

ELECTRONIC FUEL INJECTION

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL.....	529 036 166	4, 6, 13, 19, 21, 26, 28–29, 31–32
FLUKE 115 MULTIMETER	529 035 868	4–6, 12–13, 19, 21, 24, 26, 28–29, 32
FUEL HOSE DISCONNECT TOOL	529 036 037	9

SERVICE TOOLS – OTHER SUPPLIER

Description	Part Number	Page
FLUKE AUTOMOTIVE BACK PROBE PIN.....	TP40	24
FLUKE SUREGRIP INSULATED TEST LEADS.....	TL224	24

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 243 (BLUE).....	293 800 060	7, 10, 22, 25, 30, 33
LOCTITE 518.....	293 800 038	31

GENERAL

WARNING

Always disconnect battery prior to working on the fuel system. Always disconnect battery exactly in the specified order, BLACK (-) cable first. Electrical connections should be disconnected prior to disconnecting fuel lines.

WARNING

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

Deactivate fuel pump and run engine until it stalls.

Cover the fuel line connection with an absorbent shop rag before disconnecting them. Slowly disconnect the fuel hose to minimize spilling.

WARNING

Fuel lines remain under pressure at all times. Always proceed with care and use appropriate safety equipment when working on a pressurized fuel system. Wear safety glasses. Do not allow fuel to spill on hot engine parts and/or on electrical connectors. Proceed with care when removing or installing high pressure test equipment, or disconnecting fuel line connections. Wipe off any fuel spillage in the bilge. Never use a hose pincher on high pressure hoses.

When the repair is completed, ensure the hose from the fuel rail to the fuel pump is properly connected and secured in its support. Test for fuel leaks as described in *FUEL TANK AND FUEL PUMP* subsection.

WARNING

Always perform the fuel system high pressure leak test if any component has been removed or disconnected.

WARNING

If a gasoline leak and/or odor is present, do not start the engine. Repair the leak.

SYSTEM DESCRIPTION

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

This system also introduces torque management functions.

Electrical System

ECM (Electronic Control Module)

From input signals (e.g. throttle lever, iBR lever), the ECM acknowledges driver demands and converts them to an engine torque requirement through calculation of several variables. Then, the ECM controls the iTC (intelligent Throttle Control), the injection system and the ignition system to meet the torque requirement.

The ECM manages the engine torque requirements and controls engine operation to ensure it is delivering optimum performance, fuel economy and meeting emission regulations. The ECM also controls idle speed and limits maximum engine speed.

Since the ECM manages several torque requirements at the same time including contradictory demands (such as the throttle lever and the iBR lever being fully pulled in at the same time), it must prioritize the most important requirement according to predefined conditions and apply the proper action.

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 and ignition maps) as required to maintain the optimum air-fuel ratio.

Air Induction

Throttle Body

A 60 mm throttle body is mounted on the intake manifold.

Air for combustion is drawn in by a mechanically-driven supercharger. The air flows through the throttle body and is controlled by a throttle plate.

Fitted on the throttle body, an electronic throttle actuator (ETA) allows the ECM to electronically control the throttle plate opening which regulates the amount of air that enters the engine, and therefore engine speed.

There is no idle air control valve (IACV).

Fuel System

Fuel Rail

A single fuel rail is mounted on the intake manifold. The fuel rail ensures that enough fuel can be delivered to the fuel injectors throughout the engine operating range.

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

Fuel Injectors

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

Fuel Pump

An electric fuel pump with an integrated pressure regulator is used. Refer to *FUEL TANK AND FUEL PUMP* subsection.

ADJUSTMENT

IDLE SPEED

Idle speed is not adjustable. The ECM controls the idle speed of the engine through the iTC system by controlling throttle plate opening using the ETA (electronic throttle actuator).

Idle speed can be monitored in BUDS2.

CLOSED THROTTLE RESET

General Information

This operation performs a reset of the TPS values of the throttle body in the ECM.

Closed throttle reset must be carried out only when:

- Replacing the throttle body.
- Replacing the ECM.

Closed Throttle Reset Procedure

1. Use the BUDS2 software to perform this setting. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Press the START button to wake up the ECM.

3. Install the tether cord on the engine cut-off switch.
4. Ensure throttle lever is completely released.
5. In BUDS2, click the ECM **Setting** tab, then click on the **Reset** button.

Reset is completed.

NOTE: It is not necessary to click on the Write button in BUDS2.

Exit BUDS2.

NOTE: If the throttle valve was not within the allowed range when the **Closed Throttle** reset was carried out, no error message would be displayed. However, a fault code would be set when the engine is started.

6. Start engine and make sure it operates normally through its full engine RPM range.
7. Check for fault codes using BUDS2. If a fault code related to the throttle actuator appears, clear it, then carry out another **Closed Throttle** reset procedure. To clear faults, refer to *DIAGNOSTIC AND FAULT CODES* subsection.

TROUBLESHOOTING

DIAGNOSTIC TIPS

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

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

For diagnostics purposes, use BUDS2 software. See *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

After a problem has been solved, be sure to clear the fault(s) in the ECM using the BUDS2 software.

WARNING

All electrical actuators and electronic modules are powered as soon as the START button is pressed. 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
- Bus bar condition in fuse box
- 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)

CAN Continuity Tests

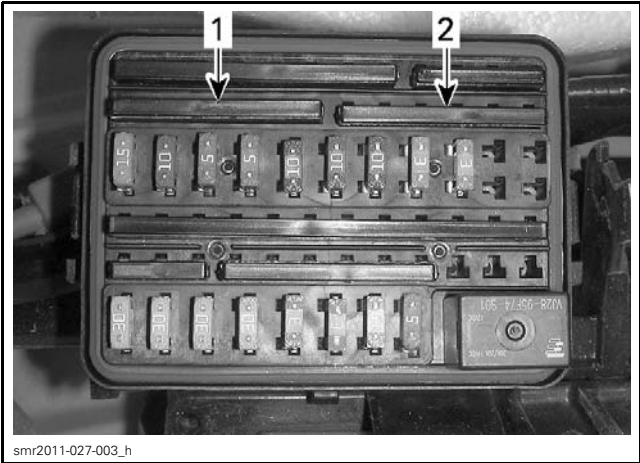
If a communication problem is present, perform the appropriate continuity test relating to the component reported by, or not available in BUDS2

Test wire continuity between the corresponding terminal of the CAN bus bar in the fuse box and the suspected component as follows.

For fuse is covered in *POWER DISTRIBUTION AND GROUNDS* subsection.

Remove both CAN bus bars.

Subsection XX (ELECTRONIC FUEL INJECTION)



1. CAN LO bus bar
2. CAN HI bus bar

Inspect bus bar condition.

Disconnect the connector from the component to be tested. Refer to its appropriate subsection.

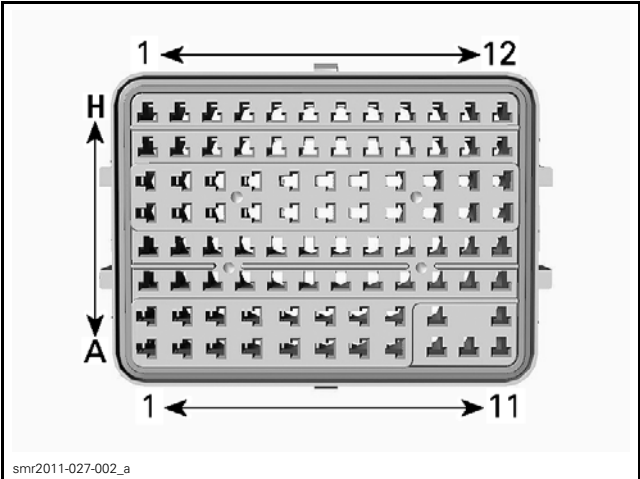
Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω .

Refer to the *CAN BUS DIAGRAM* above and read wire resistance between the each bus bar terminal and the applicable component terminal. Check the continuity of the WHITE/RED wire and the continuity of the WHITE/BLACK wire.

The following gives an example between the CAN LO wire and the ECM.

NOTE: When working with the ECM, install the ECM ADAPTER TOOL (P/N 529 036 166) on ECM "B" connector. For connector identification, refer to *ECM CONNECTOR IDENTIFICATION* in this subsection.

CONTINUITY TEST EXAMPLE: ECM TO FUSE BOX		
ECM CONNECTOR	FUSE BOX TERMINAL	RESISTANCE
B-C2	G1	Close to 0 Ω (continuity)



FUSE BOX PIN IDENTIFICATION

If continuity is good, CAN wires are in good condition.

If continuity is not good, check wiring, connectors and terminals condition.

NOTE: It may be necessary to check the continuity to more than one component.

Reconnect connectors and reinstall removed parts.

ECM Location

The ECM is located above the valve cover.

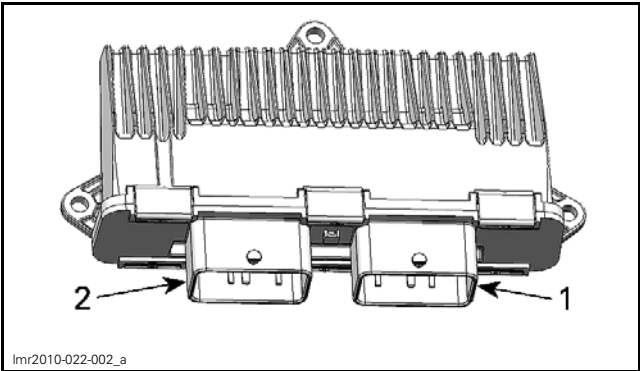
ECM Connector Identification

There are 2 connectors connected to the ECM.

The engine harness female connector is connected to the ECM module male connector "A".

The vehicle system control harness female connector is connected to the ECM module male connector "B".

The ECM connectors have 48 pins.



ECM CONNECTOR IDENTIFICATION
1. Connector A
2. Connector B

NOTE: For connector information, cleaning and probing, refer to *WIRING DIAGRAM* subsection.

ECM Wake Up Validation

Press the START button.

NOTE: Do not install the tether cord.

QUICK INDICATION THAT ECM IS POWERED (assuming the observed component is working)
Information center turns on.
Fuel pump turns on for approximately 5 seconds.

NOTE: Since the tether cord is not installed, the information center will turn off a few seconds after the self-test, but the ECM and electrical system will stay powered for approximately 3 minutes longer.

If the ECM does not turn on, check the following:

- Fuses F8, F19 and F3 in fuse box
- Battery voltage. Refer to *CHARGING SYSTEM*
- The 12 Vdc power bus bars in fuse box
- The ground bus bar in fuse box
- Relay and wiring. Refer to *POWER DISTRIBUTION AND GROUNDS* subsection
- ECM power supply wires and ground wires. See following procedure.

ECM Wake Up Logic

With Tether Cord Installed

When the START button is pressed to start engine:

- ECM pin B-D1 receives current from battery via the START switch. ECM is woken up.
- ECM pin B-H2 provides a ground to the relay coil in fuse box.
- The relay contacts close and provides main 12 Vdc power to the ECM at pin B-M4.
- The relay also powers the other components in the electrical system.
- ECM pin B-E4 monitors for a tether cord installed on the engine cut-off switch.
- When a tether cord is installed, the magnet in the tether cord cap closes the reed switches in the engine cut-off switch and the ECM pin B-F2 provides a ground. This tells the ECM the tether cord is installed.
- ECM pin B-B2 reads the D.E.S.S. key in the tether cap and determines if it is valid. If so, the engine can be started.

Without a Tether Cord Installed

When the START button is pressed:

- The information center turns on, goes through the self-test function, displays applicable messages and turns off a few seconds later.

- The engine cannot be cranked.
- The ECM stays powered up until it removes the ground to the relay coil after 3 minutes (pin B-H2).
- Relay contacts open and power to the ECM is removed.
- Power is also removed on all other electrical systems except the GPS supply to the information center.

ECM Shut Down Logic

When the engine is stopped by using the STOP button or by removing the tether cord from the engine cut-off switch, the following occurs:

- ECM stops the engine.
- After 5 seconds, the information center turns off.
- After 60 seconds, ECM (pin B-H2) removes the ground to the relay coil.
- Relay contacts open and power to the ECM is removed.
- Power is also removed on all other electrical systems except the GPS supply to the information center.

Testing ECM Power Supply

1. Remove cover from fuse box. Refer to *POWER DISTRIBUTION AND GROUNDS* subsection.

2. Press the START button to wake up the ECM.

NOTE: Do not install the tether cord.

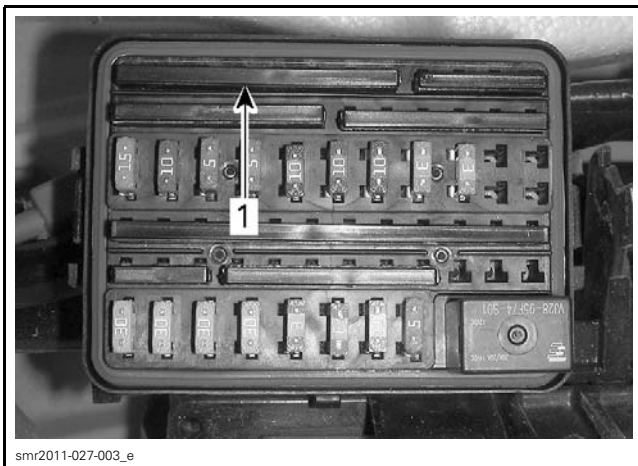
3. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Vdc.

4. Probe fuse F19 as illustrated.

NOTE: This will validate the fuse at the same time.

FUSE BOX	BATTERY POST	VOLTAGE
Fuse F19 terminal at F1	Ground	Battery voltage
Fuse F19 terminal at E1		

If measurement is out of specification, check ground bus bar in fuse box and continuity of its wires and connections with the engine grounds. Also check battery ground and engine grounds. Refer to *POWER DISTRIBUTION AND GROUNDS*.



TYPICAL
1. Ground bus bar in fuse box

If everything tests good and ECM does not power up, try a new ECM. Refer to *REPLACING THE ECM*.

Removing the ECM

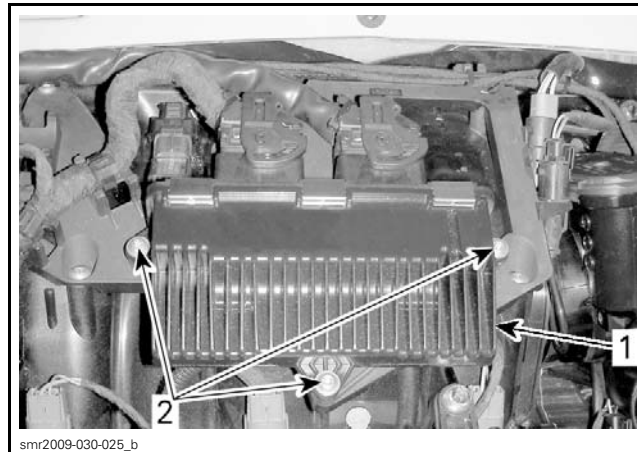
NOTE: If a new ECM is to be installed, first read the procedures in *REPLACING THE ECM* in this subsection.

1. Disconnect battery cables.

⚠ WARNING

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

2. Disconnect both ECM connectors from ECM.
3. Unscrew all retaining screws and remove the engine ECM from its support on the intake manifold.



1. ECM
2. Retaining screws

Installing the ECM

Reverse removal procedure however, pay attention to the following.

1. Install ECM.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
ECM retaining screws	5.5 N•m ± 0.6 N•m (49 lbf•in ± 5 lbf•in)

NOTICE Always replace ECM by the same part number or by a BRP approved equivalent.

2. Reconnect ECM connectors.
3. Reconnect battery cables.

⚠ WARNING

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

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

ECM Replacement

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

When installing a new ECM, data must be entered and a reset is required.

Subsection XX (ELECTRONIC FUEL INJECTION)

ECM Manual Data Entry

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

1. Use BUDS2 software and obtain the data from a saved **.buds2** file on your PC computer.
2. Collect the information from the vehicle and on the Knowledge Center.

1st Collecting Method: Obtaining the Data from a Saved **.buds2** File

1. Use the BUDS2 software.

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

2. In BUDS2, click on the **Open a BUDS2 file** button.
3. Make sure you are at: C:\Program files(x86)\BRP\BUDS2\Files
4. Choose the latest file saved for this specific vehicle.

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

NOTE: The file name structure is as follows:

VIN_date read (yyyymmdd)_hour read (hhmmss).buds2

Example:

2BPSBK8C68V000168_20090206_111640.buds2

Hence:

VIN: 2BPSBK8C68V000168

Date: 2009 02 06

Hour: 11h 16m 40s

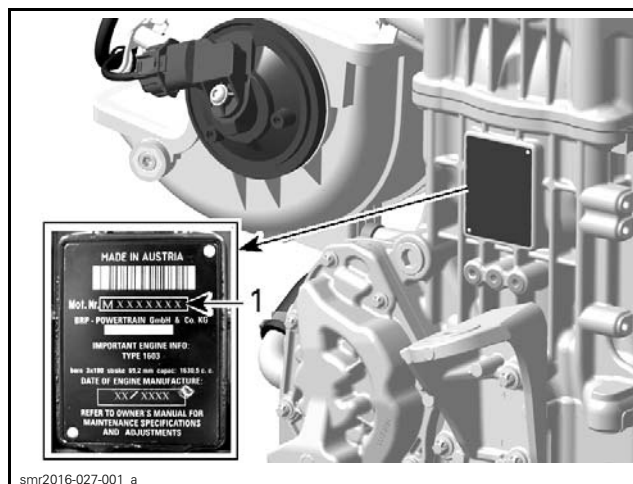
5. Go in the **Vehicle** tab and record the following information.

1. Vehicle serial number
2. Engine serial number (without the leading "M")
3. Vehicle model number
4. Customer name.

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

2nd Collecting Method: Collect the Information from the Vehicle and Knowledge Center

1. Record engine serial number.



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1. Engine serial number
2. Record the following numbers using *KNOWLEDGE CENTER*, enter the unit's serial # in the search.
 1. Vehicle model number
 2. Customer name.
3. Enter the recorded data in the new ECM as detailed in *ENTERING THE COLLECTED INFORMATION INTO THE ECM*.

Entering the Collected Information into the ECM

1. Use the BUDS2 software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Press the START button to wake up the ECM.
3. Install the tether cord on the engine cut-off switch.
4. In BUDS2, click the **Scan** button to read the new ECM.
5. In the Vehicle/Summary page, enter the model number and clic on **Write**

NOTICE Do not enter SBOAT for a PWC. Enter only the appropriate model number as obtained when gathering the information.

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

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

7. Click the **Keys** tab and click on the **Erase All Keys** button.
8. Program the desired D.E.S.S. key(s) to the watercraft. Refer to *D.E.S.S. SYSTEM* subsection.

NOTE: If you do not program at least one D.E.S.S. key to the watercraft, you will not be able to write the data to the new ECM, and will be prompted to do so.

9. Briefly press the vehicle START button to wake up the ECM. **Engine must not crank.**
10. Click on the **Write Data** button.
11. Perform the **Closed throttle** reset. Refer to **Closed Throttle Reset (TPS)** in *ADJUSTMENTS* in this subsection.
12. Reinstall remaining removed parts.

FUEL RAIL

Fuel Rail Location

Fuel rail is located above intake manifold.

Removing the Fuel Rail

Fuel Rail Hose Disconnection

1. Release fuel pressure. Refer to *FUEL PUMP* in *FUEL TANK AND FUEL PUMP* subsection.
2. Place an absorbent shop rag under the fuel supply hose fitting at the fuel rail to catch any fuel leakage.
3. Disconnect fuel hose from fuel rail.

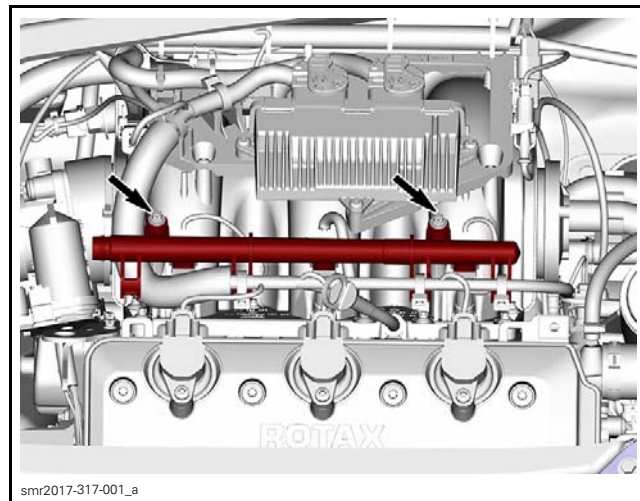
REQUIRED TOOL	
FUEL HOSE DISCONNECT TOOL (P/N 529 036 037)	



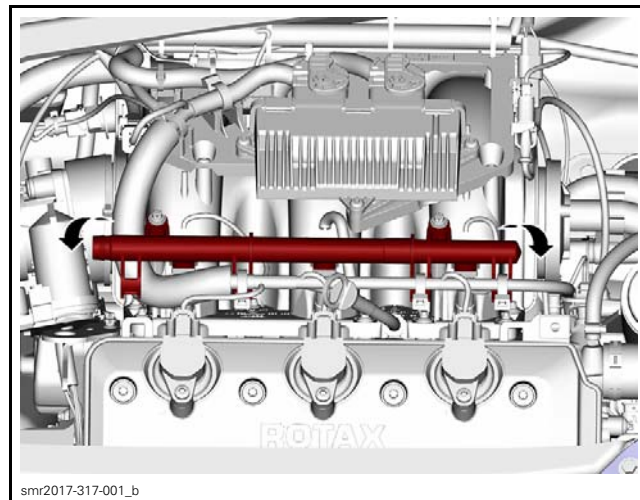
NOTE: It may be necessary to rotate fuel hose fitting to align the tool ends with the openings of the locking mechanism.

Removing the Fuel Rail

1. Cut locking ties retaining engine harness to fuel rail.
2. Remove screws retaining the fuel rail.



3. Gently pull fuel rail side to side (wiggle).



4. Disconnect all injector connectors.
5. Pull fuel rail out with fuel injectors.

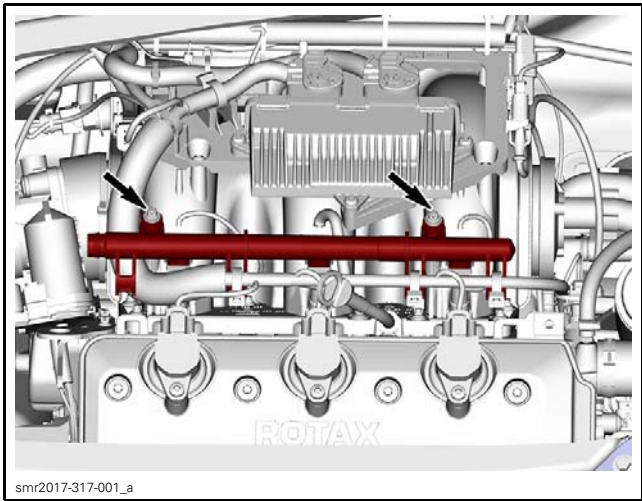
Installing the Fuel Rail

Reverse the removal procedure. However, pay attention to the following.

1. Install fuel rail with injectors.
- Lubricate O-rings of fuel injectors.

FUEL INJECTOR O-RINGS	
Service product	Engine oil

2. Tighten fuel rail retaining screws to specification.

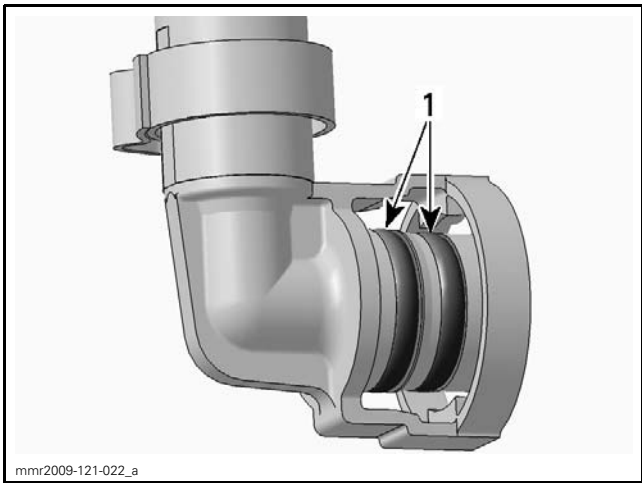


TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
Fuel rail retaining screws	9 N•m ± 1 N•m (80 lbf•in ± 9 lbf•in)

3. Properly install new locking ties to secure engine harness to fuel rail.

Fuel Rail Hose Connection

1. Apply engine oil on O-rings of fitting.



1. Apply oil on O-rings

2. Connect fuel hose to fuel rail.

IMPORTANT: Push fuel hose fitting on fuel rail until you hear a "click". Try pulling fuel hose off fuel rail to ensure fitting is properly locked.

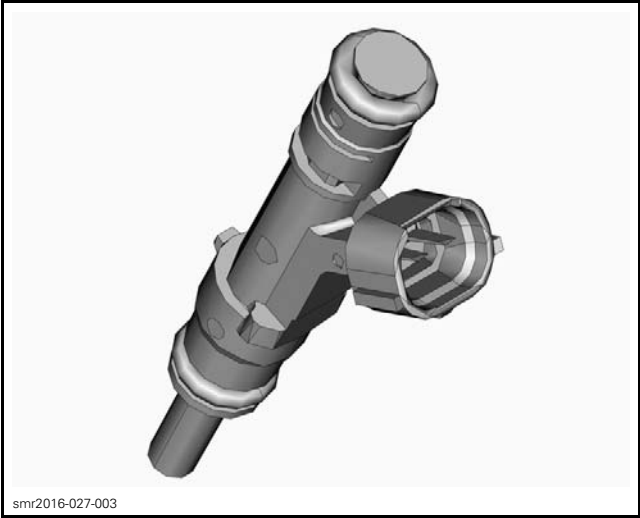
3. Pressurize the fuel system and check for a fuel leak. Refer to *FUEL TANK AND FUEL PUMP* subsection.

WARNING

Failure to pressurize the fuel system may result in severe injury or a life threatening situation should a leak occur.

4. Reinstall all remaining removed parts.

FUEL INJECTOR



Testing the Fuel Injector Operation with BUDS2 (Dynamic)

1. Connect watercraft to BUDS2 software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.*
2. Start engine.
3. In BUDS2, click the following:
 - **Scan** button
 - **Measurements** tab.
4. Using the BUDS2 software, shut down each engine cylinder one at a time by clicking on the button under the applicable cylinder.

If the engine RPM drops when clicking on a cylinder, the injector and the ignition of this cylinder are functioning normally.

If the engine RPM does not drop when clicking on a cylinder, this cylinder is not functioning properly. Check the following:

- Fuel injector operation. Refer to *TESTING THE FUEL INJECTOR OPERATION* in this subsection.
- Spark plug and ignition coil. Refer to *IGNITION SYSTEM* subsection.
- Engine condition.

Testing the Fuel Injector Operation with BUDS2 (Static)

NOTICE After fuel injector activation using BUDS2, always crank engine in drowned mode to ventilate engine and prevent a potential backfire due to fuel accumulation in the engine.

1. Connect watercraft to BUDS2 software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.*
2. Press the START button to wake up the ECM.
3. Install the tether cord on the engine cut-off switch.
4. In BUDS2, click the following:
 - Scan button
 - Functions tab.
5. On the ECM Functions page, energize the fuel injector to be tested by clicking on it in BUDS2.
6. Listen to the injector.

If you can hear the injector, it validates its operation. Carry out *TESTING THE FUEL INJECTOR BALANCE*.

If you do not hear the injector, carry out *TESTING THE INJECTOR INPUT VOLTAGE*.

Testing the Fuel Injector Balance with BUDS2

NOTICE After fuel injector activation using BUDS2, always crank engine in drowned mode to ventilate engine and prevent a potential backfire due to fuel accumulation in engine.

1. Install a fuel pressure gauge as described in *FUEL TANK AND FUEL PUMP* subsection.
2. Connect watercraft to BUDS2 software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.*
3. Press the START button to wake up the ECM.
4. Install tether cord on engine cut-off switch.
5. In BUDS2, click the following:
 - Scan button
 - Functions tab.
6. In BUDS2, click the **Fuel Pump** button to activate fuel pump.
7. Fuel pressure must be within specification. Refer to *FUEL TANK AND FUEL PUMP* subsection. Re-activate fuel pump as necessary.
8. In BUDS2, energize fuel injector **no. 1**.
9. Record the fuel pressure drop for injector **no. 1**.

10. In BUDS2, click the **Fuel Pump** button to activate fuel pump.
11. Repeat the procedure for fuel injectors **no. 2** and **no. 3** and record the pressure drop for each injector.
12. The maximum fuel pressure drop between injectors should not exceed the following specification:

MAXIMUM FUEL PRESSURE DROP ALLOWED BETWEEN FUEL INJECTORS
10 kPa (1.5 PSI)

If pressure drop of any fuel injector is greater than the specification, replace that injector then repeat the test.

13. Using the valve on the fuel pressure gauge, release the pressure in the system (if so equipped).
14. Remove fuel pressure gauge and reinstall removed parts.

Testing the Fuel Injector Input Voltage

1. Open/remove seat.

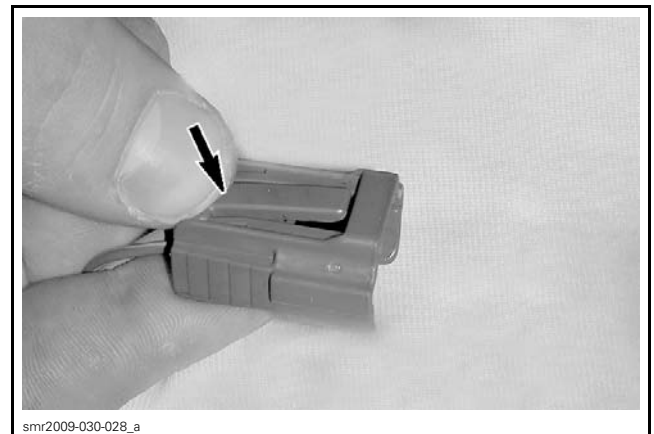
Models with Suspension

2. Remove rear ventilation box. Refer to *BODY* subsection.

All Models

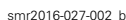
3. Remove ECM from its support.
4. Disconnect fuel injector connectors.

NOTE: Push against tab underneath connector as illustrated to unlock it.



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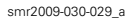
PUSH HERE TO UNLOCK



5. Press the START button to wake up the ECM.
6. Install tether cord on engine cut-off switch.
7. Read input voltage to the applicable injector as per following table.

Set multimeter to Vdc.

PROBE INJECTOR CONNECTOR	MEASUREMENT
VIOLET wire with a tracer to battery ground	Battery voltage



If battery voltage is not measured, check continuity between fuse box and injector as follows.

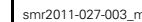
1. Remove cover of fuse box. Refer to *POWER DISTRIBUTION* subsection.

1. Remove cover of fuse box. Refer to *POWER DISTRIBUTION* subsection.

3. Read resistance of the applicable injector circuit as per following table.

Set multimeter to Ω .

INJECTOR	INJECTOR CONNECTOR	FUSE BOX	MEASUREMENT
1 (rear)	VIOLET wire with a tracer	Terminal F7	Close to 0 Ω
2		Terminal F6	
3		Terminal F5	



If continuity is not obtained, first check the fuse and replace as required.

4. If fuse is good, repair/replace wiring and connectors from fuse box to injector. Refer to *WIRING DIAGRAM* subsection.
5. Reinstall bus bar and cover.

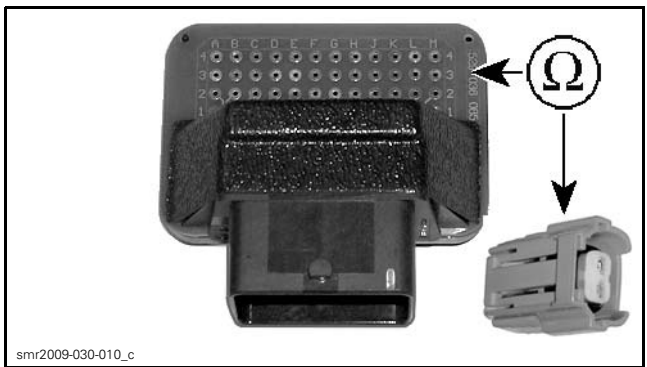
Testing the Fuel Injector Control Circuit

1. Disconnect ECM-A connector.
2. Probe terminals as per following table.

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

Install ECM connector on ECM adapter.
Set multimeter to Ω .

INJECTOR	ECM ADAPTER	INJECTOR	MEASUREMENT
1 (rear)	Pin A-B3	BROWN wire with a tracer	Close to 0 Ω
2	Pin A-K1		
3	Pin A-J1		



If control circuit is at fault, repair or replace wiring and connectors.

If control circuit and all tests applicable to the injector are good, try a new ECM. Refer to *ECM*.

Testing the Fuel Injector Resistance (at ECM Connector)

1. **Reconnect** the injector connector.
2. Disconnect the ECM-A connector.
3. Remove the long bus bar from fuse box.



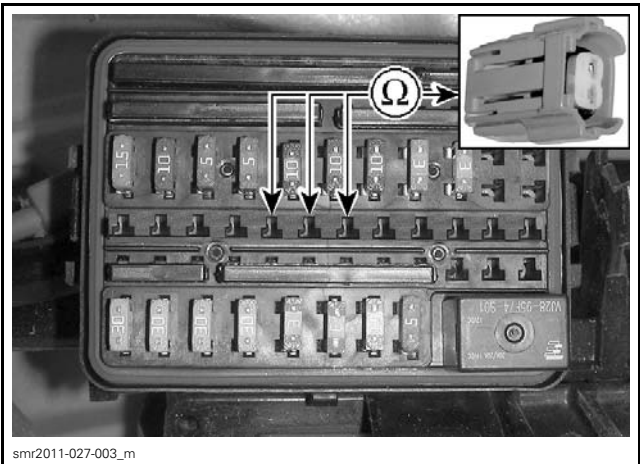
TYPICAL
1. Long bus bar

4. Measure resistance value between terminals as follows.

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

Install ECM connector on ECM adapter.
Set multimeter to Ω .

INJECTOR	FUSE BOX TERMINAL	ECM ADAPTER PIN	RESISTANCE @ 20°C (68°F)
1	F7	A-B3	11.4 - 12.6 Ω
2	F6	A-K1	
3	F5	A-J1	



Subsection XX (ELECTRONIC FUEL INJECTION)

If resistance values are as specified, injector coil is in good condition.

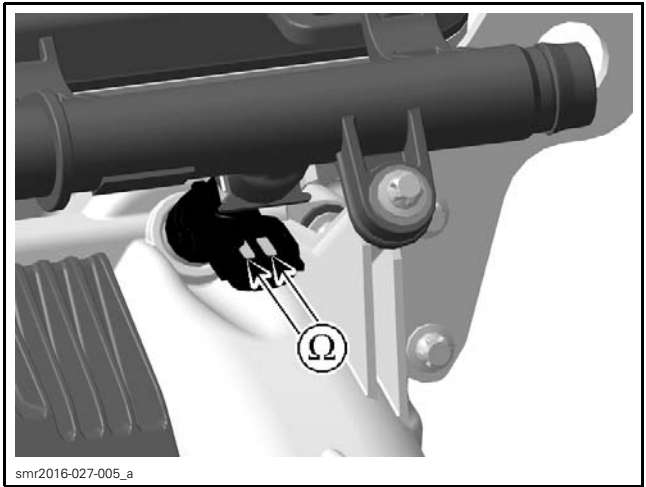
If resistance value are not as specified, repeat test at injector connector.

5. Reinstall bus bar and fuse box cover.

Testing the Fuel Injector Resistance (at Component)

- 1. Remove injector connector.
- 2. Check resistance value between injector pins as per followings table.

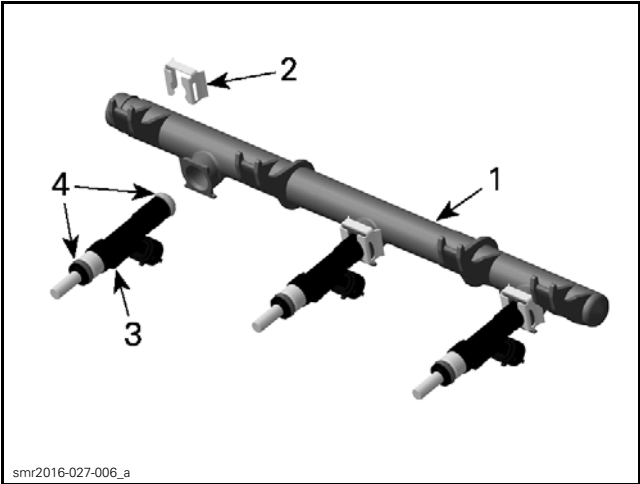
INJECTOR PIN		RESISTANCE @ 20°C (68°F)
1	2	11.4 - 12.6 Ω



If readings are not as specified, replace injector.
If readings are as specified, repair or replace wiring and connectors from ECM to injector.

Removing the Fuel Injector

- 1. Remove fuel rail. Refer to *FUEL RAIL* in this subsection.
- 2. Remove the injector clip.



FUEL RAIL ASSEMBLY

- 1. Fuel rail
- 2. Injector clip
- 3. Fuel injector
- 4. O-rings

- 3. Pull the fuel injector out of the fuel rail.

Installing the Fuel Injector

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

FUEL INJECTOR IDENTIFICATION	
ENGINE	INJECTOR COLOR CODE
1500 Series	Blue

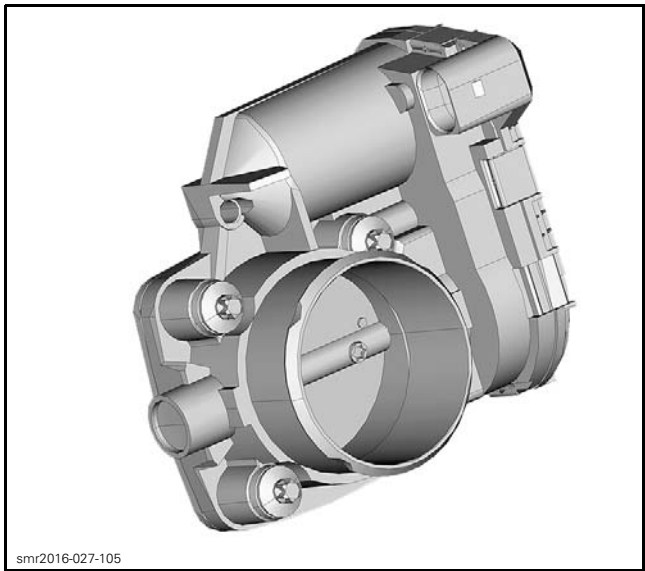
- 1. If you reinstall a used injector replace O-rings with **NEW** ones.
- 2. Apply a thin film of engine oil to O-rings.
- 3. Insert the fuel injector in the fuel rail.
- 4. Secure injector to fuel rail with a retaining clip.
- 5. Install fuel rail on engine. Refer to *FUEL RAIL* in this subsection.
- 6. Pressurize the fuel system and check for a fuel leak. Refer to *FUEL TANK AND FUEL PUMP* subsection.

 **WARNING**

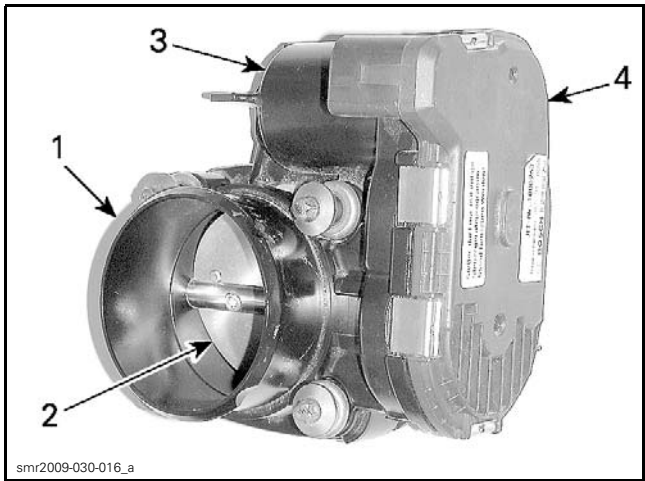
Always carry out a fuel system high pressure leak test after working on the fuel system.

- 7. Reinstall all remaining removed parts, refer to applicable subsections.

THROTTLE BODY



Throttle Body Description



- 1. Throttle body
- 2. Throttle plate
- 3. Throttle actuator (electric motor inside)
- 4. Throttle position sensor (TPS) (inside)

Electronic Throttle Actuator (ETA)

The electronic throttle actuator (ETA) is a DC motor on the throttle body that regulates the throttle plate via a drive gear. Pulse width modulation (PWM) is used to control the motor.

Throttle Plate Operating Positions

Two torsional springs are connected to the throttle plate. A main spring and another one in a plunger mechanism.

When there is no power to the throttle actuator (ETA), the plunger mechanism maintains the throttle plate at a rest position. This also serves as the limp home position.

When the throttle plate is opened by the ETA as commanded by the ECM, it acts against the main spring. If the ETA failed, the return spring would bring the throttle plate back to the limp home position.

ECM	ENGINE	THROTTLE BODY
OFF	Stopped	Throttle actuator: Off. Throttle plate: Rest position, maintained opened at approximately 8° (1). This is also the limp home position.
ON	Not started	Throttle actuator: On. Throttle plate: Moves from the rest position to approximately 14°. It then moves back to the rest position. This is the diagnostic mode where the rest position, actuator opening force to overcome the return springs and the motor return rate are monitored. If any of these parameters are out of range, a fault code is initiated.
ON	Started. Normal operation at idle	Throttle actuator: On. Throttle plate: Moves from the rest position to idle position (approximately 1-3°) according to ECM injection and ignition maps. Throttle plate is opened and closed as necessary to control the idle speed.
ON	Started. Normal operation at various RPM	Throttle actuator: On. Throttle plate: Opens and closes according to ECM torque management priorities.

(1) Degree values are given from the fully closed position.

Throttle-Body Faults and Effects

NOTE: Among other things, a weak or broken spring and a sticky throttle plate (carbon build-up, dried salt water etc) are validated by the throttle body diagnostic mode.

Subsection XX (ELECTRONIC FUEL INJECTION)

FAULT	EFFECT
Partial failure of TAS sensor (one internal sensor only)	Limp home mode. Engine speed limited to idle. ECM will use the remaining TAS sensor. Fault code set and beeper activated to emit warning signals. Check engine light is turned ON. Driveability could be reset by releasing and reapplying the throttle.
Complete failure of TAS sensor (both internal sensors)	Limp home mode. Engine speed limited to 2500 RPM. Fault code set and beeper activated to emit warning signals. Check engine light is turned ON.
Any throttle body failure	Limp home mode. Engine speed limited to 2500 RPM. Engine speed can still be increased up to 3200 RPM using the throttle lever. Fault code set and beeper activated to emit warning signals. Check engine light is turned ON.
NOTE: When one of these faults is active, O.T.A.S. and iBR will continue to monitor their input signals. However, since the engine speed is limited, the O.T.A.S. will not be activated. Also, since the ECM cannot control the throttle body, the iBR may produce a fault since the ECM does not react to its specific torque requests. It all depends on the circumstances when the iBR is applied. (vehicle and engine speed will be a factor).	

Lubricating the Throttle Body

No lubrication is required.

Testing the ETA

Testing the Throttle Body Actuator (ETA) with BUDS2.

NOTE: Use the **Setting** page, to confirm ETA movement. The **Measurements** page will not read the actual ETA movement.

1. Enable electrical system.
2. Connect vehicle to BUDS2.
3. Select the **Setting**, then **ECM** tabs.
4. Slowly depress the throttle lever from the idle to WOT. The ETA should go from 0% to 100%.

If result is out of specification, carry out a *CLOSED THROTTLE RESET*. Refer to *ADJUSTMENT* in this subsection.

NOTE: The ETA is reset at the same time as the TPS.

After the reset, test ETA again.

If the result is still out of specification, check wire continuity between ECM and throttle body before assuming the ETA is at fault.

Inspecting the ETA

Always check for corroded terminals or damaged wiring when diagnosing throttle body problems.

Testing the ETA (Dynamic)

1. Remove the parts required to access the throttle body.
2. Remove the air inlet hose from the throttle body.
3. Observe the throttle plate with the engine stopped.

NOTE: The throttle plate should be in the rest position (slightly opened).

WARNING

Keep your fingers out of the throttle plate area while the ECM turns on. The throttle actuator will cycle. This could cause serious finger injuries as throttle plate quickly moves.

4. As you observe the throttle plate, have someone press the START button to wake up the ECM.

NOTE: The throttle plate should cycle quickly from the rest position to a partially open position (approximately 14°), then back to the rest position.

5. Install the tether cord on the engine cut-off switch.

NOTE: The throttle plate should cycle again.

6. As you observe the throttle plate, have someone gradually and evenly pull in the throttle lever, then release it in the same way.

NOTE: The throttle plate should open then close according to throttle lever position. However, the movement of the throttle plate may not be linear with the displacement of the throttle lever.

If any test failed, proceed with the *TESTING THE THROTTLE BODY (STATIC)*.

Testing the ETA (Static)

⚠ WARNING

First ensure the ECM is off. Do not move the throttle plate using your fingers. Otherwise, if the START button is pressed the ECM turn on and quickly cycle the throttle plate which could cause serious finger injury.

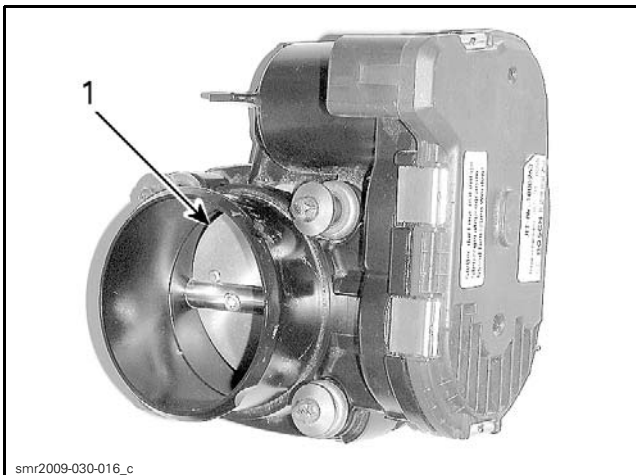
1. Using a blunt tool, push in on the throttle plate and ensure it opens smoothly within the throttle body.



1. Push here to open

NOTE: The throttle plate must open fully and return freely to the rest position (slightly opened) when released.

2. Push throttle plate closed as indicated in following illustration. It must close completely and return freely to the rest position (slightly opened) when released.



1. Push here to close

If the throttle plate does not move smoothly or does not return freely to the rest position, the problem is mechanical. Check for salt accumulation on throttle plate shaft. It may also be an actuator or gear problem. Replace throttle body as necessary.

If throttle plate operates normally, the problem is electrical. Check throttle actuator (ETA) wiring continuity, throttle position sensor (TPS) and throttle accelerator sensor (TAS).

⚠ WARNING

If the throttle plate does not return properly after a proper cleaning, replace the throttle body.

Cleaning the Throttle Body

Remove the parts required to access the throttle body.

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.

Clean as necessary.

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

⚠ WARNING

Use the product in well ventilated area. Refer to product manufacturer's warnings. Wipe off any product leakage in bilge.

To avoid getting dirt into engine, spray cleaner on a clean rag (outside the bilge) then rub rag against throttle plate and bore. A toothbrush works well too.

⚠ WARNING

First ensure ECM is off. Otherwise, if ECM should suddenly turn off, it would quickly close the throttle plate which could cause serious finger injury.

Manually open throttle and hold fully open to reach all surfaces.



WARNING

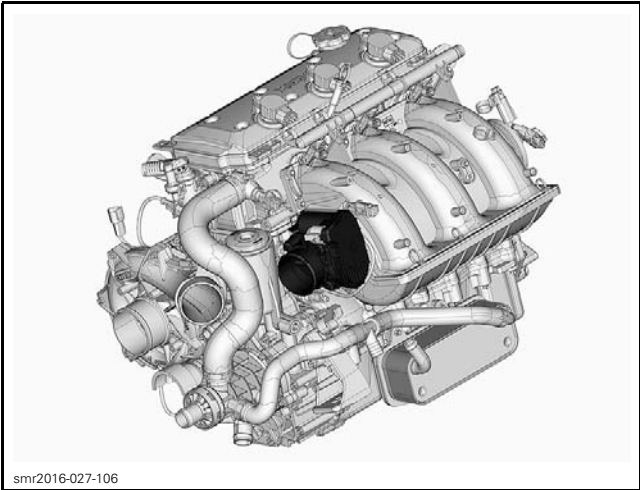
Ensure nobody presses the **START** button. The ECM would turn on and the throttle actuator (ETA) would cycle. This could cause serious finger injury as the throttle plate moves quickly.

To remove residual dirt, spray cleaner on throttle plate and on bore.

Reinstall removed parts.

Throttle Body Replacement

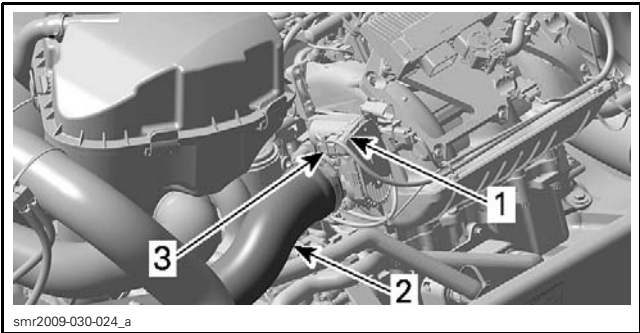
Throttle Body Location



Removing the Throttle Body

1. Disconnect inlet hose from throttle body.
2. Disconnect throttle body connector.

To remove connector from throttle body, press connector locking tab illustrated.

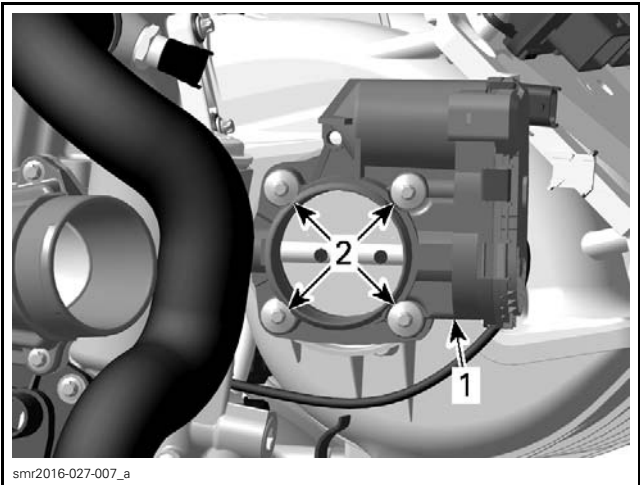


1. Throttle body
2. Inlet hose
3. Connector



PRESS HERE TO UNLOCK

3. Remove retaining screws from throttle body.



1. Throttle body
2. Retaining screws

4. Pull throttle body off intake manifold.

Installing the Throttle Body

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

1. Tighten retaining screws in a criss-cross sequence.

TIGHTENING TORQUE	
Throttle body retaining screws	9 N•m ± 1 N•m (80 lbf•in ± 9 lbf•in)

2. Perform the **Closed Throttle** reset. See procedure in *ADJUSTMENTS* in this subsection.

TPS (THROTTLE POSITION SENSOR)

General

NOTE: The TPS is part of the throttle body.

The throttle position sensor (TPS) is a double potentiometer that sends signals to the ECM that are proportional to the throttle plate angle. The TPS is located inside the throttle body.

Testing the TPS Wear

1. With the engine turned off, slowly pull in throttle lever and pay attention for smooth operation without physical stops.
2. Press the START button to wake up the ECM.
3. Install the tether cord on the engine cut-off switch.
4. Connect watercraft to BUDS2 software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
5. In BUDS2, click the following:
 - **Measurements** tab
 - **ECM** tab.
6. Slowly and regularly depress the throttle lever.
7. Observe the **Throttle Opening** needle movement in BUDS2

NOTE: The needle should move gradually and regularly as you move the throttle lever. If the needle “sticks”, bounces or suddenly drops, it may indicate a worn TPS that needs to be replaced. An initial slight delay after the throttle lever is pulled and before the needle starts to move is normal.

If the needle behavior is not as expected, proceed with the following steps.

8. Manually move the throttle plate in throttle body using a blunt tool (without sharp tip).

WARNING

Do not move throttle plate with your fingers. Otherwise, if ECM should turn off, it would quickly close the throttle plate which could cause serious finger injury.



smr2009-030-016_b

1. Push here

9. Check needle movement again.
 - If needle moves as expected, check the throttle accelerator sensor (TAS). Refer to *INTELLIGENT THROTTLE CONTROL (ITC)* subsection.
 - If needle does not move as expected, perform *TESTING THE TPS RESISTANCE* in this subsection.

Testing the TPS Resistance

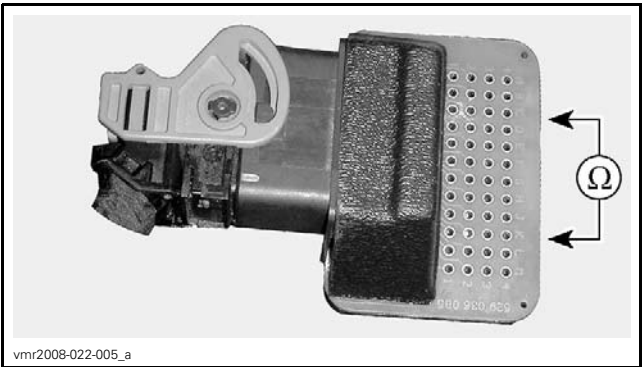
1. Remove the parts required to access the throttle body.
2. Ensure the throttle body connector is properly connected.
3. Disconnect ECM-A connector from the ECM, refer to *ECM ACCESS* in this subsection.
4. Probe circuit as per following table while using a finger to manually move throttle plate.

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

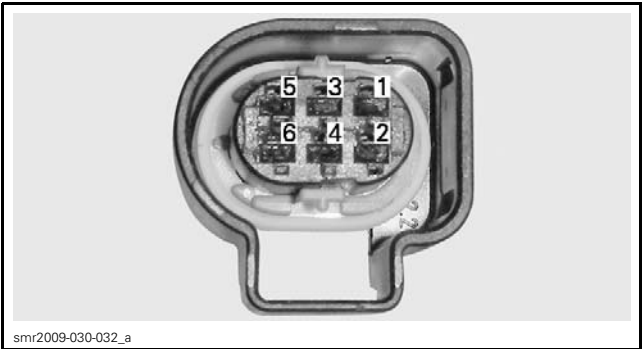
Install ECM connector on ECM adapter.
Set multimeter to Ω .

ECM ADAPTER		FULLY CLOSED THROTTLE PLATE ⁽¹⁾	FULLY OPEN THROTTLE PLATE		
		RESISTANCE (Ω)			
PIN		MIN.	MAX.	MIN.	MAX.
A-A2	A-K4	875	1625	875	1625
A-A2	A-K3	954	1934	228	585
A-A2	A-F3	254	634	980	1983
A-K3	A-K4	228	585	954	1934
A-K3	A-F3	1385	2315	1385	2315
A-K4	A-F3	980	1983	254	634

(1) To obtain the fully closed position, it is necessary to push against the throttle plate in the throttle body with a finger and hold it in this position for the measurement.



If any resistance value is incorrect, check wire continuity between ECM and throttle body before assuming the TPS is at fault. Refer to *WIRING DIAGRAM* subsection.



TPS CONNECTOR PIN-OUT

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

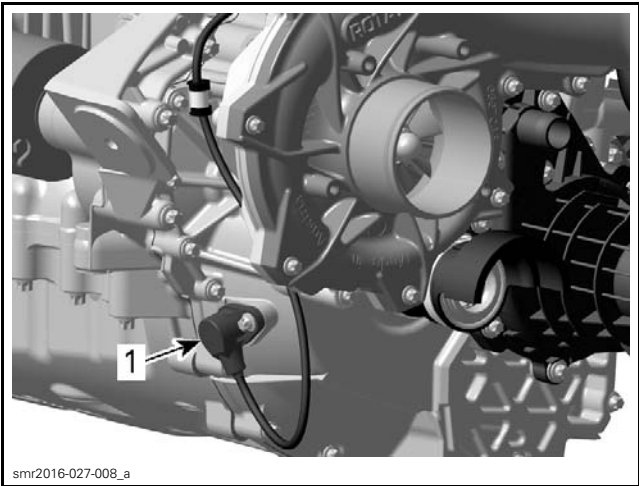
CRANKSHAFT POSITION SENSOR (CPS)

Troubleshooting the CPS

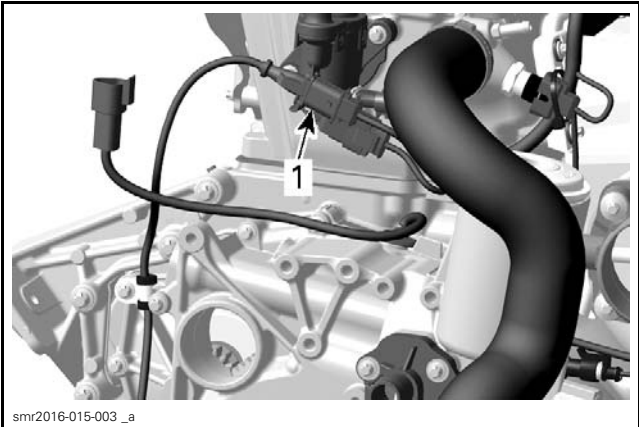
NOTICE Take into account that a CPS fault can be triggered by electronic or mechanical fault:

1. Check for fault codes
2. Test the CPS as per following procedure
3. If it tests good, check trigger wheel teeth condition. Refer to *PTO HOUSING AND MAGNETO* subsection.

CPS and CPS Connector Location



1. Crankshaft Position Sensor (CPS)



SUPERCHARGER REMOVED FOR CLARITY

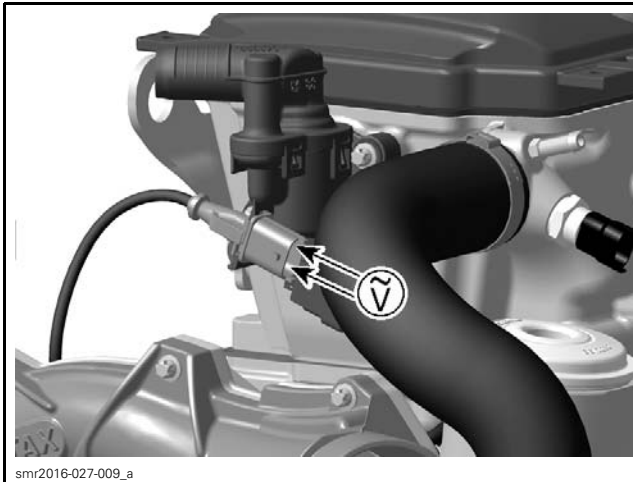
1. CPS connector

Testing the CPS Voltage

1. Disconnect CPS wiring harness connector.
2. Press the START button to wake up the ECM.
3. Install the tether cord on the engine cut-off switch.

4. Pull the throttle lever completely in to the handlebar and hold (drowned mode).
5. While cranking the engine, probe CPS terminals.

CPS CONNECTOR		MEASUREMENT
PIN		VOLTAGE
1	2	Approximately 3.7 Vac



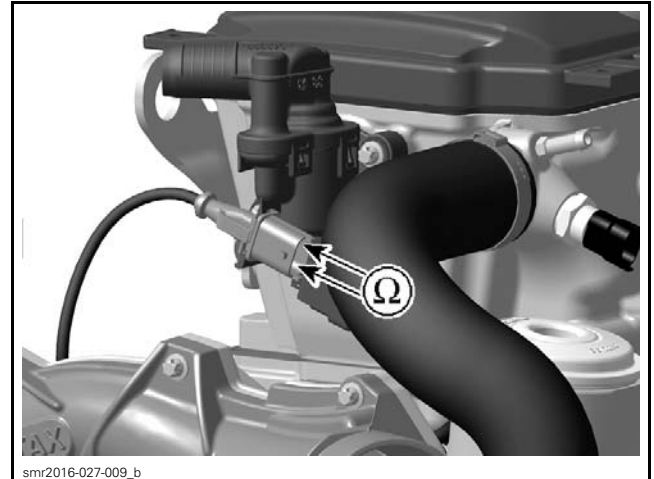
If voltage is not as specified, carry out *TESTING THE CPS RESISTANCE AT CPS CONNECTOR*.

If voltage is as specified, check continuity of wiring between CPS connector and ECM connector. Refer to *TESTING THE CPS RESISTANCE AT ECM CONNECTOR*.

Testing the CPS Resistance at CPS Connector

1. Probe CPS connector terminals as per following table.

CPS CONNECTOR		MEASUREMENT
PIN		RESISTANCE Ω @ 20°C (68°F)
1	2	775 - 950 Ω



If resistance is not within specifications, replace the CPS.

If resistance tests good carry out *TESTING THE CPS RESISTANCE AT ECM CONNECTOR*.

Testing the CPS Resistance at ECM Connector

1. Remove parts required to access ECM-A connector.
2. Disconnect ECM-A connector from the ECM.
3. Probe CPS terminals as per following table.

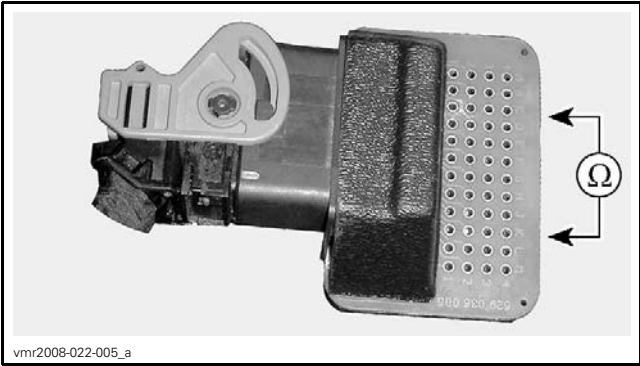
REQUIRED TOOL	
FLUKE 115 MULTIMETER (P/N 529 035 868)	
ECM ADAPTER TOOL (P/N 529 036 166)	

Set multimeter to Ω .

Install ECM connector on ECM adapter.

ECM-A CONNECTOR		MEASUREMENT
PIN		RESISTANCE Ω @ 20°C (68°F)
A-H1	A-K2	775 - 950 Ω

Subsection XX (ELECTRONIC FUEL INJECTION)



If resistance measured is as specified, check ECM. Refer to *ENGINE CONTROL MODULE (ECM)* in this subsection.

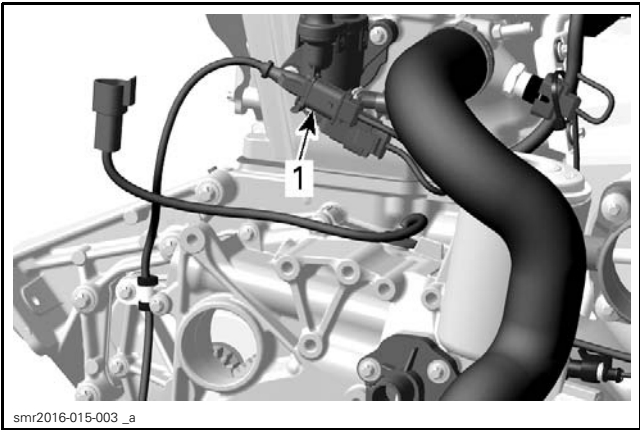
If resistance measured is not as specified, repair or replace wiring and connectors between ECM and the CPS.

Replacing the CPS

- 1. Drain oil from PTO housing. Refer to *PTO HOUSING, MAGNETO AND STARTER*.

NOTE: It is not necessary to drain oil from engine.

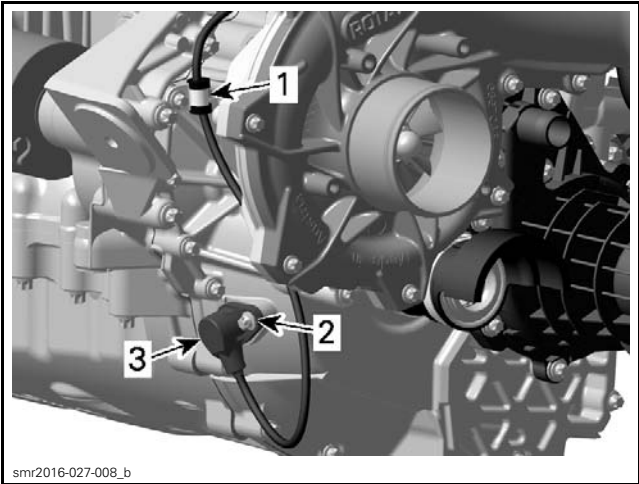
- 2. Disconnect CPS connector.



SUPERCHARGER REMOVED FOR CLARITY

- 1. CPS connector

- 3. Remove CPS harness retaining clamp.
- 4. Remove CPS retaining screw.



- 1. CPS harness retaining clamp
- 2. CPS retaining screw
- 3. CPS

- 5. Pull out CPS.

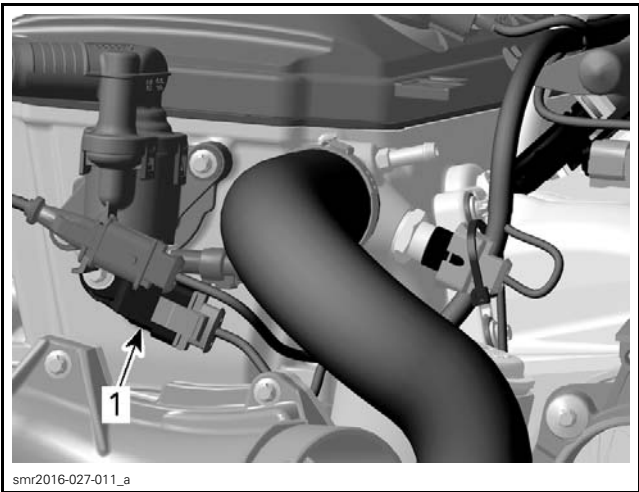
Installation is the reverse removal procedure. However, pay attention to the following.

- 6. Tighten CPS retaining screw to specification.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
CPS retaining screw	9 N•m ± 1 N•m (80 lbf•in ± 9 lbf•in)

- 7. Refill engine oil and check oil level, refer to *LUBRICATION SYSTEM* subsection.

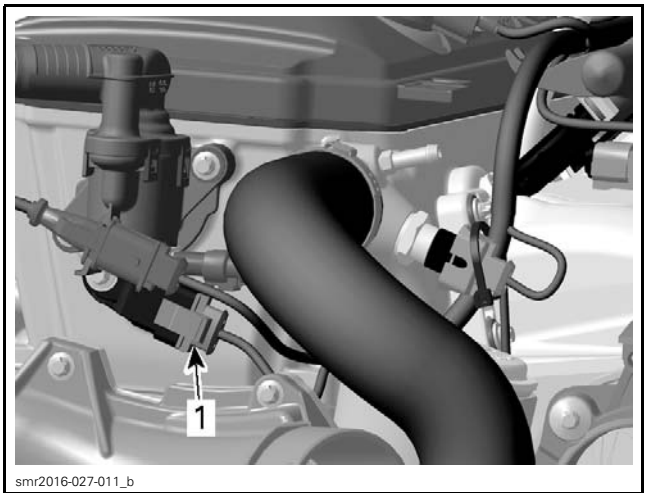
CAMSHAFT POSITION SENSOR (CAPS)



- 1. CAPS

Testing the CAPS Voltage (Harness Side)

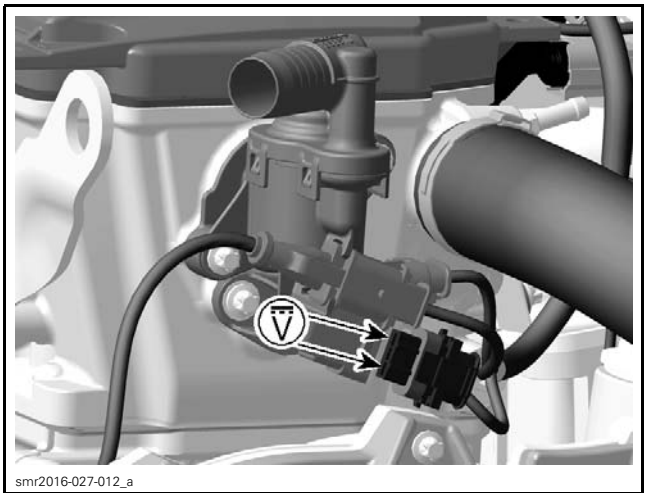
- 1. First check fuse F12 in fuse box. Replace as required.
- 2. Remove the parts required to access the CAPS.
- 3. Disconnect CAPS connector.



1. CAPS connector

- 4. Press the START button to wake up the ECM.
- 5. Install tether cord on engine cut-off switch.
- 6. Probe harness connector terminals as per following table.

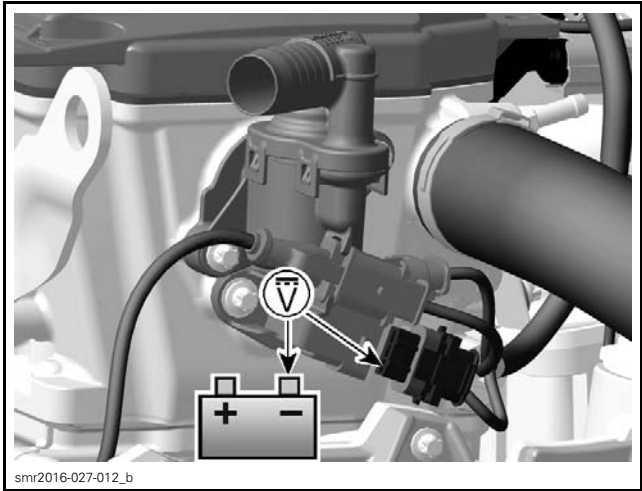
CAPS CONNECTOR		MEASUREMENT
PIN		VOLTAGE
3	1	Battery voltage



If battery voltage is read, proceed with *TESTING THE CAPS (DYNAMIC)* in this subsection.

If battery voltage is not read, probe circuit as per following table.

MEASUREMENT		VOLTAGE
CAPS connector pin 3	Battery ground	Battery voltage

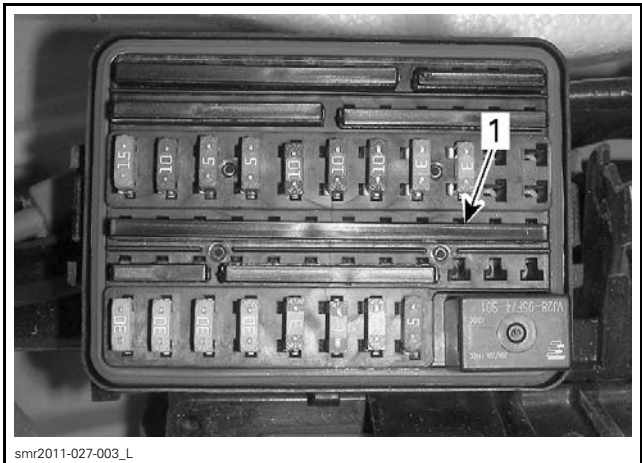


If voltage is read to battery ground, check continuity of ground circuit between CAPS pin 1 and ECM-A connector pin D4. Repair or replace wiring and connectors.

If voltage is not read to battery ground, carry out *TESTING THE CONTINUITY OF CAPS POWER CIRCUIT*.

Testing the Continuity of CAPS Power Circuit

- 1. Remove cover from fuse box. Refer to *POWER DISTRIBUTION*.
- 2. Remove the long bus bar.



1. Pull out

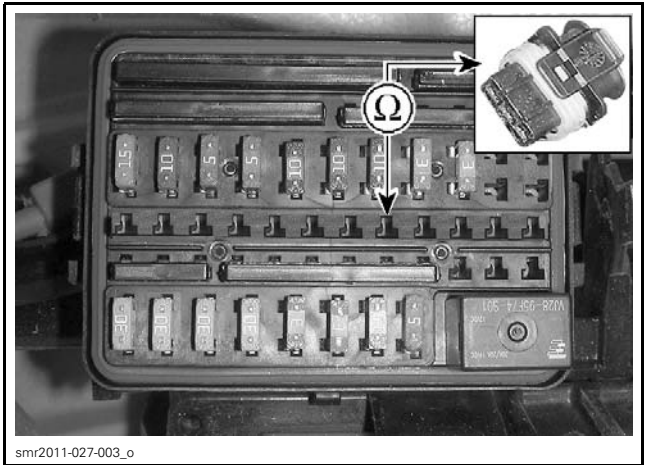
- 3. Read resistance of the CAPS circuit as per following table.

Subsection XX (ELECTRONIC FUEL INJECTION)

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

Set multimeter to Ω .

FUSE BOX	CAPS CONNECTOR	RESISTANCE
TERMINAL	PIN	Ω
H10	3	Close to 0 Ω (continuity)



If continuity is good, wiring and connectors are functional.

If a high resistance or an open circuit is measured, check the short bus bar in fuse box, repair or replace wiring and connectors from fuse box terminal to CAPS connector.

4. Reinstall bus bar and cover.

Testing the CAPS (Dynamic)

1. Remove the parts required to access the CAPS.
2. Remove CAPS sensor from engine.
3. Back-probe connector and read voltage as follows.

NOTE: To safely probe wire terminals through the back of the connector, using following tools or equivalent. Care must be taken not to damage connector seals.

REQUIRED TOOL	
FLUKE AUTOMOTIVE BACK PROBE PIN (P/N TP40)	
FLUKE SUREGRIP INSULATED TEST LEADS (P/N TL224)	

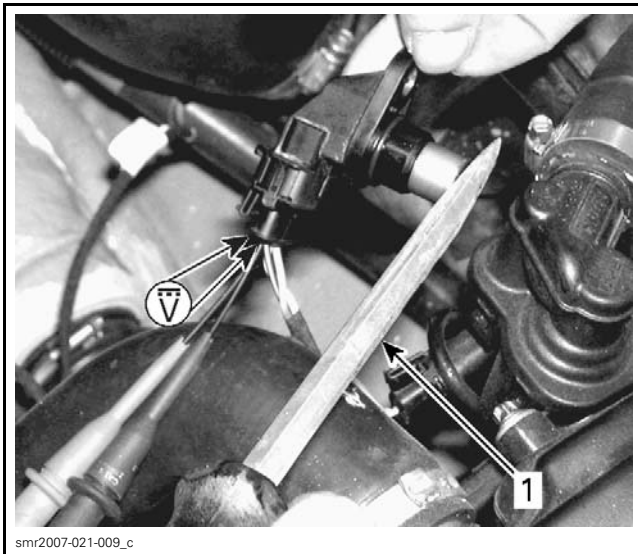
NOTICE Do not use sharp end probes. They could damage the connector seal.

CAPS CONDITION	CAPS CONNECTOR		VOLTAGE
Free	2	1	Close to 12 Vdc



TYPICAL

CAPS CONDITION	CAPS CONNECTOR		VOLTAGE
Metallic object on sensor just for a few seconds	2	1	Close to 0 Vdc



1. Metallic object

NOTE: Check several times if voltage follows the placement of the metallic object. Voltage must change each time.

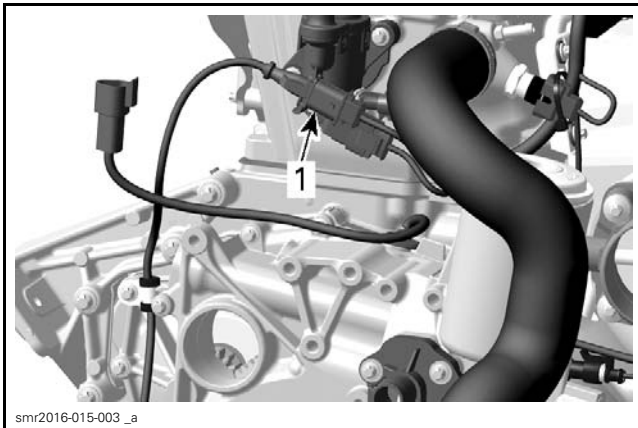
If voltage is as specified, repair or replace wiring and connectors between sensor and ECM.

If wiring is good, check ECM. Refer to *ENGINE CONTROL MODULE (ECM)*.

If voltage is not measured as specified, try a new CAPS.

Replacing the CAPS

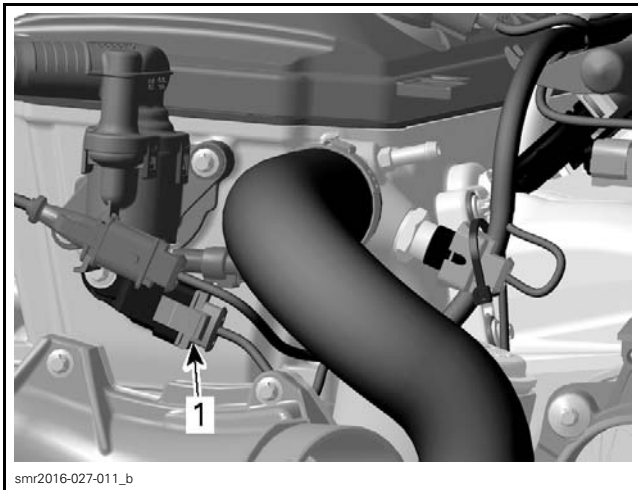
1. Detach CPS connector from its holder.



SUPERCHARGER REMOVED FOR CLARITY

1. CPS connector

2. Disconnect CAPS connector.



1. CAPS connector

3. Unscrew the CAPS retaining screw.
4. Pull CAPS from engine.
5. Install the CAPS.

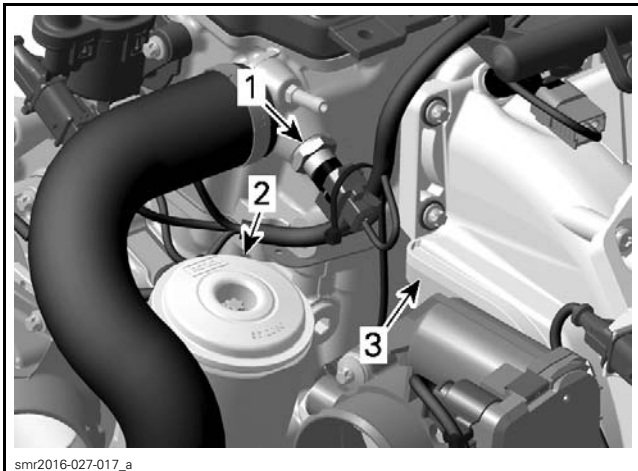
NOTICE Be sure to install new O-ring on a reused CAPS.

6. Tighten CAPS retaining screw to specification.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
CAPS retaining screw	9 N•m ± 1 N•m (80 lbf•in ± 9 lbf•in)

COOLANT TEMPERATURE SENSOR (CTS)

The CTS is located between the intake manifold and the oil filter cover.



1. Coolant temperature sensor (CTS)
2. Oil filter cover
3. Intake manifold

Subsection XX (ELECTRONIC FUEL INJECTION)

NOTE: The CTS will cause the engine overheat warning to come on when the coolant temperature is above:

OVERHEAT TEMPERATURE
110°C (230°F)

Check for debris or blockage in cooling system.

CTS Quick Test

- 1. Connect the vehicle BUDS2 Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
- 2. In BUDS2, select the following:
 - Scan button
 - Measurements page tab
 - ECM page.

3. Look for the engine temperature indication.
The engine temperature gauge in BUDS2 should provide an indication of the actual engine coolant temperature. Otherwise, test the *CTS RESISTANCE*.

Testing the CTS Resistance

- 1. Remove parts required to access ECM connectors.
- 2. Disconnect the ECM-A connector.
- 3. Check the CTS circuit resistance as per table.

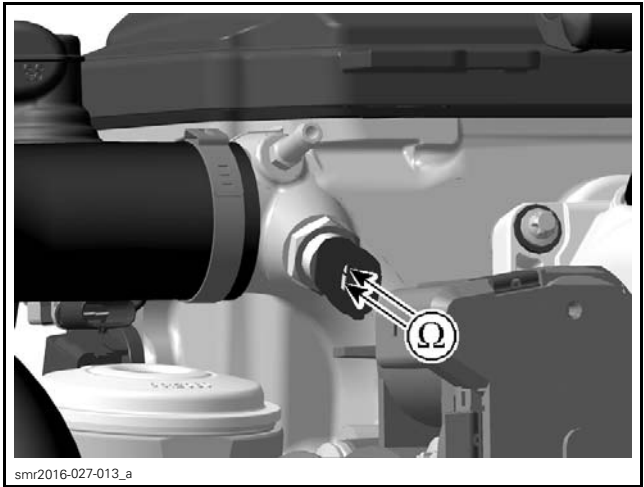
REQUIRED TOOL	
FLUKE 115 MULTIMETER (P/N 529 035 868)	
ECM ADAPTER TOOL (P/N 529 036 166)	

Set multimeter to Ω.
Install ECM connector on ECM adapter.

CTS RESISTANCE TEST		
ECM ADAPTER PIN		RESISTANCE Ω
A-A1	A-J2	See <i>CTS TEMPERATURE SENSOR TABLE</i>

- If resistance test is good, replace the ECM.
If resistance is out of specification, proceed with the following steps.
- 4. Remove the parts required to access the CTS.
 - 5. Disconnect the CTS connector.

- 6. Check continuity of wiring between ECM and CTS connector, refer to *WIRING DIAGRAM*. If there is an open circuit, repair or replace wiring and connectors.
- 7. If continuity of wiring is good, test the resistance of the sensor as per following tables.



CTS RESISTANCE TEST		
CTS SENSOR PIN		RESISTANCE Ω
1	2	See <i>CTS TEMPERATURE SENSOR TABLE</i>

CTS TEMPERATURE SENSOR TABLE			
TEMPERATURE		RESISTANCE (OHMS)	
°C	°F	LOW	HIGH
- 40	- 40	38457	52630
- 10	14	8208	10656
20	68	2233	2780
80	176	297	349
120	248	105	122

NOTE: To test sensor at various temperatures, remove sensor and use a heat gun, ice and a thermometer. Refer to *REPLACING THE CTS*.

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

If the resistance value is not within specification replace CTS.

Replacing the CTS

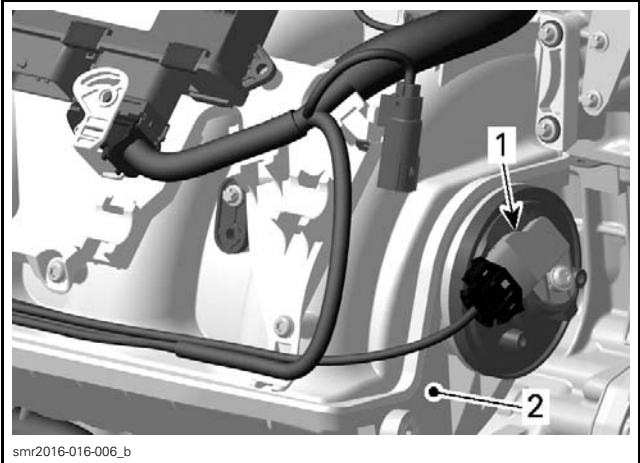
1. Drain engine coolant to below CTS level, refer to *COOLING SYSTEM* subsection.
2. Cut locking tie on wiring harness and move wiring aside for access. Be sure to take note of their position.
3. Disconnect CTS connector and remove CTS.
4. Install the new CTS and tighten to specification.

TIGHTENING TORQUE	
Coolant temperature switch	17 N•m ± 2 N•m (150 lbf•in ± 18 lbf•in)

5. Reinstall remaining removed parts. Be sure to secure wiring harness as noted prior to removal.
6. Refill and bleed the cooling system, refer to *COOLING SYSTEM* subsection.
7. Reinstall remaining removed parts.

MANIFOLD ABSOLUTE PRESSURE AND TEMPERATURE SENSOR (MAPTS)

NOTE: This sensor is a multifunction device. It measures manifold absolute pressure and intake air temperature for air flow calculations.



FRONT SIDE OF ENGINE

1. Manifold absolute pressure and temperature sensor (MAPTS)
2. Intake manifold

MAPTS Pressure Function

NOTE: This sensor is a dual function device. Before the engine is started, when power is applied to the system, the sensor measures the ambient atmospheric pressure and stores it in the ECM. Thereafter, once the engine is started, it measures the air pressure in the intake manifold at operating RPMs.

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

MAPTS Pressure Function Quick Test

1. Connect vehicle to BUDS2 software.
2. In BUDS2, select the following:
 - Scan
 - Measurements tab
 - ECM tab.
3. Look for and take note of the MAPTS pressure reading while the engine is stopped.

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

Subsection XX (ELECTRONIC FUEL INJECTION)

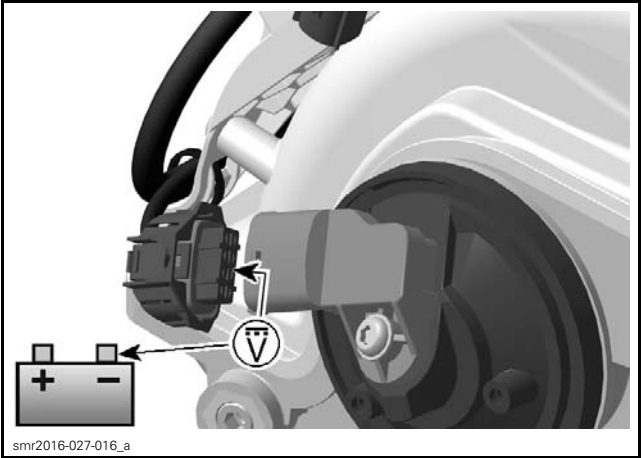
MAPTS PRESSURE FUNCTION QUICK TEST			
RESULT	SERVICE ACTION		
NO READING	Circuit Continuity Test of MAPTS Pressure Function	MAPTS Input Voltage Test	Repair or replace wiring
VALUE IS OUT OF RANGE	Replace MAPTS		

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

Testing the MAPTS Input Voltage (Pressure Function)

- 1. Remove the parts required to access the MAPTS.
- 2. Disconnect connector from MAPTS.

MAPTS CONNECTOR	VOLTAGE
Terminal 3 to battery ground	Approx. 5 V
Terminal 4 to battery ground	Approx. 0 V
Terminal 1 to battery ground	Approx. 0 V



If voltage measured is as specified, replace the MAPTS.

If voltage measured is not as specified, refer to *TESTING THE CONTINUITY OF MAPTS WIRING HARNESS (PRESSURE FUNCTION)*.

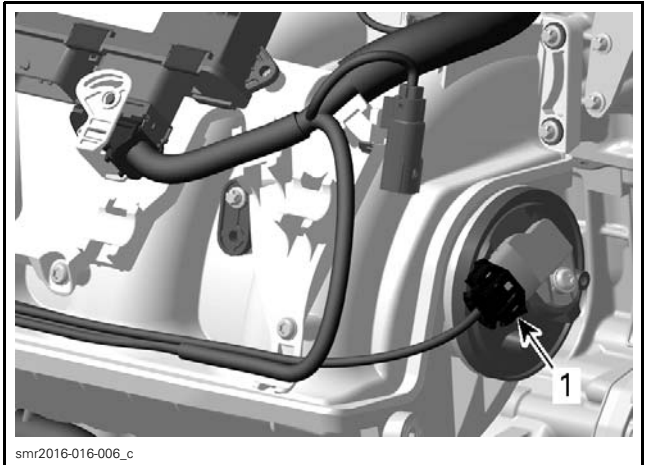
Testing the Continuity of MAPTS Wiring Harness (Pressure Function)

- 1. Disconnect ECM-A connector from the ECM.
- 2. Test for circuit continuity as per following table.

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

Install ECM connector on ECM adapter.
Set multimeter to Ω .

MAPTS CONNECTOR	ECM CONNECTOR	RESISTANCE
Pin 1	A-H2	Close to 0 Ω continuity
Pin 3	A-B4	
Pin 4	A-G4	

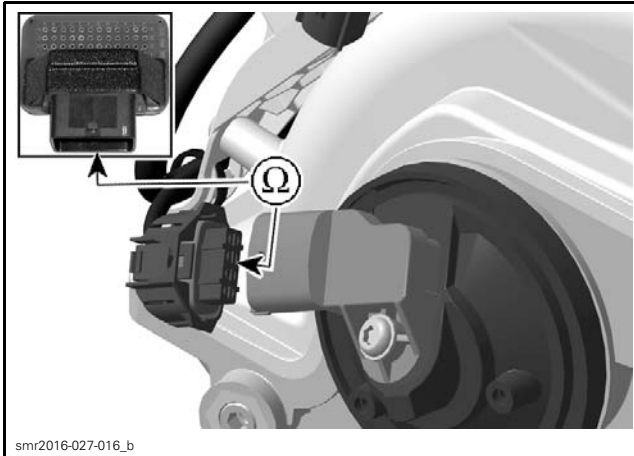


1. MAPTS connector

- 3. Press the START button to wake up the ECM.
- 4. Install the tether cord on the engine cut-off switch.
- 5. Read voltage as per following table.

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

Set multimeter to Vdc.



If resistance is not within specification, repair or replace the wiring harness between ECM connector and the MAPTS. Refer to *WIRING DIAGRAM*.

MAPTS Temperature Function

The sensor monitors the air temperature inside the intake manifold.

MAPTS Quick Test (Temperature Function)

1. Connect vehicle to BUDS2 software.
2. In BUDS2, select the following:
 - Scan
 - Measurements tab
 - ECM tab.
3. Look for the **Intake Air** temperature reading while the engine is stopped.

NOTE: If the complete vehicle is at room temperature, BUDS2 should display the ambient air temperature at the intake manifold.

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

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

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

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

Testing the MAPTS Resistance (Temperature Function)

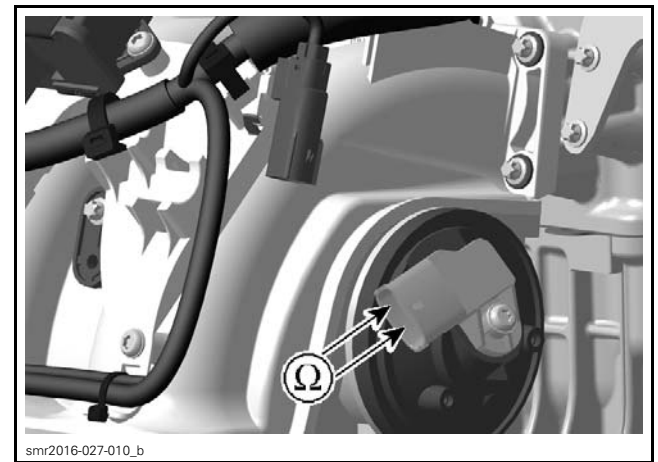
Disconnect the connector from the MAPTS.

Check the resistance of the sensor itself as shown.

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

Set multimeter to Ω .

MAPTS		MEASUREMENT
PIN		
1	2	Refer to MAPTS TEMPERATURE SENSOR TABLE



MAPTS TEMPERATURE SENSOR TABLE			
TEMPERATURE		RESISTANCE (OHMS)	
°C	°F	LOW	HIGH
- 40	- 40	40528	56935
- 10	14	8103	10919
20	68	2193	2863
80	176	294	368
120	248	98	122

If resistance is not within specification, replace the MAPTS.

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

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

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

Install ECM connector on ECM adapter.

ECM CONNECTOR		MEASUREMENT
PIN		
A-H2	A-H3	Refer to MAPTS TEMPERATURE SENSOR TABLE

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		
CORRECT RESISTANCE VALUE	Try a new ECM		

Testing the MAPTS Circuit Continuity (Temperature Function)

MAPTS CIRCUIT CONTINUITY TEST (TEMPERATURE FUNCTION)		
ECM-A	MAPTS CONNECTOR	RESISTANCE VALUE
Pin H2	Pin 1	Close to 0 Ω
Pin H3	Pin 2	

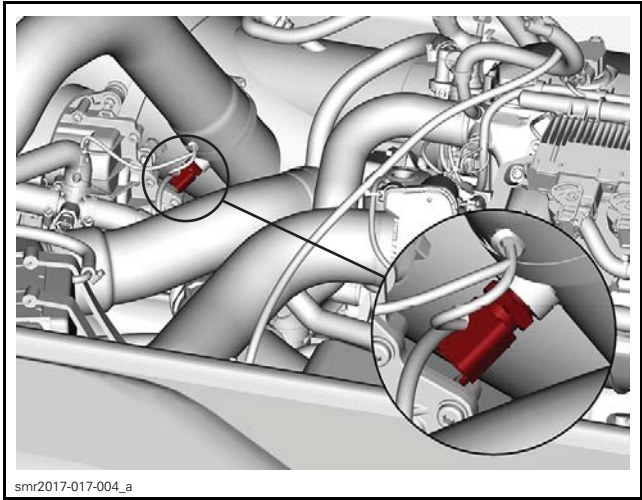
Replacing theMAPTS

- 1. Disconnect MAPTS connector and remove the MAPTS.
- 2. Install the new MAPTS paying attention to index its tab into the adaptor notch.
- 3. Tighten retaining screw to specification.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
MAPTS retaining screw	5.5 N•m ± 0.6 N•m (49 lbf•in ± 5 lbf•in)

- 4. Reinstall remaining parts removed, refer to applicable subsections.

EXHAUST GAS TEMPERATURE SENSOR (EGTS)

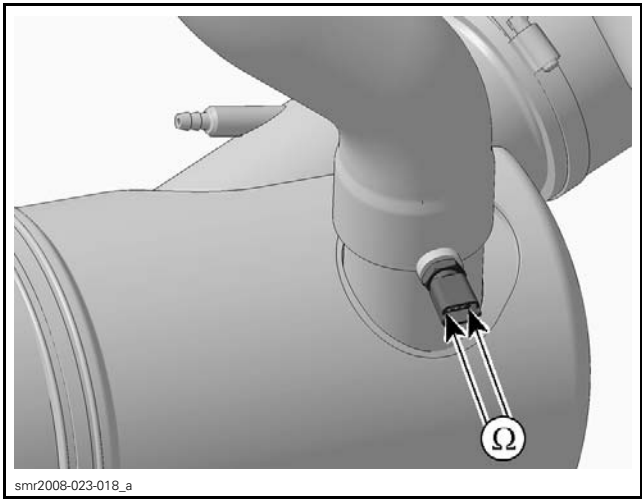


NOTE: An overheat signal will come on in the information center when the exhaust temperature reaches.

OVERHEAT TEMPERATURE
110°C (230°F)

Testing the EGTS Resistance

- 1. Remove the parts required to access the EGTS.
- 2. Disconnect the connector from the EGTS.
- 3. Measure the resistance of the sensor.



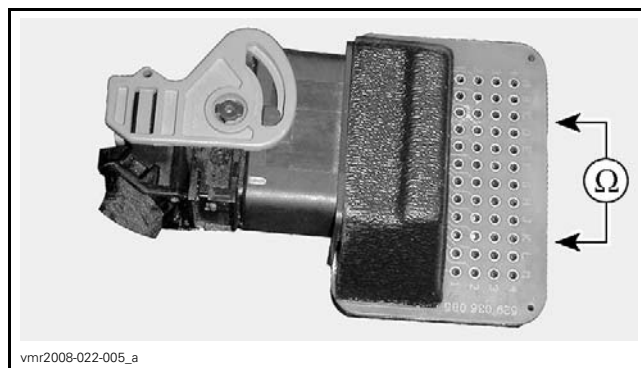
The resistance should be as per the *EGTS RESISTANCE CHART* that follows. Otherwise, replace the EGTS.

If the EGTS resistance is within specifications, proceed with the following steps.

4. Reconnect the EGTS and disconnect ECM-A connector from the ECM.
5. Using a multimeter and the ECM ADAPTER TOOL (P/N 529 036 166), check the circuit resistance as per following table.

ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE Ω
B-F3	B-G4	See <i>EGTS RESISTANCE CHART</i>

EGTS RESISTANCE CHART				
TEMPERATURE		RESISTANCE (OHMS)		
°C	°F	NOMINAL	LOW	HIGH
- 30	- 22	12600	11800	13400
- 20	- 4	11400	11000	11800
- 10	14	9500	8000	11,000
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

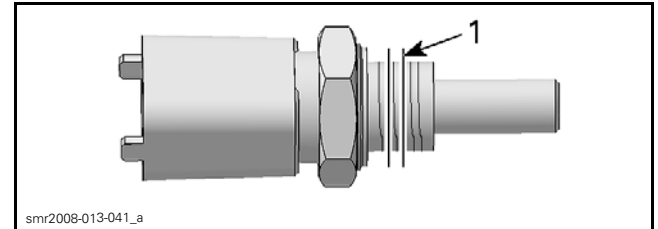


If resistance value is as specified, check ECM. Refer to *ENGINE CONTROL MODULE (ECM)* in this subsection.

If resistance value is not within specifications, repair or replace wiring and connectors between the ECM and the EGTS.

Replacing the EGTS

1. Disconnect the EGTS connector.
2. Unscrew EGTS from muffler.
3. Apply LOCTITE 518 (P/N 293 800 038) on the middle threads of the new EGTS.



1. Apply Loctite 518 in this area

4. Install the EGTS.

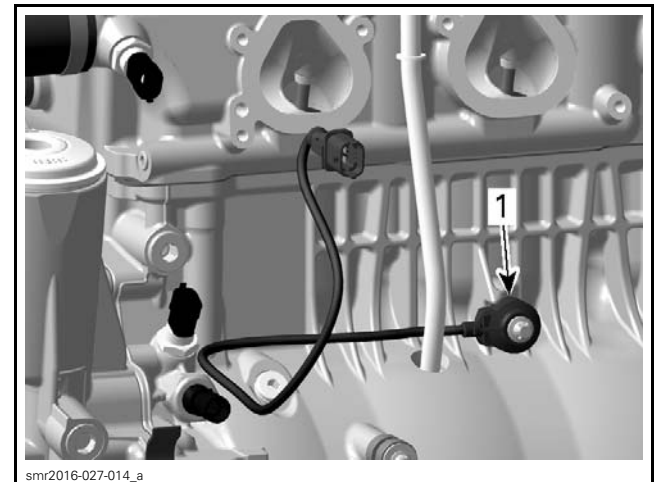
TIGHTENING TORQUE	
EGTS	16 N•m (142 lbf•in)

5. Install the EGTS connector.
6. Install all other removed parts, refer to applicable subsections.

KNOCK SENSOR (KS)

Knock Sensor Location

The KS is located in the cylinder block behind the intake manifold



1. Knock sensor (KS)

Testing the KS (Dynamic)

1. Connect watercraft to BUDS2 software, refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.

Subsection XX (ELECTRONIC FUEL INJECTION)

2. In BUDS2, click the **Faults** tab and look for a **Knock sensor fault**.

3. Start engine and throttle it to above 5000 RPM.

NOTE: The engine must not run out of the water without providing proper cooling to the exhaust system. Maximum engine run time out of water is 2 minutes. Failure to do so may result in damage to the exhaust system and engine. Refer to *EXHAUST SYSTEM* subsection.

4. Using the BUDS2 software, monitor the knock sensor for a fault code.

If no fault occurs, the knock sensor is good.

If a fault occurs, carry out the following steps.

5. Ensure sensor and cylinder block contact surfaces are clean.

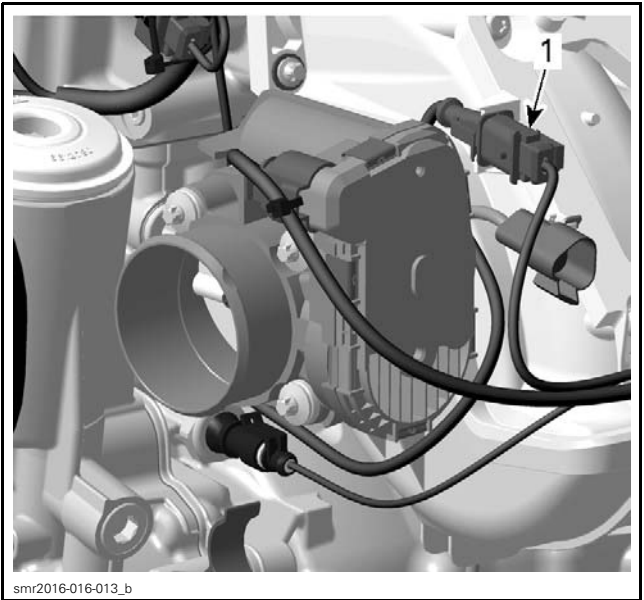
6. Ensure the correct mounting bolt and washer are used and are properly torqued.

NOTE: It is necessary to remove the intake manifold to inspect the contact surfaces. Refer to *IN-TAKE MANIFOLD* subsection.

7. Check the knock sensor resistance, refer to *TESTING THE KS RESISTANCE*.

Testing the KS Resistance

- 1. Remove parts required to access knock sensor,
- 2. Disconnect the knock sensor connector.

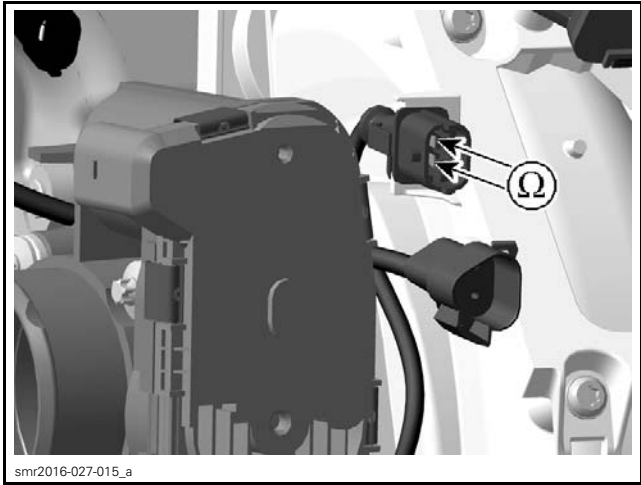


1. KS connector

3. Measure the resistance between the knock sensor terminals.

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

Set multimeter to Ω .



KNOCK SENSOR RESISTANCE @ 20°C (68°F)
Approximately 5 M Ω

If resistance is not as specified, replace knock sensor.

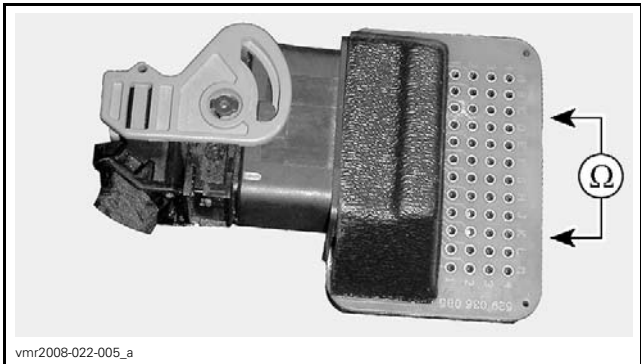
If resistance is as specified, carry on with the following steps.

- 4. Reconnect the knock sensor connector.
- 5. Disconnect ECM-A connector.
- 6. Check circuit resistance through the knock sensor as per following table.

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

Install ECM connector on ECM adapter.

ECM ADAPTER		MEASUREMENT
PIN		RESISTANCE @ 20°C (68°F)
A-C3	A-G2	Approximately 5 M Ω

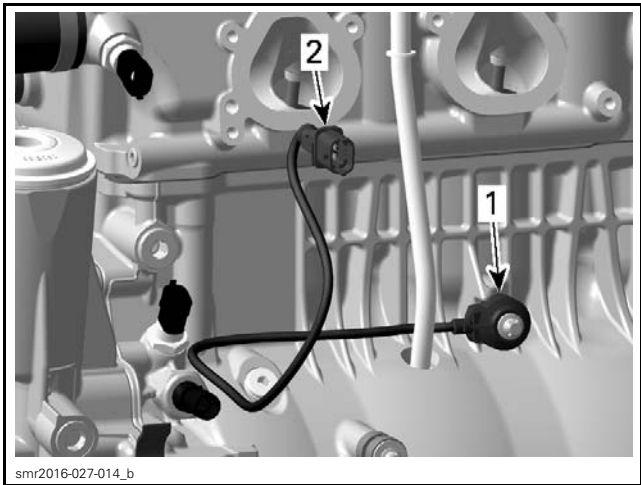


If wiring harness is good, check ECM. Refer to *ENGINE CONTROL MODULE (ECM)* in this section.

If an open circuit is measured, repair or replace wiring and connectors between ECM and knock sensor.

Replacing the KS

1. Disconnect KS sensor connector.



TYPICAL - INTAKE MANIFOLD REMOVED

1. Knock sensor
2. Knock sensor connector

2. Unscrew and remove knock sensor from engine.
3. Clean contact surfaces.
4. Apply thread locker in threaded hole.
5. Install the new knock sensor and tighten retaining screw to specification.

NOTICE Improper torque may interfere with knock sensor operation and lead to severe internal engine damage.

TIGHTENING TORQUE	
Service product	LOCTITE 243 (BLUE) (P/N 293 800 060)
KS retaining screw	23 N•m ± 3 N•m (17 lbf•ft ± 2 lbf•ft)

6. Reconnect knock sensor connector.
7. Reinstall remaining removed parts, refer to applicable subsections.