

IGNITION SYSTEM

SERVICE TOOLS

Description	Part Number	Page
D.E.S.S. POST REMOVER	529 035 943	6

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 engine control module (ECM) controls the ignition system, as well as many other engine related functions.

The battery supplies power to the primary side of the ignition coils through a relay while the ECM completes the circuit to each coil primary winding by switching it to ground at the appropriate moment.

The ignition system is a digital inductive type system.

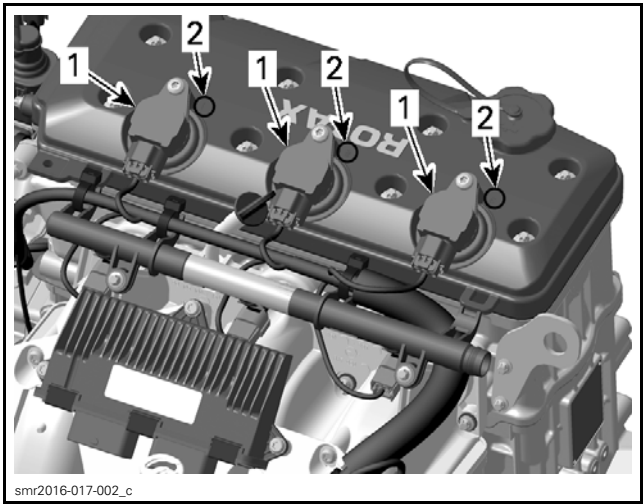
Ignition system parameters such as ignition timing, dwell time and firing order are controlled by the ECM in order to meet engine operational requirements.

Direct ignition coils (stick coils) are used for each cylinder.

Three separate ignition coils receive power from three separate fuses.

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 the valve cover.



1. Ignition coils
2. Cylinder identification number on valve cover

Ignition Timing

Ignition timing is not adjustable.

The ECM is programmed with ignition maps that it uses along with data received from a variety of sensors to establish optimum ignition timing under all engine operating conditions.

The firing of each spark plug is independent of the others.

Engine RPM Limiter

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

RPM LIMITER
8050 RPM

Knock Sensor

A knock sensor is mounted on the cylinder block behind the intake manifold. It detects specific vibrations that would typically be generated by engine detonation.

Subsection XX (IGNITION SYSTEM)

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 BUDS2 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.

TESTING THE IGNITION SYSTEM

1. Ensure fuses F13, F14 and F15 are powered and in good condition.
2. 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.

3. If there is no active fault code, start diagnostic by testing ignition coils.
4. If a primary winding of an ignition coil or a circuit is at fault, a fault code will be set. Refer to *DIAGNOSTIC AND FAULT CODES* 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 *PTO HOUSING, 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 BUDS2 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. Defective T.O.P.S. sensor
 - Test T.O.P.S. Refer to *LUBRICATION* subsection.
3. Damaged trigger wheel/loose CPS
 - Check. Refer to *PTO HOUSING, MAGNETO AND STARTER* subsection.
4. Defective ignition circuit
 - Check fuses, ignition coils, wiring and connectors.
5. 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 *PTO HOUSING, 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 Location

1. Open or remove seat.
- Ignition coils are located on top of the valve cover.

Testing the Ignition Coil Using BUDS2

1. Connect BUDS2 software. Refer to *COMMUNICATION TOOLS AND B.U.D.S.* section.
2. Navigate to the **functions** page.
3. Energize the ignition coil to be tested.

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 *TESTING THE IGNITION COIL INPUT VOLTAGE*.

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.

Testing the Ignition Coil Input Voltage

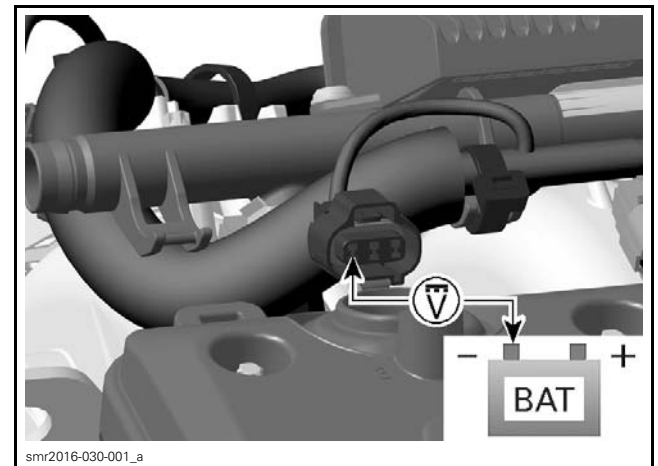
Make sure fuses F13, F14 and F15 are good before testing.

1. Disconnect the applicable ignition coil connector.
2. Remove tether cord from the engine cut-off switch.
3. Press the START button to activate the ECM.

4. Measure voltage within 3 minutes after depressing START/STOP button.

Set multimeter to Vdc.

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



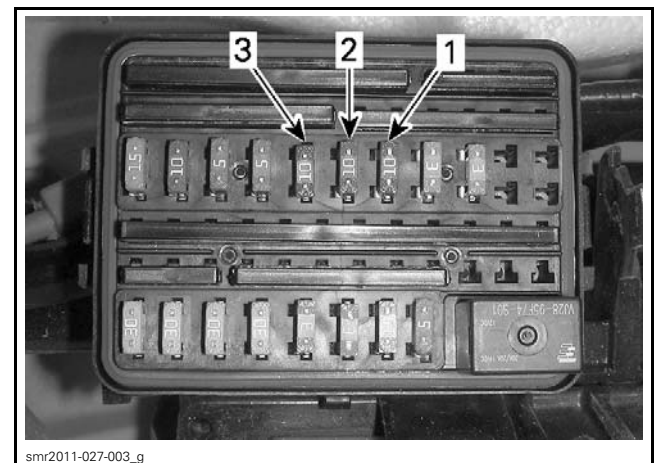
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IGNITION COIL INPUT VOLTAGE TEST

If test succeeds, carry out *TESTING THE IGNITION COIL RESISTANCE*.

If test fails, carry out *TESTING THE IGNITION COIL POWER CIRCUIT CONTINUITY*.

Testing the Ignition Coil Power Circuit Continuity

1. Remove fuses F13, F14 and F15.



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1. Fuse F13
2. Fuse F14
3. Fuse F15

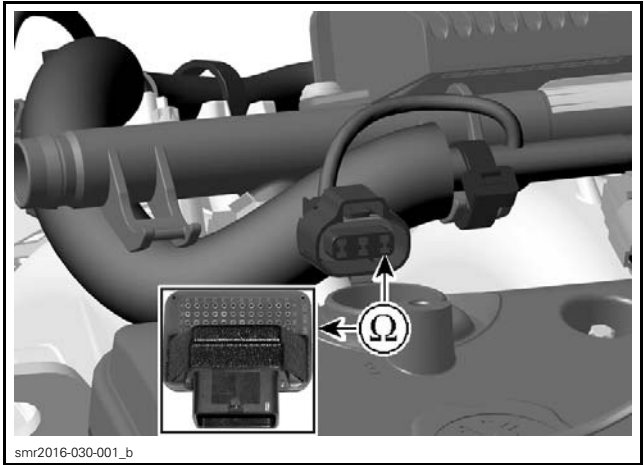
Subsection XX (IGNITION SYSTEM)

2. Read resistance of the desired ignition coil circuit.

Set multimeter to Ω .

IGNITION COIL	IGNITION COIL WIRE	FUSE BOX	MEASUREMENT
1 (rear)	VT/BU	Terminal F7	Close to 0 Ω
2	VT/GN	Terminal F6	
3	VT/OR	Terminal F5	

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



IGNITION COIL CONTROL CIRCUIT TEST

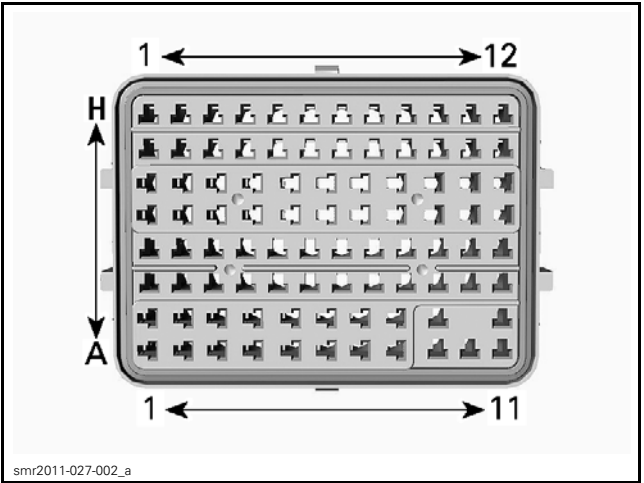
If test fails, repair the connector or replace the engine wiring harness.

Testing the Ignition Coil Resistance

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.

Primary Winding

1. Remove ignition coil. Refer to *REMOVING THE IGNITION COIL* 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, measure the resistance of the primary winding.



FUSE BOX PIN IDENTIFICATION

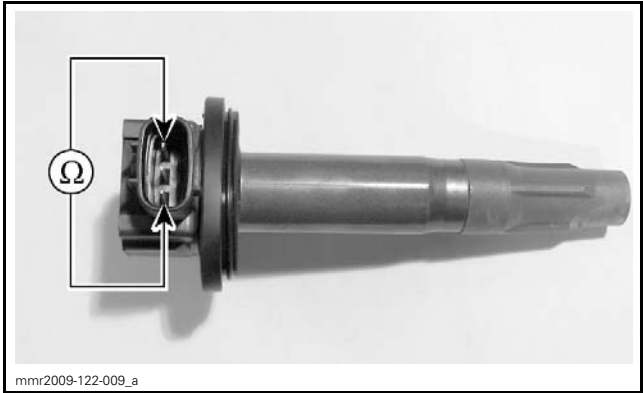
If test fails at any ignition coil, test the following items separately and repair/replace wiring or terminals from fuse box to the applicable ignition coil.

- Wiring from fuse box to engine C04-4POS connector
- Wiring from C04-4POS connector to ignition coil.

Refer to *WIRING DIAGRAM* for details.

Testing the Ignition Coil Control Circuit Continuity

1. Disconnect ECM connector "A". For connector identification, refer to *WIRING HARNESS AND CONNECTOR* subsection.
2. Connect ECM connector to the adapter.
3. Disconnect ignition coil connector.
4. Test for continuity of circuit as per following table.



PRIMARY WINDING

TERMINAL	RESISTANCE @ 20°C (68°F)
1 and 3	0.80 - 0.97 Ω

If test fails, replace ignition coil.
If test succeeds, carry out *TESTING THE IGNITION COIL CONTROL CIRCUIT CONTINUITY*.

Secondary Winding

The secondary winding on this type of ignition coil cannot be tested.

Removing the Ignition Coil

- 1. Disconnect ignition coil connector.

NOTICE Do not pry on ignition coil using any tool.

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

Installing the Ignition Coil

- 1. Install ignition coil on spark plug.
- 2. Align the retaining screw hole of the ignition coil with the threaded hole on the valve cover.
- 3. Push the ignition coil all the way down until it rests on the valve cover.
- 4. Install and tighten retaining screw.

TIGHTENING TORQUE	
Ignition coil retaining screw	9 N•m ± 1 N•m (80 lbf•in ± 9 lbf•in)

- 5. Reconnect ignition coil connector.

SPARK PLUG

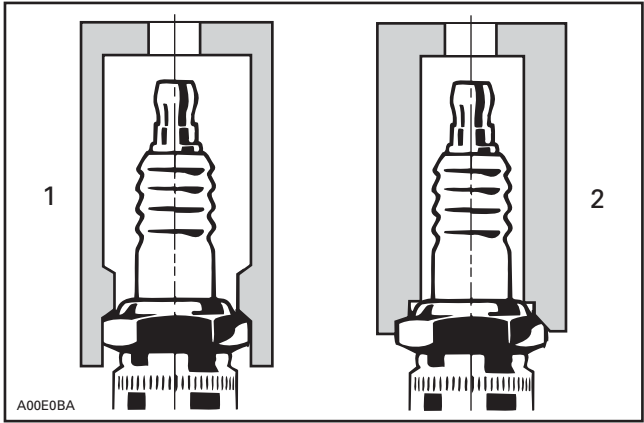
Removing the Spark Plug

- 1. Remove ignition coil. Refer to *REMOVING THE IGNITION COIL* in this subsection.

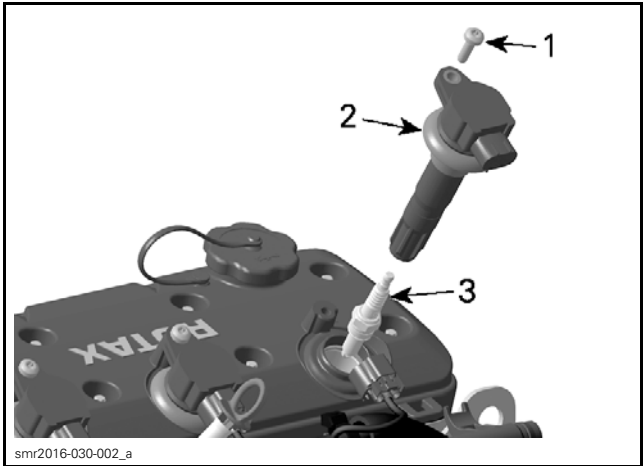
WARNING

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. Retaining screw
- 2. Ignition coil
- 3. Spark plug

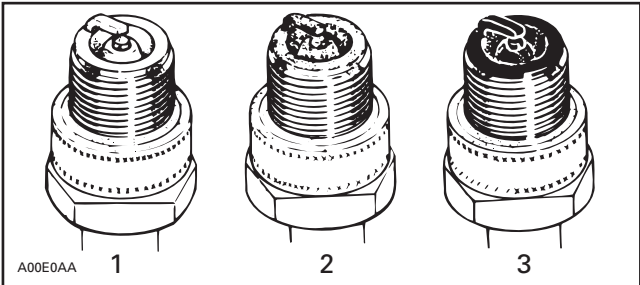
Troubleshooting a Fouled Spark Plug

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).

Installing the Spark Plug

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

- 1. Using a wire feeler gauge, set electrode gap as specified in the *TECHNICAL SPECIFICATIONS*.
- 2. Hand screw spark plug into cylinder head.
- 3. Then tighten the spark plug clockwise to specification using an approved spark plug socket.

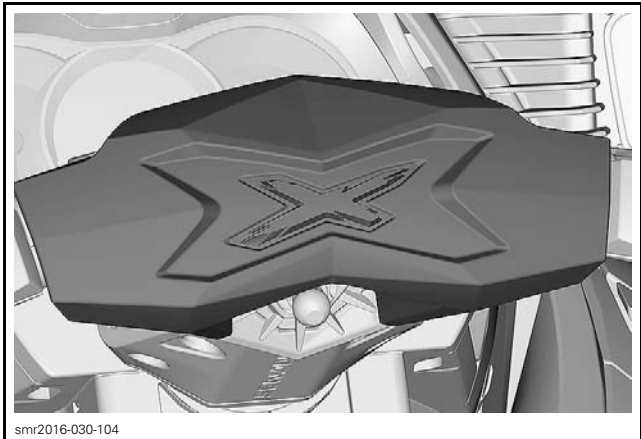
TIGHTENING TORQUE	
Spark plug	17 N•m ± 2 N•m (150 lbf•in ± 18 lbf•in)

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

ENGINE CUT-OFF SWITCH

Refer to D.E.S.S. subsection for operation.

Replacing the Cut-Off Switch



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

