

# E-TEC DIRECT FUEL INJECTION

## SERVICE TOOLS

Description	Part Number	Page
EXTRACTOR ADAPTOR .....	529 036 136 .....	195
FLUKE 115 MULTIMETER .....	529 035 868 .....	193, 203, 219, 221
INJECTOR RETAINER PLATE.....	529 036 137 .....	191
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## SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
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SNAP-ON SCREW.....	CJ93-1 .....	195

## SERVICE PRODUCTS

Description	Part Number	Page
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LOCTITE 592 (PIPE SEALANT) .....	293 800 018 .....	222
PULLEY FLANGE CLEANER .....	413 711 809 .....	213

## GENERAL

### WARNING

Always disconnect the magneto connector prior to:

- Disconnecting any fuel hose.
- Removing a fuel injector.
- Removing a spark plug cable or spark plug.

Otherwise, fuel vapors may ignite in presence of a spark creating a fire hazard.

### WARNING

The fuel system is under high pressure. Proceed with care when working on the fuel system. Wear safety glasses and work in a well ventilated area.

Release fuel system pressure prior to removing fuel system components. Refer to *FUEL TANK REMOVAL* in *FUEL TANK AND FUEL PUMP* subsection.

### WARNING

Perform a fuel pressure test each time a component from the fuel system is removed. Prior to starting the engine when a fuel hose was disconnected or a fuel injector removed:

- Ensure all fuel lines are properly connected.
- Inspect engine compartment to detect any fuel leakage or an abnormally strong fuel odor which may be an indication of a fuel leak that is not readily visible.

## SYSTEM DESCRIPTION

The ECM reads the input signals from different sensors which indicate engine operating conditions at micro-second intervals.

The ECM calculates the proper air/fuel ratio and activates the output to fuel injectors.

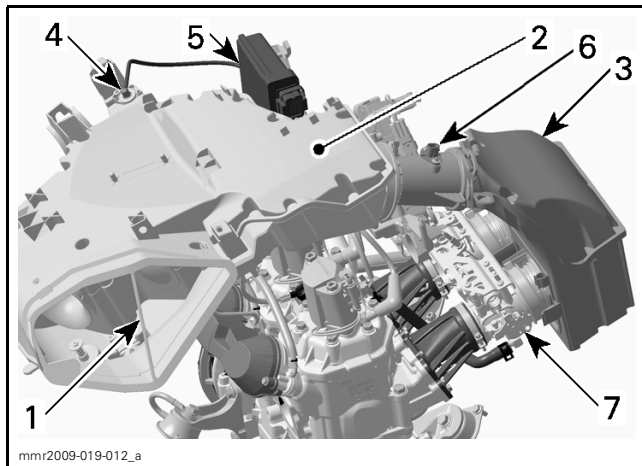
Signals from sensors are used by the ECM to determine the injection parameters (fuel maps required for optimum air-fuel ratio).

The crankshaft position sensor (CPS), the throttle position sensor (TPS) are the primary sensors used to control the injection. Other sensors (like temperature sensors, etc.) are used as secondary input.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

#### Air Induction



##### TYPICAL

1. Mesh filter
2. Secondary air intake silencer
3. Primary air intake silencer
4. Air pressure fitting and hose
5. Air pressure sensor in ECM
6. Air temperature sensor
7. Throttle body

Air flows through a mesh filter in the secondary air intake silencer mounted on top of engine. The mesh filter prevents snow from being drawn into the engine.

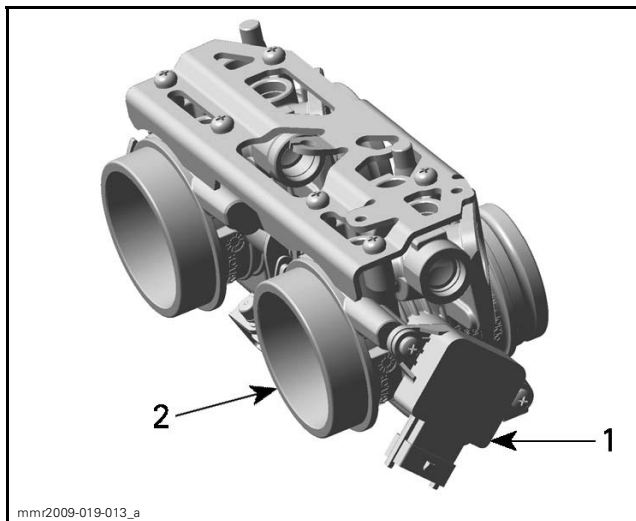
Air pressure is measured in the secondary air intake silencer through a tube connected to the ECM.

Air then flows through the primary air intake silencer.

Air temperature is measured at the entry point of the primary air intake silencer.

Air is then drawn in through a dual throttle body mounted on the engine intake side.

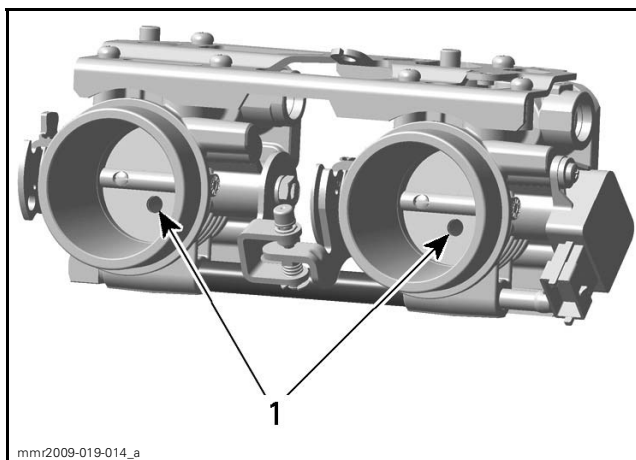
#### Throttle Body



1. Throttle body
2. TPS (Throttle Position Sensor)

A Dell'Orto dual throttle body assembly is directly mounted on the intake flange of each cylinder ((52 mm)).

The air flow is controlled by two throttle plates. Each throttle plate has a 6.8 mm (.268 in) idle port in it.

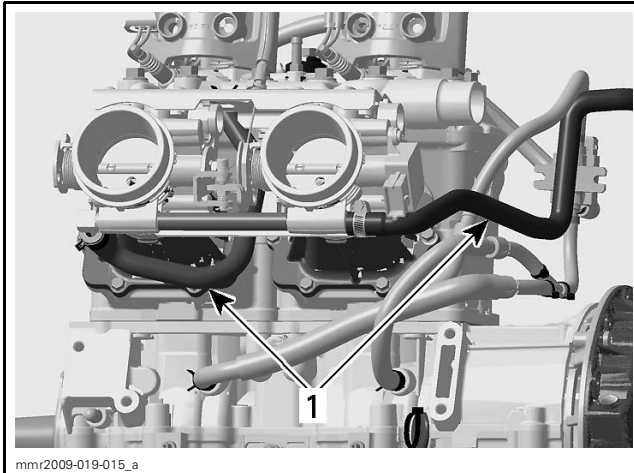


1. Idle ports

Since there is a constant airflow through the idle ports of the throttle plates, the idle speed is controlled by the ECM by varying the amount of fuel injected in the combustion chamber and by controlling the injection timing.

The TPS (Throttle Position Sensor) is fitted on the throttle body. The TPS sends throttle angle position to the ECM.

Engine coolant flows through the throttle body to prevent potential freezing of throttle plates due to the temperature drop naturally created by the venturi.



1. Coolant-heated lines

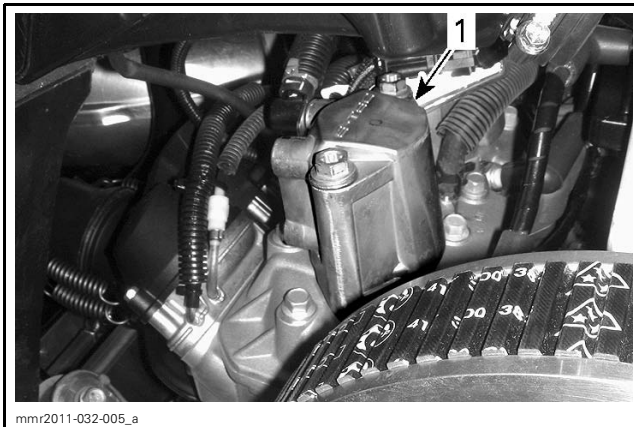
The air then continues through the reed valves into the cylinder base then into the crankcase.

### Fuel Injector

The fuel injectors are powered from the 60 Vdc system.

One fuel injector per cylinder is used.

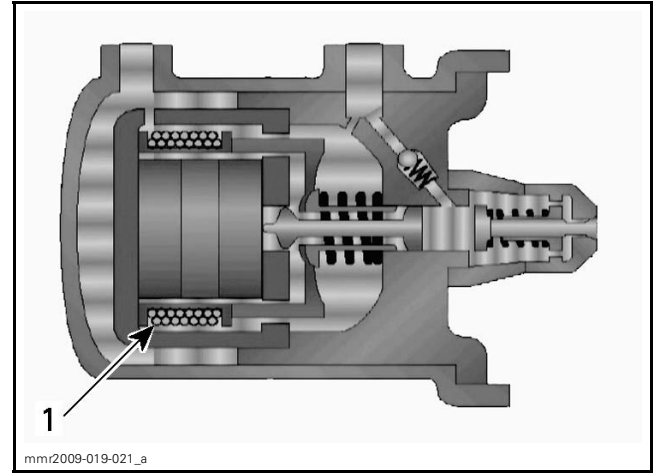
The E-TEC fuel injector is mounted directly on top of the cylinder head.



1. Fuel injector

The fuel injector achieves a direct injection right into the combustion chamber. This keeps the piston cooler with less fuel.

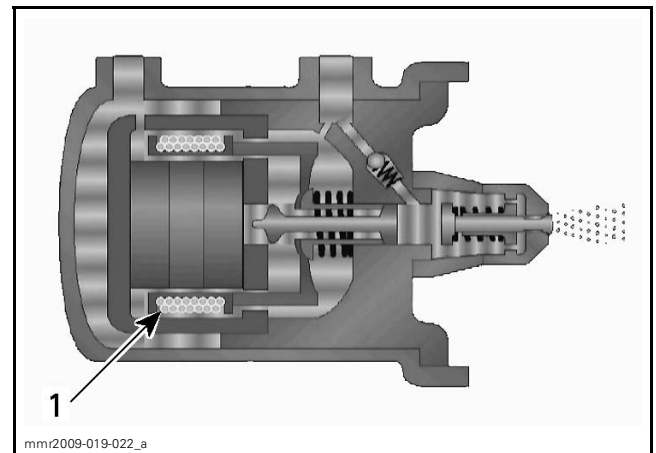
A voice coil type is used to open and close the fuel injector nozzle. This allows for quick operation of the fuel injector; opening stage as well as the closing stage. This results in the ability to operate the engine at a higher RPM and lowers unburned fuel to the exhaust port.



**FUEL INJECTOR CLOSED**

1. Voice coil

When a positive current is supplied to the coil by the ECM, the fuel injector plunger moves towards the spring loaded injector needle. As the injector plunger moves, this builds up a pressure in the fuel injector chamber. When the pressure reaches approximately 1724 kPa (250 PSI), the injector needle spring is overcome and the needle opens. Fuel injection then takes place while the pressure peaks at 3103 kPa (450 PSI).



**FUEL INJECTOR OPENED**

1. Voice coil

Swirl channels are used in the fuel injector to better atomize the fuel charge.

The quantity of injected fuel is controlled by varying the injector plunger stroke.

To bring the injector plunger backward to its rest position, the current is reversed and the return springs close the injector needle and plunger. Near the end of the return stroke, a brief positive current is applied to "brake" the injector plunger. This results in a quieter operation of the fuel injectors.

**Section 04 FUEL SYSTEM**  
**Subsection 02 (E-TEC DIRECT FUEL INJECTION)**

The fuel injectors provide a stratified fuel charge to the combustion chamber up to clutch engagement speed. Beyond this RPM, the fuel charge becomes homogeneous.

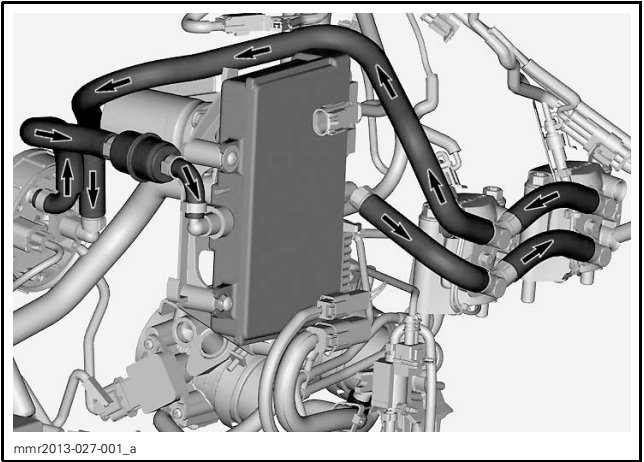
The stratified fuel charge provides a cleaner combustion, better idling and less smoke.

**Fuel Injector Cooling**

Fuel is used to maintain proper fuel injector operating temperature.

The flow starts from the fuel pump, through the ECM, then around the voice coil inside the fuel injector housings to cool down the fuel injector components.

Fuel enters the inlet port located at the bottom of the fuel injector housing and exits through the outlet port on top of the fuel injector.



**ADJUSTMENT**

**IDLE SPEED**

Idle speed is controlled by the ECM and is not adjustable with an idle screw.

If idle speed is not as per specification (refer to *TECHNICAL SPECIFICATIONS*), perform the *CLOSED THROTTLE RESET (TPS)*.

**CLOSED THROTTLE RESET (TPS)**

**General Information**

This operation performs a reset of the TPS (throttle position sensor) values in the ECM when the throttle is closed. This reset is very important as the setting of the TPS will determine the basic parameters for all fuel mapping and several ECM calculations for idle speed control of the engine.

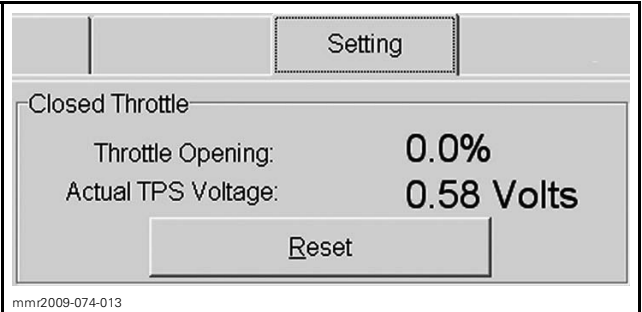
**NOTICE** An improperly set TPS may lead to poor engine performance.

**TPS Closed Throttle Verification**

1. Connect vehicle to the latest applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. In B.U.D.S., select the **Setting** and **ECM** tabs.
3. **Ensure** throttle cable is properly adjusted, refer to *THROTTLE CABLE ADJUSTMENT* in this subsection.
4. Look for the throttle opening indication in the **Close Throttle** area.

**NOTE:** The **Throttle Opening** indication must be within the following specification.

THROTTLE OPENING SPECIFICATION
(0 % ± 0.2)



**THROTTLE OPENING INDICATION**

If the throttle opening is within the % specification, **DO NOT** carry out the **Closed Throttle Reset** unless the following parts were replaced:

- Engine control module (ECM)
- Throttle body
- Throttle position sensor (TPS).

If TPS is not within specification, carry out the **Closed Throttle** reset procedure that follows.

**Closed Throttle Reset Procedure (TPS)**

**NOTICE** Proper throttle cable adjustment must be verified before proceeding with the Closed Throttle reset.

1. In B.U.D.S.
  - 1.1 Select the **Setting** tab.
  - 1.2 Select the **ECM** tab.
2. In the **Closed Throttle** area, confirm the **Actual TPS Voltage** is within specification.

ACTUAL TPS VOLTAGE SPECIFICATION
0.3 to 0.7 Volts

*TYPICAL - ACTUAL TPS VOLTAGE*

**NOTE:** If the **Actual TPS Voltage** is out of specification, the TPS cannot be reset. The cause must be found. See *TROUBLESHOOTING ACTUAL TPS VOLTAGE OUT OF RANGE*.

3. Press on the **Reset** button.
4. Confirm **Throttle Opening** value indicates 0.0%.

**NOTE:** A throttle opening of 0.0% after reset indicates the operation is successful.

*TYPICAL - THROTTLE OPENING MUST BE 0.0%*

## Troubleshooting Actual TPS Voltage Out of Range

If the **Actual TPS Voltage** is out of specification, check the following.

- Fault codes related to TPS
- Throttle cable adjustment
- TPS properly installed
- TPS connector and terminal condition.

## TROUBLESHOOTING

### DIAGNOSTIC TIPS

Engine problems are not necessarily related to the injection system.

It is important to ensure the mechanical integrity of the engine is present.

## No Engine Acceleration, No Throttle Response

If this occurs, use B.U.D.S. and check the following.

1. Select the **Setting** tab then **Vehicle Configuration**.

2. In the **Vehicle Configuration** page:

- 2.1 Select: **with tuned pipe sensor**.

## Spark Plugs

### 800R E-TEC

Improper spark plug indexing may lead to engine misfiring. Check if BRP spark plugs are installed or if spark plugs are properly indexed. Refer to *IGNITION SYSTEM* subsection.

### 3D RAVE Valves

Improper position of RAVE valves may lead to engine misfiring. Check RAVE valves. Refer to *RAVE* subsection.

### Crankshaft Position Sensor (CPS)

Confirm that ECM receives the CPS signal. Refer to *CRANKSHAFT POSITION SENSOR (CPS)* in this subsection.

## Electrical System

It is important to check that the electrical system is functioning properly:

- 60V system voltage

Section 04 FUEL SYSTEM

Subsection 02 (E-TEC DIRECT FUEL INJECTION)

- Capacitor (refer to *CHARGING SYSTEM*)
- Ground connections
- Wiring and connectors.

Ensure that all electronic components are original BRP recommended components.

Any modification to the wiring harness may lead to fault codes or bad operation.

Always refer to the wiring diagram when diagnosing an electrical problem.

⚠ WARNING

The EMS operates on high voltage (60 Vdc), be careful to avoid electrical shocks.

⚠ WARNING

All electrical actuators (example: fuel injectors, fuel pump, ignition coils and electronic oil injection pump) are powered as soon as engine is cranked when the emergency engine stop switch is at the RUN position.

Electrical Connections

Pay particular attention to ensure that pins are not out of their connectors or out of shape.

Make sure that connections are very tight, make good contact, are corrosion-free, and show no signs of moisture. Particularly check ECM ground connections.

**NOTE:** Do not apply dielectric grease or other lubricant in the ECM connectors.

Check if wiring harness shows any signs of scoring.

Resistance Measurement

When measuring the resistance with an ohmmeter, all values are given for a temperature of 20°C (68°F). The value of a resistor varies with the temperature. The value for common resistor or windings (such as solenoid) increases as the temperature increases. However, our temperature sensors are NTC types (Negative Temperature Coefficient) except for the EGTS, which means that the value decreases as the temperature increases. Use the provided tables for sensor resistive values at given temperature.

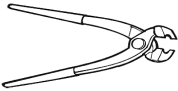
The resistive value of a temperature sensor may test good at a certain temperature but may be defective at other temperatures.

A good test is to put the sensor in a container filled with ice and water and measure resistance. Then, heat the water and read the resistance at different temperatures.

PROCEDURES

FUEL HOSES AND OETIKER CLAMPS

Oetiker Clamp Removal and Installation

REQUIRED TOOL	
OETIKER PLIERS (P/N 295 000 070)	

Always use a shop rag when disconnecting a fuel hose.

**⚠ CAUTION** Fuel system is under high pressure.

⚠ WARNING

- Never use a hose pincher on high pressure hoses.
- Never change the routing of a fuel hose.
- Always reinstall the corrugated protective tubing on fuel hoses.
- Secure fuel hoses using the appropriate locking tie or fastener to prevent contact with sharp edges or hot, rotating and moving parts.
- After connecting a hose or a quick connect fitting, pull on the hose near the fitting to make sure it is securely locked.

Use of improper fuel lines could compromise fuel system integrity.

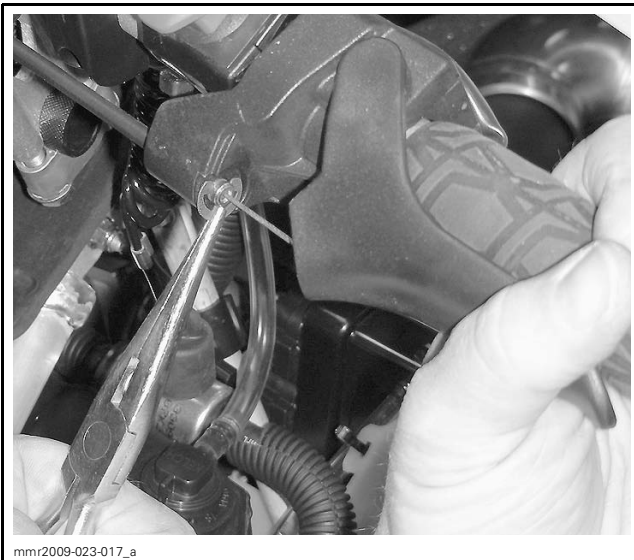
THROTTLE CABLE

Throttle Cable Removal

1. Remove handlebar cover.
2. Depress and hold throttle lever.
3. Pull out circlip using long nose pliers. Keep circlip for re-use.

## Section 04 FUEL SYSTEM

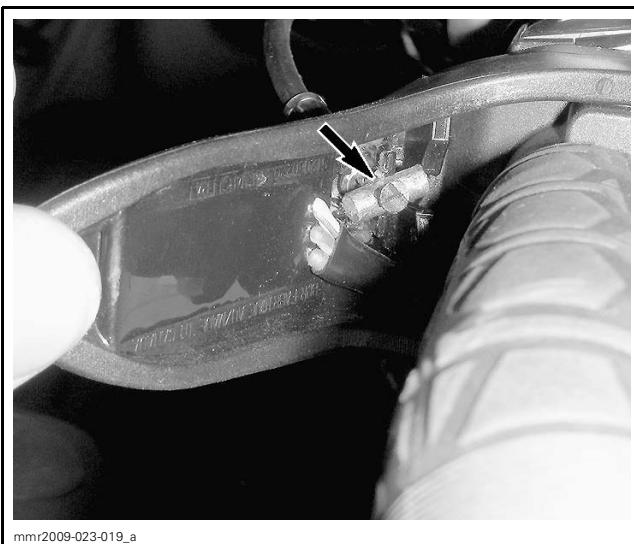
### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



4. Pull throttle cable out of the throttle lever housing.

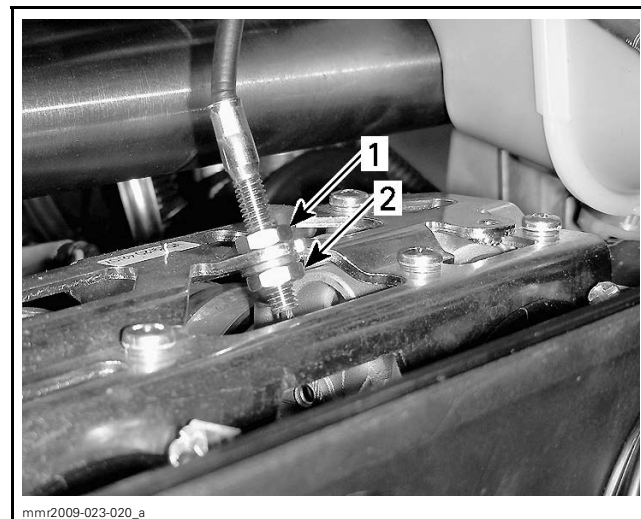


5. Unhook cable end barrel from throttle lever and remove cable.



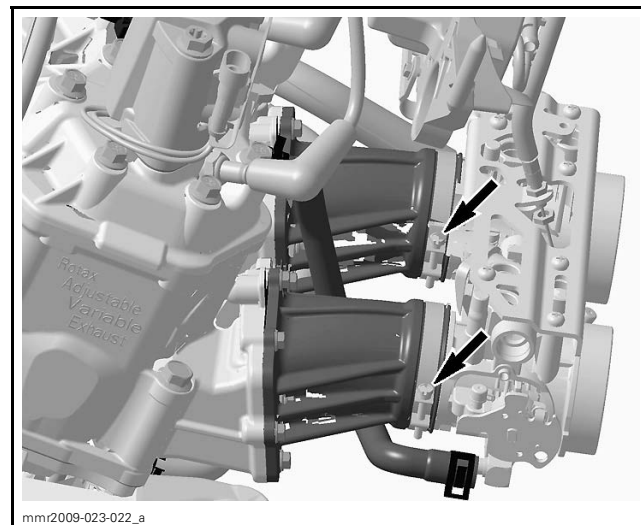
**NOTE:** Take note of cable routing before removal.

6. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
7. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
8. At throttle body, fully unscrew cable adjuster lock nut.



1. Adjustment nut  
2. Lock nut

9. Loosen throttle body retaining clamps and remove throttle body from air intake adapters.



10. Pull out throttle body sufficiently to unhook throttle cable end.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



11. Remove throttle cable.

#### Throttle Cable Installation

Reverse removal procedure however, pay attention to the following.

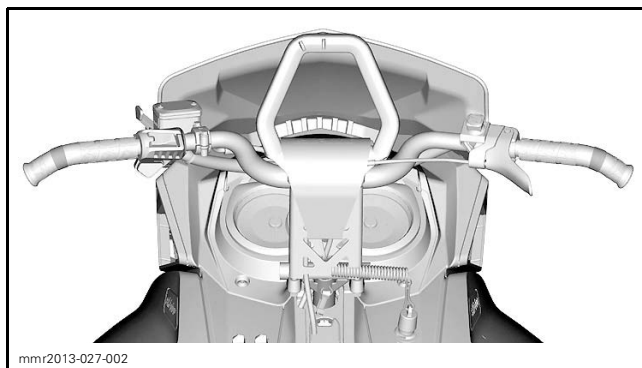
Route cable as noted prior to removal.

Ensure that cable ends are properly secured in their levers.

Proceed with throttle cable adjustment.

#### Throttle Cable Adjustment

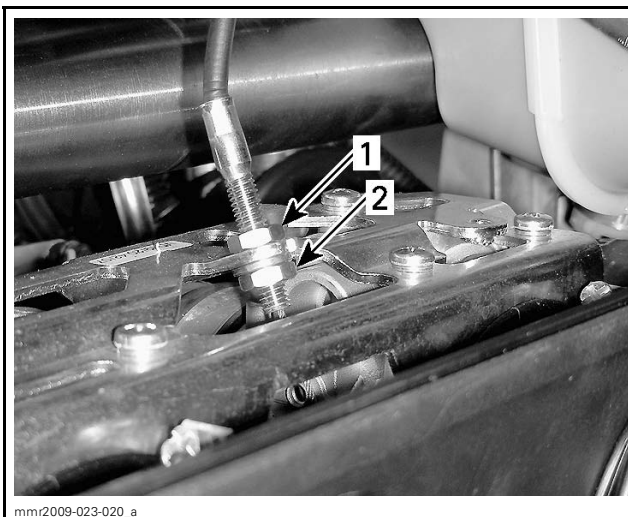
1. Position handlebar straight and level.



TYPICAL - HANDLEBAR IN STRAIGHT AHEAD POSITION

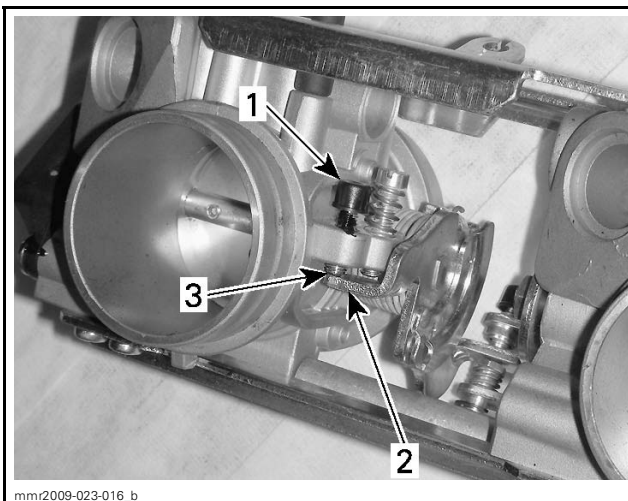
2. Turn throttle cable adjuster nut until the following is observed:

- Throttle plate stopper is in contact with master zero position screw
- Throttle cable is slightly loose (cable free play).



THROTTLE CABLE ADJUSTER

1. Adjuster nut (top)
2. Adjuster lock nut (Bottom)



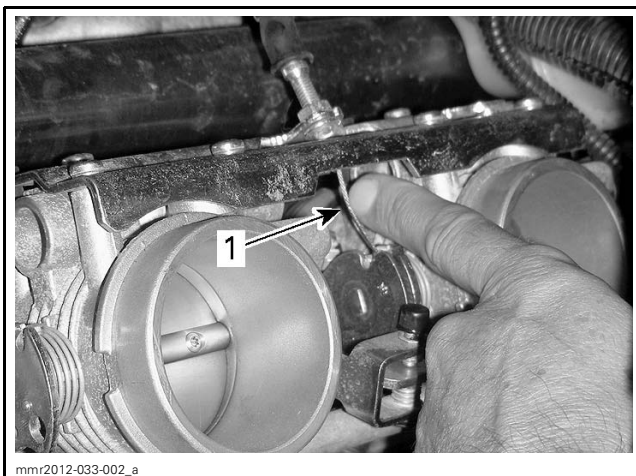
THROTTLE BODY MASTER ZERO POSITION

1. Master zero position screw (black)
2. Throttle plate stopper
3. Contact here

**NOTICE** Do not tamper with any throttle body adjustment screws. Otherwise, throttle body must be replaced.

**NOTE:** To ensure cable free play, lightly press on throttle cable as in following illustration.





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**THROTTLE CABLE FREE PLAY**  
 1. Cable slightly loose here

3. Activate and release throttle lever 2 - 3 times to settle throttle plate.
4. Confirm throttle plate stopper is STILL in contact with master zero position screw.
5. Readjust throttle cable if necessary.
6. Carry out the *THROTTLE CABLE OPERATING RANGE INSPECTION WITH B.U.D.S.*

**Throttle Cable Operating Range Inspection with B.U.D.S.**

1. In B.U.D.S.
  - 1.1 Select the **Monitoring** tab.
  - 1.2 Select the **ECM** tab.
2. Fully depress throttle lever and hold.
  - 2.1 Confirm throttle opening is within specification.

THROTTLE OPENING SPECIFICATION (WIDE OPEN THROTTLE)
95% to 100%



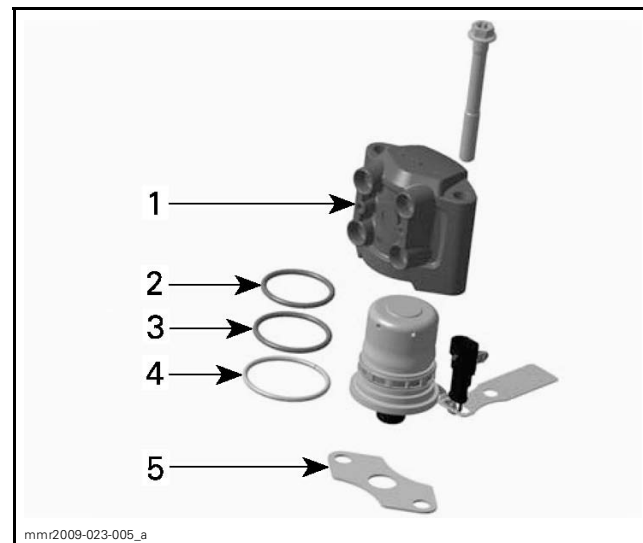
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**THROTTLE CABLE OPERATING RANGE**

3. If throttle opening is out of specification, readjust as follows.

THROTTLE OPENING OUT OF SPECIFICATION	
Above specification	Loosen throttle cable
Below specification	Tighten throttle cable

**FUEL INJECTOR**



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1. Fuel injector housing
2. Top O-ring
3. Bottom O-ring
4. Crush ring
5. Thermal insulator

Every fuel injector is bench tested. Its electrical and flow characteristics are registered throughout all its operating range in a calibration file.

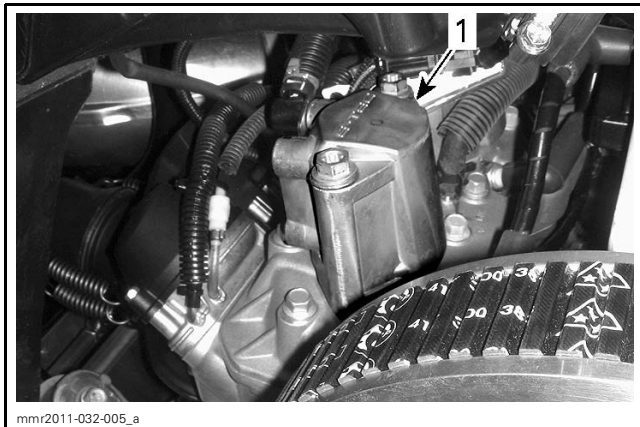
**NOTICE** When a fuel injector is replaced, the matching calibrated file must be loaded in the ECM using B.U.D.S. so that the ECM properly controls the fuel injector.

**Fuel Injector Visual Inspection**

1. Open LH panel.
2. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
3. Visually inspect the fuel injector area.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



1. Fuel injector

If a fuel leak is noticed in the hoses area, inspect hoses and connections.

If a fuel leak is noticed in fuel injector base area, it indicates a leak of the lower O-ring of fuel injector.

If a dark carbon sooted area is noticed in fuel injector base area, it indicates a leak between the fuel injector nozzle and the cylinder head. The fuel injector retaining screws may not be tight enough.

#### Fuel Injector Troubleshooting Tips

Usually, a faulty fuel injector will lead to poor engine idling and a low RPM (around 800 RPM and below). It may also lead to engine misfiring.

Ensure the correct fuel injector is installed on the proper cylinder. Refer to *FUEL INJECTOR POSITION VALIDATION*.

While engine is running, try disconnecting a fuel injector connector:

#### WARNING

Be careful while working close to rotating parts.

- If engine RPM does not change, the fuel injector could be faulty.
- If engine RPM decreases, the other fuel injector could be faulty.

If one injector is thought to be faulty, proceed with the injector tests.

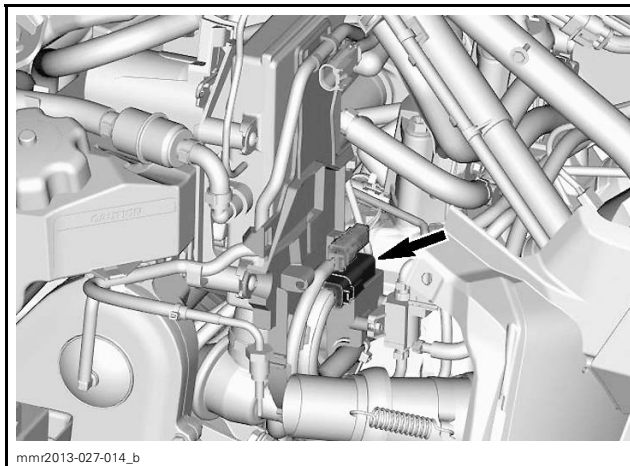
#### Fuel Injector Leak Test

##### Test Preparation

1. First make sure fuel pressure is within specifications. Refer to *FUEL TANK AND FUEL PUMP* subsection.

**NOTE:** Keep the pressure gauge installed for the leak test.

2. Disconnect magneto connector (6-pin connector). Refer to *Stator Connector* in *MAGNETO SYSTEM* subsection.



#### WARNING

The magneto connector must be disconnected to prevent any spark in the engine compartment should the engine be cranked. Fuel vapors may ignite in presence of a spark creating a fire hazard.

3. Release fuel pressure. Refer to *FUEL TANK AND FUEL PUMP*.

**NOTICE** If the fuel pressure is not released, the pressure will push the fuel injector out of its housing when removing the fuel injector from the engine. This could damage the fuel injector and lead to an important fuel spill.

4. Remove upper body module. Refer to *BODY* subsection.
5. Unlock ECM support to move ECM as necessary to lift fuel injectors.

**NOTE:** Fuel injector leak test can be done on one injector at a time or on both injectors simultaneously.

6. Unscrew both fuel injectors. Refer to *FUEL INJECTOR REMOVAL* in this subsection.
7. Carefully lift both fuel injectors. Be careful not to pry hoses against their plastic fittings.

**CAUTION** If both fuel injectors are not lifted carefully from the engine together, the strain on the injector fuel fittings may cause them to crack and leak fuel when pressurized, resulting in a fire hazard.

## Section 04 FUEL SYSTEM

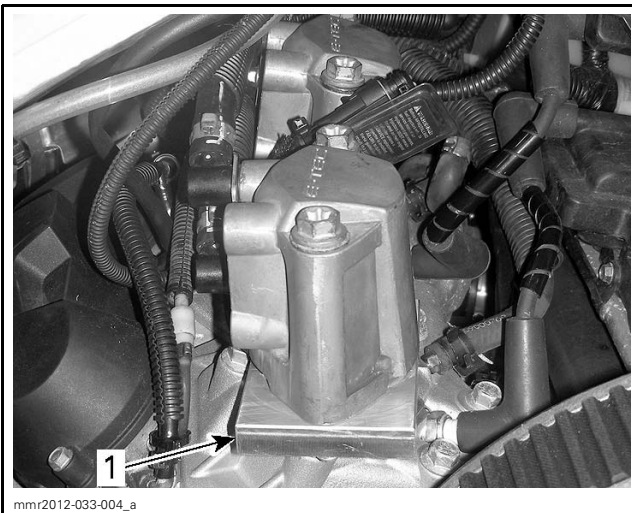
### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



TYPICAL

**NOTE:** Do not install the thermal insulators against fuel injectors.

8. Secure each fuel injector to an INJECTOR RETAINER PLATE (P/N 529 036 137).



TYPICAL

1. Fuel injector retainer plate

**NOTICE** Ensure to position machined groove in the retainer plate on the fuel injector wiring side.

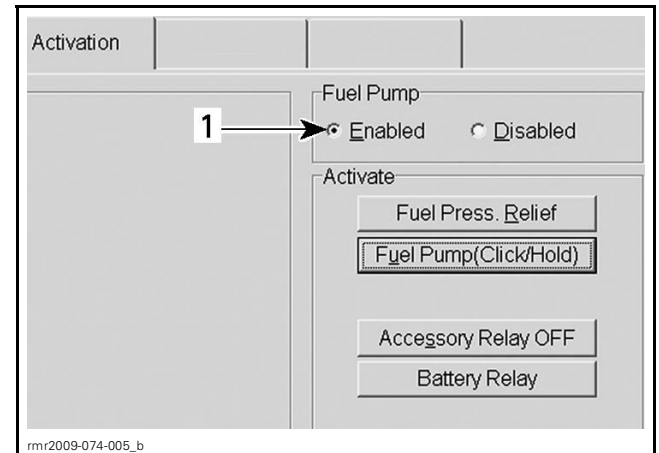
### ⚠ WARNING

Fuel injector must be secured during the leak test to avoid the fuel injector to be projected.

9. Place an appropriate container under the fuel injectors.
10. Ensure spark plug caps are installed on spark plugs.
11. Ensure there is enough fuel in fuel tank.
12. Connect vehicle to latest applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

### Leak Test

1. In B.U.D.S., select the **Activation** tab.
2. Ensure fuel pump is enabled.

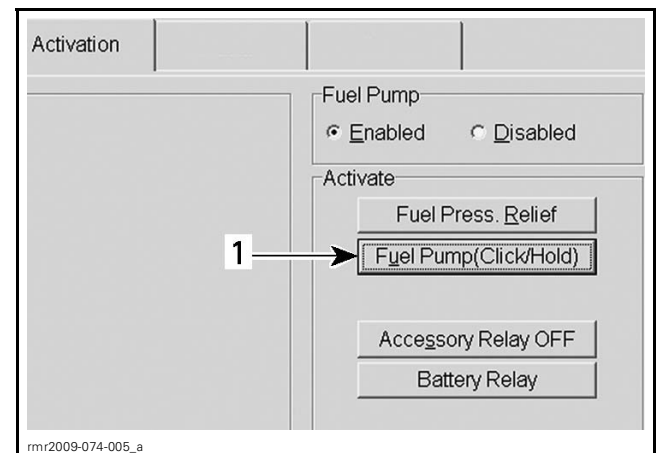


### ACTIVATION TAB

1. Pump enabled

3. Click and hold the **Fuel Pump** button.

**NOTE:** Fuel pump will operate as long as button is held depressed in B.U.D.S.



### ACTIVATION TAB

1. Click and hold

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Subsection 02 (E-TEC DIRECT FUEL INJECTION)

- 4. Check for fuel leakage from the fuel injector nozzle.
- 5. Monitor fuel pressure at fuel pressure gauge. If pressure drops below 275 kPa (40 PSI) during the test, re-activate fuel pump as necessary.

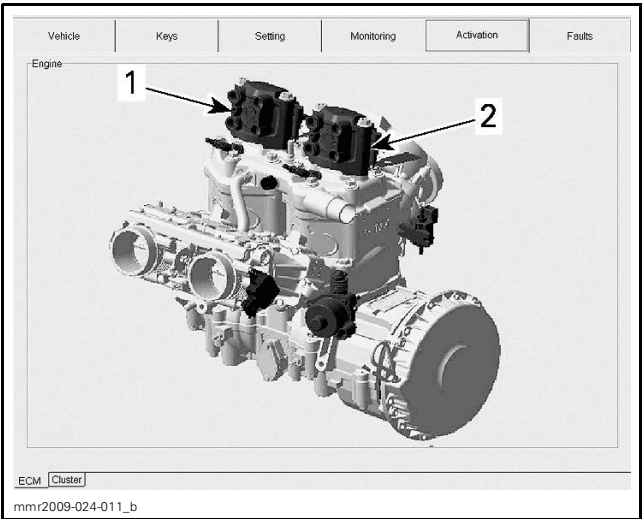
Table with 2 columns: TEST DURATION, SPECIFICATION. Row 1: 2 minutes, 2 drops per minute maximum.

- 6. If test is not within specification, replace the faulty fuel injector.
- 7. Properly reinstall fuel injectors. Refer to FUEL INJECTOR INSTALLATION in this subsection.
- 8. Reinstall remaining removed components.
- 9. Connect magneto connector.

WARNING
Wipe up any spilled fuel.

Fuel Injector Functional Test

- 1. Connect vehicle to latest applicable B.U.D.S. version. Refer to COMMUNICATION TOOLS AND B.U.D.S. subsection.
- 2. Select the ECM and Activation tabs.
- 3. Activate each fuel injector by clicking on it in B.U.D.S.



ACTIVATION TAB
1. Click on PTO fuel injector to activate
2. Click on MAG fuel injector to activate

With each activation a sound coming from the targeted injector should be heard.

If the fuel injector does not function, possible causes are:
- Injector

- Harness
- ECM.

If the fuel injector does not function, connect it to the opposite fuel injector connector, then test again.

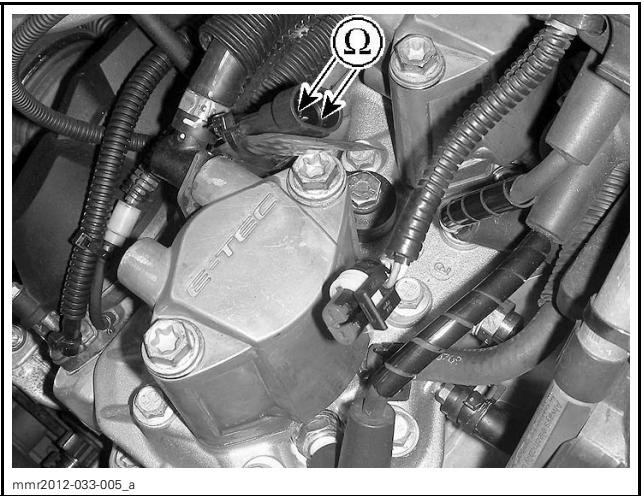
If the suspected fuel injector functions normally with the opposite fuel injector connector, carry out the FUEL INJECTOR INPUT VOLTAGE TEST in this subsection.

If the fuel injector still does not function, carry out the FUEL INJECTOR RESISTANCE TEST.

Fuel Injector Resistance Test

- 1. Remove upper body module. Refer to BODY subsection.
- 2. Disconnect the fuel injector connector.
- 3. Measure fuel injector resistance directly on its terminals.

Table with 3 columns: FUEL INJECTOR, MEASUREMENT @ 22°C (72°F). Row 1: Pin 1, Pin 2, Below 2.7 Ω



TYPICAL

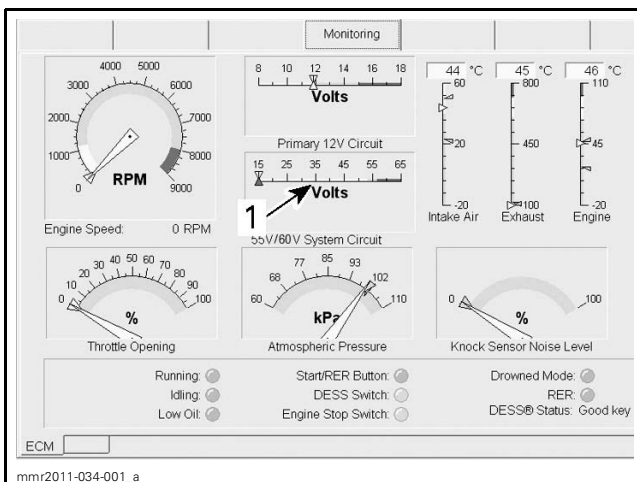
If measurement is out of specification, replace fuel injector.

Fuel Injector Input Voltage Test

- 1. Connect vehicle to latest applicable B.U.D.S. version. Refer to COMMUNICATION TOOLS AND B.U.D.S. subsection.
- In B.U.D.S., select Monitoring tab, then ECM tab.
- 2. With the emergency stop switch set to off, attempt to start the engine.
- 3. Read the voltage on the 60 V System Circuit meter in B.U.D.S. as the engine is being cranked.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



1. 60 V System circuit

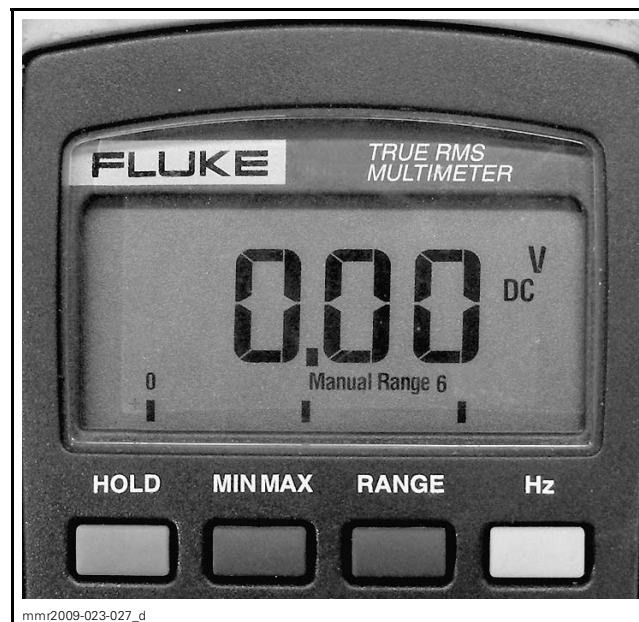
60 V SYSTEM CIRCUIT VALUE
30 Vdc minimum

If voltage test is as per specification, carry out the **FUEL INJECTOR CONTROL CIRCUIT SIGNAL TEST**.

If voltage test is not as per specification, check wire continuity between ECM and fuel injector connector.

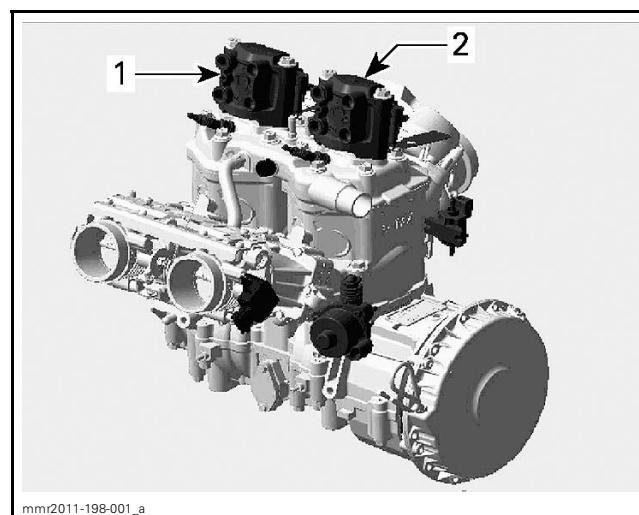
#### Fuel Injector Control Circuit Signal Test

1. Connect vehicle to the latest applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to Vdc (Hz).
3. Repeatedly press the **RANGE** button until the display shows Manual Range 6.



DC VOLTS AND MANUAL RANGE 6 SELECTED

4. Press the **Hz** button so that the display shows Hz.
5. In B.U.D.S., select the **Activation** and **ECM** tabs.
6. Activate fuel injector and read the frequency on the multimeter.



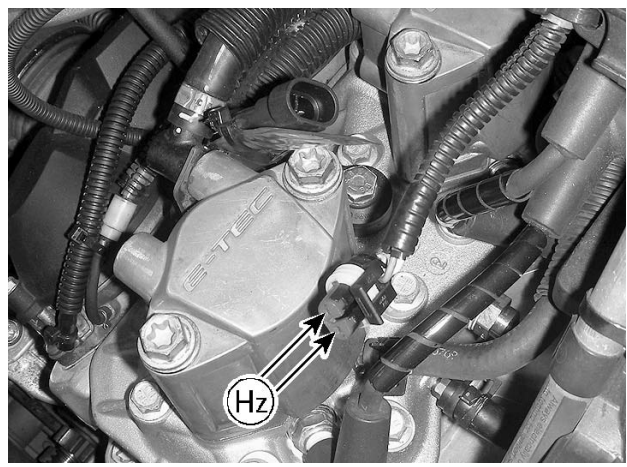
ECM, ACTIVATION PAGE  
1. PTO injector activation  
2. MAG injector activation

**NOTE:** The multimeter counts the pulses per minute (Hertz) of current the ECM sends to the fuel injector.

FUEL INJECTOR CONNECTOR		MEASUREMENT
Pin 1	Pin 2	Approximately 2 Hz

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



TYPICAL

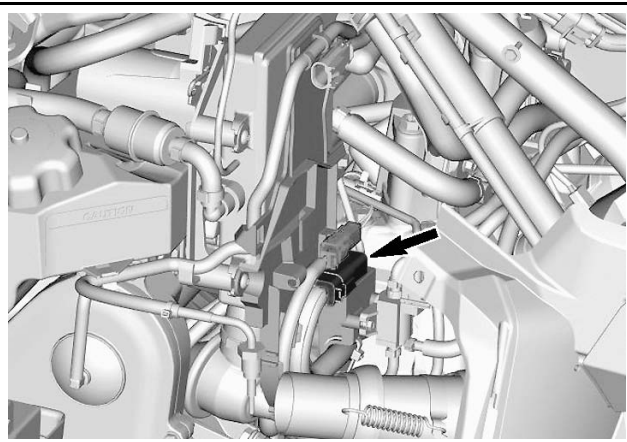
If there is no reading, check continuity of wiring between ECM and fuel injector connector.

If reading is good, the control circuit is functional.

#### Fuel Injector Removal

**IMPORTANT:** NEW O-rings and crush ring must be installed if fuel injector is removed (fuel injector disassembly required). Otherwise, leakage or damage to fuel injector/cylinder head might occur.

1. Remove upper body module. Refer to *BODY* subsection.
2. Disconnect magneto connector (6-pin connector). Refer to *Stator Connector* in *MAGNETO SYSTEM* subsection.



#### **! WARNING**

The magneto connector must be disconnected to prevent any spark in the engine compartment should the engine be cranked. Fuel vapors may ignite in presence of a spark creating a fire hazard.

3. Clean fuel injector area.

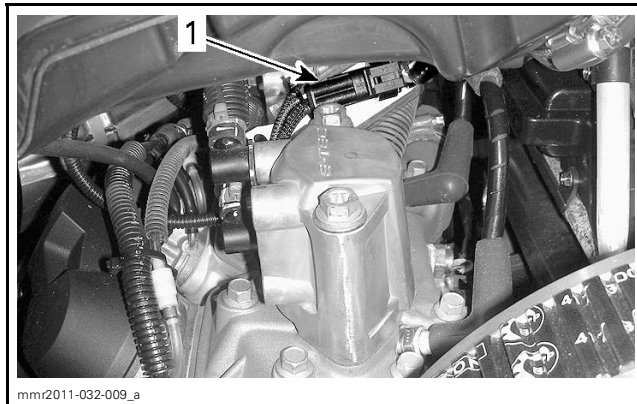
4. Release the fuel pressure in the system. Refer to *FUEL TANK AND FUEL PUMP* subsection.

**NOTICE** If fuel pressure is not released, the pressure will push the fuel injector out of its housing when removing the fuel injector. This could damage the fuel injector and lead to an important fuel spill.

#### **! WARNING**

Fuel vapors in the engine compartment could be lit by a spark. This might create a fire.

5. Disconnect fuel injector connector.

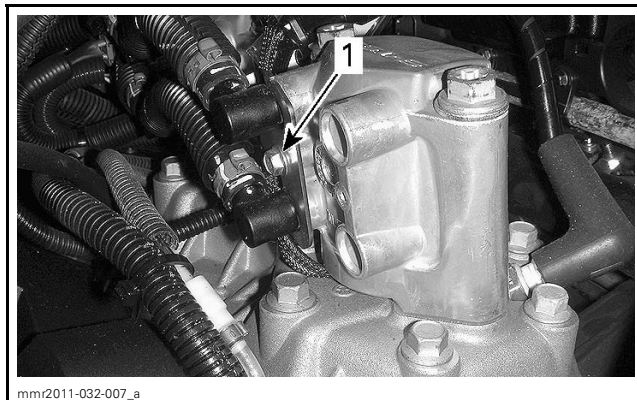


TYPICAL

1. Fuel injector connector

6. Install a rag under the hose ends to catch fuel spillage.

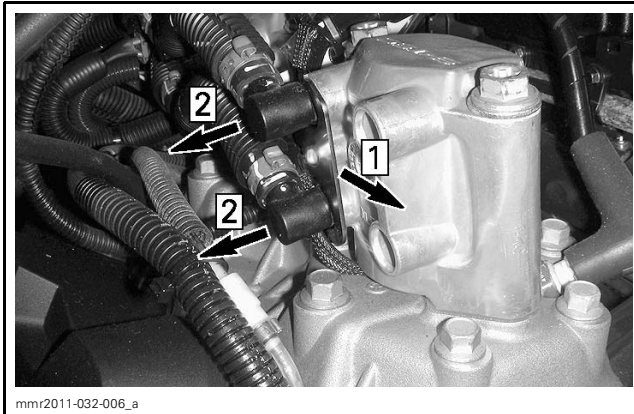
7. Remove fuel hose retainer screw.



1. Fuel hose retainer screw

8. Slide the fuel hose retainer out and disconnect fuel hoses from fuel injector.





Step 1: Remove fuel hose retainer  
Step 2: Remove fuel hoses

**⚠ WARNING**

More fuel than usual will flow out of the fuel injectors. Work in a well ventilated area and wipe up spilled fuel.

9. Remove fuel injector screws.
  10. Gently pull up on the fuel injector to remove it.
- NOTE:** If a fuel injector is to be reinstalled, mark it (MAG or PTO) to reinstall it in the same cylinder position.

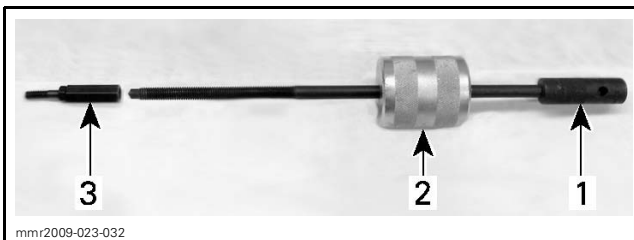
**NOTICE** Use caution when handling fuel injector. Never hold injector by its electrical wires. Prevent dirt and debris from entering fuel inlet and outlet ports of fuel injectors or fuel hoses. Cover the fuel injector nozzle port in cylinder head to prevent contamination of combustion chamber.

### Fuel Injector Disassembly

To remove fuel injector from its housing, use a Snap-on slide hammer puller including:

- SNAP-ON SCREW (P/N CJ93-1)
- SNAP-ON HAMMER (P/N CJ125-6).

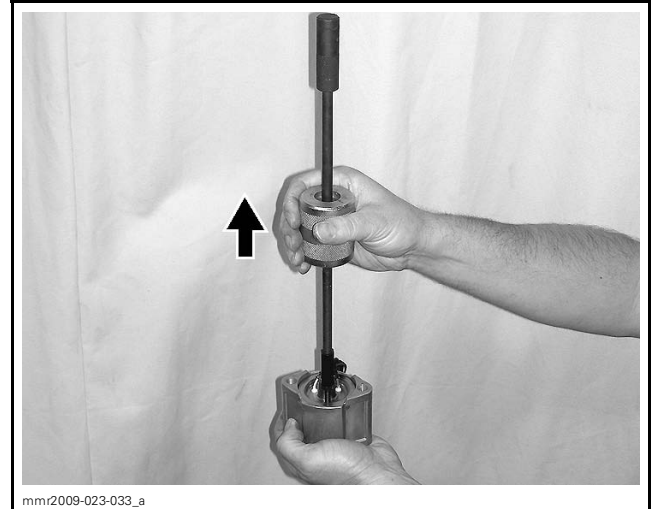
1. Install the EXTRACTOR ADAPTOR (P/N 529 036 136) on the Snap-on screw.



1. Snap-on screw
2. Snap-on hammer
3. Extractor adapter (P/N 529 036 136)

2. Thread the extractor adapter into the fuel injector.

3. Securely hold the fuel injector housing upside down to avoid dropping it.
4. Work slide hammer to pull the fuel injector out.



5. Remove the extractor adaptor from the fuel injector.
6. Remove O-rings, crush ring and filter from the fuel injector.

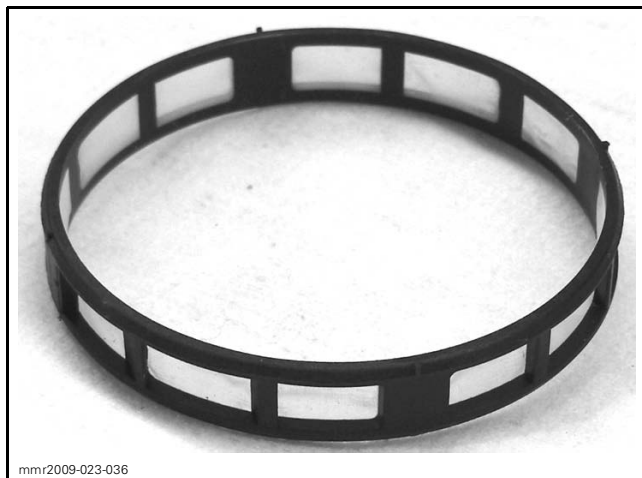
## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



1. Crush ring
2. ORANGE O-ring
3. Filter
4. BLUE O-ring

7. Inspect and clean fuel injector filter.



#### Fuel Injector Assembly

The assembly procedure is the reverse of disassembly. However, pay attention to the following:

**IMPORTANT:** Apply injection oil on O-rings.

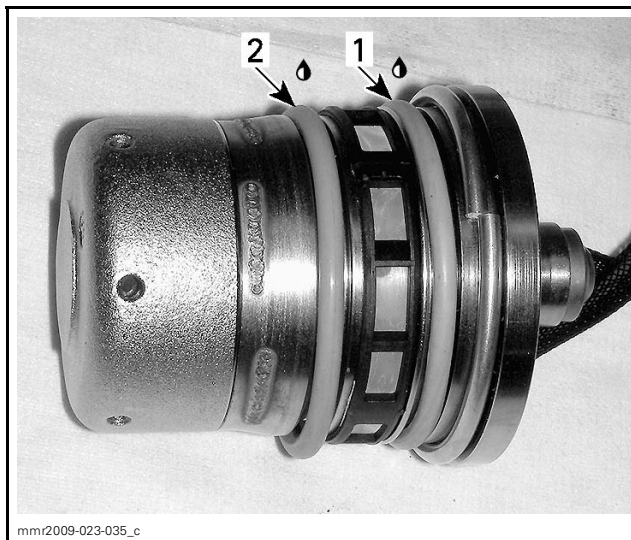
Install a new crush ring.

Install a new orange O-ring on top.

**NOTICE** Always use the O-rings specifically designed for these fuel injectors.

Install filter. Ensure filter is retained firmly on fuel injector. Otherwise, remove it, invert it half a turn, then reinstall. If it still not retained securely, install a new one.

Install a new blue O-ring at bottom.



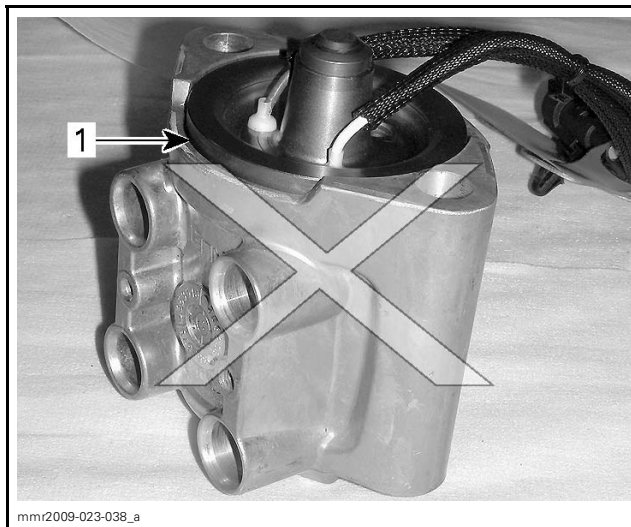
#### OIL INJECTION ON O-RINGS

1. ORANGE
2. BLUE

Reinstall fuel injector in its housing.

**NOTE:** Be sure to fully insert fuel injector in the housing with the wire outlets towards the fuel ports.

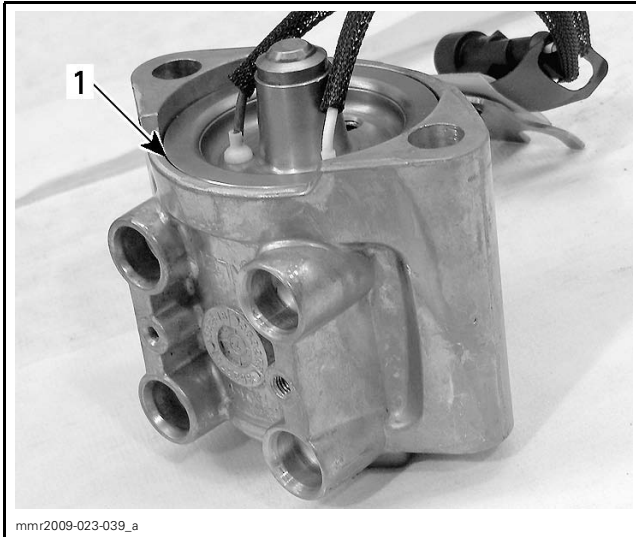
**NOTICE** Never press or tap the fuel injector tip.



#### WRONG INSTALLATION

1. Fuel injector not fully inserted in its housing





**CORRECT INSTALLATION**

1. Fuel injector fully inserted in its housing

### Fuel Injector Installation

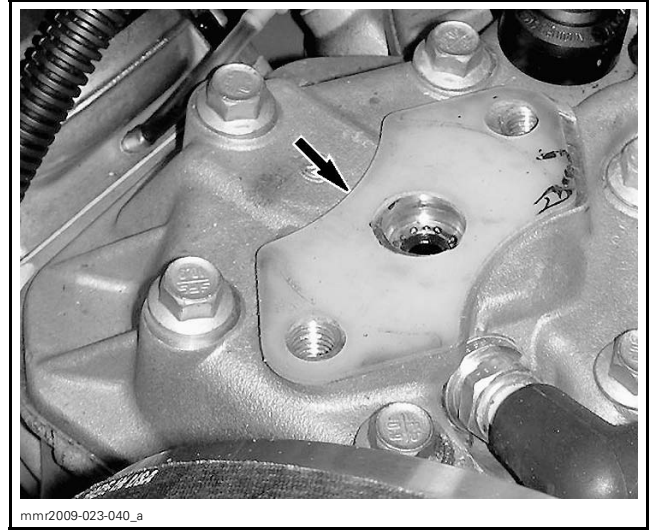
The following items and their mating surfaces must be cleaned and inspected prior to assembly:

- Fuel Injector
- Cylinder head: fuel injector housing and fuel injector tip contact surfaces
- Fuel injector screw threads and cylinder head threads (**must be dry**).

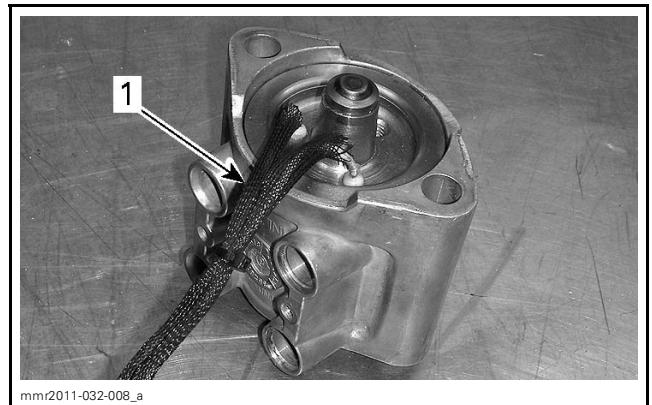
**NOTICE** All fuel injector components must be clean to ensure correct torque tightening specifications and to avoid leakage. Carefully follow the installation instructions.

**NOTE:** When installing a **used** fuel injector, re-install the fuel injector in the same location. If it was not marked at removal, verify the correct fuel injector-cylinder match using B.U.D.S. Refer to *FUEL INJECTOR POSITION VALIDATION*.

1. Position the thermal insulator on cylinder head.



2. Route the fuel injector wires towards the fuel ports.



1. Fuel injector wires towards fuel ports

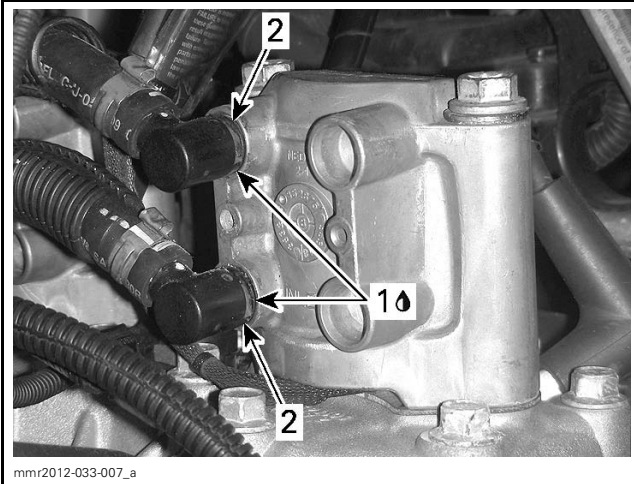
3. Place the fuel injector on the cylinder head, then thread in NEW screws with NEW washers.

**NOTICE** Torque fuel injector retaining screws prior to installing fuel hoses.

4. Tighten both injector retaining screws alternately in the following sequence:
- 4.1 Hand tighten until the screw heads contact the fuel injector housing
  - 4.2 5 N•m (44 lbf•in)
  - 4.3 25 N•m (18 lbf•ft)
  - 4.4 60 N•m (44 lbf•ft).
5. Check condition of fuel hose O-rings and plastic flange on hose fittings.
6. Apply injection oil on O-rings.
7. Insert fuel hoses in fuel injector housing.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

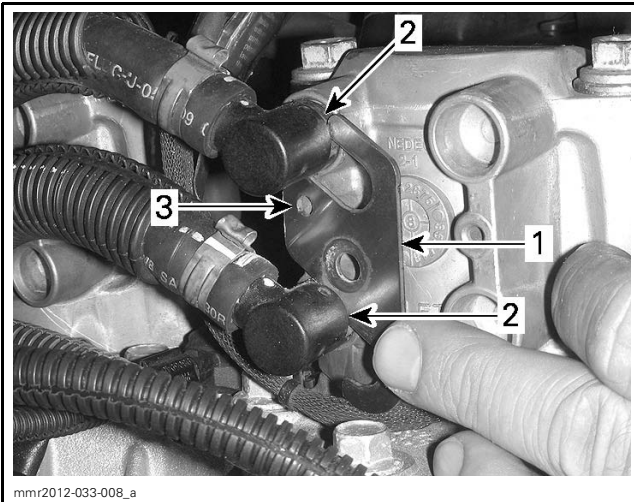


#### TYPICAL

1. Injection oil on O-rings
2. Hose fittings fully inserted here

**NOTE:** Both hose fittings must be fully seated in the fuel injector housing.

8. Insert the hose retainer so that it engages the groove in the fuel injector fittings.



#### TYPICAL

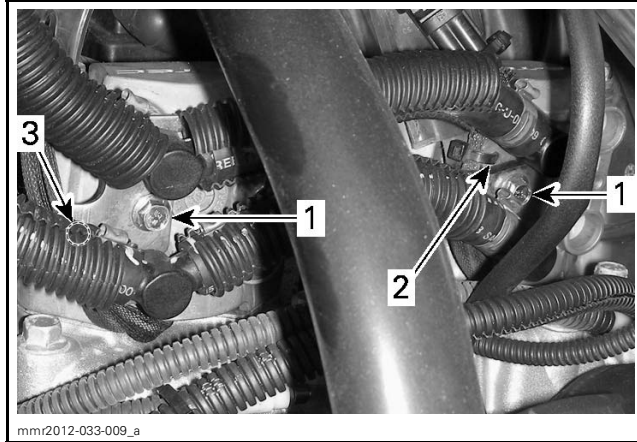
1. Retainer
2. Retainer engagement in fuel injector fitting groove
3. Hole for securing injector wiring (up on PTO side)

**NOTE:** Ensure open end of retainer that locks in the fuel hoses faces inboard. The hole in the hose retainer used to secure the injector wiring must be on top for the PTO injector, and on the bottom for the MAG injector.

9. Install a NEW screw to secure hose retainer.

**NOTICE** The screw features a scotch grip threadlocker coating that is destroyed when loosening screw. Always replace screw with a new one each time it is loosened.

10. Torque fuel hose retainer screw to 5 N•m (44 lbf•in).



1. NEW fuel hose retainer screw
2. PTO injector wiring secured with locking tie
3. MAG injector wiring secured with locking tie (not visible)

11. Secure fuel injector wiring using a new locking tie.

12. Apply some DIELECTRIC GREASE (P/N 293 550 004) in fuel injector connector.

13. Reconnect fuel injector connector.

**NOTICE** Never fasten the electrical connector to the fuel injector. The connector must be "free floating".

14. If installing a **NEW** fuel injector, use B.U.D.S. to configure it in the ECM. Refer to *SETTING A FUEL INJECTOR TO A CYLINDER*.

**NOTE:** The engine will be able to run with an improperly matched fuel injector. However, the engine may misfire, run rough at idle, have poor fuel economy or run lean.

#### **WARNING**

Perform a fuel pressure test and make sure there is no leak.

### Fuel Injector Position Validation

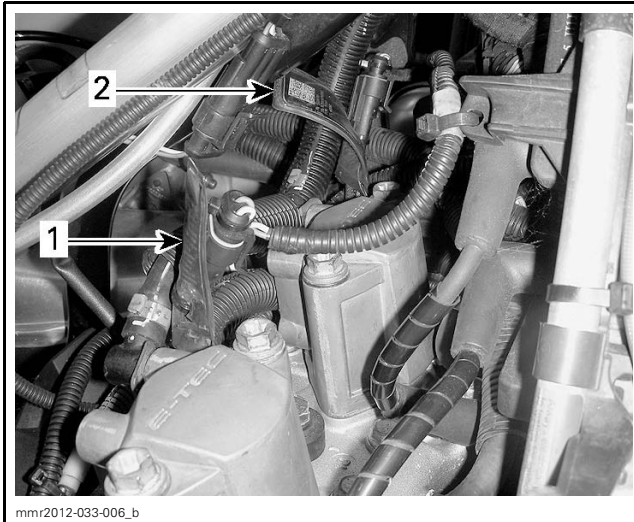
When troubleshooting or reinstalling a fuel injector, the correct matching of the fuel injector and cylinder must be confirmed using B.U.D.S. An incorrect match between the fuel injector and cylinder may lead to engine misfiring, improper idling or poor fuel economy.

**NOTE:** To configure a new fuel injector at installation, refer to *SETTING A FUEL INJECTOR TO A CYLINDER*.

1. Look for the fuel injector identification tag.

## Section 04 FUEL SYSTEM

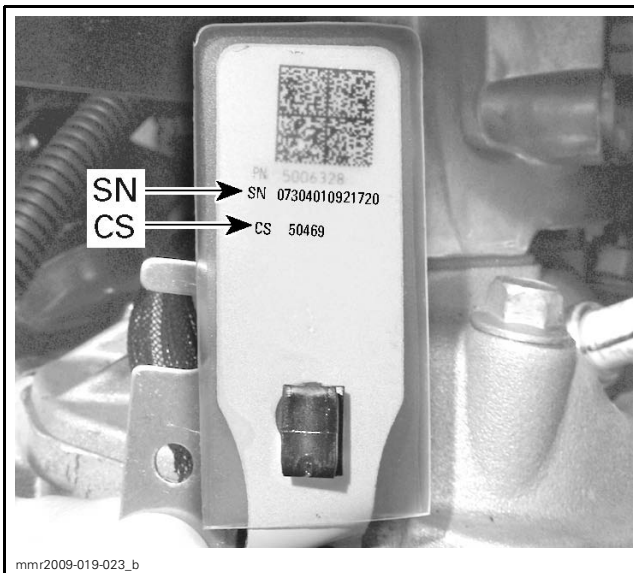
### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



#### TYPICAL

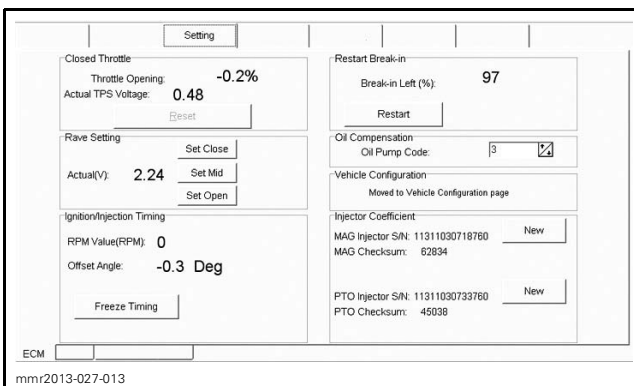
1. PTO fuel injector tag
2. MAG fuel injector tag

2. Note the fuel injector serial number (SN) on the tag of the fuel injector you wish to validate.

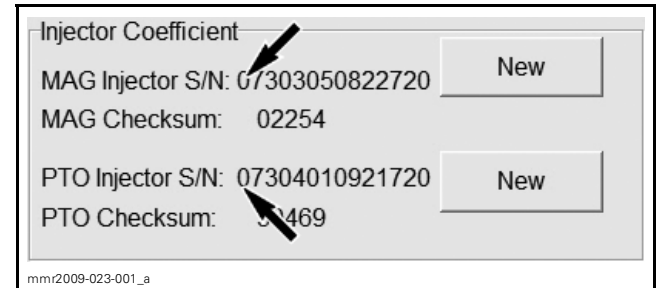


SN: Serial number  
CS: Checksum number

3. In B.U.D.S., select **Setting** and **ECM** tabs.



4. In the **Injector Coefficient** box, look for the fuel injector serial numbers (S/N) that are registered in the ECM.



#### PTO AND MAG INJECTOR S/N

5. Compare the **MAG** or **PTO Injector S/N** that is configured in the ECM with the fuel injector SN installed on the engine.

**NOTICE** The actual fuel injector number (SN) must match the number in B.U.D.S. (Injector S/N). If not, check if fuel injectors have been installed in the wrong position (or replaced).

If numbers do not match, configure the fuel injector in B.U.D.S. Refer to *SETTING A FUEL INJECTOR TO A CYLINDER*.

### Setting a Fuel Injector to a Cylinder

1. Note the serial number (SN) and the checksum number (CS) on the fuel injector tag.



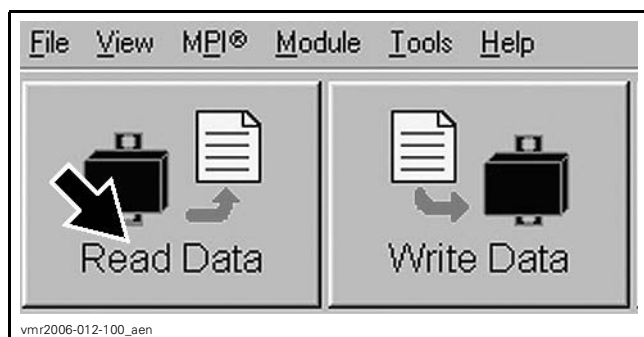
SN: Serial number  
CS: Checksum number

**NOTE:** If you were unable to read data before replacing the ECM, search *KNOWLEDGE CENTER* for article number 30098, follow the instructions to download the matching calibration file.

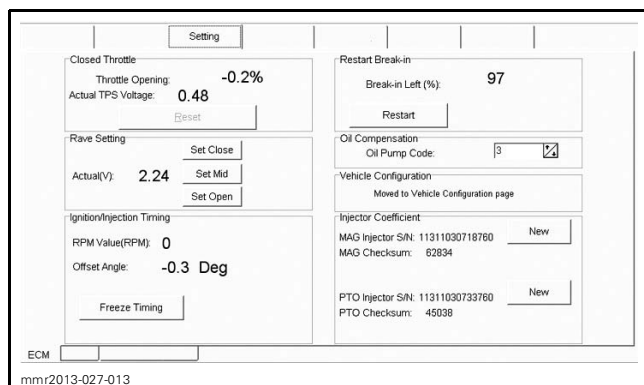
## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

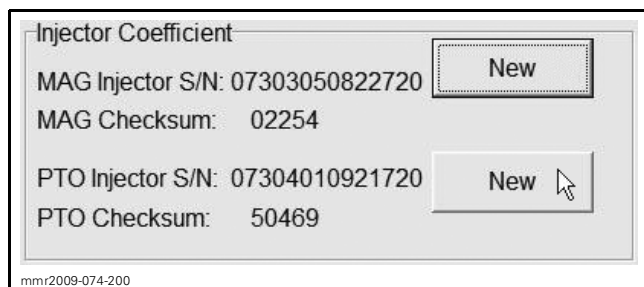
2. Start B.U.D.S. and click on the **Read Data** button.



3. Select **Setting** and **ECM** tabs.



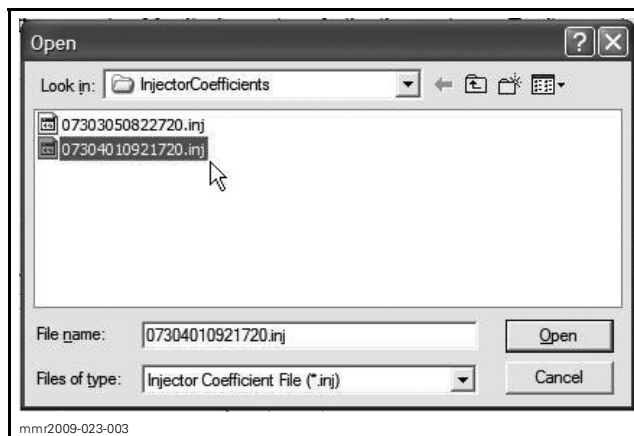
4. In the **Injector Coefficient** box, click on the **New** button of the fuel injector you want to replace (MAG or PTO).



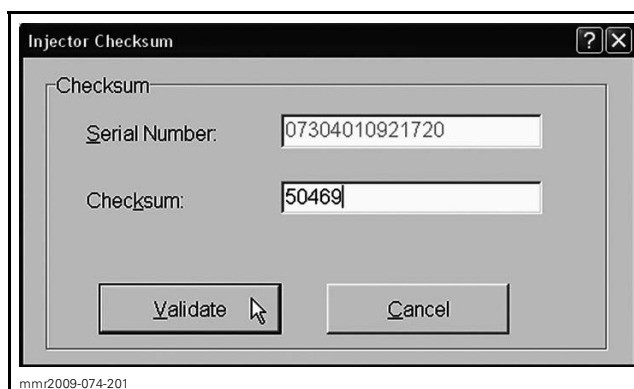
ECM TAB UNDER SETTING TAB

**NOTE:** Every time the **New** button is clicked, B.U.D.S. will automatically open the **Injector Coefficients** folder.

5. Select and open the fuel injector serial number file that matches the fuel injector installed on the engine.

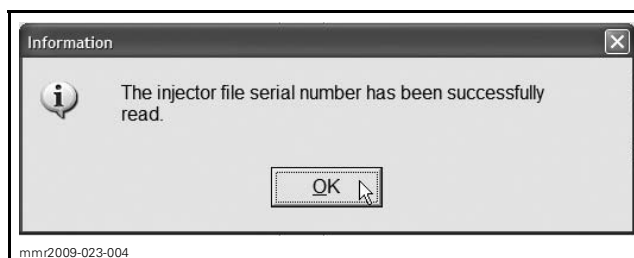


6. Enter the checksum number noted earlier and select **Validate**.



**NOTE:** The file will be quickly read and loaded in B.U.D.S.

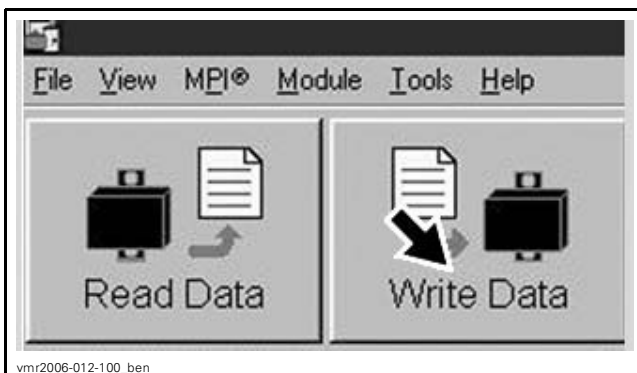
7. Click the **OK** button when the confirmation box appears.



8. Click on the **Write Data** button to save the changes to the ECM.

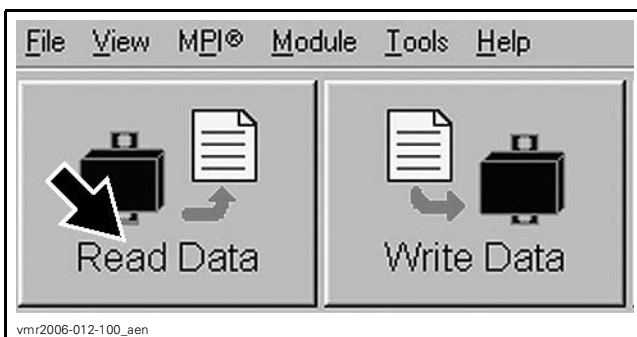
## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

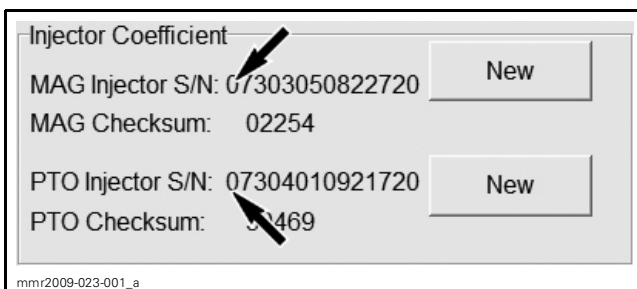
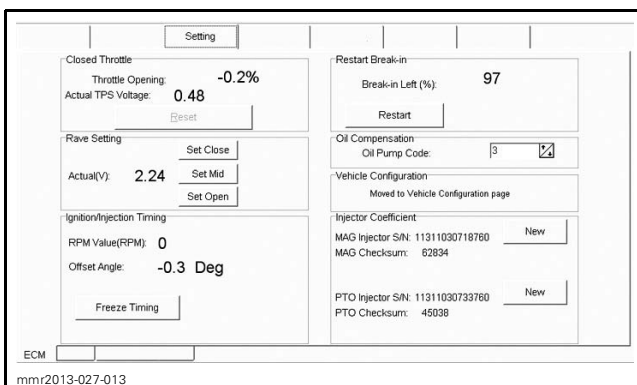


**IMPORTANT:** To ensure the proper file has been saved in the ECM, do the following:

9. Click on the **Read Data** button again in B.U.D.S.



10. Look in the **Injector Coefficient** area in the **ECM Setting** page.



11. Ensure the S/N in B.U.D.S. matches the SN of the fuel injector installed on the engine and the PTO/MAG numbers are not inverted.

12. If there is a mismatch, reload the proper configuration file. Write data and read it again to recheck.

#### NOTE

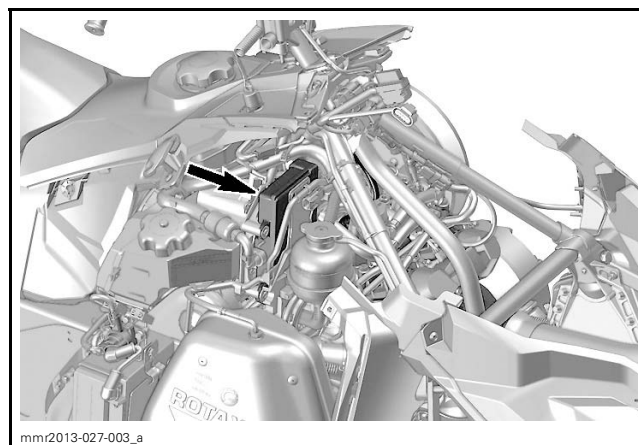
Every time an ECM is read or when an **.mpem** file is opened, the fuel injector calibration files (example: 07303050822720 and 07304010921720.inj) are automatically stored on your PC computer under a folder that will be common to all versions of B.U.D.S.:

C:\Program Files\BRP\BUDSCommon\InjectorCoefficients.

If B.U.D.S. is uninstalled, the files won't be deleted.

If you ever replace an ECM from which you were not able to read the data, you could load its latest **.mpem** file, look at the fuel injector serial numbers stored in the ECM and then read the matching calibration files from the common files without the need to download the file from Knowledge Center.

## ECM (ENGINE CONTROL MODULE)

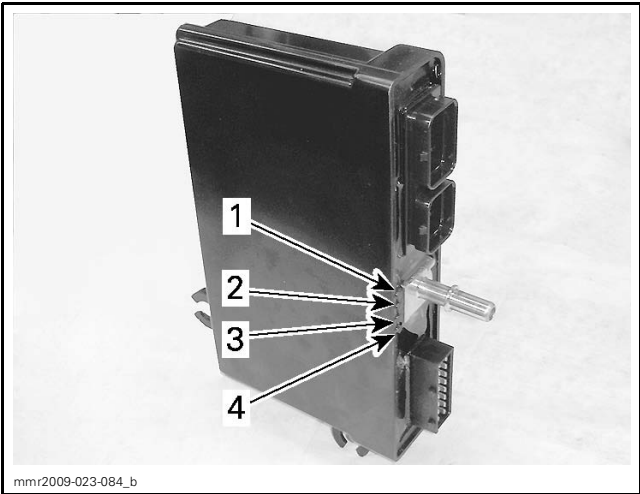


**NOTE:** Prior to replacing an ECM, carry out all testing procedures.

Section 04 FUEL SYSTEM

Subsection 02 (E-TEC DIRECT FUEL INJECTION)

ECM Self Diagnostic LEDs



SELF DIAGNOSTIC LED

- 1. LED 1
- 2. LED 2
- 3. LED 3
- 4. LED 4

LED ON	ENGINE STARTING	ENGINE RUNNING
1	Charging OK	Charging fault
2	CPS signal OK	Fuel injection or ignition fault
3	Sensors OK	Sensor fault
4	Emergency and engine cut-off switch OK	No oil or engine overheat

ECM Pin Identification

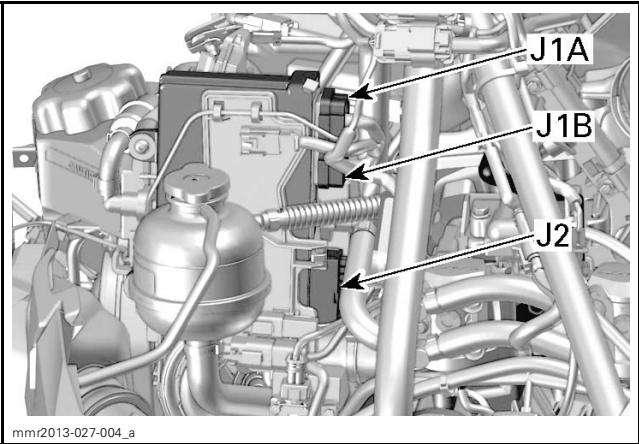
Refer to *WIRING DIAGRAM*

ECM Connectors

ECM Connector Access

To access ECM connectors:

- 1. Remove upper body module. Refer to *BODY*.
- 2. Unlock ECM support to move ECM as necessary.

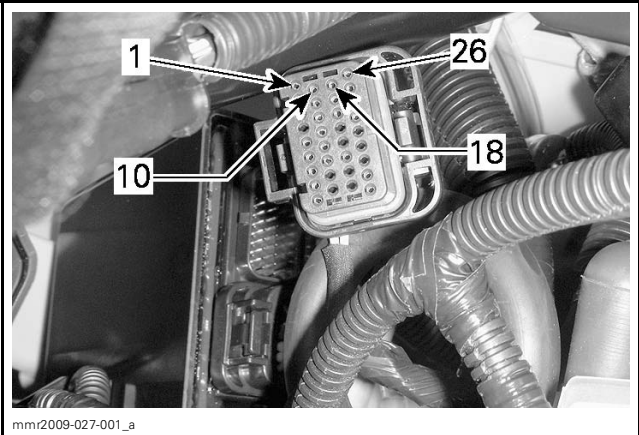


ECM CONNECTORS — PARTS REMOVED FOR CLARITY

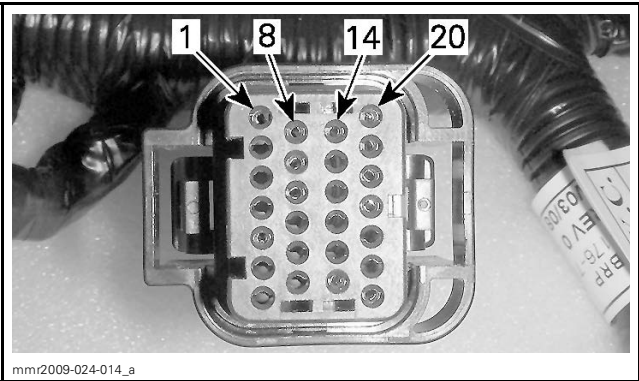
ECM Connector Removal

Refer to *CONNECTOR INFORMATION* subsection.

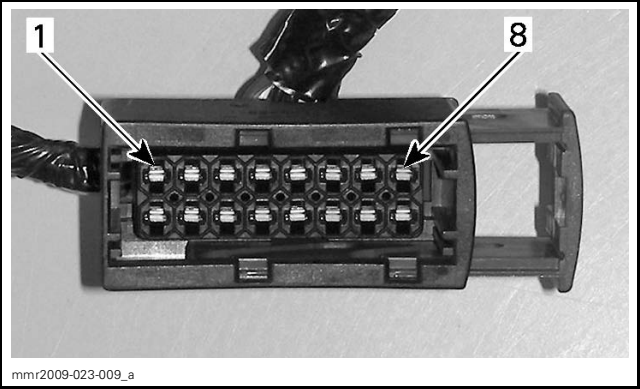
ECM Connector Pin-Outs



J1A PIN-OUT



J1B PIN-OUT



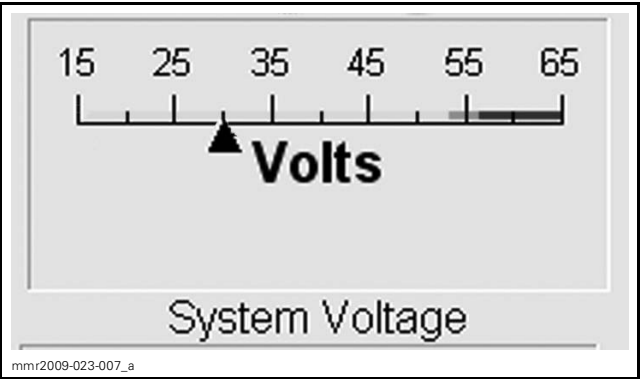
J2 PIN-OUT

### ECM Power Supply Troubleshooting

#### System Voltage Verification

Connect vehicle to latest applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

In B.U.D.S., select **Monitoring** tab, then **ECM** tab. Crank engine while viewing **System Voltage**.



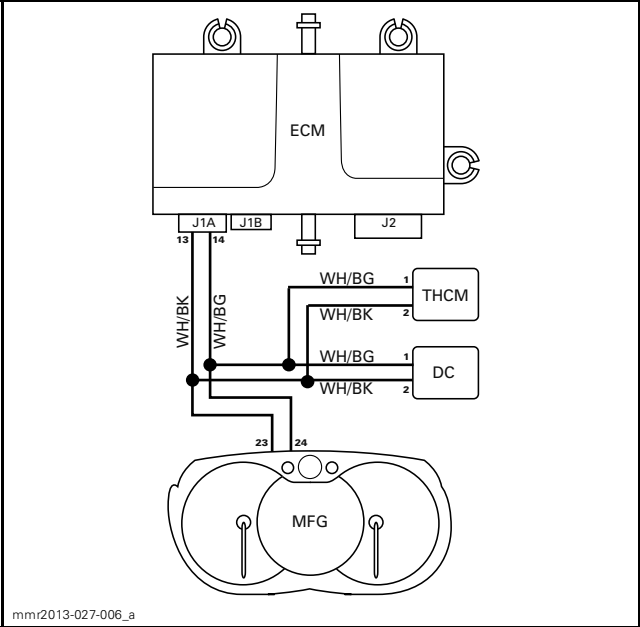
TEST CONDITION	VOLTAGE
Manual crank speed	30 Vdc min.

If voltage is as per specification, ECM is properly powered.

If voltage is out of specification, refer to *CHARGING SYSTEM*.

#### CAN Line Test

CAN lines link the ECM, multifunction gauge, THCM and vehicle diagnostic connector.



#### 800R E-TEC

DC: Diagnostic connector  
ECM: Electronic control module  
MFG: Multifunction gauge  
THCM: Thermocouple module

Test CAN wire continuity as follows.

1. Disconnect ECM connector J1A.
2. Disconnect multifunction gauge connector. Refer to *LIGHTS, GAUGE AND ACCESSORIES* subsection.
3. Using the FLUKE 115 MULTIMETER (P/N 529 035 868), read wire resistance as follows.

ECM	GAUGE CONNECTOR	MEASUREMENT
Pin 13	Pin 23	Close to 0 $\Omega$
Pin 14	Pin 24	

If continuity is out of specification, repair or replace wiring harness between ECM and multifunction gauge.

If continuity is as per specification, carry out the following test.

4. Disconnect vehicle diagnostic connector from its protective cap.
5. Read wire resistance as follows.

DIAGNOSTIC CONNECTOR	GAUGE CONNECTOR	MEASUREMENT
Pin 2	Pin 23	Close to 0 $\Omega$
Pin 1	Pin 24	

If continuity is out of specification, repair or replace wiring harness between diagnostic connector and multifunction gauge.



**Section 04 FUEL SYSTEM**  
**Subsection 02 (E-TEC DIRECT FUEL INJECTION)**

If continuity is as per specification, carry out the following test.

- 6. Disconnect THCM connector. Refer to *EX-HAUST SYSTEM* subsection for THCM module access.
- 7. Read wire resistance as follows.

DIAGNOSTIC CONNECTOR	THERMOCOUPLE MODULE	MEASUREMENT
Pin 2	Pin 2	Close to 0 Ω
Pin 1	Pin 1	

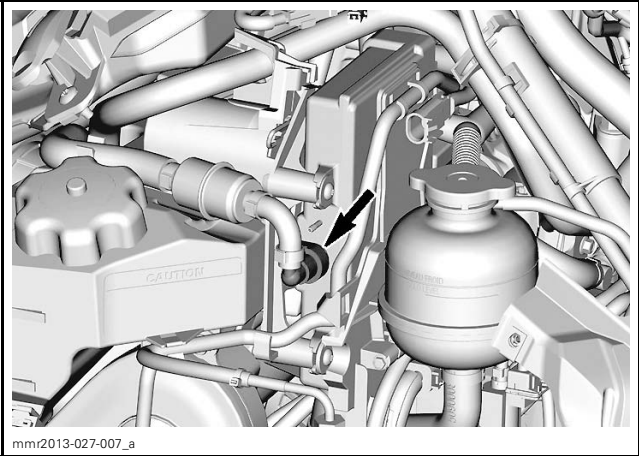
If continuity is as per specification, CAN lines are functional.

- 8. Reconnect connectors and reinstall removed parts.

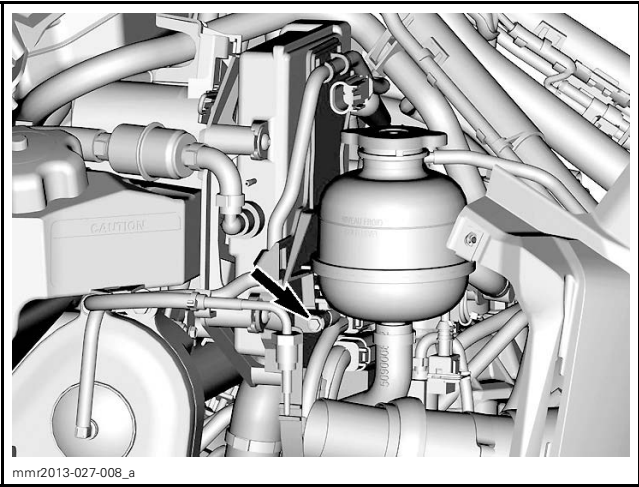
**ECM Removal**

**NOTE:** If a new ECM is to be installed, read *ECM REPLACEMENT* in this subsection **before** removing the ECM.

- 1. Remove tether cord cap (D.E.S.S. key) from engine cut-off switch.
- 2. Set emergency engine stop switch to STOP.
- 3. Remove upper body module. Refer to *BODY* subsection.
- 4. Install a rag under the ECM fuel hose quick connect to catch fuel spillage.
- 5. Place a container under the hose connector to recover fuel.



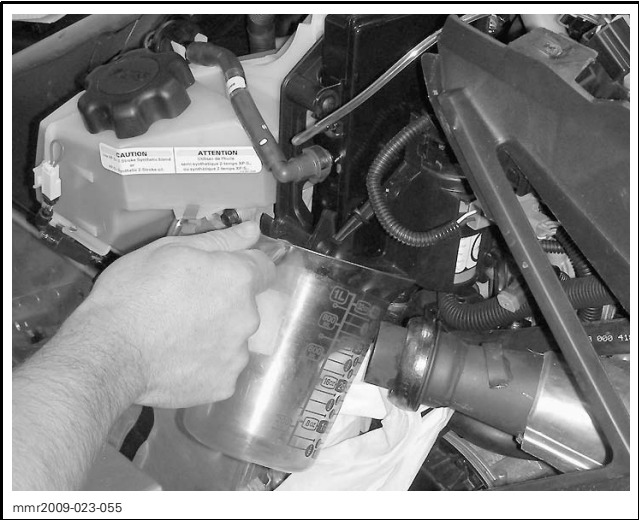
- 7. Detach coolant tank from its support.



- 8. Unlock ECM support and slide toward right.



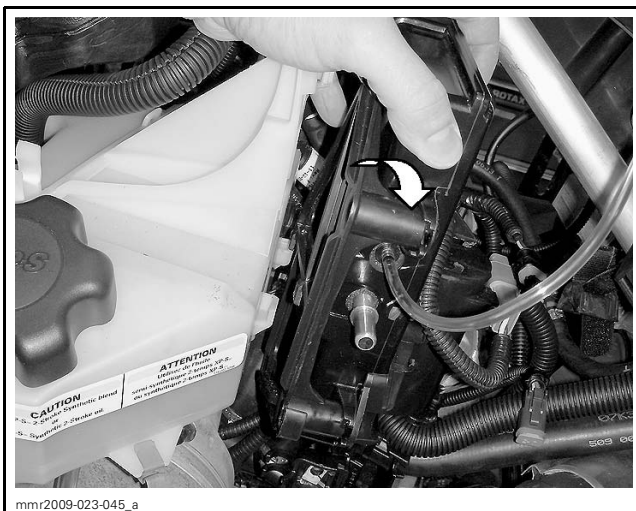
- 9. Slightly pull ECM out.
- 10. Tilt ECM in order to drain fuel remaining in ECM.



TYPICAL

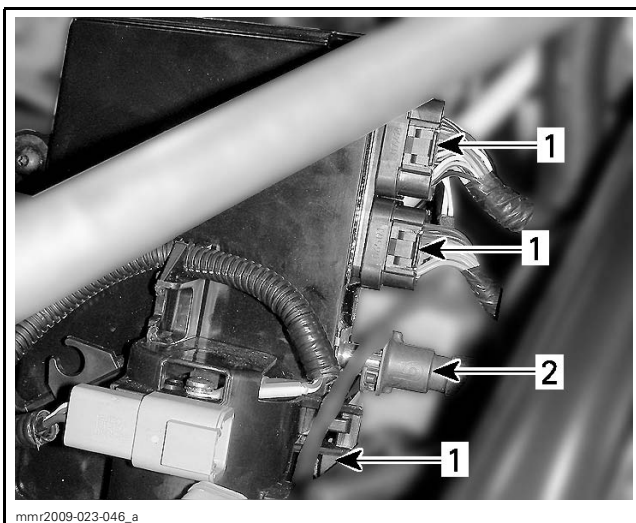
- 6. Slowly disconnect fuel hose from ECM and drain fuel.





**TYPICAL**

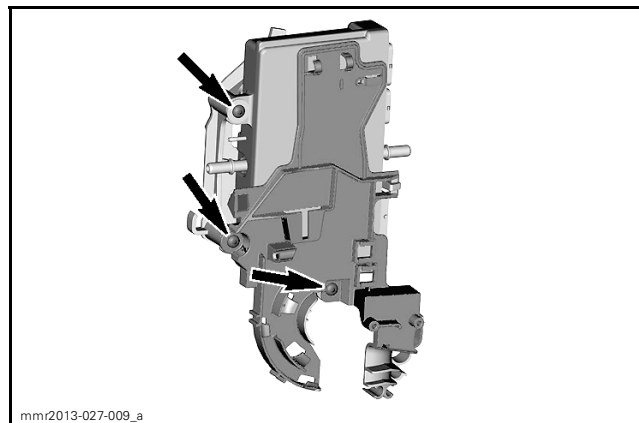
11. Disconnect APS tube (air pressure sensor) from the ECM.
12. Disconnect ECM connectors.
13. Disconnect remaining fuel hose from ECM.



**TYPICAL**

1. ECM connectors
2. Fuel hose

14. Remove ECM from its support.



## ECM Installation

Reverse removal procedure however, pay attention to the following.

Ensure the ECM tabs are properly engaged on the oil injection reservoir.



## **⚠ WARNING**

**Wipe up all spilled fuel.**

Set engine stop switch to RUN.

Install tether cord cap on engine cut-off switch.

Transfer or enter data in new ECM. Refer to *ECM REPLACEMENT* in this subsection.

## ECM Replacement

When installing a new ECM, data must be transferred and several resets are required to be carried out in B.U.D.S.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

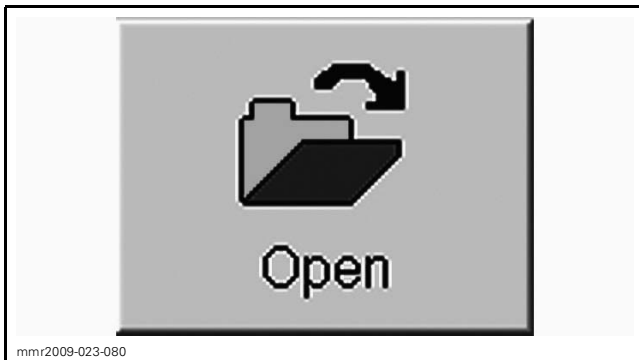
#### ECM Manual Data Entry

There are 2 possible methods to manually collect the required information. The 1<sup>st</sup> being the easiest.

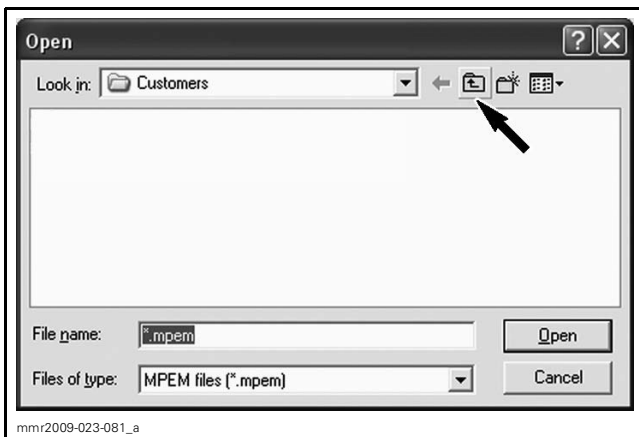
- Use B.U.D.S. software and obtain the data from a saved .mpem file on your PC computer.
- Collect the information from the vehicle and obtain the fuel injector coefficient files from Knowledge Center.

##### 1<sup>st</sup> Collecting Method: Get the Data from a Saved .mpem File

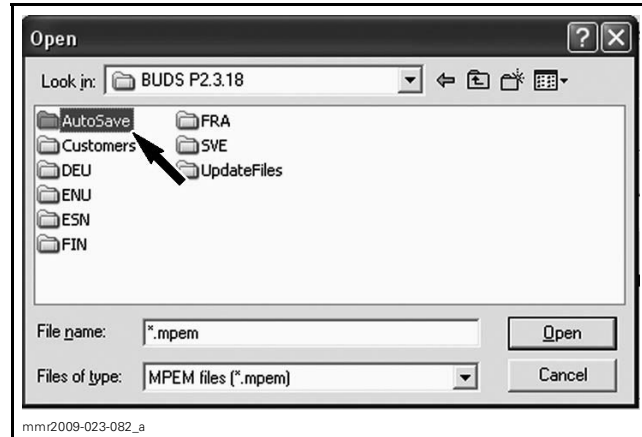
1. Remove the faulty ECM, refer to *ECM REMOVAL* in this subsection.
2. Install and connect the new ECM, refer to *ECM INSTALLATION* in this subsection.
3. Connect vehicle to latest applicable B.U.D.S. version and log on. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
4. Click on the **Open** button.



5. Click once on the **Folder Up** button in the **Open** box.

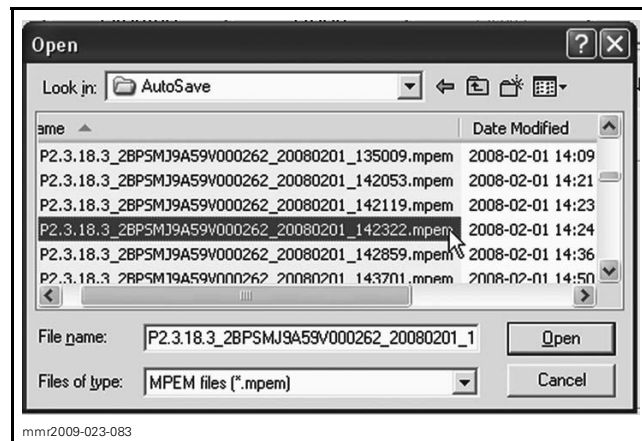


6. Double click on the **AutoSave** folder.



**NOTE:** You may have to go to another **AutoSave** folder from a previous version of B.U.D.S.

7. Choose the latest file saved for this specific vehicle.



**IMPORTANT:** Ensure to use the file that specifically matches the vehicle you are servicing.

**NOTE:** The file name structure is as follows:

BUDS version\_VIN\_date read (yyyymmdd)\_hour read (hhmmss).mpem

Example:

P2.3.18.3\_2BPSMJ9A59V000262\_20080201\_142322.mpem

8. In the **Vehicle** tab, record the following information;
  - Engine number (without the leading "M")
  - Customer name.

**NOTE:** It is not necessary to record the vehicle (VIN) and model numbers. They will be transferred later.

9. Select the **ECM** and **Setting** tabs and record the following information;
  - Ignition/Injection timing: Offset angle

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

- Oil compensation: Oil pump code
- Fuel injector coefficients: MAG/PTO injectors S/N and Checksums.

Setting

Closed Throttle  
Throttle Opening: -0.2%  
Actual TPS Voltage: 0.48  
Reset

Rave Setting  
Actual(V): 2.24  
Set Close  
Set Mid  
Set Open

Ignition/Injection Timing  
RPM Value(RPM): 0  
Offset Angle: -0.3 Deg  
Freeze Timing

Restart Break-in  
Break-in Left (%): 97  
Restart

Oil Compensation  
Oil Pump Code: 3

Vehicle Configuration  
Moved to Vehicle Configuration page

Injector Coefficient  
MAG Injector S/N: 11311030718760 New  
MAG Checksum: 62834  
PTO Injector S/N: 11311030733760 New  
PTO Checksum: 45038

ECM

mmr2013-027-013

Injector Coefficient

MAG Injector S/N: 07303050822720 New

MAG Checksum: 02254

PTO Injector S/N: 07304010921720 New

PTO Checksum: 50469

mmr2009-023-001\_a

FUEL INJECTOR SERIAL NUMBER (S/N)

Injector Coefficient

MAG Injector S/N: 07303050822720 New

MAG Checksum: 02254

PTO Injector S/N: 07304010921720 New

PTO Checksum: 50469

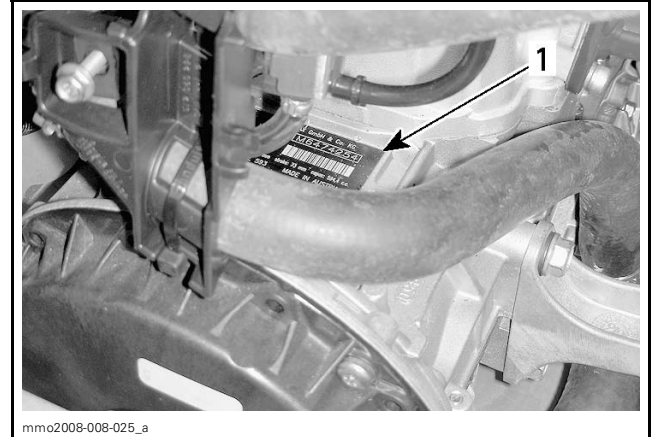
mmr2009-023-001\_b

FUEL INJECTOR CHECKSUM (CS)

10. Enter data in ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM*.

#### 2<sup>nd</sup> Collecting Method: Collect the Information from the Vehicle

1. Record engine serial number.



RH SIDE OF ENGINE COMPARTMENT

1. Engine serial number

2. Record oil injection pump code.

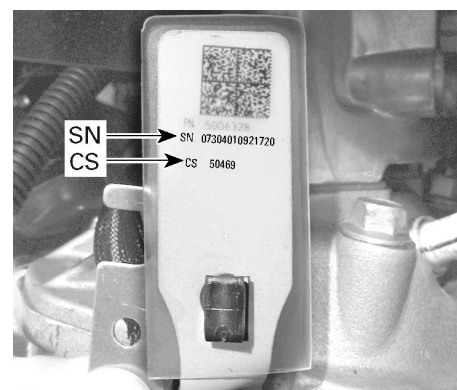


BACK OF OIL INJECTION PUMP

1. Oil pump code (0 to 9)

3. Record MAG/PTO injector S/N and Checksum numbers.

Record the serial number (SN) and the checksum (CS) on the fuel injector tag.



SN: Serial number  
CS: Checksum number

Use *KNOWLEDGE CENTER* article 30098 to get the matching calibration file.

Save the calibration file to your PC computer in the folder:

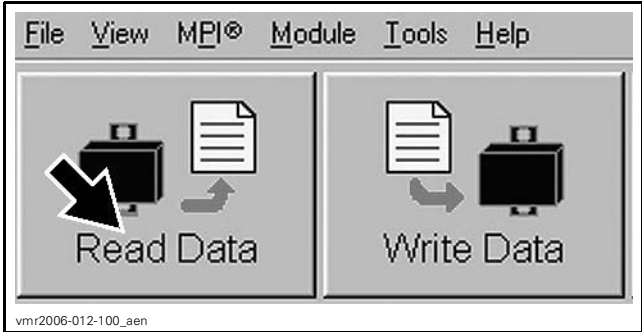
C:\Program Files\BRP\BUDSCommon\  
InjectorCoefficients.

**Section 04 FUEL SYSTEM**  
**Subsection 02 (E-TEC DIRECT FUEL INJECTION)**

Enter data in ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM*.

**Entering the Collected Information Into the ECM (Pre-programmed ECM)**

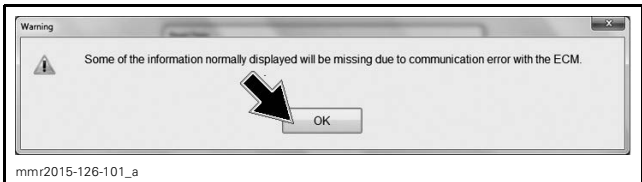
- 1. Ensure B.U.D.S. is properly connected to the vehicle and logged on.
- 2. In B.U.D.S., click the **Read Data** button to read the new "empty" ECM.



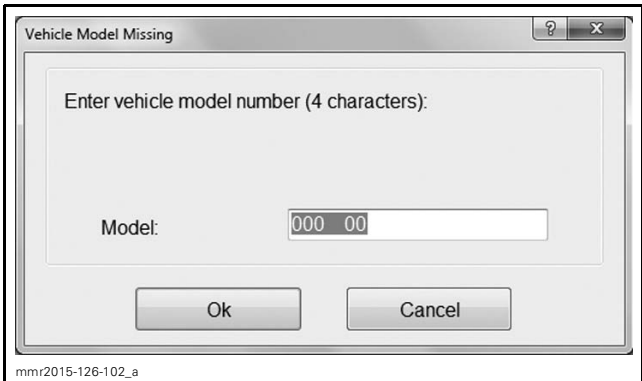
Then, a message will appear saying that the cluster (multifunction gauge) does not recognize the ECM.

*Virgin ECM*

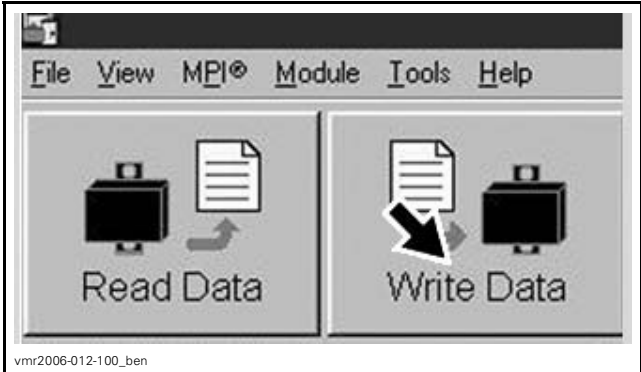
**NOTE:** If you get the following message, the setup is slightly different.  
Click "OK".



Enter the model number and follow instructions in B.U.D.S.

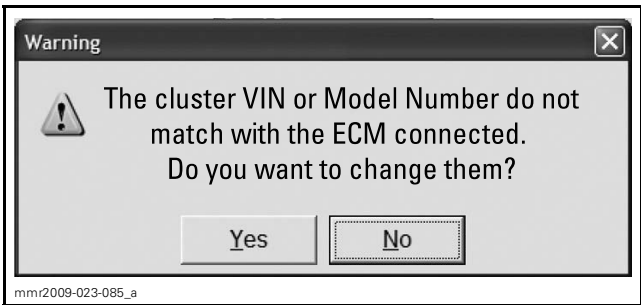


Write data before disconnecting the external battery.



When prompted, disconnect external battery. Re-connect it when display message changes.  
Skip ahead to **"All ECMs"** in this procedure.

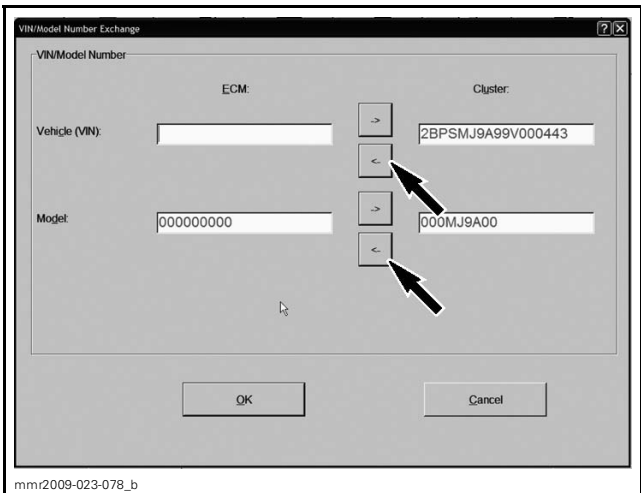
*Pre-Programmed ECM (continued)*



- 3. Click **Yes**.

**NOTE:** If the numbers are not matched, the gauge will stop operating within 10 seconds of engine operation. Only its D.E.S.S. LED will be turned ON.

- 4. Click on the arrows to transfer the numbers from the **Cluster** column to the **ECM** column.

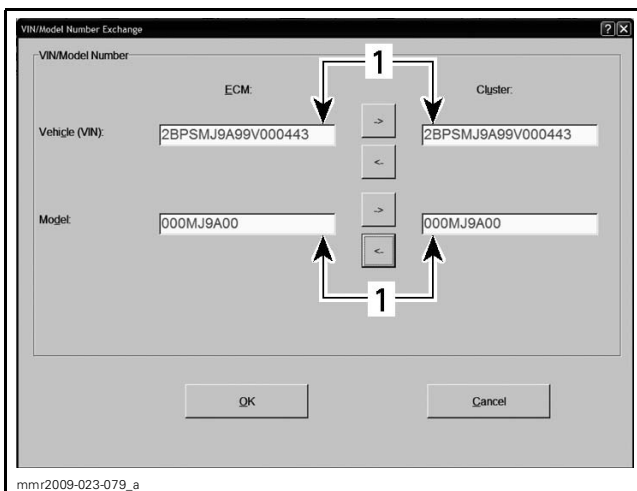


**TYPICAL**

Ensure the **VIN** and **Model** numbers in the ECM and cluster are exactly matched.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

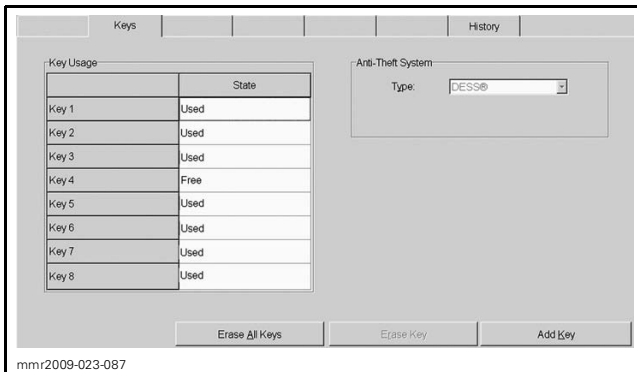


*TYPICAL*

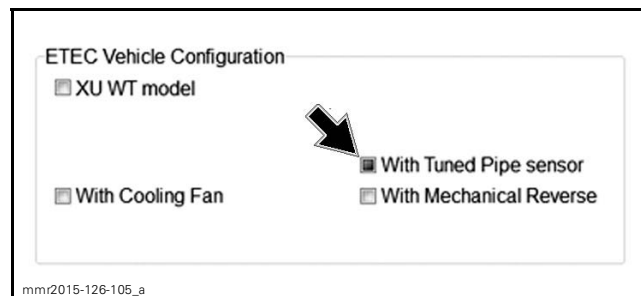
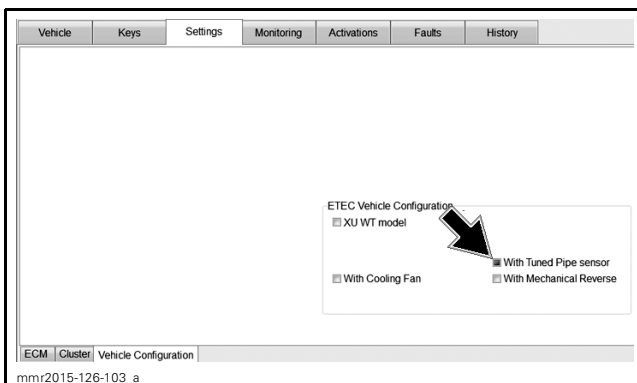
1. Matching numbers

#### All ECMs

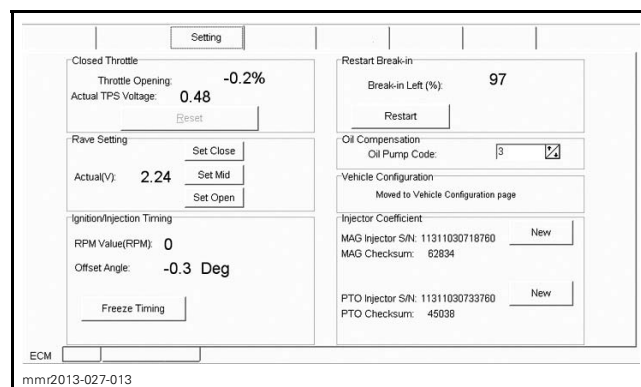
5. On the **Vehicle** page, enter the information you recorded previously:
  - Engine number (do not enter the leading "M")
  - Customer name.
6. In the **Keys** page, select **Erase All Keys**.



7. Program the desired key(s). Refer to *D.E.S.S. SYSTEM* subsection.
8. In the **Vehicle Configuration** page:
  - 8.1 Check illustrated box.



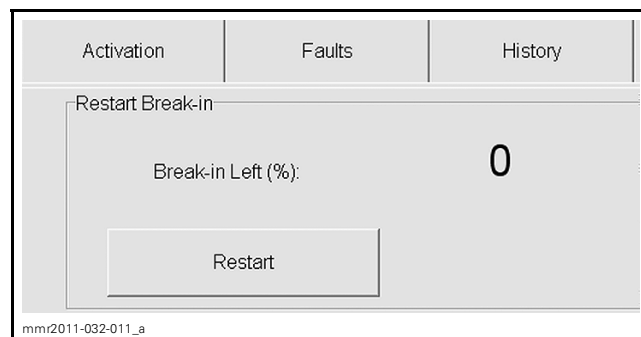
9. Select the **Setting** tab then **ECM**.



10. Reset the **Closed Throttle** setting as detailed in *CLOSED THROTTLE RESET (TPS)*.

**NOTICE** The Closed Throttle Reset must be carried out as described in the specific procedure or engine damage may occur.

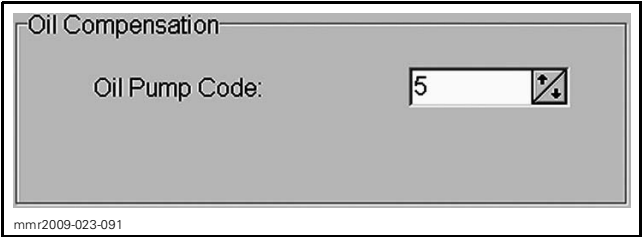
11. Carry the **3D Rave Valves Position Sensor Setting**. Refer to *RAVE* subsection.
12. Set the **Ignition/Injection Timing**. Refer to *IGNITION SYSTEM* subsection.
13. **Restart Break-In**. Click **Restart** button if the actual engine hours are less than 5 hours.



*TYPICAL*

14. **Oil Compensation**. Enter the previously recorded **Oil Pump Code**.

Section 04 FUEL SYSTEM
Subsection 02 (E-TEC DIRECT FUEL INJECTION)



TYPICAL

- 15. MAG and PTO fuel injector S/N.
15.1 If the data was obtained from a saved .mpem file, refer to table A.
15.2 If the fuel injector calibration file was obtained from Knowledge Center, refer to table B.

TABLE A (DATA FROM A SAVED .MPEM FILE)

Click on the New button and open the file that matches the previously recorded serial number.

Injector Coefficient window showing MAG and PTO injector S/N and Checksum values with New buttons.

Ensure the PTO and MAG side injector S/N correctly match those on the engine.

Once the file has been read, ensure the checksum number (CS) displayed in B.U.D.S. matches the CS previously recorded.

Injector Coefficient window showing MAG and PTO injector S/N and Checksum values with New buttons.

If the numbers do not match, the wrong file was read. Repeat the procedure to record the correct file.

TABLE B (CALIBRATION FILE FROM KNOWLEDGE CENTER)

Click on the New button and open the file that you previously saved on your PC computer in the folder: C:\Program Files\BRP\BUDSCommon\InjectorCoefficient

Ensure to correctly match the PTO and MAG side injector serial numbers.

Once the file has been read, ensure the fuel injector tag SN and CS matches those shown in B.U.D.S.

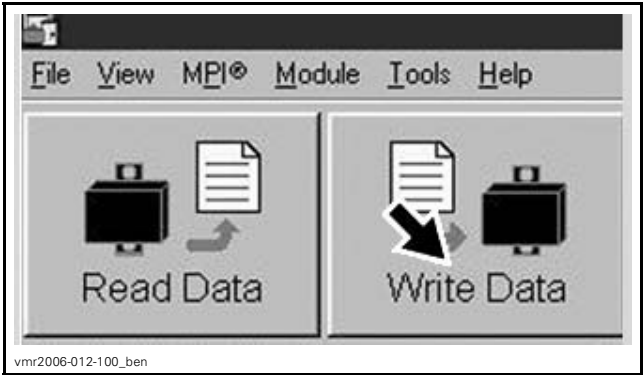
Image of a fuel injector with SN and CS labels pointing to the serial number and checksum values.

SN: Serial Number
CS: Checksum number

Injector Coefficient window showing MAG and PTO injector S/N and Checksum values with New buttons.

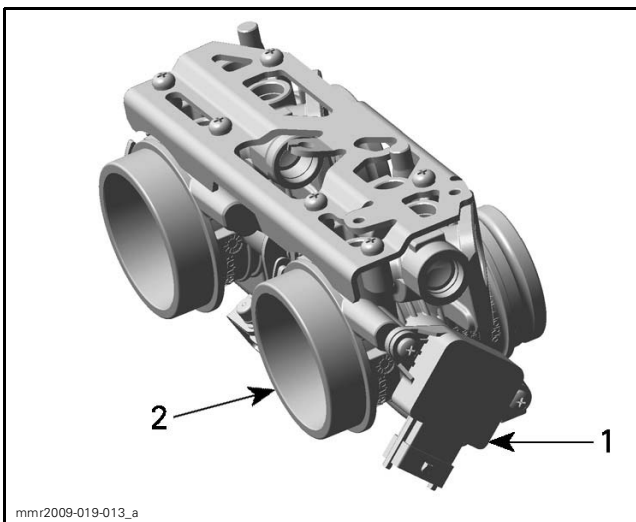
If the numbers do not match, the wrong file was read. Repeat the procedure to record the correct file.

- 16. Click on the Write Data button to save the data to the ECM.



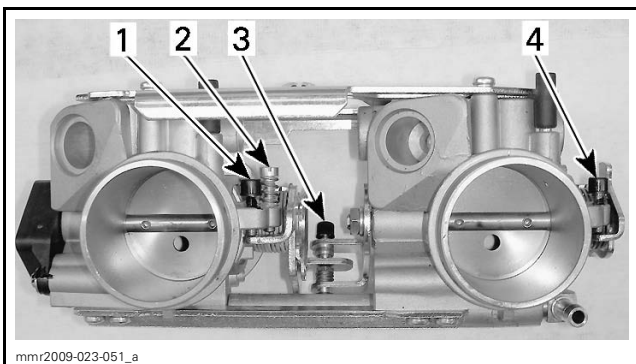
17. Lift rear of vehicle and safely support.
18. Start the engine and increase engine speed above 6000 RPM to be sure no fault codes appear.
19. Let engine idle to ensure idle is adequate.
20. If engine does not run as expected, ensure that the fuel injector calibration files are valid. Check with the tag of the fuel injectors installed on the engine.
21. Reinstall remaining removed parts.

## THROTTLE BODY



1. Throttle body
2. TPS (Throttle position sensor)

## Throttle Body Screw Identification



1. Master zero position screw (capped)
2. Idle screw (not used on E-TC engine)
3. Synchronizing screw (capped)
4. Slave zero position screw (capped)

**NOTICE** Do not tamper with any capped screw. Otherwise, throttle body may have to be replaced.

## Throttle Body Inspection

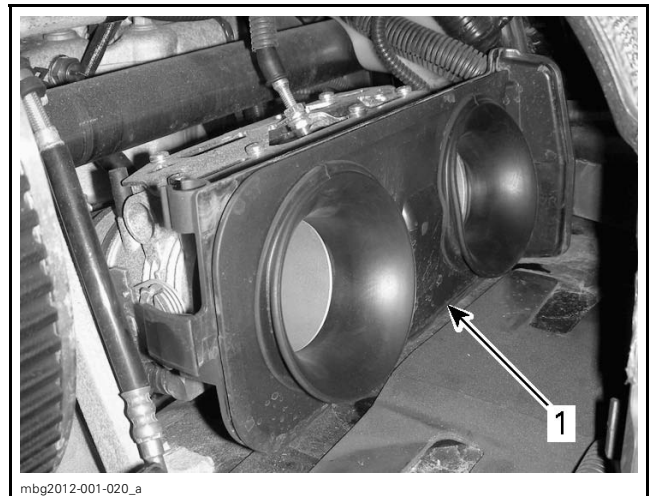
- Ensure throttle plates move freely and smoothly when depressing throttle lever.
- Ensure throttle body master zero position screw is **NOT** loose. If so, replace throttle body.
- Ensure that the master zero position screw stops the throttle plate, **not** the idle screw. There **must** be a gap under the idle screw.
- Ensure TPS is **NOT** loose.
- Check for corroded or damaged wiring or connectors.

## Throttle Body Removal

### **WARNING**

Always remove tether cord cap (D.E.S.S. key) before removing the throttle body.

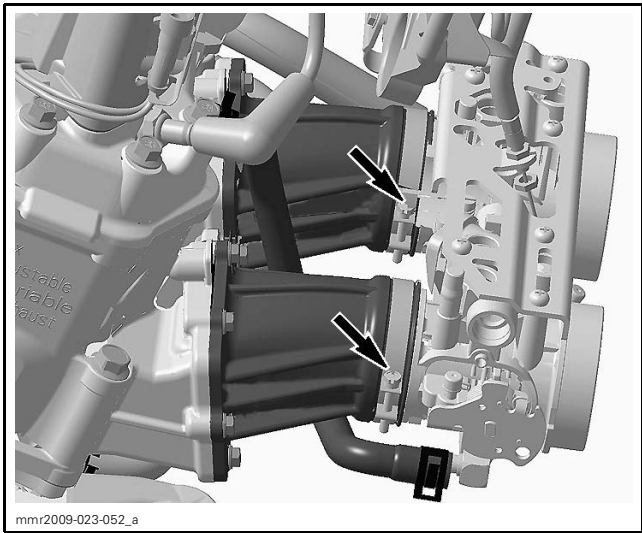
1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
3. Remove adapter plate from throttle body.



1. Adapter plate

4. Loosen clamps retaining throttle body.

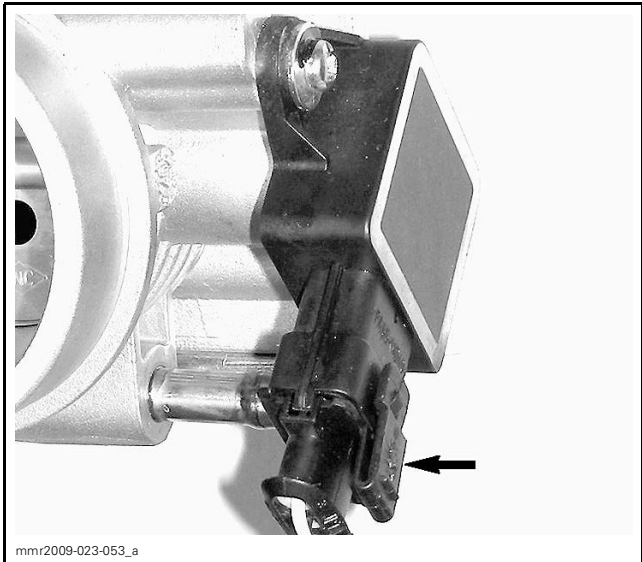
**Section 04 FUEL SYSTEM**  
**Subsection 02 (E-TEC DIRECT FUEL INJECTION)**



5. Pull out throttle body sufficiently to access coolant hoses and TPS connector.
6. Disconnect TPS connector.

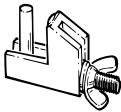


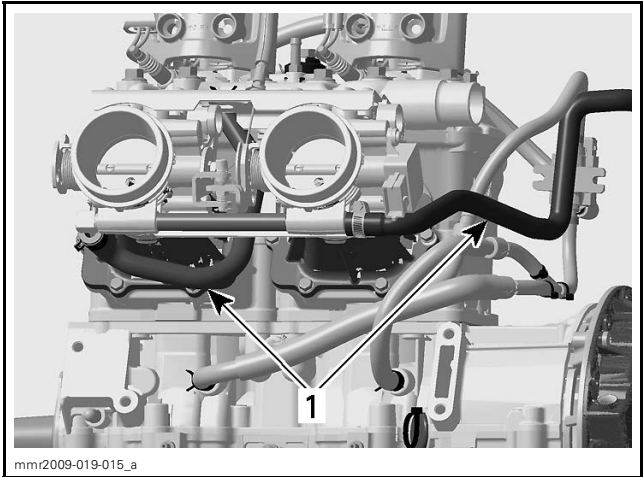
1. TPS connector



**PUSH TAB TO UNLOCK**

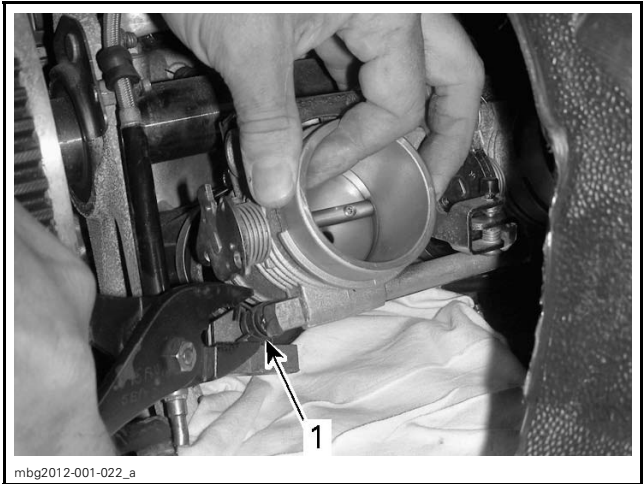
7. Install a small hose pincher on coolant hoses connected to throttle body.

REQUIRED TOOL	
SMALL HOSE PINCHER (P/N 295 000 076)	



1. Install hose pinchers here

8. Remove coolant hoses from throttle body.



1. Coolant hose clamp to remove



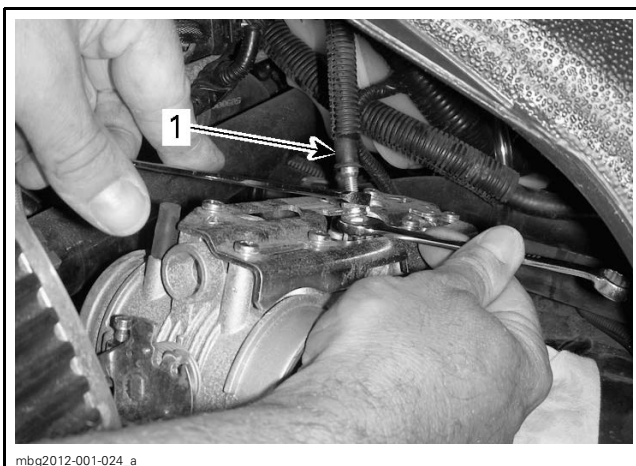
## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



1. Coolant hose clamp to remove

9. Disconnect throttle cable.



1. Throttle cable

10. Remove throttle body from vehicle.

#### Throttle Body Installation

1. If installing the removed throttle body, clean throttle plates and bores using PULLEY FLANGE CLEANER (P/N 413 711 809) before installation.
2. Install cooling hoses on throttle body.
3. Remove hose pinchers.
4. Connect TPS connector.

**NOTICE** Ensure TPS connector tab is properly locked.

5. Install throttle body on intake adapters.
6. Tighten throttle body clamps to specification.

TIGHTENING TORQUE	
Throttle body clamps	1.4 N•m ± 0.2 N•m (12 lbf•in ± 2 lbf•in)

7. Install throttle cable loosely.

8. Carry out the *THROTTLE CABLE ADJUSTMENT* as detailed in this subsection.

9. If a new throttle body or TPS is installed, carry out the *CLOSED THROTTLE RESET (TPS)* as detailed in this subsection.

10. Refill engine coolant.

**NOTE:** If an important quantity of coolant was spilled, bleed cooling system. Refer to *COOLING SYSTEM* subsection.

11. Install adapter plate (primary air intake silencer) on throttle body.

TIGHTENING TORQUE	
Adapter plate clamps	0.7 N•m ± 0.2 N•m (6 lbf•in ± 2 lbf•in)

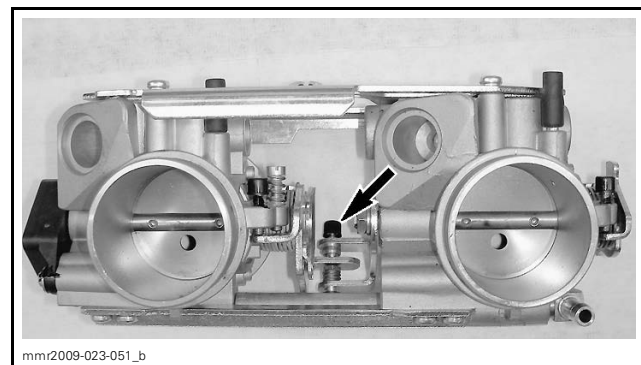
12. Install primary air intake silencer, refer to *AIR INTAKE SYSTEM* subsection.

13. Install all remaining removed parts.

#### Throttle Body Synchronization

No synchronization is required as it has already been done at the factory.

**NOTICE** Do not alter synchronization screw setting. Otherwise throttle body must be replaced.



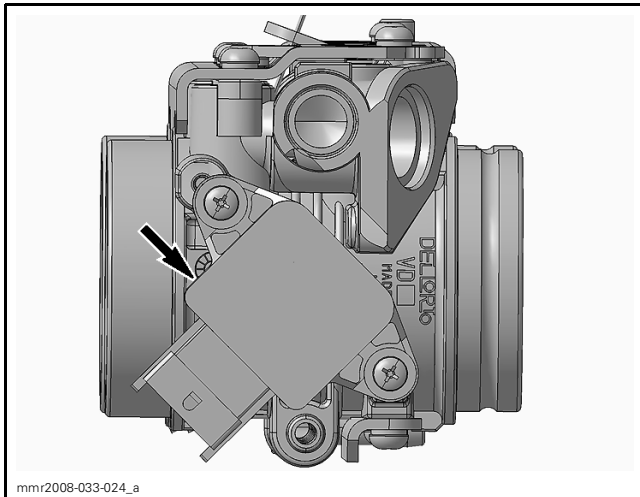
#### TPS (THROTTLE POSITION SENSOR)

##### Description

The throttle position sensor (TPS) is a potentiometer that sends a signal to the ECM which is proportional to the throttle shaft angle.

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



THROTTLE POSITION SENSOR (TPS)

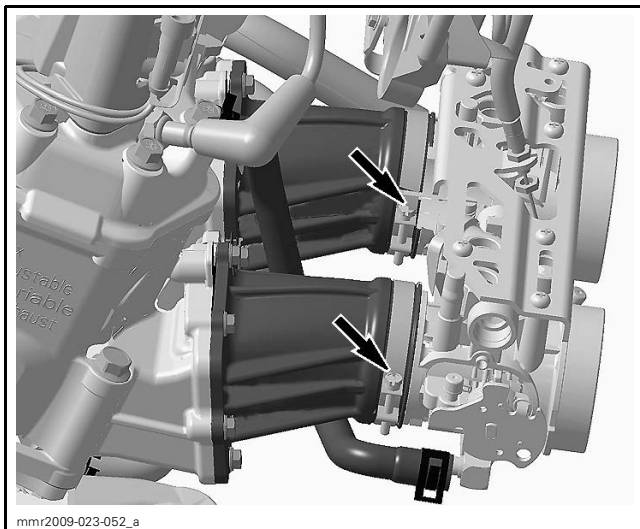
#### TPS Connector Access

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.

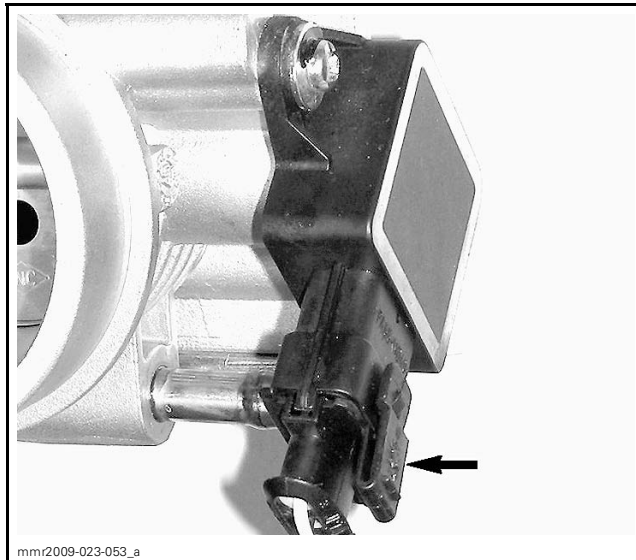
#### WARNING

Always remove tether cord cap (D.E.S.S. key) before removing the throttle body.

3. Loosen clamps retaining throttle body.

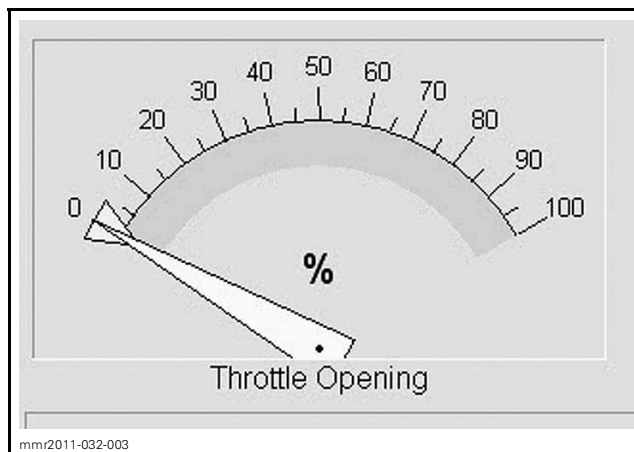


4. Pull out throttle body for access to TPS connector.
5. Disconnect TPS connector.



#### TPS Wear Test

1. Ensure TPS connector is properly connected.
2. While engine is not running, activate throttle and pay attention for smooth operation without physical stops of the cable.
3. Use B.U.D.S. software.
4. Select the **Monitoring** and **ECM** tabs. Monitor the TPS using the **Throttle Opening** indicator.



THROTTLE OPENING INDICATOR

5. Slowly and regularly depress the throttle. Observe the needle movement.

The needle must change gradually and regularly as the throttle is activated. If the needle "sticks", bounces, suddenly drops off or if any discrepancy between the throttle movement and the needle movement is noticed, it indicates a worn TPS that needs to be replaced.

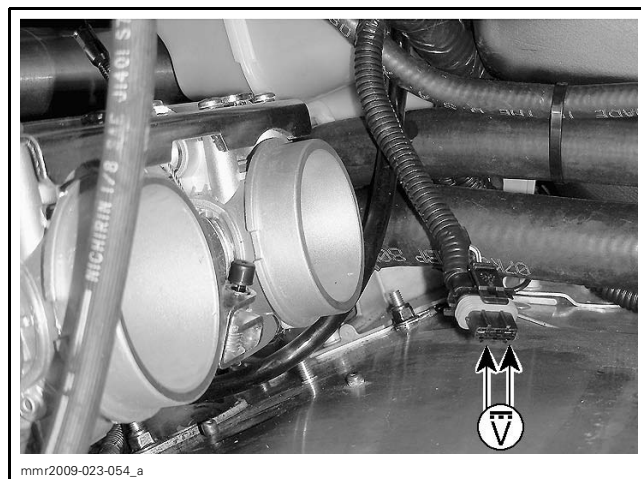
#### TPS Reset (Closed Throttle)

Refer to *CLOSED THROTTLE RESET (TPS)* in the *ADJUSTMENT* topic of this subsection.

### TPS Input Voltage Test

1. Remove parts required to access TPS connector, refer to *TPS CONNECTOR ACCESS* in this subsection.
2. Connect B.U.D.S. to power 12 Vdc system.
3. Disconnect TPS connector.
4. Read voltage at TPS harness connector as follows.

TPS HARNESS CONNECTOR		VOLTAGE
Pin 1	Pin 2	5.0 Vdc



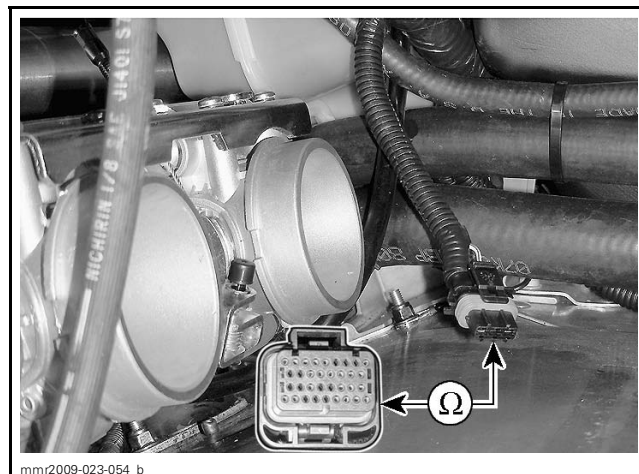
If voltage is good, carry out the *TPS SIGNAL WIRE TEST*.

### TPS Signal Wire Test

Disconnect J1A connector from ECM, refer to *CONNECTOR INFORMATION* subsection.

Check the wiring continuity as follows.

TPS HARNESS CONNECTOR	ECM J1A CONNECTOR	RESISTANCE
Pin 3	Pin 1	Close to 0 $\Omega$ (continuity)



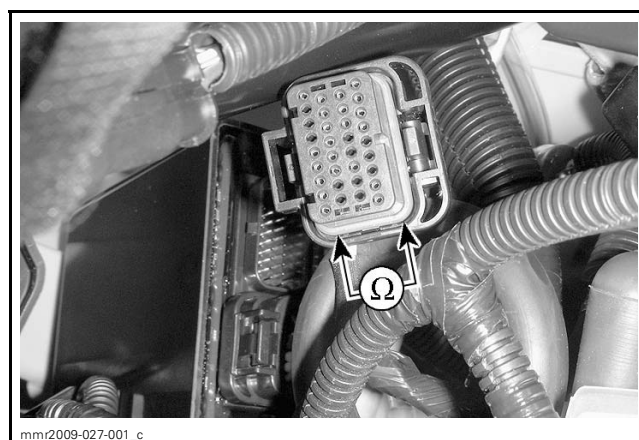
If tests are good, replace the TPS.

If tests are not good, continue to check the resistance of the remainder of the TPS circuit.

### TPS Resistance Test

1. Reconnect the TPS.
2. Disconnect connector J1A from the ECM.

ECM CONNECTOR		THROTTLE IDLE POSITION	WIDE OPEN THROTTLE POSITION
PIN		RESISTANCE $\Omega$	
J1A-1	J1A-27	1000 $\pm$ 200	2500 $\pm$ 500
J1A-27	J1A-10	2000 $\pm$ 400	2000 $\pm$ 400
J1A-1	J1A-10	2500 $\pm$ 500	1000 $\pm$ 200



**NOTE:** The resistive value should change smoothly and proportionally to the throttle movement. Otherwise, replace TPS.

If resistive values are correct, try a new ECM. Refer to *ENGINE CONTROL MODULE (ECM)* elsewhere in this subsection.

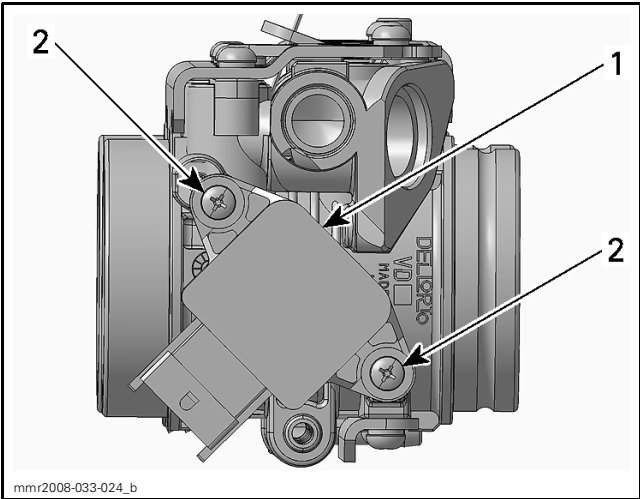
**Section 04 FUEL SYSTEM**  
**Subsection 02 (E-TEC DIRECT FUEL INJECTION)**

If resistive values are incorrect:

- Repair/replace wiring/connectors.
- Replace TPS.

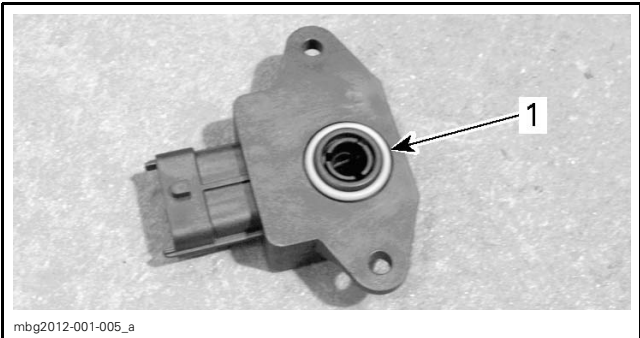
**TPS Replacement**

1. Remove the throttle body, refer to *THROTTLE BODY REMOVAL* in this subsection.
2. Remove TPS retaining screws.



1. Throttle position sensor (TPS)  
2. Screws

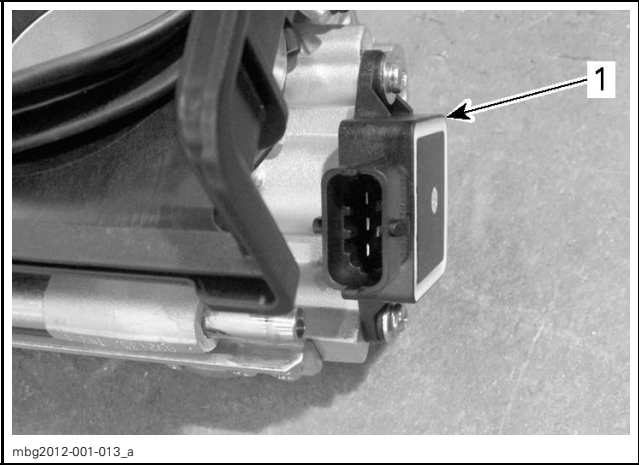
3. Remove TPS.
4. Ensure O-ring is still positioned on TPS after removal.



1. TPS O-ring

**NOTE:** If O-ring is missing, remove it from throttle body shaft.

5. Install new TPS.



1. New TPS

6. Tighten TPS retaining screws to specification.

TIGHTENING TORQUE	
TPS retaining screws	2.0 N•m ± 0.4 N•m (18 lbf•in ± 4 lbf•in)

7. Open and quickly release throttle plates 6 times (throttle plates must snap shut).



TYPICAL - PUSH TO OPEN THROTTLE PLATES

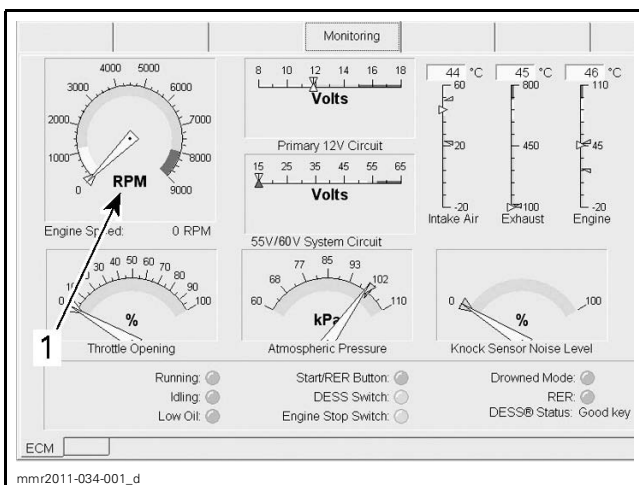
8. Reinstall remaining removed parts.
9. Reset TPS, refer to *CLOSED THROTTLE RESET (TPS)* in this subsection.

**CRANKSHAFT POSITION SENSOR (CPS)**

**CPS Test with B.U.D.S.**

1. Connect vehicle to the latest applicable B.U.D.S. version.
2. In B.U.D.S., select the **Monitoring** and **ECM** tabs.

3. Monitor the **Engine Speed (RPM)** indicator while cranking engine.



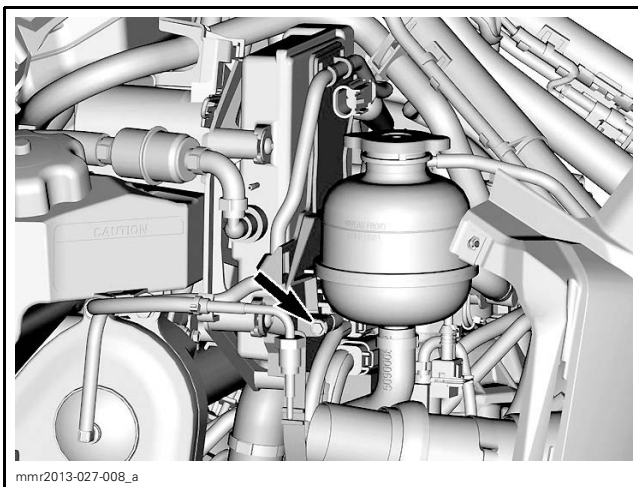
1. B.U.D.S. RPM indicator

The needle should move proportionally to the cranking RPM. If no needle movement is observed, carry out the **CPS OUTPUT VOLTAGE TEST**.

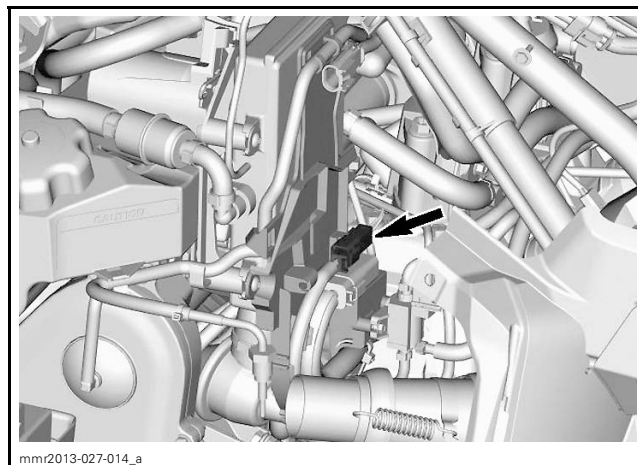
**NOTE:** A loose CPS or CPS connector can send an intermittent signal that can prevent the engine from starting.

### CPS Output Voltage Test

1. Remove upper body module. Refer to *BODY* subsection.
2. Remove muffler. Refer to *EXHAUST SYSTEM* subsection.
3. Detach coolant tank from its support.

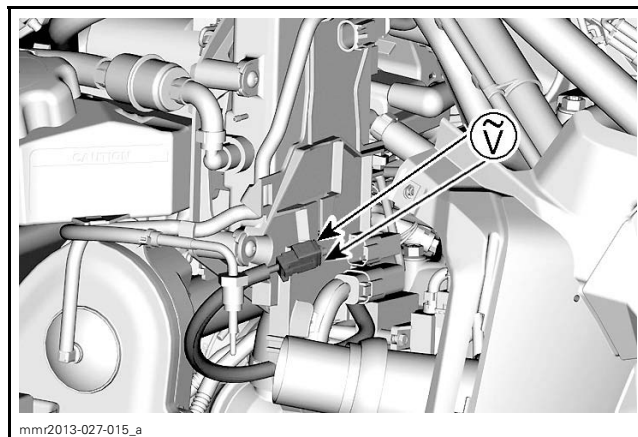


4. Disconnect CPS connector (2-pin connector).



5. Probe terminals coming from CPS while cranking engine.

CPS CONNECTOR		VOLTAGE
Pin 1	Pin 2	1 - 2 Vac min.



If voltage is out of specification, inspect wiring/connectors. Replace CPS if wiring is good.

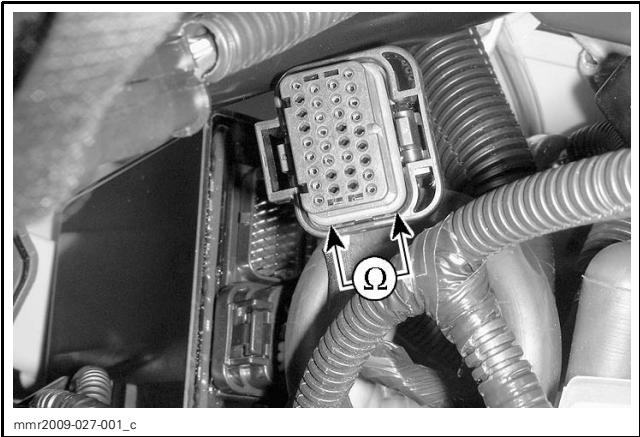
### CPS Resistance Test

1. Disconnect connector J1A from ECM.
2. Measure the resistance of the sensor through its wiring.

ECM J1A CONNECTOR		RESISTANCE @ 20°C (68°F)
Pin 6	Pin 7	190 - 290 Ω

Section 04 FUEL SYSTEM

Subsection 02 (E-TEC DIRECT FUEL INJECTION)

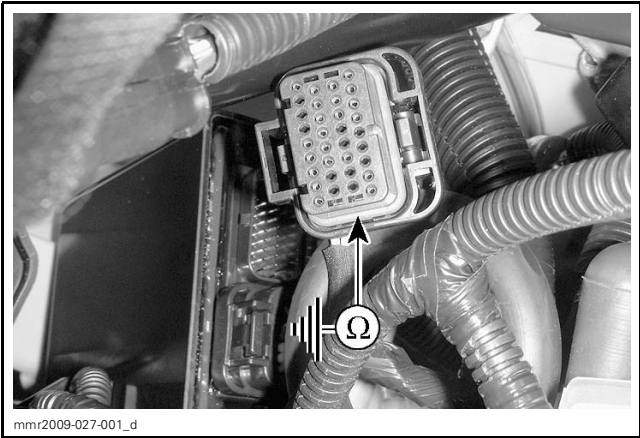


TYPICAL

If measurement is out of specification, check wiring continuity between ECM and CPS.

3. Also check for a shorted connection to ground as per table.

ECM J1A CONNECTOR		RESISTANCE @ 20°C (68°F)
Pin 6	Engine ground	Open circuit (OL)
Pin 7	Engine ground	



TYPICAL

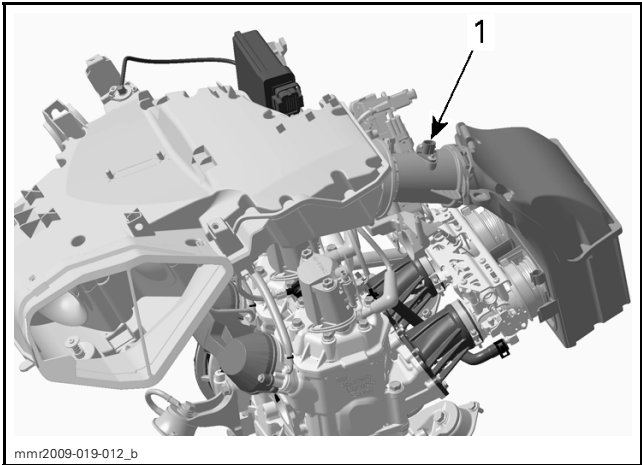
If the previous tests were good, replace CPS.

CPS Replacement

Refer to *MAGNETO SYSTEM* subsection.

ATS (AIR TEMPERATURE SENSOR)

ATS Location



TYPICAL - ATS SENSOR

1. Air temperature sensor (ATS)

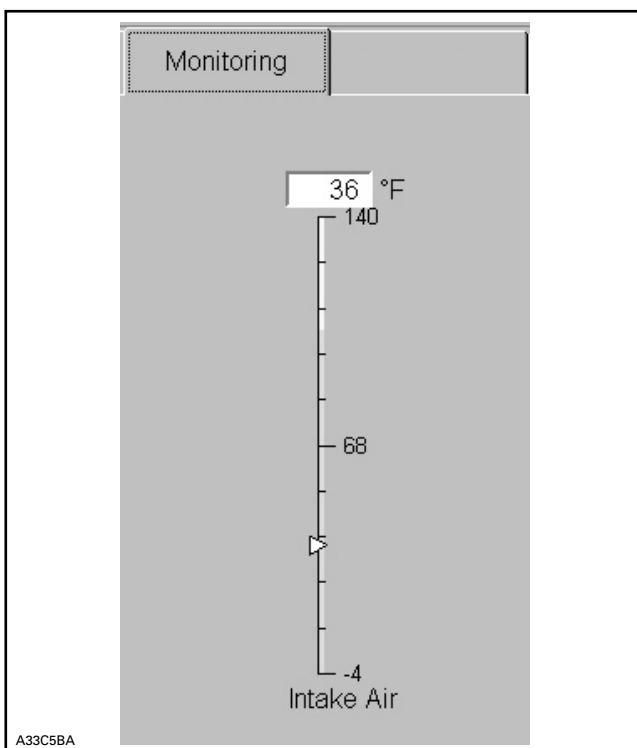
ATS Access

Remove drive belt guard. Refer to *DRIVE BELT* subsection.

Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.

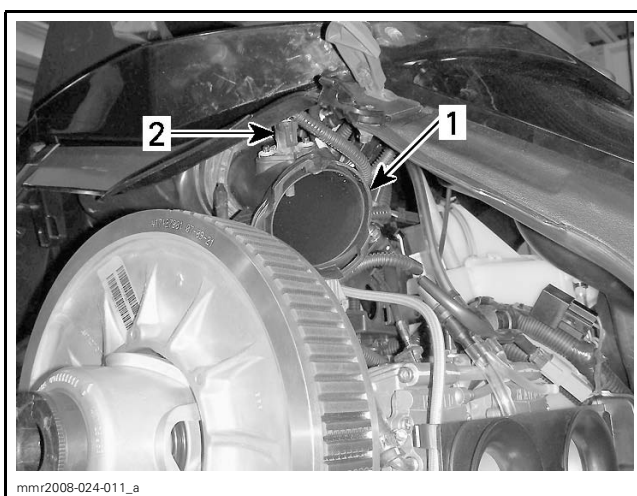
ATS Test with B.U.D.S.

1. Connect vehicle to latest applicable B.U.D.S. version.
2. Select the **Monitoring** and **ECM** tabs.
3. Monitor the **Intake Air** temperature indicator. It should indicate ambient temperature. Otherwise, perform the *ATS RESISTANCE TEST*.



### ATS Connector Access

1. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
2. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
3. Rotate intake adapter to disconnect ATS sensor connector.



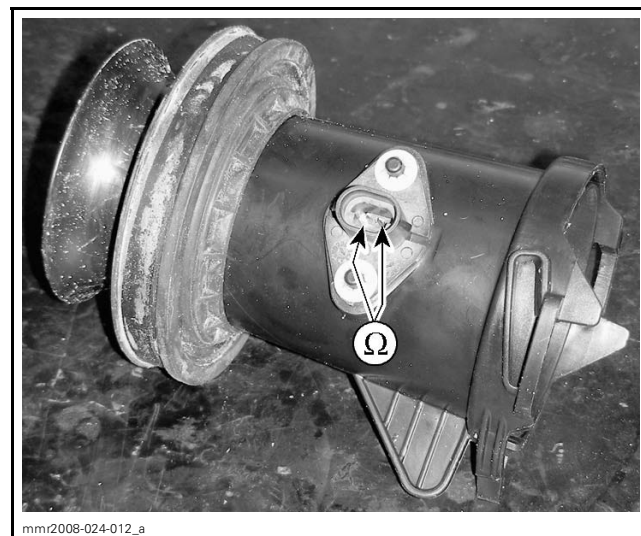
- TYPICAL**
1. Rotate intake adapter
  2. Disconnect sensor connector

### ATS Resistance Test

1. Remove parts required for access to ATS connector, refer to *ATS CONNECTOR ACCESS* in this subsection.

2. Measure sensor resistance.

ATS		MEASUREMENT
Pin 1	Pin 2	Refer to <i>SENSOR TEMPERATURE TABLE</i>



INTAKE ADAPTER REMOVED FOR CLARITY PURPOSE ONLY

ATS SENSOR TEMPERATURE TABLE	
TEMPERATURE	RESISTANCE
-40°C (-40°F)	43610 Ω
0°C (32°F)	5705 Ω
20°C (68°F)	2436 Ω
110°C (230°F)	141 Ω
150°C (302°F)	57 Ω
200°C (392°F)	23 Ω

If resistance is out of specifications, replace sensor.

If resistance tests good, carry out the following steps.

3. Reconnect the ATS connector.
4. Disconnect the J1A connector from ECM.
5. Using the FLUKE 115 MULTIMETER (P/N 529 035 868), measure sensor circuit resistance value as follows.

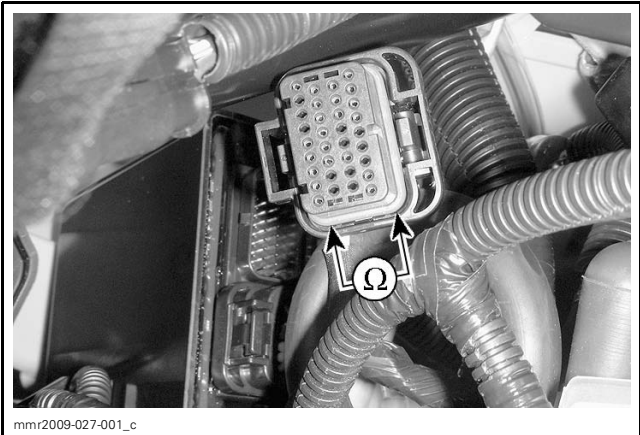
**IMPORTANT:** Move wiring harness back and forth near the sensor connector while measuring the resistance. If the resistance value varies as the harness is moved, check sensor connections.



Section 04 FUEL SYSTEM

Subsection 02 (E-TEC DIRECT FUEL INJECTION)

J1A CONNECTOR		MEASUREMENT
Pin J1A-20	Pin J1A-27	Refer to <i>SENSOR TEMPERATURE TABLE</i>

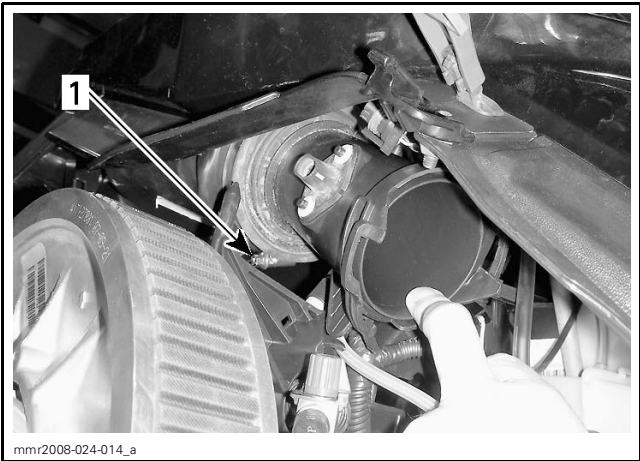


If resistance value is incorrect, repair the connectors or replace the wiring harness between ECM connector and the ATS.

6. Reinstall removed parts. Ensure intake adapter boot is properly installed on the adapter. See below in *ATS REPLACEMENT*.

ATS Replacement

- 1. Remove parts required for access to ATS, refer to *ATS ACCESS* in this subsection.
- 2. Loosen clamp retaining adapter boot seal.



- 1. Boot clamp
- 3. Disconnect ATS connector.
- 4. Pull out intake adapter.
- 5. Remove sensor push nuts.



ATS SENSOR PUSH NUTS

- 6. Pull out sensor.
- 7. Using new push nuts, secure the new sensor to the adapter.
- 8. Reconnect ATS.
- 9. Ensure adapter boot is properly installed as shown.



CORRECT BOOT INSTALLATION

- 10. Reinstall removed parts.

COOLANT TEMPERATURE SENSOR (CTS)

CTS Test with B.U.D.S.

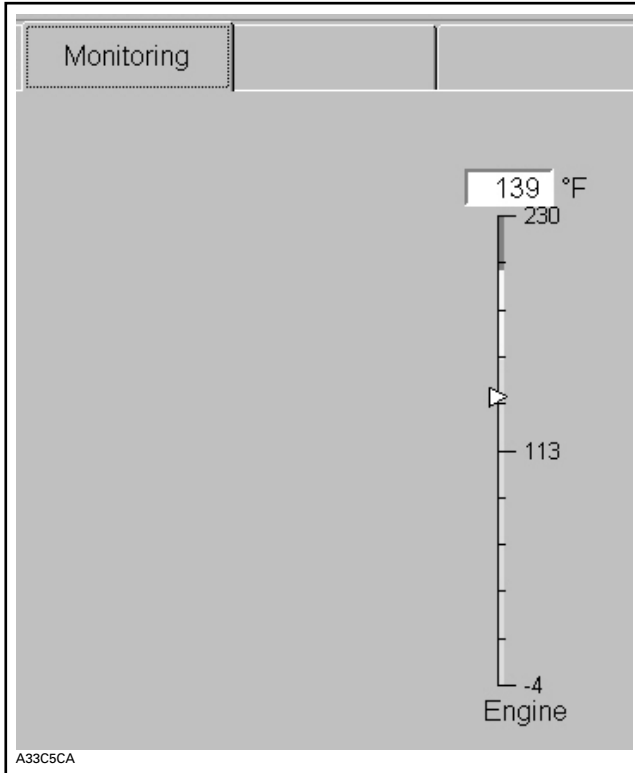
- 1. Connect vehicle to latest applicable B.U.D.S. version.
- 2. Select the **Monitoring** and **ECM** tabs.



## Section 04 FUEL SYSTEM

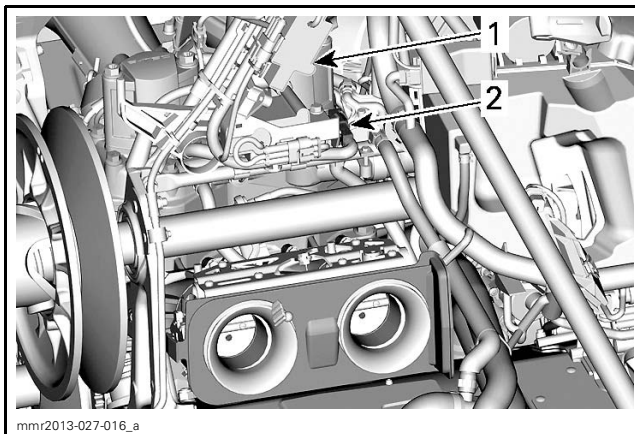
### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

3. Monitor the **Engine** temperature indicator. It should show the coolant temperature. Otherwise, perform the following *CTS RESISTANCE TEST*.



#### CTS Connector Access

Remove primary air intake silencer. Refer to *A/R INTAKE SYSTEM* subsection.



**CTS CONNECTOR LOCATION**

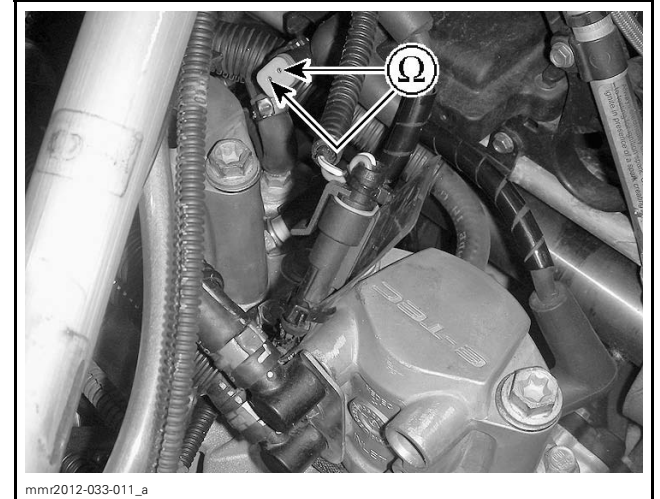
1. PTO ignition coil
2. CTS connector

#### CTS Resistance Test

1. Disconnect CTS sensor connector, refer to *CTS CONNECTOR ACCESS*.

2. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and set it to  $\Omega$ .
3. Measure resistance between sensor terminals.

CTS		MEASUREMENT
Pin 1	Pin 2	Refer to <i>CTS SENSOR TEMPERATURE TABLE</i>
Pin 1 or 2	Engine ground	Open circuit (OL)



**CTS RESISTANCE CHECK**

CTS SENSOR TEMPERATURE TABLE	
TEMPERATURE	RESISTANCE
-40°C (-40°F)	72412 $\Omega$
0°C (32°F)	7418 $\Omega$
20°C (68°F)	2919 $\Omega$
110°C (230°F)	186 $\Omega$
150°C (302°F)	57 $\Omega$

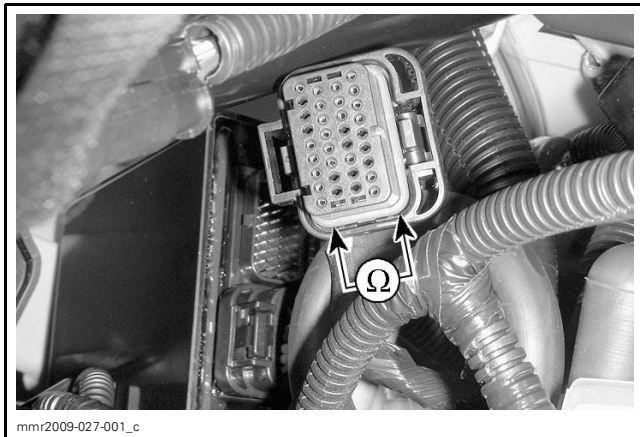
If resistance is out of specifications, replace CTS. If resistance tests good, carry out the following steps.

4. Reconnect the CTS.
5. Disconnect the J1A connector from ECM.
6. Measure CTS circuit resistance as follows.

J1A CONNECTOR		MEASUREMENT
Pin 19	Pin 27	Refer to <i>CTS SENSOR TEMPERATURE TABLE (E-TEC)</i>

## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)



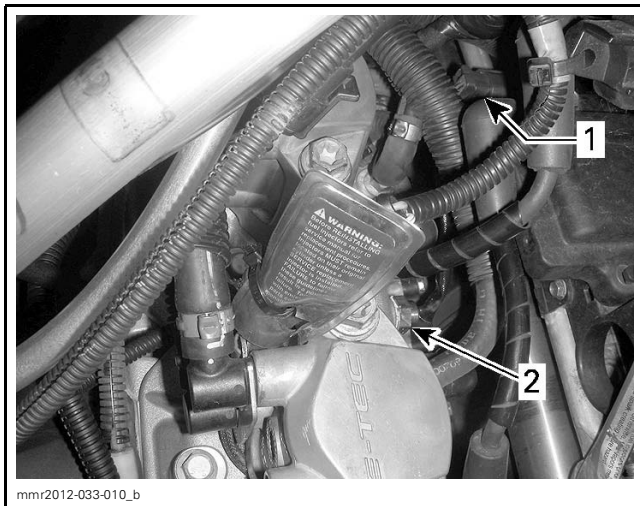
TYPICAL

If resistance value is correct, sensor and wiring/connectors are good.

If resistance value is incorrect, repair/replace wiring/connectors between ECM and CTS.

#### CTS Replacement

1. Remove parts required to access CTS, refer to *CTS ACCESS* in this subsection.
2. Lift rear of vehicle to minimize coolant spillage.
3. Disconnect CTS connector.
4. Remove CTS.

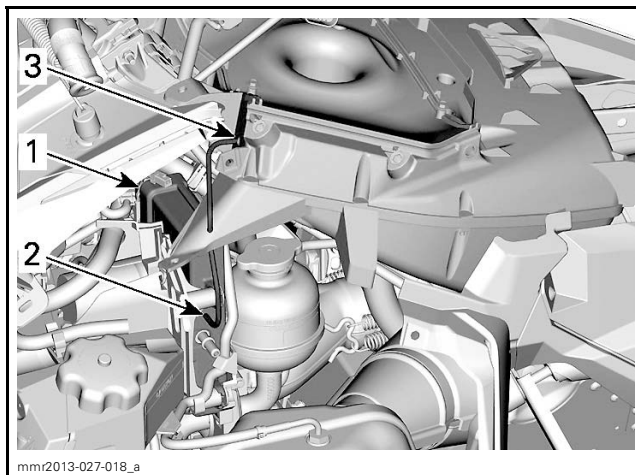


1. CTS connector
2. CTS

5. Apply LOCTITE 592 (PIPE SEALANT) (P/N 293 800 018) to CTS threads.
6. Install new CTS and torque to 12 N•m (106 lbf•in).
7. Reinstall removed parts.
8. Refill engine coolant. If an important quantity of coolant spilled from the engine, bleed cooling system. Refer to *COOLING SYSTEM* subsection.

#### APS (AIR PRESSURE SENSOR)

##### APS Location

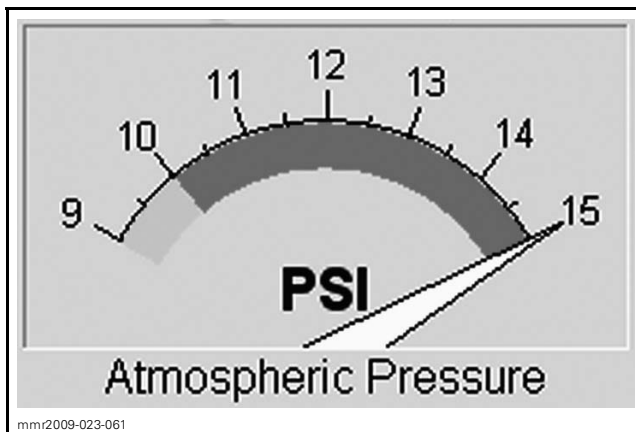


1. ECM
2. APS (inside ECM)
3. APS tube to secondary air intake silencer

#### APS Inspection

1. Open RH side panel. Refer to *BODY* subsection.
2. Ensure sensor hose is correctly connected on secondary air intake silencer and on ECM.
3. Check inside hose for cleanliness, water, or ice. Ensure it is not bent, kinked or burnt.
4. Connect to latest applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
5. Select the **Monitoring** and **ECM** tabs.
6. In B.U.D.S., monitor the **Atmospheric Pressure** indicator. The gauge should read the local atmospheric pressure of the day.

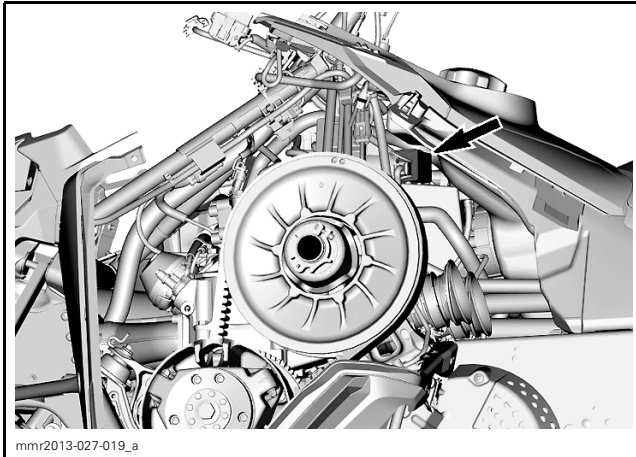
**NOTE:** At sea level, the atmospheric pressure gauge should read around 101.3 kPa (14.7 PSI) and less as altitude increases.



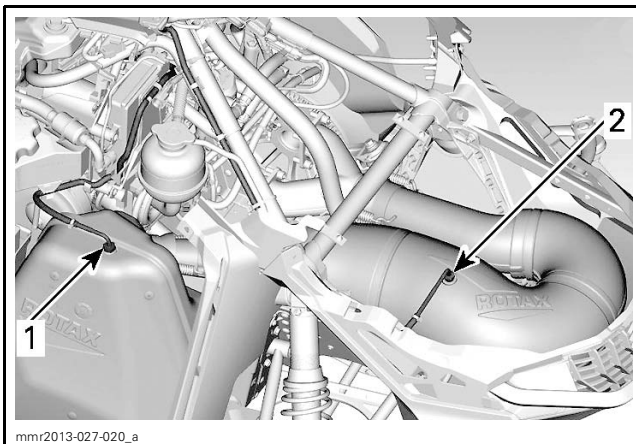
ATMOSPHERIC PRESSURE

Otherwise, replace ECM.

## THCM (THERMOCOUPLE MODULE)



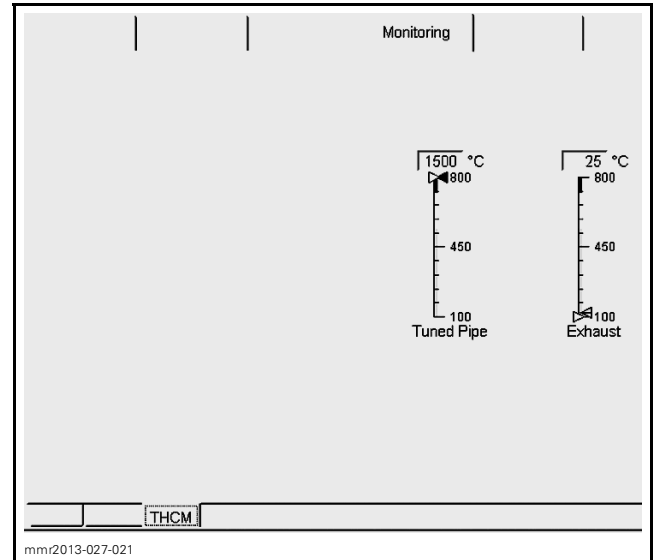
THCM MODULE



1. Thermocouple on muffler
2. Thermocouple on tuned pipe

### THCM Test with B.U.D.S.

1. Connect vehicle to latest applicable B.U.D.S. version.
2. Select the **Monitoring** tab then **THCM**.
3. In B.U.D.S., monitor the **Exhaust** (Muffler) and **Tuned Pipe** temperature indicators (as applicable).



If sensor temperature continuously read(s), 1 500°C (2,732°F) then the sensor is defective (open circuit). Replace THCM.

If sensor temperature is(are) read, THCM operates normally.

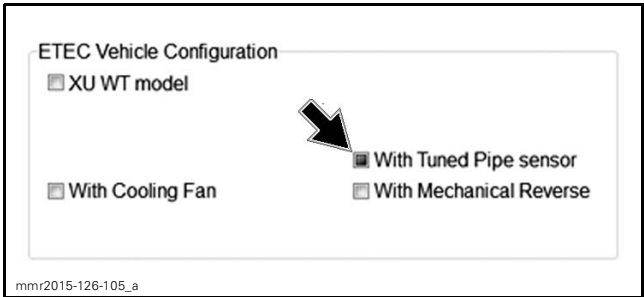
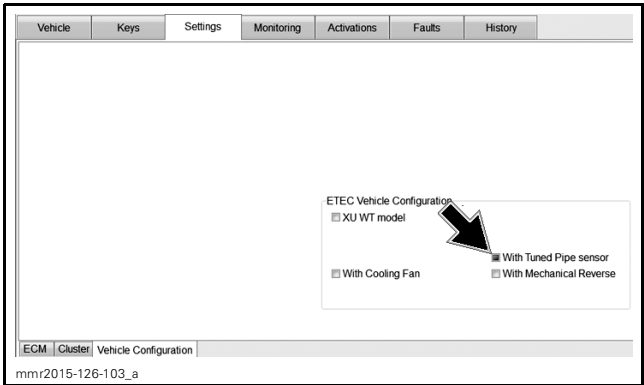
If sensor temperature is(are) not read, carry out the following steps.

4. In B.U.D.S., select the **Setting** and **ECM** tabs.

5. Ensure the **With Tuned Pipe Sensor** selection box is checked in the **Vehicle Configuration** area . Otherwise, the THCM will not be monitored by the ECM.

Section 04 FUEL SYSTEM

Subsection 02 (E-TEC DIRECT FUEL INJECTION)

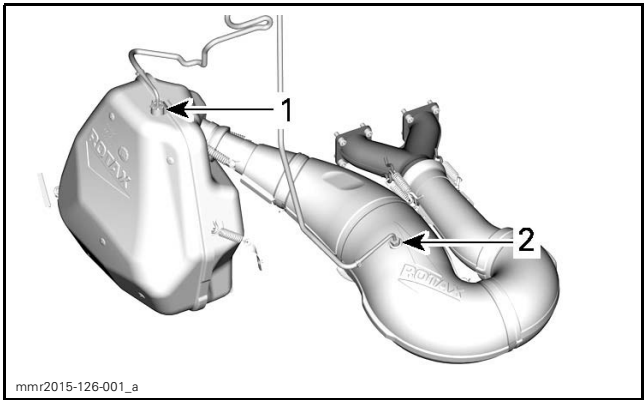


6. Check for an applicable fault codes.

If configuration is Ok, carry out service action as suggested by fault code.

If the THCM or thermocouple requires replacement, refer to *EXHAUST SYSTEM* subsection.

EXHAUST GAS TEMPERATURE SENSOR (EGTSm AND EGTStp)

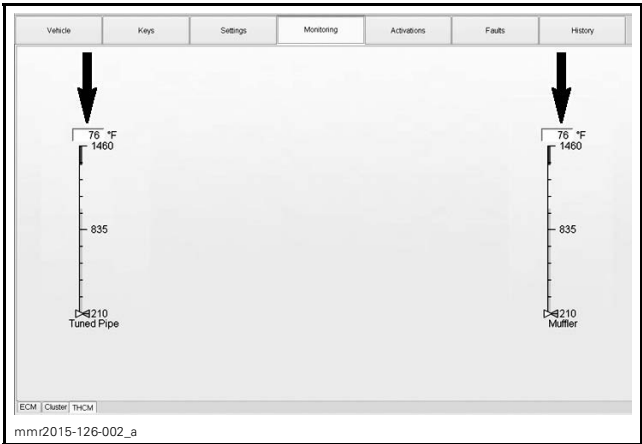


- 1. EGTSm
- 2. EGTStp

EGTS Test with B.U.D.S.

In B.U.D.S., select the **Monitoring** and **THCM** tabs.

Monitor the **Exhaust** temperature indicators. They should show the exhaust temperature.



Use an infrared thermometer and measure the sensor's temperature.

The measured temperature should be the same as the temperature displayed in B.U.D.S.

If temperature is not the same, replace EGTSm, EGTStp and THCM.

**NOTE:** If engine runs with the EGTS connected but not installed in the muffler, the reading will be 710°C (1,310°F) steady.

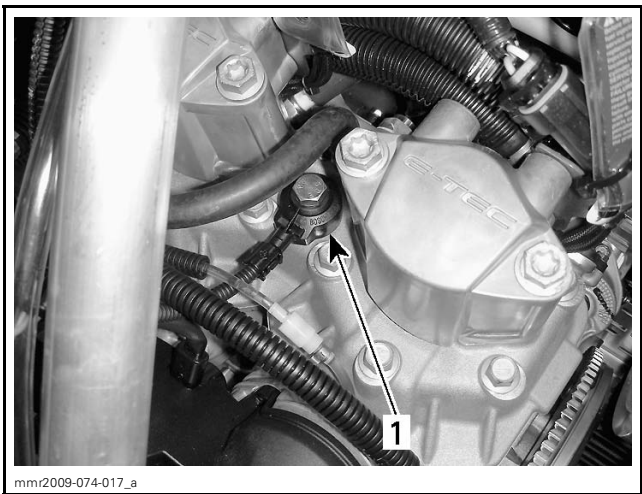
EGTS Replacement

Refer to *EXHAUST SYSTEM* subsection.

KNOCK SENSOR (KS)

Knock Sensor Location

The knock sensor is located on top of the cylinder head, between the fuel injectors.

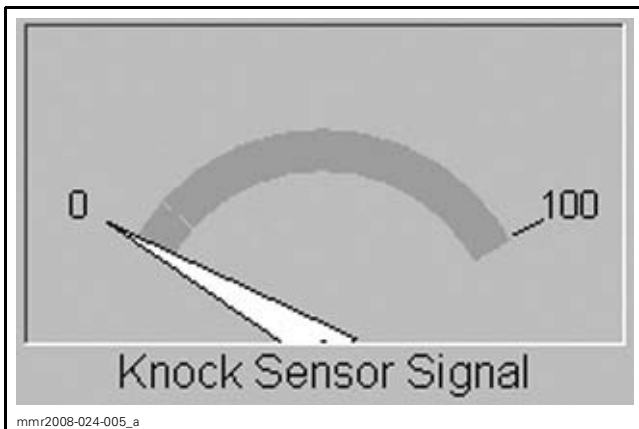


- TYPICAL
- 1. Knock sensor

KS Test with B.U.D.S.

1. Lift rear of vehicle off the ground and support it with a wide-base mechanical stand.

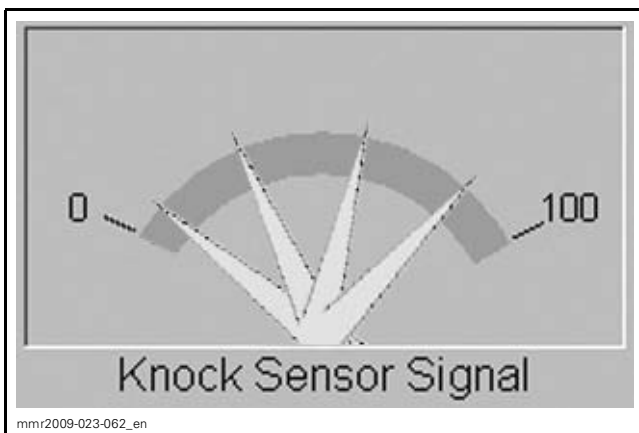
2. Use the latest applicable B.U.D.S. version.
3. Monitor the knock sensor using the **Knock Sensor Signal** indication in the **ECM Monitoring** page of B.U.D.S.



**MONITORING TAB**

4. Start the engine.
5. Bring engine speed above 5200 RPM and vary engine RPM above 5200 RPM.

The needle of the **Knock Sensor Signal** gauge should move between 0 and 100. The needle movement pattern is of no importance as long as it moves indicating the knock sensor senses the engine vibrations.



If the needle moves as described, the knock sensor should be good.

If the needle sticks either at 0 or 100, there is a problem.

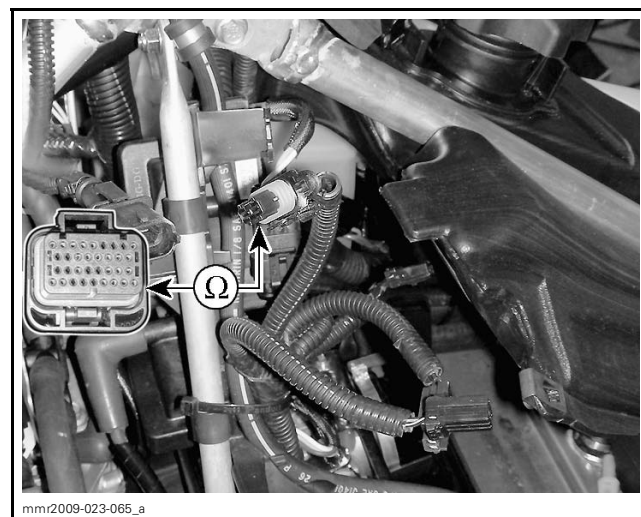
**NOTE:** Ensure ignition coil cables are not close to knock sensor harness. If so, this might generate a false fault code.

Carry out the *KS CIRCUIT CONTINUITY TEST*.

### KS Circuit Continuity Test

1. Ensure sensor and cylinder head contact surfaces are clean and mounting bolt and washer are correct and properly torqued down.
2. Disconnect knock sensor connector (DT). Refer to *KNOCK SENSOR REPLACEMENT*.
3. Disconnect J1A connector from ECM.
4. Check wire continuity of circuit as per following table.

J1A CONNECTOR	KS CONNECTOR	MEASUREMENT
J1A-34	Pin 1	Close to 0 $\Omega$ (continuity)
J1A-33	Pin 2	



If test is not good, repair/replace wiring/connectors between ECM and knock sensor.

If test is good, try a new knock sensor.

### KS Replacement

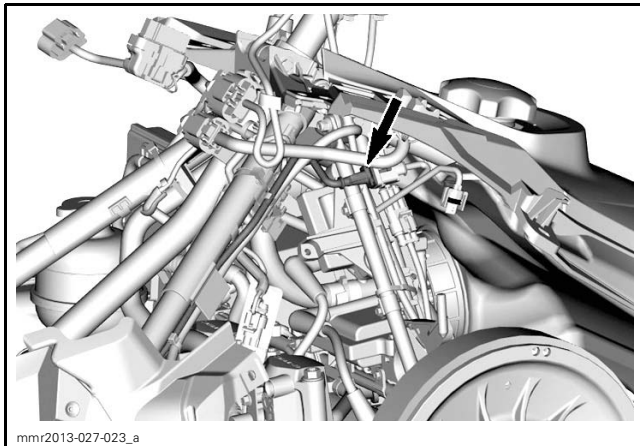
1. Unscrew and remove knock sensor from cylinder head.
2. Remove drive belt guard. Refer to *DRIVE BELT* subsection.
3. Remove primary air intake silencer. Refer to *AIR INTAKE SYSTEM* subsection.
4. Disconnect knock sensor connector located near ATS.

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## Section 04 FUEL SYSTEM

### Subsection 02 (E-TEC DIRECT FUEL INJECTION)

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5. Clean contact surfaces on cylinder head, then install the new knock sensor.

6. Torque knock sensor screw to 29 N•m (21 lbf•ft).

**NOTICE** Improper torque may prevent sensor from functioning properly possibly leading to severe internal engine component damage.

7. Reconnect connector.

8. Reinstall remaining parts.