

STARTING SYSTEM

SERVICE TOOLS

Description	Part Number	Page
DIAGNOSTIC HARNESS	529 036 188	3
ECM ADAPTER TOOL.....	529 036 166	2, 4
FLUKE 115 MULTIMETER	529 035 868	2-4

GENERAL

BASIC STARTING SYSTEM OPERATION

Engine Cranking Conditions

The following conditions must be met to allow engine cranking:

1. START/STOP button pressed and released to activate the ECM.
2. The tether cord securely installed on the engine cut-off switch and the D.E.S.S. key recognized by the ECM as valid (2 short beeps)
3. START/STOP button pressed and held.

Starting System Logic

If the ECM recognizes a valid D.E.S.S. key, it allows engine cranking by providing the ground to the starter solenoid when the START/STOP button is pressed and held.

If the START/STOP button is activated while the throttle lever is depressed more than 60%, the engine will crank but will not start (engine drowned mode).

If the START/STOP button is held after engine has started, the ECM automatically stops the starter if engine speed reaches at least 1400 RPM.

If the START/STOP button is pressed when the engine is running, the engine will shut down.

TROUBLESHOOTING

DIAGNOSTIC TIPS

NOTE: It is a good practice to check for fault codes using B.U.D.S. as a first troubleshooting step. Refer to *DIAGNOSTIC AND FAULT CODES* subsection.

Starting system failures are not necessarily related to the starter but may be due to one the following:

- Starter solenoid fuse F16

- Battery, refer to *CHARGING SYSTEM*
- START/STOP switch
- Starter solenoid
- Engine cut-off switch
- ECM
- Wiring/connections.

Check these components before removing the starter.

NOTE: This subsection assumes the problem is related to an electrical component of the starting system. If the starting system tests good, ensure engine and jet pump integrity. Refer to applicable subsection.

DIAGNOSTIC GUIDELINES

NOTHING HAPPENS WHEN START/STOP BUTTON PRESSED

1. **Battery not connected**
 - Connect battery.
2. **Burnt fuse**
 - F3 fuse: (START/STOP switch circuit).
 - F8 fuse: (main DC power fuses).
 - F19 fuse (ECM power fuse).
3. **Defective relay or related circuits**
 - Test relay and circuits.
4. **Defective START/STOP switch**
 - Test START/STOP switch, wiring and connections.

ENGINE DOES NOT CRANK

1. **D.E.S.S. not functional or wrong D.E.S.S. key**
 - If 2 short beeps are not heard when pressing the START/STOP button, refer to *RADIO FREQUENCY DIGITALLY ENCODED SECURITY SYSTEM* subsection.
2. **Burnt fuse**
 - F16 fuse: (starter solenoid power) Carry out *TESTING THE SOLENOID INPUT VOLTAGE*.

Subsection 04 (STARTING SYSTEM)

3. **Discharged battery**
 - *Recharge and test. Refer to CHARGING SYSTEM subsection.*
4. **Battery connections**
 - *Check/clean/tighten.*
5. **Poor/bad or corroded ground contacts (engine, battery ground cable, starter etc.)**
 - *Check/clean/repair, refer to POWER DISTRIBUTION AND GROUNDS subsection.*
6. **Starter solenoid**
 - *Test solenoid, wiring and connections.*
7. **Damaged starter or ground cables**
 - *Carry out TESTING THE SOLENOID (DYNAMIC).*
8. **Obstructed starter drive gear assembly**
 - *Check/repair, refer to PTO HOUSING, MAGNETO AND STARTER.*
9. **No ground provided by ECM to starter solenoid**
 - *Refer to TESTING THE CONTINUITY OF START/STOP SWITCH CONTROL CIRCUIT in this subsection.*
10. **Engine cannot be rotated (possibly seized or jet pump blocked)**
 - *Refer to ENGINE subsection.*

ENGINE CRANKS SLOWLY

1. **Loose, corroded or dirty battery cable connections**
 - *Check/clean/tighten.*
2. **Discharged/weak battery**
 - *Recharge and test. Refer to CHARGING SYSTEM subsection.*
3. **Low voltage from starter solenoid**
 - *Carry out a TESTING THE SOLENOID (DYNAMIC).*
4. **Damaged starter or ground cables**
 - *Carry out TESTING THE SOLENOID (DYNAMIC).*
5. **Worn starter**
 - *Check.*

STARTER TURNS, BUT STARTER DRIVE DOES NOT MESH WITH RING GEAR

1. **Worn starter drive gear/starter gear/ring gear**
 - *Replace worn parts. Refer to STARTER GEAR in this subsection and PTO HOUSING, MAGNETO AND STARTER subsection.*

2. **Defective drive**
 - *Replace starter drive. Refer to PTO HOUSING, MAGNETO AND STARTER subsection.*

STARTER KEEPS RUNNING

1. **Shorted solenoid winding**
 - *Replace solenoid.*
2. **Melted solenoid contacts**
 - *Replace solenoid.*
3. **Sticking or defective starter drive**
 - *Lubricate or replace. Refer to PTO HOUSING, MAGNETO AND STARTER.*

PROCEDURES

WARNING

When carrying out any kind of maintenance on the starting system, always disconnect the battery ground cable. This will eliminate the possibility of shorting out a power cable, and generating a spark which could result in a fire or and explosion. Do not place any tool on the battery.

ENGINE START/STOP SWITCH

Testing the START/STOP Switch Circuit Continuity

1. Remove START/STOP switch fuse (F3).
For fuse box access, refer to *POWER DISTRIBUTION AND GROUNDS* subsection.
- Disconnect connector "B" from the ECM, refer to *WIRING HARNESS AND CONNECTOR* subsection.
- Install ECM ADAPTER TOOL (P/N 529 036 166) on ECM harness connector "B".



Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω .

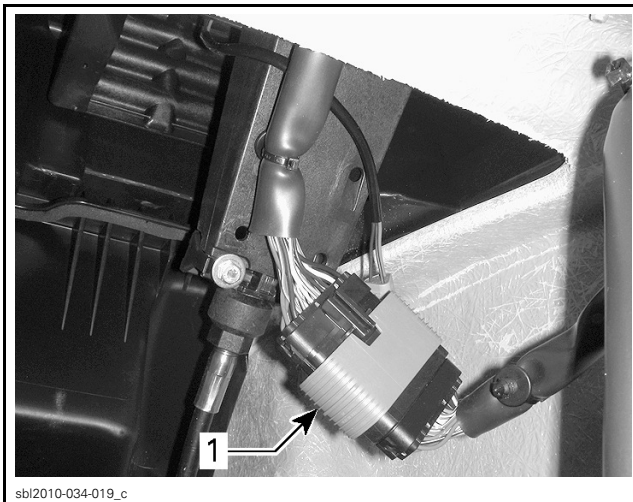
Press and hold the START/STOP switch and test for continuity of the switch circuit as per following table.

CONTINUITY TEST OF START/STOP SWITCH CIRCUIT (BUTTON PRESSED AND HELD)		
FUSE BOX	ECM CONNECTOR B	RESISTANCE
Pin A6	B-D1	Close to 0 Ω (continuity)

- If the reading is as specified, the START/STOP switch and its wiring are good.
- If a high resistance or an open circuit is measured, carry out *TESTING THE START/STOP SWITCH CONTINUITY*.

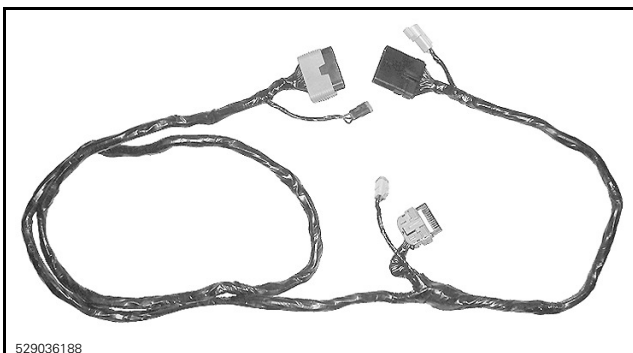
Testing the START/STOP Switch Continuity

- Remove START/STOP switch fuse (F3).
- Disconnect the 24-pin steering connector:



1. 24-pin steering connector

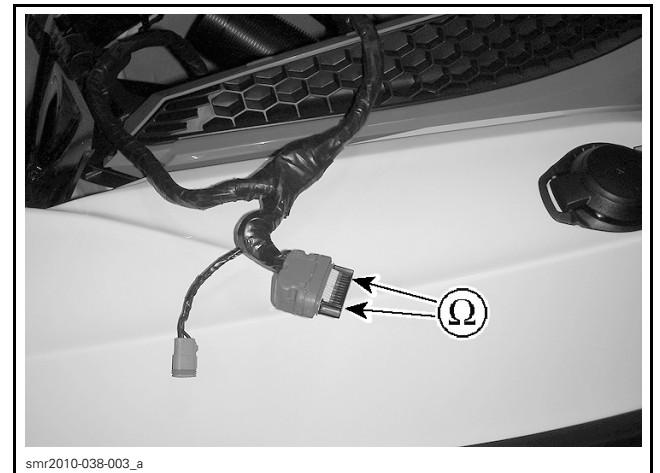
- Connect the DIAGNOSTIC HARNESS (P/N 529 036 188) to make an in-line connection between the disconnected connector.



NOTE: Use the 24 pin connectors only.

- Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω .
- Measure resistance through switch as per following table.

CONTINUITY TEST OF START/STOP SWITCH CIRCUIT		
SWITCH POSITION	DIAGNOSTIC HARNESS CONNECTOR	RESISTANCE
Released	Pins 2 and 23	Infinite (OL)
Pressed and held		Close to 0 Ω



If the switch does not test as specified, replace the engine START/STOP switch.

If the switch tests as specified, check for an open circuit between connections as per table:

OPEN CIRCUIT TEST		
CIRCUIT CONNECTIONS		RESISTANCE
Fuse box pin A6	Steering connector pin 23	Must be close to 0 Ω
Steering connector pin 2	ECM connector B, pin D1	

STARTER SOLENOID

Testing Solenoid Input Voltage

- Make sure F16 fuse is powered and in good condition before testing.
- Disconnect solenoid connector.
- Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Vdc.
- Install tether cord on the engine cut-off switch.

Subsection 04 (STARTING SYSTEM)

- 5. Press the START/STOP button to activate ECM.
- 6. Measure voltage within 3 minutes after START/STOP switch has been depressed.

SOLENOID INPUT VOLTAGE TEST (SOLENOID COIL)		
TEST PROBES		VOLTAGE READING
Pin A	Battery ground	Battery voltage

If test succeeded, carry out *TESTING SOLENOID CONTROL CIRCUIT*.
If test failed, carry out *TESTING THE START/STOP SWITCH CIRCUIT CONTINUITY*.

Testing Solenoid Control Circuit Continuity

- 1. Set the FLUKE 115 MULTIMETER (P/N 529 035 868) to Ω .
- 2. Disconnect connector "B" from ECM.
- 3. Install ECM ADAPTER TOOL (P/N 529 036 166) on ECM harness connector.
- 4. Test continuity of wiring from solenoid to ECM as per following table.

SOLENOID CONTROL CIRCUIT TEST		
SOLENOID CONNECTOR	ECM CONNECTOR B	RESISTANCE
Pin B	B-L4	Close to 0 Ω (continuity)

If test failed, repair or replace wiring/connectors.
If test succeeded, carry out *TESTING SOLENOID COIL RESISTANCE*.

Testing Solenoid Coil Resistance

- 1. Set multimeter to Ω .
- 2. Disconnect solenoid connector.
- 3. Measure solenoid coil resistance as per following table.

SOLENOID COIL RESISTANCE TEST		
SOLENOID CONNECTOR		RESISTANCE
Pin A	Pin B	4.5 to 5.5 Ω

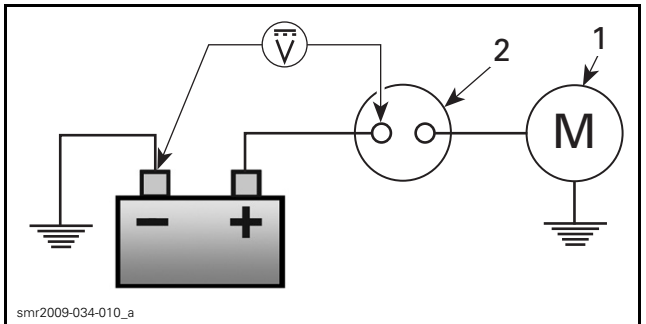
If test fails, replace solenoid.

Testing Solenoid (Dynamic)

- 1. Ensure fuse F16, battery, and starter solenoid are properly connected.

- 2. Make sure the battery ground cable is securely connected to the engine. Refer to *POWER DISTRIBUTION AND GROUNDS*.
- 3. Set ECM in engine drowned mode:
 - 3.1 Depress throttle lever.
 - 3.2 Install a rubber band to hold lever in full throttle position.
- 4. Set multimeter to Vdc.
- 5. Crank engine.
- 6. **As engine is cranking**, measure the voltage as per following tables.

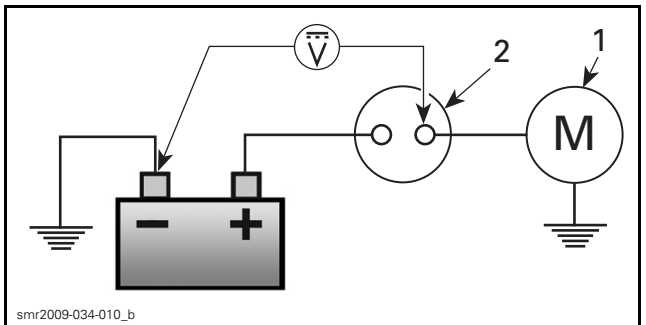
SOLENOID DYNAMIC TEST (ENGINE CRANKING)		
TEST PROBES		VOLTAGE (DC)
Solenoid battery post	Battery ground	Battery voltage



- 1. Starter motor
- 2. Starter solenoid

- 7. If test failed, check battery positive cable (from battery to solenoid).
- 8. If test succeeded, continue with next step.

SOLENOID DYNAMIC TEST (ENGINE CRANKING)		
TEST PROBES		VOLTAGE (DC)
Solenoid starter post	Battery ground	Battery voltage

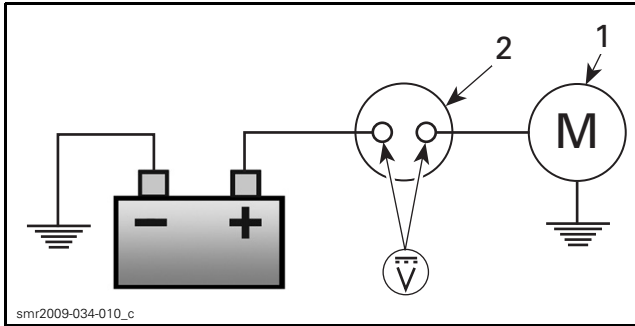


- 1. Starter motor
- 2. Starter solenoid

- 9. If test failed, carry out a *TESTING SOLENOID INPUT VOLTAGE*.

10. If test succeeded, continue with next step.

SOLENOID DYNAMIC TEST (ENGINE CRANKING)		
TEST PROBES		VOLTAGE (DC)
Solenoid battery post	Solenoid starter post	0.2 Vdc max.



1. Starter motor
2. Starter solenoid

If test failed, replace solenoid.

If all solenoid dynamic tests are as specified, replace starter.

11. Remove rubber band from throttle lever.

12. Attach the electrical component support to the battery holder. Refer to *ELECTRICAL COMPONENT SUPPORT* in *CHARGING SYSTEM* subsection.

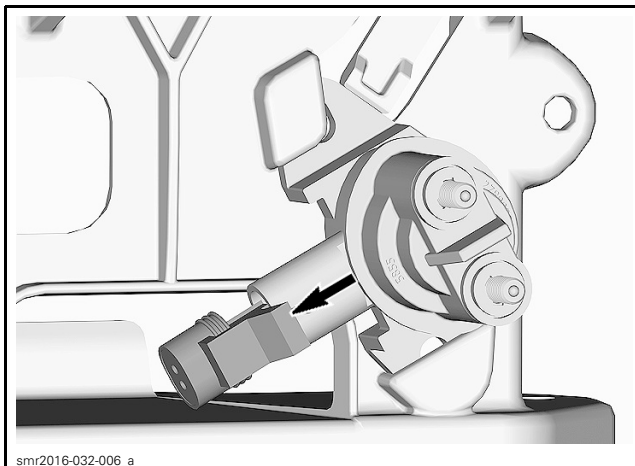
13. Reinstall removed parts.

Removing the Solenoid

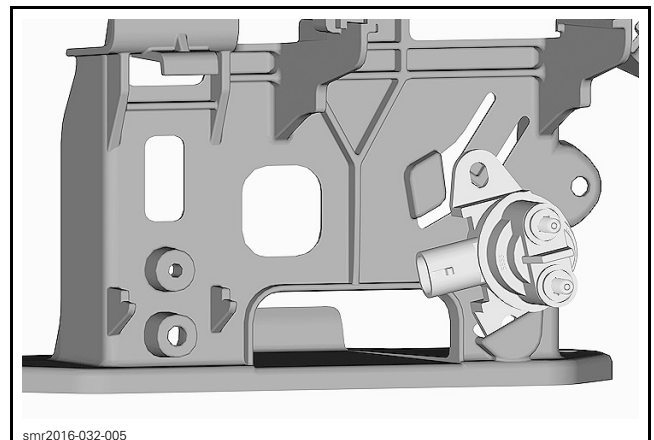
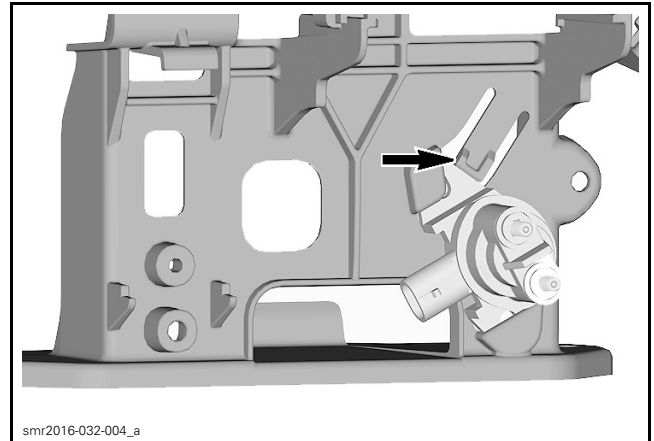
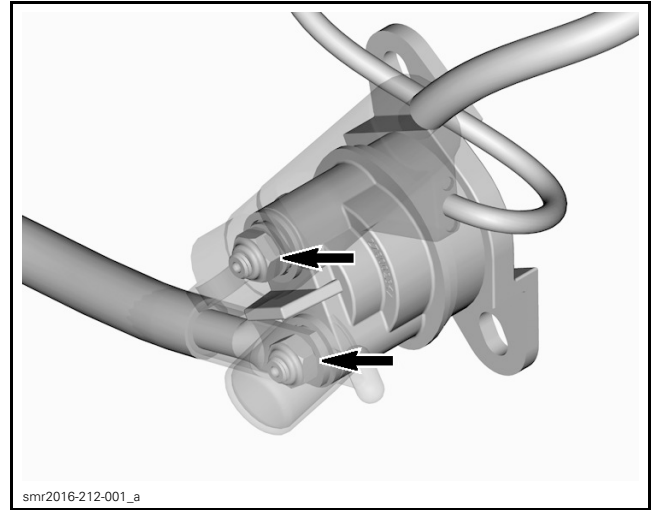
1. Disconnect battery. Refer to *CHARGING SYSTEM* subsection.

⚠ WARNING

Always disconnect the BLACK (-) battery cable first and reconnect last.



2. Disconnect solenoid cables.



Installing the Solenoid

Reverse the removal procedure and pay attention to the following.

STARTER

For starter information refer to *PTO HOUSING, MAGNETO AND STARTER* subsection.