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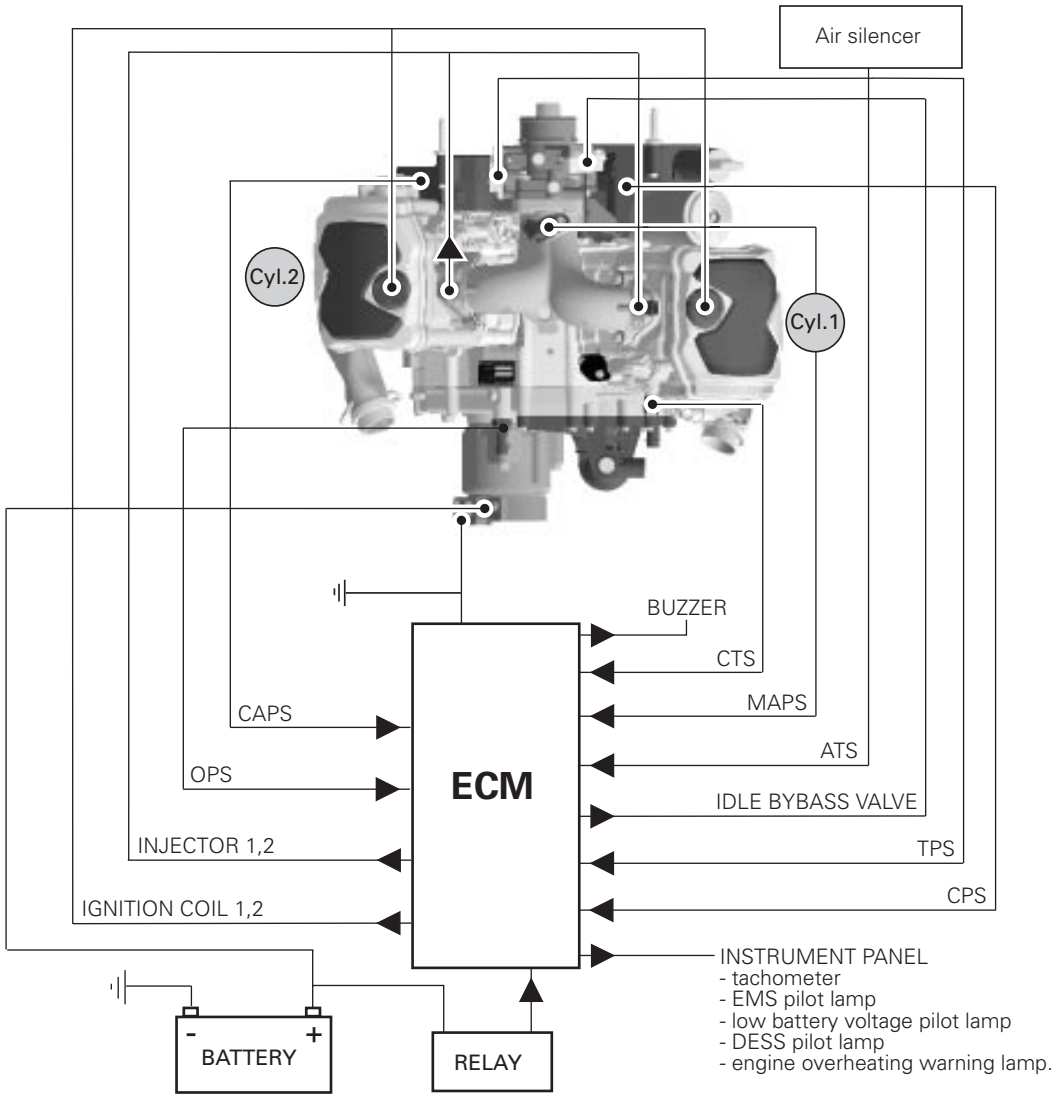
OVERVIEW

ENGINE MANAGEMENT SYSTEM - OVERVIEW
ROTAX 4-TEC 1004

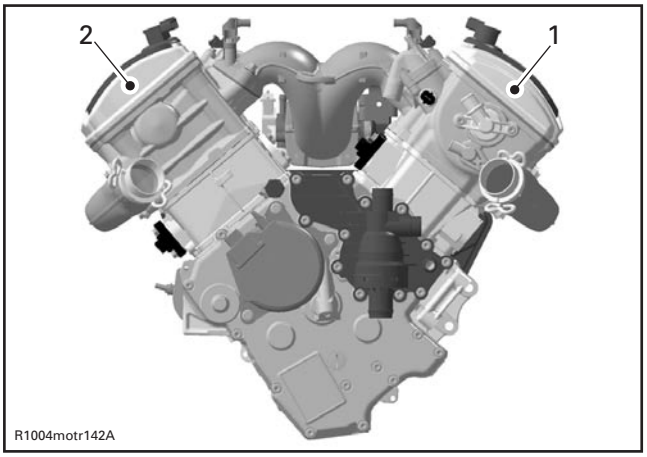


CPS	Crankshaft Position Sensor
TPS	Throttle Position Sensor
ATS	Air Temperature Sensor
CTS	Coolant Temperature Sensor
OPS	Oil Pression Switch
CAPS	Camshaft Position Sensor
MAPS	Manifold Air Pression Sensor
EMS	Engine Management System
ECM	Engine Control Module

OPERATING PRINCIPLE OF ENGINE MANAGEMENT

A highly advanced engine management system (EMS) has been used to ensure a high power output with cleanest combustion. The EMS calculates the proper air/fuel mixture and ignition timing for each cylinder separately. The fuel is injected into the intake port of each cylinder.

NOTE: On the 1004, the cylinders are referenced as **1** (front) and **2** (rear) instead of PTO and MAG.

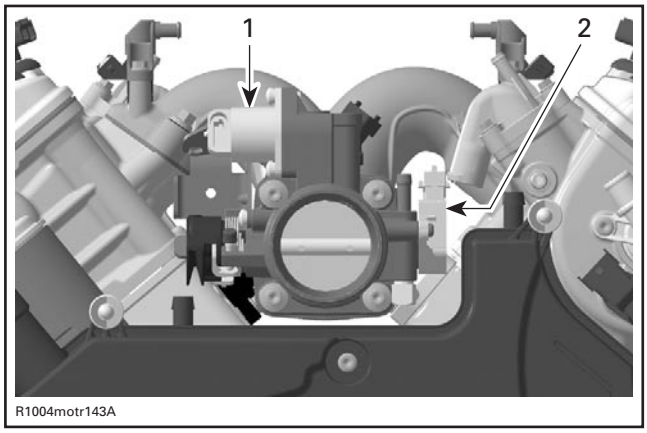


1. Cylinder 1
2. Cylinder 2

NOTE: "EMS" stands for engine management system. "EMS" includes an ECM (engine control module), sensors and injectors.

AIR INDUCTION

Through air filters, air goes into the air silencer. ECM measures at this point air temperature. Air pressure is measured directly in the intake manifold. Then, air for combustion is drawn through one 52 mm throttle body. The air flow is controlled by a throttle plate and an idle bypass valve respectively. The air continues through the intake manifold and goes into the cylinder head.



52 mm THROTTLE BODY

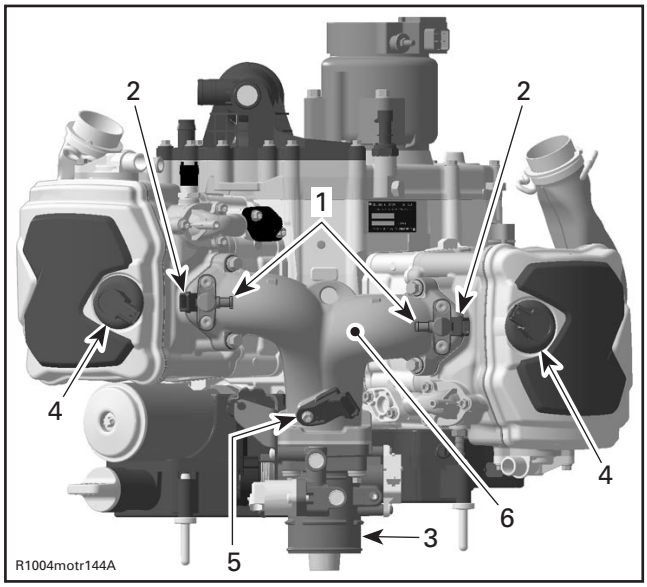
1. Idle bypass valve
2. Throttle position sensor (TPS)

FUEL DELIVERY SYSTEM

BASIC OPERATION

When the intake valve reaches the correct position, the ECM (engine control module) opens the fuel injector and fuel is discharged into the intake port at the air intake manifold by the high fuel pressure inside the fuel rail. The air/fuel mixture enters then the combustion chamber through the open intake valve. This mixture is then ignited by the spark plug.

INTAKE MANIFOLD



INTAKE MANIFOLD

1. Fuel rail
2. Injector
3. Throttle body
4. Ignition coil
5. Manifold air pressure sensor (MAPS)
6. Intake manifold

The intake manifold is mounted on the top of the engine on both cylinder heads. It provides support for the fuel injectors, the fuel rails MAPS (manifold air pressure sensor) and the throttle body. The air intake manifold is a resonator between the throttle body and the air intake at the cylinder heads.

Fuel Rail

Two fuel rails, one for each injector, are mounted on the intake manifold. The fuel rails ensure all the time, that enough fuel at the right pressure can be delivered to the fuel injectors. The fuel rails are fed by the fuel pump with a fuel pressure of approximately 400 kPa (58 PSI).

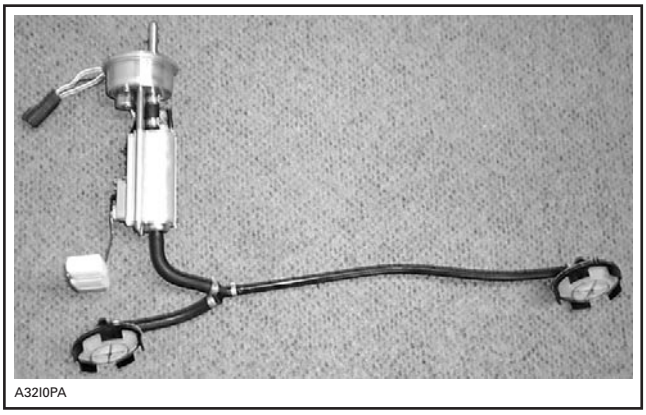
Fuel Injector

Two fuel injectors (one per cylinder) are used to inject fuel into the intake port of the cylinder head.

Throttle Body

It is a 52 mm heated throttle body mounted on intake manifold. Fitted on the throttle body, there is the TPS and the idle bypass valve which allows the ECM to control the RPM while the throttle plate is closed.

FUEL PUMP MODULE


A32I0PA

The fuel pump module is located inside the fuel tank. The module includes fuel pump, fuel pressure regulator and fuel level sensor.

Fuel Pump

It provides fuel pressure and flow rate to the system.

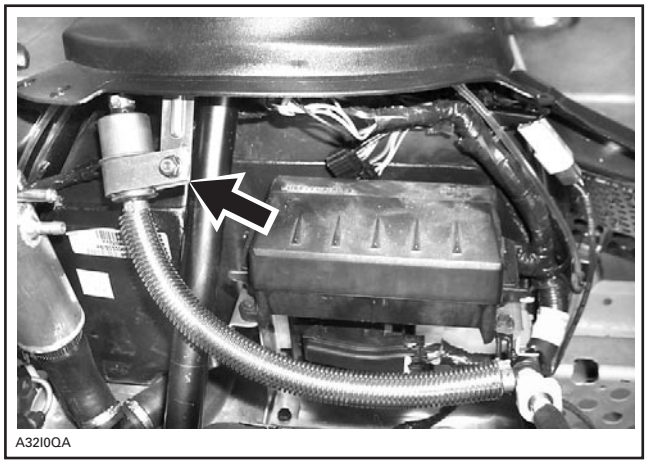
Fuel Pressure Regulator

A fuel pressure regulator controls the pressure in the system and allows excess fuel to return to the fuel tank. The fuel pressure regulator regulates the fuel pressure at approximately 400 kPa (58 PSI).

Fuel Pickups

Two fuel pickups come with 50 micron filter. One is located at the front right side of the fuel tank and the other at the rear left side.

In-Line Fuel Filter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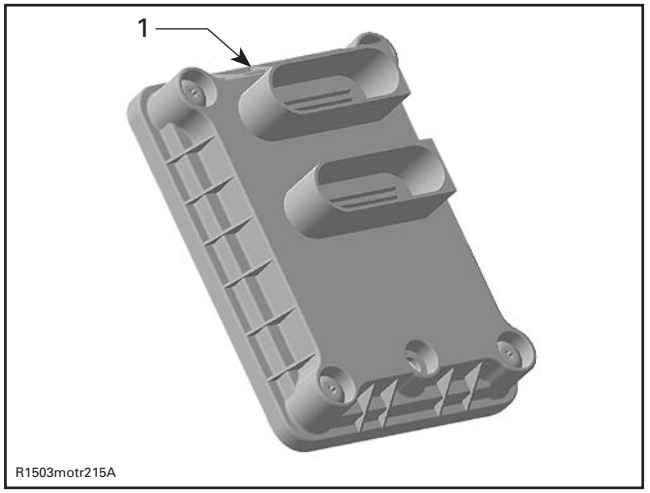
The in-line fuel filter is fastened under the steering console. It comes as a complete assembly.

ELECTRONIC MANAGEMENT

EMS (Engine Management System)

The engine management system is controlled by the ECM.



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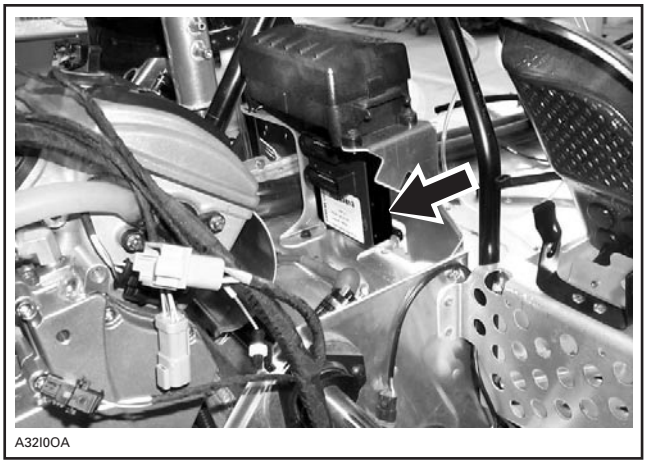
1. ECM

ECM

The ECM is located between the engine and the fuel tank, under the fuse box.

It controls all engine management functions, by processing the information given by various sensors.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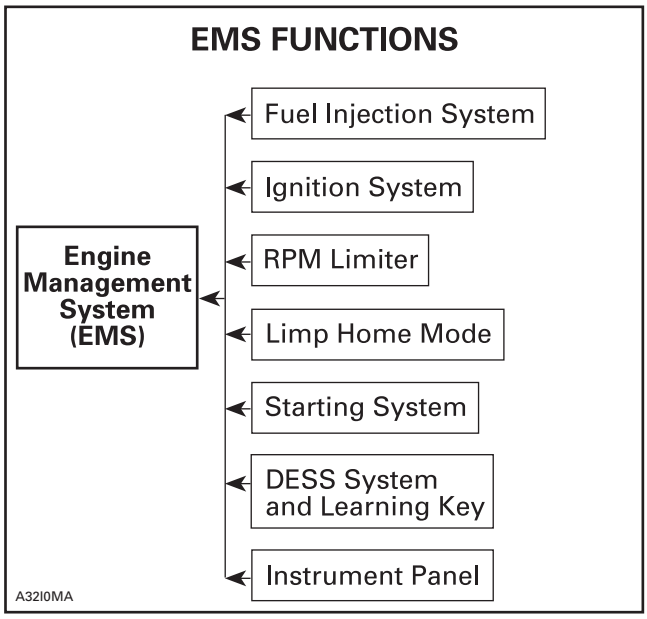


The ECM (engine control module) is directly powered by the battery. It is responsible for the following engine management/electrical functions:

– analysis of information
– distribution of information
– start/stop function
– timer
– DESS (Digitally Encoded Security System)
– ignition timing control
– injection control
– proper mapping (injection and ignition) for optimum engine operation in all conditions.
– engine RPM limiter
– etc.

The ECM features a permanent memory that will keep the programmed tether cord cap (s) active, fault codes and other engine information, even when the battery is removed from the vehicle.

EMS — GENERAL FUNCTIONS

Anti-Drive Feature

This system allows the engine to reach pulley engagement speed only if a programmed tether cord cap is installed on DESS post. See below for details.

Digitally Encoded Security System (DESS)

The following components are specially designed for this system: ECM, tether cord cap and DESS post.

The tether cord cap contains a magnet and a ROM chip. The magnet actually closes the reed switch inside the post which is the equivalent of a mechanical ON/OFF switch. The chip has a unique digital code.

NOTE: Actually, it is the memory of the ECM which is programmed to recognize the digital code of the tether cord cap. This is achieved with the VCK (Vehicle Communication Kit) P/N 529 035 676. Refer to B.U.D.S. help system to program a tether cord cap.

The system is quite flexible. Up to 8 tether cord caps may be programmed in the memory of the vehicle ECM. They can also be erased individually.

NOTE: If desired, a tether cord cap can be used on other vehicles equipped with the DESS. It only needs to be programmed for that vehicle.

The memory of the ECM features a self-diagnostic mode for the DESS operation. Refer to DIAGNOSTIC PROCEDURES section for more information.

The memory of the ECM is permanent. If the battery is disconnected, no information is lost.

Note that the DESS anti-drive circuitry is already activated on all new ECM.

Engine RPM Limiter

The ECM will limit the maximum engine speed.

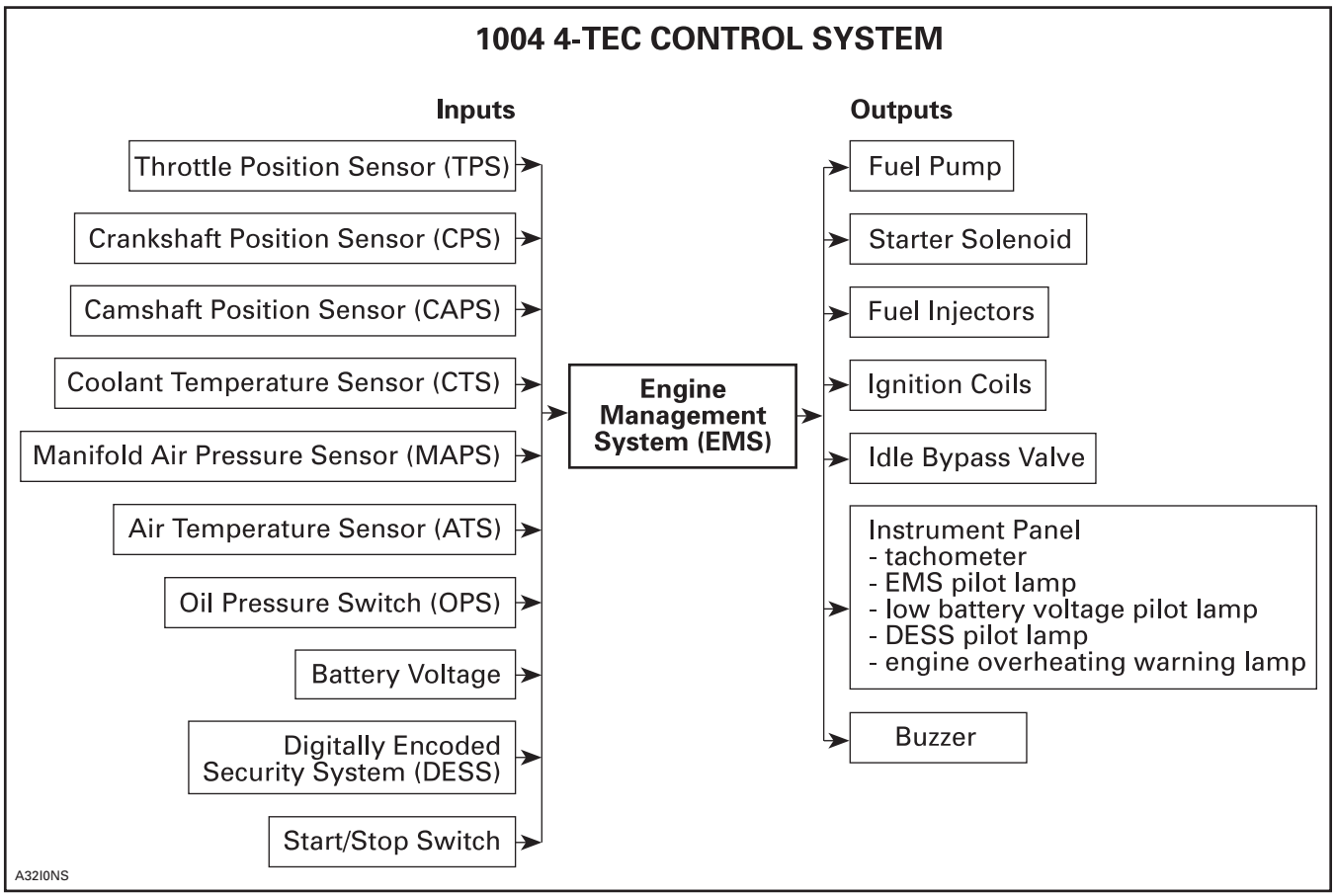
Low Oil Pressure Warning Device

When the oil pressure falls under a certain level, the low oil pressure lamp will be illuminated.

High Coolant Temperature Warning Device

When the coolant temperature is getting to high, the ECM sends out signals to the buzzer, the engine overheating warning lamp and to the EMS pilot lamp.

EMS — ENGINE MANAGEMENT FUNCTIONS



This engine management system controls both the fuel injection and the ignition timing.

As shown in the 1004 4-TEC CONTROL SYSTEM illustration, the ECM is the central point of the fuel injection system. It reads the inputs, makes computations, uses pre-determined parameters and sends the proper signals to the outputs for proper engine management.

The ECM also stores the fault codes and general information such as: operating conditions, vehicle hours, serial numbers, customer and maintenance information.

Electronic Fuel Injection

The ECM reads the signals from different sensors which indicate engine operating conditions at millisecond intervals.

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

The CPS, the ATS, the MAPS and the TPS are the primary sensors used to control the injection and ignition timing. Other sensors (like temperature sensors, etc.) are used for secondary input.

Ignition System

The ignition system is fully managed by the ECM which controls the ignition system parameters, such as spark timing, duration and firing in order to achieve the proper engine requirements.

Ignition Coils

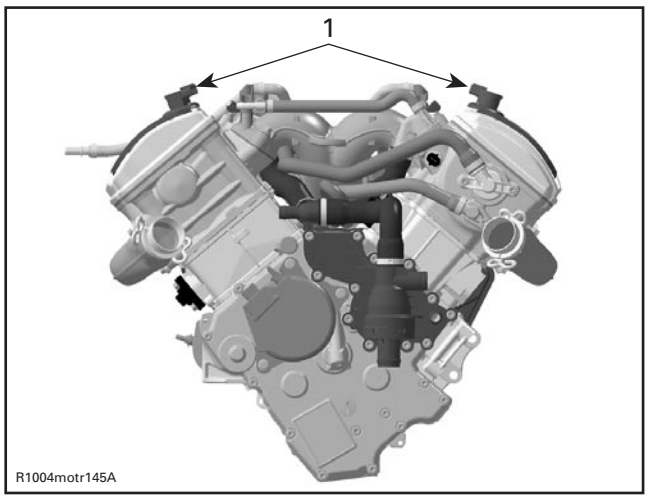
Two separate ignition coils induce voltage to a high level in the secondary windings to produce a spark at the spark plug.

The ignition coils receive input from the ECM. Each coil provides high voltage to its corresponding spark plug.

This ignition system allows spark plugs to spark independently.

NOTE: Ignition coil wires are not interchangeable due to different lengths of the wiring harness.

Both ignition coils are located on the cylinder heads directly on the spark plugs.



1. Ignition coils

Ignition Timing

The ECM is programmed with data (it contains ignition mappings) for optimum ignition timing under all operating conditions. Using engine operating conditions provided by the sensors, the ECM controls the ignition timing for optimum engine operation.There is no mechanical adjustment to perform.

Engine Modes of Operation

The ECM controls different operation modes of the engine to allow proper operation for all possible conditions: Cranking, start-up, idle, warm up, part load, full load, engine speed limiter, drowned engine and limp home (see below).

Flooded Engine (drowned mode)

If engine is fuel-flooded and does not start, this special mode can be activated to prevent fuel injection and ignition while cranking. Proceed as follows to activate it.

With tether cord cap on its post while engine is stopped, press and HOLD throttle lever at WOT position.

Press the start button. The mode is now on.

Releasing throttle lever will bring back the normal mode.

If engine does not start, it may be necessary to remove spark plugs and crank engine with rags over spark plug holes. Refer to COMPONENT INSPECTION AND ADJUSTMENT subsection.

⚠ WARNING

When disconnecting coil from spark plug, always disconnect coil from main harness first. Never check for engine ignition spark from an open coil and/or spark plug in the engine compartment as spark may cause fuel vapor to ignite.

Limp Home Modes

Besides the signals as seen above, the ECM may automatically set default parameters to the engine management to ensure the adequate operation of the vehicle if a component of the fuel injection system is not operating properly.

Sensor failures will not lead to a limp home mode, warning will follow through the EMS pilot lamp and the buzzer.

When minor fault occurs, the fault and message/ buzzer disappear automatically when the condition no longer exists.

Releasing throttle and letting the engine returning at idle speed may allow normal operation to come back. If it does not work, try removing and reinstalling the tether cord cap on its post.

These performance-reduced modes allow the rider to go back home which would not be possible without this advanced system. Refer to the DIAGNOSTIC PROCEDURES for a complete chart.

Shutdown Mode

ECM will shut down all outputs 5 seconds after the tether cord cap is removed.

If the tether cord cap is still on DESS post but the engine is turned off using engine cut-out switch, the ECM will shut down all outputs after 30 seconds.

Diagnostic Mode

The malfunctions are recorded in the memory of the ECM. The memory of the ECM can be checked using the VCK (Vehicle Communication Kit) (P/N 529 035 676) to see the fault codes.

The ECM and the VCK are able to communicate through a connector on the vehicle. Refer to the DIAGNOSTIC PROCEDURES section. B.U.D.S. Version G2.00 or P2.00 and up must be used for this system.

Monitoring System

The ECM monitors the electronic components of the fuel injection system and also the electrical system. When a fault occurs, it sends visual messages through the referring LED and/or audible signals through a buzzer to inform you of a particular condition. Refer to the DIAGNOSTIC PROCEDURES section for the LED and the buzzer coded signals chart.

COMPONENT INSPECTION AND ADJUSTMENT

GENERAL

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

It is important to ensure that the mechanical integrity of the engine/propulsion system is present:

– good transmission system operation

– good engine compression and properly operating mechanical components, no leaks etc.

– fuel pump connection and fuel lines without leaks.

Check the chart in TROUBLESHOOTING section to have an overview of problems and suggested solutions.

When replacing a component, always check its operation after installation.

FUEL SYSTEM

⚠ WARNING

The fuel system of a fuel injection system holds much more pressure than on a carbureted snowmobile. Prior to disconnecting a hose or to removing a component from the fuel system, follow the recommendation described here. Pay attention that some hoses may have more than one clamp at their ends. Ensure to reinstall the same quantity of clamps at assembly.

– Use the VCK (Vehicle Communication Kit) (P/N 529 035 676) to release the fuel pressure in the system. Look in the **Activation** section of the software B.U.D.S.

⚠ 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 and work in a well ventilated area. Do not allow fuel to spill on hot engine parts and/or on electrical connectors. Proceed with care when removing/installing pressure test equipment or disconnecting fuel line connections. Use the VCK (Vehicle Communication Kit) to release fuel pressure prior to removing a hose. Cover the fuel line connection with an absorbent shop rag. Slowly disconnect the fuel hose to minimize spilling. Wipe off any fuel spillage in the engine compartment. Fuel is flammable and explosive under certain conditions. Always work in a well ventilated area. Always disconnect battery prior to working on the fuel system. After performing a pressure test, use the valve on the fuel pressure gauge to release the pressure (if so equipped).

– Always disconnect battery properly prior to working on the fuel system. Refer to BATTERY section.

When the job is done, ensure that hoses from fuel rail going to fuel pump are properly secured in their supports. Then, pressurize the fuel system. Perform the pressure test as explained in this section and pressurize the fuel tank and fuel lines as explained in FUEL SYSTEM section.

Properly reconnect the battery.

⚠ WARNING

Ensure to verify fuel line connections for damage and that NO fuel line is disconnected prior to installing the tether cord cap on the DESS post. Always perform the pressure test if any component has been removed. A pressure test must be done before connecting the tether cord cap. The fuel pump is started each time the tether cord cap is installed and it builds pressure very quickly.

To check fuel rails for leaks, first pressurize the system then spray soapy water on all hose connections, regulators and injectors. Air bubbles will show the leaking area. Check also for leaking fuel or fuel odor.

⚠ WARNING

Never use a hose pincher on injection system high pressure hoses.

ELECTRICAL SYSTEM

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

– battery
– fuses
– DESS
– ignition (spark)
– ground connections
– wiring connectors.

It is possible that a component seems to operate in static condition but in fact, it is defective. In this case, the best way to solve this problem is to remove the original part and replace it with one which is in good condition.

Never use a battery charger to substitute temporarily the battery, as it may cause the ECM (engine control module) to work erratically or not to work at all. Check related-circuit fuse solidity and condition with an ohmmeter. Visual inspection could lead to false results.

⚠ WARNING

All electrical actuators (idle bypass valve, injectors, fuel pump, ignition coils and starter solenoid) are permanently supplied by the battery when the VCK (Vehicle Communication Kit) is connected to the diagnostic connector of the engine wiring harness and the tether cord cap is installed. Always disconnect the battery prior to disconnecting any electric or electronic parts.

To perform verifications, a good quality multimeter such as Fluke 111 (P/N 529 035 868) should be used.

Pay particular attention to ensure that pins are not out of their connectors or out of shape. The troubleshooting procedures cover problems not resulting from one of these causes.

⚠ WARNING

Ensure all terminals are properly crimped on wires and connector housings are properly fastened.

Before replacing an ECM, always check electrical connections. Make sure connectors are properly crimped on wires and fastened in housing, and that they are free of corrosion. Ensure proper electrical connection. Particularly check ECM ground connections. Ensure that contacts are good and clean. A "defective module" could possibly be repaired simply by unplugging and replugging the ECM. The voltage and current might be too weak to go through dirty wire pins. Check carefully if pins show signs of moisture, corrosion or if they look dull. Clean pins properly and then coat them prior to assembling as follows:

Ensure that all electronic components are genuine — any modification on the wiring harness may lead to generate fault codes or bad operation.

NOTE: For diagnostics purposes, use Vehicle Communication Kit (VCK). See DIAGNOSTIC PROCEDURES subsection.

After a problem has been solved, ensure to clear the fault(s) in the ECM using the VCK. Refer to DIAGNOSTIC PROCEDURES subsection.

Resistance Measurement

When measuring the resistance with an ohmmeter, all values are given for a temperature of 20°C (68°F). The resistance value of a resistance varies with the temperature. The resistance value for usual resistor or windings (such as injectors) **increases** as the temperature increases. However, our temperature sensors are NTC types (Negative Temperature Coefficient) and work the opposite which means that the resistance value **decreases** as the temperature increases. Take it into account when measuring at temperatures different from 20°C (68°F). Use this table for resistance variation relative to temperature for **temperature** sensors.

TEMPERATURE		RESISTANCE (ohms)		
°C	°F	NOMINAL	LOW	HIGH
- 30	- 22	12600	11800	13400
- 20	- 4	11400	11000	11800
- 10	14	9500	8000	11000
0	32	5900	4900	6900
10	50	3800	3100	4500
20	68	2500	2200	2800
30	86	1700	1500	1900
40	104	1200	1080	1320
50	122	840	750	930
60	140	630	510	750
70	158	440	370	510
80	176	325	280	370
90	194	245	210	280
100	212	195	160	210
110	230	145	125	160
120	248	115	100	125

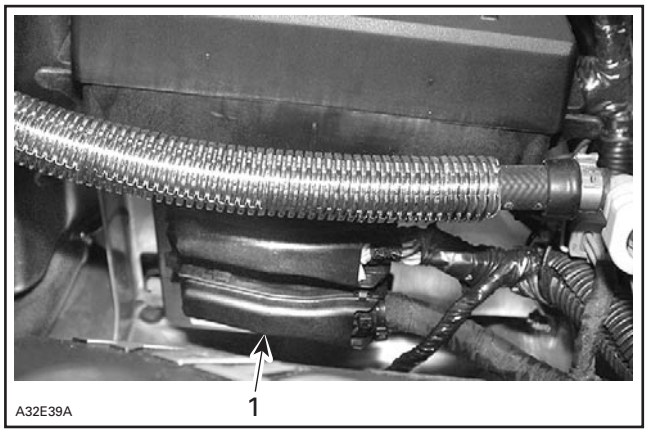
CONVERSION CHART FOR TEMPERATURE SENSORS

The resistance value of a temperature sensor may test good at a certain temperature but it might be defective at other temperatures. If in doubt, try a new sensor.

Also remember this validates the operation of the sensor at room temperature. It does not validate the over temperature functionality. To test it, the sensor could be removed from the engine and heated with a heat gun while it is still connected to the harness to see if the ECM will detect the high temperature condition and generate a fault code.

ENGINE CONNECTOR PIN-OUTS

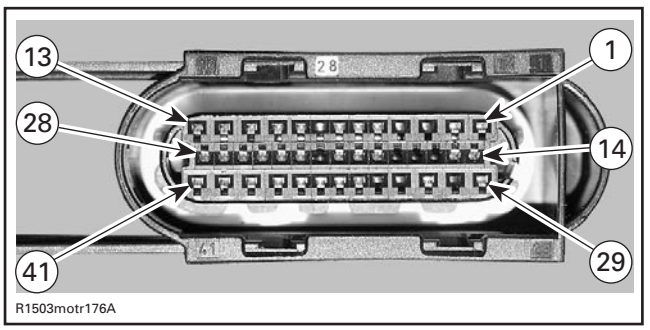
Connector Position



1. ECM connector A

ECM Connector

Use this diagram to locate the pin numbers on the ECM connector A of the wiring harness when performing tests.



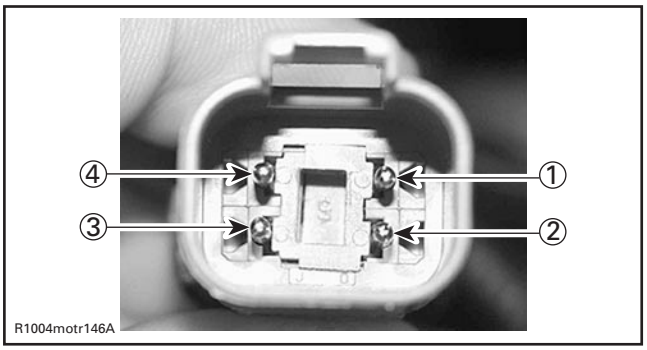
ECM CONNECTOR PIN-OUT (WIRING HARNESS SIDE)

CAUTION: Probe on top of terminal only. Do not try to probe inside terminal or to use a paper clip to probe inside terminal, it can damage the square-shaped terminal.

CAUTION: Do not disconnect the ECM connector needlessly. They are not designed to be disconnected/reconnected repeatedly.

Engine Connector

Use this diagram to locate the pin numbers on the Engine connector of the wiring harness when performing tests.

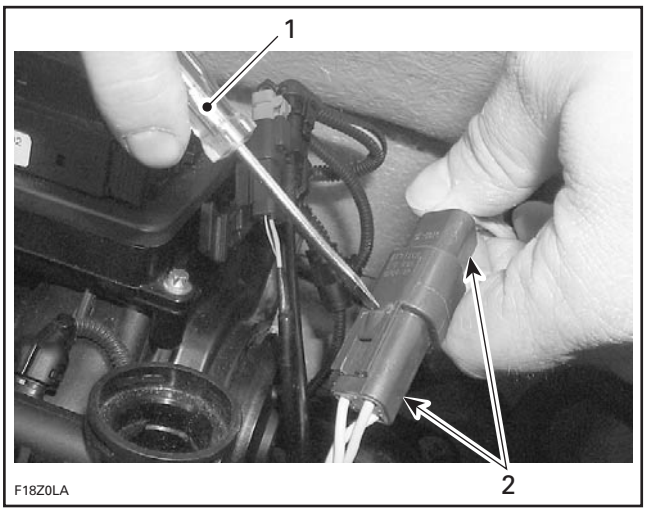


ENGINE CONNECTOR PIN-OUT (WIRING HARNESS SIDE)

CONNECTORS ON ENGINE

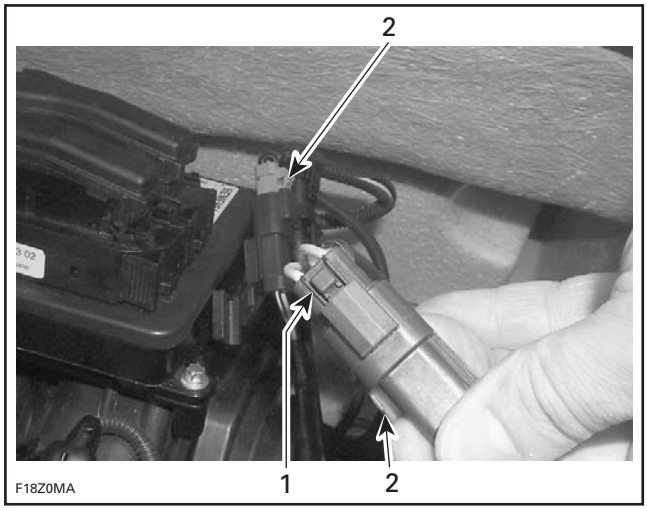
Removal

To disconnect two connectors, slide a flat screwdriver between each of them. To disengage, press the release button and disconnect them.



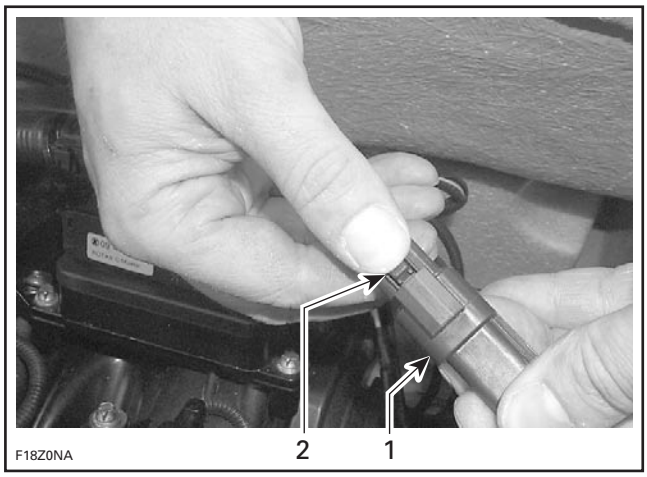
TYPICAL

1. *Flat screwdriver*
2. *Connectors*



TYPICAL

1. *Release button*
2. *Connectors*

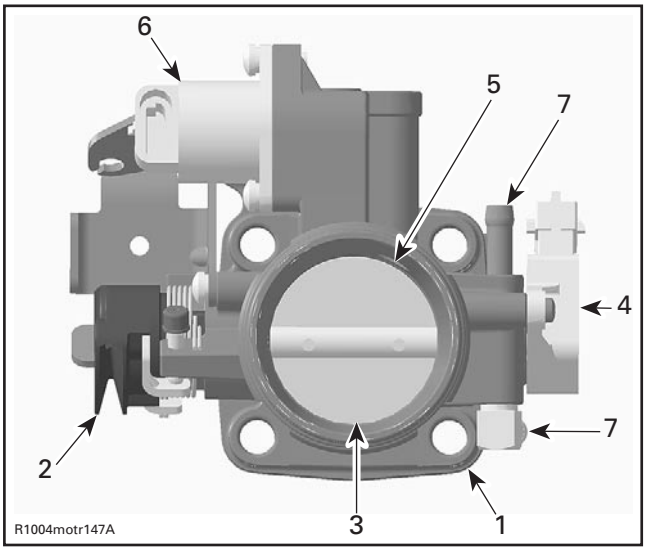


TYPICAL

1. *Connector*
2. *Press release button*

AIR INDUCTION SYSTEM

THROTTLE BODY



1. *Throttle body*
2. *Throttle cable attachment*
3. *Throttle plate*
4. *TPS*
5. *Idle bypass channel*
6. *Idle bypass valve*
7. *Nipples for throttle body heating*

Mechanical Inspection

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

IMPORTANT: The throttle body is designed to be tamper proof. Changing the idle stop or modifying it in any way will not increase performance or change the idle speed but may cause poor startability and erratic idling.

Before replacing any part, check the following as these could be causing the fault. Perform the test while the engine is off.

– Throttle cable adjustment too tight. Not returning fully to idle stop.
– Throttle body idle set screw is loose or worn.
– TPS is loose.
– Idle bypass valve is loose.
– Corroded or damaged wiring or connectors.
– Throttle body has been replaced and the **Closed Throttle and Idle Actuator** reset has not been performed.
– ECM has been replaced and the **Closed Throttle and Idle Actuator** reset has not been performed.

Electrical Inspection

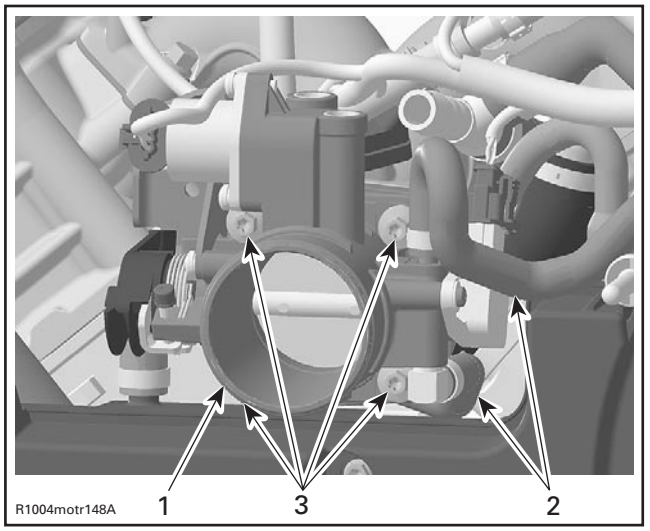
Refer to THROTTLE POSITION SENSOR (TPS) and IDLE BYPASS VALVE in ELECTRONIC MANAGEMENT below.

Replacement

Removal

To remove the throttle body from engine, proceed as follows:

– Disconnect air intake silencer from throttle body.
– Drain cooling system.
– Remove clamps and hoses for throttle body heating from nipples.
– Remove retaining screws of throttle body.



1. *Throttle body*
2. *Hoses*
3. *Screws*

– Slightly pull throttle body out.
– Disconnect connectors from idle bypass valve, and TPS.
– Disconnect throttle cable.

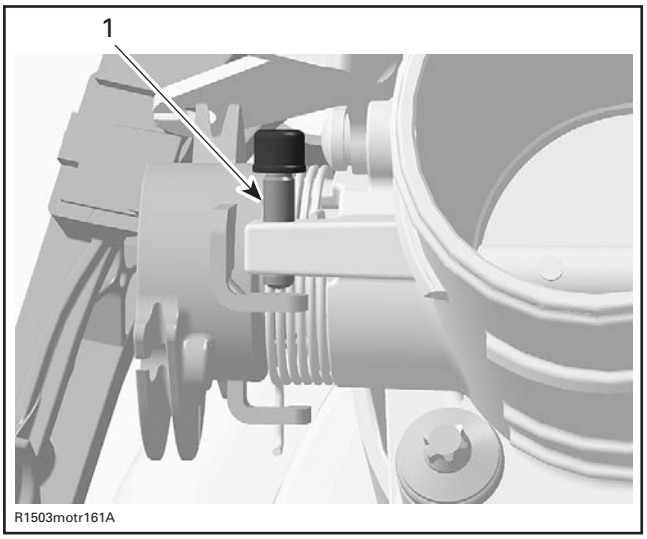
Installation

Installation of the new throttle body is the reverse of the removal procedure. Pay attention for the following details.

Refill and bleed the cooling system, refer to COOLING SYSTEM subsection.

For TPS and idle bypass valve replacement procedures, refer to the respective paragraph in ELECTRONIC MANAGEMENT below.

Adjustment



THROTTLE BODY
1. Idle stop screw

CAUTION: It is not allowed to perform any change on the idle stop screw.

The adjustment of the idle stop screw is optimized by the throttle body manufacturer and locked to prevent any modification.

CAUTION: Never attempt to adjust the idle speed through the throttle body tamper proof screw. If so, it would impair the idle speed stability. Besides, no adjustment could be performed by the dealer nor the factory to correct the idle speed. The throttle body would need to be replaced.

CAUTION: Do not alter or tamper with throttle cable adjustment or routing. It may cause poor start ability and erratic idling.

The only thing that has to be performed when the throttle body has been replaced is the **Closed Throttle and Idle Actuator** reset. Refer to THROTTLE POSITION SENSOR (TPS) in ELECTRONIC MANAGEMENT below.

Throttle Cable Adjustment

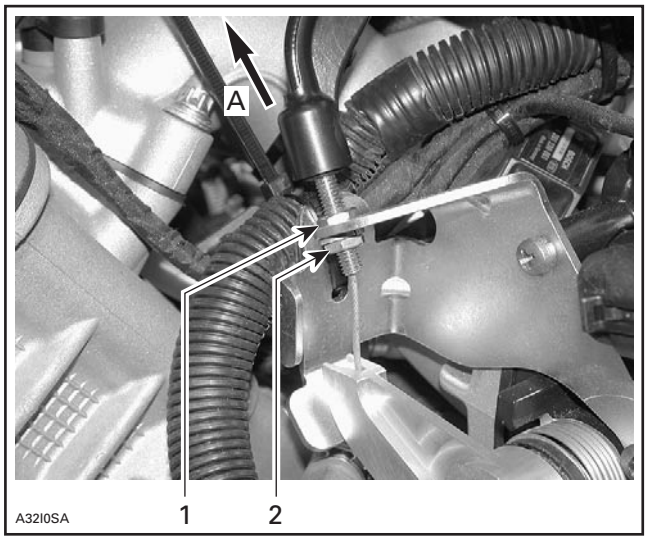
Mechanically adjust the throttle cable.

Handlebar and throttle cable must be at their normal position.

Apply full throttle.

Pull on throttle cable housing with a force of 50 N (11 lbf). Tighten top nut to 1 N•m (9 lbf•**in**).

Tighten bottom nut to 4.5 N•m (40 lbf•**in**).



WIDE OPEN THROTTLE POSITION
*1. Top nut torqued to 1 N•m (9 lbf•**in**)*
*2. Bottom nut torqued to 4.5 N•m (40 lbf•**in**)*
A. 50 N (11 lbf)

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

CAUTION: If there is no free-play at idle position, it may cause poor idling and start ability. 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.

Closed Throttle and Idle Actuator Reset

Perform the **Closed Throttle and Idle Actuator** reset as described in THROTTLE POSITION SENSOR (TPS) in ELECTRONIC MANAGEMENT below.

FUEL PUMP

Before proceeding to the pressure test ensure the battery is fully charged. Battery voltage must be over 12 volts.

Release the fuel pressure in the system using B.U.D.S. Look in the **Activation** tab.

⚠ WARNING

The fuel hose may be under pressure. Cover the fuel line connection with an absorbent shop rag. Slowly disconnect the fuel hose to release the pressure. Wipe off any fuel spillage inside engine compartment.

The pressure test will show the available pressure at the fuel pump outlet. It validates the pressure regulator, the fuel pump and leaks in the system.

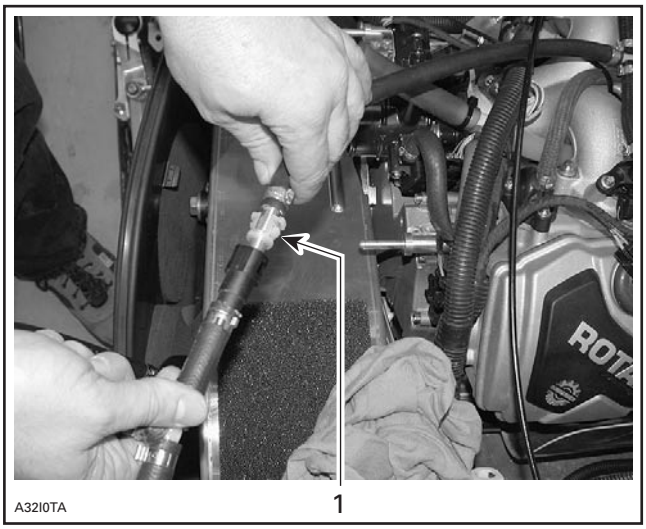
Ensure there is no leak from hoses and fittings. Repair any leak.

Ensure there is enough gas in fuel tank.

Disconnect outlet hose.

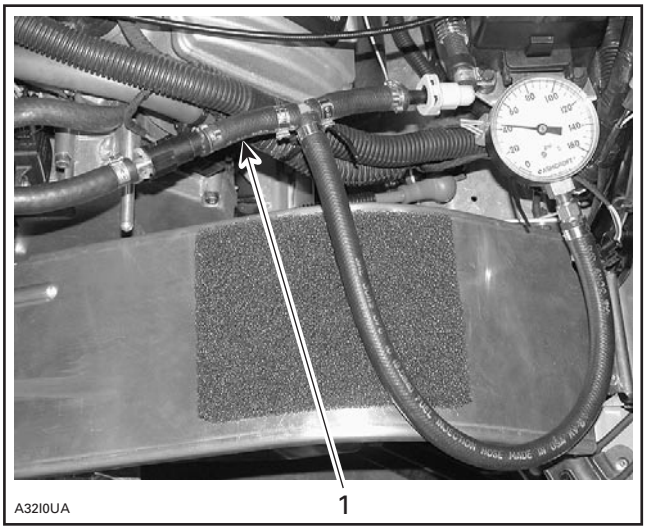
Remove plastic clip (P/N 275 500 429) from male fitting of pressure gauge (P/N 529 035 591).

Install the clip on male fitting of fuel rail inlet hose.



1. Clip installed on male fitting of fuel rail inlet hose

Install fuel pressure gauge (P/N 529 035 591) between disconnected hose (inline installation).



1. In-line installation of fuel pressure gauge

Remove tether cord cap. Depress start button and observe fuel pressure. **Do not crank engine.** Repeat twice. Release pressure using B.U.D.S. between tests so that the gauge is "reset" to zero (0).

FUEL PRESSURE (when depressing START button)
400 kPa (58 PSI)

Crank or start engine and observe fuel pressure. The fuel pressure should be the same as above.

If pressure is within limits, fuel pump and pressure regulator are working adequately.

A rapid pressure drop indicates leakage either from the fuel rail or from the fuel pump check valve. Check fuel rail for leaks. If it is not leaking then replace fuel pump.

A slow pressure drop indicates leakage either from the fuel injector or from the fuel pressure regulator. Check fuel injector for leaks (see below). If it is not leaking then replace fuel pump module.

Release fuel pressure in the system using B.U.D.S. Look in the **Activation** tab.

Remove pressure gauge and plastic clip from inlet hose. Reconnect inlet hose.

⚠ WARNING

Wipe off any fuel spillage in the engine compartment. Fuel is flammable and explosive under certain conditions. Always work in a well ventilated area.

Reinstall removed parts.

Electrical Test

When depressing start button, the fuel pump should run for 2 seconds to build up the pressure in the system.

If the pump does not work, disconnect the plug connector from the fuel pump.

Install a temporary connector to the fuel pump connector 6-PE. Apply 12 V (+ on pin 4 and - on pin 3) to this test harness.

If pump does not run, replace the fuel pump module.

Otherwise, probe terminals 3 and 4 of fuel pump connector 6-PE on vehicle harness side. When depressing start button, you should read battery voltage for approximately 2 seconds (then voltage will drop to approximately 11 V). If battery voltage is read, the problem can be in harness or in fuel pump connector. Repair or replace appropriate part.

Fuel Pump Module Replacement

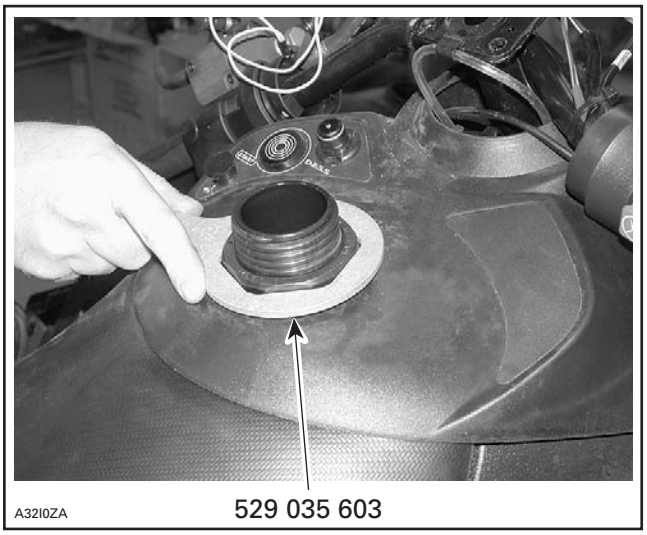
Removal

Open hood. Connect VCK (P/N 529 035 676). Use B.U.D.S. to release fuel pressure.

Drain fuel tank as much as possible.

Remove steering pad. Unbolt handlebar and move it forward.

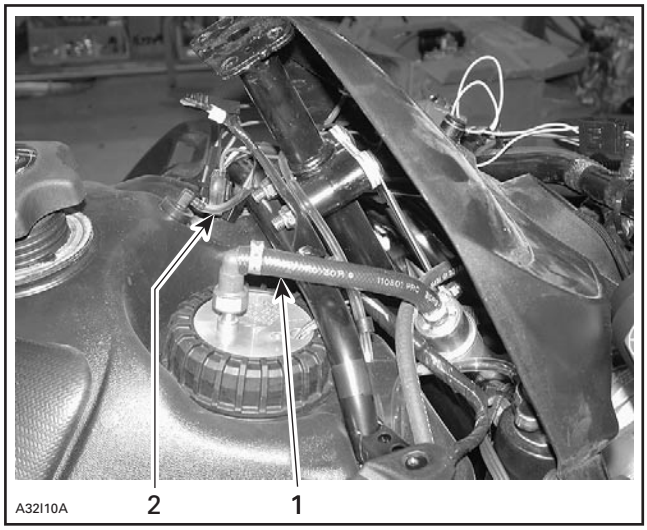
Unscrew fuel tank nut using wrench (P/N 529 035 603).



Unbolt console, then move it forward.

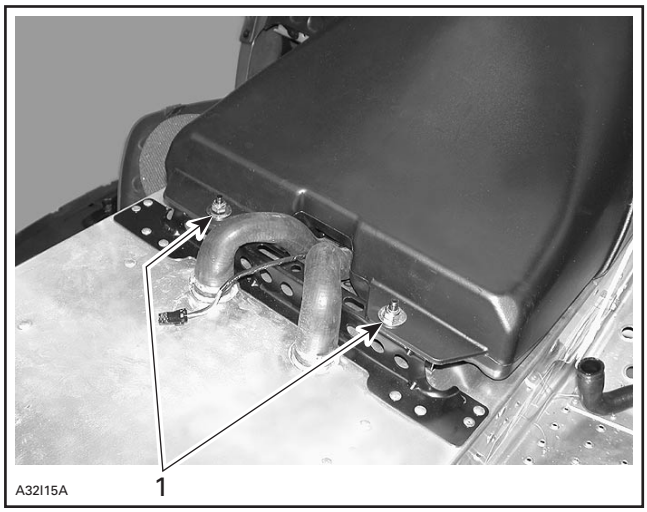
Disconnect fuel supply hose from fuel pump module.

Disconnect vent tube from vent elbow.



1. Fuel supply hose
2. Vent tube

Remove seat. Unbolt fuel tank.



1. Fuel tank retaining screws

Move fuel tank rearward, then unplug the fuel pump module electric connector.

With two screwdrivers holding the flange, unscrew fuel pump nut using fuel pump nut wrench (P/N 529 035 899).


A32I11A

Pull fuel pump module out of fuel tank to expose sensor body. Unclip retainer from sensor body, then remove float ass'y from sensor body.


A32I12A

FLOAT ASS'Y REMOVAL

Remove fuel pump module. Guide fuel pickups when pulling out fuel pickup hoses.

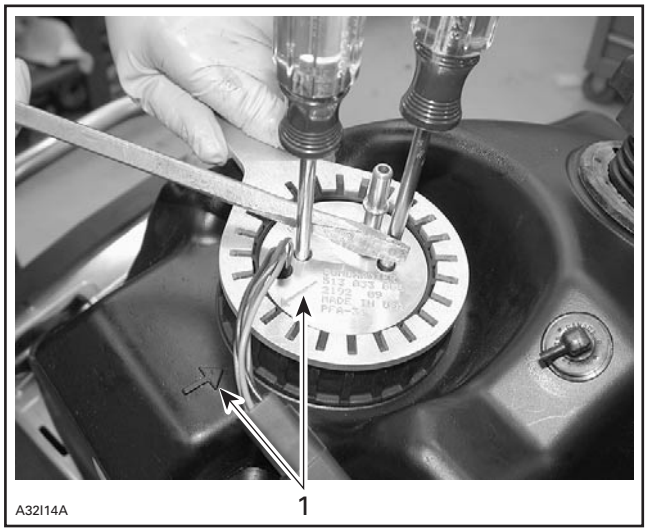

A32I13A

Installation

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

Align the arrow on fuel pump module with the one on fuel tank. Keep arrows aligned during fuel pump module nut tightening.

Install a torque wrench perpendicularly (90°) to fuel pump nut wrench (P/N 529 035 899). Torque fuel pump nut to 27 - 30 N•m (20 - 22 lbf•ft).



A32I14A

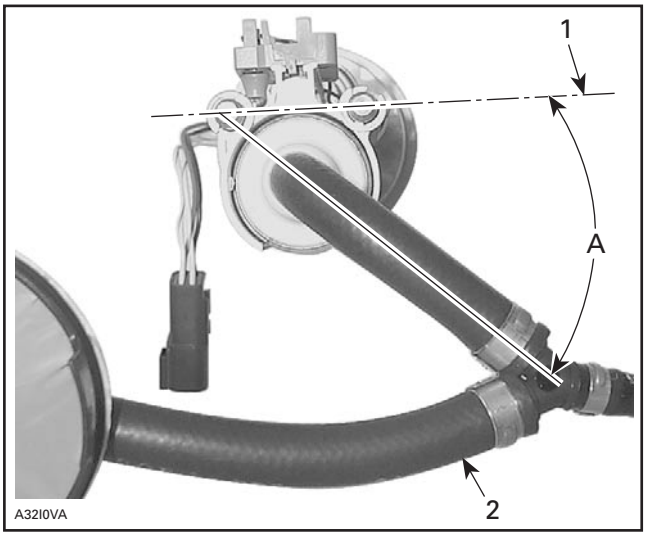
1. Arrows

Fuel Hose Kit (P/N 861 301 700)

Remove fuel pump module as explained above.

Unfasten blue hose clamp retaining old fuel hose ass'y to pump inlet nipple. Remove old fuel hose ass'y.

Install fuel hose ass'y to pump at an angle of 46 ± 3° from retaining rods axis.



1. Retaining rods axis
2. Fuel hose ass'y
A. 46 ± 3°

Install a new blue hose clamp on fuel hose ass'y.

Install a new gasket, then reinstall fuel pump module as explained above.

Resistor Card Ass'y Kit (P/N 861 301 800)

Remove fuel pump module as explained above.

Unclip retainer from sensor body, then remove float ass'y from sensor body.

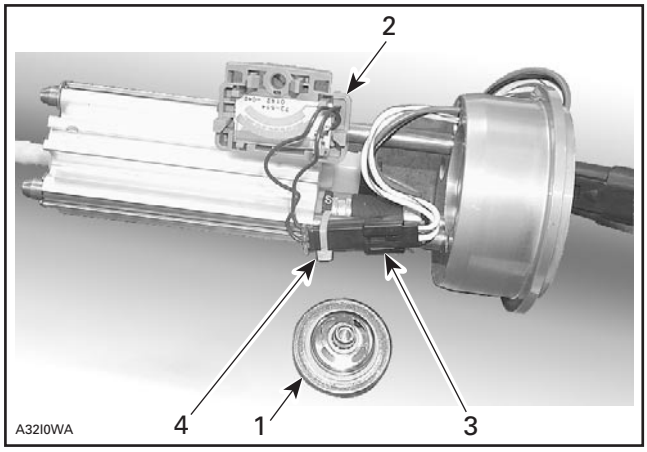
Loosen screw retaining lock plate. Slide lock plate out of aluminum extrusion.

Cut locking tie retaining electric connectors of resistor card ass'y. Unplug the connectors.

Remove regulator from pump module flange to make room for resistor card ass'y removal.

Slide old resistor card ass'y out of aluminum extrusion.

Reverse removal procedure for installation.



1. Fuel regulator removed
2. Resistor card ass'y ready to be installed
3. Connectors to be unplugged
4. Locking tie to be cut

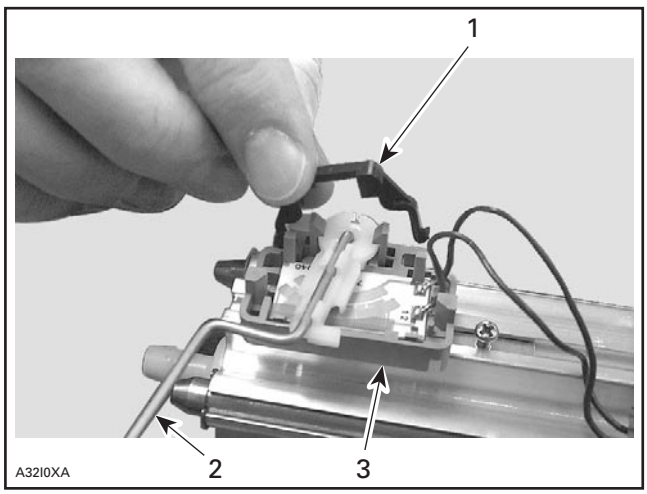
Install a new gasket, then reinstall fuel pump module as explained above.

Float Ass'y Kit (P/N 861 301 900)

Remove fuel pump module as explained above.

Unclip retainer from sensor body, then remove old float ass'y from sensor body.

Install new float ass'y on sensor body, then install new retainer.



1. Retainer
2. Float ass'y
3. Sensor body

Install a new gasket, then reinstall fuel pump module as explained above.

Pump Ass'y Kit (P/N 861 302 000)

Remove fuel pump module as explained above.

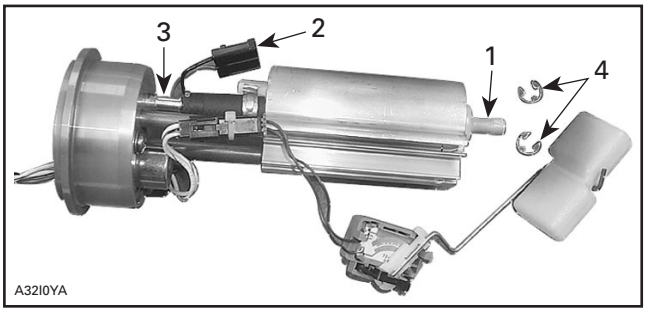
Disconnect fuel hose from pump inlet nipple.

Unlock and remove lock plate of resistor card ass'y.

Disconnect pump electric connector.

Disconnect pump outlet hose from pump module flange nipple.

Remove circlips. Slide pump ass'y out of retaining rods. Make sure that resistor card ass'y slides along the aluminum extrusion.



1. *Pump inlet nipple*
2. *Pump electric connector*
3. *Pump module flange nipple*
4. *Circlips*

Reverse removal procedure for installation.

Install a new gasket, then reinstall fuel pump module as explained above.

Regulator Kit (P/N 861 302 100)

Remove fuel pump module as explained above.

Remove 2 screws retaining regulator to pump module flange.

Remove regulator from pump module flange.

Replace O-rings with new ones. Install them in pump module flange bore.

CAUTION: Regulator O-rings must be installed in pump module flange bore.

Reverse removal procedure for installation.

Install a new gasket, then reinstall fuel pump module as explained above.

FUEL RAILS

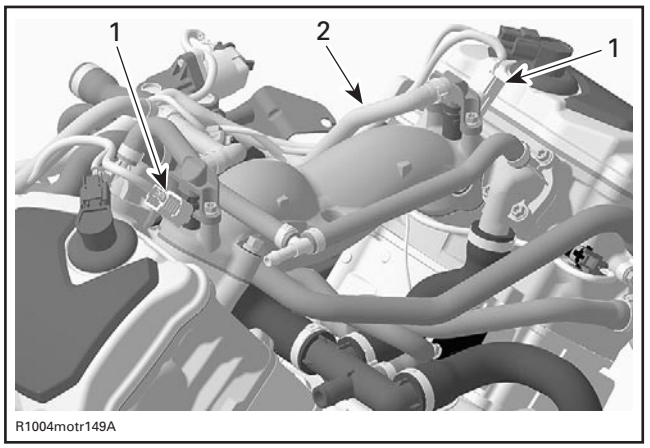
Pressure at fuel rails is supplied and controlled by the fuel pump module. Refer to FUEL PUMP for pressure test.

Fuel Rail Replacement

Removal

Release the fuel pressure in the system using B.U.D.S. Look in the **Activation** tab.

Wrap a rag around the hose end to prevent rail draining.



1. *Fuel injector connectors*
2. *Fuel hose*

Remove clamps and fuel hose from the fuel rails.

Disconnect wiring harness from the two fuel injectors.

Unscrew rail retaining screws.

Gently pull rail up by hand.

Pull rail out with fuel injector.

If necessary remove fuel injector as described below.

Installation

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

A thin film of injection oil should be applied to O-rings of fuel injectors to ease installation in intake manifold.

Tightening torque of the rail retaining screws is 10 N•m (89 lbf•**in**).

⚠ WARNING

Perform a fuel pressure test and ensure that there is no leak. Refer to FUEL PUMP above. Run engine and check for leaks.

FUEL INJECTORS

Leakage Test

To perform a leakage test, the injectors and fuel rails have to be removed from the engine.

NOTE: Do not detach injectors and fuel rails from the intake manifold. Remove complete intake manifold with installed fuel rails and injectors to perform this test.

Reconnect the fuel line and the wiring harness.

Place each injector in a clean bowl.

Install the tether cord cap on the DESS post and push start button, without cranking the engine, to activate the fuel pump.

Check for fuel leakage from the injector nozzle. There should be less than 1 drop per minute. Perform the test for 2 minutes.

If not within specification, replace the fuel injector(s).

The leakage test is validated when performing the FUEL DELIVERY SYSTEM DIAGNOSTIC FLOW CHART elsewhere in this section.

Electrical Test

Tether cord cap must be on DESS post.

Using the vehicle communication kit (VCK) with the B.U.D.S. software, energize the fuel injector from the **Activation** section.

If the injector does not work, disconnect the plug connector from the injector.

Install a temporary connector to the injector with wires long enough to make the connection outside the engine compartment and apply voltage (12 V) to this test harness.

This will validate the injector mechanical and electrical operation.

If it does not work, replace it.

Using B.U.D.S., activate injector while probing pin 2 (of injector on harness side) and battery ground.

a. If 12 V is read, check continuity of circuit as per following table. If it is good, try a new ECM.

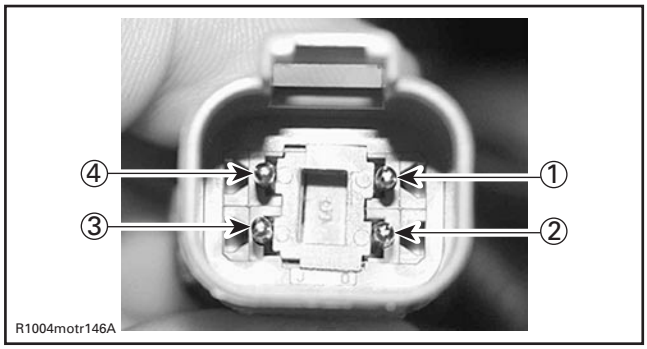
CIRCUIT NUMBER (ECM connector "A")	INJECTOR NUMBER
A-15	1
A-33	2

b. If it does not read 12 V, check continuity of circuit between pin 2 (of injector on harness side) and the corresponding fuse. If continuity is faulty, repair wiring harness.

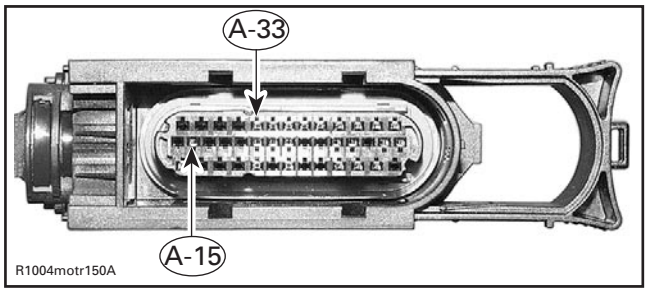
If not, check the resistance of the fuel injector circuit.

Reconnect the injector and disconnect the ECM connector A ECM.

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



ENGINE CONNECTOR



ECM CONNECTOR

COMPONENT	CONTACT LOCATION
Fuel injector cylinder 1	1 (Engine Connector) and A-15 (ECM Connector)
Fuel injector cylinder 2	2 (Engine Connector) and A-33 (ECM Connector)

The resistance should be between 13.8 and 15.2 Ω.

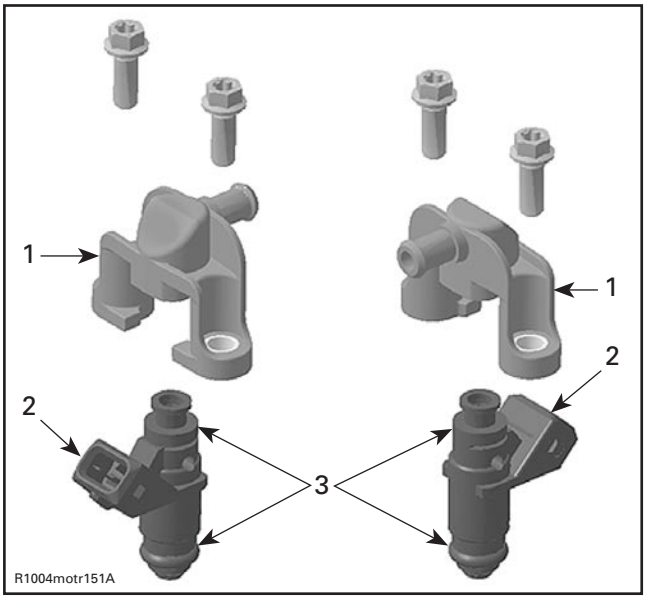
If resistance value is correct, try a new ECM. Refer to ECM REPLACEMENT procedures elsewhere in this section.

If resistance value is incorrect, repair the wiring harness/connectors or replace the wiring harness between ECM plug connector and fuel injector.

Fuel Injector Replacement

Removal

Before removing the injector, the fuel rail has to be removed from the engine. Refer to REMOVAL in FUEL RAIL REPLACEMENT for the procedure.



FUEL RAIL ASS'Y

1. *Fuel rail*
2. *Fuel injector*
3. *O-ring*

The fuel injector can be easily pulled out of the fuel rail.

Installation

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

Install new O-rings, if you reinstall a used injector then insert the fuel injector in place with your hand. Do not use any tool.

NOTE: A thin film of engine oil should be applied to O-rings to ease insertion in rail.

Tightening torque of the rail retaining screws is 10 N•m (89 lbf•**in**).

⚠ WARNING

Perform a fuel pressure test and ensure that there is no leak. Refer to FUEL PUMP above. Run engine and check for leaks.

ELECTRONIC MANAGEMENT

ECM REPLACEMENT

General

Prior to replacing a possibly faulty ECM, ensure that all the recommendations in the general introduction of this section have been carried out.

IMPORTANT: When the ECM is replaced, the tether cord cap(s) and the **Closed Throttle and Idle Actuator** must be reprogrammed/reset. Refer to their specific section for adjustment.

To allow transferring the previous recorded information from the old ECM to the new one, use the vehicle communication kit (VCK) with the B.U.D.S. software. Use **Replace** ECM in the ECM menu. Follow instructions in its help system.

NOTE: If the old ECM still works, its information must be read by B.U.D.S. before being removed from the vehicle in order to transfer vehicle information and history to the new ECM.

ECM Replacement

Disconnect battery cables.

⚠ WARNING

Battery BLACK negative cable must always be disconnected first and connected last.

Disconnect both EMS ECM connectors from EMS ECM.

Unscrew all retaining screws and remove the ECM from vehicle.

Install the new ECM to the vehicle.

Reconnect ECM connectors to ECM, and then battery cables.

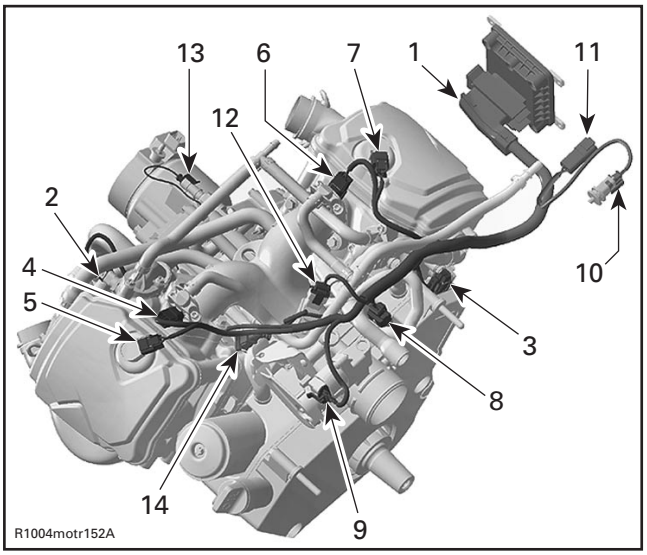
Transfer the data from the previous ECM to the new one using B.U.D.S. then proceed with the required resets and reprogram tether cord cap(s), if you were unable to transfer the data.

NOTE: If data cannot be transferred, manually enter information in **Vehicle** tab.

After performing the required resets, ensure to clear all faults from the newly replaced ECM.

Start the engine and increase engine speed above 5000 RPM to be sure no fault appears.

ENGINE WIRING HARNESS



1. ECM connector A
2. CTS connector
3. CAPS connector
4. Fuel injector connector (cylinder 1)
5. Ignition coil connector (cylinder 1)
6. Fuel injector connector (cylinder 2)
7. Ignition coil connector (cylinder 2)
8. TPS connector
9. Idle bypass valve connector
10. ATS connector
11. Engine connector
12. MAPS connector
13. OPS connector
14. CPS connector

Resistance Test

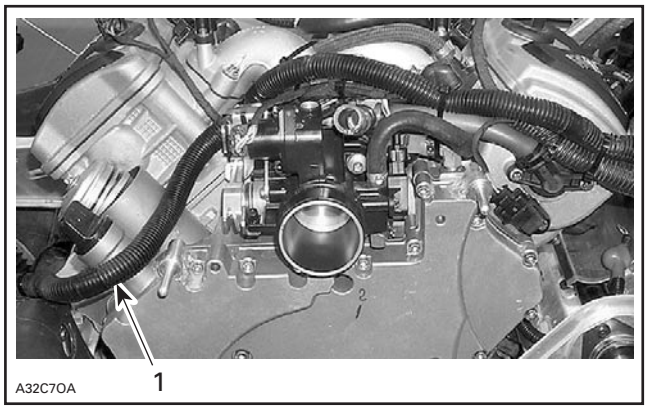
Check continuity of the circuits according to the wiring diagram in the WIRING DIAGRAMS section of this manual.

If wiring harness is good, check the respective sensor/actuator as described in this section.

Otherwise, repair the connectors, replace the wiring harness or the ECM as diagnosed.

Removal

Cut the locking ties retaining vehicle harness to engine. Move the vehicle harness away from engine.

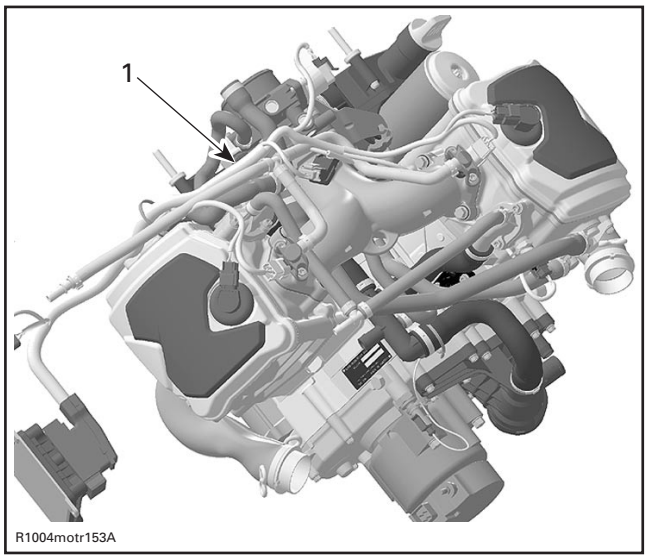


1. Vehicle harness

Disconnect the wiring harness from all sensors/actuators.

Disconnect the ECM connector A from the ECM.

Cut all locking ties which are holding the wiring harness in position.



1. Wiring harness

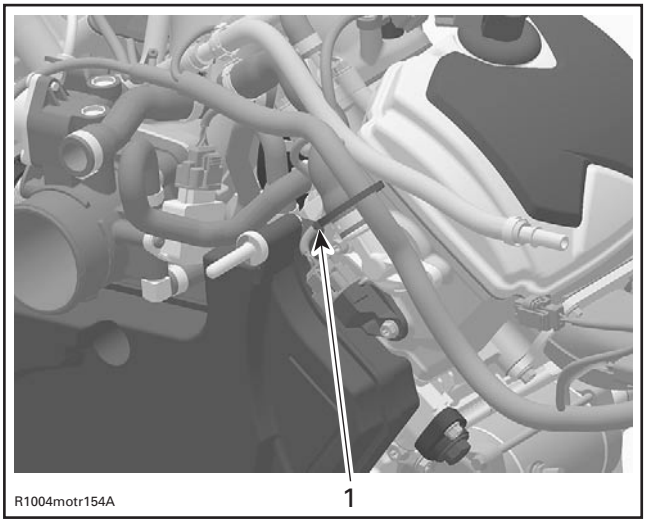
Remove complete wiring harness.

Installation

First connect the ECM connector A to the ECM and the engine connector to the vehicle wiring harness.

Connect ATS connector to the ATS fitted in the air intake silencer.

Then connect CAPS. Ensure the cable is above the breather hose, then fasten it with a locking tie.

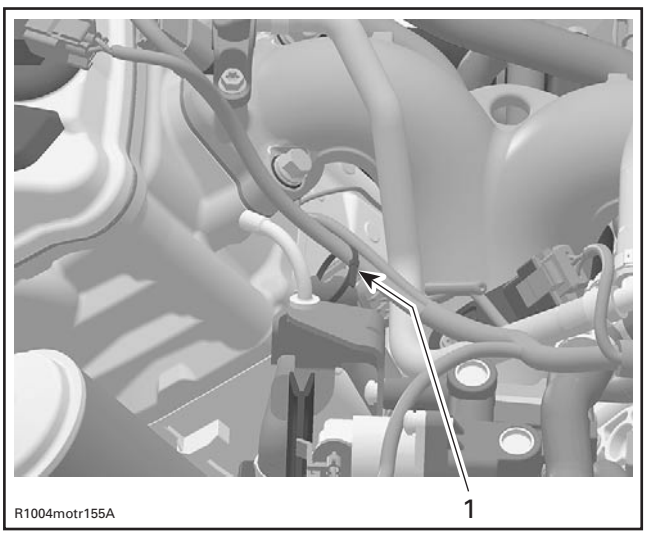


1. Locking tie

Connect injector and ignition coil of cylinder 2 to the wiring harness. Ensure that cables are underneath the fuel line.

Also connect the TPS, MAPS (grey connector) and the idle bypass valve to the wiring harness.

Then connect injector and ignition coil of cylinder 1 to the wiring harness. Loosely attach the cable with locking tie on the throttle cable bracket.

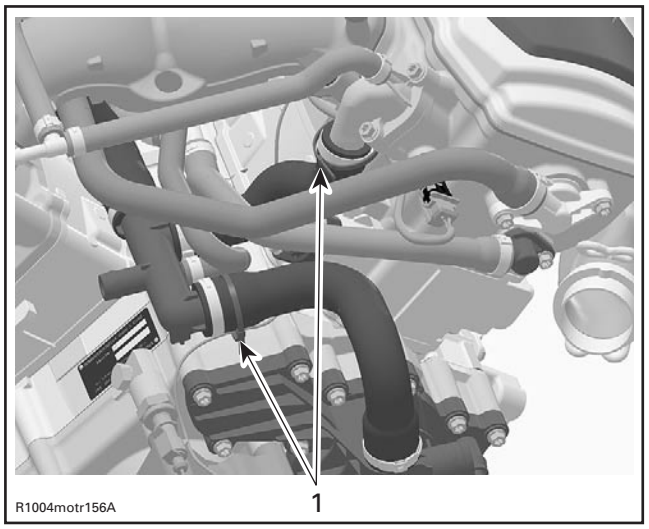


1. Locking tie

Connect the CPS, CTS and OPS to the wiring harness.

NOTE: Routing of the harness for CAPS, CTS and OPS has to be between the intake manifold and cylinder 1, underneath the water hoses.

Use locking ties to attach the cables for the CTS on the water hose and for the OPS on the T-fitting.



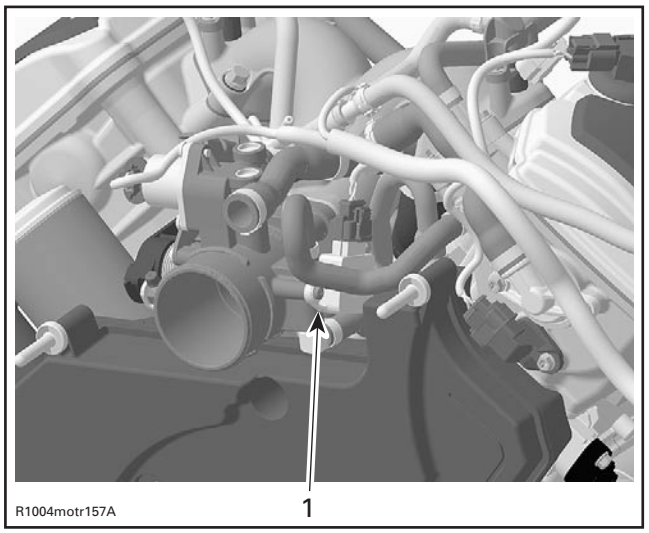
1. Locking ties

Install all remaining parts, which have been removed.

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 shaft angle.



1. Throttle position sensor (TPS)

IMPORTANT: Prior to testing the TPS, ensure that mechanical components/adjustments are adequate according to THROTTLE BODY in AIR INDUCTION SYSTEM above.

The EMS may generate several fault codes pertaining to the TPS. Refer to SYSTEM FAULT CODES in DIAGNOSTIC PROCEDURES section for more information.

Wear Test

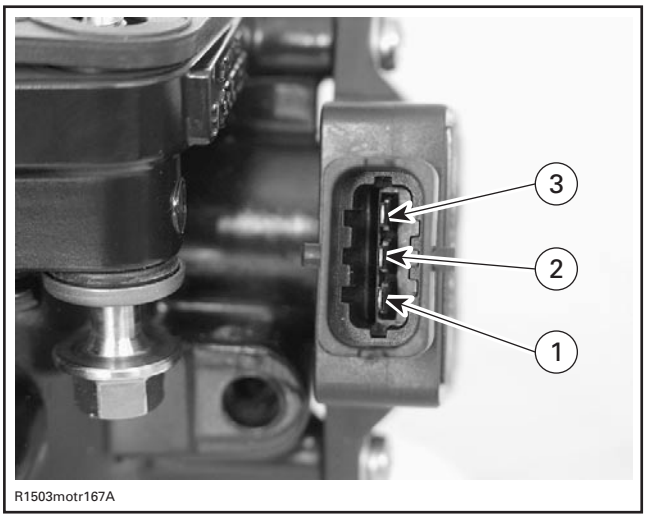
While engine is not running, activate throttle and pay attention for smooth operation without physical stops of the cable.

Using the vehicle communication kit (VCK) with 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.

Voltage Test

Check the voltage output from ECM to the desired throttle position sensor.



TPS

Disconnect plug connector from throttle position sensor. To unlock connector, insert a small screwdriver between the folded tab. To see the connector pin-out, temporarily remove the connector shield joining the harness, to expose the pin numbers. Connect a voltmeter between pin 1 and 3 and also between pin 1 and 2 in the wiring harness.

Remove and reinstall the tether cord cap and connect the VCK (Vehicle Communication Kit) to activate the ECM.

Check the voltage readings as follows.

CONNECTION	VOLTAGE
Pin 1 with engine ground	0 V
Pin 2 with engine ground	5 V
Pin 3 with engine ground	4.75 - 5 V

NOTE: Make sure the engine is properly grounded.

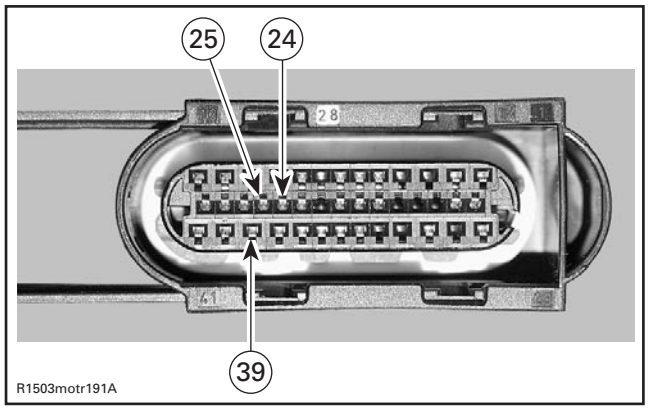
If voltage test is good, replace the TPS.

If voltage test is not good, check the resistance of the TPS circuit.

Resistance Test

Reconnect the TPS.

Disconnect the ECM connector A on the ECM.



Using a multimeter, check resistance value between terminal A-25 and A-39.

The resistance should be 1600 - 2400 Ω.

Check the resistance between terminal A-24 and terminal A-39 with the throttle plate in **idle** position.

The resistance should be approximately 2500 Ω.

Check the resistance between terminal A-24 and terminal A-39 with the throttle plate in **wide open** position.

The resistance should be 1000 - 1100 Ω.

Check the resistance between terminal A-24 and A-25 with throttle plate in **idle** position.

The resistance should be 1000 - 1100 Ω.

Now check the resistance with the throttle plate in **wide open** position.

The resistance should be 2600 - 2700 Ω.

NOTE: When measuring between pins A-24 and A-39, resistance **value decreases** while depressing throttle lever. when measuring between pins A-24 and A-25, resistance **value increases** while depressing throttle lever. The resistance value should change smoothly and proportionally to throttle movement. Otherwise, replace TPS.

If resistance values are correct, try a new ECM. Refer to ECM REPLACEMENT procedures elsewhere in this section.

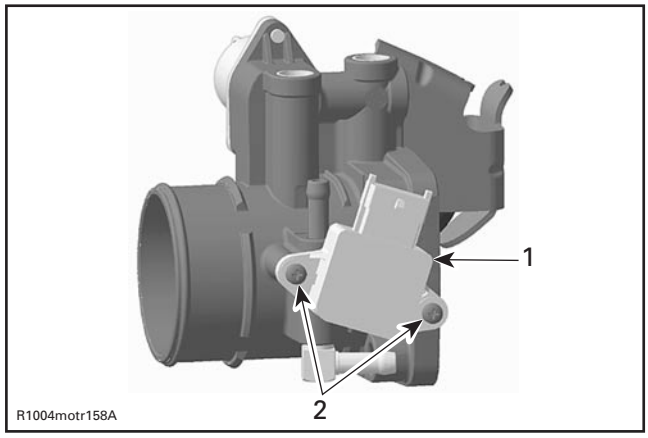
If resistance values are incorrect, repair connector or replace the wiring harness between ECM connector and the TPS.

Replacement

Remove the throttle body as described above.

Loosen two screws retaining the TPS.

Remove TPS.



THROTTLE BODY

1. *Throttle position sensor (TPS)*
2. *Screws*

Install the new TPS.

Apply Loctite 243 on the TPS retaining screws, then torque to 3 N•m (27 lbf•**in**).

Reinstall remaining removed parts.

Proceed with the CLOSED THROTTLE AND IDLE ACTUATOR RESET. See below.

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 bypass valve will determine the basic parameters for the idle speed control of the engine.

NOTE: Reset must be done each time the throttle position sensor (TPS) or the idle bypass valve is loosened or removed or throttle body is replaced or ECM is replaced.

CAUTION: An improperly set TPS or idle bypass valve may lead to poor engine performance.

Use the vehicle communication kit (VCK) with the B.U.D.S. software to perform this adjustment.

Ensure the throttle body plate stop lever rest against its stopper. 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 BODY in AIR INDUCTION SYSTEM above.

Click on the **Reset** button in the **Setting** section of B.U.D.S.

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

NOTE: There is no idle speed adjustment to perform. The ECM takes care of that. 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.

Start engine and make sure it operates normally through its full engine RPM range. If fault codes appear, refer to SYSTEM FAULT CODES in the DIAGNOSTIC PROCEDURES section for more information.

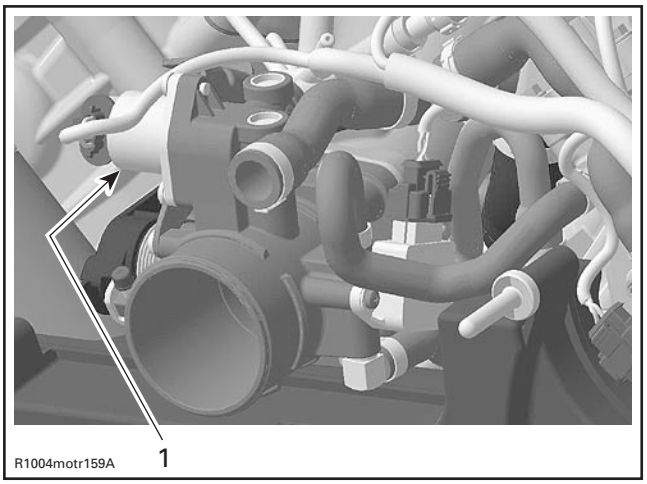
IDLE BYPASS VALVE

An idle bypass 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 idle bypass valve may be necessary as a test.

Resistance Test

Disconnect idle bypass valve from the wiring harness.

Using a multimeter, check the resistance in both windings.



1. Idle bypass valve

Check the resistance between pin A and pin D and also between pin C and pin B of the idle bypass valve.

The resistance in each winding should be approximately 50 Ω at 23°C (73°F).

If the resistance of one or both windings is not good, replace the idle bypass valve.

If resistance test of valve windings is good, check continuity of circuits A-35, A-36, A-37, A-38.

Visual Inspection

Remove idle bypass valve from throttle body.

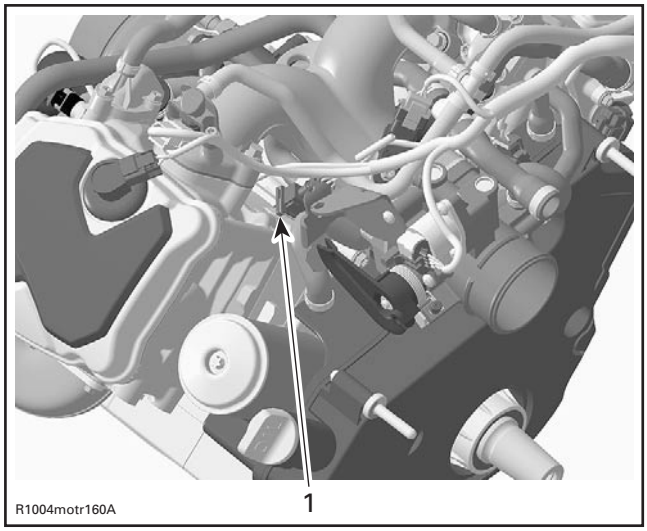
Check the piston and bypass channel for dirt/deposits which can cause a sticking piston.

CAUTION: Do not try to operate the piston of the idle bypass valve when it is dismounted. Also do not move the piston by hand. The drive screw is very sensitive and will be destroyed.

Clean the parts and install the idle bypass valve on the throttle body.

Proceed with the CLOSED THROTTLE AND IDLE ACTUATOR RESET. See above.

CRANKSHAFT POSITION SENSOR (CPS)



1. CPS connector

NOTE: Take into account that a CPS fault can be triggered by bent or missing encoder wheel teeth. First check fault codes then check the teeth condition if necessary. See below.

Disconnect CPS wiring harness connector. Probe terminals 1 and 2 coming from CPS while cranking engine. Voltage should be within 1-2 Vac. Otherwise, inspect wiring and replace CPS if wiring is good.

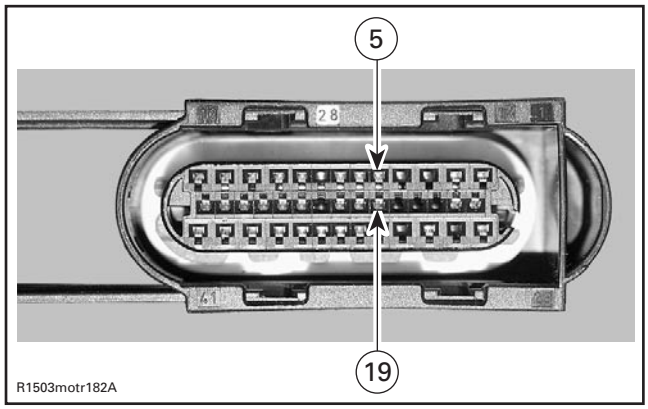
Resistance Test

Disconnect the CPS plug connector from the wiring harness and check the resistance of the sensor itself.

The resistance should be between 0.7 kΩ and 1.1 kΩ.

Otherwise, replace the CPS.

If resistance tests good, **reconnect** the CPS and disconnect the ECM connector A on the ECM.



Using a multimeter, recheck resistance value between terminals 5 and 19.

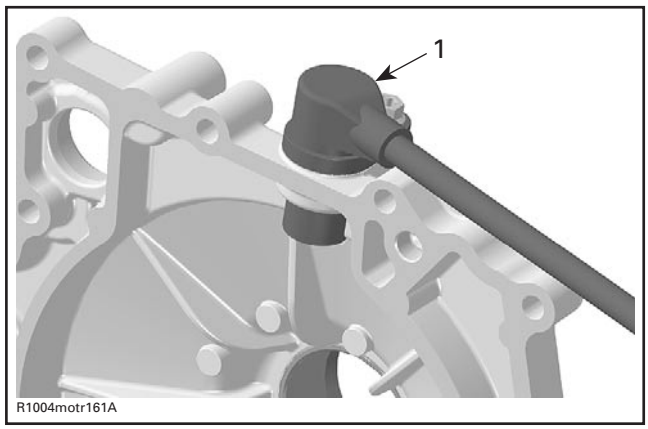
If resistance value is correct, try a new ECM. Refer to ECM REPLACEMENT procedures elsewhere in this section.

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

Replacement

Disconnect CPS connector and remove the PTO cover. Refer to CRANKCASE subsection in ENGINE section.

Remove CPS.



1. CPS inside PTO cover

Install new CPS.

Tightening torque of the CPS retaining screws is 6 N•m (53 lbf•**in**).

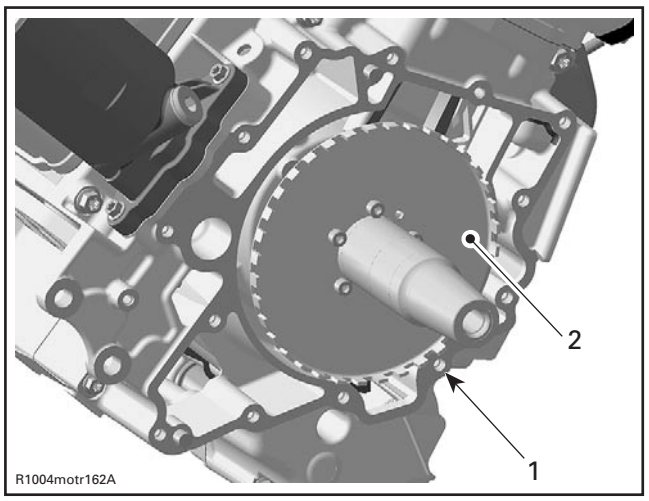
Reinstall remaining removed parts.

Trigger Wheel Inspection

Remove PTO cover. Refer to CRANKCASE subsection in ENGINE section.

Remove trigger wheel.

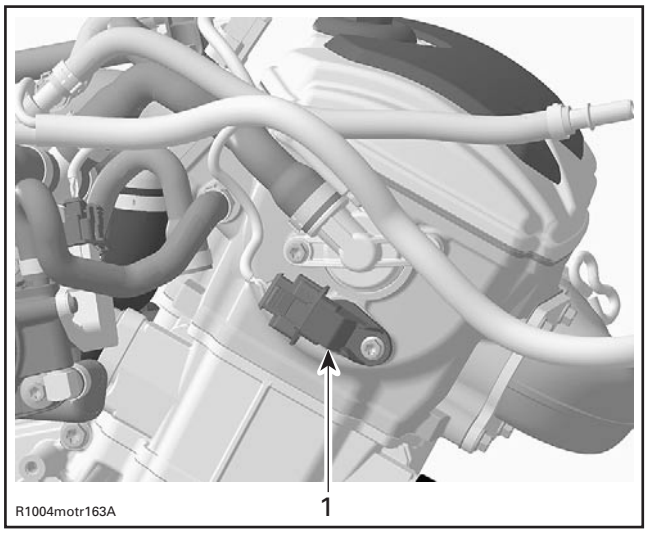
Perform visual inspection of the trigger wheel for bent teeth and also check the mating surface for straightness. If necessary, straighten the teeth or replace the trigger wheel.



1. Trigger wheel
2. Mating surface

Properly reinstall trigger wheel and cover.

CAMSHAFT POSITION SENSOR (CAPS)



1. CAPS

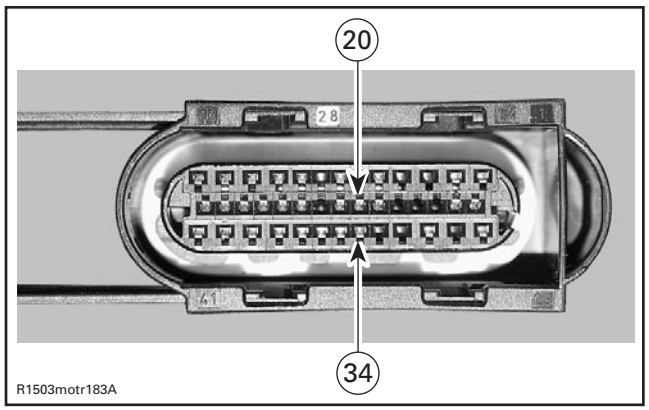
Voltage Test (harness)

Disconnect the connector from the CAPS.

Remove and reinstall tether cord cap and connect the VCK (Vehicle Communication Kit) to activate the system.

Probe pin 3 of CAPS connector (wiring harness side) and battery ground.

a. If 12 V is read, check continuity of circuits A-20 and A-34. If they test good, perform the CAPS voltage test as explained below. If CAPS tests good, try a new ECM.

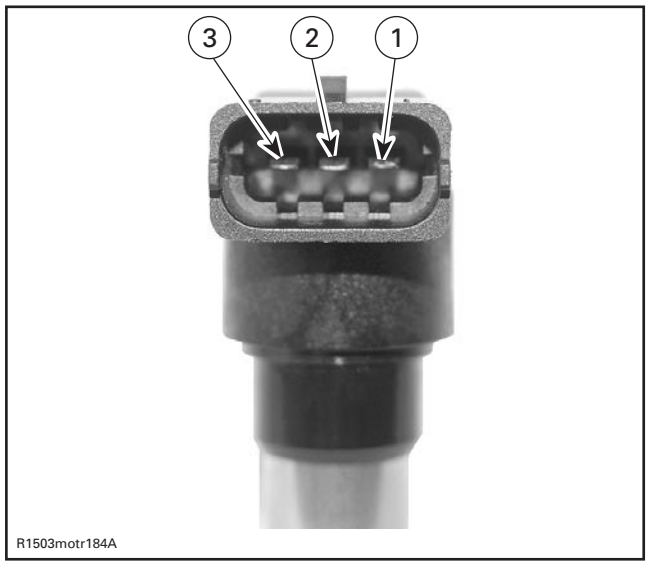


ECM CONNECTOR

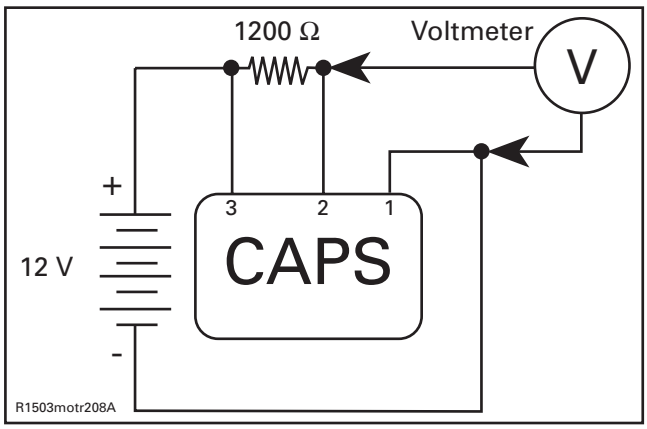
b. If 12 V is not read, check continuity of circuit between pin 3 of CAPS connector and the corresponding fuse. Otherwise, repair wiring harness.

Remove the CAPS from the cylinder head.

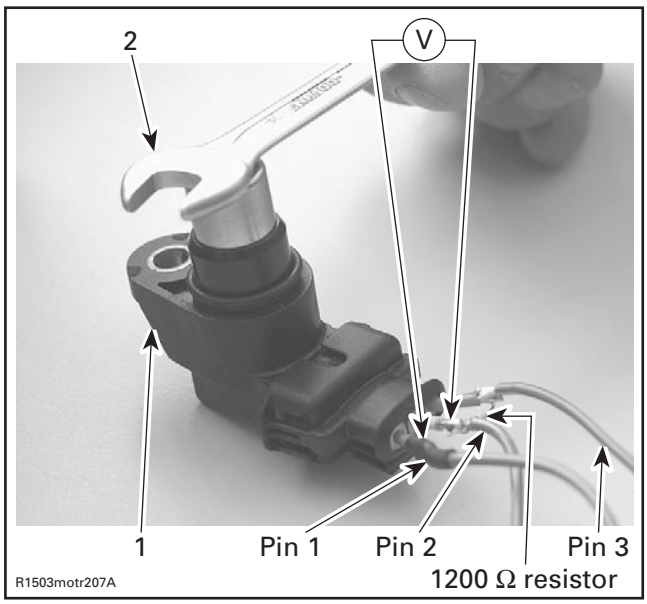
Set up the following electric circuit to perform the voltage test.



CAPS PIN-OUT



Touch the CAPS with a conductor (ex.: screwdriver) and look if the voltage at the multimeter switches from 12 V to less than 1 V.



1. *CAPS*
2. *Conductor*

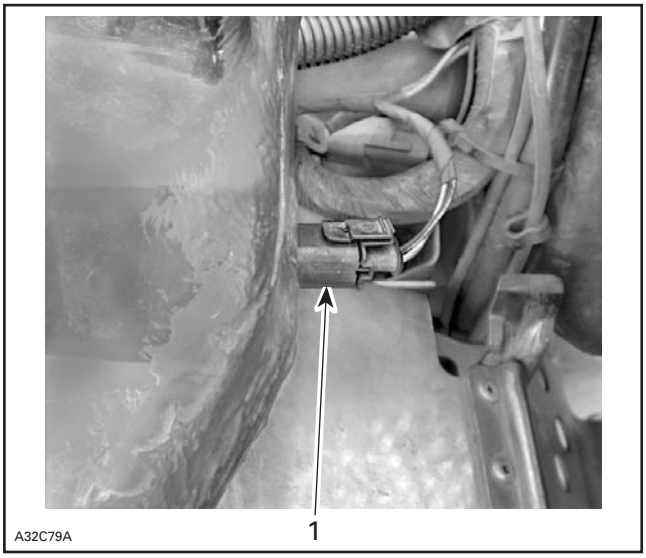
If the voltage is not good, replace the CAPS.

Replacement

Unscrew the retaining screw and replace the CAPS. Ensure to reinstall O-ring.

Apply Loctite 243 (blue) on thread and torque to 6 N•m (53 lbf•**in**).

AIR TEMPERATURE SENSOR (ATS)



AIR SILENCER

1. Air temperature sensor (ATS)

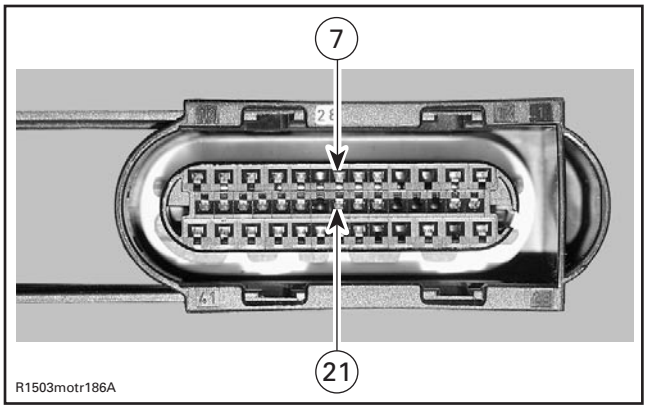
Resistance Test

Disconnect the plug connector from the ATS and check the resistance of the sensor itself.

The resistance should be between 2280 Ω and 2740 Ω at 20°C (68°F).

Otherwise, replace the ATS.

If resistance tests good, **reconnect** the ATS and disconnect the ECM connector A on the ECM.



Using a multimeter, recheck resistance value between terminals 7 and 21.

If resistance value is correct, try a new ECM. Refer to ECM REPLACEMENT procedures elsewhere in this section.

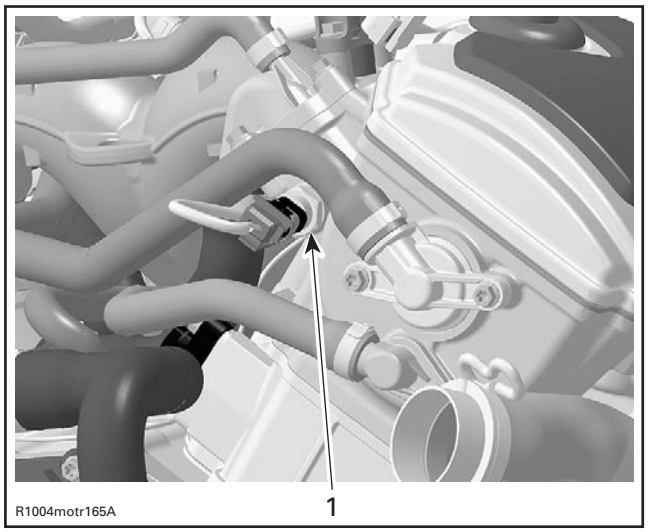
If resistance value is incorrect, repair the connectors or replace the wiring harness between ECM connector and the ATS.

Replacement

Disconnect the connector of the ATS.

Pull ATS out and install the new one.

COOLANT TEMPERATURE SENSOR (CTS)



1. Coolant temperature sensor (CTS)

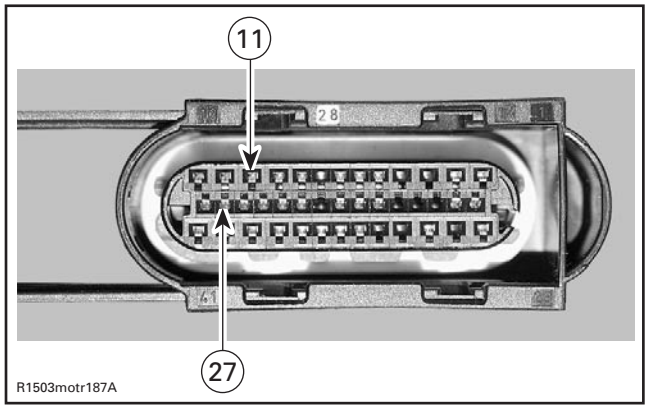
Resistance Test

Disconnect the plug connector from the CTS and check the resistance of the sensor itself.

The resistance should be between 2280 Ω and 2740 Ω at 20°C (68°F).

Otherwise, replace the CTS.

If resistance tests good, **reconnect** the CTS and disconnect the ECM connector A on the ECM.



Using a multimeter, recheck resistance value between terminals 11 and 27.

If resistance value is correct, try a new ECM. Refer to ECM REPLACEMENT procedures elsewhere in this section.

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

Replacement

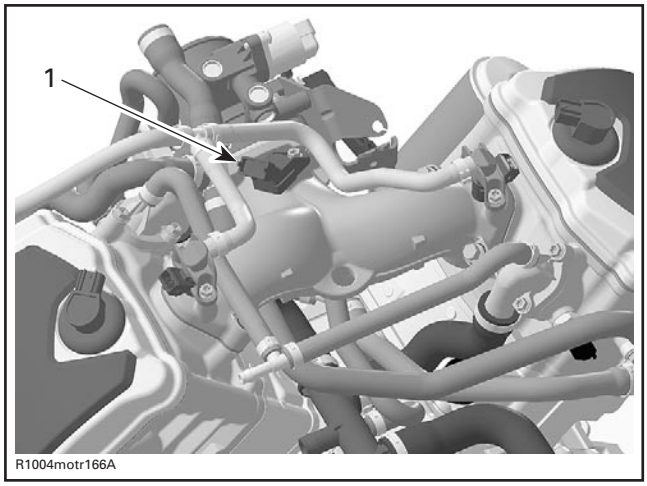
Disconnect CTS connector and remove CTS.

Install the new CTS and torque to 18 N•m (159 lbf•**in**).

Reinstall remaining removed parts.

Refill and bleed the cooling system, refer to COOLING SYSTEM subsection.

MANIFOLD AIR PRESSURE SENSOR (MAPS)



1. Manifold air pressure sensor (MAPS)

NOTE: This sensor is a dual function device. When engine is started and it runs at idle speed, the sensor takes the atmospheric pressure and stores it in the ECM. Thereafter, it takes the manifold air pressure at operating RPMs.

Ensure sensor is correctly installed on intake manifold. Otherwise, the MAPS could generate a fault code for an unexpected sensor range at idle when it reads the atmospheric pressure. 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.

Voltage Test

Check the voltage output from ECM to the manifold air pressure sensor (MAPS).

Disconnect plug connector from MAPS and connect a voltmeter between pin 1 and 3 and also between pin 1 and 2 of wiring harness.

Remove and reinstall tether cord cap and connect the VCK (Vehicle Communication Kit) to activate the system. There should be 5 Vdc in each test.

If voltage test is good, replace the MAPS.

If voltage test is not good, check the continuity of the MAPS circuit.

Resistance Test

Disconnect the ECM connector A on the ECM.

Using a multimeter, check continuity of circuits 12, 28 and 40.

If wiring harness is good, try a new ECM. Refer to ECM REPLACEMENT procedures elsewhere in this section.

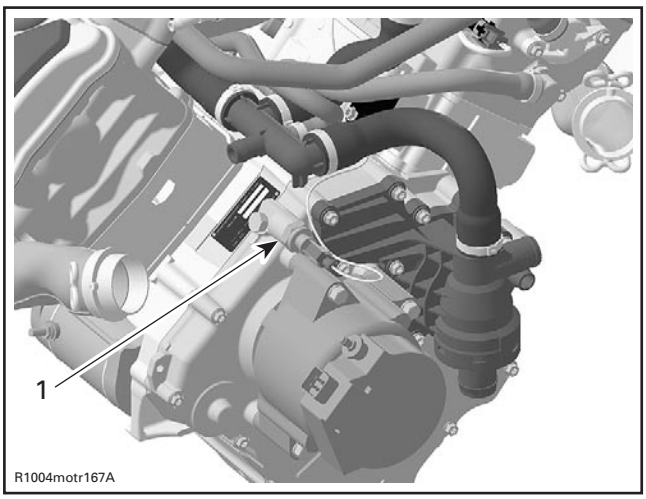
Otherwise, repair the connectors or replace the wiring harness between ECM connector and the MAPS.

Replacement

Disconnect MAPS connector and remove the MAPS.

Install the new MAPS paying attention to index its tab into the adaptor notch. Apply Loctite 243 (blue) on screw then torque to 6 N•m (53 lbf•**in**).

OIL PRESSURE SWITCH (OPS)



1. OPS

Oil Pressure Test

To check the function of the oil pressure switch, an oil pressure test has to be performed. Refer to OIL PRESSURE TEST in LUBRICATION SYSTEM section.

If the engine oil pressure is out of specifications, check the points described in TROUBLESHOOTING section.

If the engine oil pressure is good, check the resistance of the OPS while engine is off and while engine is running.

Resistance Test

Disconnect the plug connector from the OPS and use a multimeter to check the resistance between OPS pin and engine ground while engine is stopped (without oil pressure) and while engine is running (with oil pressure).

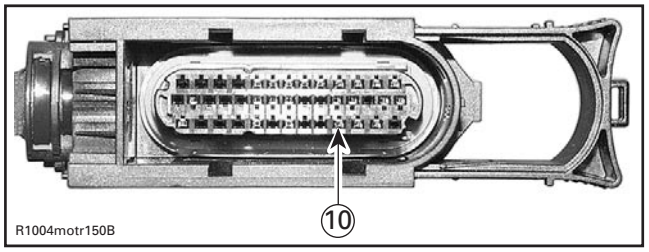
When engine is stopped the resistance is close to 0 Ω (normally close switch).

When engine is running and the oil pressure reaches 20 - 40 kPa (2.9 - 5.8 PSI), the resistance of the OPS is infinitely high.

If resistance values are incorrect, replace OPS.

If the values are correct, check the continuity of the wiring harness.

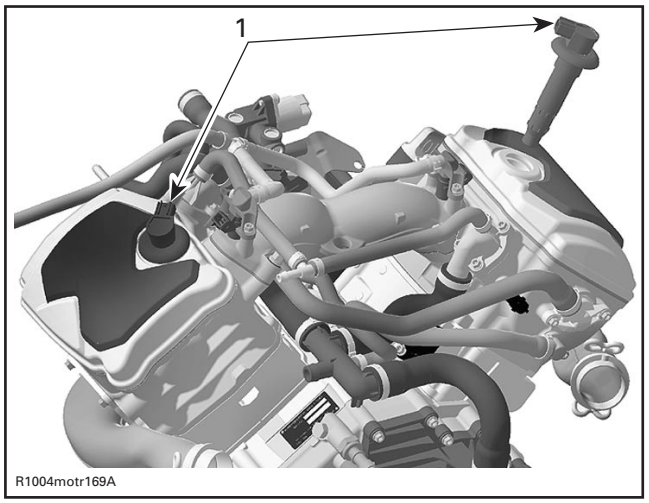
Disconnect the ECM connector A from the ECM and check continuity of circuit 10.



If wiring harness is good, try a new ECM. Refer to ECM REPLACEMENT procedures elsewhere in this section.

Otherwise, repair the connector or replace the wiring harness between ECM connector and OPS.

IGNITION COILS



1. Ignition coil

NOTE: The ECM energizes the primary side of each ignition coil individually. It can detect open and short circuit in the primary winding but it does not check the secondary winding.

Using the vehicle communication kit (VCK) with the B.U.D.S. software, energize the ignition coil from the **Activation** section.

You should hear the spark occurring. In doubt, use an inductive spark tester or a sealed tester – available from after-market tool/equipment suppliers – to prevent spark occurring in the engine compartment. Otherwise, perform the following checks.

An ignition coil with good resistance measurement can still be faulty. Voltage leak can occur at high voltage level which is not detectable with an ohmmeter. Replacing the ignition coil may be necessary as a test.

⚠ WARNING

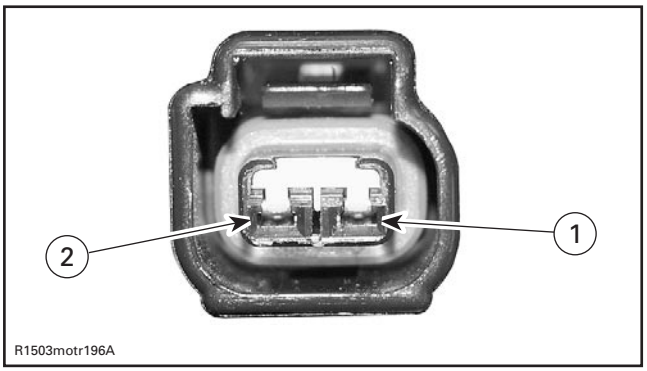
Never make a spark test with spark plug removed. Flammable vapors may be present in the engine compartment and ignited which could cause an explosion.

Voltage Test

⚠ WARNING

When disconnecting coil from spark plug, always disconnect coil from main harness first. Never check for engine ignition spark from an open coil and/or spark plug in the engine compartment as spark may cause fuel vapor to ignite.

Disconnect the plug connector from the ignition coil and check the voltage supplied by the battery.



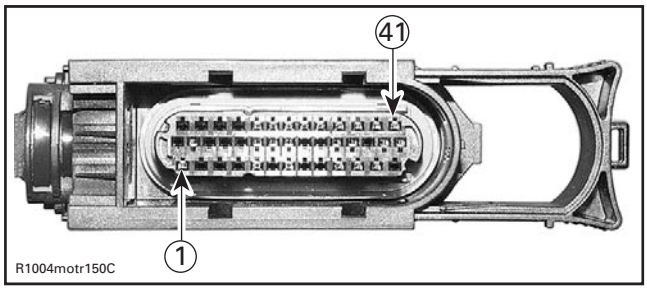
Install tether cord cap and connect the VCK (Vehicle Communication Kit) to activate the system.

Check voltage between terminal 2 of ignition coil connector on the wiring harness and battery ground.

The voltage should be 12 V.

If 12 V is NOT read, check continuity between terminal 2 of ignition coil and the corresponding fuse. Otherwise, repair wiring harness.

If 12 V is read, disconnect the ECM connector A from the ECM and check the continuity of appropriate circuit 41 (cylinder 1) or 1 (cylinder 2).



ECM CONNECTOR

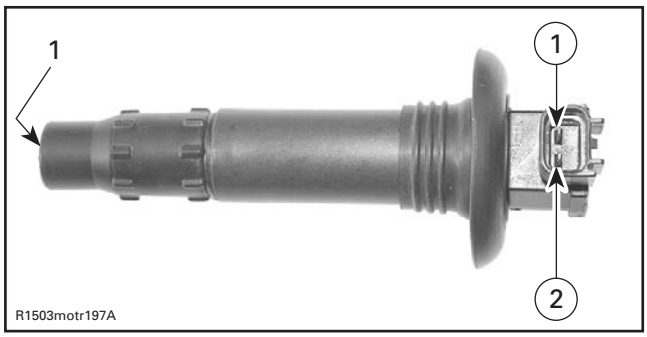
If wiring harness is defective, repair the connector or replace the wiring harness between ECM connector and the ignition coil.

If wiring harness is good, test resistance of primary and secondary winding of ignition coil.

Resistance Test

CAUTION: Do not remove the ignition coil before disconnecting the connector, or the wires will be damaged. To avoid damage, do not pry up ignition coil with a screwdriver.

Remove ignition coil from spark plug.



1. Spark plug terminal

Using a multimeter, check the resistance in both primary and secondary windings.

For primary winding check the resistance between pin 1 and pin 2 of the ignition coil.

The resistance should be between 0.85 and 1.15 Ω at 20°C (68°F).

For secondary winding check the resistance between pin 1 and spark plug terminal.

The resistance should be between 9.2 and 13.8 kΩ at 20°C (68°F).

If the resistance of one of both windings is not good, replace the defective ignition coil.

If the windings test good, try a new engine ECM.

NOTE: Prior to inserting the ignition coil to its location, apply some silicone lubricant (P/N 293 600 041) around the seal area that touches the spark plug hole. After installation, ensure the seal seats properly with engine top surface.

⚠ WARNING

Always reconnect ignition coil cables at the same spark plugs where they come from. Otherwise, severe backfire may occur with possible damage to exhaust system components. The genuine wiring harness is designed to prevent mixing up the cables since they are different in length.

TDC SETTING (Top Dead Center)

The EMS is able to determine the exact position of camshaft and crankshaft. Which means that no TDC setting has to be performed. It is used for both injection and ignition timings.

ENGINE START SWITCH VERIFICATION

A quick operation test can be done using the vehicle communication kit (VCK) with the B.U.D.S. software, using the **Monitoring** section. Press the start button and look at the start button LED. It should turn on, indicating the starting system is working on the input side of the starting system (start button, ECM and wiring). You know now the problem is on the output side of the starting system (ECM output signal to starting solenoid, wiring harness going to the solenoid and starter motor. Refer to STARTING SYSTEM for testing procedures). Otherwise, check the input side as follows.

This is a piezoelectric-type switch.

NOTE: You will not feel any button movement when you press it.

Disconnect the start switch connector. Using an ohmmeter, connect test probes to RED/BROWN and BEIGE wires.

Measure resistance. It must be at least 5 megohm (5 000 000 ohms) (switch is normally open). Depress and hold switch, the ohmmeter should read lower than 300 ohms during the first 2 seconds. Otherwise, replace switch. Reconnect connector.

Test continuity of circuit B-17. If it is good, try a new ECM. Otherwise, repair harness/connectors.

Test continuity of circuit B-19. If it is good, try a new EMS ECM. Otherwise, repair harness/connectors.

DESS SWITCH VERIFICATION

If 2 short beeps are not heard when installing the tether cord cap, refer to DIAGNOSTIC PROCEDURES.

The following continuity tests can also be performed using an ohmmeter.

Disconnect DESS post wires.

Tether Cord Cap Removed

Connect test probes to DESS post BLACK/GREEN and BLACK/WHITE wires. Measure resistance, there should be NO continuity (open circuit).

Connect one test probe to the WHITE/GRAY wire and the other test probe to the DESS post top terminal. Measure resistance, it must be close to 0 ohm.

Connect one test probe to the BLACK/GREEN wire and the other test probe to the DESS post ring. Measure resistance, it must be close to 0 ohm.

Tether Cord Cap on DESS Post

Connect test probes to DESS post BLACK/GREEN and BLACK/WHITE wires. Measure resistance, it must be close to 0 ohm.

SPARK PLUGS

Disassembly

⚠ WARNING

Never remove ignition coil from the spark plug without disconnecting it from the wiring harness. Flammable vapors may be present in the engine compartment and ignited by a spark which could cause an explosion.

Disconnect the wiring harness from the ignition coil.

Remove the ignition coil.

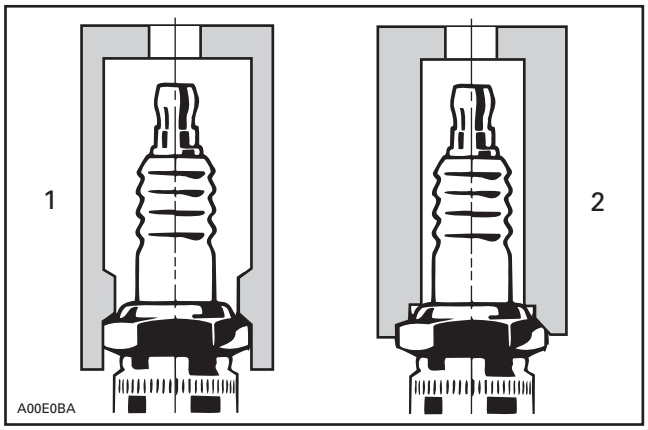
First unscrew the spark plug one turn.

Clean the spark plug and cylinder head with pressurize air then completely unscrew.

Spark Plug Installation

Prior to installation make sure that contact surfaces of the cylinder head and spark plug are free of grime.

1. Using a wire feeler gauge, set electrode gap according to the following chart.
2. Apply anti-seize lubricant over the spark plug threads to prevent possible seizure.
3. Hand screw spark plug into cylinder head. Then, tighten the spark plug clockwise an additional 1/4 turn with a proper socket.



1. Proper socket
2. Improper socket

ENGINE	SPARK PLUG	TORQUE	GAP ± 0.05 mm (± .002 in)
1004 4-TEC	NGK DCPR8-E	Hand tighten + 1/4 turn with a socket	0.75 (.030)

CRANKING SYSTEM

See above for start/stop switch and the DESS post testing. Refer to STARTING SYSTEM section for other tests.

DIAGNOSTIC PROCEDURES

GENERAL

Here is the basic order suggested to diagnose a suspected engine management or fuel injection related problem:

– Check the chart in the TROUBLESHOOTING section to have an overview of problems and suggested solutions.
– Check if the engine management system (EMS) pilot lamp lights up. If so, use the VCK (Vehicle Communication Kit) and look for fault codes to diagnose the trouble.
– Check all fuses.
– Check fuel pressure.
– Check spark plugs condition.
– Check all connections of the wiring harness.
– Refer to COMPONENT INSPECTION AND ADJUSTMENT section for procedures.

TROUBLESHOOTING

The following chart is provided to help in diagnosing the probable source of simple troubles.

MONITORING BEEPER CODED SIGNALS

CODED SIGNALS	POSSIBLE CAUSE	REMEDY
2 short beeps (when engine is started). DESS/RER pilot lamp also blinks.	• Confirms that proper tether cord cap is installed. Engine can rev above pulley engagement.	• Normal condition.
1 short beep every 1.5 seconds (when engine is started). DESS/RER pilot lamp also blinks. Engine cannot reach pulley engagement speed. Vehicle cannot be driven.	• Bad DESS system connection. • Defective tether cord cap. • Dirt or snow in tether cord cap. • Defective DESS post.	• Reinstall tether cord cap correctly over post. • Use another programmed tether cord cap. • Clean tether cord cap. • Replace DESS post.
1 long beep per second.	• Reverse is selected.	• Vehicle can be driven in reverse.
3 short beeps per second. DESS/RER pilot lamp also blinks. Engine cannot reach pulley engagement speed. Vehicle cannot be driven.	• Wrong tether cord cap is installed.	• Install proper tether cord cap. • Program key into ECM.
3 short beeps per second. Engine overheating pilot lamp also blinks.	• Engine is overheating.	• Stop engine immediately and allow to cool. Check cooling system.
3 short beeps per second. Oil pilot lamp also lights up.	• Low oil pressure on 4-TEC models.	• Stop engine immediately and check oil level and top it. Check lubrication system.
3 short beeps per second.	• Low battery voltage.	• Check battery and charging system.
Battery pilot lamp lights up.	• No charging.	• Check battery and charging system.
4 short beeps every 2 minutes.	• Too high battery voltage. • DESS system has detected a shorted key installed on DESS post.	• Check battery and charging system. • Use another programmed tether cord cap.

ENGINE PILOT LAMP	BUZZER	DESCRIPTION	P CODE
OFF	OFF	Air pressure sensor voltage too high.	P0108
OFF	OFF	Air pressure sensor voltage too low.	P0107
OFF	OFF	Battery lamp open circuit or shorted to ground.	P1649
OFF	OFF	Battery lamp shorted to battery.	P1648
OFF	OFF	DESS line shorted to ground.	P1656
OFF	OFF	Engine temperature gauge signal open circuit or shorted to ground.	P1653
OFF	OFF	Engine temperature gauge signal shorted to battery.	P1652
OFF	OFF	Engine temperature lamp open circuit or shorted to ground.	P1647
OFF	OFF	Engine temperature lamp shorted to battery.	P1646
OFF	OFF	Exhaust temperature sensor functional problem.	P0426
OFF	OFF	Exhaust temperature sensor voltage too high.	P0428
OFF	OFF	Exhaust temperature sensor voltage too low.	P0427
OFF	OFF	Idle control valve output stage cutoff memory difference.	P0505
OFF	OFF	Incorrect DESS key.	P0513
OFF	OFF	Inner MAG injector open circuit or shorted to ground.	P0267
OFF	OFF	Inner MAG injector shorted to battery.	P0268
OFF	OFF	Inner PTO injector open circuit or shorted to ground.	P0270
OFF	OFF	Inner PTO injector shorted to battery.	P0271
OFF	OFF	Knock sensor below minimum noise.	P0326
OFF	OFF	Module call monitoring.	P0601
OFF	OFF	No crankshaft signal detected.	P0337
OFF	OFF	Oil lamp open circuit or shorted to ground.	P1658
OFF	OFF	Oil lamp shorted to battery.	P1654
OFF	OFF	Oil pressure switch leakage.	P1203
OFF	OFF	Oil pressure switch still closed.	P1202
OFF	OFF	P+ Test of ISC output signal failed.	P1611
OFF	OFF	R.A.V.E. solenoid open circuit or shorted to ground.	P0079
OFF	OFF	R.A.V.E. solenoid shorted to battery.	P0080
OFF	OFF	Relay 3 open circuit or shorted to ground.	P1678
OFF	OFF	Relay 3 shorted to battery.	P1677
OFF	OFF	Safety fuel cut off detected.	P1148
OFF	OFF	Starter relay open circuit or shorted to ground.	P0616
OFF	OFF	Starter relay shorted to battery.	P0617
OFF	OFF	T.O.P.S. functional problem.	P1502
OFF	OFF	Tachometer RPM signal open circuit or shorted to ground.	P0654
OFF	OFF	Tachometer RPM signal shorted to battery.	P0654
OFF	2 s/15 mn ③	Warning lamp open circuit or shorted to ground.	P0650
OFF	2 s/15 mn ③	Warning lamp shorted to battery.	P0650

ENGINE PILOT LAMP	BUZZER	DESCRIPTION	P CODE
ON	2 s/mn ②	Throttle position sensor adaptation canceled.	P1104
BLINKS ①	OFF	Air pressure sensor voltage out of range.	P0106
BLINKS ①	OFF	Air temperature sensor functional problem.	P0111
BLINKS ①	OFF	Buzzer open circuit or shorted to ground.	P1671
BLINKS ①	OFF	Buzzer shorted to battery.	P1670
BLINKS ①	2 s/mn ②	Battery voltage too low.	P0562
BLINKS ①	2 s/mn ②	Engine temperature sensor voltage too high.	P0118
BLINKS ①	2 s/mn ②	Air pressure sensor voltage too high.	P0108
BLINKS ①	2 s/mn ②	Air pressure sensor voltage too low.	P0107
BLINKS ①	2 s/mn ②	Battery voltage too high.	P0563
BLINKS ①	2 s/mn ②	DESS® shorted to battery.	P1655
BLINKS ①	2 s/mn ②	Engine temperature sensor functional problem.	P0116
BLINKS ①	2 s/mn ②	Engine temperature sensor voltage too low.	P0117
BLINKS ①	2 s/mn ②	Fuel pump open circuit or shorted to ground.	P0231
BLINKS ①	2 s/mn ②	Fuel pump shorted to battery.	P0232
BLINKS ①	2 s/mn ②	High engine RPM detected.	P0336
BLINKS ①	2 s/mn ②	MAG injector open circuit or shorted to ground.	P0261
BLINKS ①	2 s/mn ②	MAG injector shorted to battery.	P0262
BLINKS ①	2 s/mn ②	No MAG ignition output stage.	P0351
BLINKS ①	2 s/mn ②	No PTO ignition output stage.	P0352
BLINKS ①	2 s/mn ②	Oil pressure switch functional problem.	P0520
BLINKS ①	2 s/mn ②	Outer MAG injector open circuit or shorted to ground.	P0261
BLINKS ①	2 s/mn ②	Outer MAG injector shorted to battery.	P0262
BLINKS ①	2 s/mn ②	Outer PTO injector open circuit or shorted to ground.	P0264
BLINKS ①	2 s/mn ②	Outer PTO injector shorted to battery.	P0265
BLINKS ①	2 s/mn ②	PTO injector open circuit or shorted to ground.	P0264
BLINKS ①	2 s/mn ②	PTO injector shorted to battery.	P0265
BLINKS ①	2 s/mn ②	Throttle position sensor voltage too high.	P0123
BLINKS ①	2 s/mn ②	Throttle position sensor voltage too low.	P0122
BLINKS ①	2 s/15 mn ③	Air temperature sensor voltage too high.	P0113
BLINKS ①	2 s/15 mn ③	Air temperature sensor voltage too low.	P0112
BLINKS ①	2 s/15 mn ③	Cam sensor signal missing.	P0344
BLINKS ①	2 s/15 mn ③	Coding checksum fault.	P0605
BLINKS ①	2 s/15 mn ③	Coding ID checksum fault.	P0605
BLINKS ①	2 s/15 mn ③	Crankshaft signal fault.	P0339
BLINKS ①	2 s/15 mn ③	DESS lamp open circuit or shorted to ground.	P0648
BLINKS ①	2 s/15 mn ③	DESS lamp shorted to battery.	P0648
BLINKS ①	2 s/15 mn ③	EEPROM checksum fault.	P0605
BLINKS ①	2 s/15 mn ③	EEPROM fault.	P0605

ENGINE PILOT LAMP	BUZZER	DESCRIPTION	P CODE
BLINKS ①	2 s/15 mn ③	Engine temperature lamp open circuit or shorted to ground.	P0655
BLINKS ①	2 s/15 mn ③	Engine temperature lamp shorted to battery.	P0655
BLINKS ①	2 s/15 mn ③	Idle control valve output stage fault.	P0505
BLINKS ①	2 s/15 mn ③	MPEM not coded.	P0602
BLINKS①	2 s/15 mn ③	Programming checksum fault.	P0605
BLINKS ①	2 s/15 mn ③	RAM fault.	P0604
BLINKS ①	2 s/15 mn ③	Relay 2 open circuit or shorted to ground.	P1676
BLINKS ①	2 s/15 mn ③	Relay 2 shorted to battery.	P1675
BLINKS ①	2 s/15 mn ③	Sensor's power supply voltage too high.	P0608
BLINKS ①	2 s/15 mn ③	Sensor's power supply voltage too low.	P0608
BLINKS ①	2 s/15 mn ③	Throttle position sensor adaptation failure.	P1102
BLINKS ①	2 s/15 mn ③	TPS learns unlikely or checksum fault.	P0601

① Engine pilot lamp is on for half a second and off for half a second.

② Buzzer sounds for 2 seconds every minute.

③ Buzzer sounds for 2 seconds every 15 minutes.

VCK (Vehicle Communication Kit)

The VCK (Vehicle Communication Kit) (P/N 529 035 844) is the primary tool to diagnose engine management and fuel injection related problems.

NOTE: The MPEM programmer does not work on 4-TEC models.

The 4-TEC requires B.U.D.S. version G2.0 or P2.0 or above.

B.U.D.S. (Bombardier Utility and Diagnostic Software) is designed to allow actuators, sensors and electronic equipments inspection, diagnostic options and reset such as the closed throttle and idle actuator.

For more information pertaining to the use of the software B.U.D.S., use its help which contains detailed information on its functions.

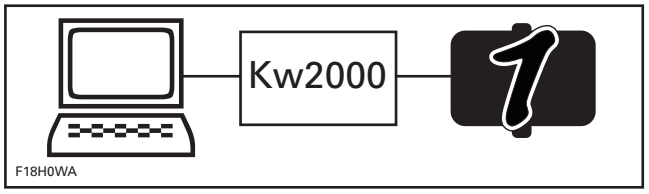
⚠ WARNING

If the computer you are using is connected to the power outlet, there is a potential risk of electrocution when working in contact with water. Be careful not to touch water while working with the VCK.

IMPORTANT: When using the software B.U.D.S., with the 4-TEC engine, ensure that the protocol "KW2000" is properly selected in " MPI" (multi protocol interface) under "Choose protocol".

When B.U.D.S. is connected to the vehicle, the status bar shows the protocol (KW2000) and the number 1 to the right. To communicate with the ECM, number 1 must be displayed.

Number 1 means that one ECM is connected.



ONE ECM IS CONNECTED

If an "X" is shown, this means that no communication between the MPI and the ECM is possible. Possible causes are:

– ECM is not powered-up

– wrong protocol is used

– bad connection between MPI and module.

ECM Supply

To power-up the ECM, push the START button shortly while the engine cut-out switch is OFF and the tether cord cap installed on DESS post.

The supply cable (P/N 529 035 869) may also be used. Connecting it between MPI and vehicle will power-up the ECM.

VCK Supply

The VCK (MPI box) can use the vehicle power for its supply. Four AA batteries or an AC/DC power supply can also be used. Make sure to respect MPI specification if a power supply is used.

Writing in ECM

When writing in ECM through B.U.D.S., there will be an "EMS Tracking" message that will say "Remove key from vehicle". When this occurs, remove the tether cord cap from its post and wait until the message disappears (approximately 15 seconds after tether cord cap removal).

4-TEC SYSTEM FAULT CODES

General

The faults saved in the ECM (Engine Control Module) are kept even if the battery is disconnected.

IMPORTANT: After a problem has been solved, ensure to clear the fault(s) in the ECM using the VCK. This will properly reset the appropriate counter(s) and will also record that the problem has been fixed in the ECM memory.

Many fault codes at the same time is likely to be burnt fuse(s).

For more information pertaining to the code faults (state, count, first, etc.) and report, refer to B.U.D.S. online help.

Supplemental Information for Some Specific Faults

– Electrical noise is picked up by the ECM. Ensure that all connections are in good condition, also grounds (battery, ECM, engine and ignition system), they are clean and well tightened and that all electronic components are genuine — particularly in the ignition system. Installing non-resistive spark plugs may lead to generate this fault code.
– Electrical noise might also lead engine to occasional cutout without generating a fault code when engine is restarted. When looking at the fault code, pay attention to the "count" value in the software B.U.D.S. A value between 1 and 9 confirms an electrical noise problem. A value of 10 and above will generate a fault code.
– If everything is in good condition, try a new ECM.

When using the service action suggested in the Fault section of B.U.D.S., the system circuits are referred to as A-41, which means connector "A" on the ECM and the circuit 41.

TPS (Throttle Position Sensor) Faults

Faults which are reported in B.U.D.S. fall into two groups TPS faults and adaption faults. These are displayed on the B.U.D.S. system as TPS OUT OF RANGE and TPS ADAPTION FAILURE.

TPS "OUT OF RANGE" Fault

It is caused by the sensor reading going out of its allowable range. This fault can occur during the whole range of movement of the throttle.

To diagnose this fully, it is recommended to operate the throttle through its full range. It is also recommended to release the throttle quickly as this may also reveal a fault that is intermittent.

POSSIBLE CAUSES	RESULT	ACTION
Check if connector is disconnected from TPS	Yes	• Fix.
Check if sensor is loose	Yes	• Fix and reset **Closed Throttle and Idle Actuator**.
Inspect sensor for damage or corrosion	Yes	• Replace and reset **Closed Throttle and Idle Actuator**.
Inspect wiring (voltage test)	Failed	• Repair.
Inspect wiring and sensor (resistance test)	Failed	• If bad wiring, repair. • If bad TPS, replace and reset **Closed Throttle and Idle Actuator**.
Test sensor operation (wear test)		• Replace and reset **Closed Throttle and Idle Actuator**.

TPS "ADAPTATION FAILURE" Fault

It is caused by the idle position moving out of an acceptable range.

Following failures can be effected by a TPS "Adaption Failure":

– Idle speed is out of range.
– Engine stops, when throttle is released quickly.
– Engine runs inconsistent in low partload or low RPM.

POSSIBLE CAUSES	RESULT	ACTION
Sensor has been replaced and TPS closed position not reset	Yes	• Reset **Closed Throttle and Idle Actuator**.
Throttle body has been replaced and TPS closed position not reset	Yes	• Reset **Closed Throttle and Idle Actuator**.
EMS ECM has been replaced and TPS closed position not reset	Yes	• Reset **Closed Throttle and Idle Actuator**.
Throttle cable too tight	Yes	• Fix and reset **Closed Throttle and Idle Actuator**.
Sensor is loose	Yes	• Fix and reset **Closed Throttle and Idle Actuator**.
Throttle bracket is loose	Yes	• Fix and reset **Closed Throttle and Idle Actuator**.
Adjustment screw worn or loose	Yes	• Change throttle body.
Idle bypass valve replaced but not reset	Yes	• Reset **Closed Throttle and Idle Actuator** using B.U.D.S.