaner Assembly, Removal*.
4. Squeeze clip and remove EVAP tube (A) to throttle body adapter. See Figure 5-18.
5. Remove three hex screws to release fuel pump module from bracket.
6. Pull out grey secondary lock and press to disconnect fuel pump module connector (B).
7. Squeeze two tabs on quick disconnect fitting to release fuel rail from fuel outlet port (C).

**NOTE:** Wrap shop towel around fitting to catch any fuel leakage.

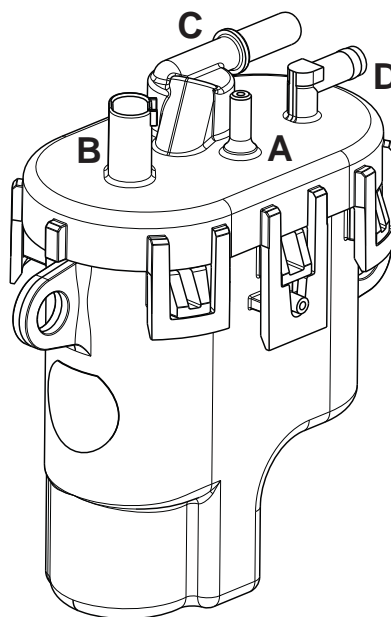


Figure 5-18 Fuel Pump Module.

8. Squeeze hose clip at fuel inlet port (D) and remove hose from fuel filter.
9. Remove fuel pump module.

**NOTE:** Fuel pump module may contain a small quantity of fuel. Hold fuel pump module with inlet and outlet fittings pointing upward until fuel can be drained into suitable container.

### Installation

1. Install **new** fuel pump module into bracket.
2. Squeeze hose clip and install hose from fuel filter onto fuel inlet port (D).
3. Firmly push quick disconnect fitting on fuel rail onto fuel outlet port (C). Gently tug fitting to verify that it is properly seated and secure.
4. Connect fuel pump module connector (B). Push in grey secondary lock to secure.
5. Squeeze clip and install EVAP tube (to throttle body adapter) at top of fuel pump module (A).
6. Install three hex screws to fasten fuel pump module to bracket. Alternately tighten screws to 78-96 in-lbs (9-11 Nm).
7. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the ignition switch back to ON and check for fuel leaks.
8. See *Air Cleaner Assembly, Installation*.

9. Install access cover. See *Access Cover/Blower Housing, Installation*, steps 7-10.

### Fuel Rail/Fuel Injectors

#### Removal

1. See *Safety Precautions, Relieve Fuel System Pressure*.
2. See *Access Cover/Blower Housing, Removal*.
3. See *Air Cleaner Assembly, Removal*.
4. Pull out green secondary lock and press to disconnect fuel injector connectors.
5. Remove two hex flange screws to release fuel injector cap flanges from intake manifold.
6. Remove two hex flange screws to release fuel rail clamps from intake manifold.
7. Remove retaining clips to release fuel injector caps from fuel injectors. Note orientation of the retaining clips prior to removal.
8. Remove fuel injectors from intake manifold.
9. Squeeze two tabs on quick disconnect fitting to release fuel rail from fuel pump module.

**NOTE:** Wrap shop towel around fitting to catch any fuel leakage.

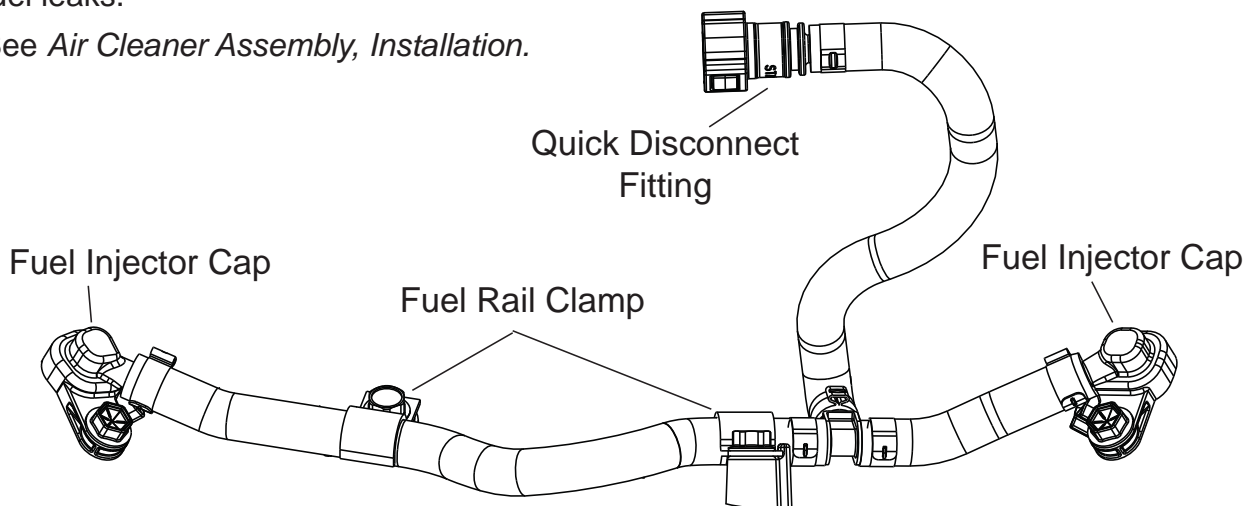


Figure 5-19 Fuel Rail Assembly.

**Installation**

1. Lightly lubricate fuel injector O-rings with clean engine oil.
2. Install fuel injectors into intake manifold.
3. Install retaining clips to secure fuel injector caps to fuel injectors. Orient retaining clips as noted during removal. Be sure retaining clips are fully engaged.
4. Install two hex flange screws to fasten fuel injector cap flanges to intake manifold. Tighten screws to 104-122 in-lbs (12-14 Nm).
5. Install two hex flange screws to fasten fuel rail clamps to intake manifold. Tighten screws to 78-96 in-lbs (9-11 Nm).
6. Connect fuel injector connectors. Push in green secondary locks to secure.
7. Firmly push quick disconnect fitting onto fuel pump module. Gently tug on fitting to verify that it is properly seated and secure.
8. Turn ignition switch ON for two seconds, and then OFF for 10 seconds. Turn the ignition switch back to ON and check for fuel leaks.
9. See *Air Cleaner Assembly, Installation*.
10. See *Access Cover/Blower Housing, Installation*.

**CKP Sensor****Removal**

1. See *Access Cover/Blower Housing, Removal*.
2. Remove two Phillips screws to release CKP sensor bracket from cylinder mounting bosses.
3. Disconnect CKP sensor connector.

**Installation**

1. Start two Phillips screws to fasten CKP sensor bracket to cylinder mounting bosses. Alternately tighten screws until snug.
2. On side opposite electrical connector, install mounting plate in groove of CKP sensor housing.
3. Insert CKP sensor into bracket. Align hole in mounting plate with hole stamped "61" on bracket. Install TORX screw and tighten to 25-35 in-lbs (3-4 Nm).
4. Loosen two bracket screws and adjust as necessary until gap between CKP sensor and flywheel tooth is 0.030 inches (0.76 mm).
5. Alternately tighten CKP sensor bracket screws to 22-35 in-lbs (3-4 Nm).
6. Connect CKP sensor connector.
7. See *Access Cover/Blower Housing, Installation*.

**Air Cleaner Assembly****Removal**

1. Remove plastic knob to release air filter cover.
2. Remove thumb nut from threaded stud.
3. Remove metal retainer plate.
4. Remove air filter element.
5. See A of Figure 5-20. Remove upper hex flange screws (1-2) to release air cleaner backplate from ECM/fuse block bracket.
6. Remove lower hex flange screws (3-4) to release air cleaner backplate from fuel pump module bracket.



7. Remove four hex screws (5-8) to release carburetor shield and throttle body adapter from throttle body.
8. See B of Figure 5-20. Squeeze clip and remove EVAP tube (to throttle body adapter) from top of fuel pump module.

### Installation

1. Insert four hex screws (5-8) through carburetor shield and air cleaner backplate.
 

**NOTE:** Air cleaner backplate is stamped “Air Filter Side” to ensure proper installation. Also, be sure carburetor shield is oriented so that the threaded stud is at the bottom.
2. At back of air cleaner backplate, hang gasket on four hex screws.
3. Insert four hex screws (5-8) through throttle body adapter and start into throttle body.
4. Start lower hex flange screws (3-4) to fasten air cleaner backplate to fuel pump module bracket.
5. Start upper hex flange screws (1-2) to fasten air cleaner backplate to ECM/fuse block bracket.
6. Alternately tighten four carburetor shield hex screws (5-8) to 78-96 in-lbs (9-11 Nm) using a crosswise pattern.
7. Alternately tighten four backplate hex flange screws (1-4) to 174-217 in-lbs (20-25 Nm) using a crosswise pattern.
8. Place air filter element onto air filter mount.
9. Fit metal retainer plate evenly and snugly into air filter element.
10. Install thumb nut onto threaded stud and tighten until snug.
11. Install air filter cover.

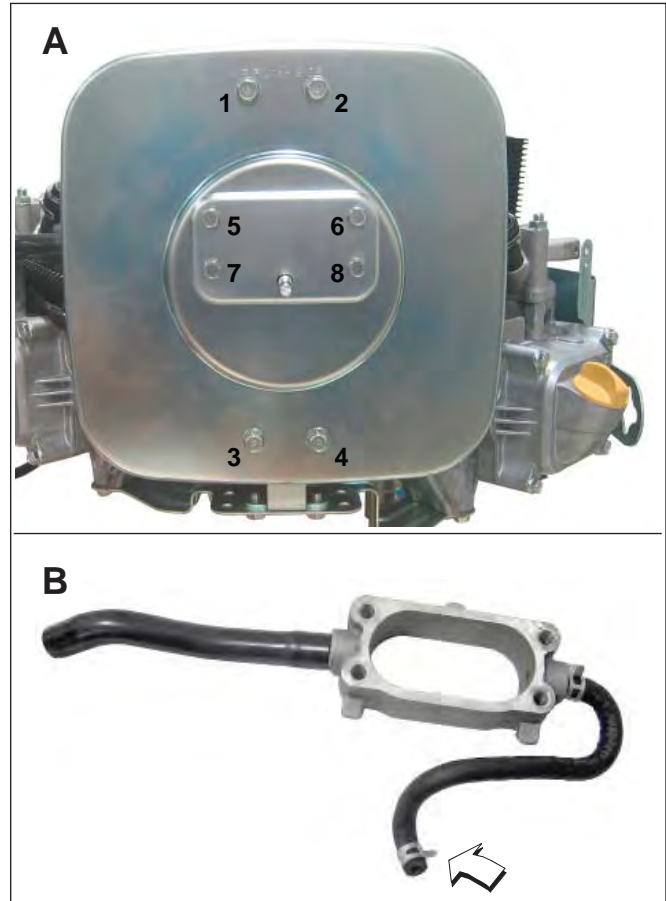


Figure 5-20 Air Cleaner Backplate/Throttle Body Adapter.

12. Install plastic knob onto threaded rod to secure air filter cover.

### Throttle Body

#### Removal

1. Remove access cover. See *Access Cover/Blower Housing, Removal*, steps 1-3.
2. See *Air Cleaner Assembly, Removal*.
3. Remove two Phillips screws to release ECM and ECM ground wire ring terminal from ECM/fuse block bracket.
4. Remove hex flange screw to release ECM/fuse block bracket from throttle body.
5. Remove two hex flange screws to release throttle body from intake manifold.
6. Disconnect IAC connector.

7. Disconnect TPS connector.

### Installation

1. Connect TPS connector.
2. Connect IAC connector.
3. Install two hex flange screws in throttle body flanges. Hang **new** gasket on screws, so that tab points toward idle screw with spring. See Figure 5-21.
4. Start hex flange screws into intake manifold. Alternately tighten screws to 78-96 in-lbs (9-11 Nm).
5. Install hex flange screw to fasten ECM/fuse block bracket to throttle body. Tighten screw until snug.
6. See *Air Cleaner Assembly, Installation*.
7. Tighten ECM/fuse block bracket to throttle body screw to 78-96 in-lbs (9-11 Nm).
8. Slide Phillips screw through ECM flange (Grey ECM J1 connector side) and ground wire ring terminal. Start screw into ECM/fuse block bracket.
9. Install second Phillips screw on opposite side, and alternately tighten screws to 35-52 in-lbs (4-6 Nm).



Figure 5-21 Throttle Body Gasket.



Figure 5-22 EHT Sensor.

10. Install access cover. See *Access Cover/Blower Housing, Installation*, steps 7-10.

### EHT Sensor

**NOTE:** The EHT sensor is an integral part of the EFI wire harness and is not sold separately. Replace EFI wire harness if EHT sensor is bad.

### EFI Wire Harness

#### Removal

1. See *Access Cover/Blower Housing, Removal*.
2. See *Air Cleaner Assembly, Removal*.
3. See A of Figure 5-23. On cylinder 2 side of engine, proceed as follows:
  - Remove screw to release fuse block cover from ECM/fuse block bracket.
  - Disconnect MAP/MAT sensor connector.
  - Disconnect fuel injector connector.
  - Disconnect ignition coil connector.
  - Remove Phillips screw to release ground wire ring terminal from cylinder boss.
  - Disconnect ECM J2 connector.



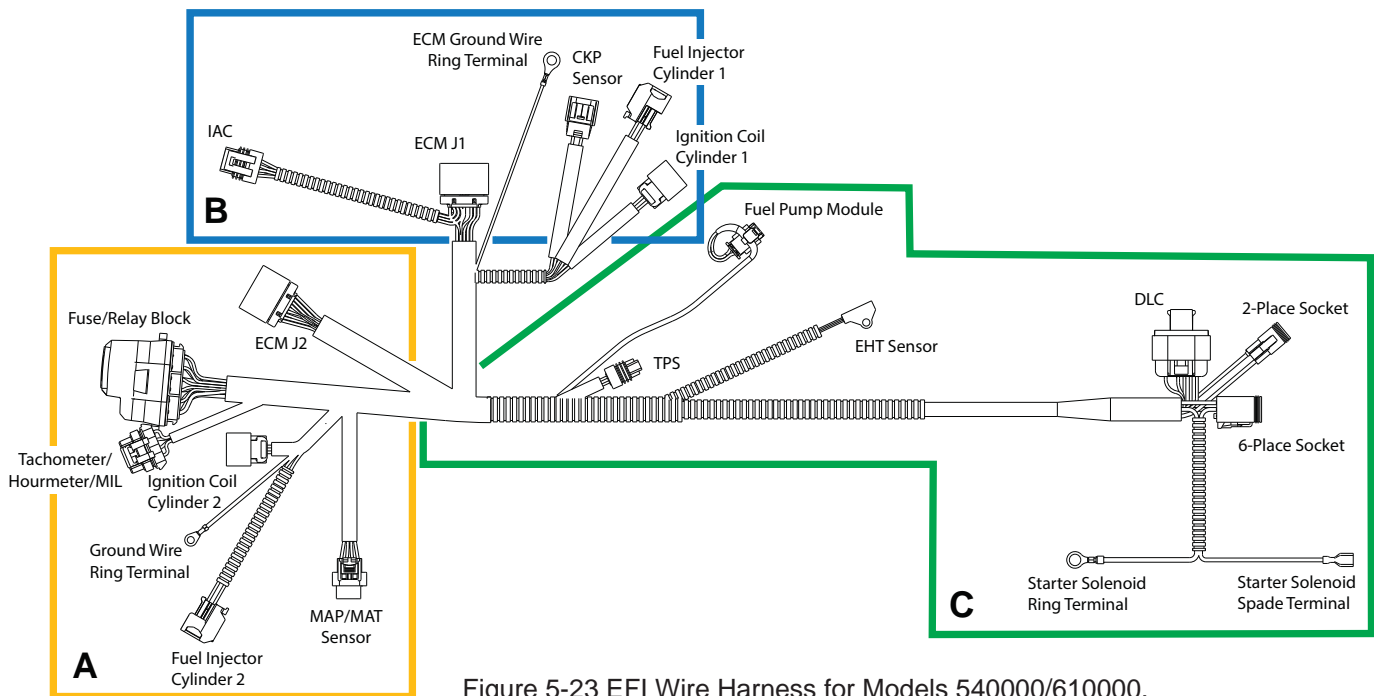


Figure 5-23 EFI Wire Harness for Models 540000/610000.

4. See B of Figure 5-23. On cylinder 1 side of engine, proceed as follows:

- Disconnect ECM J1 connector.
- Remove Phillips screw to release ECM ground wire ring terminal from ECM/fuse block bracket.
- Disconnect fuel injector connector.
- Disconnect ignition coil connector.
- Disconnect CKP sensor connector.
- Disconnect IAC connector.

5. See C of Figure 5-23. Proceed as follows:

- Disconnect TPS connector.
- Disconnect fuel pump module connector.
- Remove TORX screw to release EHT sensor bracket from cylinder 1.
- Disconnect 2- and 6-place (or single 8-place) engine to chassis connectors.
- Disconnect starter solenoid ring and spade terminals.

6. Remove two Phillips screws to remove air block mounting plate.

7. See C of Figure 5-23. Feed wire harness conduit and connectors up through air block mounting plate opening.

8. Cut two cable straps around intake manifold between air block mounting plate and inside ignition coil mounting bosses. Remove EFI wire harness from engine.

### Installation

1. Position **new** EFI wire harness at top of intake manifold separating conduit and connectors into three groups as shown in Figure 5-23.

2. See C of Figure 5-23. Feed wire harness connectors and conduit down through air block mounting plate opening to area below intake manifold.

3. See B of Figure 5-23. On cylinder 1 side of engine, proceed as follows:

- Connect ECM J1 connector.

- Slide Phillips screw through ECM flange (Grey ECM J1 connector side) and ground wire ring terminal. Start screw into ECM/fuse block bracket and tighten to 35-52 in-lbs (4-6 Nm).
  - Connect fuel injector connector. Push in green secondary lock to secure.
  - Install **new** cable strap through ignition coil wire harness socket connector, install over inside ignition coil mounting boss, and connect connector.
  - Connect CKP sensor connector.
  - Connect IAC connector.
4. See A of Figure 5-23. On cylinder 2 side of engine, proceed as follows:
    - Install screw to fasten fuse block cover to ECM/fuse block bracket. Tighten screw to 78-96 in-lbs (9-11 Nm).
    - Connect MAP/MAT sensor connector. Push in red secondary lock to secure.
    - Connect fuel injector connector. Push in green secondary lock to secure.
    - Install **new** cable strap through ignition coil wire harness socket connector, install over inside ignition coil mounting boss, and connect connector.
    - Install Phillips screw to fasten ground wire ring terminal to cylinder boss. Tighten screw to 22-35 in-lbs (3-4 Nm).
    - Connect ECM J2 connector.
  5. See C of Figure 5-23. Proceed as follows:
    - Connect TPS connector.
    - Connect fuel pump module connector. Push in grey secondary lock to secure.
    - Orient EHT sensor with end rotated against tab on cylinder 1. Install TORX screw and tighten to 35-52 in-lbs (4-6 Nm). See Figure 5-22.
  6. Connect starter solenoid ring and spade terminals.
  - Connect 2- and 6-place (or single 8-place) engine to chassis connectors.
  6. Install two Phillips screws (with captive washers) to fasten air block mounting plate to cylinder. Alternately tighten screws to 22-35 in-lbs (3-4 Nm).
  7. Install cable strap around intake manifold between air block mounting plate and inside cylinder 2 ignition coil mounting boss capturing convoluted tubing of ignition coil and fuel injector.
  8. Install cable strap around intake manifold between air block mounting plate and inside cylinder 1 ignition coil mounting boss capturing fuel injector, ignition coil and CKP sensor conduit.
  9. See *Air Cleaner Assembly, Installation*.
  10. See *Access Cover/Blower Housing, Installation*.

## IAC

### Removal

1. Remove access cover. See *Access Cover/Blower Housing, Removal*, steps 1-3.
2. See *Air Cleaner Assembly, Removal*.
3. Disconnect IAC connector.
4. Remove two Phillips screws to release IAC from throttle body.

### Installation

1. Install two Phillips screws to fasten IAC to throttle body. Alternately tighten screws to 22-35 in-lbs (2-4 Nm).
2. Connect IAC connector.
3. See *Air Cleaner Assembly, Installation*.
4. Install access cover. See *Access Cover/Blower Housing, Installation*, steps 7-10.

## TPS

### Removal/Installation/Adjustment

1. See *Throttle Body, Removal*.
2. Remove two Phillips screws to release TPS from throttle body. See A and B of Figure 5-24.
3. Remove dead idle screw with spring from throttle body. See C of Figure 5-24.
4. Mark throttle plate position for ease of installation. See D of Figure 5-24.
5. Remove two screws to release throttle plate. See E of Figure 5-24.
6. Rotate throttle, so that lever contacts the dead idle screw boss. See F of Figure 5-24.
7. Install two Phillips screws to fasten **new** TPS to throttle body, but leave loose for later adjustment. See G of Figure 5-24.
8. Apply Loctite 271 or equivalent to two throttle plate screws. Install screws to fasten throttle plate to throttle body. Alternately tighten screws to 8 in-lbs (1.0 Nm).
9. Install dead idle screw with spring, but leave loose for later adjustment.

**NOTE:** If ETA software is not available, use DVOM and follow instructions beginning at step 19.

### Using ETA Diagnostic Software

10. See *Throttle Body, Installation*, steps 1-8.
11. Run the engine at no load idle, throttle in the idle position.
12. Slew the IAC to 0 steps. See H of Figure 5-24.
13. Adjust the dead idle screw until the engine runs at 600 +/- 50 RPM.
14. Turn the engine off.
15. With throttle resting against the dead idle screw, use the software to adjust the TPS Sensor Actual voltage to 0.73 +/- .02 volts. See H of Figure 5-24.
16. Alternately tighten two TPS screws to 10-16 in-lbs (1-2 Nm).
17. Install access cover. See *Access Cover/Blower Housing, Installation*, steps 7-10.
18. Proceed to step 26 to reset ECM memory.

### Using DVOM

19. See *Throttle Body, Installation*, steps 1-4.
20. Run engine at no load idle, throttle in the idle position.
21. Use index finger or plug to block IAC air passage. See I of Figure 5-24.
22. While IAC air passage is blocked, adjust dead idle screw until engine runs at 600 +/- 50 RPM.
23. Turn engine OFF and proceed as follows:
  - a. Back probe terminal 3 (Pink/Black wire) of TPS connector.
  - b. Connect terminal 3 back probe to red meter test lead on DVOM.
  - c. Back probe terminal 2 (Brown wire) of TPS connector.
  - d. Connect terminal 2 back probe to black meter test lead on DVOM.
  - e. Set DVOM to read volts DC.
  - f. Turn Ignition ON, Engine OFF.
  - g. Observe voltage on DVOM.

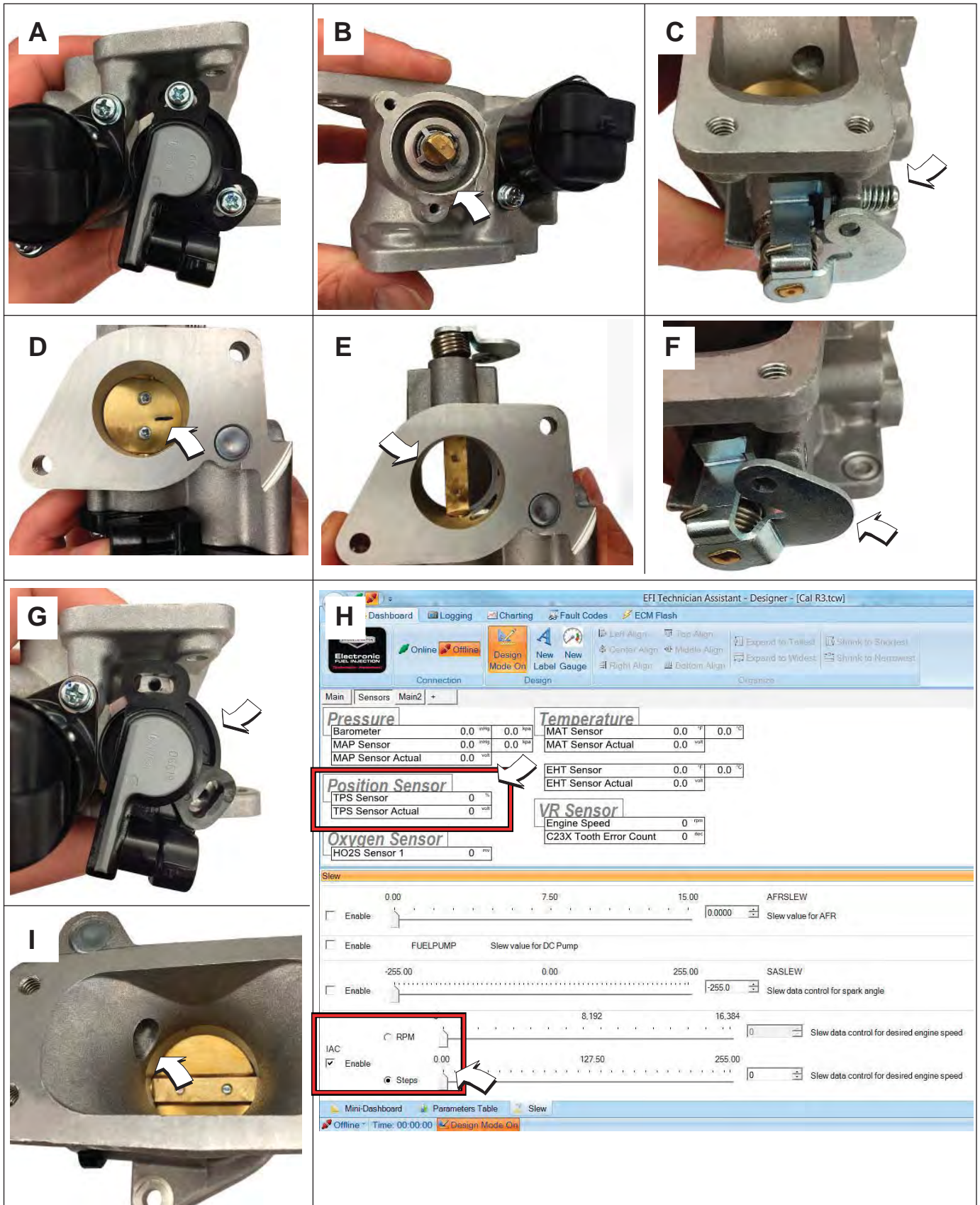


Figure 5-24 TPS Removal/Installation/Adjustment.



- h. With throttle resting against the dead idle screw, rotate the TPS until the output voltage is 0.73 +/- 0.02 volts.
- i. Alternately tighten two TPS screws to 10-16 in-lbs (1-2 Nm).

24. See *Throttle Body, Installation*, steps 5-9.

25. Proceed to step 26 to reset ECM memory.

26. Reset ECM memory as follows:

- a. Turn Ignition OFF for at least 10 seconds.
- b. Cycle Ignition ON and OFF five times in five seconds.
- c. End cycle in the OFF position and wait at least 10 seconds.
- d. Turn Ignition ON to reset ECM memory to the default values.

## HO<sub>2</sub> Sensor

### Removal

1. Remove access cover. See *Access Cover/Blower Housing, Removal*, steps 1-3.
2. See *Air Cleaner Assembly, Removal*.
3. Disconnect HO<sub>2</sub> sensor connector.
4. Rotate sensor body hex CCW to release sensor from muffler.

### Installation

1. Rotate sensor body hex CW to secure sensor to muffler. Tighten to 146-173 in-lbs (16-19 Nm).
2. Connect HO<sub>2</sub> sensor connector.
3. See *Air Cleaner Assembly, Installation*.
4. Install access cover. See *Access Cover/Blower Housing, Installation*, steps 7-10.

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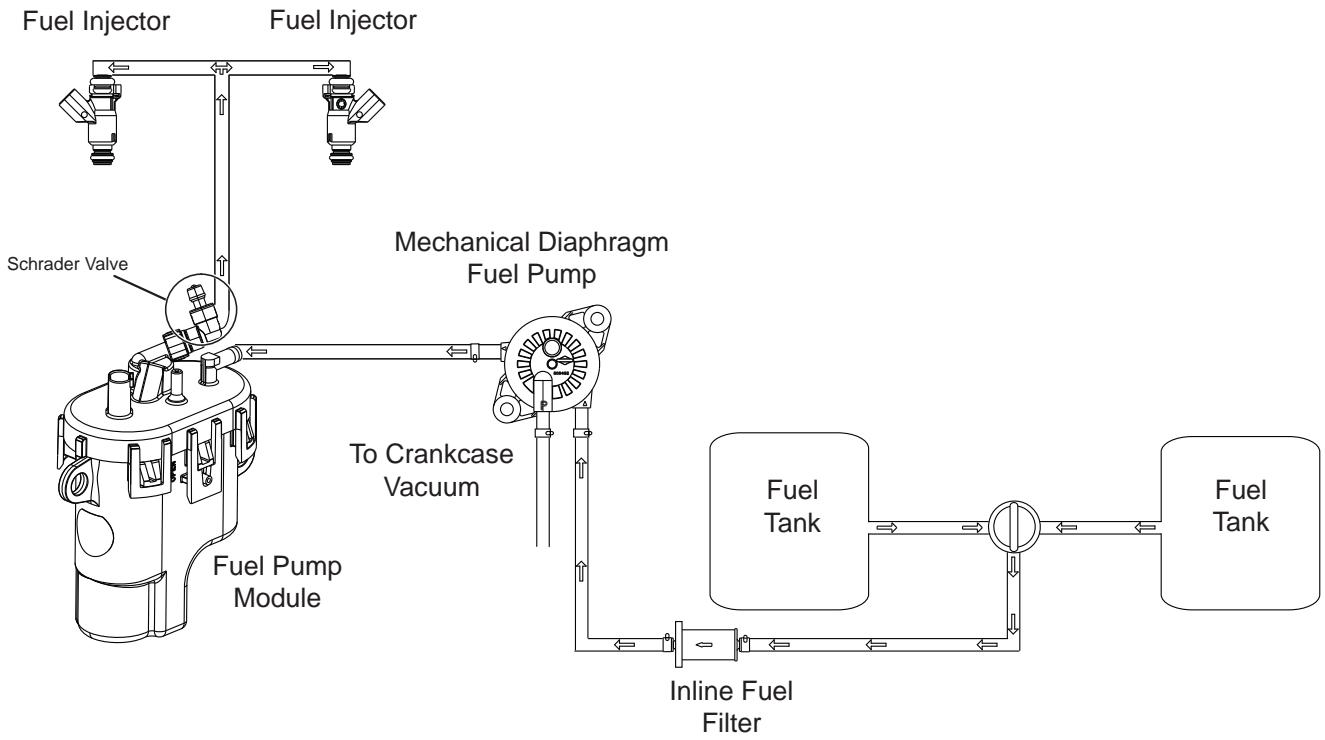


Figure 5-25 Typical Fuel Flow Diagram for Model 490000.

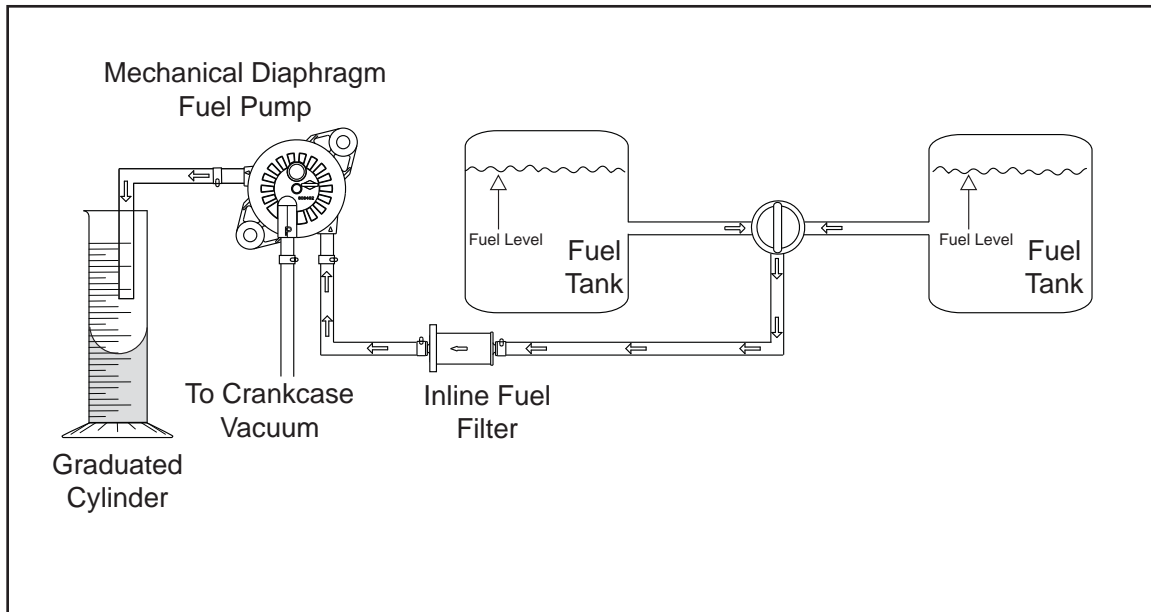


Figure 5-26 Perform Volumetric Test.



## Mechanical Diaphragm Fuel Pump for Model 490000

### Volumetric Test

Perform a volumetric test to verify that the proper amount of fuel is being delivered to the engine. Proceed as follows:

1. See *Safety Precautions*.
2. Remove battery negative cable (black) from battery negative (-) terminal.
3. Squeeze clip at fuel outlet port and remove hose to fuel pump module.  
**NOTE:** Wrap shop towel around fitting to catch any fuel leakage.
4. Obtain a stop watch and a graduated cylinder.
5. Attach suitable hose to fuel outlet port and direct free end into graduated cylinder. See Figure 5-26.
6. Install battery negative cable (black) to battery negative (-) terminal.
7. Start engine and watch for fuel discharge from outlet port hose. As soon as fuel flow is observed, start the stopwatch.
8. Run engine for 30 seconds at 2200 RPM.
9. After the time has elapsed, turn off the engine and stop the watch.
10. Measure the volume of fuel discharged into the graduated cylinder. See the table below for the approximate amount of fuel that should be discharged.

Pump Fuel for 30 Seconds	
Approximate Fuel Amount	237 ml
	0.5 pint
	0.25 quart
	1.0 cup

### NOTES:

- Position the fuel tank so that it is near level with the fuel pump. Do not place the graduated cylinder **BELOW** the fuel pump or gravity feed will produce false results.
- The engine will run longer than the 30 second test interval using fuel trapped in the fuel pump module.
- View the graduated cylinder with your eyes directly level with the fuel. Note that the fuel curves up the sides of the graduated cylinder. This curve is called a meniscus. For the most accurate reading, read the measurement from the bottom of the meniscus.
- The volumetric measurement is only approximate. The fuel pump is likely functioning properly if the test results are within 10% of the approximate fuel amount.

### Engine Cranks But Will Not Start

Use the starter to turn the engine over for 10 seconds. See the table below for the approximate amount of fuel that should be discharged.

Crank Engine for 10 Seconds	
Approximate Fuel Amount	65 ml
	0.13 pint
	0.06 quart
	0.27 cup

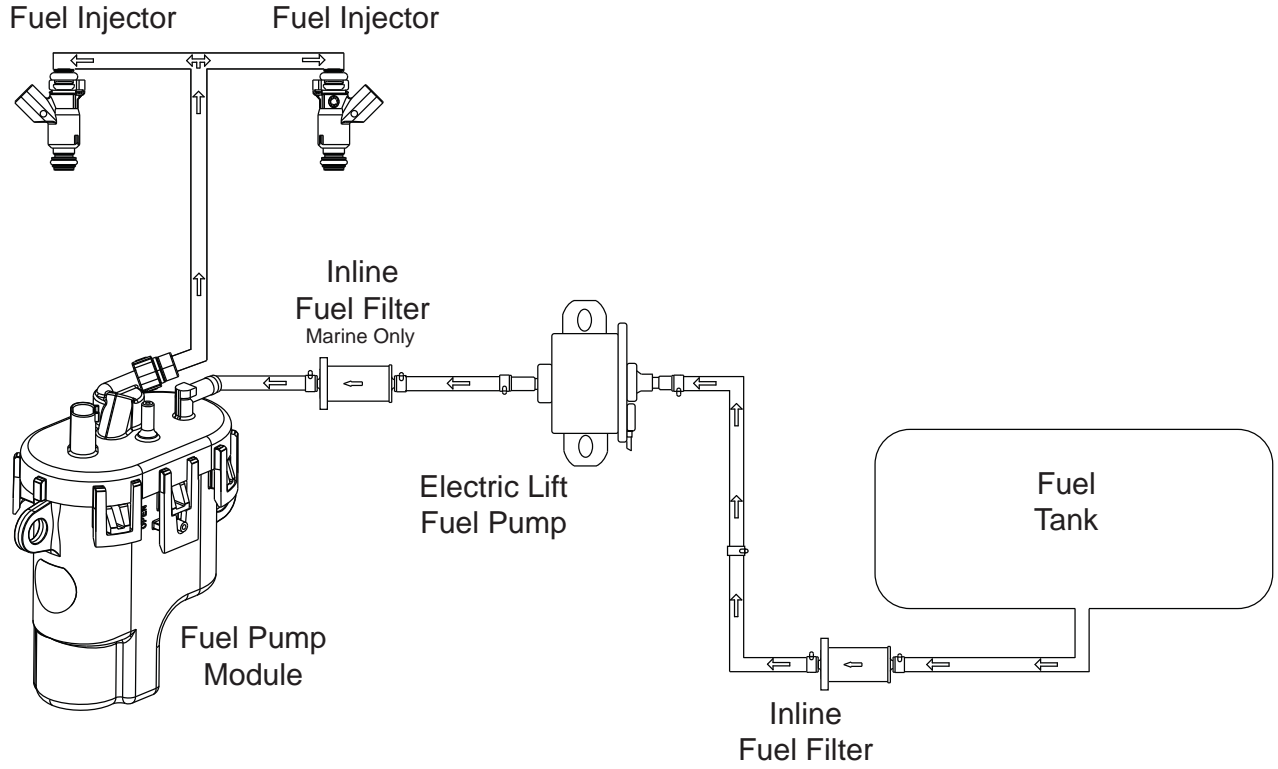


Figure 5-27 Typical Fuel Flow Diagram for Models 540000/610000.

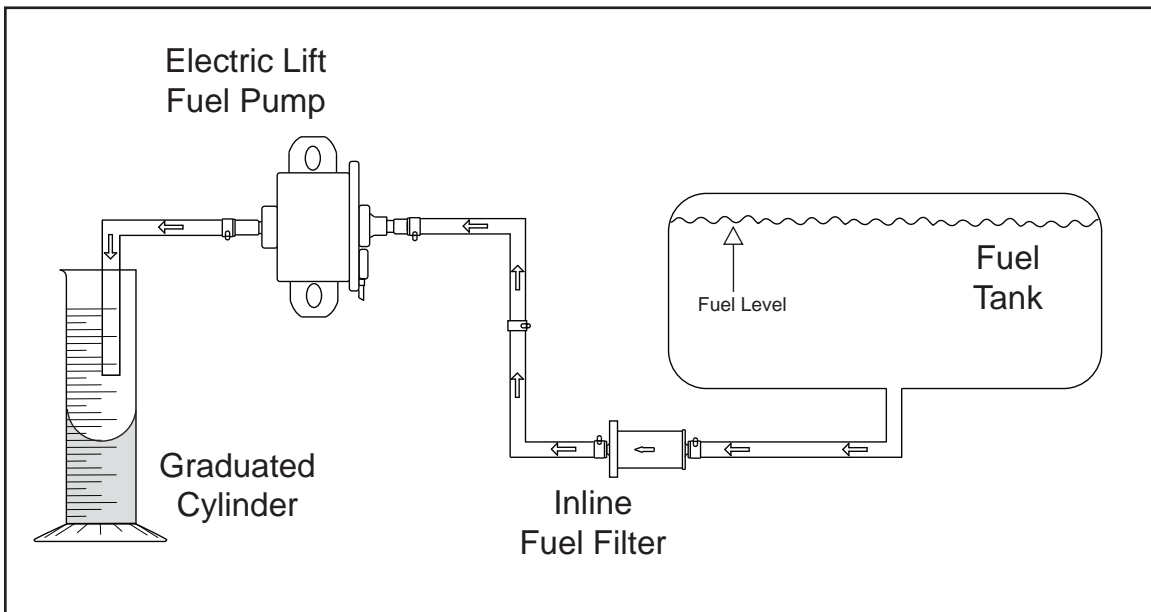


Figure 5-28 Perform Volumetric Test.

## Electric Lift Fuel Pump for Models 540000/610000

### Volumetric Test

Perform a volumetric test to verify that the proper amount of fuel is being delivered to the engine. Proceed as follows:

1. See *Safety Precautions*.
2. Remove battery negative cable (black) from battery negative (-) terminal.
3. Squeeze clip at fuel outlet port and remove hose to fuel pump module.  
**NOTE:** Wrap shop towel around fitting to catch any fuel leakage.
4. Obtain a stop watch and a graduated cylinder.
5. Attach suitable hose to fuel outlet port and direct free end into graduated cylinder. See Figure 5-28.
6. Install battery negative cable (black) to battery negative (-) terminal.
7. Start engine and watch for fuel discharge from outlet port hose.
8. Start the stopwatch as soon as fuel flow is observed.

**NOTE: The fuel pump primes for 2 seconds when the ignition is turned ON. Do not count this fuel in the volumetric measurement.**

- If the engine will not run, connect a fused jumper wire from the fuel pump electrical connector to 12v B+. See *Section 3: Wire Schematics and Pin-Outs* for reference.
9. After 30 seconds has elapsed, turn off the engine and stop the watch.

10. Measure the volume of fuel discharged into the graduated cylinder. See the table below for the approximate amount of fuel that should be discharged.

Pump Fuel for 30 Seconds	
Approximate Fuel Amount	478 ml
	1.0 pint
	0.5 quart
	2.0 cup

### NOTES:

- Position the fuel tank so that it is near level with the fuel pump. Do not place the graduated cylinder **BELOW** the fuel pump or gravity feed will produce false results.
- The engine will run longer than the 30 second test interval using fuel trapped in the fuel pump module.
- View the graduated cylinder with your eyes directly level with the fuel. Note that the fuel curves up the sides of the graduated cylinder. This curve is called a meniscus. For the most accurate reading, read the measurement from the bottom of the meniscus.
- The volumetric measurement is only approximate. The fuel pump is likely functioning properly if the test results are within 10% of the approximate fuel amount.

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