ELECTRONIC FUEL INJECTION (EFI)

SERVICE TOOLS

Description	Part Number	Page
DIGITAL INDUCTION TACHOMETER	529 014 500	2
ECM ADAPTER TOOL	529 036 166	5, 10, 17, 19, 21–23
FLUKE 115 MULTIMETER	529 035 868	5–6, 10, 17, 21–23
OETIKER PLIERS	295 000 070	12

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE)	293 800 060	18, 23
XPS SYNTHETIC GREASE	293 550 010	20

GENERAL

⚠ WARNING

Fuel is flammable and explosive under certain conditions. Ensure work area is well ventilated. Do not smoke or allow open flames or sparks in the vicinity.

⚠ WARNING

Fuel lines remain under pressure at all times. Always proceed with care and use appropriate safety equipment when working on pressurized fuel system. Wear safety glasses. Wipe off any fuel spillage. Do not allow fuel to spill on hot engine parts and/or on electrical connectors.

⚠ WARNING

Replace any damaged, leaking or deteriorated fuel lines or connections. Always, pressurize the fuel system if any fuel related component was disconnected or removed. Proceed with care when removing/installing high pressure test equipment.

SYSTEM DESCRIPTION

The electronic fuel injection system (EFI) is comprised of various sensors used for detecting ongoing operating conditions of the engine and vehicle, and includes all the components that perform the required adjustments to the engine.

Electrical System

ECM (Electronic Control Module)

The ECM controls the electrical system and the engine management functions, by processing the information given by various sensors.

EFI Sensors

The ECM reads the inputs from the sensors which it compares to predetermined parameters stored in the ECM, makes computations, and activates the outputs accordingly (injectors, ignition coils etc.).

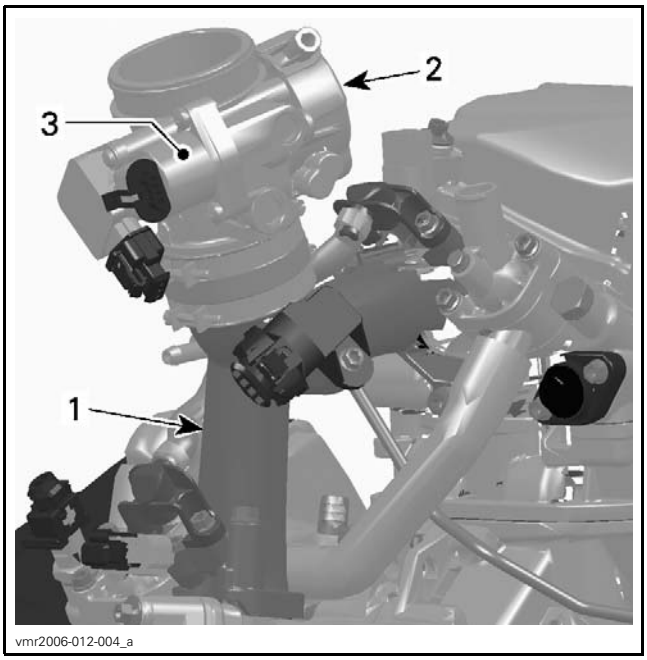
Signals from sensors are used by the ECM to determine the injection and ignition parameters (referenced to fuel maps) as required to maintain the optimum air-fuel ratio.

Air Intake System

Throttle Body

The throttle body is mounted on the intake manifold.

Air for combustion, drawn in by the engine, flows through the air intake system, then through the throttle body where it is regulated by a throttle plate.



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1. *Intake manifold*
2. *Throttle body*
3. *Idle air control valve (IACV)*

Fitted on the throttle body, a throttle plate regulates the amount of air that enters the engine.

A TPS is incorporated on the throttle body. It provides a signal to the ECM of the actual throttle plate position.

Anidle air control valve (IACV) is also incorporated on the throttle body, It allows the ECM to control the idle speed while the throttle plate is closed.

Fuel System

Fuel Rail

Two fuel rails, one for each injector, are mounted on the intake manifold. The fuel rails, which are used to secure the injectors to the manifold, also provide to the injectors the fuel pressure that they receive from the fuel pump.

The fuel pressure applied to the fuel rails is regulated by the fuel pressure regulator located in the fuel pump module.

Fuel Injectors

The fuel injectors are used to inject fuel into the intake ports of the cylinder head. One injector is used per cylinder.

Fuel Pump

An electric fuel pump with an integrated pressure regulator and fuel system filters is used. For more details on the fuel pump unit, refer to *FUEL TANK AND FUEL PUMP* subsection.

ADJUSTMENT

IDLE SPEED

Idle speed is not adjustable. The ECM controls the idle speed of the engine primarily through control of the throttle plate position.

NOTICE **Never attempt to adjust the sealed idle stop screw. It is calibrated at the factory. If the screw adjustment is changed, the throttle body must be replaced.**

The vehicle multifunction gauge can provide an accurate digital readout of the engine's idle speed.

If desired, the engine RPM can be verified using a DIGITAL INDUCTION TACHOMETER (P/N 529 014 500).

Install the tachometer wire on a spark plug cable.

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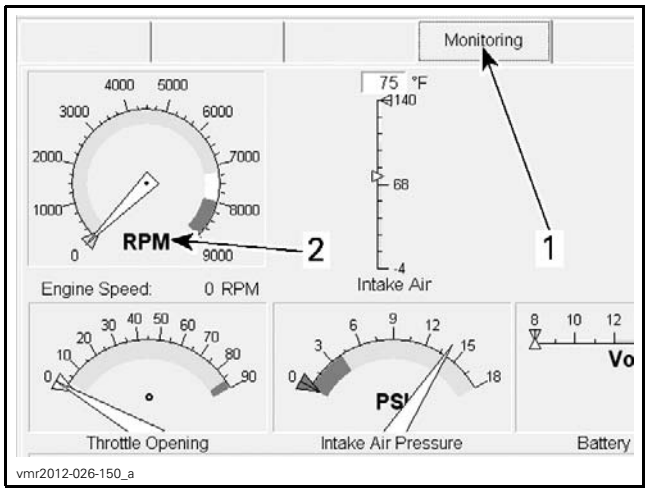
VERIFYING ENGINE RPM USING A DIGITAL INDUCTION TACHOMETER

The engine RPM may also be verified using the applicable B.U.D.S. software version, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

In B.U.D.S., click the following:
- **Read Data** button
- **Monitoring** tab
- **ECM** tab.



VERIFYING ENGINE RPM USING B.U.D.S.
1. Monitoring *tab*
2. *Engine RPM indication*

NOTE: The multifunction gauge and B.U.D.S. use the same signal to provide the engine RPM indication.

CLOSED THROTTLE AND IDLE ACTUATOR RESET

NOTE: This operation performs a reset of the values in the ECM.

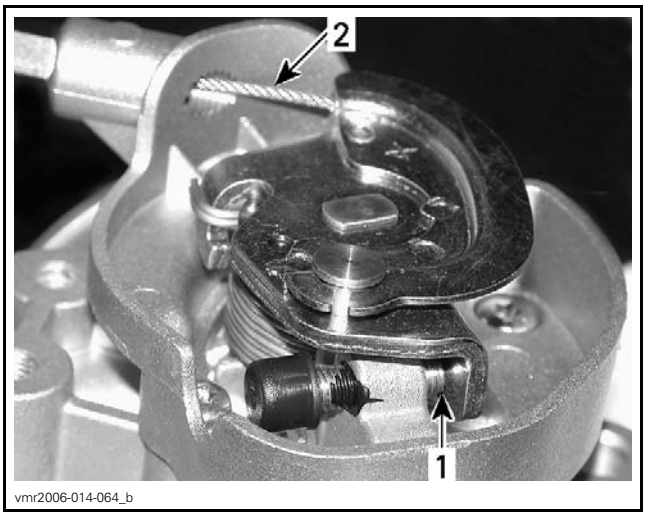
This reset is very important. The setting of the TPS will determine the basic parameters for all fuel mapping and several ECM calculations and the setting of the idle air control valve will determine the basic parameters for the idle speed control of the engine.

Closed throttle and idle actuator reset must be done if:

– TPS is loosened, removed or replaced
– Throttle body is replaced
– Idle air control valve is replaced
– ECM is replaced.

NOTICE **An improperly set TPS or IACV may lead to poor engine performance and emission compliance could possibly be affected. In addition, improper IACV reset may lead to poor engine starting, improper idle (too low or too high) and engine stop on deceleration.**

Remove throttle body cap and ensure the throttle cam of throttle body rests against set screw without any tension in the cable.



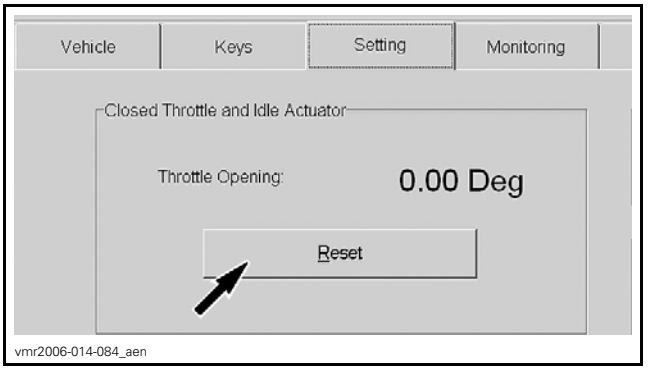
1. *Contact here*
2. *Free-play here*

Open throttle approximately one quarter then quickly release. Repeat 2 - 3 times to settle throttle plate. If stopper does not rest against its stop lever, perform throttle cable adjustment. Refer to *THROTTLE CABLE* in this subsection.

To reset IACV and TPS, perform the following:

1. Connect the 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., click the following:
   – **Read Data** button
   – **Setting** tab
   – **ECM** tab

Click on the Reset button in the **Closed Throttle and Idle Actuator** area.



NOTE: No message will be displayed if operation is successful. If operation is wrong, an error message will be displayed.

NOTE: If TPS is not within the allowed range while resetting the Closed Throttle and Idle Actuator, the ECM will generate a fault code and will not accept the setting. Repeat the reset procedure.

Start engine and make sure it operates normally through its full engine RPM range. If fault codes appear, refer to *DIAGNOSTIC AND FAULT CODES* subsection for more information.

TROUBLESHOOTING

DIAGNOSTIC TIPS

Engine problems are not necessarily related to the fuel injection system.

It is important to ensure that the engine and propulsion system, fuel delivery and electrical systems are functioning normally.

For diagnostics purposes, use B.U.D.S. software. See *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

After a problem has been solved, be sure to clear the fault(s) in the ECM using the B.U.D.S. software.

⚠ WARNING

Electrical actuators and electronic modules may be powered up as soon as the ignition switch is set to ON and emergency engine stop switch is set to RUN. Always disconnect the battery prior to disconnecting any electrical or electronic parts.

Never use a battery charger to temporarily substitute the battery as it may cause the ECM to function erratically, or not at all.

Check related-circuit fuse solidity and condition with an ohmmeter. A visual inspection could lead to a false diagnosis.

Electrical Related Problems

It is important to check the following in the electrical system:

– Battery voltage
– Fuses
– Ground connections
– Wiring and connectors.

Ensure that all electronic components are genuine OEM. Any modification to the wiring harness may lead to poor system operation or generate fault codes.

Electrical Connections

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

When probing terminals, pay attention not to deform the terminals as this could cause a loose or intermittent connection that would be difficult to troubleshoot.

PROCEDURES

ENGINE CONTROL MODULE (ECM)

NOTE: As a first troubleshooting step, always check for applicable fault codes using B.U.D.S. software.

Quick Test to Validate ECM Operation

Turn ignition key to ON.

Set emergency engine stop switch to RUN.

NOTE: This wakes up the ECM, which then turns on the following.

QUICK INDICATION THAT ECM IS FUNCTIONING (assuming the observed component is in good working order)
Multifunction gauge turns ON.
Fuel pump turns on for approx. 5 seconds.
Rear lights turn on.
Headlamps turn on (ignition key on with lights position).

ECM Access

Refer to *BODY* and remove the LH panel.

LH PANEL REMOVED
1. ECM location

ECM Connector

There is one connector connected to the ECM. It links:

– Engine harness
– Vehicle system control harness.

NOTE: For connector information, cleaning and probing, refer to *WIRING HARNESS AND CONNECTORS* subsection.

ECM Adapter Tool

To probe ECM connector terminals, use the ECM ADAPTER TOOL (P/N 529 036 166).

NOTE: This tool will prevent deforming or enlarging terminals which would lead to bad ECM terminal contact creating intermittent or permanent problems.

ECM Power Supply Test

1. Disconnect ECM connector.
2. Install ECM connector on the ECM ADAPTER TOOL (P/N 529 036 166).
3. Install a jumper wire between K1 and M4 on the ECM adapter tool.
4. Turn the ignition switch to ON.
5. Set emergency engine stop switch to RUN.
6. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Vdc.
7. Check for voltage as follows.

ECM ADAPTER	BATTERY	VOLTAGE
L1	Negative post	Battery voltage

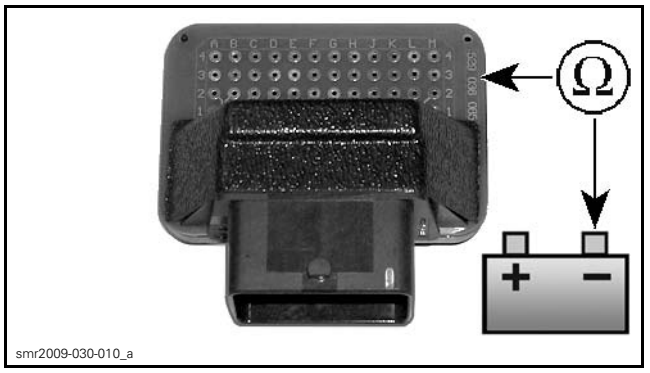
If voltage is not measured, check the following:

– ECM fuse
– Main relay
– Wiring and connections, refer to the *WIRING DIAGRAM*.

Continuity Test of ECM Ground Circuits

1. Disconnect ECM connector.
2. Install the ECM ADAPTER TOOL (P/N 529 036 166) on ECM connector.
3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω.
4. Probe adapter terminals as per following table.

ECM ADAPTER	BATTERY POST	RESISTANCE
Pins G1, M3 and M4	Ground	Close to 0 Ω (continuity)

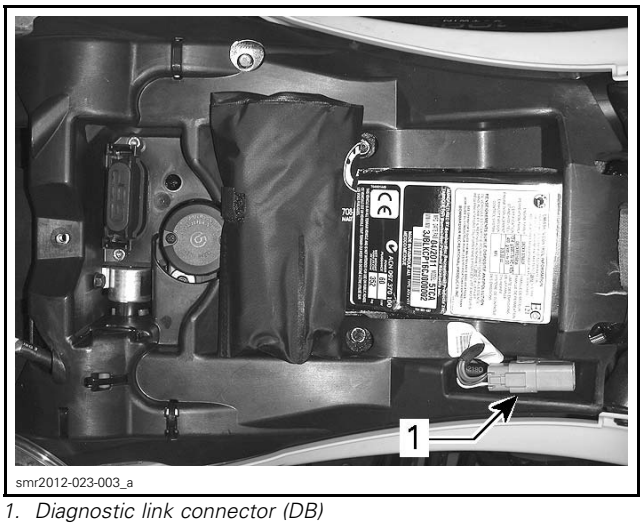


If any measurement is out of specification, refer to *POWER DISTRIBUTION* and check all grounds.

CAN Resistor Test

Remove the DPS1 connector (4-pin connector) from DPS module (if so equipped). Refer to *STEERING SYSTEM* subsection.

1. Remove seat to access the diagnostic link connector (DB).
2. Remove diagnostic link connector from its holder.



1. Diagnostic link connector (DB)

3. Set a FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω setting.

4. Measure the resistance of the CAN resistors as per following table.

CAN RESISTOR TEST	
DIAGNOSTIC LINK CONNECTOR	RESISTANCE
Pins 1 and 2	Approximately 60 Ω

TEST RESULT	
READING	RESULT
Approximately 60 Ω	ECM and CLUSTER CAN wires and resistors good
Approximately 120 Ω	– ECM CAN resistor open, or – CLUSTER CAN resistor open, or – CAN wire to CLUSTER or ECM open
Infinite (open circuit)	CAN wire to DB connector open circuit

If 120 ohms is read, isolate the CLUSTER from CAN by disconnecting it and measuring again at the diagnostic link connector.

If 120 ohms is still read, the ECM CAN resistor and wires are good. Check for continuity of the CLUSTER CAN wires, refer to *WIRING DIAGRAM*.

If an open circuit is read, the ECM CAN resistor (or wire) is open. Check for continuity of the ECM CAN wires, refer to *WIRING DIAGRAM* to determine if the wires or the resistor is at fault.

If the CAN resistor of a module is at fault, replace that module.

If a module cannot communicate and the CAN resistor and wires test good, try a new module.

5. Reconnect DPS1 to DPS module,

ECM Removal

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

1. Disconnect battery cables.

NOTICE **Always disconnect the BLACK negative (–) battery cable first, then disconnect RED positive (+) cable.**

2. Disconnect ECM connector.
3. Unscrew all retaining screws and pull out ECM.

ECM Installation

Reverse removal procedure however, pay attention to the following.

1. Reconnect ECM connector.
2. Reconnect battery cables.

⚠ WARNING

Always reconnect the RED positive (+) battery cable first, then reconnect BLACK negative (–) cable.

3. If a new ECM is installed, refer to *ECM REPLACEMENT* in this subsection.

ECM Replacement

Prior to replacing an ECM, ensure that all the recommendations in the general introduction of this section have been followed.

NOTE: Proceed with the *CLOSED THROTTLE AND IDLE ACTUATOR RESET* as it may resolve the problem.

If the ECM is replaced, data must be entered into the new ECM.

ECM Manual Data Entry

There are 2 possible methods to collect the required information. The 1st being the easiest:

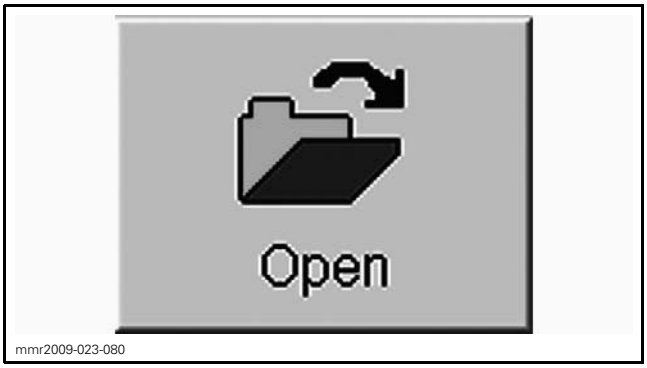
1. Use B.U.D.S. to obtain the data from a saved **.mpem** file on your PC computer.
2. Collect the information from the vehicle and BOSSWeb.

1st Collecting Method: Obtaining the Data from a Saved **.mpem** File

1. Use the B.U.D.S.

NOTE: It is not necessary to perform any connection. The PC computer can be used alone.

2. In B.U.D.S., click on the **Open** button.



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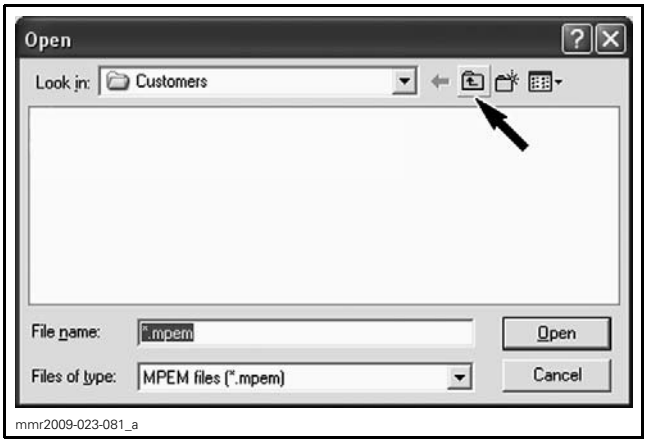
3. Click once on the **Folder Up** button in the Open box.



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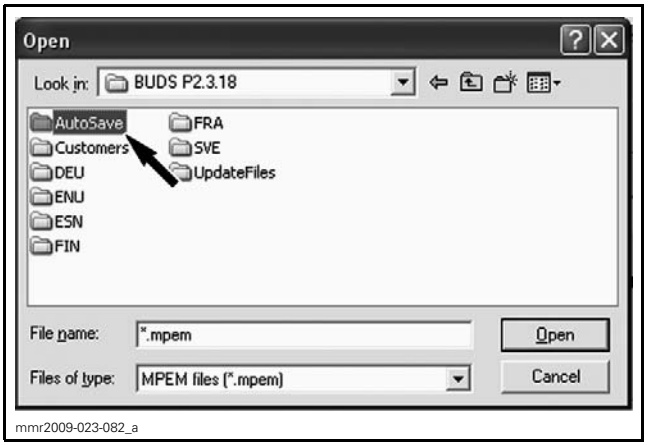
Double click on the **AutoSave** folder.



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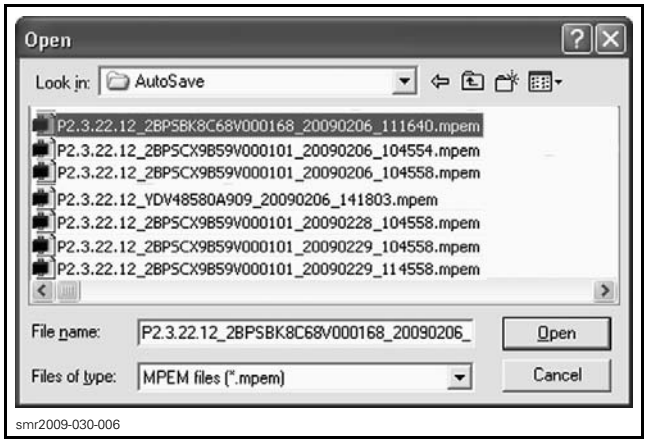
NOTE: You may have to go to another AutoSave folder from a previous version of B.U.D.S.

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



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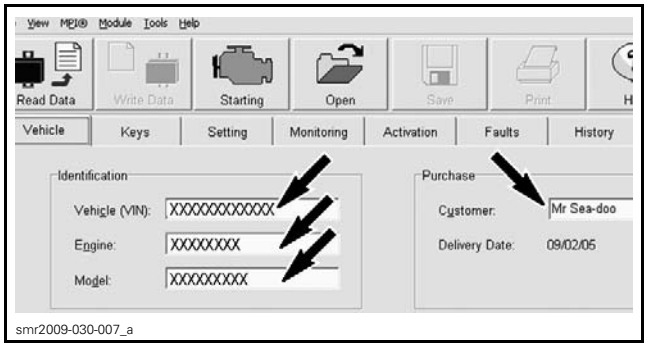
IMPORTANT: Be sure to use the file that specifically matches the vehicle you are servicing.

NOTE: The file name structure is as follows:
B.U.D.S. version_VIN_date read (yyyymmdd)_hour read (hhmmss).mpem
Example: **P2.3.22.12_2BPSBK8C68V000168_20090206_111640.mpem** Hence: B.U.D.S. version: P2.3.22.12 VIN: 2BPSBK8C68V000168 Date: 2009 02 06 Hour: 11h 16m 40s

5. Select the **Vehicle** tab and record (write down) the following information.
   1. Vehicle serial number
   2. Engine serial number (without the leading "M")
   3. Vehicle model number
   4. Customer name.



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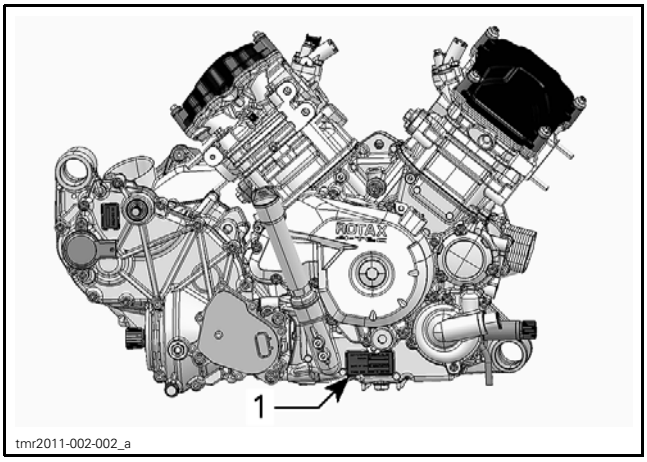
VEHICLE TAB

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

2nd Collecting Method: Collect the Information from the Vehicle and BOSSWeb

1. Record engine serial number.



TYPICAL - RH SIDE OF ENGINE
1. Engine serial number

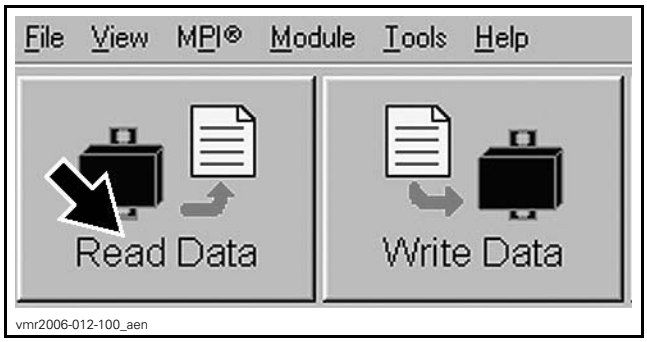
2. Record the following numbers using BOSSWeb. Look in **Service** menu and choose Unit history.
   1. Vehicle serial number
   2. Vehicle model number
   3. Customer name.

SERVICE, UNIT HISTORY

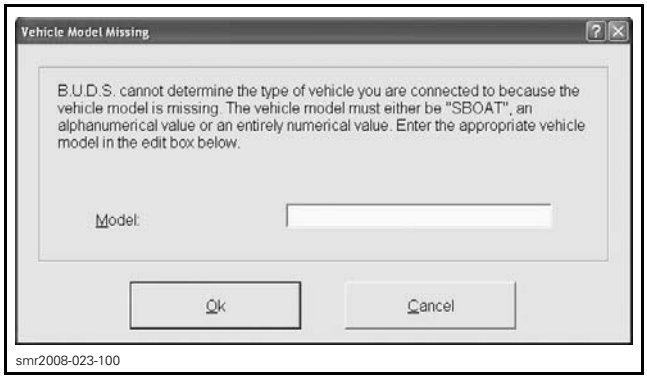
3. Enter the recorded data in the new ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM*.

Entering the Collected Information Into the ECM

1. Use the applicable B.U.D.S. version. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Turn ignition key to ON position.
3. Set emergency engine stop switch to RUN.
4. In B.U.D.S., click the **Read Data** button to read the new ECM.

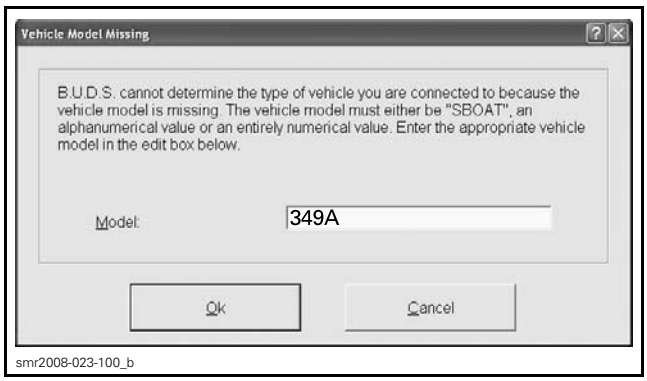


The following screen window will pop up.

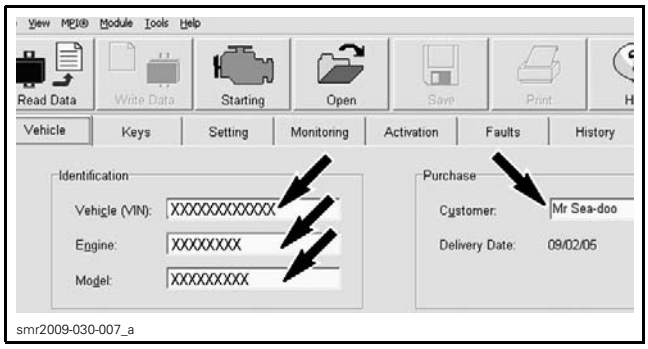


5. Enter the vehicle model number.

NOTICE **Enter only the appropriate product model number as obtained when gathering the information.**

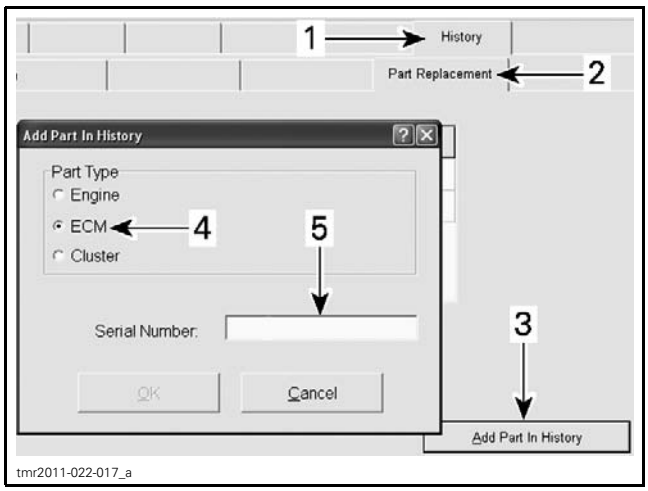


6. Select the **Vehicle** tab and enter the information you recorded previously.
   1. Vehicle serial number
   2. Engine number (do not enter the "M" at the beginning of the engine number)
   3. Customer name.



VEHICLE TAB

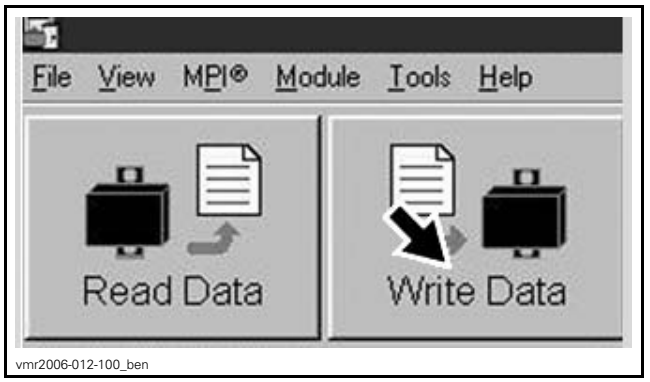
7. Click on the following tabs:
   - History
   - Part Replacement
   - Add Part in History.
8. Enter the **old** ECM serial number in the Add Part In History window.



ADDING PART IN HISTORY
1. History *tab*
2. Part Replacement *tab*
3. Add part in history *button*
4. ECM *selection*
5. *Add ECM serial number here*

NOTE: The ECM serial number can be found on the ECM sticker that also identifies the part number.

9. Click on the **OK** button.
10. Click on the **Write Data** button.



11. Perform the **Closed Throttle and Idle Actuator Reset**. Refer to *CLOSED THROTTLE AND IDLE ACTUATOR RESET* in this subsection.
12. Perform the **GBPS Reset** (1000 engine only). Refer to *GEARBOX AND 4X4 COUPLING UNIT (1000)* subsection.
13. Program the vehicle ignition keys into the new ECM, refer to *DIGITAL ENCODED SECURITY SYSTEM (D.E.S.S.)* subsection.
14. Reinstall any remaining removed parts.

FUEL INJECTOR

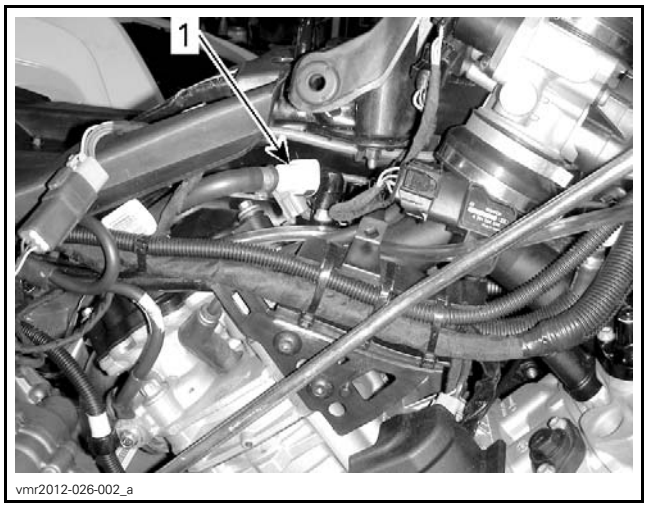
Fuel Injector Leak Test

Carry out the *FUEL PUMP PRESSURE TEST* as detailed in the *FUEL TANK AND FUEL PUMP* subsection.

Fuel Injector Input Voltage Test

Remove the RH side panel. Refer to *BODY* subsection.

To reach the rear injector, disconnect the fuel line. Refer to *FUEL TANK AND FUEL PUMP* subsection.



1. *Disconnect*

Disconnect the fuel injector electrical connector.

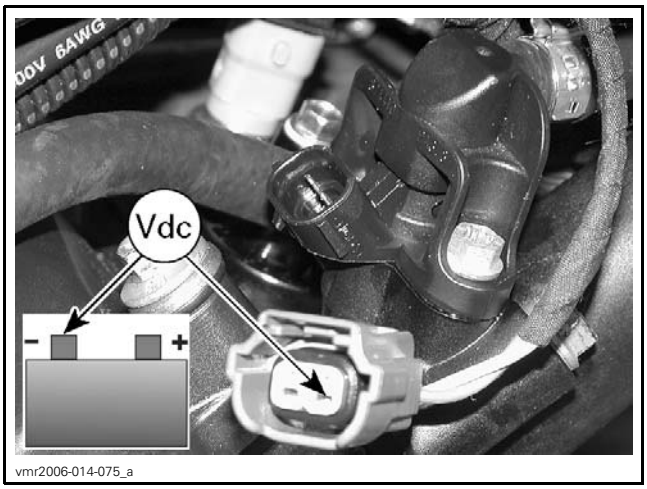
Turn on ignition switch.

Set emergency engine stop switch to RUN.

NOTE: Ensure to read voltage before ECM automatically turns off.

Use a multimeter and set it to Vdc. Read voltage.

CYLINDER	INJECTOR CONNECTOR		MEASUREMENT
	WIRE		
FRONT	VIOLET/ BLUE	Battery ground	Battery voltage
REAR			



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TYPICAL

If supply voltage is not good, check fuse and if good, perform an *INJECTOR POWER CIRCUIT RESISTANCE TEST*.

If supply voltage is good, perform a *FUEL INJECTOR RESISTANCE TEST*.

Injector Power Circuit Resistance Test

Check continuity between main relay and injector as follows:

– Remove main relay.
– Disconnect the fuel injector connector.
– Use a multimeter and set it to Ω.
– Read resistance.

CYLINDER	INJECTOR CIRCUIT		MEASUREMENT
	WIRE		
FRONT	VIOLET/ BLUE	2B	Close to 0 Ω
REAR			

If continuity is not good, repair or replace wiring going to injector.

If continuity is good, perform the *FUEL INJECTOR RESISTANCE TEST*.

Fuel Injector Resistance Test

Disconnect ECM connector.

Install the ECM connector on the ECM ADAPTER TOOL (P/N 529 036 166).

Connect the fuel injector connector.

Using a FLUKE 115 MULTIMETER (P/N 529 035 868), check resistance value between terminals as follows.

FUEL INJECTOR RESISTANCE TEST AT ECM ADAPTER			
INJECTOR	FUSE BOX TERMINAL	ECM ADAPTER	RESISTANCE @ 20°C (68°F)
FRONT	4B	K4	11.4 - 12.6 Ω
REAR		L4	

If resistance value obtained is incorrect, perform an *INJECTOR GROUND CIRCUIT RESISTANCE TEST*.

Injector Ground Circuit Resistance Test

Disconnect the fuel injector connector.

Disconnect ECM connector.

Install ECM connector on the ECM ADAPTER TOOL (P/N 529 036 166).

Using a FLUKE 115 MULTIMETER (P/N 529 035 868), check resistance value between terminals as follows.

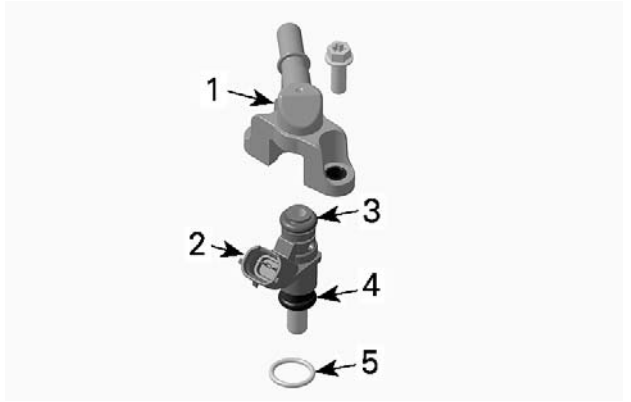
CYLINDER	INJECTOR GROUND CIRCUIT		MEASUREMENT
	WIRE	ECM ADAPTER	
FRONT	Striped BROWN wire	K4	Close to 0 Ω
REAR		L4	

If continuity is not good, repair or replace wiring going to injector.

If continuity is good, replace the injector.

Fuel Injector Removal

To remove the injector, first remove the fuel rail. Refer to *FUEL RAIL*.



TYPICAL - FUEL RAIL ASS'Y
1. *Fuel rail*
2. *Fuel injector*
3. *Injector top O-ring*
4. *Injector bottom O-ring*
5. *Manifold O-ring*

Then, pull fuel injector out of the fuel rail.

Fuel Injector Installation

For the installation, reverse the removal procedure. Pay attention to the following details.

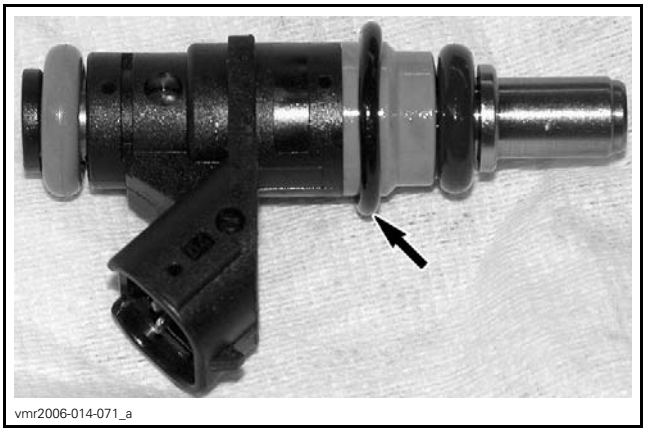
FUEL INJECTOR IDENTIFICATION	
ENGINE	INJECTOR COLOR CODE
800R	RED
1000	GREEN

Apply a thin film of engine oil to O-rings to ease insertion in rail.

Install fuel injector with your hand. Do not use any tool.

FUEL INJECTOR INSTALLATION		
O-RINGS	New	Lubricate with engine oil

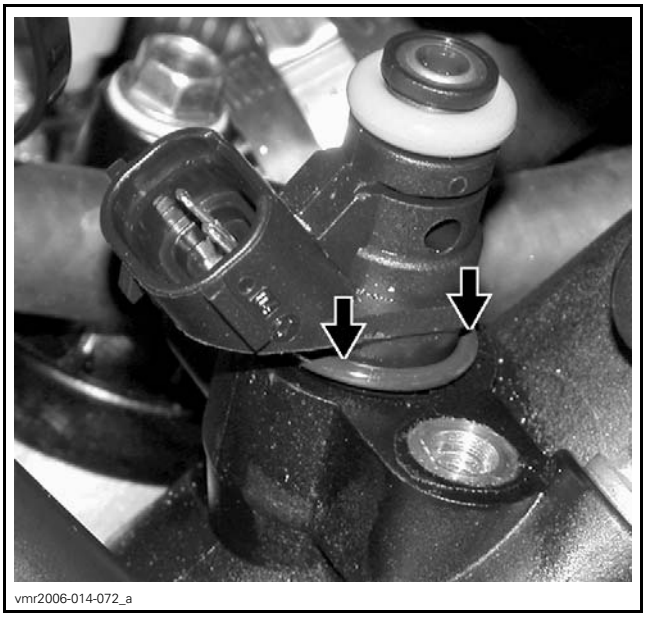
Position the manifold O-ring on injector as in following illustration.



TYPICAL - MANIFOLD O-RING POSITION

Carefully insert injector in manifold paying attention to the manifold O-ring.

NOTICE **Gently push O-ring in evenly all around while inserting injector. O-ring must be completely inserted and not visible, before completing the insertion of the injector.**



Firmly push injector until it bottoms out.

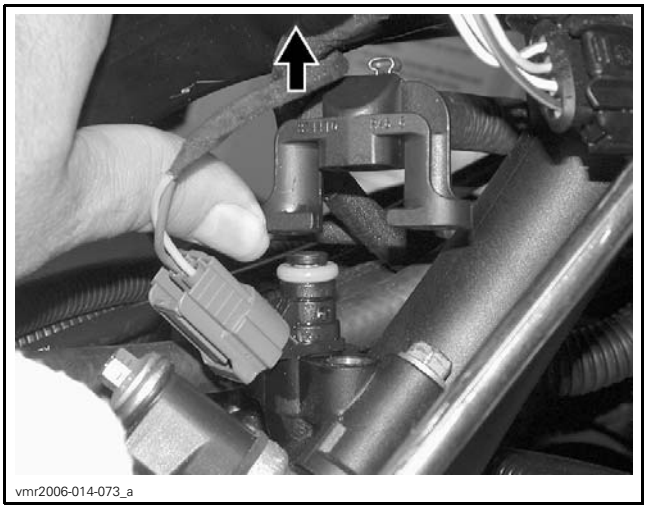
Reinstall fuel rail.

FUEL RAIL

Fuel Rail Replacement

Fuel Rail Removal

1. Disconnect fuel line to reach the rear injector. Refer to *FUEL TANK AND FUEL PUMP* subsection.
2. Unscrew rail retaining screws.
3. Gently pull rail off by hand.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TYPICAL

To disconnect fuel rail from hose, cut clamp on fuel hose using OETIKER PLIERS (P/N 295 000 070). Refer to *FUEL TANK AND FUEL PUMP* for clamp removal/installation procedures.

NOTE: If fuel rail is removed for access to fuel injector, it is not necessary to cut hose clamp. Only to replace fuel rail.

Fuel Rail Installation

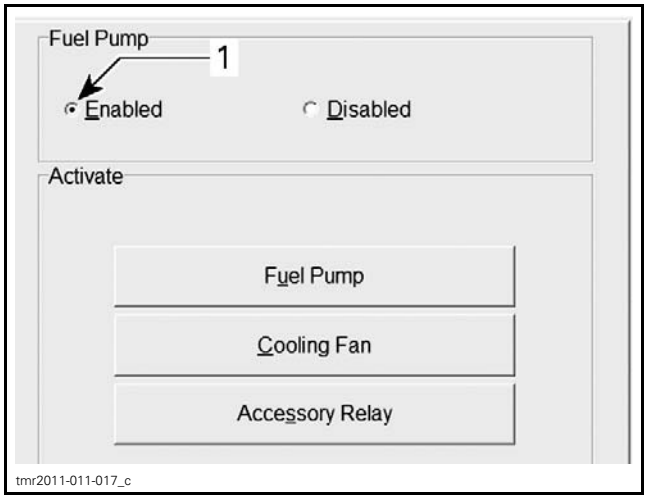
For installation, reverse the removal process however, pay attention to the following.

Install new clamps using pliers as per removal (if fuel rail was replaced).

Install fuel rail and evenly tighten screws a little at a time each side.

FUEL RAIL INSTALLATION	
INJECTOR O-RINGS	RETAINING SCREW TORQUE
NEW (Lubricate with engine oil)	10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**)

After securing fuel hose quick fitting to injector, ensure fuel pump is enabled using B.U.D.S.



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TYPICAL
1. Ensure fuel pump is enabled

NOTE: Activate fuel pump a few times to built fuel pressure.

⚠ WARNING

Perform a fuel pressure test and ensure that there is no leak. Refer to *FUEL TANK AND FUEL PUMP*.

THROTTLE CABLE

Throttle Cable Removal

Remove steering cover.

Remove LH side panel.

Disconnect throttle cable from throttle body. Refer to procedure in this subsection.

Disconnect throttle cable from throttle lever.

Remove throttle cable.

Throttle Cable Installation

Reverse removal procedure.

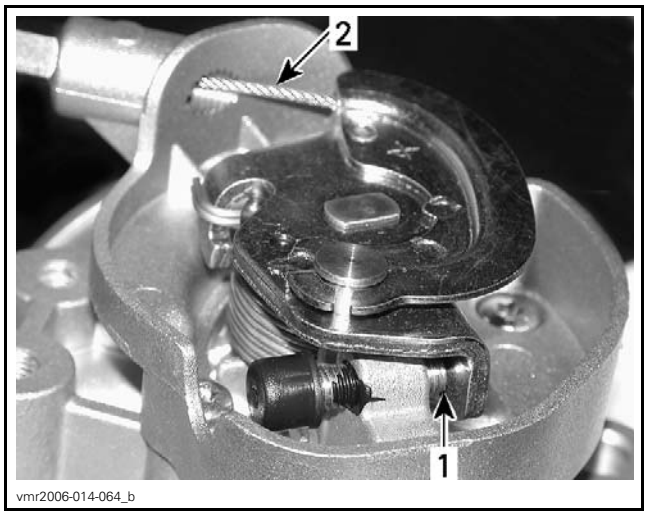
Proceed with *THROTTLE CABLE ADJUSTMENT* in this subsection.

Throttle Cable Adjustment

Mechanically adjust the throttle cable as follows.

Handlebar and throttle cable must be at their normal position. Throttle cable routing must have been performed before adjusting cable.

Activate throttle lever a few times. Make sure throttle cam of throttle body rests against set screw without any tension in the cable.



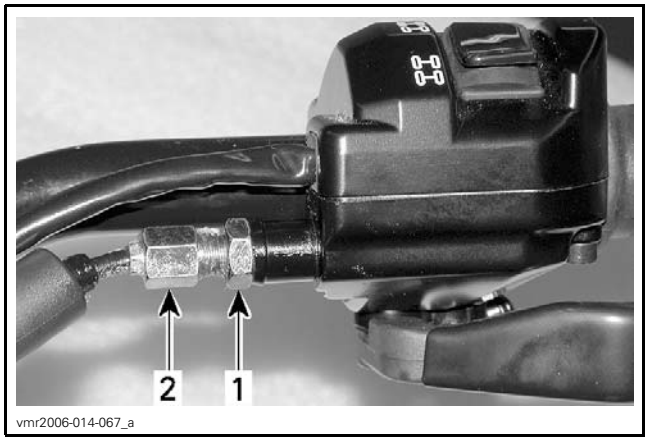
1. Contact here
2. Free-play here

⚠ CAUTION If there is no free-play at idle position, it may cause poor idling and startability problems. Improper cable adjustment will cause strain on cable and/or damage cable bracket or throttle lever at handlebar.

⚠ WARNING

Make sure idle speed stopper contacts throttle cam when throttle lever is fully released at handlebar.

If adjustment is needed, proceed with adjuster at handlebar. Adjust to have 2 mm (.078 in) free-play at the end of throttle lever. When done, slide back cable protector over adjuster.

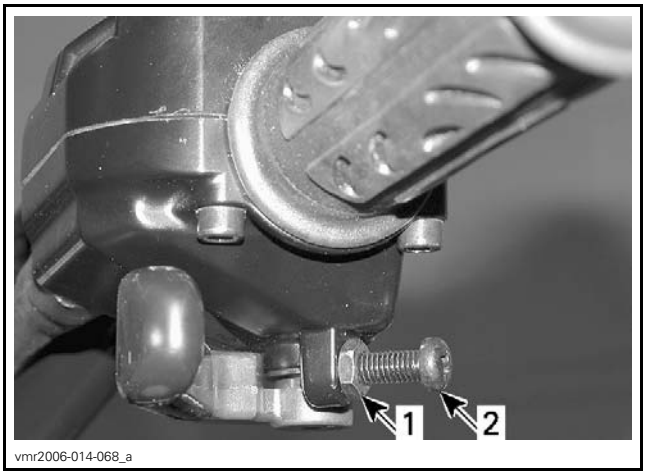


1. Adjuster lock nut
2. Adjuster

Turn handlebar side to side and ensure there is still free-play in each position.

To ensure there is no strain in the cable at wide open position:

– Fully depress throttle lever and hold.
– Loosen adjuster lock nut/adjuster until it just releases lever.
– Turn adjuster clockwise until it touches lever again.
– From there, tighten adjuster 1/2 turn (to remove strain in cable).
– Tighten lock nut.
– Release throttle lever.

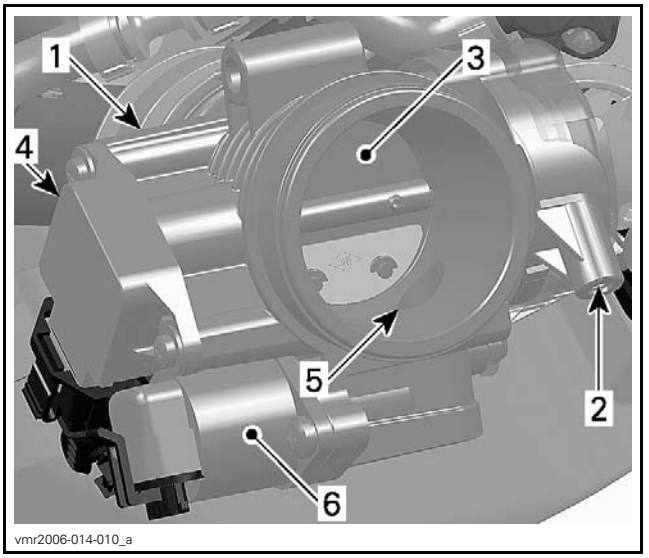


1. Adjuster lock nut
2. Adjuster

Reinstall throttle cable cover.

THROTTLE BODY

Throttle Body Description



1. Throttle body
2. Throttle cable attachment
3. Throttle plate
4. TPS
5. Idle air bypass channel
6. Idle air control valve

Throttle Body Access

Remove the RH side panel. Refer to *BODY* subsection.

Throttle Body Inspection

Check that the throttle plate moves freely and smoothly when depressing throttle lever.

– Check if throttle body idle set screw is loose or worn.
– **NOTE:** Throttle body must be replaced if idle set screw is loose or worn.
– Check if TPS is loose.
– Check if idle air control valve is loose.
– Check for corroded or damaged connectors.

Throttle Body Cleaning

1. Check throttle body cleanliness using a flashlight. Fully open throttle plate and verify:
   – Throttle body bore
   – Throttle plate edge.

Look for:
– Dirt
– Oily surfaces
– Carbon and salt deposits on throttle plate and the surrounding bore.

2. Clean as necessary.
3. Use a throttle body cleaner such as GUNK INTAKE MEDIC or an equivalent.

NOTICE **Only use an appropriate throttle body cleaner that will not damage O-rings and EFI sensors.**

⚠ CAUTION **Use the product in a well ventilated area. Refer to product manufacturer's warnings.**

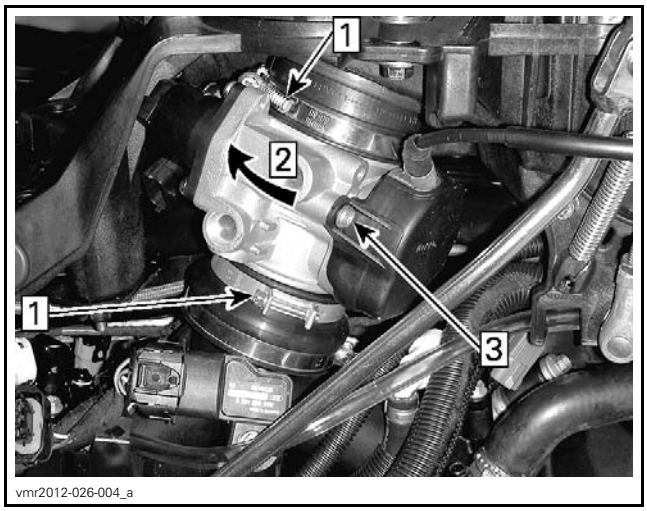
4. To avoid getting dirt into engine, spray cleaner on a clean rag then rub rag against throttle plate and bore. A toothbrush may also be used.
5. Gently open throttle plate and hold fully open to reach all surfaces.
6. To remove residual dirt, spray cleaner on throttle plate and on bore.
7. Reinstall removed parts.

Throttle Body Removal

1. Remove the RH side panel. Refer to *BODY* subsection.
2. Remove the air intake silencer retaining screws.

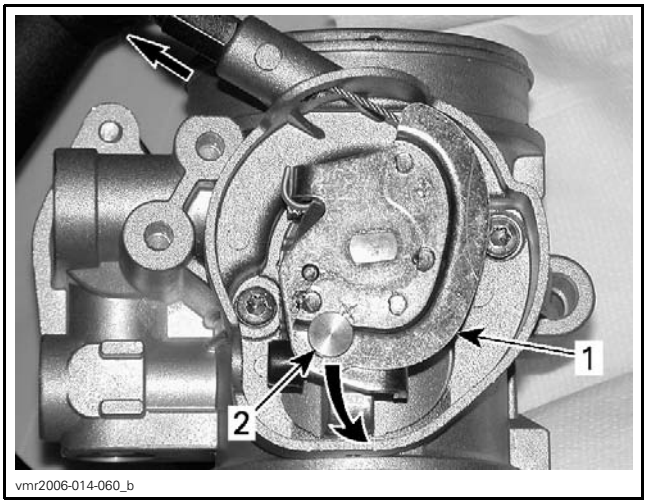
1. Remove these screws

3. Lift rear of air intake silencer as much as possible and block in this position.
4. Unplug connectors from TPS and IACV.
5. Loosen both throttle body clamps.
6. Rotate throttle body to gain access to throttle cable.
7. Remove throttle cable cover.



Step 1: Loosen
Step 2: Rotate
Step 3: Remove

8. Rotate throttle lever and pull out cable barrel.



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1. Throttle lever
2. Cable barrel

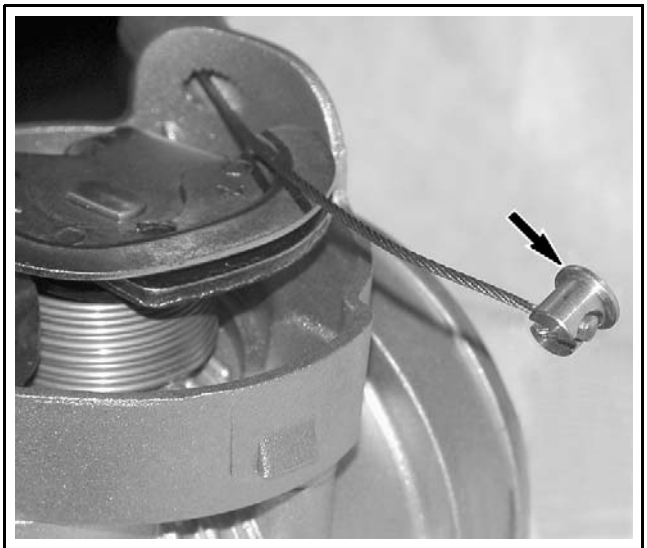
9. Remove barrel from cable.
10. Pull out throttle cable.
11. Pull out throttle body.

Throttle Body Installation

Installation of the throttle body is the reverse of the removal procedure. However, pay attention to the following.

Temporarily install throttle body into position.

Properly install cable barrel to throttle cable end.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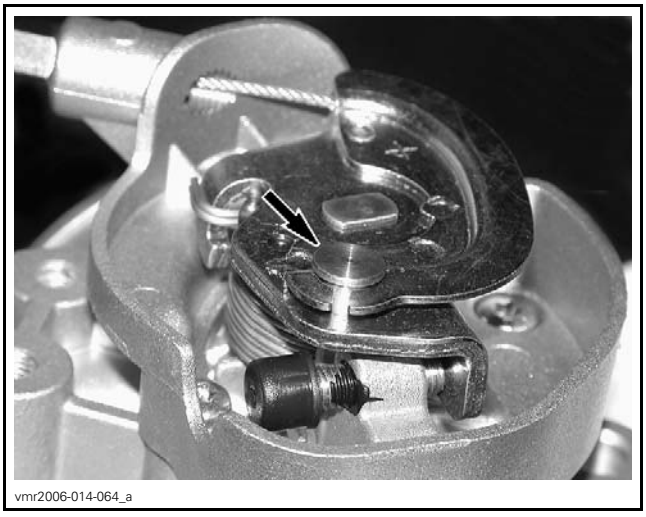
Hook cable to throttle lever.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Rotate throttle body into position and ensure to index throttle body tab with boot notch.


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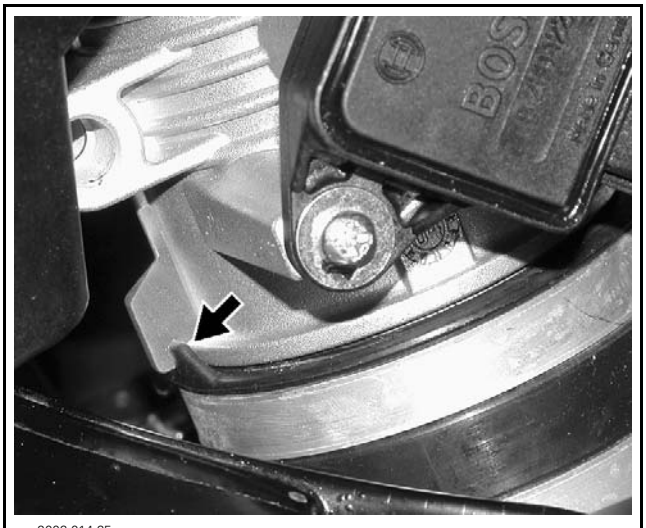
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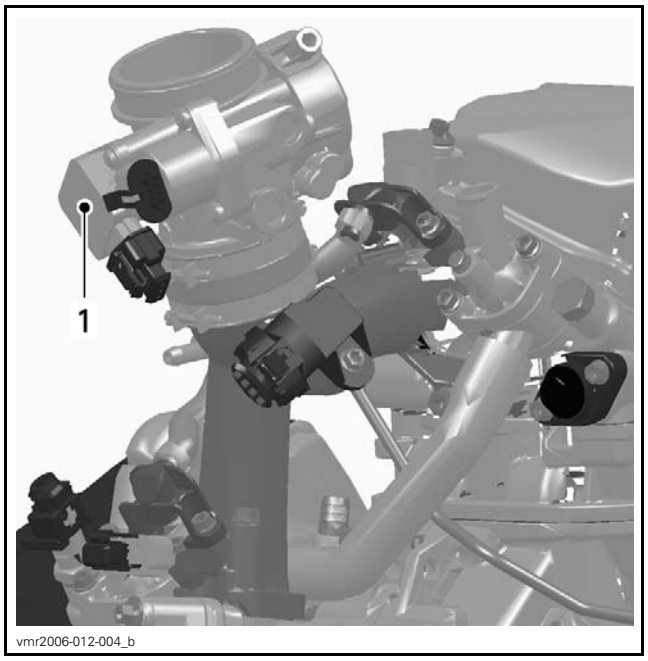
Tighten clamps.

– Check throttle cable adjustment. Refer to *THROTTLE CABLE* in this subsection.
– If throttle body was replaced, perform the **Closed Throttle And Idle Actuator Reset** procedure. Refer to *CLOSED THROTTLE AND IDLE ACTUATOR RESET* in this subsection.

THROTTLE POSITION SENSOR (TPS)

General

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



1. Throttle position sensor (TPS)

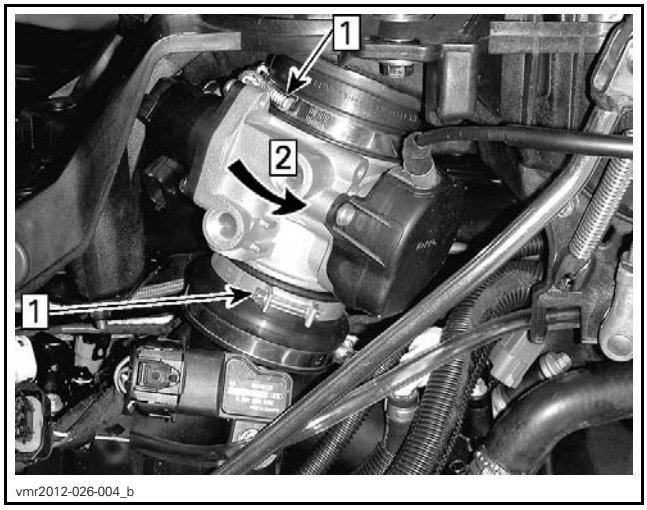
The ECM may generate several fault codes pertaining to the TPS. Refer to *DIGANOSTIC AND FAULT CODES* subsection for more information.

TPS Access

Remove the RH side panel. Refer to *BODY* subsection.

Loosen both throttle body clamps.

Rotate throttle body to gain access to TPS.



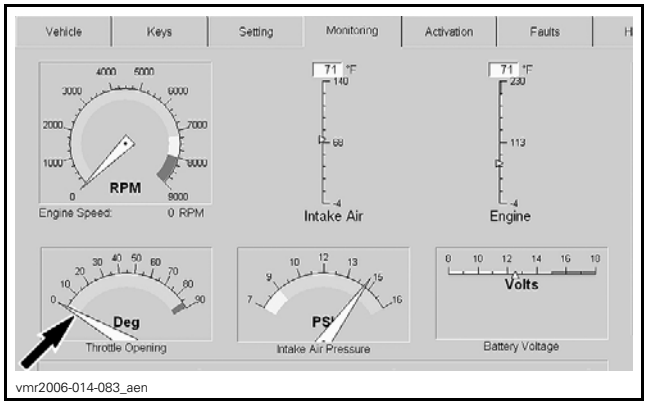
Step 1: Loosen
Step 2: Rotate

TPS Wear Test

IMPORTANT: Prior to testing the TPS, ensure that mechanical components of throttle body are checked.

While engine is not running, activate throttle and pay attention for smooth operation without physical stops of the cable.

Using the B.U.D.S. software, use the Throttle Opening display under Monitoring.



TYPICAL

Slowly and regularly depress the throttle. Observe the needle movement. It must change gradually and regularly as you move the throttle. If the needle "sticks", bounces, suddenly drops or if any discrepancy between the throttle movement and the needle movement is noticed, it indicates that the TPS needs to be replaced or the computer used may be too slow to transfer data fast enough for real time display.

TPS Resistance Test

Ensure TPS is connected to wiring harness.

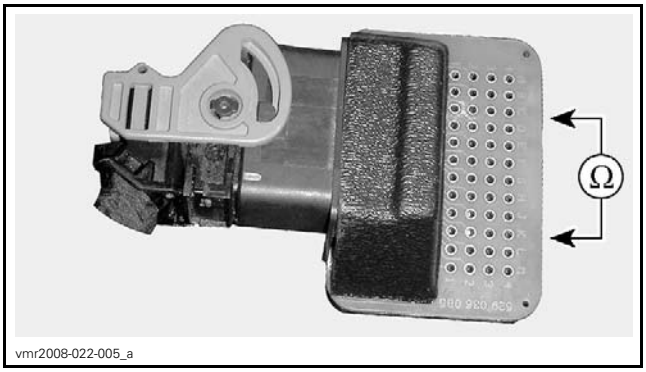
Disconnect the ECM connector.

Using the following tools, check resistance values.

REQUIRED TOOL
ECM ADAPTER TOOL (P/N 529 036 166)

REQUIRED TOOL
FLUKE 115 MULTIMETER (P/N 529 035 868)

ECM ADAPTER		THROTTLE IDLE POSITION	WIDE OPEN THROTTLE POSITION
PIN		RESISTANCE (Ω) @ 20°C (68°F)	
G3	G2	710 - 1300 1124	2600 - 2700 2260
G2	A1	1600 - 2400 1504	1600 - 2400 1504
G3	A1	2600 - 2700 2295	710 - 1300 1201



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

If resistance values are correct, perform the *TPS INPUT VOLTAGE TEST* below.

If resistance values are incorrect, check wiring harness. If wiring is faulty, repair/replace. If wiring is good, replace TPS.

Reconnect ECM connector.

TPS Input Voltage Test

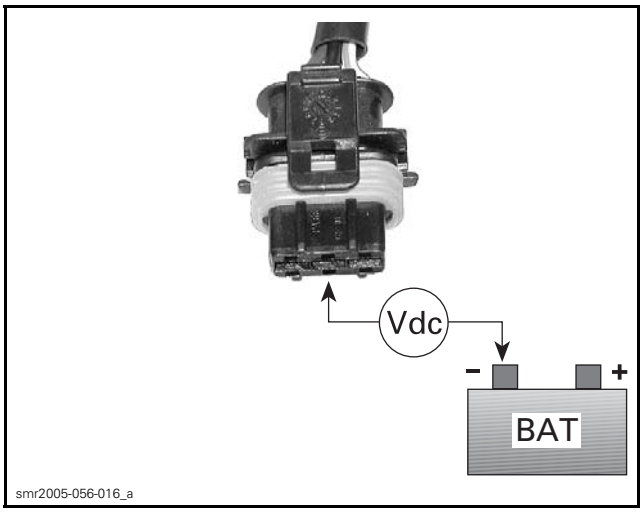
Disconnect connector from TPS.

Turn ignition key ON and.

Set emergency engine stop switch to RUN.

Check the voltage readings from harness connector as follows.

CONNECTION	VOLTAGE
Pin 1 with battery ground	5.0 V
Pin 2 with battery ground	0 V
Pin 3 with battery ground: idle	0.5 V
Pin 3 with battery ground: WOT	4.75 - 5 V



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If voltage test is not good, check/repair wiring harness. If wiring tests good, refer to *ECM REPLACEMENT*.

If voltage test is good, everything is in order (assuming resistance test was performed).

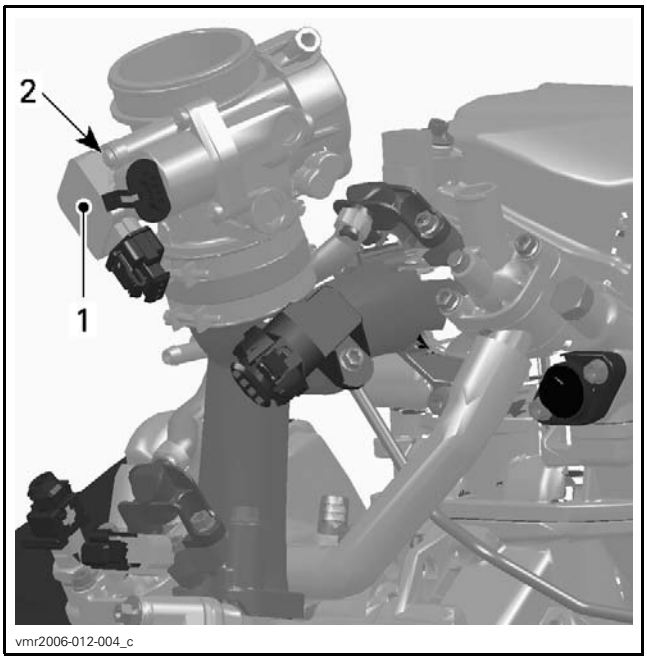
TPS Replacement

Refer to *TPS ACCESS* in this subsection to gain access to TPS.

Unplug connector from TPS.

Loosen TPS retaining screws.

Remove TPS.



TYPICAL – THROTTLE BODY
1. TPS
2. Screws

Install the new TPS.

Apply LOCTITE 243 (BLUE) (P/N 293 800 060) on the TPS retaining screws, then torque to 3 N•m (27 lbf•**in**).

Perform the **Closed Throttle And Idle Actuator Reset** procedure. Refer to *CLOSED THROTTLE AND IDLE ACTUATOR RESET* in this subsection.

IDLE AIR CONTROL VALVE (IACV)

An idle air control valve with good resistance measurement can still be faulty. It is also possible that a mechanical failure occurs which is not detectable without measuring the air flow. Replacing the IACV may be necessary as a test.

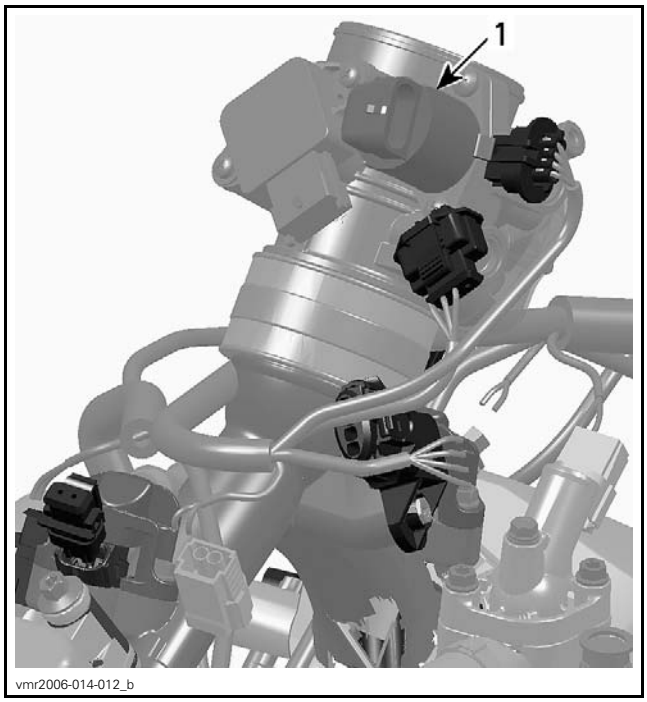
IACV Access

Refer to *TPS ACCESS* in this subsection to gain access to IACV.

IACV Resistance Test

Disconnect IACV from the wiring harness.

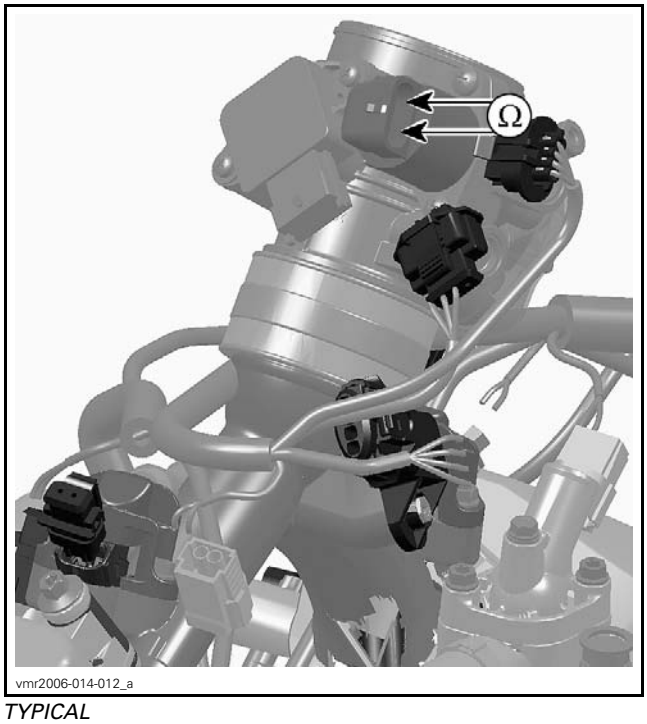
Using a multimeter, check the resistance in both windings.



TYPICAL
1. Idle air control valve

Check the resistance between pins as shown.

IDLE AIR CONTROL VALVE		MEASUREMENT
PIN		RESISTANCE (Ω) @ 20°C (68°F)
A	D	50
B	C	



TYPICAL

If the resistance of any winding is not good, replace the idle air control valve.

If resistance test of valve windings is good, check continuity of circuits C4, D3, D4, E4. If not good, check/repair wiring/connectors.

IACV Visual Inspection

NOTE: Make sure the ignition key is turned off during the following procedure.

Remove Idle air control valve from throttle body.

Check the piston and bypass channel for dirt / deposits which can cause a sticking piston.

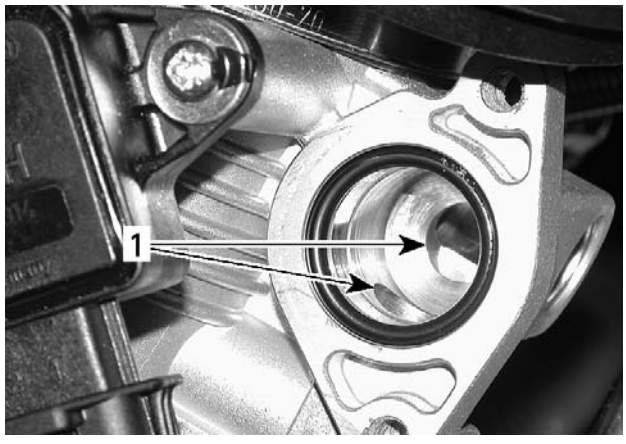
NOTICE Always keep the ignition key turned OFF, while the idle air control valve is removed.

NOTICE Do not try to operate the piston of the idle air control valve when it is dismounted. Also do not move the piston by hand. The drive screw is very sensitive and may be destroyed.

Using a part cleaner, clean idle bypass in throttle body from contamination then use an compressed air to dry it.

⚠ WARNING

Always wear eye protector. Chemicals can cause a rash break out and injure your eyes.

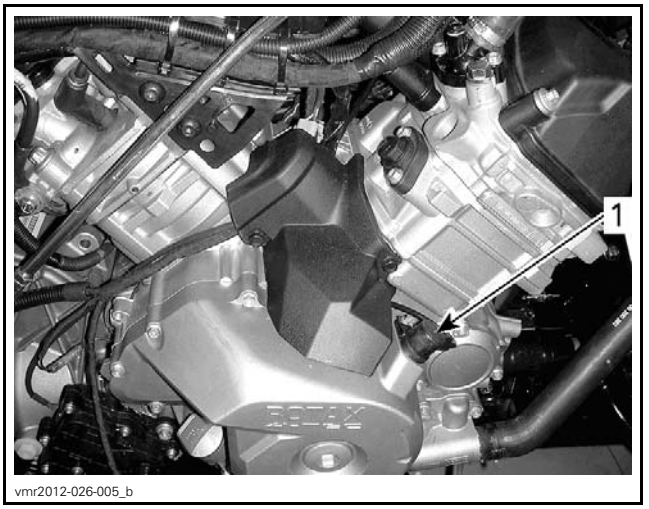


1. Clean bore from contamination

Clean all remaining parts and install the idle air control valve on the throttle body.

Proceed with the **Closed Throttle and Idle Actuator Reset**. See procedure in *CLOSED THROTTLE AN D IDLE ACTUATOR RESET* in this subsection.

CRANKSHAFT POSITION SENSOR (CPS)



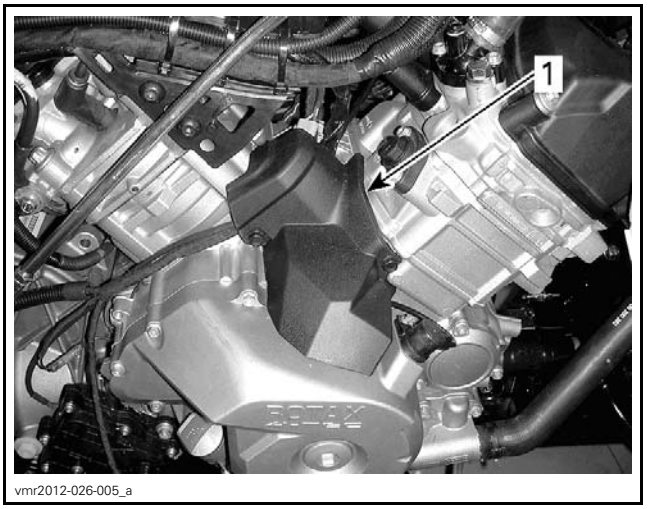
RH SIDE OF VEHICLE
1. CPS

NOTE: Take into account that a CPS fault can be triggered by bent or missing encoder wheel teeth. First check fault codes using B.U.D.S., then check the encoder wheel teeth condition if necessary. Refer to *MAGNETO SYSTEM*.

CPS Access

Remove the RH side panel. Refer to *BODY* subsection.

To reach the CPS connector, remove protector from engine.



1. Remove

CPS Resistance Test

Disconnect the ECM connector.

Install ECM connector on ECM ADAPTER TOOL (P/N 529 036 166).


529036166

Using a multimeter, measure resistance as per table.

ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE Ω @ 20°C (68°F)
D1	E1	700 - 900 Ω

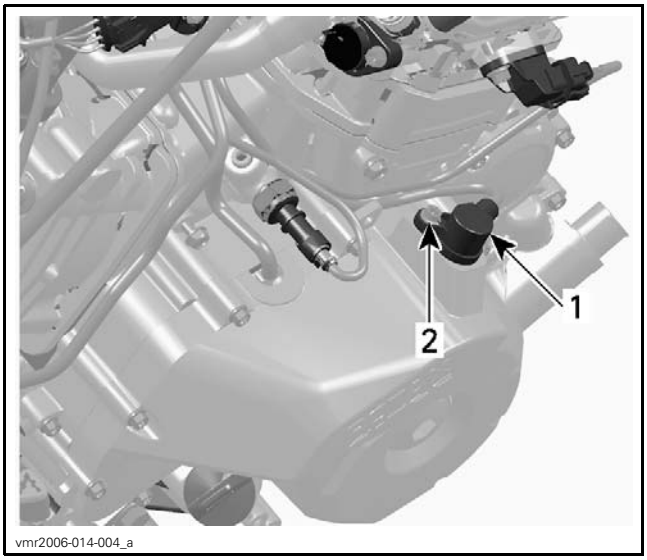
If resistance value is incorrect, check or repair the connectors and the wiring harness between ECM connector and the CPS. If resistance value is still incorrect, replace CPS.

CPS Replacement

Refer to *CPS ACCESS* in this subsection to reach CPS.

Disconnect CPS connector and cut harness locking tie (if applicable).

Remove CPS retaining screw and pull up on CPS to remove it.



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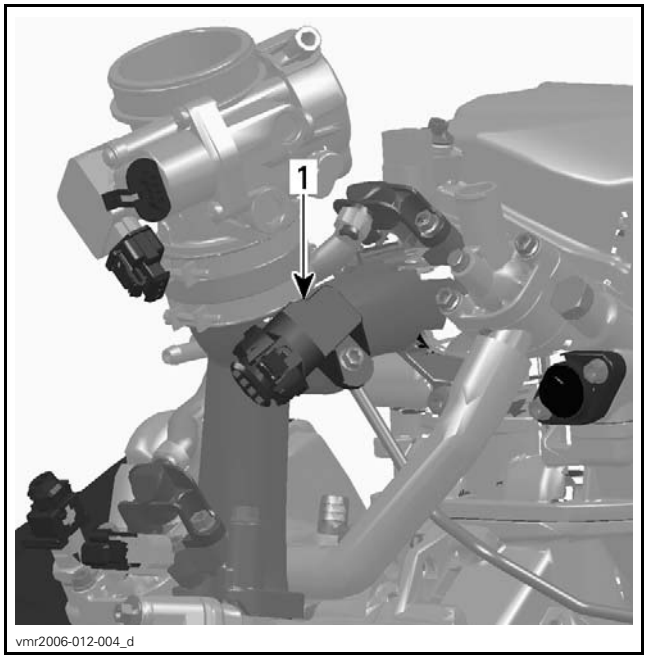
TYPICAL
1. *CPS*
2. *Retaining screw*

Install new CPS and secure harness with a new locking tie (as applicable).

CPS INSTALLATION	
O-RING	PRODUCT
	XPS SYNTHETIC GREASE (P/N 293 550 010)
SENSOR SCREW	TORQUE
	10 N•m ± 1 N•m (89 lbf•**in** ± 9 lbf•**in**)

MANIFOLD ABSOLUTE PRESSURE AND TEMPERATURE SENSOR (MAPTS)



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1. *Manifold absolute pressure and temperature sensor (MAPTS)*

NOTE: This sensor is a multifunction device.

MAPTS Access

Remove the RH side panel. Refer to *BODY* subsection.

MAPTS Pressure Function

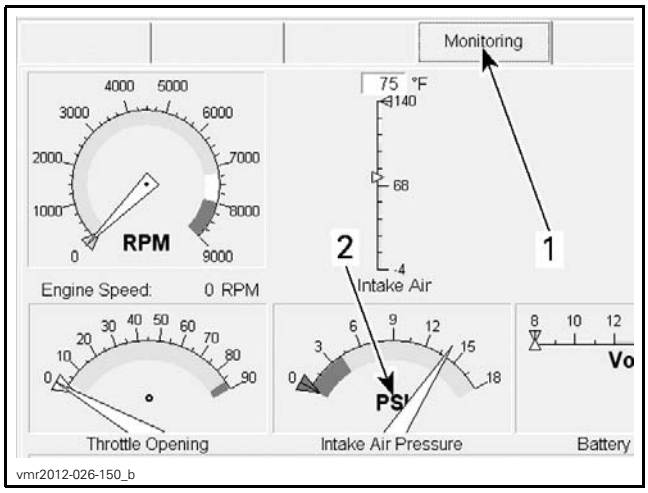
Before the engine is started, when power is applied to the system, the sensor measures the ambient air atmospheric pressure. The ambient pressure is, at that moment, stored in the ECM. Thereafter, once the engine is started, it measures the air pressure in the intake manifold at operating RPMs.

The sensor must be correctly installed on intake manifold. Otherwise, the MAPTS could generate a fault code for an unexpected sensor range at idle when it reads the atmospheric pressure. If this

is the case, remove sensor and check for oil or dirt on its end and if problem persists, check throttle plate condition/position and the wiring harness. Perform the following tests.

MAPTS Pressure Function Quick Test

1. Connect vehicle to the latest applicable B.U.D.S. software version.
2. In B.U.D.S., click the following:
   - Read Data
   - Monitoring tab
   - ECM tab.



TYPICAL
1. Monitoring tab
2. MAPTS pressure reading

3. Look for and take note of the MAPTS pressure reading while the engine is stopped.
4. Perform the same test with a new MAPTS and compare both readings.

Values have to be within ± 3.4 kPa (.5 PSI).

MAPTS PRESSURE FUNCTION QUICK TEST			
RESULT	SERVICE ACTION		
NO READING	Circuit Continuity Test of MAPTS Pressure Function	MAPTS Input Voltage Test	Repair or replace wiring
VALUE IS OUT OF RANGE	Replace MAPTS		

MAPTS Input Voltage Test

Check the voltage output from ECM to the pressure sensor.

1. Turn ignition key ON.
2. Set emergency engine stop switch to RUN.
3. Remove electrical connector from MAPTS.
4. Using a FLUKE 115 MULTIMETER (P/N 529 035 868), measure for input voltage as per following table.

MAPTS CONNECTOR		MEASUREMENT
PIN		VOLTAGE
1	3	5 Vdc

If voltage test is good, replace the MAPTS.

If voltage test is not good, carry out the *MAPTS CIRCUIT CONTINUITY TEST (PRESSURE FUNCTION)*.

MAPTS Circuit Continuity Test (Pressure Function)

1. Disconnect the ECM connector.
2. Install ECM connector on ECM ADAPTER TOOL (P/N 529 036 166).
3. Using a multimeter, check continuity of the following circuits.

MAPTS CIRCUIT CONTINUITY TEST (PRESSURE FUNCTION)		
ECM ADAPTER	MAPTS CONNECTOR	RESISTANCE VALUE
A1	Pin 3	Close to 0 Ω
F2	Pin 4	
G2	Pin 1	

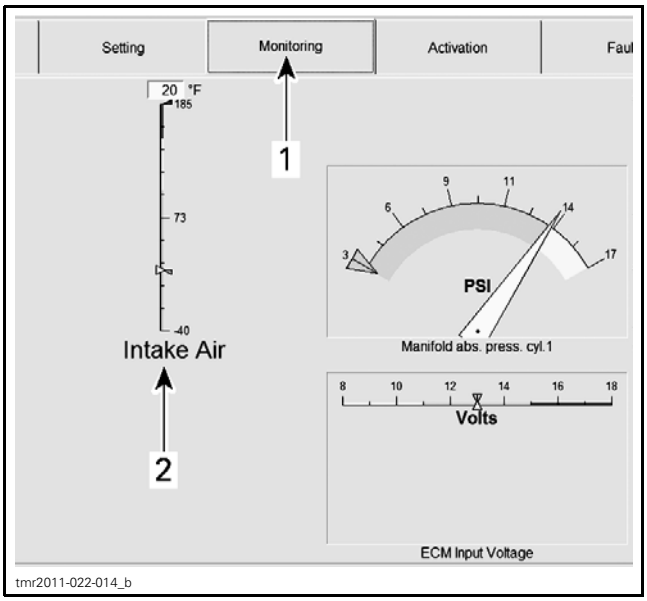
If resistance is not within specification, repair or replace the wiring harness between ECM connector and the MAPTS.

MAPTS Temperature Function

The sensor monitors the temperature in the intake manifold.

MAPTS Quick Test (Temperature Function)

1. Connect vehicle to the applicable B.U.D.S. software version.
2. In B.U.D.S., click the following:
   - Read Data
   - Monitoring tab
   - ECM tab.
3. Look for the Intake Air temperature reading while the engine is stopped.



TYPICAL
1. *Monitoring tab*
2. *MAPTS temperature reading*

4. Perform the same test with a new MAPTS and compare both readings.

If the engine MAPTS temperature reading is significantly different than the new MAPTS, replace it.

NOTE: Both sensors must feel the same ambient air temperature.

If there is no reading, carry out a *MAPTS RESISTANCE TEST (TEMPERATURE FUNCTION)*.

MAPTS Resistance Test (Temperature Function)

Disconnect the connector from the MAPTS.

Using the FLUKE 115 MULTIMETER (P/N 529 035 868), check the resistance of the sensor itself as shown.

MAPTS		MEASUREMENT
PIN		RESISTANCE Ω @ 20°C (68°F)
1	2	2280 - 2740

If resistance is not within specification, replace the MAPTS.

If resistance tests good, **reconnect** the MAPTS and disconnect the ECM connector.

Install ECM-A connector on ECM ADAPTER TOOL (P/N 529 036 166).

Using a multimeter, recheck resistance value as per following table.

ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE Ω @ 20°C (68°F)
F3	G2	2280 - 2740

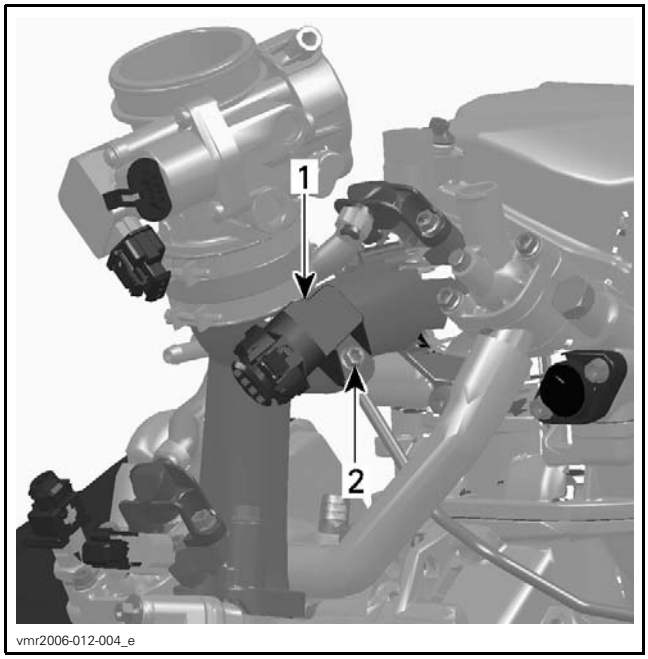
MAPTS TEMPERATURE SENSOR TEST RESULTS			
RESULT	SERVICE ACTION		
NO READING	Circuit Continuity Test of MAPTS Temperature Function	MAPTS Input Voltage Test	Repair or replace wiring
INCORRECT RESISTANCE VALUE	Replace MAPTS		

MAPTS Circuit Continuity Test (Temperature Function)

MAPTS CIRCUIT CONTINUITY TEST (TEMPERATURE FUNCTION)		
ECM ADAPTER	MAPTS CONNECTOR	RESISTANCE VALUE
G2	Pin 1	Close to 0 Ω
F3	Pin 2	

MAPTS Replacement

Remove the RH side panel. Refer to *BODY* subsection.



1. MAPTS
2. Retaining screw

Disconnect MAPTS connector and remove the MAPTS.

Install new MAPTS as per following table.

TORQUE	PRODUCT
6 N•m ± 0.7 N•m (53 lbf•**in** ± 6 lbf•**in**)	LOCTITE 243 (BLUE) (P/N 293 800 060)

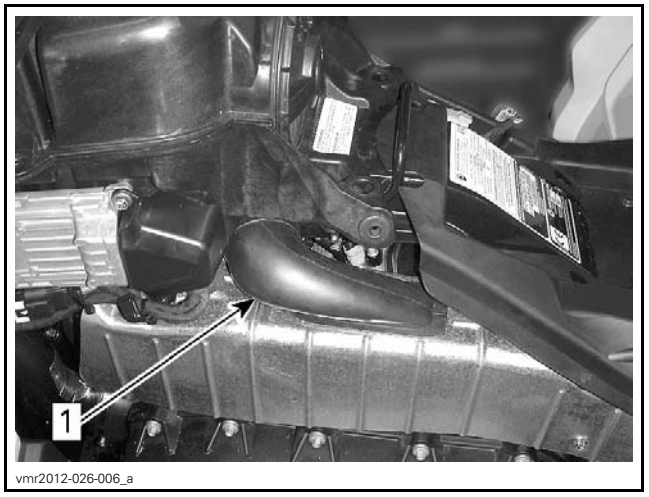
CTS (COOLANT TEMPERATURE SENSOR)

LH SIDE OF VEHICLE
1. CTS

CTS Access

Remove the LH panel. Refer to *BODY* subsection.

Remove the CVT duct.



1. Pull out

CTS Resistance Test

1. Disconnect the ECM connector.
2. Using the following tools, check resistance values.

REQUIRED TOOL
ECM ADAPTER TOOL (P/N 529 036 166)

REQUIRED TOOL
FLUKE 115 MULTIMETER (P/N 529 035 868)

3. Install ECM connector on the following tool.

ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE (Ω) @ 20°C (68°F)
C3	F4	2280 - 2736

If resistance value is incorrect, check wiring continuity between ECM connector and the CTS. Refer to *CTS CIRCUIT CONTINUITY TEST* in this subsection.

CTS Circuit Continuity Test

1. Disconnect connector from CTS and check the circuit continuity.

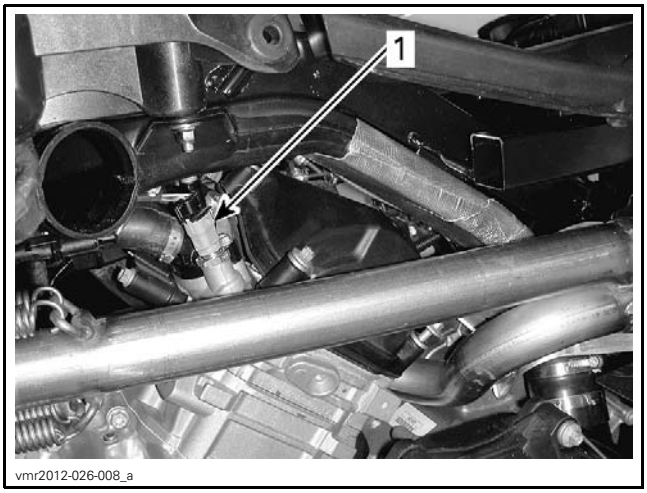
CTS CIRCUIT CONTINUITY TEST		
ECM ADAPTER	CTS CONNECTOR	RESISTANCE VALUE
Pin F4	Pin 1	Close to 0 Ω
Pin C3	Pin 2	

If resistance value is incorrect, repair or replace wiring or connectors/terminals.

If resistance test is good, replace the CTS.

CTS Replacement

1. Refer to *CTS ACCESS* in this subsection to reach CTS.
2. Remove heat shield over exhaust pipe to expose CTS. Refer to *EXHAUST SYSTEM*.



1. CTS

3. Disconnect CTS connector and remove CTS.
4. Install the new CTS and torque as specified.

CTS TORQUE
16 N•m ± 2 N•m (142 lbf•**in** ± 18 lbf•**in**)

5. Reinstall remaining removed parts.
6. Refill and bleed the cooling system. Refer to *COOLING SYSTEM* subsection.