

IGNITION SYSTEM

SERVICE TOOLS

Description	Part Number	Page
D.E.S.S. POST REMOVER	529 035 943	256
ECM ADAPTER TOOL.....	529 036 166	252, 255
FLUKE 115 MULTIMETER	529 035 868	252, 255

SERVICE PRODUCTS

Description	Part Number	Page
LOCTITE 767 (ANTISEIZE LUBRICANT)	293 800 070	255

GENERAL

WARNING

Torque wrench tightening specifications must be strictly adhered to.
Locking devices when removed (e.g.: locking tabs, elastic stop nuts, self-locking fasteners, cotter pins, etc.) must be replaced.

Hoses, cables or locking ties removed during a procedure must be reinstalled as per factory standards.

WARNING

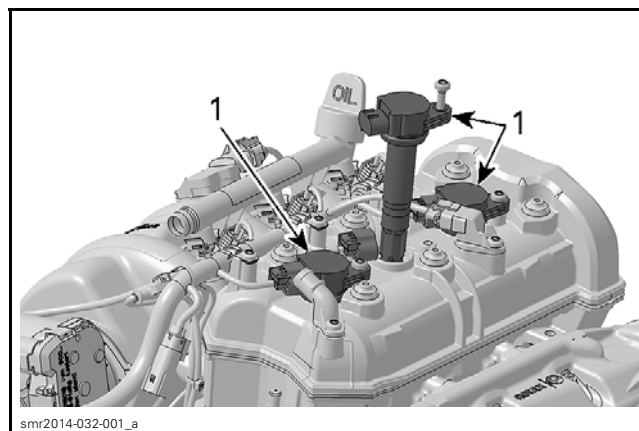
Never check for engine ignition spark from an open coil and/or spark plug as spark may cause potential fuel vapors to ignite. Always use an approved spark tester.

SYSTEM DESCRIPTION

The ignition system is a digital inductive type (IDI) system.

Ignition system parameters such as ignition timing, spark duration, and firing order, as well as many other engine related functions are controlled by the engine management system (EMS) in order to meet engine operational requirements. The EMS can detect many abnormalities including a short circuit in the primary winding of the ignition coils as well as its associated circuits.

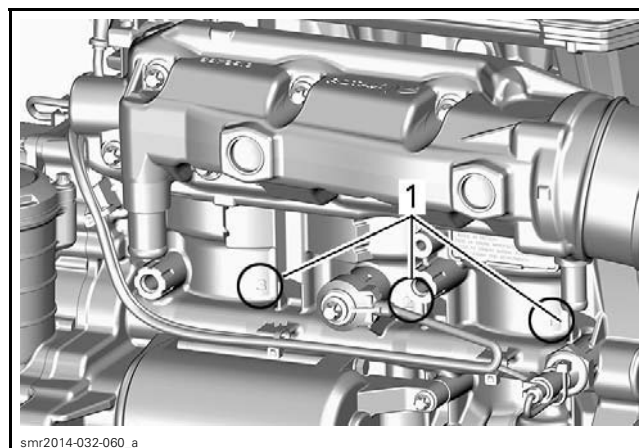
Three direct ignition coils receive power from the fuse F3 through the relay.



1. Ignition coils

When a ground signal is provided by the ECM to an ignition coil primary winding, a high voltage is induced in the coil secondary winding that is used to produce a spark at the spark plug electrode.

Cylinder 1 is located on the PTO side of the engine. Each cylinder is identified by a number on cylinder block housing.



1. Cylinder identification numbers

Ignition Timing

Ignition timing is not adjustable.
The ECM is programmed with data (ignition mappings) that it uses to establish optimum ignition timing under all engine operating conditions.
It receives signals from a variety of sensors that it compares with the ignition mappings and uses it to control the ignition spark timing, duration and firing order.
The firing of each spark plug is independent of the others.

Engine RPM Limiter

The ECM will limit the maximum engine speed by cutting off ignition spark and fuel at a predetermined engine RPM.

Table with 2 columns: ENGINE SPEED LIMITER SETTING, 8300 RPM

Knock Sensor

A knock sensor is mounted on the cylinder block below the exhaust manifold. It detects specific vibrations that would typically be generated by engine detonation.
If detonation occurs, the knock sensor detects it and the ECM goes into a specific operating mode whereby it temporarily retards the ignition advance until detonation stops.
The ECM is able to identify in which cylinder the knocking occurs and modifies the ignition advance on that cylinder only.
Refer to the ELECTRONIC FUEL INJECTION (EFI) subsection for testing and replacement procedures.

TROUBLESHOOTING

It is good practice to check for fault codes using the B.U.D.S. as a first troubleshooting step. Refer to DIAGNOSTIC AND FAULT CODES subsection.
Refer to POWER DISTRIBUTION for fuses and relay information.
Always refer to the WIRING DIAGRAM when troubleshooting an electrical circuit.

IGNITION SYSTEM TESTING

The ECM controls the ignition system.
If a fault is detected by the ECM, the check engine light will turn on.
The ECM can detect a problem on the primary winding or circuit of the ignition coils.

The secondary winding of the ignition coils is not monitored by the ECM.
Other sensors in relation with the ignition system are also monitored by the ECM.

Ignition System Testing Sequence

Check for fault codes using B.U.D.S. software as a first troubleshooting step. Refer to DIAGNOSTIC SYSTEM AND FAULT CODES subsection.
Ensure fuse F3 and relay are powered and in good condition.
If a fuse is burnt, test for a short circuit or faulty component on that fuse circuit before replacing the fuse.

WARNING
Due to the possibility of flammable vapors accumulating in the bilge, you should always test for a short circuit which may produce a spark and ignite the vapors before replacing a burnt fuse.

Check ignition spark, refer to IGNITION COIL QUICK TEST USING B.U.D.S. in this subsection.

DIAGNOSTIC GUIDELINES

The following is provided to help in diagnosing the probable cause of a problem. It is a guideline and should not be assumed to list all possible causes.

ENGINE WILL NOT STOP WHEN REMOVING KEY FROM ENGINE CUT-OFF SWITCH

- 1. Defective engine cut-off switch
- Check engine cut-off switch. Replace if necessary.

ENGINE WILL NOT START (ENGINE TURNS OVER)

- 1. Fouled or defective spark plug
- Check spark plug condition. Replace if necessary.
- 2. Defective CPS
- Test CPS, refer to ELECTRONIC FUEL INJECTION (EFI) subsection.
- 3. Defective trigger wheel
- Check. Refer to MAGNETO AND STARTER subsection.
- 4. Defective ignition circuit
- Check fuses, ignition coils, wiring and connectors.

ENGINE HARD TO START

1. Faulty, fouled or worn out spark plug
 - Check spark plug condition. Replace if necessary.
2. Drowned engine
 - Check engine temperature value using B.U.D.S. monitoring page. If the temperature read is lower than the ambient temperature, CTS sensor may be defective or have a bad connection. Therefore, the ECM would erroneously set the engine in cold start mode and it could flood the spark plugs.

ENGINE MISFIRES, RUNS IRREGULARLY

1. Fouled, defective, worn spark plugs
 - Check spark plug condition. Replace if necessary.
2. Damaged trigger wheel/loose CPS
 - Check. Refer to MAGNETO AND STARTER subsection.
3. Defective ignition circuit
 - Check fuses, ignition coils, wiring and connectors.
4. Poor engine grounds
 - Check ground condition, refer to POWER DISTRIBUTION AND GROUNDS subsection.

ENGINE CONTINUALLY BACKFIRES

1. Fouled, defective spark plugs
 - Check spark plug condition. Replace if necessary.
2. Damaged trigger wheel/defective or loose CPS
 - Check, refer to MAGNETO AND STARTER and ELECTRONIC FUEL INJECTION (EFI) subsections.

ENGINE DETONATION OR PINGING

1. Faulty or disconnected knock sensor
 - Check, refer to ELECTRONIC FUEL INJECTION (EFI) subsection.

ENGINE LACKS ACCELERATION OR POWER

1. Weak spark
 - Check spark plugs, coils, wiring and connections.

PROCEDURES

IGNITION COILS

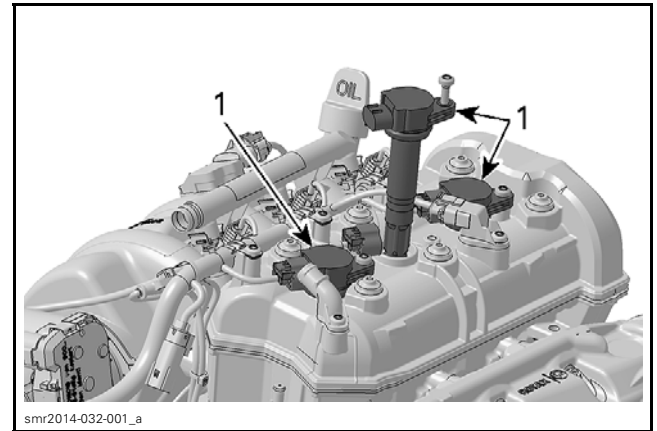
⚠ WARNING

Never check for engine ignition spark from an open coil and/or spark plug in the engine compartment as a spark may cause fuel vapors which may have accumulated in the bilge to ignite.

Ignition Coil Access

1. Remove the central body.

Ignition coils are located on top of the valve cover.



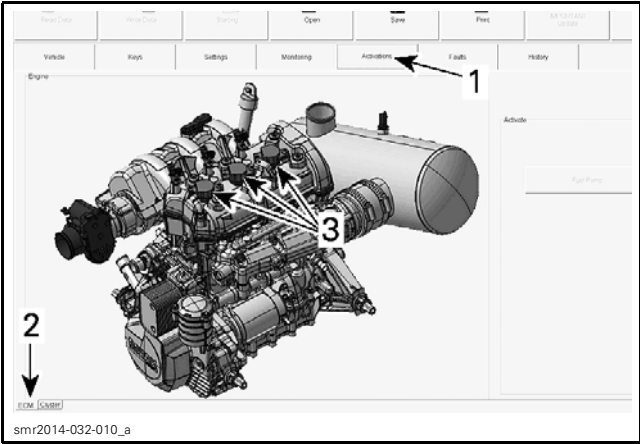
1. Ignition coils

Ignition Coil Test Using B.U.D.S.

1. Connect to the latest applicable B.U.D.S. software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* subsection.
2. Select the **Activation** and **ECM** tabs.
3. Energize the ignition coil to be tested by clicking on the corresponding illustration.

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Subsection 02 (IGNITION SYSTEM)



IGNITION COIL ACTIVATION

- 1. Activation tab
- 2. ECM tab
- 3. Click on the desired ignition coil

You should hear the spark occurring. If in doubt, use a sealed **vapor proof** spark tester or an inductive spark tester as available from tool suppliers, to prevent a spark from occurring in the bilge.

If there is no ignition at one or more coils, carry out a *IGNITION COIL INPUT VOLTAGE TEST*.

If spark is weak, try a new spark plug. If spark is still weak, try a new ignition coil.

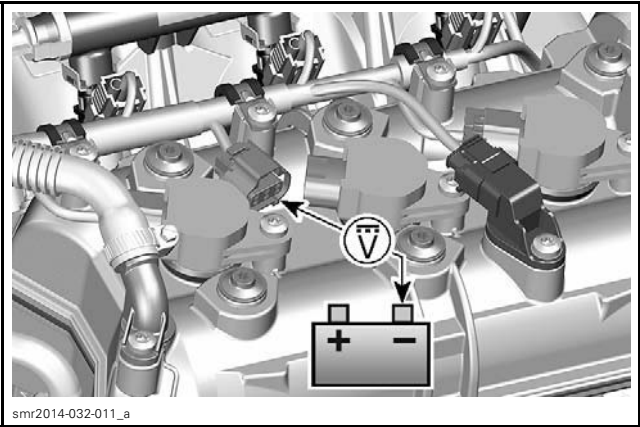
NOTE: The voltage required to produce a spark in the combustion chamber is higher when the engine is running.

Ignition Coil Input Voltage Test

Make sure fuse F3 and the relay are good before testing.

- 1. Disconnect the applicable ignition coil connector.
- 2. Remove tether cord from the engine cut-off switch.
- 3. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
- 4. Press the START button to activate the ECM.
- 5. Measure voltage.

TEST PROBES		VOLTAGE
VIOLET/BUE wire (ignition coil no. 1)	Battery ground	Battery voltage
VIOLET/GREEN wire (ignition coil no. 2)		
VIOLET/ORANGE wire (ignition coil no. 3)		



IGNITION COIL INPUT VOLTAGE TEST

If test succeeds, carry out an *IGNITION COIL RESISTANCE TEST*.

If test fails, carry out an *IGNITION COIL POWER CIRCUIT CONTINUITY TEST*.

Ignition Coil Power Circuit Continuity Test

- 1. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω .
- 2. Press the START button to activate the ECM.
- 3. Read resistance of the desired ignition coil circuit.

IGNITION COIL	IGNITION COIL WIRE	FUSE BOX	MEASUREMENT
1 (rear)	VT/BU	Terminal A4	Close to 0 Ω
2	VT/GN		
3	VT/OG		

If test fails at any ignition coil, test the following items separately and repair/replace wiring or terminals from fuse box to the applicable ignition coil. Refer to *WIRING DIAGRAM* for details.

- Wiring from fuse box to engine connector
- Wiring from engine connector to ignition coil.

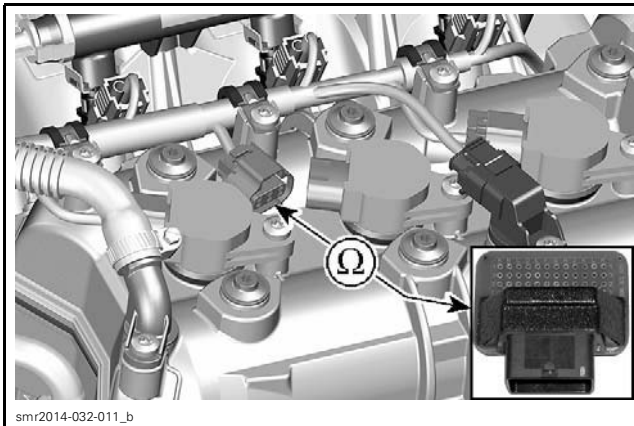
Ignition Coil Control Circuit Continuity Test

- 1. Disconnect ECM connector "A". For connector identification, refer to *WIRING HARNESS AND CONNECTOR* subsection.
- 2. Connect ECM connector to the ECM ADAPTER TOOL (P/N 529 036 166).



3. Disconnect ignition coil connector.
4. Test for continuity of circuit as per following table.

COIL	IGNITION COIL WIRE	ECM ADAPTER	RESISTANCE
Cylinder 1 (rear)	BN/BK	A-M4	Close to 0 Ω (continuity)
Cylinder 2	BN/OG	A-M2	
Cylinder 3	BN/YE	A-M1	



IGNITION COIL CONTROL CIRCUIT TEST

If test fails, repair the connector or replace the engine wiring harness.

Ignition Coil Resistance Test

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

1. Remove ignition coil. Refer to *IGNITION COIL REMOVAL* in this subsection.
2. Perform a visual inspection of the ignition coils. Check for corrosion, bent pins, loose or burnt contacts, and cracked or torn insulator.

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



PRIMARY WINDING

CIRCUIT	TERMINAL	RESISTANCE @ 20°C (68°F)
Primary winding	1 and 2	0.85 - 1.15 Ω



SECONDARY WINDING

CIRCUIT	TERMINAL	RESISTANCE @ 20°C (68°F)
Secondary winding	1 and spark plug terminal	9.5 - 13.5 k Ω

If any test fails, replace ignition coil.

If test succeeds, carry out an *IGNITION COIL CONTROL CIRCUIT CONTINUITY TEST*.

Ignition Coil Removal

1. Disconnect ignition coil connector.
2. Remove ignition coil retaining screw.

NOTICE Do not pry on ignition coil with a tool.

3. Remove ignition coil from spark plug by rotating coil side to side as you pull up.

Ignition Coil Installation

Install the ignition coil on the spark plug.

Align the retaining screw hole of the ignition coil with the threaded hole on the valve cover.

Push the ignition coil all the way down until it rests on the valve cover.

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Install and tighten retaining screw.

IGNITION COIL RETAINING SCREW	
Tightening torque	9 N•m ± 1 N•m (80 lbf•in ± 9 lbf•in)

Connect ignition coil connector.

SPARK PLUGS

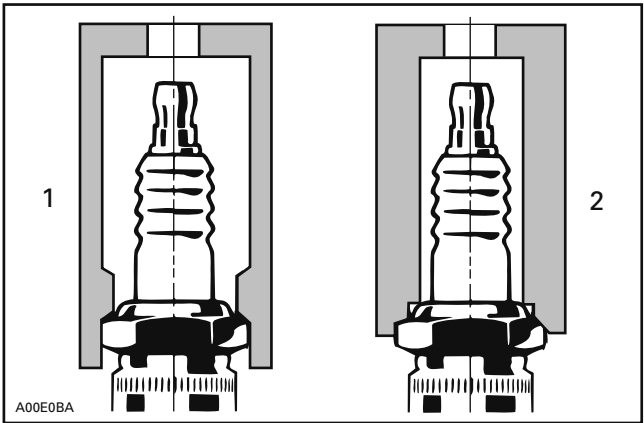
Spark Plug Removal

1. Remove ignition coil. Refer to *IGNITION COIL REMOVAL* in this subsection.

WARNING

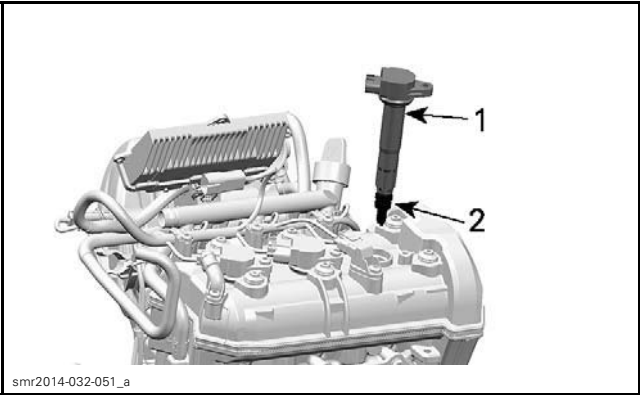
Never remove an ignition coil from a spark plug without disconnecting it from the wiring harness. Flammable vapors may be present in the bilge. Should the tether cord be installed on the engine cut-off switch, a spark could be generated at the spark plug end of the coil possibly resulting in an explosion.

2. Using a spark plug socket, release the torque applied to the spark plug.



1. Approved socket
2. Improper socket

3. Clean the spark plug and cylinder head with pressurized air.
4. Unscrew spark plug then use the ignition coil to take spark plug out of spark plug hole.



1. Ignition coil
2. Spark plug

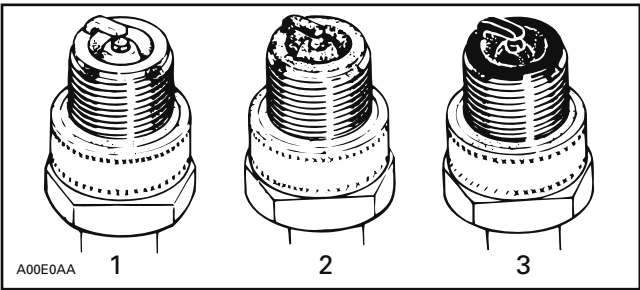
Troubleshooting a Fouled Spark Plug

Fouling of the spark plug is indicated by irregular running or misfiring of the engine, decreased engine speed due to misfiring, reduced performance, and increased fuel consumption.

Other possible causes are: use of an incorrect or bad fuel, defective ignition system, incorrect spark plug gap, loss of compression, or lubricating oil entering the combustion chamber.

The plug face of a fouled spark plug has either a wet or dry black carbon deposit. Such coatings form a conductive connection between the center electrode and the ground electrode.

Spark Plug Analysis



- TYPICAL**
1. Overheated (light gray, white)
2. Normal (light brown, brown)
3. Fouled (black, wet or dry, dark deposits, gray, melted coating)

The plug face reveals the condition of the engine, operating condition, method of driving and fuel mixture. For this reason it is advisable to inspect the spark plug at prescribed intervals, examining the plug face (i.e. the part of the plug projecting into the combustion chamber).

Spark Plug Installation

Prior to installation, ensure the contact surfaces of the cylinder head and spark plug are free of grime.

1. Using a wire feeler gauge, check electrode gap as specified in *TECHNICAL SPECIFICATIONS*.
2. Apply LOCTITE 767 (ANTISEIZE LUBRICANT) (P/N 293 800 070) over the spark plug threads to prevent possible seizure.
3. Hand screw spark plug into cylinder head. Then, tighten the spark plug to specification with an approved spark plug socket.

TIGHTENING TORQUE	
Spark plug	13 N•m ± 1 N•m (115 lbf•in ± 9 lbf•in)

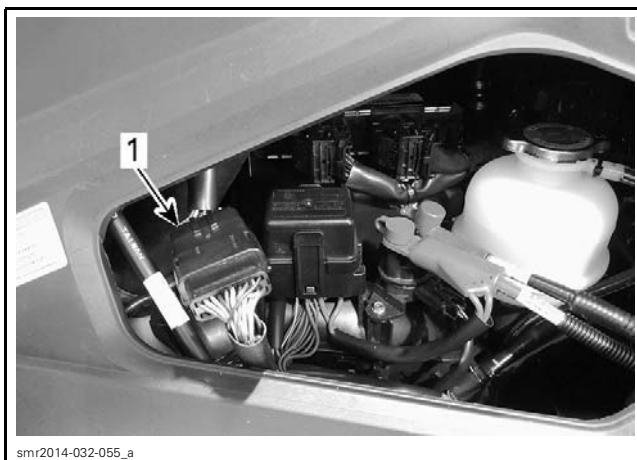
4. Install ignition coil. Refer to *IGNITION COIL INSTALLATION* in this subsection.
5. Complete the installation in the reverse order of the removal.

ENGINE CUT-OFF SWITCH

Continuity Test of Engine Cut-Off Switch

REQUIRED TOOLS
Diagnostic harness (P/N 529 036 276)
FLUKE 115 MULTIMETER (P/N 529 035 868)

1. Disconnect the steering connector from the vehicle harness.



1. Steering connector

2. **IMPORTANT:** Connect the diagnostic harness to the steering connector only, **NOT** to the vehicle harness connector.

NOTICE Do not attempt to probe the steering connector on the watercraft. Use the test connector on the diagnostic harness.

3. Set multimeter to Ω .
4. Probe test connector on diagnostic harness to check continuity as follows.

TETHER CORD	DIAGNOSTIC HARNESS	READING
Removed	Pin 6 and Pin 9	Open circuit
Installed		Close to 0 Ω

If continuity test fails:

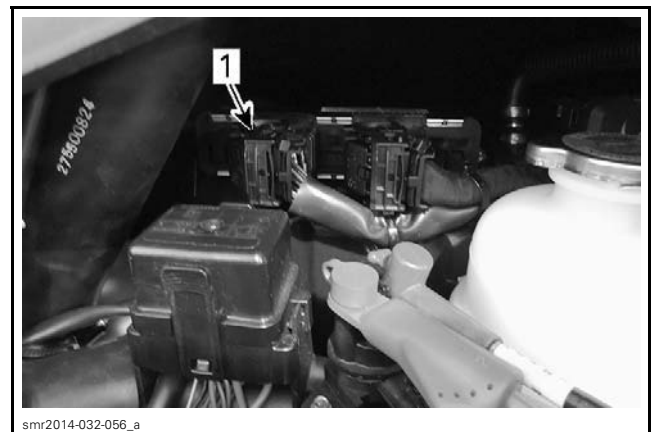
- Check steering harness between steering connector and engine cut-off switch. Repair or replace.
- If harness is good, replace the engine cut-off switch.

If all readings were as specified, carry out the *CONTINUITY TEST OF VEHICLE HARNESS TO ENGINE CUT-OFF SWITCH*.

Continuity Test of Vehicle Harness to Engine Cut-Off Switch

REQUIRED TOOLS
Diagnostic harness (P/N 529 036 276)
FLUKE 115 MULTIMETER (P/N 529 035 868)
ECM ADAPTER TOOL (P/N 529 036 166)

1. Disconnect the diagnostic harness from the steering connector and reconnect it to vehicle connector.
2. Disconnect connector "B" from ECM.



3. Install the ECM ADAPTER TOOL (P/N 529 036 166) on ECM connector "B".
4. Probe test connector as follows.

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DIAGNOSTIC HARNESS CONNECTOR	ECM ADAPTER TOOL	READING
Pin 9	B-E4	Close to 0 Ω
Pin 6	B-F2	

If any continuity test failed, check wiring harness between steering connector and ECM connector.

If problem persists and all tests have been performed, try a new ECM. Refer to *ELECTRONIC FUEL INJECTION (EFI)* subsection.

5. Reconnect ECM "B" connector and steering harness connector.
6. Reinstall removed components.

Engine Cut-Off Switch Replacement

REQUIRED TOOL
D.E.S.S. POST REMOVER (P/N 529 035 943)

