

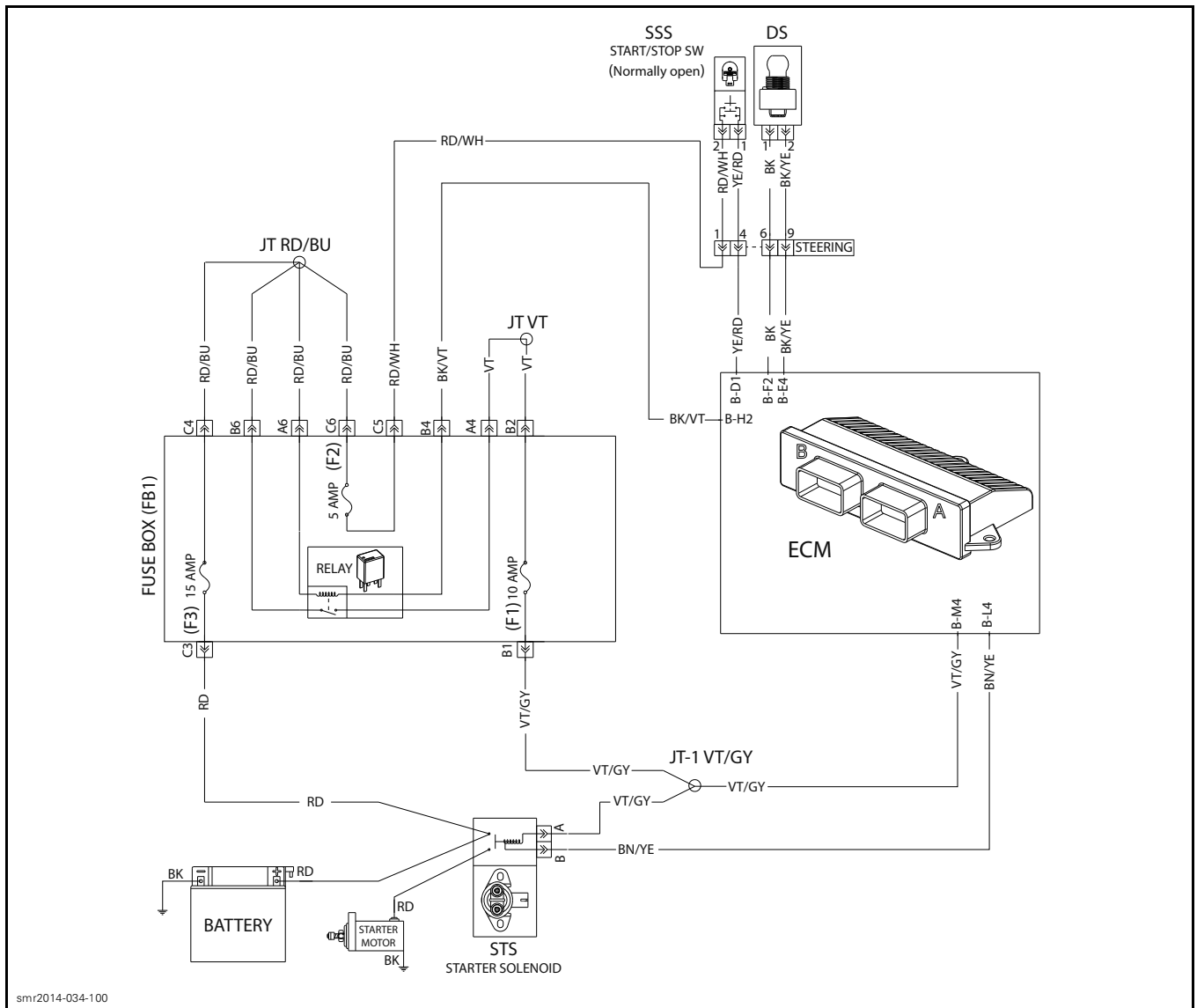
STARTING SYSTEM

SERVICE TOOLS

Description	Part Number	Page
ECM ADAPTER TOOL.....	529 036 166	267, 269
FLUKE 115 MULTIMETER	529 035 868	267-269

SERVICE PRODUCTS

Description	Part Number	Page
DIELECTRIC GREASE	293 550 004	271



Section 05 ELECTRICAL SYSTEM

Subsection 04 (STARTING SYSTEM)

GENERAL

BASIC STARTING SYSTEM OPERATION

Engine Cranking Conditions

The following conditions must be met to allow engine cranking:

1. The tether cord securely installed on the engine cut-off switch and it's recognized by the ECM as valid (2 short beeps)
2. START/STOP button pressed and held.

Starting System Logic

When the ECM detects a tether cord, 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 SYSTEM 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 F1
- Battery, refer to *CHARGING SYSTEM*
- START/STOP button
- 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**
 - *F2 fuse: (START/STOP switch circuit).*
 - *F3 fuse: (main DC power fuses).*
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. **Burnt fuse**
 - *F1 fuse: (starter solenoid power) Carry out a SOLENOID INPUT VOLTAGE TEST (Solenoid Coil).*
2. **Discharged battery**
 - *Recharge and test. Refer to CHARGING SYSTEM subsection.*
3. **Battery connections**
 - *Check/clean/tighten.*
4. **Poor/bad or corroded ground contacts (engine, battery ground cable, starter etc.)**
 - *Check/clean/repair, refer to POWER DISTRIBUTION AND GROUNDS subsection.*
5. **Starter solenoid**
 - *Test solenoid, wiring and connections.*
6. **Damaged starter or ground cables**
 - *Carry out SOLENOID DYNAMIC TEST.*
7. **Obstructed starter drive gear assembly**
 - *Check/repair, refer to PTO HOUSING AND MAGNETO.*
8. **No ground provided by ECM to starter solenoid**
 - *Refer to CONTINUITY TEST OF START/STOP SWITCH CONTROL CIRCUIT in this subsection.*
9. **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 SOLENOID DYNAMIC TEST.
4. Damaged starter or ground cables
- Carry out SOLENOID DYNAMIC TEST.
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 AND MAGNETO subsection.
2. Defective drive
- Replace starter drive. Refer to 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 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.

START/STOP SWITCH

START/STOP Switch Circuit Continuity Test

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

1. Remove START/STOP switch fuse (F2).
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 C5	B-D1	Close to 0 Ω (continuity)

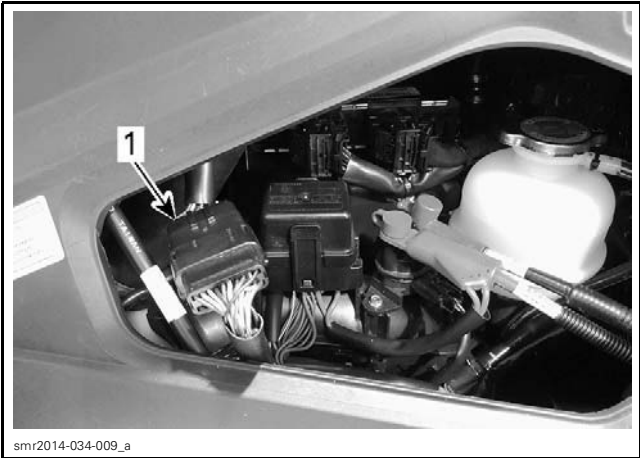
2. If the reading is as specified, the START/STOP switch and its wiring are good.
3. If a high resistance or an open circuit is measured, carry out START/STOP SWITCH CONTINUITY TEST.

START/STOP Switch Continuity Test

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

1. Remove START/STOP switch fuse (F2).
2. Disconnect the steering connector.

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1. Steering connector

3. Connect the diagnostic harness (P/N 529 036 276) to make an in-line connection between the disconnected connector.
4. Use the FLUKE 115 MULTIMETER (P/N 529 035 868) and select Ω .
5. Measure resistance through switch as per following table.

CONTINUITY TEST OF START/STOP SWITCH CIRCUIT		
SWITCH POSITION	DIAGNOSTIC HARNESS CONNECTOR	RESISTANCE
Released	Pins 1 and 4	Infinite (OL)
Pressed and held		Close to 0 Ω

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

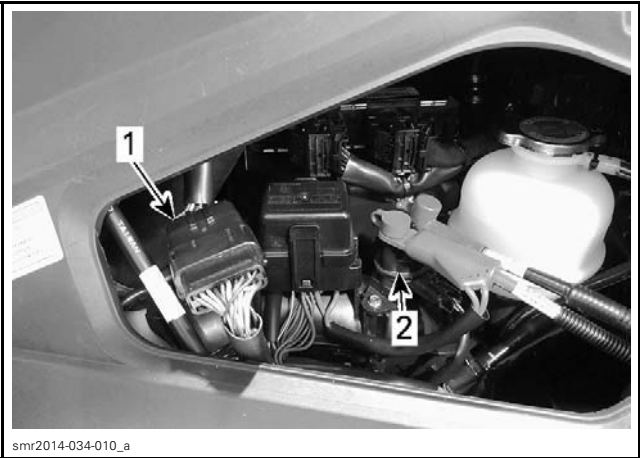
If the switch tests as specified, check for an open circuit between connections as per table:

OPEN CIRCUIT TEST		
CIRCUIT CONNECTIONS		RESISTANCE
Fuse box pin C5	Steering connector pin 1	Must be close to 0 Ω
Steering connector pin 4	ECM connector B, pin D1	

STARTER SOLENOID

Starter Solenoid Access

The starter solenoid is located beside the fuse box and it is accessible through the LH access opening.



1. Steering connector
2. Starter solenoid

Solenoid Input Voltage Test (Solenoid Coil)

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

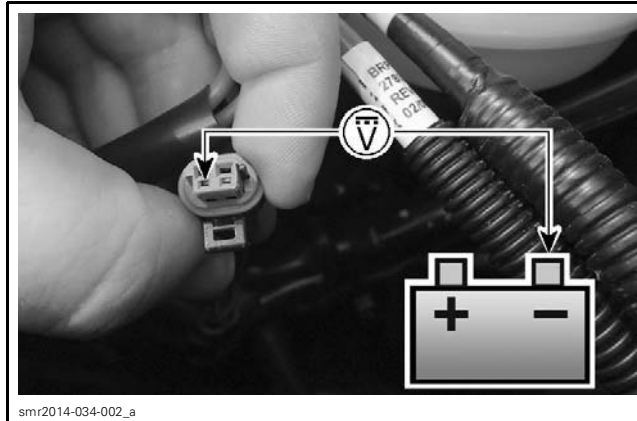
1. Make sure F1 fuse is powered and in good condition before testing.
2. Disconnect solenoid connector.



1. Solenoid connector

3. Set the multimeter to Vdc.
4. Install tether cord on the engine cut-off switch.
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 (VT/GY)	Battery ground	Battery voltage



If test succeeded, carry out a *SOLENOID CONTROL CIRCUIT TEST*.

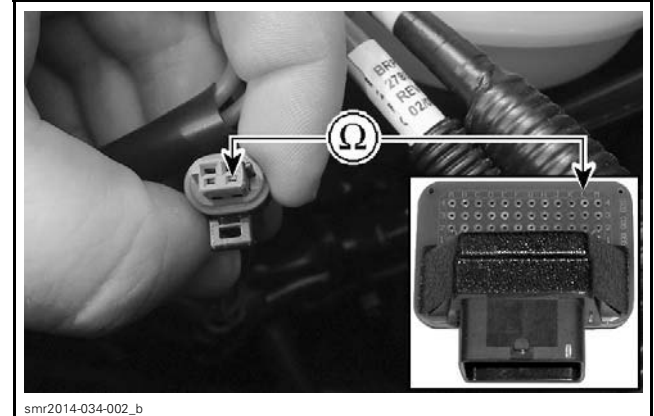
If test failed, carry out a *START/STOP SWITCH CIRCUIT CONTINUITY TEST*.

Solenoid Control Circuit Continuity Test

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

1. Set the multimeter to Ω .
2. Disconnect connector "B" from ECM, refer to *WIRING HARNESS AND CONNECTOR* subsection.
3. Install the ECM adaptor tool 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 (BN/YE)	B-L4	Close to 0 Ω (continuity)



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

Solenoid Coil Resistance Test

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

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.

Solenoid Dynamic Test

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

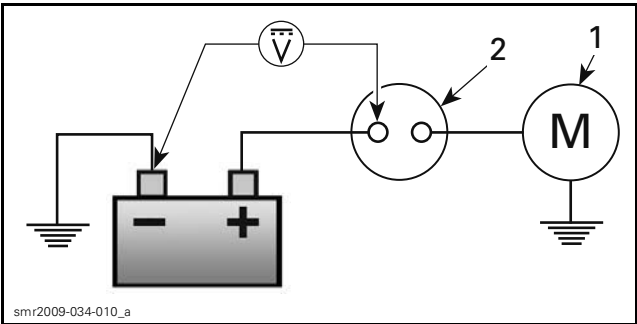
1. Ensure fuse F1, battery, and starter solenoid are properly connected.
2. Make sure the battery ground cable is securely connected to the engine. Refer to *POWER DISTRIBUTION AND GROUNDS*.
3. Depress the throttle lever to place the ECM in engine drowned mode. Hold throttle lever in place using a rubber band
4. Set multimeter to Vdc.
5. Crank engine.

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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

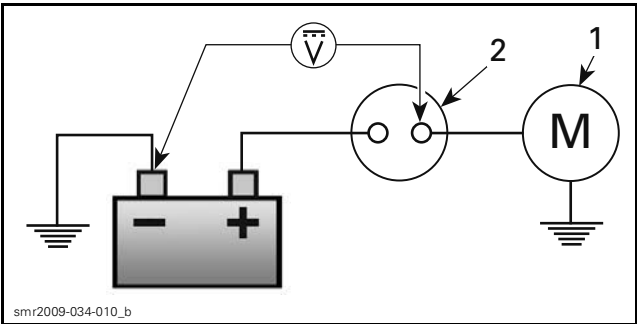


- 1. Starter motor
- 2. Starter solenoid

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

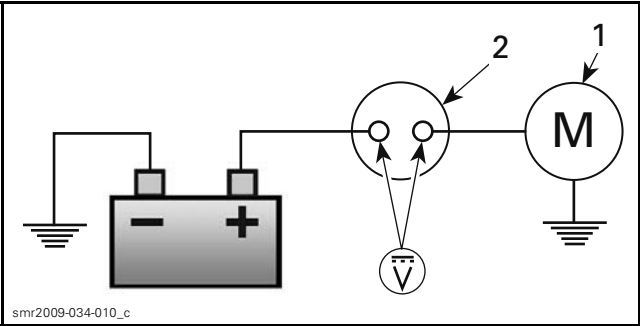


- 1. Starter motor
- 2. Starter solenoid

9. If test failed, carry out a *SOLENOID INPUT VOLTAGE TEST (SOLENOID COIL)*.

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. Reinstall removed parts.

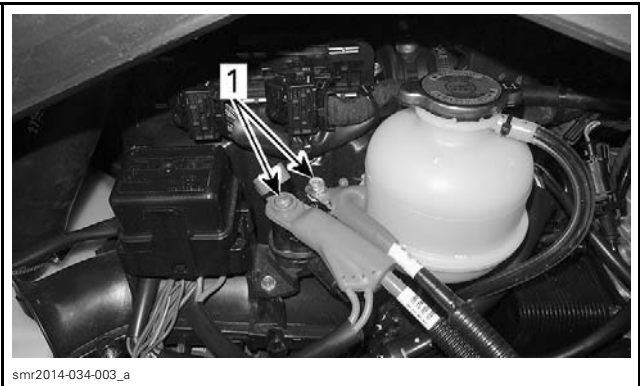
Solenoid Removal

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

 **WARNING**

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

2. Disconnect solenoid cables.



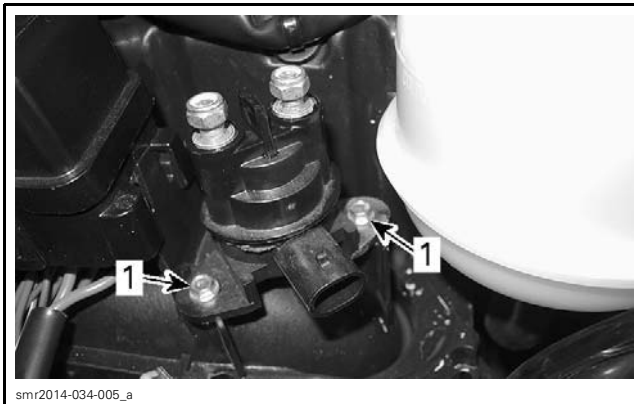
- 1. Solenoid cable nuts

3. Disconnect starter solenoid connector.



1. Starter solenoid connector

4. Remove both screws retaining the solenoid.



1. Solenoid retaining screws

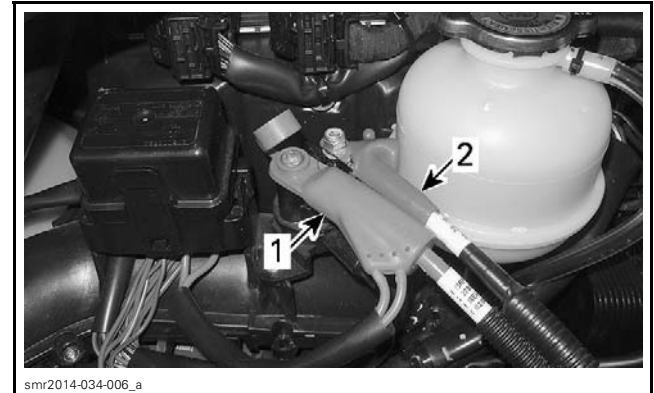
Solenoid Installation

Reverse the removal procedure and pay attention to the following.

1. Secure solenoid on its supports using previously removed screws.

TIGHTENING TORQUE	
Solenoid retaining screws	2 N•m ± 0.5 N•m (18 lbf•in ± 4 lbf•in)

2. Connect solenoid connector.
3. Reinstall cables to solenoid as shown.



1. Cable from battery
 2. Cable to starter motor

NOTE: Apply DIELECTRIC GREASE (P/N 293 550 004) under and over each connections and make sure each nut are well covered.

TIGHTENING TORQUE	
Solenoid cable retaining nuts	4 N•m ± 0.5 N•m (35 lbf•in ± 4 lbf•in)

4. Close or slide protective caps.
5. Reconnect battery and test starter solenoid operation.

STARTER

For starter information refer to *MAGNETO AND STARTER* subsection.