

ELECTRONIC FUEL INJECTION (EFI)

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL.....	529 036 166	5
FLUKE 115 MULTIMETER	529 035 868	5
OETIKER PLIERS.....	295 000 070	10

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE).....	293 800 060	10, 16, 21
XPS SYNTHETIC GREASE.....	293 550 010	18

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

Refer to the appropriate *ENGINE MANAGEMENT SYSTEM* subsection for a general layout of the various EFI system components.

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.

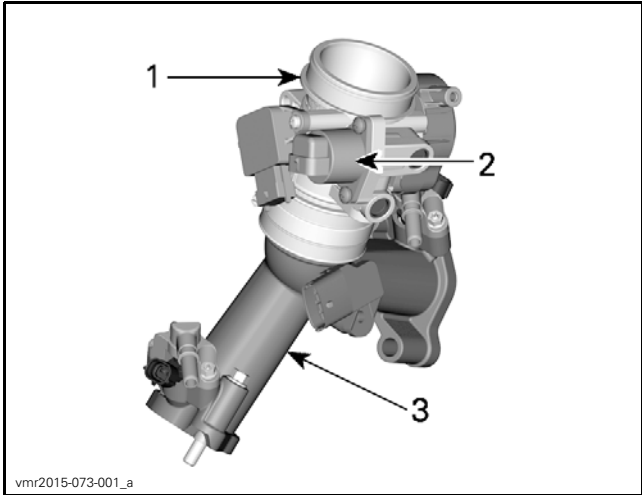
Air Intake System

Refer to the applicable *AIR INTAKE SYSTEM* subsection for additional information.

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.



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

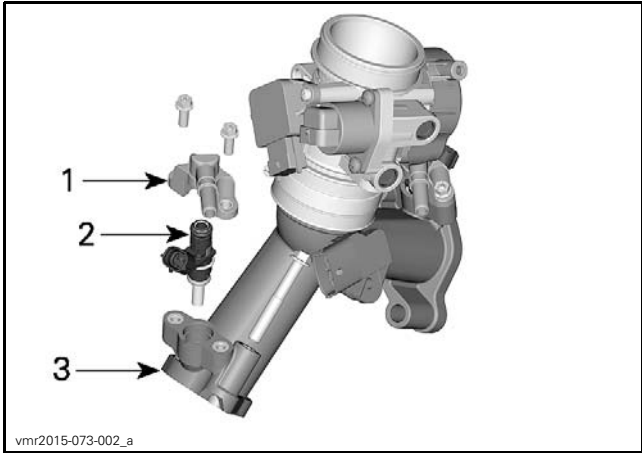
Fitted on the throttle body, a throttle plate regulates the amount of air that enters the engine.

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

An idle 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

Refer to the applicable *FUEL TANK AND FUEL PUMP* subsection for additional information.



1. Fuel rail
2. Fuel Injector
3. Intake manifold

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 IACV.

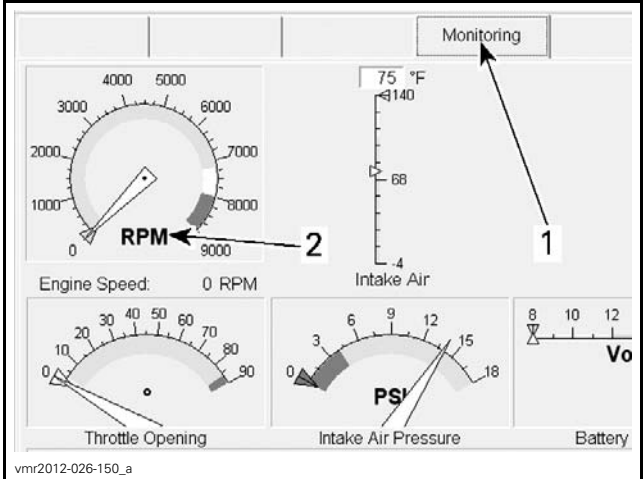
NOTICE Never attempt to adjust the sealed idle stop screw. It is calibrated at the factory. If the screw adjustment is changed, the throttle body must be replaced.

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

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

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

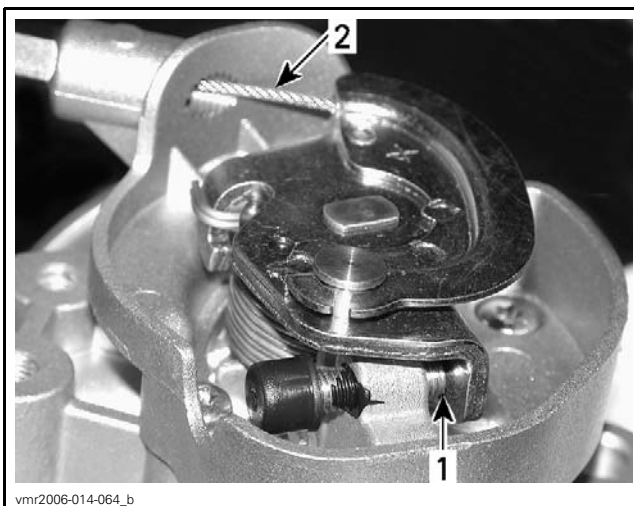
This reset is very important. The setting of the TPS will determine the basic parameters for all fuel mapping and several ECM calculations and the setting of the idle air control valve will determine the basic parameters for the idle speed control of the engine.

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.

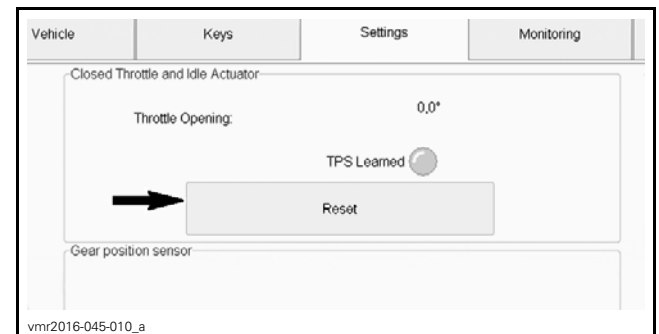


1. Contact here
2. Free-play here

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



If operation is wrong, an error message will be displayed.

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.

4. 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.

Subsection 01 (ELECTRONIC FUEL INJECTION (EFI))

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)

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. If the following do not turn on, check ECM fuse (PF1 (F5 and F8)).

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.

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

Testing the ECM Power Supply

REQUIRED TOOL	
ECM ADAPTER TOOL (P/N 529 036 166)	
FLUKE 115 MULTIMETER (P/N 529 035 868)	

1. Disconnect ECM connector.
2. Install the ECM adapter tool on the ECM connector.
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. Set multimeter to Vdc and 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*.

Testing the Continuity of ECM Ground Circuits

1. Disconnect ECM connector.
2. Install the ECM adapter tool on ECM connector.
3. Set multimeter to Ω and probe adapter terminals as per following table.

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

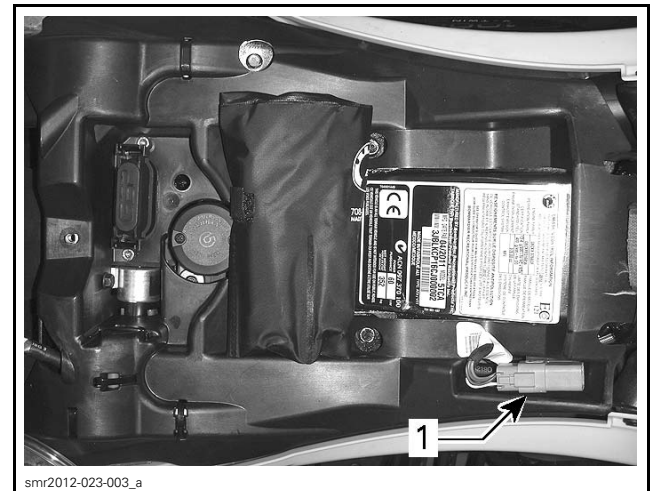


If any measurement is out of specification, refer to *POWER DISTRIBUTION* and check all grounds.

Testing the CAN Resistor

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 multimeter 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,

Removing the ECM

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

1. Disconnect battery cables.

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

2. Disconnect ECM connector.

3. Unscrew all retaining screws and pull out ECM.

Installing the ECM

Reverse removal procedure however, pay attention to the following.

1. Reconnect ECM connector.

2. Reconnect battery cables.

 **WARNING**

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

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

Replacing the ECM

1. Transfer ECM data. Refer to *ECM DATA TRANSFER* for complete procedure.

2. Perform the *CLOSED THROTTLE AND IDLE ACTUATOR RESET*.

3. Program the vehicle ignition key(s) in the new ECM.

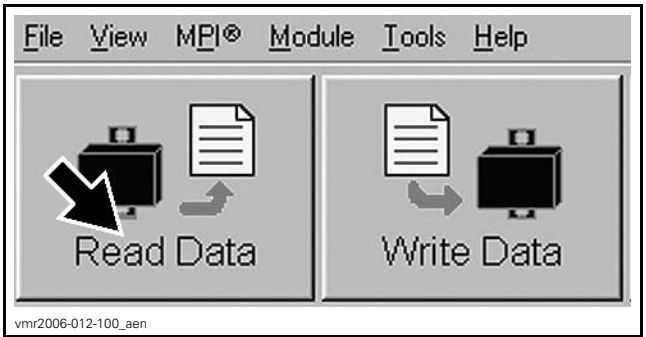
4. Calibrate the IACV. Refer to *IACV CALIBRATION* in this subsection.

ECM Data Transfer

To transfer the original ECM recorded information to the new ECM, use the B.U.D.S. software and proceed as follows.

1. Connect the original ECM to vehicle.

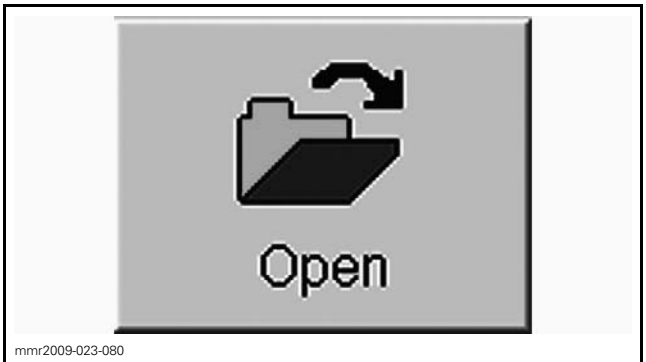
2. In B.U.D.S., click the Read Data button to load the information from the original ECM.



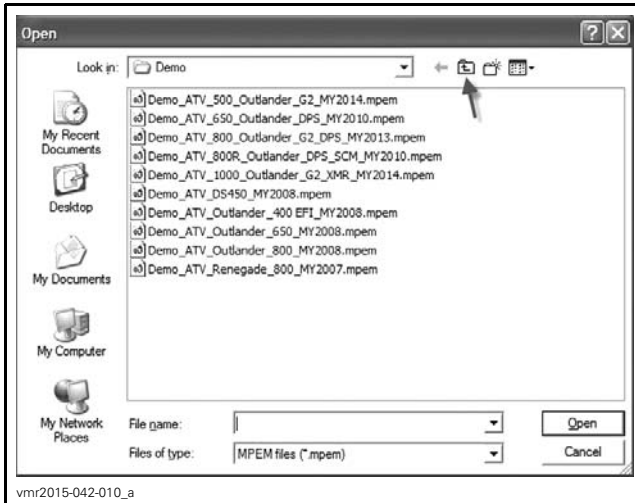
NOTE: Keep B.U.D.S. running while replacing ECMs. The data will remain stored in the PC computer as long as B.U.D.S. is running.

3. Get the Data from the saved .mpem file.

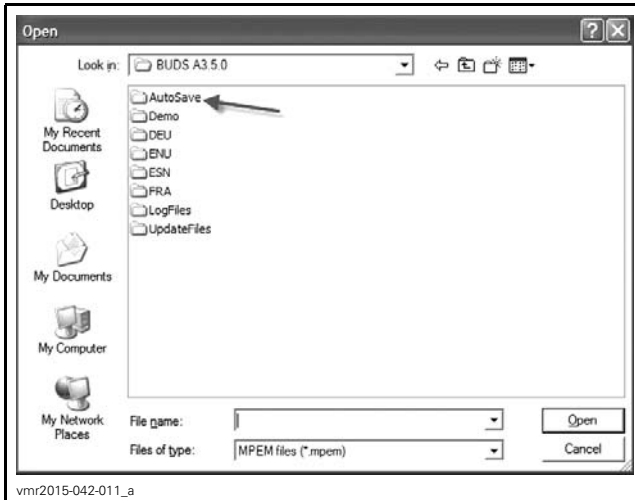
3.1 Click on the Open button.



3.2 Click once on the Folder Up button in the open box.

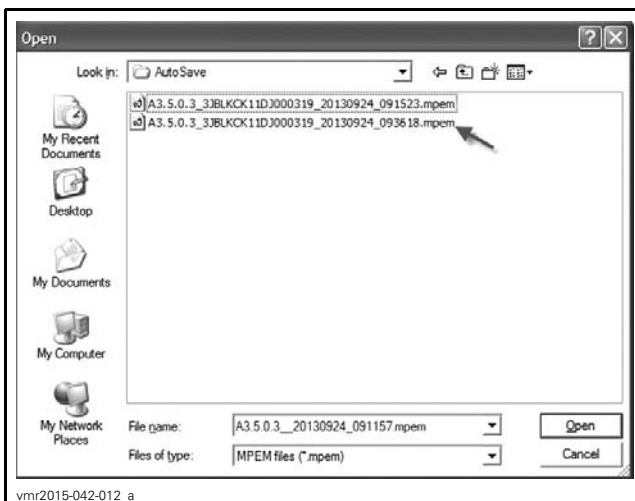


3.3 Double click on the AutoSave folder.



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

3.4 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:

A3.5.0.3_3JBLKCK11DJ000319_20130924_093618.mpem

B.U.D.S. version = A3.5.0.3

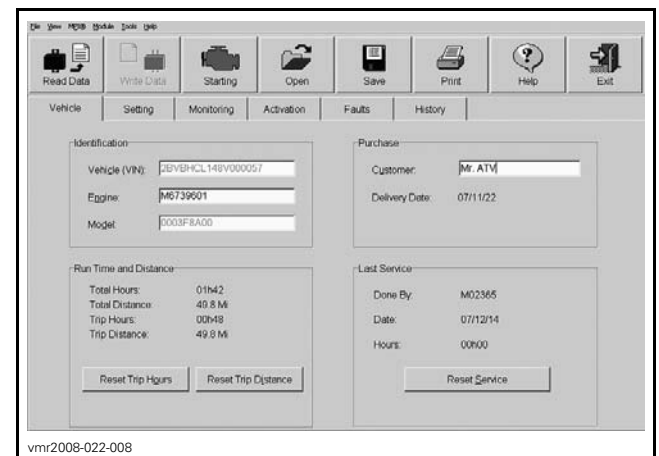
VIN = 3JBLKCK11DJ000319

Date file was read = 2013-09-24

Hour file was read = 09h 36m 18s

4. Go to the Vehicle tab and record the following information.

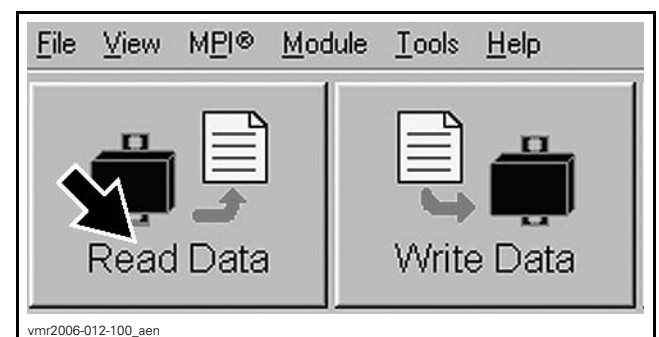
- Vehicle (V.I.N.) number
- Engine number (without the leading "M")
- Model number
- Customer.



5. Remove the original ECM.

6. Install the new ECM.

7. In B.U.D.S., click the **Read Data** button to read the new ECM.

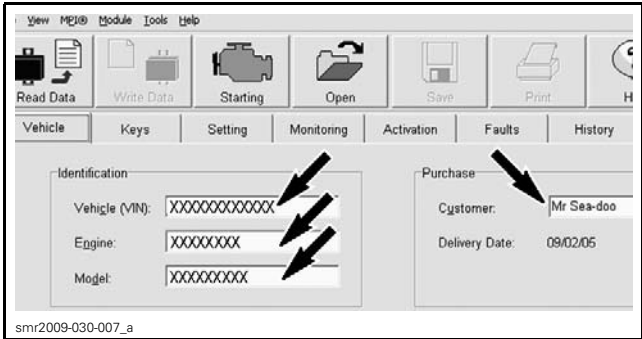


8. Select the **Vehicle** tab and enter the information you recorded previously.

- Vehicle serial number

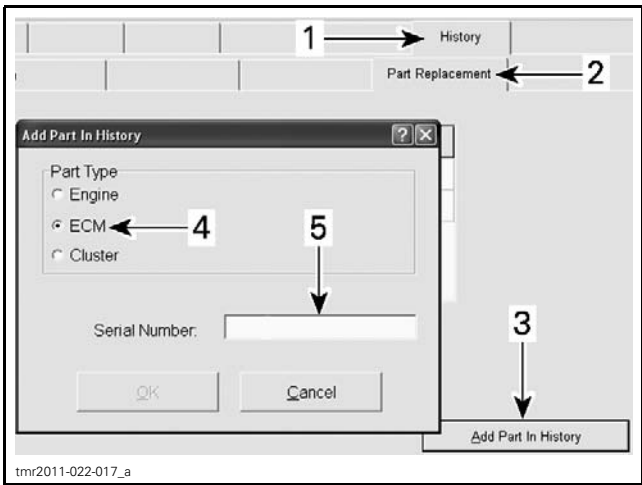
Subsection 01 (ELECTRONIC FUEL INJECTION (EFI))

- Engine number (do not enter the “M” at the beginning of the engine number)
- Enter model number.
- Customer name.



VEHICLE TAB

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

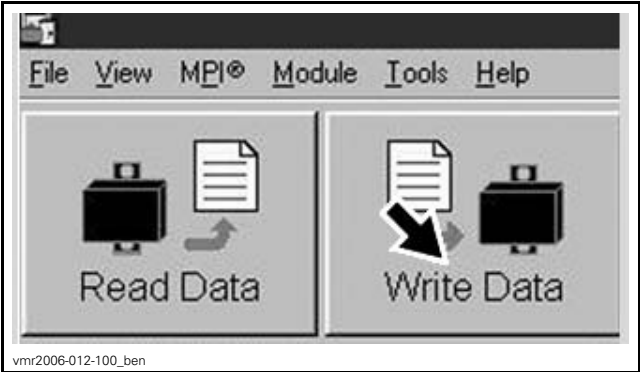


ADDING PART IN HISTORY

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.

11. Click on the **OK** button.
12. Click on the **Write Data** button.



FUEL INJECTOR

Refer to the applicable *ENGINE MANAGEMENT SYSTEM* subsection for component and connector locations.

Fuel Injector Leak Test

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

Testing the Fuel Injector Input Voltage

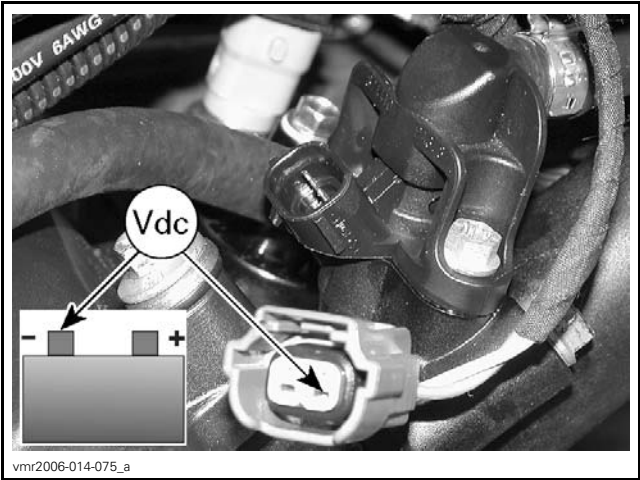
Disconnect the fuel injector electrical connector. Turn on ignition switch.

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	INJ1-2	BAT2 (-)	Battery voltage
REAR	INJ2-2		



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*.

Testing the Injector Power Circuit Resistance

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	INJ1-2	PF1-B2	Close to 0 Ω
REAR	INJ2-2		

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

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

Testing the Fuel Injector Resistance

Disconnect ECM connector.

Install the ECM adapter tool on the ECM connector.

Connect the fuel injector connector.

Using a multimeter, 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	PF1-B2	K4	11.4 - 12.6 Ω
REAR		L4	

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

Testing the Injector Ground Circuit Resistance

Disconnect the fuel injector connector.

Disconnect ECM connector.

Install the ECM adapter tool on the ECM connector.

Using a multimeter, check resistance value between terminals as follows.

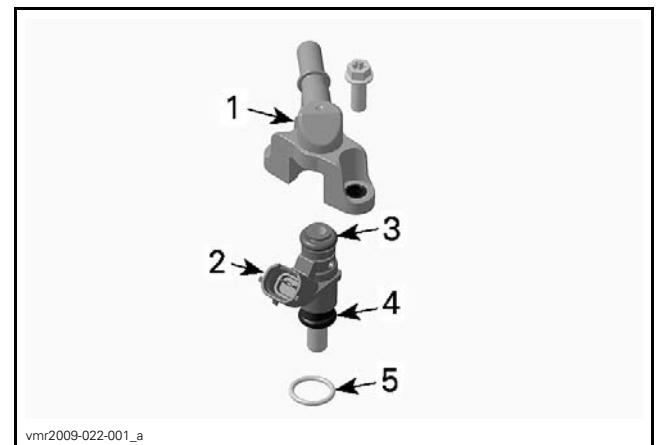
CYLINDER	INJECTOR GROUND CIRCUIT		MEASUREMENT
	WIRE	ECM ADAPTER	
FRONT	INJ1-1	K4	Close to 0 Ω
REAR	INJ2-1	L4	

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

If continuity is good, replace the injector.

Removing the Fuel Injector

Remove the fuel rail. Refer to *FUEL RAIL* in this subsection.



FUEL RAIL ASSEMBLY

1. Fuel rail
2. Fuel injector
3. Injector top O-ring
4. Injector bottom O-ring
5. Manifold O-ring

Pull fuel injector out of the fuel rail.

Installing the Fuel Injector

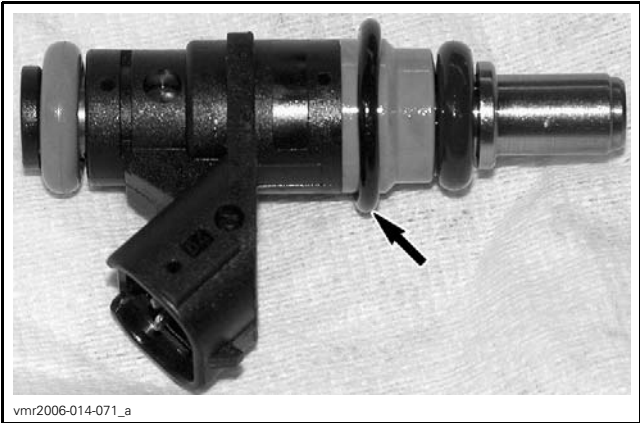
For the installation, reverse the removal procedure. Pay attention to the following details.

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

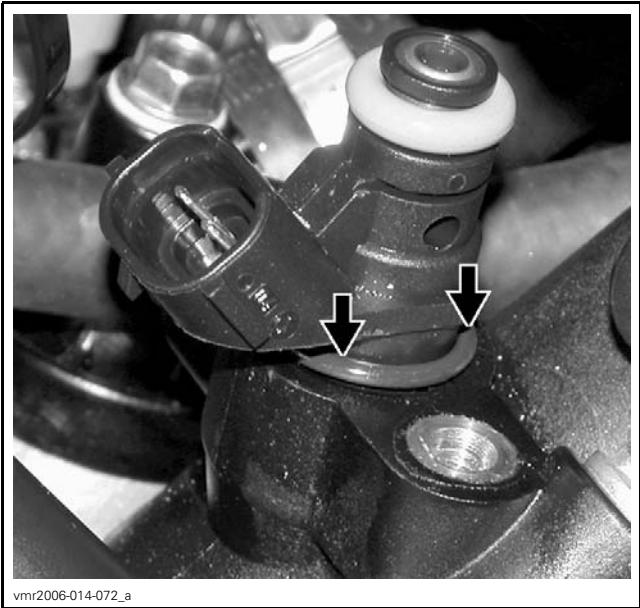
Position the manifold O-ring on injector as in following illustration.



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.



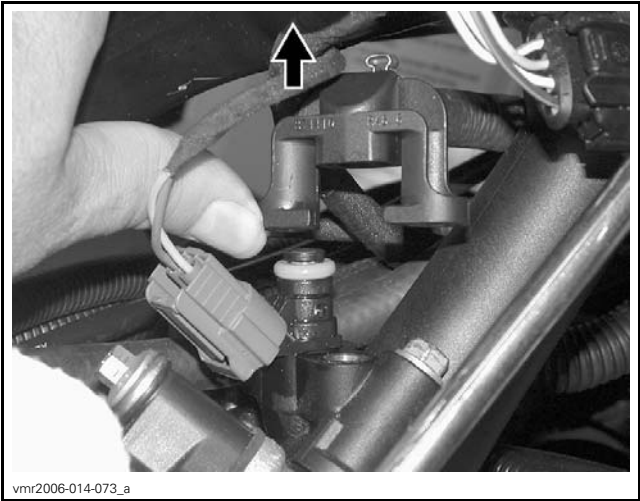
Firmly push injector until it bottoms out.
Reinstall fuel rail.

FUEL RAIL

Replacing the Fuel Rail

Removing the Fuel Rail

- 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.



To disconnect fuel rail from hose, cut clamp on fuel hose. Refer to *FUEL TANK AND FUEL PUMP* for clamp removal/installation procedures.

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

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

Installing the Fuel Rail

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

INJECTOR O-RINGS	
SERVICE PRODUCT	Lubricate with engine oil

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

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Fuel rail retaining screws	10 N•m ± 1 N•m (89 lbf•in ± 9 lbf•in)

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

Removing the Throttle Cable

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.

Installing the Throttle Cable

Reverse removal procedure.

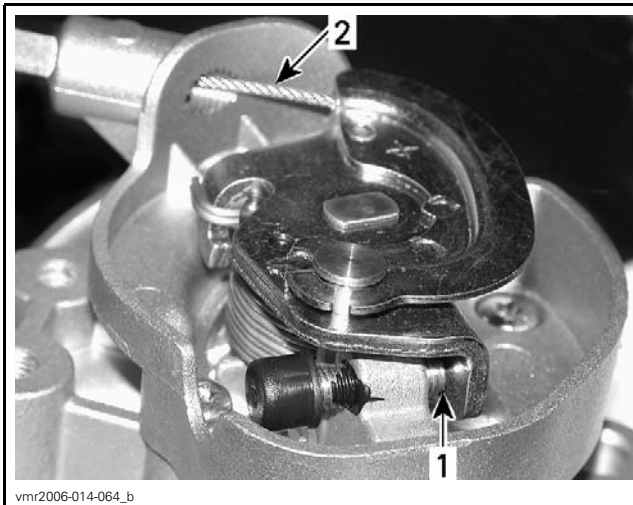
Proceed with *THROTTLE CABLE ADJUSTMENT* in this subsection.

Adjusting the Throttle Cable

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.



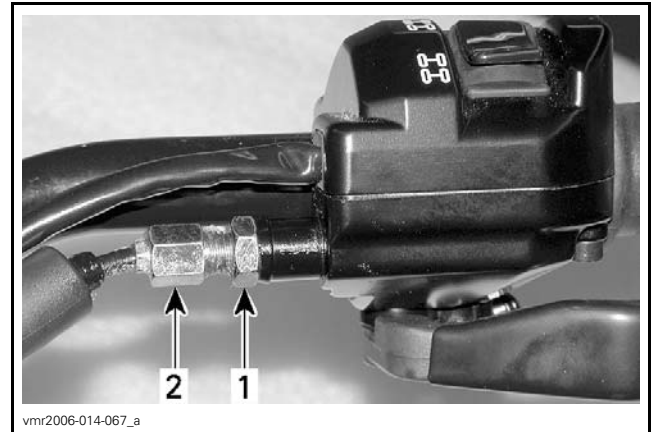
1. Contact here
2. Free-play here

⚠ 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 (.079 in) free-play at the end of throttle lever. When done, slide back cable protector over adjuster.

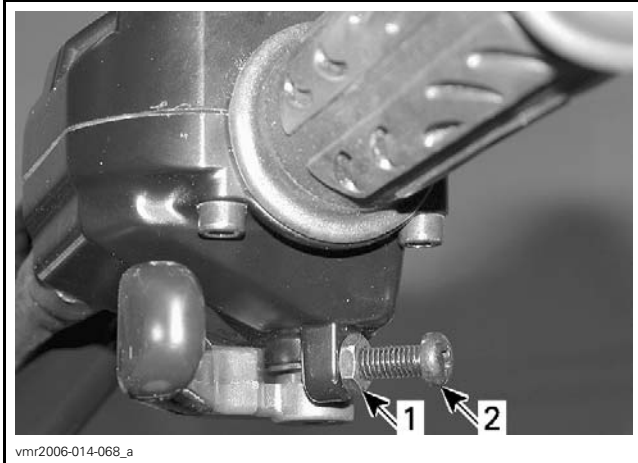


1. Adjuster lock nut
2. Adjuster

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.

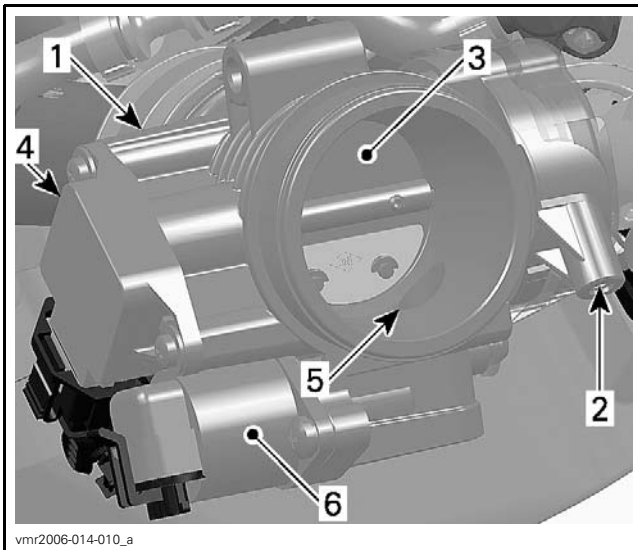


1. Adjuster lock nut
2. Adjuster

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.

Inspecting the Throttle Body

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

- Check if throttle body 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.

NOTICE The throttle body must be replaced if idle set screw is loose or worn.

Cleaning the Throttle Body

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. Refer to manufacturer's instructions.

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

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.

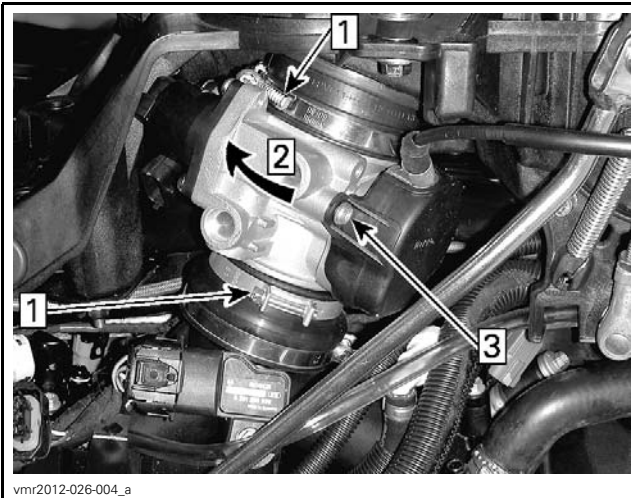
Removing the Throttle Body

1. Remove the air intake silencer retaining screws.



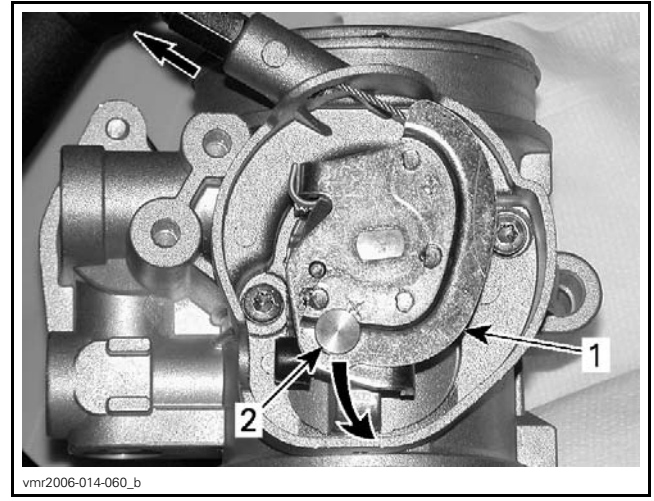
1. Remove these screws

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



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

7. Rotate throttle lever and pull out cable barrel.



1. Throttle lever
2. Cable barrel

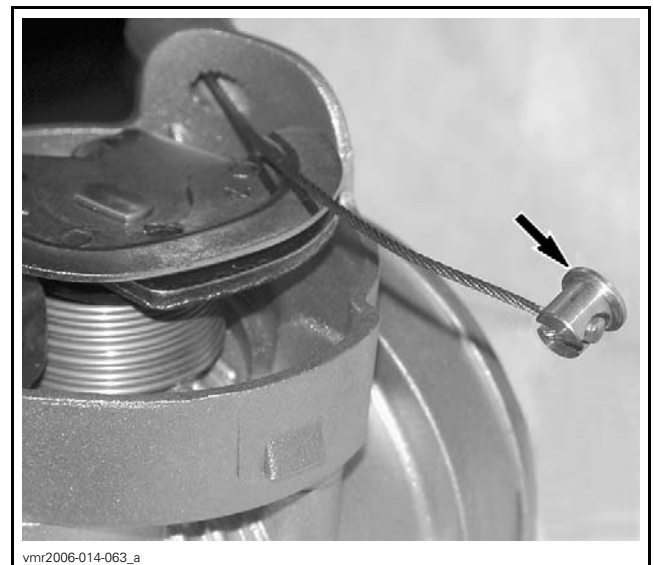
8. Remove barrel from cable.
9. Pull out throttle cable.
10. Pull out throttle body.

Installing the Throttle Body

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

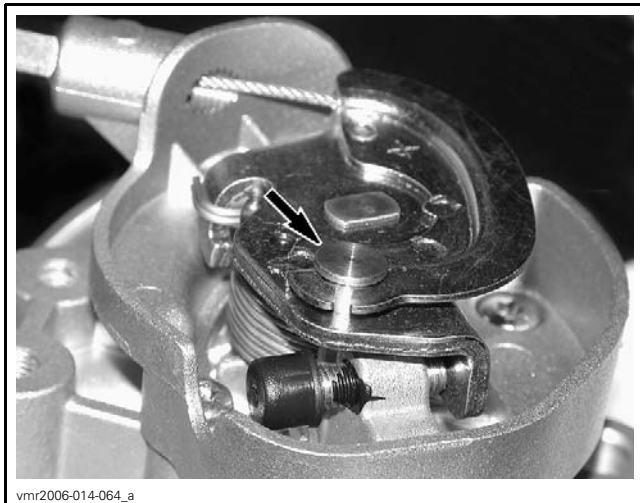
Temporarily install throttle body into position.

Properly install cable barrel to throttle cable end.

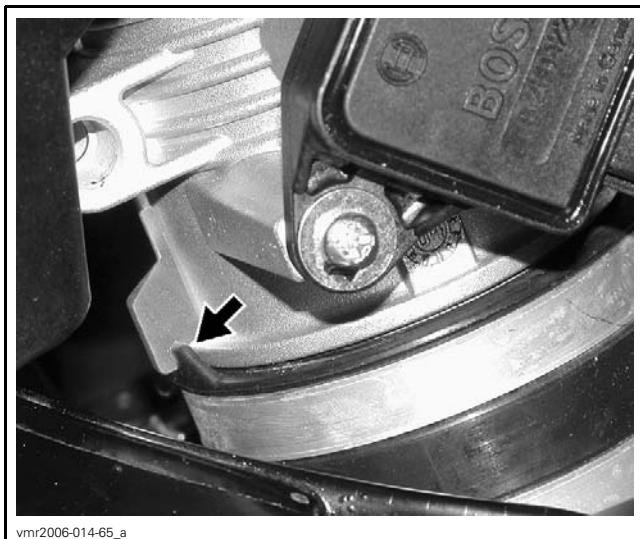


Hook cable to throttle lever.

Subsection 01 (ELECTRONIC FUEL INJECTION (EFI))



Rotate throttle body into position and ensure to index throttle body tab with boot notch.



Tighten clamps.

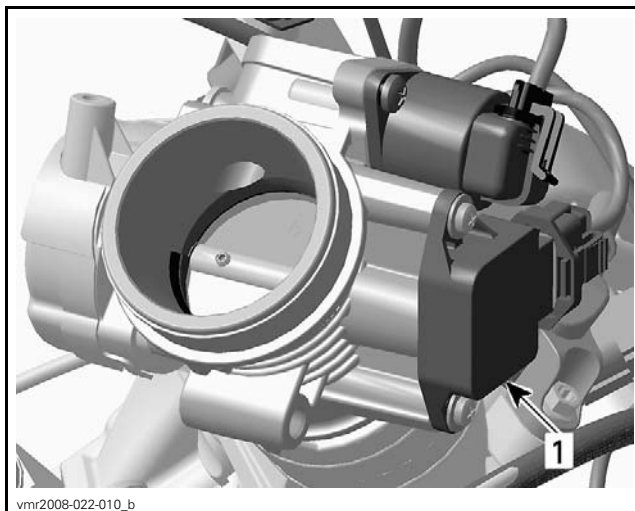
- Check throttle cable adjustment. Refer to *THROTTLE CABLE* in this subsection.
- If throttle body was replaced, perform the *CLOSED THROTTLE AND IDLE ACTUATOR RESET* and the *IACV CALIBRATION*. See procedures in this subsection.

THROTTLE POSITION SENSOR (TPS)

Refer to the applicable *ENGINE MANAGEMENT SYSTEM* subsection for component and connector locations.

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)

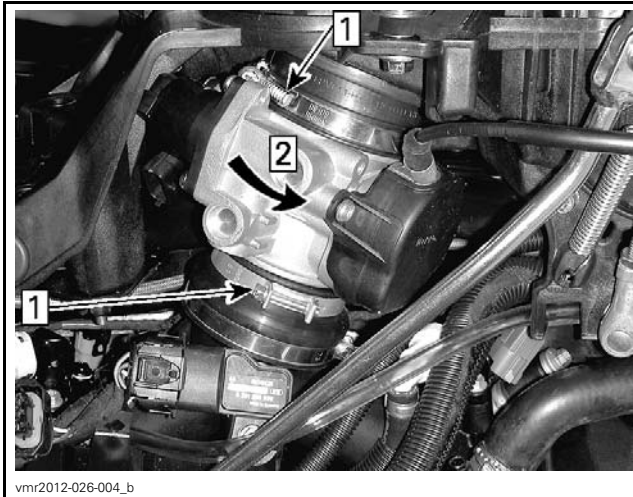
The ECM may generate several fault codes pertaining to the TPS. Refer to *DIAGNOSTIC AND FAULT CODES* subsection for more information.

TPS Access

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

Loosen both throttle body clamps.

Rotate throttle body to gain access to TPS.



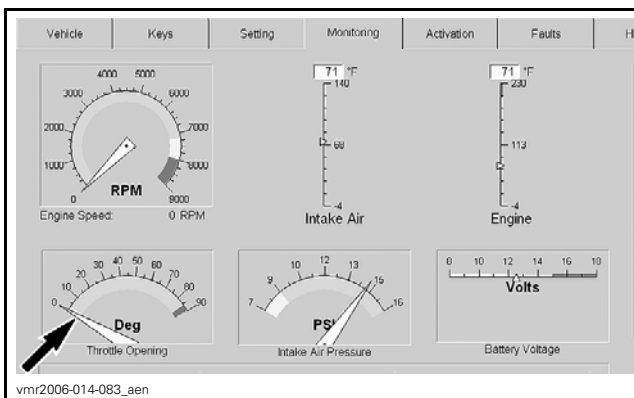
Step 1: Loosen
Step 2: Rotate

Testing the TPS Wear

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.



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.

Testing the TPS Resistance

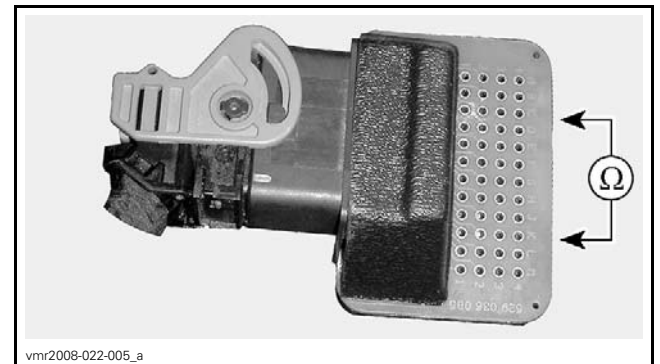
Ensure correct throttle cable adjustment. Refer to *THROTTLE CABLE ADJUSTMENT* in this subsection.

Ensure TPS is connected to wiring harness.

Disconnect the ECM connector.

Using the ECM adapter tool and a multimeter, check resistance values.

ECM ADAPTER		THROTTLE IDLE POSITION	WIDE OPEN THROTTLE POSITION
PIN		RESISTANCE (Ω) @ 20°C (68°F)	
G3	G2	900-1600	2600-3100
G2	A1	1800-2200	1800-2200
G3	A1	2200-3100	800-1200



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.

Testing the TPS Input Voltage

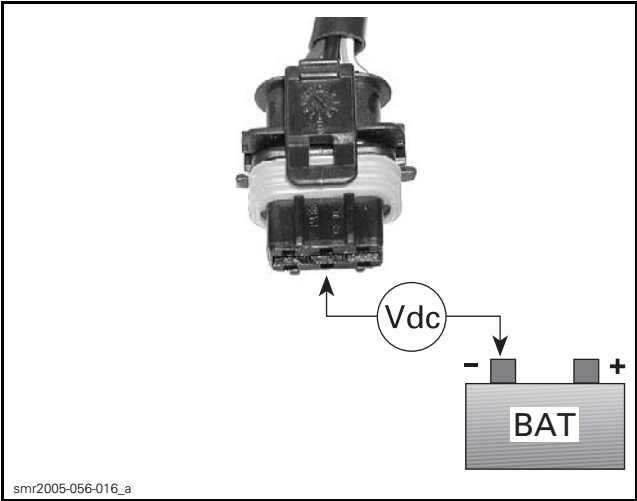
Disconnect connector from TPS.

Turn ignition key ON.

Set emergency engine stop switch to RUN.

Check the voltage readings from harness connector as follows.

ENGINES	CONNECTION	VOLTAGE
570 and 650	Pin 1 with battery ground	5.0 V
850 and 1000R	Pin 3 with battery ground	
All	Pin 2 with battery ground	0 V



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

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

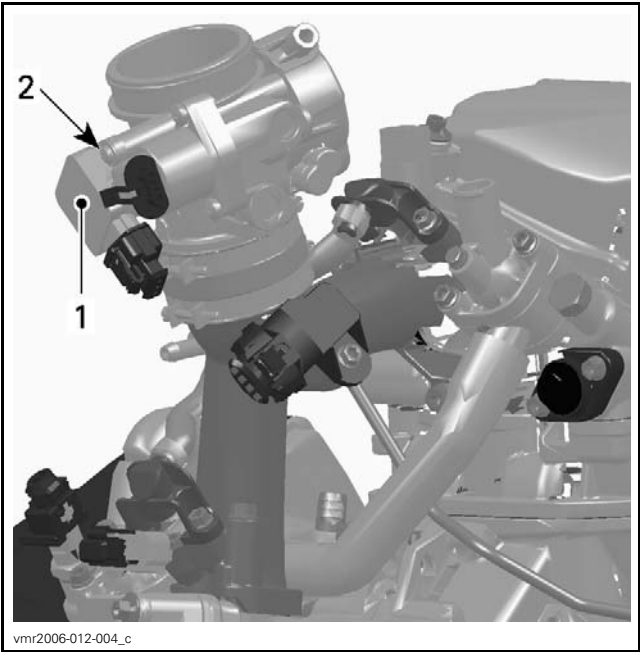
Replacing the TPS

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

Unplug connector from TPS.

Loosen TPS retaining screws.

Remove TPS.



- 1. TPS
- 2. Screws

Install the new TPS and tighten retaining screws to specification.

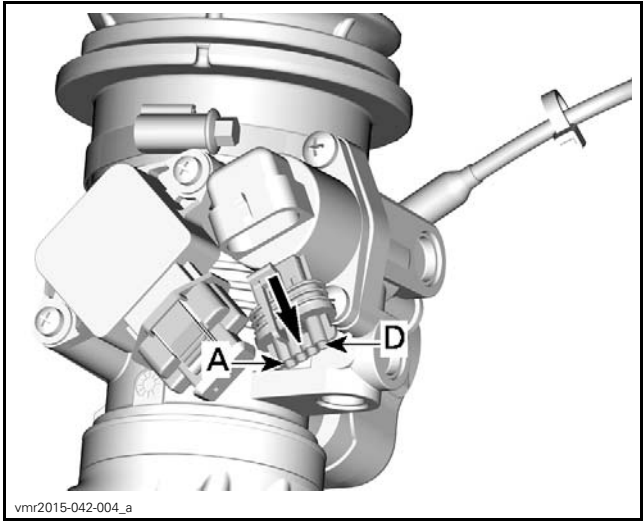
TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
TPS retaining screws	3 N•m (27 lbf•in)

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)

Refer to the applicable *ENGINE MANAGEMENT SYSTEM* subsection for component and connector locations.

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.

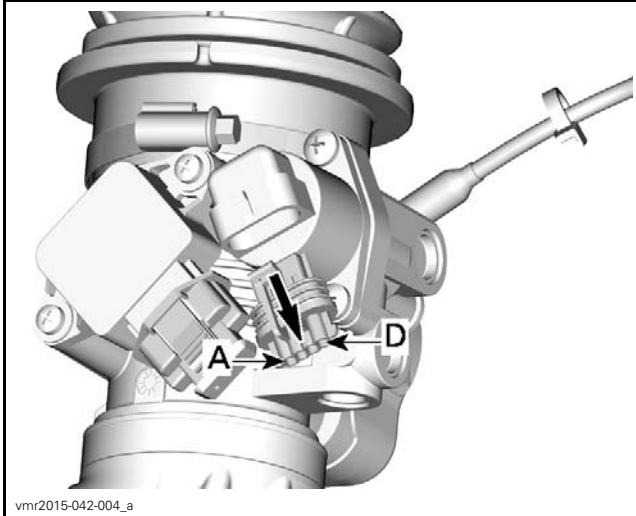
Testing the IACV Resistance

Disconnect IACV from the wiring harness.

Using a multimeter, check the resistance in both windings.

Check the resistance between pins as shown.

IDLE AIR CONTROL VALVE		MEASUREMENT
PIN		RESISTANCE (Ω) @ 20°C (68°F)
A	D	50 $\pm$ 5
B	C	



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.

Inspecting the IACV Visual

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

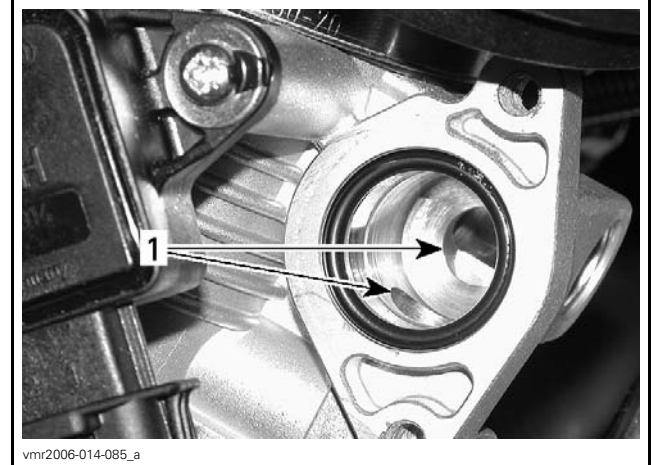
Remove Idle air control valve from throttle body.

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 blow compressed air to dry it.



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** and the **IACV CALIBRATION**. See procedures in this subsection.

IACV Calibration

The IACV calibration is required to avoid a potential erratic or frozen RPM needle.

1. Start the vehicle to increase engine temperature.
2. Let engine run at **idle** until the cooling fan performed a complete cycle (ON/OFF).
3. When the cycle is done, turn ignition key to OFF position.
4. The calibration is completed.

CRANKSHAFT POSITION SENSOR (CPS)

Refer to applicable *ENGINE MANAGEMENT SYSTEM* subsection for component and connector locations.

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 AND STARTER* subsections.

CPS Access

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

To reach the CPS connector, remove protector from engine.

Testing the CPS Resistance

Disconnect the ECM connector.

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Install ECM adapter tool on the ECM connector.
Using a multimeter, measure resistance as per table.

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

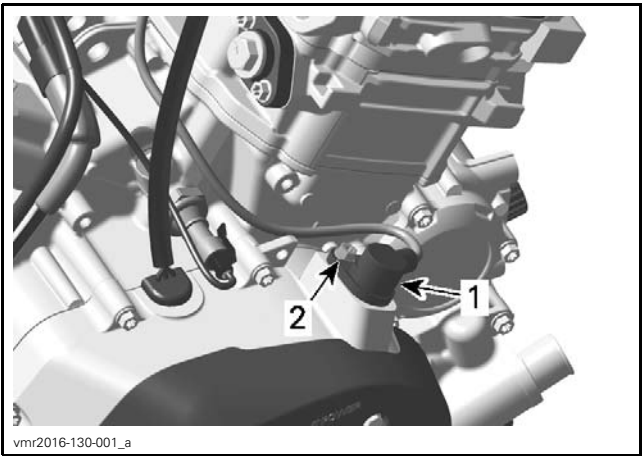
If resistance value is incorrect, check or repair the connectors and the wiring harness between ECM connector and the CPS. If resistance value is still incorrect, replace CPS.

Replacing the CPS

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.



- 1. CPS
- 2. Retaining screw

Lubricate O-ring of CPS.

O-RING	
Service product	XPS SYNTHETIC GREASE (P/N 293 550 010)

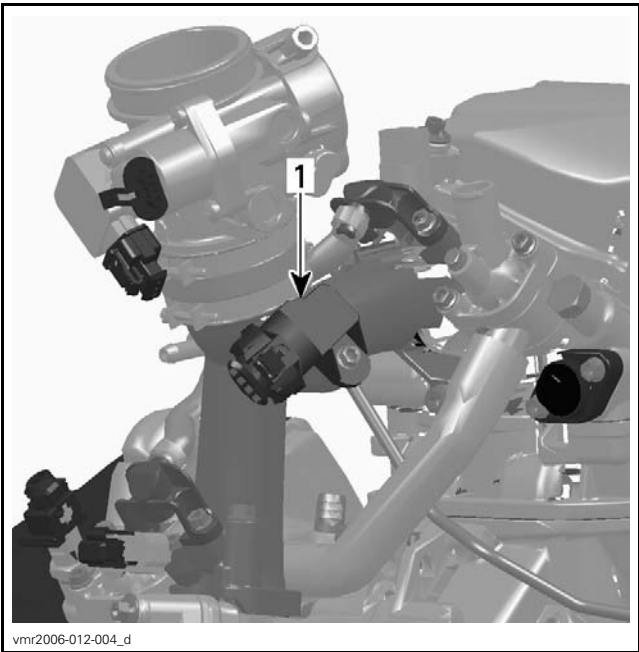
Install new CPS and secure harness with a new locking tie (as applicable).

Tighten CPS retaining screw to specification.

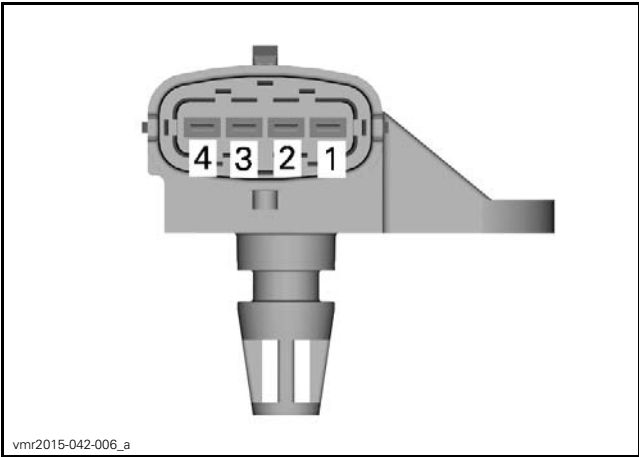
TIGHTENING TORQUE	
CPS retaining screw	10 N•m $\pm$ 1 N•m (89 lbf•in $\pm$ 9 lbf•in)

MANIFOLD ABSOLUTE PRESSURE AND TEMPERATURE SENSOR (MAPTS)

Refer to applicable *ENGINE MANAGEMENT SYSTEM* subsection for component and connector locations.



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

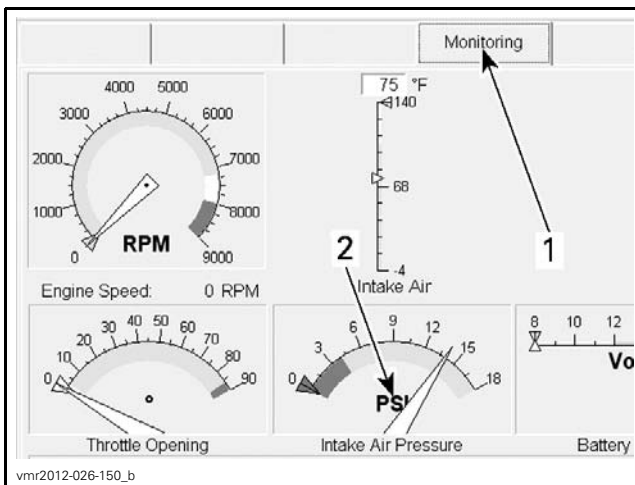
Before the engine is started, when power is applied to the system, the sensor measures the ambient air atmospheric pressure. The ambient pressure is, at that moment, stored in the ECM.

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:
 - **Monitoring** tab
 - **ECM** tab.



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		

Testing the MAPTS Input Voltage

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 multimeter 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)*.

Testing the MAPTS Circuit Continuity (Pressure Function)

1. Disconnect the ECM connector.
2. Install the ECM adapter tool on the ECM connector.
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.

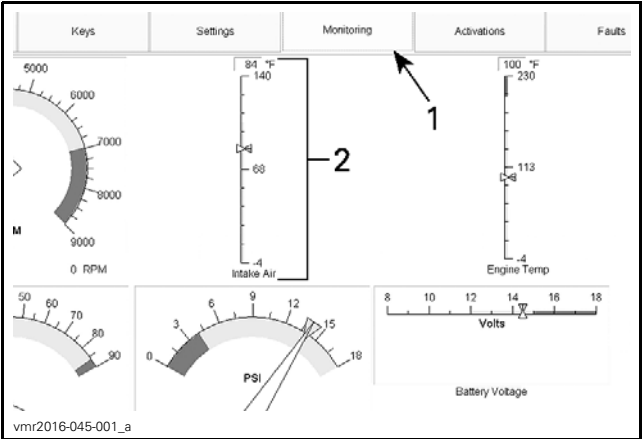
MAPTS Temperature Function

The sensor monitors the temperature in the intake manifold.

Testing the MAPTS Temperature Function

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

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- 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)*.

Testing the MAPTS Resistance (Temperature Function)

Disconnect the connector from the MAPTS.
Using a multimeter, 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 the ECM adapter tool on the ECM connector.

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

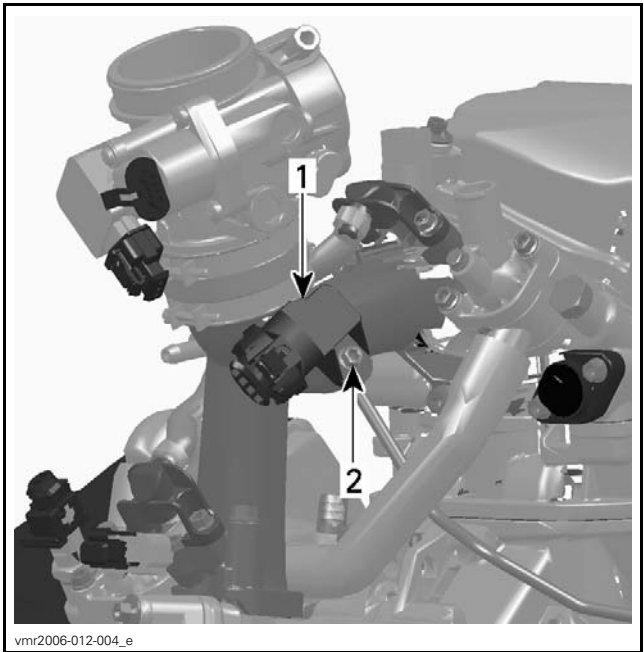
ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE Ω @ 20°C (68°F)
F3	G2	2280 - 2740

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		

Testing the MAPTS Circuit Continuity (Temperature Function)

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

Replacing the MAPTS



- 1. MAPTS
- 2. Retaining screw

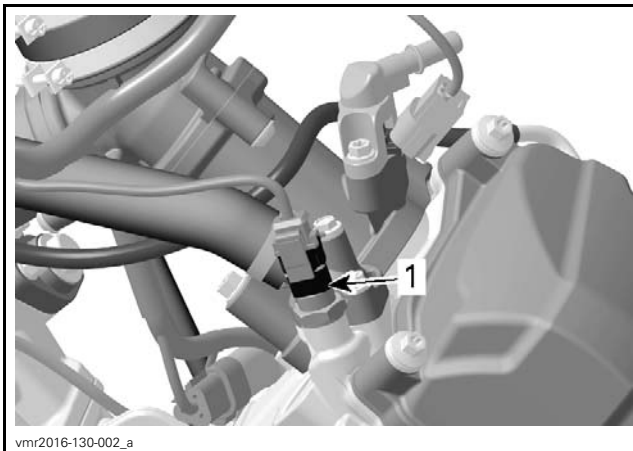
Disconnect MAPTS connector and remove the MAPTS.

Install new MAPTS as per following table.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
MAPTS retaining screw	6 N•m ± 0.7 N•m (53 lbf•in ± 6 lbf•in)

CTS (COOLANT TEMPERATURE SENSOR)

Refer to appropriate *ENGINE MANAGEMENT SYSTEM* subsection for component and connector locations.



1. CTS



LH SIDE OF VEHICLE
1. CTS

CTS Access

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



TYPICAL
1. Pull out

Testing the CTS Resistance

1. Disconnect the ECM connector.
2. Using the ECM adapter tool and a multimeter, check resistance values.

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.

Testing the CTS Circuit Continuity

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

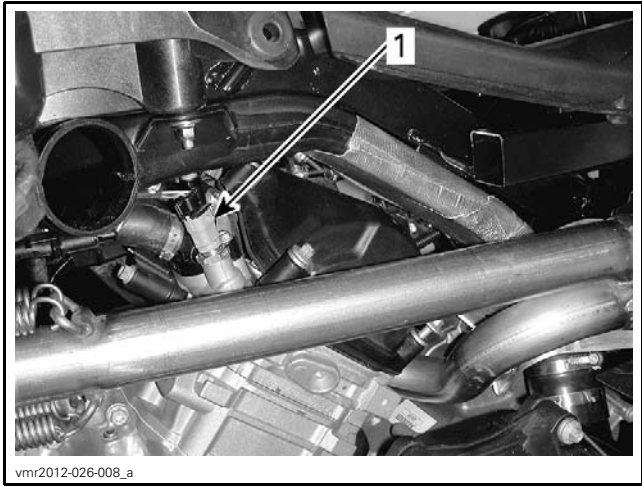
CTS CIRCUIT CONTINUITY TEST		
ECM ADAPTER	CTS CONNECTOR	RESISTANCE VALUE
Pin F4	Pin 1	Close to 0 Ω
Pin C3	Pin 2	

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

If resistance test is good, replace the CTS.

Replacing the CTS

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* subsection.



1. CTS
3. Disconnect CTS connector and remove CTS.
4. Install the new CTS and torque as specified.
- | TIGHTENING TORQUE | |
|-------------------|--|
| CTS | 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.