

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

**2007 ENGINE****Engine Electrical - Outlook****SPECIFICATIONS****FASTENER TIGHTENING SPECIFICATIONS****Fastener Tightening Specifications**

<b>Application</b>	<b>Specification</b>	
	<b>Metric</b>	<b>English</b>
Accessory Wiring Junction Block Nut	22 N.m	16 lb ft
Battery Cover Screw	1.6 N.m	14 lb in
Battery Hold Down Bolt	25 N.m	18 lb ft
Battery Negative Cable Extension Cable to Cylinder Head Bolt	58 N.m	43 lb ft
Battery Negative Cable Extension Cable to Left Wheelhouse Panel Upper Reinforcement Bolt	58 N.m	43 lb ft
Battery Positive Junction Block Cable to Generator Nut	22 N.m	16 lb ft
Generator Nut	50 N.m	37 lb ft
Negative Battery Cable Ground Bolt	25 N.m	18 lb ft
Negative Battery Cable Terminal Nut	9 N.m	80 lb in
Positive Battery Cable Terminal Nut	9 N.m	80 lb in
Starter Bolt	50 N.m	37 lb ft
Starter Heat Shield Bolt	7 N.m	62 lb in
Starter Solenoid BAT Terminal Nut	25 N.m	18 lb ft

**BATTERY USAGE****Battery Usage**

<b>Application</b>	<b>Specification</b>
Cold Cranking Amperage (CCA)	730 A
Amp Hours	70 A/H
Reserve Capacity	100 Minutes
Replacement Model Number	48-7YR

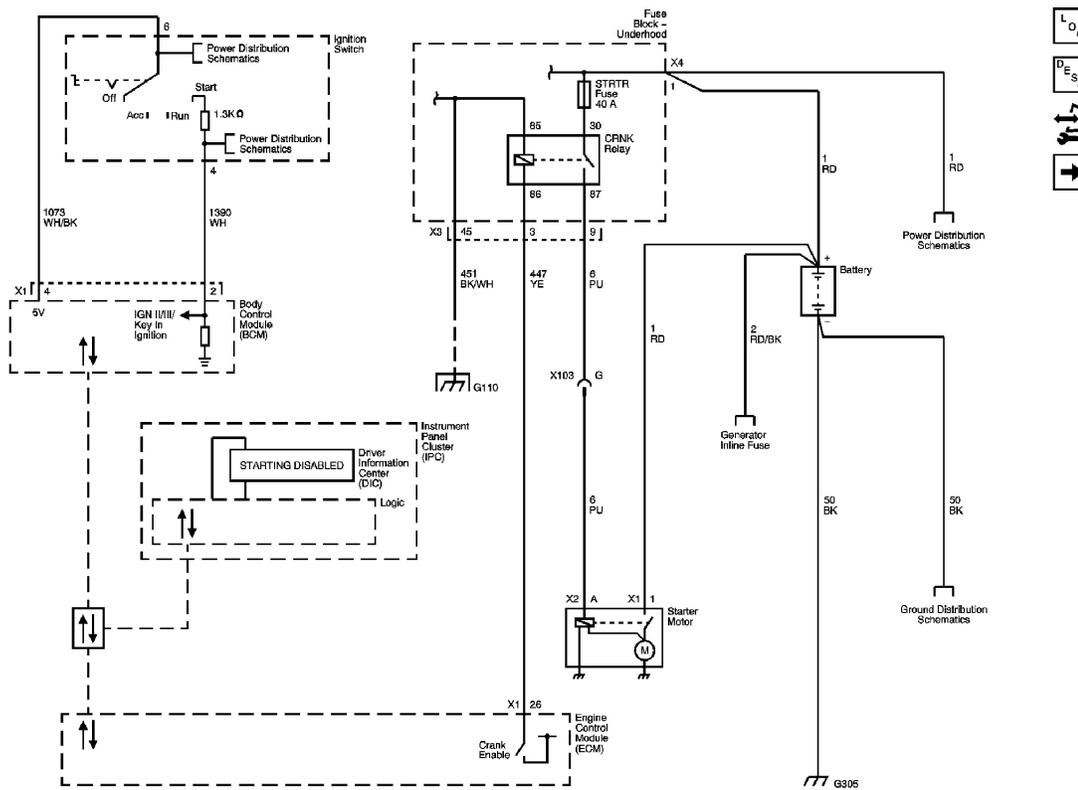
**GENERATOR USAGE**

## Generator Usage

Application	Specification
Generator Model	SC3
Rated Output	170 Amps
Load Test Output	119 Amps

## SCHEMATIC AND ROUTING DIAGRAMS

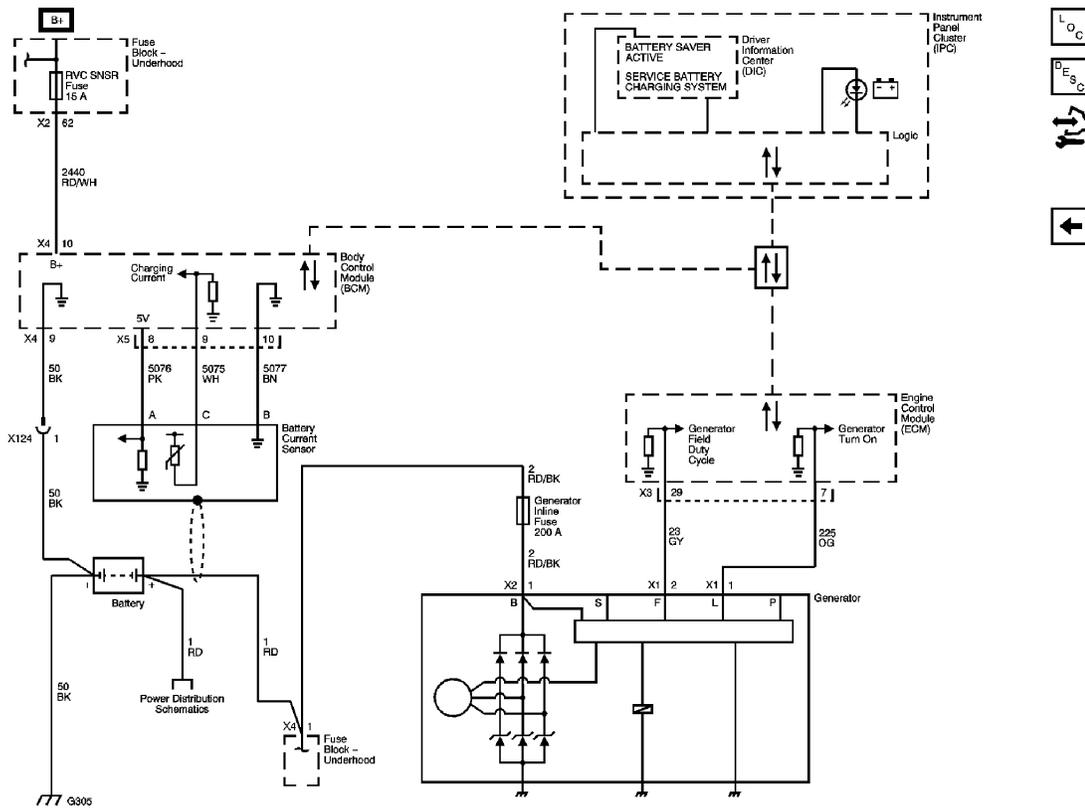
### STARTING AND CHARGING SCHEMATICS



**Fig. 1: Starting - Schematic**  
 Courtesy of GENERAL MOTORS CORP.

# 2007 Saturn Outlook XE

## 2007 ENGINE Engine Electrical - Outlook



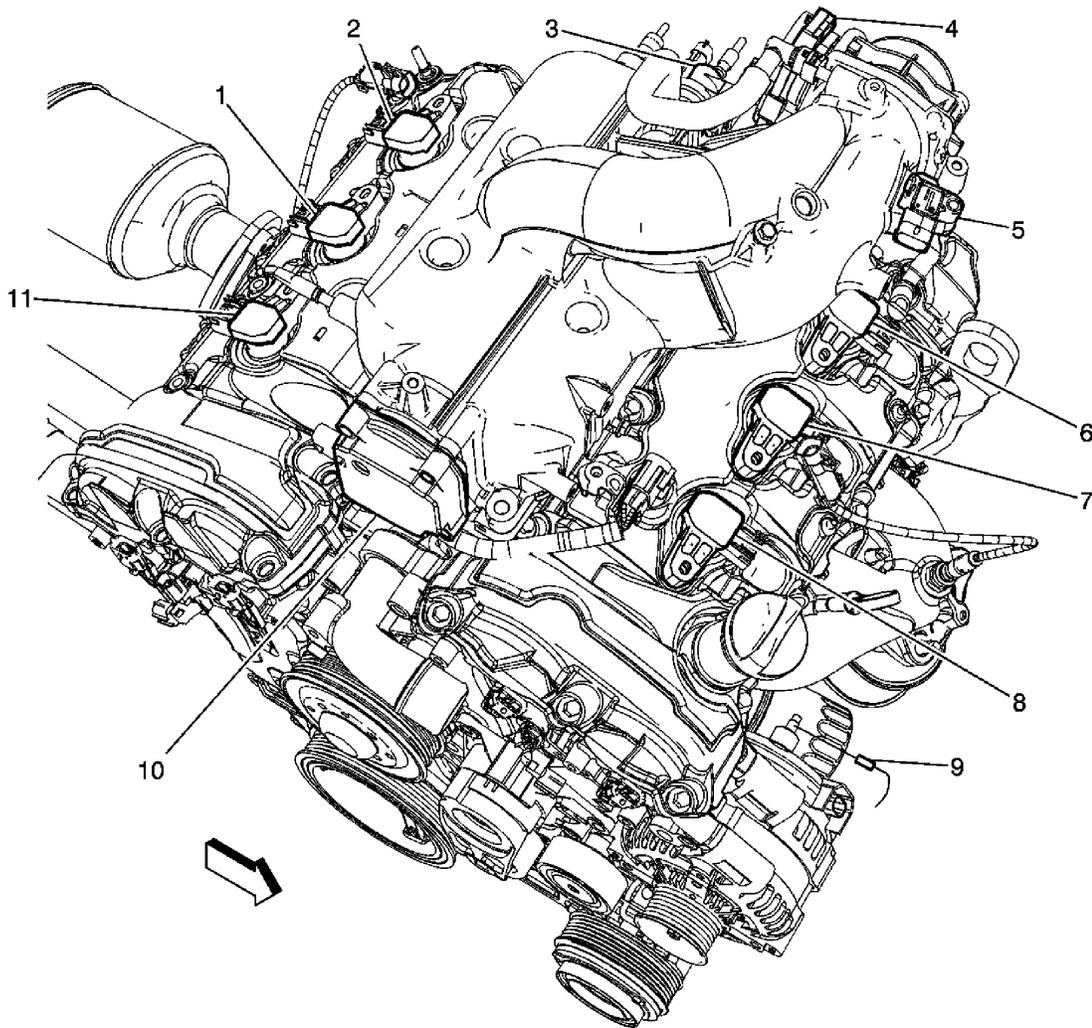
**Fig. 2: Charging - Schematic**  
Courtesy of GENERAL MOTORS CORP.

### COMPONENT LOCATOR

### ENGINE ELECTRICAL COMPONENT VIEWS

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook



**Fig. 3: Identifying Engine Components - Top**  
Courtesy of GENERAL MOTORS CORP.

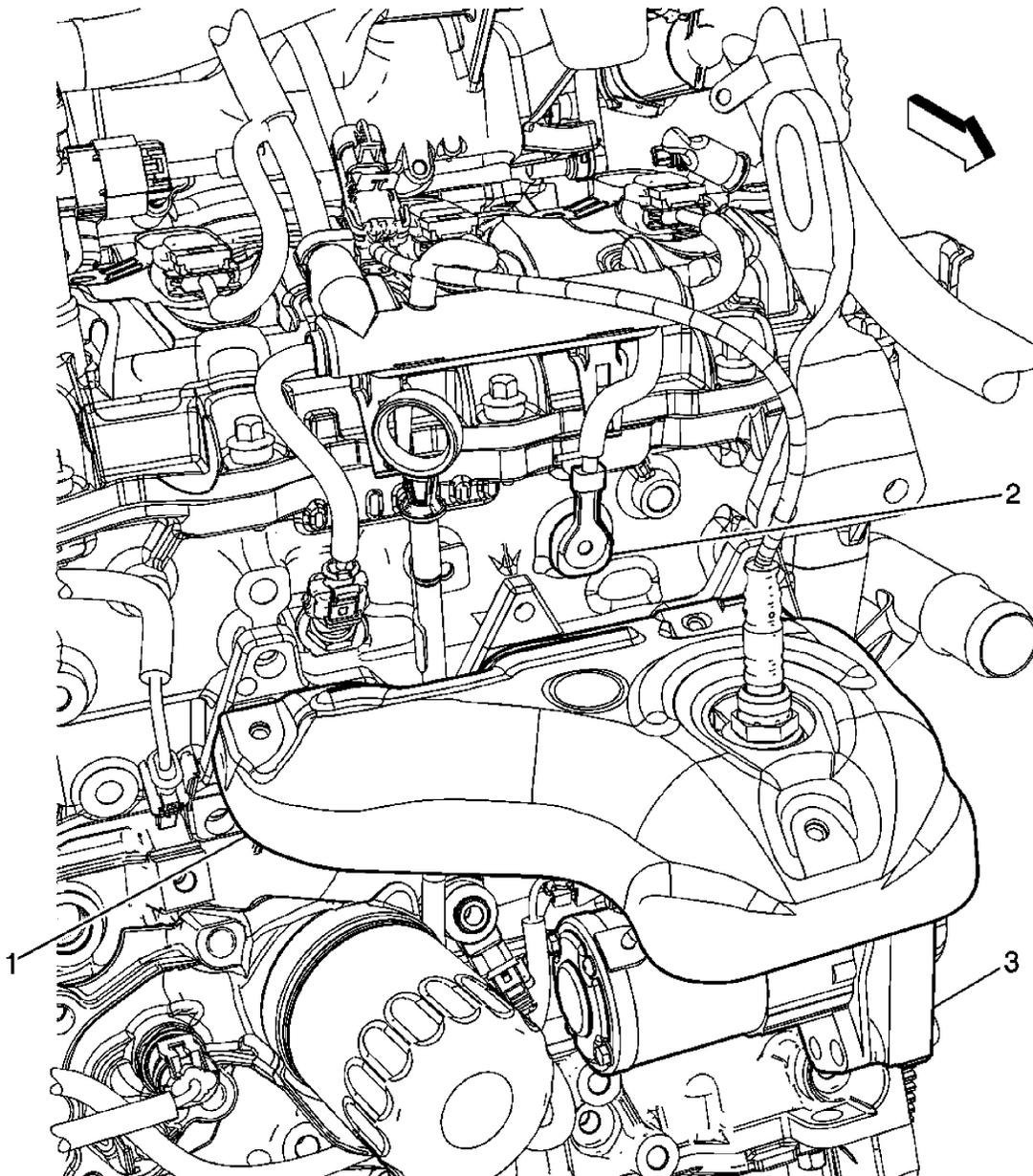
### Callouts For Fig. 3

Callout	Component Name
1	Ignition Coil 3
2	Ignition Coil 5
3	Evaporative Emission (EVAP) Canister Purge Solenoid Valve
4	Throttle Body
5	Barometric Pressure (BARO) Sensor
6	Ignition Coil 6
7	Ignition Coil 4
8	Ignition Coil 2

2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

9	Generator Inline Fuse
10	Intake Manifold Tuning (IMT) Solenoid Valve
11	Ignition Coil 1



**Fig. 4: View Of Left Rear Of Engine**  
Courtesy of GENERAL MOTORS CORP.

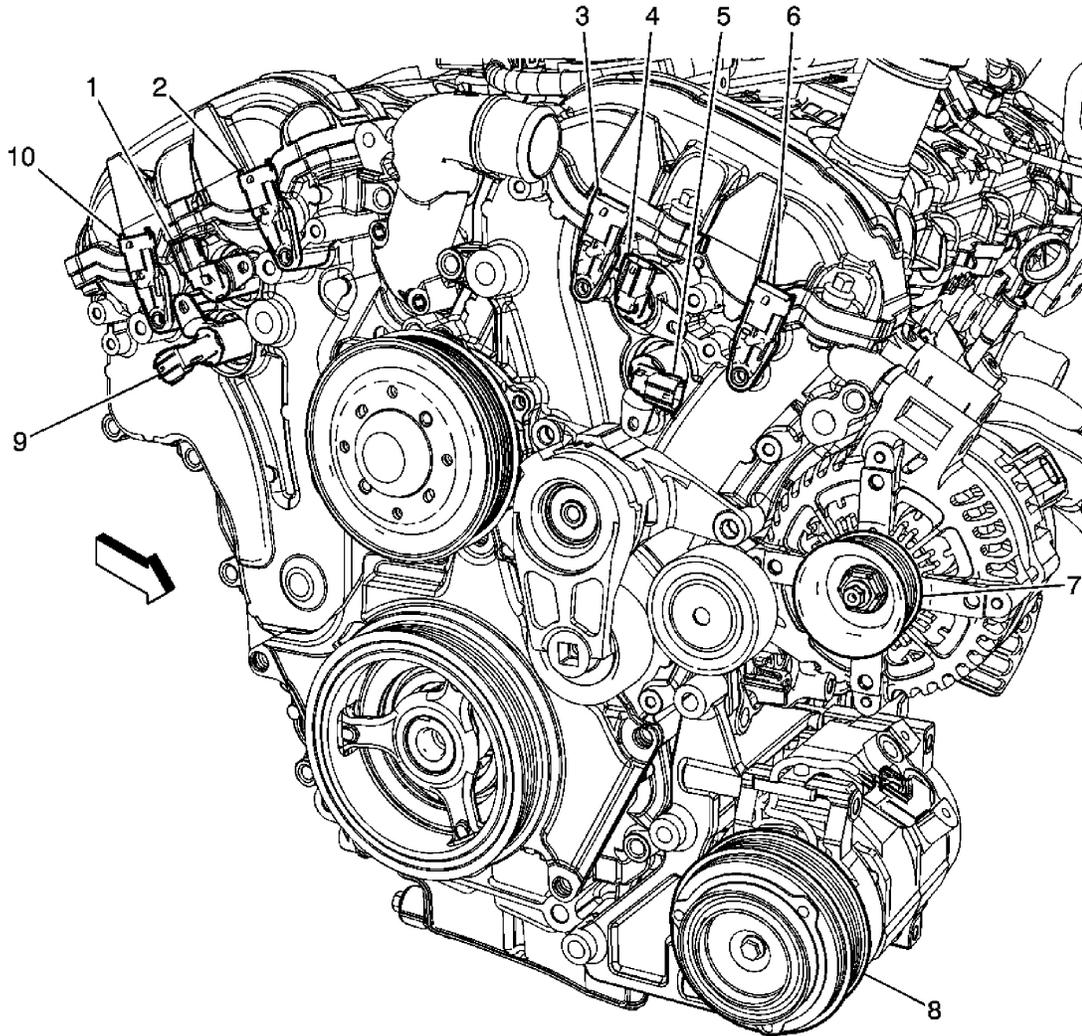
**Callouts For Fig. 3**

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**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

<b>Callout</b>	<b>Component Name</b>
1	Exhaust Manifold
2	G114
3	Starter Motor



**Fig. 5: View Near The Water Pump**  
 Courtesy of GENERAL MOTORS CORP.

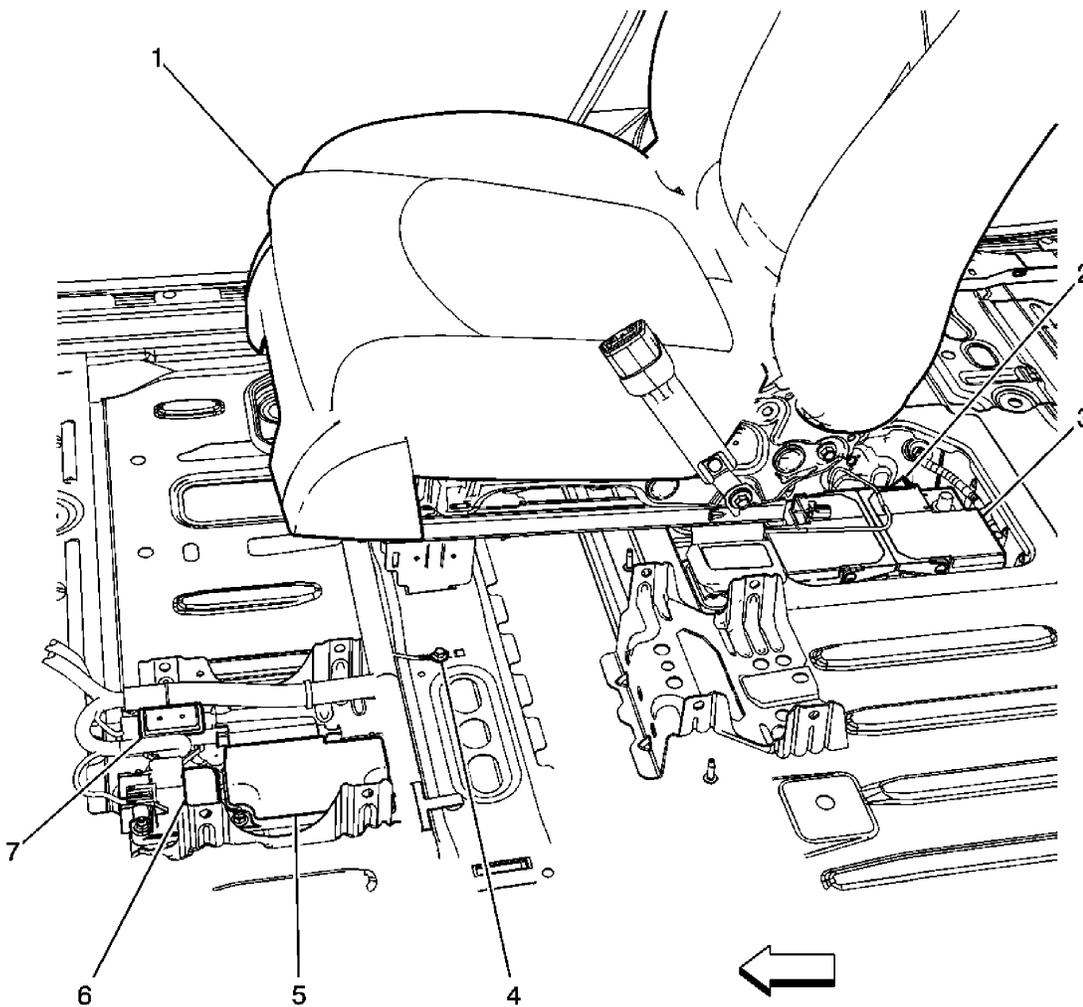
**Callouts For Fig. 54**

<b>Callout</b>	<b>Component Name</b>
1	Camshaft Position (CMP) Actuator Solenoid - Intake Bank 1
2	Camshaft Position (CMP) Sensor - Intake Bank 1

2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

3	Camshaft Position (CMP) Sensor - Intake Bank 2
4	Camshaft Position (CMP) Actuator Solenoid - Intake Bank 2
5	Camshaft Position (CMP) Actuator Solenoid - Exhaust Bank 2
6	Camshaft Position (CMP) Sensor - Exhaust Bank 2
7	Generator
8	A/C Compressor Clutch
9	Camshaft Position (CMP) Actuator Solenoid - Exhaust Bank 1
10	Camshaft Position (CMP) Sensor - Exhaust Bank 1



**Fig. 6: Identifying Components Near Passenger Seat**  
 Courtesy of GENERAL MOTORS CORP.

**Callouts For Fig. 6**

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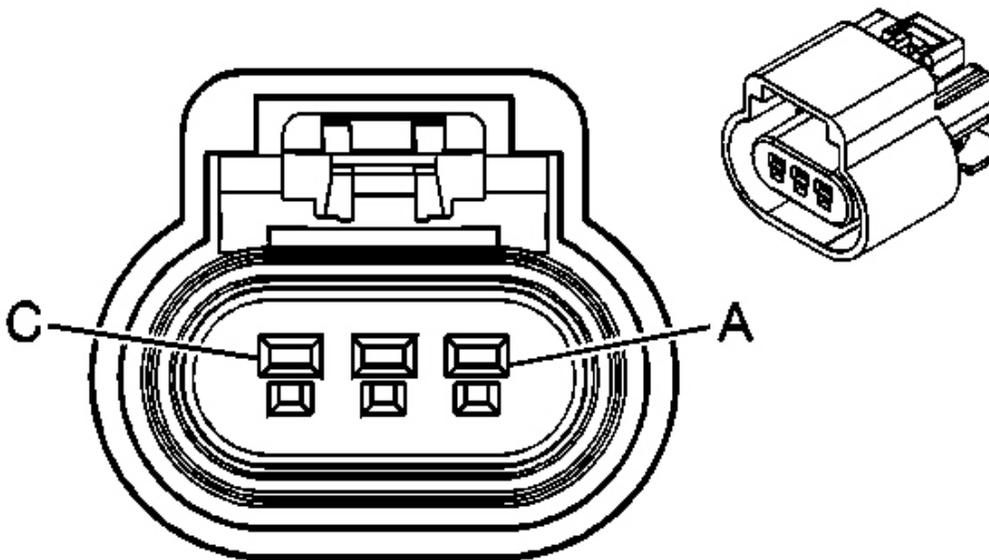
## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

Callout	Component Name
1	Passenger Seat
2	Battery Current Sensor
3	Battery
4	G304
5	Inflatable Restraint Sensing and Diagnostic Module (SDM)
6	Inflatable Restraint Vehicle Rollover Sensor
7	YAW Rate and Lateral Acceleration Sensor

### ENGINE ELECTRICAL CONNECTOR END VIEWS

#### Battery Current Sensor (WDA)



**Fig. 7: Battery Current Sensor (WDA) Connector End View**  
Courtesy of GENERAL MOTORS CORP.

#### Battery Current Sensor (WDA) Connector Parts Information

##### Connector Part Information

- OEM: 15326808

- Service: See Catalog
- Description: 3-Way F GT 150 Series, Sealed (BK)

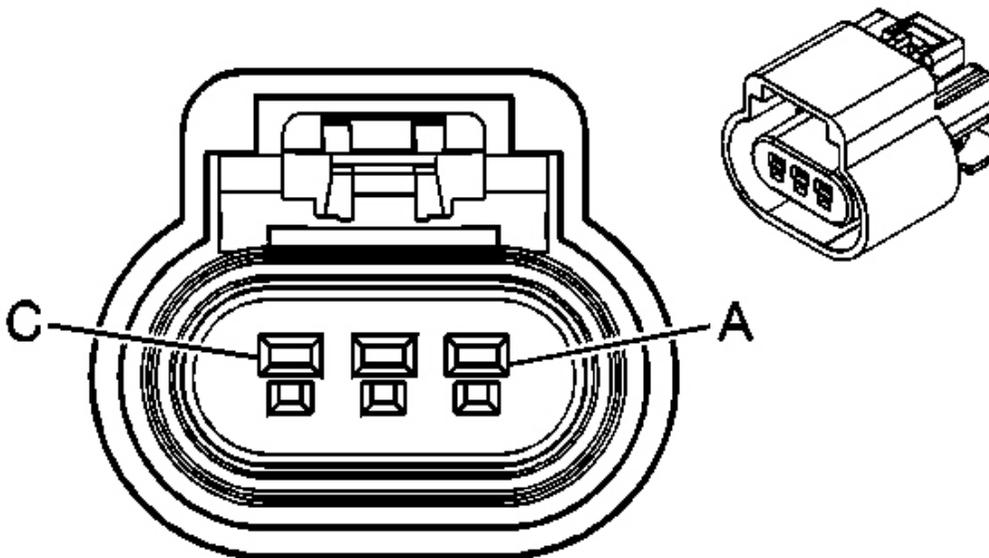
### Terminal Part Information

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

### Battery Current Sensor (WDA) Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	0.35 PK	5076	Current Sensor Supply Voltage
B	0.35 BN	5077	Current Sensor Low Reference
C	0.35 WH	5075	Current Sensor Signal

### Battery Current Sensor (Z88)



**Fig. 8: Battery Current Sensor (Z88) Connector End View**  
 Courtesy of GENERAL MOTORS CORP.

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

### Battery Current Sensor (Z88) Connector Parts Information

#### Connector Part Information

- OEM: 15326808
- Service: See Catalog
- Description: 3-Way F GT 150 Series, Sealed (BK)

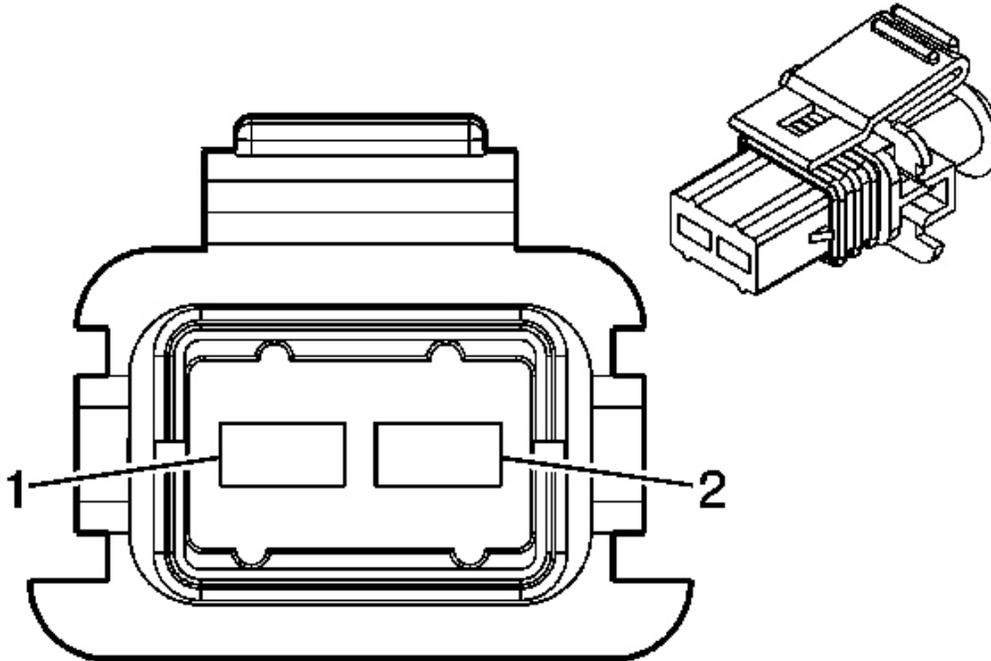
#### Terminal Part Information

- Terminal/Tray: 12191819/8
- Core/Insulation Crimp: E/A
- Release Tool/Test Probe: 15315247/J-35616-2A (GY)

### Battery Current Sensor (Z88) Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	0.35 PK	5076	Current Sensor Supply Voltage
B	0.35 BN	5077	Current Sensor Low Reference
C	0.35 WH	5075	Current Sensor Signal

Generator X1



**Fig. 9: Generator X1 Connector End View**  
 Courtesy of GENERAL MOTORS CORP.

**Generator X1 Connector Parts Information**

**Connector Part Information**

- OEM: 1928403137
- Service: 89046837
- Description: 2-Way F 2.8 Junior Power Timer (BK)

**Terminal Part Information**

- Terminal/Tray: 4-964286-1/16
- Core/Insulation Crimp: E/1
- Release Tool/Test Probe: 12093647/J-35616-4A (PU)

**Generator X1 Connector Terminal Identification**

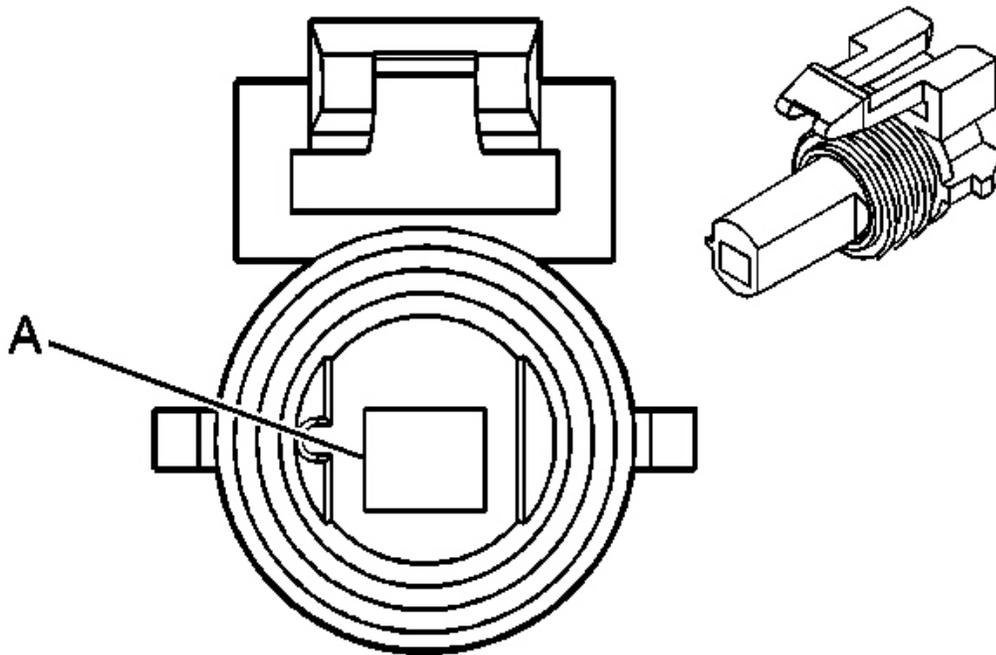
Pin	Wire	Circuit No.	Function

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

1	0.5 OG	225	Generator Turn On Signal
2	0.5 GY	23	Generator Field Duty Cycle Signal

### Starter Motor X2



**Fig. 10: Starter Motor X2 Connector End View**  
Courtesy of GENERAL MOTORS CORP.

### Starter Motor X2 Connector End Views

#### Connector Part Information

- OEM: 12089916
- Service: 12101763
- Description: 1-Way F Metri-Pack 280 Series, Sealed (BK)

#### Terminal Part Information

- Terminal/Tray: 12129493/2
- Core/Insulation Crimp: 4/5

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

- Release Tool/Test Probe: 12094430/J-35616-4A (PU)

### Starter Motor X2 Connector Terminal Identification

Pin	Wire	Circuit No.	Function
A	3 PU	6	Starter Solenoid Crank Voltage

## DIAGNOSTIC INFORMATION AND PROCEDURES

### DIAGNOSTIC CODE INDEX

### DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC B1325</u>	Device Power Circuit
<u>DTC B1424</u>	Device 1 Voltage Low
<u>DTC B1516</u>	Battery Current Sensor Signal Invalid
<u>DTC B1517</u>	Battery Voltage
<u>DTC B1527</u>	High Parasitic Load Detected
<u>DTC C0899</u>	Device Voltage Low
<u>DTC C0900</u>	Device Voltage High
<u>DTC P0562</u>	System Voltage Low
<u>DTC P0563</u>	System Voltage High
<u>DTC P0615</u>	Starter Relay Control Circuit
<u>DTC P0621</u>	Generator L-Terminal Circuit
<u>DTC P0622</u>	Generator F-Terminal Circuit

### DIAGNOSTIC STARTING POINT - ENGINE ELECTRICAL

Begin the system diagnosis with **Diagnostic System Check - Vehicle** . The Diagnostic System Check - Vehicle will provide the following information:

- The identification of the control modules which command the system
- The ability of the control modules to communicate through the serial data circuit
- The identification of any stored diagnostic trouble codes (DTCs) and their status

The use of the Diagnostic System Check - Vehicle will identify the correct procedure for diagnosing the system and where the procedure is located.

### SCAN TOOL OUTPUT CONTROLS

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

**Scan Tool Output Controls**

<b>Scan Tool Output Control</b>	<b>Additional Menu Selection(s)</b>	<b>Description</b>
Engine Output Controls	GEN L-Terminal	The engine control module (ECM) commands the generator OFF by removing the 5-volt reference signal from the L-terminal of the voltage regulator when you select OFF. The generator will then stop generating an output voltage.
Engine Output Controls	Starter Relay Control	The ECM supplies 12 volts to the starter relay control circuit when ON is selected. When OFF is selected, 12 volts is removed from the control circuit

**SCAN TOOL DATA LIST****Body Control Module (BCM)**

<b>Scan Tool Parameter</b>	<b>Data List</b>	<b>Units Displayed</b>	<b>Typical Data Value</b>
<b>Operating Conditions: Ignition ON/Engine Running</b>			
Battery Low at Start	Data Display/Charging Info	Yes/No	No
Batt. Open Ckt. Tested	Data Display/Charging Info	Yes/No	No
Batt. Open Ckt. Voltage	Data Display/Charging Info	Volts	13.03 Volts
Battery Voltage	Data Display/Charging Info	Volts	13.9 Volts
Batt. Voltage High Res.	Data Display/Charging Info	Volts	12.417 Volts
Parasitic Current	Data Display/Charging Info	Amps	0.0 Amps
	Data		

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

Prev. State of Charge	Display/Charging Info	%	90%
Start Up State of Charge	Data Display/Charging Info	%	80%
State of Charge	Data Display/Charging Info	%	85%
State of Charge Low	Data Display/Charging Info	Yes/No	No

### Digital Radio Receiver (DRR)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
<b>Operating Conditions: Ignition ON/Engine Running</b>			
Battery Voltage	Data Display	Volts	13.9 Volts

### Engine Control Module (ECM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
<b>Operating Conditions: Ignition ON/Engine OFF</b>			
Crank Request Signal	Electrical/Theft Data	Yes/No	No
GEN F-Terminal Signal	Electrical/Theft Data	%	0%
GEN L-Terminal Signal Command	Electrical/Theft Data	ON/OFF	OFF
GEN L-Terminal Circuit Status	Electrical/Theft Data	Incomplete/Short Gnd/Open/Short to B+/OK	OK
Ignition 1 Signal	Electrical/Theft Data	Volts	Varies
PNP Switch	Electrical/Theft Data	Park/Neutral/In Gear	Park
Starter Relay Command	Electrical/Theft Data	On/Off	Off

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

Starter Relay Circuit Status	Electrical/Theft Data	Incomplete/Short Gnd/Open/Short to B+/OK	OK
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### Instrument Panel Cluster (IPC)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
<b>Operating Conditions: Ignition ON/Engine Running</b>			
Battery Voltage	Data Display	Volts	13.9 Volts

### Vehicle Theft Deterrent (VTD)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
<b>Operating Conditions: Ignition ON</b>			
Ignition Voltage Signal	Data Display	Present/Not Present	Present
Start Disabled	Data Display	Yes/No	No

### Sensing Diagnostic Module (SDM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
<b>Operating Conditions: Ignition ON/Engine Running</b>			
Battery Voltage Signal	Data Display	Volts	13.9 Volts

### Transmission Control Module (TCM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
<b>Operating Conditions: Ignition ON/Transmission in Park</b>			
IMS	Engine Electrical	Park, Park/Reverse, Reverse, Reverse/Neutral, Neutral, Neutral/Drive 4, Drive 4, Drive 4/Drive 3, Drive 3, Drive 3/Drive 2, Drive 2, Drive 2/Drive 1, Drive 1, INVALID, OPEN	Park

## SCAN TOOL DATA DEFINITIONS

### Battery Voltage

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received by the Module.

### **Battery Voltage Signal**

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received by the Module.

### **Crank Request Signal**

The scan tool displays Yes/No. The scan tool displays No until the ignition is placed into the START position then Yes is displayed.

### **GEN F-Terminal Signal**

The scan tool displays 0-100%. The display indicates the generator F terminal duty cycle in percent. The scan tool displays 0-5% until the engine is running, then the percentage value varies depending on engine or electrical loads.

### **GEN L-Terminal Command**

The scan tool displays 0-100%. The scan tool displays the percentage of the output voltage of the generator.

### **GEN L-Terminal Circuit Status**

The scan tool displays Incomplete, Short Gnd/Open, Short to B+ or OK. The scan tool displays the status of the GEN-L Terminal circuit.

### **Ignition 1 Signal**

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received on the Ignition 1 circuit to the module.

### **Ignition Accessory Signal**

The scan tool displays ON/OFF. The scan tool displays if the ignition 0 signal is On or OFF.

### **Ignition Voltage Signal**

The scan tool displays Present/Not Present. The scan tool displays the status of the ignition voltage signal on the theft deterrent module (TDM).

**PNP Switch (If Equipped)**

The scan tool displays Park/Neutral or In Gear. The scan tool displays the position of the transmission setting.

**Start Disabled**

The scan tool displays YES/NO. The scan tool displays YES if the TDM has disabled the starting function.

**Starter Relay Command**

The scan tool displays ON/OFF. The scan tool displays Off until the ignition is placed into the CRANK position, then it reads On.

**Starter Relay Circuit Status**

The scan tool displays Incomplete, Short Gnd/Open, Short to B+ or OK. The scan tool displays the status of the STRTR relay.

**Start Up State of Charge**

The scan tool displays 1-100%. The scan tool displays the state of charge at initial key up.

**Prev. State of Charge**

The scan tool displays 0-100%. The scan tool displays the state of charge from the previous ignition cycle.

**State of Charge**

The scan tool displays 0-100%. The scan tool displays the present state of charge.

**State of Charge Low**

The scan tool displays YES/NO. The scan tool displays YES if the present state of charge is low.

**DTC B1325****Circuit Description**

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

The control modules on this vehicle monitor the battery voltage through the battery positive voltage circuits. This vehicle has multiple modules that will set this DTC. For more information on which modules, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .

### DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1325 Device Power Circuit

### DTC B1325

DTC Symptom	DTC Symptom Descriptor
03	Voltage Below Threshold
07	Voltage Above Threshold

### Conditions for Running the DTC

The voltage supplied to the control modules are in the range of 7-26 volts.

### Conditions for Setting the DTC

#### B1325 03

- The control module detects a system voltage below the calibrated value usually 9 volts.
- The above condition is present at least 5 seconds.

#### B1325 07

- The control module detects a system voltage above the calibrated value usually 18 volts.
- The above condition is present at least 5 seconds.

### Action Taken When the DTC Sets

- The control module immediately disables all outputs when a out of range voltage condition has been detected, with the exception of GMLAN and Run/Crank relay that are disabled after a 3 minute delay.
- The setting of other DTCs is inhibited.

### Conditions for Clearing the DTC

- A current DTC clears when the malfunction is no longer present.

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

- A history DTC clears when the module ignition cycle counter reaches the reset threshold, without a repeat of the malfunction.

**DTC B1325**

Step	Action	Values	Yes	No
<b>Schematic Reference: <u>Control Module References</u></b>				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to <b>Step 2</b>	Go to <b>Diagnostic System Check - Vehicle</b>
2	<ol style="list-style-type: none"> <li>1. Install a scan tool.</li> <li>2. Turn ON the ignition, with the engine OFF.</li> <li>3. With a scan tool, observe the Battery Voltage Signal parameter in the data list of the module setting the DTC</li> </ol> <p>Is the Battery Voltage Signal parameter displayed in the specified range?</p>	9-18 V	Go to <b>Step 3</b>	Go to <b>Step 4</b>
3	Is the DTC set as a current DTC?	-	Go to <b>Step 7</b>	Go to <b>Testing for Intermittent Conditions and Poor Connections</b>
4	<ol style="list-style-type: none"> <li>1. Disconnect the harness connector of the module setting the DTC.</li> <li>2. Measure the voltage between the battery positive voltage circuit at the module harness connector and a good ground.</li> </ol> <p>Is the measured value in the specified range?</p>	9-18 V	Go to <b>Step 6</b>	Go to <b>Step 5</b>
	Test the battery positive voltage			

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

5	<p>circuit for the following:</p> <ul style="list-style-type: none"> <li>• A short to ground</li> <li>• An open</li> <li>• A high resistance</li> </ul> <p>Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> . Did you find and correct the condition?</p>	-	Go to <b>Step 9</b>	Go to <b><u>Charging System Test</u></b>
6	<p>Test the all of ground circuits of the module for an open or high resistance. Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> . Did you find and correct the condition?</p>	-	Go to <b>Step 9</b>	Go to <b>Step 7</b>
7	<p>Inspect for poor connections at the harness connector of the affected module. Refer to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b> and <b><u>Connector Repairs</u></b> . Did you find and correct the condition?</p>	-	Go to <b>Step 9</b>	Go to <b>Step 8</b>
8	<p>Replace the affected module Refer to <b><u>Control Module References</u></b> for replacement, setup and programming. Did you complete the replacement?</p>	-	Go to <b>Step 9</b>	-
9	<p>Operate the system in order to verify the repair. Did you find and correct the condition?</p>	-	System OK	Go to <b>Step 2</b>

**DTC B1424**

**Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor**

**DTC B1424**

Device 1 Voltage Low

**Circuit/System Description**

Voltage at Pass Key 3 module is lower than the voltage being reported on the serial data line.

**Conditions for Running the DTC**

The ignition must be in Accessory or Run mode for this code to set.

**Conditions for Setting the DTC**

Module battery voltage between low voltage limits 6-9 volts for a minimum of 2 seconds and serial data voltage is greater than normal low voltage 9 volts.

**Action Taken When the DTC Sets**

Security telltale ON.

**Conditions for Clearing the DTC**

Module battery voltage is greater than normal voltage low limit 9 volts.

**Reference Information**

**Schematic Reference**

**Immobilizer Schematics**

**Connector End View Reference**

**Immobilizer Connector End Views**

**Electrical Information Reference**

- **Circuit Testing**

- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

#### Circuit/System Testing

1. Ignition OFF, disconnect the theft deterrent module (TDM) harness connector.
2. Measure and record the voltage at the battery terminals. Ignition in ON position, measure the voltage between the accessory voltage circuit and the ground circuit of the TDM. Verify that the voltage readings do not differ more than 1 volt.
  - If greater than 1 volt, test the accessory voltage circuit and the ground circuit of the TDM for an open/high resistance. If the circuits test normal, replace the TDM.
3. Refer to **Charging System Test**.

#### Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

**Control Module References** for TDM replacement, setup and programming

#### DTC B1516

##### Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

##### DTC Descriptors

#### DTC B1516 08

Battery Current Sensor Signal Invalid

#### DTC B1516 66

Battery Current Sensor Wrong Mounting Position

##### Diagnostic Fault Information

#### DTC B1516

**2007 Saturn Outlook XE**

## 2007 ENGINE Engine Electrical - Outlook

<b>Circuit</b>	<b>Short to Ground</b>	<b>Open/High Resistance</b>	<b>Short to Voltage</b>	<b>Signal Performance</b>
Battery Current Sensor Supply Voltage	B1516 08	B1516 08	-	B1516 08
Battery Current Sensor Signal Circuit	B1516 08	B1516 08	-	B1516 08
Battery Current Sensor Low Reference Circuit	-	B1516 08	-	B1516 08

**Circuit/System Description**

The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the body control module (BCM). It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

**Conditions for Running the DTC**

- The ignition is ON.
- The engine is running.

**Conditions for Setting the DTC****B1516 08**

The BCM detects a duty cycle of PWM input signal is less than 4 percent or more than 96 percent for more 33 seconds.

**B1516 66**

The BCM detects the battery current sensor is improperly installed.

**Action Taken When the DTC Sets**

The charge indicator illuminates in the instrument panel cluster (IPC) and the SERVICE BATTERY CHARGING SYSTEM warning message will be displayed in the driver information center (DIC) if equipped.

**Conditions for Clearing the DTC**

The DTC clears as current status when the battery sensed current returns to normal range for more

than 5 seconds.

#### Reference Information

##### Schematic Reference

- **Starting and Charging Schematics**
- **Body Control System Schematics**

##### Connector End View Reference

### **Engine Electrical Connector End Views**

##### Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

##### Circuit/System Testing

#### B1516 08

1. Ignition OFF, disconnect the harness connector at the battery current sensor.
2. Ignition OFF, test for less than 1.0 ohm of resistance between the low reference circuit terminal B and ground.
  - If the greater than the specified range, test the low reference circuit terminal B for an open/high resistance. If the circuit tests normal replace the BCM.
3. Ignition ON, test for 5 volts between the battery current sensor supply voltage circuit terminal A and ground.
  - If less than the specified range, test the battery current sensor supply voltage circuit terminal A for a short to ground or an open/high resistance. If the circuit test normal replace the BCM.
4. Test for 5 volts between the battery current sensor signal circuit terminal C and ground.
  - If less than 5 volts test the battery current sensor signal circuit terminal C for a short to ground or an open/high resistance. If the circuit test normal replace the BCM.
5. If all circuits test normal test or replace the battery current sensor.

#### B1516 66

When diagnosing B1516 66 verify that the battery current sensor is installed securely and positioned in the correct current flow direction.

- If the battery current sensor is not, remove and reinstall the sensor properly.

#### Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for BCM replacement, setup and programming
- **Battery Positive Cable Replacement** for current sensor replacement

### DTC B1517

#### Circuit Description

The body control module (BCM) has designated circuits for monitoring vehicle system voltage. The BCM monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur when the voltage is out of range. The BCM monitors the system voltage over an extended length of time. If the BCM detects the system voltage is outside an expected range for the calibrated length of time or the BCM battery sense circuits differ by 2 volts DTC B1517 will set. Other modules also monitor system voltage the system voltage message is sent to the other modules and will default to 12.9 volts.

#### DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1517 Battery Voltage

### DTC B1517

DTC Symptom	DTC Symptom Descriptor
03	Voltage Below Threshold
07	Voltage Above Threshold
5A	Battery Voltage Plausibility Failure

#### Conditions for Running the DTC

This DTC shall run only if the BCM has power, ground and the ignition is not in START mode. This DTC shall execute regardless of the battery voltage.

#### Conditions for Setting the DTC

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

- The battery voltage falls below 11 volts, engine speed greater than 1,100 RPM for 15 seconds.
- The battery voltage is greater 16 volts, engine speed greater than 1,100 RPM for 15 seconds.
- The battery voltage differs by 2 volts on the BCM battery sense circuits for 10 seconds.

#### Action Taken When the DTC Sets

##### B1517 03

The Battery indicator turns ON, the driver information center (DIC) displays the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM Message.

##### B1517 07

The Battery indicator turns ON, the DIC displays the SERVICE BATTERY CHARGING SYSTEM Message.

##### B1517 5A

The Battery indicator turns ON, the DIC displays the SERVICE VEHICLE SOON Message.

#### Conditions for Clearing the DTC

- The DTC will clear current status when the fault is no longer present.
- A history DTC will clear after 50 consecutive ignition cycles if the condition for the malfunction is no longer present.
- Use a scan tool.

#### Test Description

The numbers below refer to the step numbers on the diagnostic table.

**3:** This step tests for the proper voltage at battery positive voltage sense circuits of the BCM. If voltages are not within the proper operating range, the voltage sense circuits needs to be tested.

**4:** This step tests the ground sense circuit of the BCM.

**5:** This step tests for the proper voltage of the battery sense circuits to the BCM. If voltage is not within the proper operating range, the battery positive voltage and ground circuits of the BCM need to be tested.

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

**DTC B1517**

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
<b>Schematic Reference: <u>Starting and Charging Schematics</u> or <u>Power Distribution Schematics</u> and <u>Body Control System Schematics</u></b> <b>Connector End View Reference: <u>Master Electrical Component List</u></b>				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <b><u>Diagnostic System Check - Vehicle</u></b>
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Battery Voltage parameters in the body control module (BCM) data list.  Do any of the voltages differ more than the specified value?	2 V	Go to Step 5	Go to Step 3
3	1. Turn OFF the ignition. 2. Disconnect the BCM harness connectors. 3. Turn ON the ignition, with the engine OFF. 4. Measure the voltage between the battery positive voltage circuits of the BCM and the ground circuits of the BCM.  Do the voltages differ more than the specified value?	2 V	Go to Step 9	Go to Step 4
4	Measure the voltage from the battery positive voltage circuits of the BCM and a good ground. Do the voltages differ more than the specified value?	2 V	Go to Step 8	Go to Step 7

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

5	<p>1. Turn ON the ignition.</p> <p>2. Measure the voltage between the battery positive voltage circuits of the BCM and the ground circuits of the BCM.</p> <p>Does the voltage measure within the specified range?</p>	10.5-15.5 V	Go to <b>Step 9</b>	Go to <b>Step 6</b>
6	<p>Measure the voltage between the battery positive voltage circuits of BCM and a good ground.</p> <p>Does the voltage measure within the specified range ?</p>	10.5-15.5 V	Go to <b>Step 8</b>	Go to <b>Step 7</b>
7	<p>Test the battery positive voltage circuits of BCM for a high resistance or an open. Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> .</p> <p>Did you find and correct the condition?</p>	-	Go to <b>Step 11</b>	Go to <b>Step 9</b>
8	<p>Test the ground circuits of the BCM for a high resistance or an open. Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> .</p> <p>Did you find and correct the condition?</p>	-	Go to <b>Step 11</b>	Go to <b>Step 9</b>
9	<p>Inspect for poor connections at the harness connector of the BCM. Refer to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b> and <b><u>Connector Repairs</u></b> .</p> <p>Did you find and correct the condition?</p>	-	Go to <b>Step 11</b>	Go to <b>Step 10</b>
10	<p>Replace the module BCM. Refer to <b><u>Control Module References</u></b> for replacement, setup and programming.</p> <p>Did you complete the replacement?</p>	-	Go to <b>Step 11</b>	-
	<p>1. Use the scan tool in order to clear the DTCs.</p>			

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

11	2. Operate the vehicle within the Conditions for Running the DTC as specified in the supporting text.	-		
	Does the DTC reset?		Go to <b>Step 2</b>	System OK

### DTC B1527

#### Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

#### DTC Descriptor

### DTC B1527

High Parasitic Load Detected

#### Circuit/System Description

The body control module (BCM) monitors the State Of Charge (SOC) of the electrical system. If the BCM senses that the SOC at key-on is 30 percent lower than what it was when the engine was running, DTC B1527 will set.

#### Conditions for Running the DTC

The ignition must be in Accessory or Run mode for this code to set.

#### Conditions for Setting the DTC

The SOC at key-on is 30 percent lower than when the engine was running and battery drain is more than 2 amps.

#### Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

#### Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.

- The DTC will clear when run SOC is greater than or equal to 80 percent.

#### Reference Information

#### Schematic Reference

### Starting and Charging Schematics

#### Connector End View Reference

### Engine Electrical Connector End Views

#### Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

#### Scan Tool Reference

- Scan Tool Data List
- Scan Tool Data Definitions

#### Circuit/System Verification

Ignition ON, with scan tool compare the Prev. State of Charge and Start Up State of Charge parameters. The readings should not differ my more than 30 percent.

- If the readings differ by more than 30 percent, refer to Battery Electrical Drain/Parasitic Load Test.

#### Repair Procedures

Perform the Diagnostic Repair Verification after completing the diagnostic procedure.

#### DTC C0899

#### Diagnostic Instructions

- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure.
- Review Strategy Based Diagnosis for an overview of the diagnostic approach.

- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor**

**DTC C0899**

Device Voltage Low

**Circuit/System Description**

The electronic brake control module (EBCM) monitors the ignition voltage level available for system operation. A low voltage condition prevents the system from operating properly.

**Conditions for Running the DTC**

Ignition is ON.

**Conditions for Setting the DTC**

This fault will be set if the ignition voltage to EBCM is less than 9 volts for 100 msec.

**Action Taken When the DTC Sets**

- Traction control system (TCS) and vehicle stability enhancement system (VSES) for the duration of the ignition cycle.
- The TCS indicator turns ON.
- The DIC displays the Service Stability System message.

**Conditions for Clearing the DTC**

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

**Reference Information**

**Schematic Reference**

**Antilock Brake System Schematics**

**Connector End View Reference**

**Antilock Brake System Connector End Views**

**Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

**Circuit/System Testing**

1. Measure the voltage at the battery terminals.
2. With scan tool, read the ignition voltage in the EBCM data list. Verify that battery terminal voltage and ignition voltage readings do not differ more than 1 volt.
  - If more than 1 volt, test the ignition voltage and ground circuits of the EBCM for high resistance or replace the EBCM.
3. Go to **Charging System Test**.

**Repair Procedures**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

**Control Module References** for EBCM replacement, setup and programming

**DTC C0900**

**Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor**

**DTC C0900**

Device Voltage High

**Circuit/System Description**

The electronic brake control module (EBCM) monitors the ignition voltage. If the voltage level is too high, damage may result in the system. When a high voltage condition is detected the EBCM turns OFF the system relay which removes battery voltage from the solenoid valves and pump

motor.

**Conditions for Running the DTC**

Ignition is ON.

**Conditions for Setting the DTC**

The system voltage is greater than 16 volts for 100 msec.

**Action Taken When the DTC Sets**

- Traction control system (TCS) and vehicle stability enhancement system (VSES) disabled for the duration of the ignition cycle.
- The antilock brake system (ABS) disabled if ignition voltage exceeds 19.5 volts.
- The TCS indicator turns ON.
- The ABS indicator turns ON if voltage exceeds 19.5 volts.
- The driver information center (DIC) displays the Service Stability System message.

**Conditions for Clearing the DTC**

- The condition for the DTC is no longer present and the DTC is cleared with a scan tool.
- The EBCM automatically clears the history DTC when a current DTC is not detected in 100 consecutive drive cycles.

**Reference Information**

**Schematic Reference**

**Antilock Brake System Schematics**

**Connector End View Reference**

**Antilock Brake System Connector End Views**

**Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

**Diagnostic Aids**

- A possible cause of this DTC could be overcharging with a battery charger or jump starting.
- A high voltage value in multiple modules indicates a concern in the charging system.

**Circuit/System Verification**

1. If the DTC is history, refer to **Charging System Test**
2. Start the engine, record the voltage at the battery terminals. Observe the battery voltage signal parameter in the EBCM data list. Voltages should not differ by more than 1 volt.
  - If more than 1 volt, replace the EBCM.

**Repair Procedures**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

**Control Module References** for EBCM replacement, setup and programming

**DTC P0562****Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor****DTC P0562**

System Voltage Low

**Diagnostic Fault Information****DTC P0562**

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Signal	P0562	P0562	-	-

**Circuit/System Description**

The engine control module (ECM) monitors the system voltage to ensure that the voltage stays

within the proper range. Damage to components and incorrect data may occur when the voltage is out of range.

#### Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 volts.

#### Conditions for Setting the DTC

The ECM detects a system voltage below 10 volts for 5 seconds.

#### Action Taken When the DTC Sets

- The ECM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Failure Records data only.

#### Conditions for Clearing the DTC

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- Using the scan tool Clear DTC Information function can clear the DTC.

#### Reference Information

##### Schematic Reference

### Starting and Charging Schematics

##### Connector End View Reference

### Engine Electrical Connector End Views

##### Electrical Information Reference

- Circuit Testing
- Connector Repairs

- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

**Scan Tool Reference**

- **Scan Tool Data List** for ECM
- **Scan Tool Data Definitions** for ECM

**Circuit/System Verification**

With the scan tool installed, ignition ON and the engine OFF, observe the Ignition 1 Signal parameter in the ECM data list. The Ignition 1 Signal parameter should read 10.5 volts or greater.

**Circuit/System Testing**

1. Measure the voltage at the battery terminals and compare it with the Ignition 1 Signal parameter in the ECM data list. Verify that battery and ignition 1 signal readings do not differ more than 1.0 volt.
  - If greater than 1.0 volt, test the ignition 1 ground circuits of the ECM for high resistance or replace the ECM.
2. Go to **Charging System Test**.

**Repair Procedures**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

**Control Module References** for ECM replacement, setup and programming

**DTC P0563**

**Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor**

**DTC P0563**

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

### System Voltage High

#### Diagnostic Fault Information

#### DTC P0563

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Signal	P0562	P0562	-	-

#### Circuit/System Description

The engine control module (ECM) monitors the system voltage to ensure that the voltage stays within the proper range. Damage to components and incorrect data may occur when the voltage is out of range.

#### Conditions for Running the DTC

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 volts.

#### Conditions for Setting the DTC

The ECM detects a system voltage above 16 volts for less than 1 second.

#### Action Taken When the DTC Sets

- The ECM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Failure Records data only.

#### Conditions for Clearing the DTC

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- Using the scan tool Clear DTC Information function can clear the DTC.

#### Reference Information

Schematic Reference

**Starting and Charging Schematics**

Connector End View Reference

**Engine Electrical Connector End Views**

Electrical Information Reference

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List** for ECM
- **Scan Tool Data Definitions** for ECM

Circuit/System Verification

1. If the DTC is history, refer to **Charging System Test**
2. Start the engine, record the voltage at the battery terminals. Observe the Ignition 1 signal parameter in the ECM data list. Voltages should not differ by more than 1 volt.
  - If more than 1 volt, replace the ECM.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

**Control Module References** for ECM replacement, setup and programming

**DTC P0615**

Circuit Description

The engine control module (ECM) supplies 12 volts to the control circuit of the crank relay when start enable has been requested. The ECM monitors this circuit for conditions that are incorrect for the commanded state. If the ECM detects an improper circuit condition, crank relay DTC P0615 will set.

**DTC Descriptor**

This diagnostic procedure supports the following DTC:

**DTC P0615 Starter Relay Control Circuit****Conditions for Running the DTC**

System voltage is between 9-16 volts.

**Conditions for Setting the DTC**

- The ECM detects an improper voltage level on the control circuit that controls the crank relay.
- The condition exists for at least 2 seconds.

**Action Taken When the DTC Sets**

- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Failure Records data only.

**Conditions for Clearing the MIL/DTC**

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

**Diagnostic Aids**

Ignition system DTCs set with the ignition switch in the START position if the crank relay or the starter is inoperative. When the ECM enables starter operation, the ECM also initiates the diagnostic test routines for other DTCs. If a condition exists which prevents the engine from cranking, the ECM will not receive signal input from the crankshaft position (CKP) and camshaft position (CMP) sensors and the DTCs will set.

Reviewing the Failure Records vehicle mileage since the diagnostic test last failed may assist in diagnosing the condition. The information may help determine how often the condition that set the DTC occurs.

**Test Description**

The numbers below refer to the step numbers on the diagnostic table.

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

**2:** Listen for an audible click when the crank relay operates. Turn the ignition switch back and forth from the ON to START positions. Repeat this as necessary.

**3:** This step tests the ground circuit of the crank relay.

**4:** This step verifies that the ECM is providing 12 volts to the control circuit of crank relay.

**5:** This step tests for an open in the control circuit to the crank relay.

**DTC P0615**

Step	Action	Yes	No
<b>Schematic Reference: <u>Starting and Charging Schematics</u></b>			
<b>Connector End View Reference: <u>Power and Grounding Connector End Views</u></b>			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <b><u>Diagnostic System Check - Vehicle</u></b>
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Turn the ignition back and forth from the ON to START positions.  Does the crank relay click with each command?	Go to Step 3	Go to <b><u>Starter Solenoid Does Not Click</u></b>
3	1. Turn OFF the ignition. 2. Remove the crank relay. 3. Turn ON the ignition, with the engine OFF. 4. Test the ground circuit of the crank relay with a test lamp that is connected to battery positive.  Does the test lamp illuminate?	Go to Step 4	Go to Step 8
4	1. Connect a test lamp between the crank relay control circuit and the crank relay ground circuit of the crank relay.  2. Turn the ignition back and forth from		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

	the ON to START positions. Does the test lamp turn ON and OFF with each command?	Go to <b>Step 6</b>	Go to <b>Step 5</b>
5	Test the control circuit of the crank relay for an open or a high resistance. Refer to <b>Circuit Testing</b> and <b>Wiring Repairs</b> . Did you find and correct the condition?	Go to <b>Step 11</b>	Go to <b>Step 7</b>
6	Inspect for poor connections at the starter relay. Refer to <b>Testing for Intermittent Conditions and Poor Connections</b> and <b>Connector Repairs</b> . Did you find and correct the condition?	Go to <b>Step 11</b>	Go to <b>Step 9</b>
7	Inspect for poor connections at the engine control module (ECM). Refer to <b>Testing for Intermittent Conditions and Poor Connections</b> and <b>Connector Repairs</b> . Did you find and correct the condition?	Go to <b>Step 11</b>	Go to <b>Step 10</b>
8	Repair the ground circuit of the crank relay. Refer to <b>Connector Repairs</b> . Did you complete the repair?	Go to <b>Step 11</b>	-
9	Replace the crank relay. Did you complete the replacement?	Go to <b>Step 11</b>	-
10	Replace the ECM. Refer to <b>Control Module References</b> for replacement, setup and programming. Did you complete the replacement?	Go to <b>Step 11</b>	-
11	<ol style="list-style-type: none"> <li>1. Review and record the scan tool Failure Records data.</li> <li>2. Clear the DTCs.</li> <li>3. Operate the vehicle within the Failure Records conditions as noted.</li> <li>4. Using a scan tool, monitor the Specific DTC Information for DTC P0615.</li> </ol> Does the scan tool indicate DTC P0615 failed this ignition?	Go to <b>Step 2</b>	System OK

**DTC P0621****Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor****DTC P0621**

## Generator L-Terminal Circuit

**Circuit/System Description**

The engine control module (ECM) uses the generator turn on signal circuit to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This signals the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn on signal circuit. The ECM should detect low voltage on generator turn on signal circuit when the ignition is ON and the engine is OFF or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on signal circuit. The ECM performs key ON and RUN tests to determine the status of the generator turn on signal circuit.

**Conditions for Running the DTC****Key ON Test**

- No generator, crankshaft position (CKP) sensors or camshaft position (CMP) sensor DTCs are set.
- The ignition is in RUN position.
- The engine is not running.

**Run Test**

- No generator, CKP sensors, CMP sensor DTCs are set.
- The engine is running.

**Conditions for Setting the DTC**

- During the key ON test, the ECM detects high voltage on the generator turn on signal circuit

for at least 5 seconds.

- During the RUN test, the ECM detects low voltage on the generator turn on signal circuit for at least 15 seconds.

#### Action Taken When the DTC Sets

- The ECM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Failure Records data only.

#### Conditions for Clearing the DTC

- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- Using the scan tool Clear DTC Information function can clear the DTC.

#### Reference Information

##### Schematic Reference

### Starting and Charging Schematics

##### Connector End View Reference

### Engine Electrical Connector End Views

##### Electrical Information Reference

- Circuit Testing
- Connector Repairs
- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

##### Scan Tool Reference

- Scan Tool Data List for ECM
- Scan Tool Data Definitions for ECM

##### Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the generator.
2. Ignition ON, test for less than 1 volt between the generator turn on signal and ground.
  - If greater than the specified range, test the generator turn on signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
3. Engine Running, test for greater than 3.5 volts between the generator turn on signal and ground.
  - If less than the specified range, test the generator turn on signal circuit for a short to ground, an open or a high resistance. If the circuit tests normal, replace the ECM.
4. If circuit tests normal during the Ignition ON/RUN tests, replace the generator.

**Repair Procedures**

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for ECM replacement, setup and programming
- **Generator Replacement**

**DTC P0622****Diagnostic Instructions**

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.
- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

**DTC Descriptor****DTC P0622**

## Generator F-Terminal Circuit

**Circuit/System Description**

The engine control module (ECM) uses the generator field duty cycle signal circuit to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the key is in the RUN position and the engine is OFF, the ECM should

detect a duty cycle near 0 percent. However, when the engine is running, the duty cycle should be between 5-95 percent.

**Conditions for Running the DTC**

- The vehicle speed is above 8 km/h (5 mph).
- The system voltage is between 9.5-18 volts.

**Conditions for Setting the DTC**

- The ECM detects an out of range PWM signal during the KEY ON test.
- The ECM detects a PWM signal greater than 65 percent for at least 5 seconds
- The ECM detects a PWM signal less than 5 percent for at least 15 seconds during the RUN test.

**Action Taken When the DTC Sets**

- The ECM will command the charge indicator and or warning message to be illuminated on the instrument panel cluster (IPC) and the driver information center (DIC), if equipped.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Failure Records data only.

**Conditions for Clearing the DTC**

- The ECM will command the message OFF after one trip in which the diagnostic test has been run and passed.
- The history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- Using the scan tool Clear DTC Information function can clear the DTC.

**Reference Information****Schematic Reference****Starting and Charging Schematics****Connector End View Reference****Engine Electrical Connector End Views****Electrical Information Reference**

- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**

Scan Tool Reference

- **Scan Tool Data List** for ECM
- **Scan Tool Data Definitions** for ECM

Circuit/System Verification

With the scan tool installed, ignition ON and the engine running, observe the GEN-F Terminal Signal parameter in the ECM data list. The GEN-F Terminal Signal parameter should read between 5-95 percent.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the generator.
2. Ignition ON and the engine OFF, connect a test lamp to battery positive voltage and repeatedly probe the generator field duty cycle circuit, harness side while monitoring the GEN-F Terminal Signal Parameter in the ECM data list. It should change from 0 percent to above 95 percent.
  - If the GEN-F Terminal Signal parameter was not affected by the test lamp, test the GEN-F Terminal Signal circuit for a short to voltage, short to ground, a high resistance or an open circuit. If the circuit tests normal, replace the ECM.
3. If the circuit tests normal during the Ignition ON/RUN tests and the ECM parameter changed from 0 percent to above 95 percent, replace the generator.

Repair Procedures

Perform the **Diagnostic Repair Verification** after completing the diagnostic procedure.

- **Control Module References** for ECM replacement, setup and programming
- **Generator Replacement**

SYMPTOMS - ENGINE ELECTRICAL

**IMPORTANT: The following steps must be completed before using the symptom tables.**

- Perform **Diagnostic System Check - Vehicle** before using the Symptom Tables in order to verify that all of the following are true:
  - There are no DTCs set.
  - The control modules can communicate via the serial data link.
- Review the system descriptions and operations in order to familiarize yourself with the system functions. Refer to one of the following system operations:
  - **Battery Description and Operation**
  - **Charging System Description and Operation**
  - **Electrical Power Management Description and Operation**
  - **Starting System Description and Operation**

#### Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components for obvious damage or conditions which could cause the symptom.

#### Intermittent

Faulty electrical connections or wiring may be the cause of intermittent conditions. Refer to **Testing for Intermittent Conditions and Poor Connections** .

#### Symptom List

Refer to a symptom diagnostic procedure from the following list in order to diagnose the symptom:

- **Starter Solenoid Does Not Click**
- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**
- **Charge Indicator Always On**
- **Charge Indicator Inoperative**
- **Battery Inspection/Test**
- **Battery Electrical Drain/Parasitic Load Test**
- **Battery Common Causes of Failure**
- **Starter Motor Noise Diagnosis**

- Charging System Test
- Generator Noise Diagnosis

## BATTERY INSPECTION/TEST

### Tools Required

**SA9154Z-A** Starting and Charging System Tester. See Special Tools.

### Diagnostic Aids

- IMPORTANT:**
- **A dead battery is usually a symptom of another problem. Fix the problem, do not just charge or change the battery.**
  - **Failure to properly understand the battery and its function could lead to a misdiagnosis and unneeded repairs. Refer to Battery Description and Operation and Battery Common Causes of Failure for more information.**

Follow these instructions in order to avoid an incorrect diagnosis because of connections:

- If testing the vehicle with the battery cables still connected, wiggle the **SA9154Z-A** clips on the terminal. See Special Tools. This may cut through any coating or through any oxidation that may be present on the terminal.

Even new terminals contain a protective coating that may insulate or cause a resistance in the test circuit.

- If correct connections to the battery terminals in the vehicle are in doubt, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
- If the tester displays a "Bad Battery" result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.

## Battery Inspection/Test

Step	Action	Values	Yes	No
<b>CAUTION:</b>				

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

Refer to **BATTERY DISCONNECT CAUTION** .

1	<p>Inspect the battery for a cracked, broken or damaged case, which may be indicated by battery acid leakage.</p> <p>Is the battery OK?</p>	-	Go to <b>Step 2</b>	Go to <b>Step 9</b>
2	<p>Compare the cold cranking amperage (CCA) and Reserve Capacity (RC) and/or amp hour (AH) rating of the battery to the original battery or original equipment (OE) specification.</p> <p>Refer to <b>Battery Usage</b>.</p> <p>Does the battery meet or exceed the specifications?</p>	-	Go to <b>Step 3</b>	Go to <b>Step 9</b>
3	<ol style="list-style-type: none"> <li>1. Turn OFF the ignition.</li> <li>2. Attempt to rotate the negative battery cable connector with light finger pressure.</li> </ol> <p>Does the negative connector rotate?</p>	-	Go to <b>Step 6</b>	Go to <b>Step 4</b>
4	<p>Attempt to rotate the positive battery cable connector clockwise with light finger pressure.</p> <p>Does the positive connector rotate?</p>	-	Go to <b>Step 6</b>	Go to <b>Step 5</b>
5	<p><b>IMPORTANT:</b> Ensure that all of the electrical loads are turned OFF.</p> <ol style="list-style-type: none"> <li>1. Install the <b>SA9154Z-A</b> Starting and Charging System Tester. See <b>Special Tools</b>.</li> <li>2. Follow the directions supplied with the tester.</li> <li>3. Follow any directions displayed on the tester.</li> <li>4. If the tester displays "Good, Low Charge" or "Charge and</li> </ol>	-		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

	Retest", refer to <b><u>Battery Charging</u></b> .			
	Did the tester pass the battery?		Battery OK	Go to <b>Step 6</b>
6	<ol style="list-style-type: none"> <li>1. Disconnect the negative battery cable.</li> <li>2. Disconnect the positive battery cable.</li> <li>3. Clean and wire brush both battery post and the metal contact rings on both cable connectors.</li> <li>4. If either of the battery terminals or the contact rings are excessively damaged or corroded, replace as needed.</li> </ol>	-		
	Did you complete the repair?		Go to <b>Step 7</b>	-
7	<p><b>IMPORTANT:</b> Ensure that both battery cables are disconnected.</p> <ol style="list-style-type: none"> <li>1. Install the <b>SA9154Z-A</b> . See <b><u>Special Tools</u></b>.</li> <li>2. Follow any directions displayed on the tester.</li> <li>3. If the tester calls for charging the battery, refer to <b><u>Battery Charging</u></b>.</li> </ol>	-		
	Did the tester pass the battery?		Go to <b>Step 8</b>	Go to <b>Step 9</b>
	<ol style="list-style-type: none"> <li>1. Connect the positive battery cable to the batteries positive terminal.</li> </ol> <p><b>NOTE:</b> Refer to <b><u>Fastener Notice</u></b> .</p>			

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

8	<p>2. Tighten the positive battery cable bolt to the specified value.</p> <p>3. Connect the negative battery cable to the battery negative terminal.</p> <p>4. Tighten the negative battery cable bolt to the specified value.</p> <p>Are the cable bolts properly tightened?</p>	6 N.m (53 lb in)	Battery OK	-
9	<p>Replace the battery. Refer to <b><u>Battery Replacement</u></b>.</p> <p>Did you complete the replacement?</p>	-	Battery OK	-

### BATTERY CHARGING

#### Tools Required

**SA9154Z-A** Starting and Charging System Tester. See **Special Tools**.

- IMPORTANT:**
- For best results, use an automatic taper-rate battery charger with a voltage capability of 16 volts.
  - The charging area should be well ventilated.
  - Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the **SA9154Z-A** before charging. See **Special Tools**.

#### Battery State of Charge

**IMPORTANT:** Using voltage to determine the batteries state of charge (SOC) is only accurate after the battery has been at rest for 24 hours. This is enough time for the acid in each cell to equalize. If the battery has been charged or discharged in the past 24 hours, the battery SOC will only be an estimate.

The maintenance-free batteries SOC is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the battery's state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
  - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
  - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.

**IMPORTANT: The table is accurate to within 10 percent only after the battery has been at rest for 12 hours.**

4. Measure the battery voltage at the battery terminals. Refer to the following table to determine the state of charge according to the estimated battery temperature:

#### Battery Charging

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
12.75 V	100%	100%
12.7 V	100%	90%
12.6 V	90%	75%
12.45 V	75%	65%
12.2 V	65%	45%
12.0 V	40%	20%

Use the state of charge information as follows:

- A battery with a state of charge that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65 percent or greater is generally considered to be charged enough in order to be returned to normal service or in order to continue storage. However, if the battery is being used in slow traffic or with short drive times or if the temperature is very hot or very cold, the battery should be fully charged, to at least 90

percent, before returning it to service or continuing storage.

### Charging Time Required

The time required to charge a battery will vary depending upon the following factors:

- The battery charger capacity-The higher the charger's amperage, the less time it will take to charge the battery.
- The SOC of the battery-A completely discharged battery requires more than twice as much charging time as a half charged battery. In a discharged battery with a voltage below 11 volts, the battery has a very high internal resistance and may only accept a very low current at first. Later, as the charging current causes the acid content to increase in the electrolyte, the charging current will increase. Extremely discharged batteries may not activate the reversed voltage protection in some chargers. Refer to the manufacturers instructions for operating this circuitry.
- The temperature of the battery-The colder the battery is, the more time it takes to recharge the battery. The charging current accepted by a cold battery is very low at first. As the battery warms, the charging current will increase.

### Charging Procedure

**NOTE:** Always turn the ignition OFF when connecting or disconnecting battery cables, battery chargers or jumper cables. Failing to do so may damage the Powertrain Control Module (PCM) or other electronic components.

**NOTE:** Refer to Fastener Notice .

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

**Tighten:** Tighten the battery side terminal adapters to 15 N.m (11 lb ft).

Use the following procedure to charge the battery:

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or fuse

block - underhood.

**NOTE: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.**

4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
5. Turn ON the charger and set to the highest setting for normal charging.
6. Inspect the battery every half hour after starting the battery charger.
  - Charge the battery until the taper-rate charger indicates that the battery is fully charged.
  - Estimate the battery temperature by feeling the side of the battery. If it feels hot to the touch or its temperature is over 45°C (125°F), discontinue charging and allow the battery to cool before resuming charging.
7. After charging, test the battery. Refer to **Battery Inspection/Test**.

## BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

### Safety Precautions

**CAUTION: Refer to BATTERY DISCONNECT CAUTION .**

### Parasitic Load Testing

Small current drains, called parasitic drains, constantly draw current from the battery even with the ignition switch in the OFF position. These parasitic drains can discharge a battery in 4-6 weeks depending on the battery's state of charge and when the vehicle went into storage.

For normal parasitic current drain, refer to individual component parasitic loads. Remember, when checking for parasitic current draw, take a look to see what types of equipment the customer may have had installed on the vehicle. A cellular phone, anti-theft system or any device added that requires constant voltage to retain a memory, will draw current at all times. So take these added accessories into account when testing for parasitic current drain.

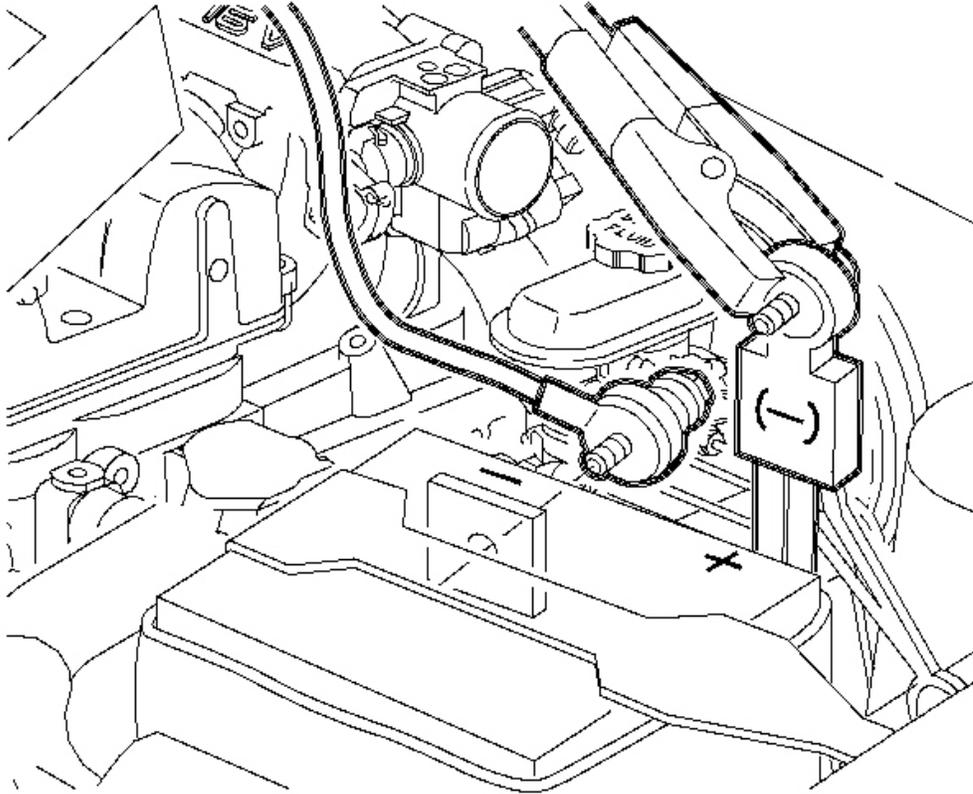
### Saturn Parasitic Load Test Device

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

The parasitic load test device (SA9130Z) is used with a DMM. The test device is used to measure parasitic current drain from the battery with the ignition and all accessories OFF. The load tester, constructed with 1 ohm resistance and built-in circuit protection device, opens when the current exceeds approximately 1-amp. When the circuit is opened, the user is alerted by a red light-emitting diode (LED) indicator. The parasitic load test device is put into the circuit between the negative battery terminal and the negative battery cable so it effectively becomes a load in series with all other vehicle loads.

**IMPORTANT: The ignition key must be removed from the cylinder before parasitic load testing. The key-minder circuit is activated by the key cylinder switch when the key is in the ignition cylinder, which adds 20 milliamps of current draw.**



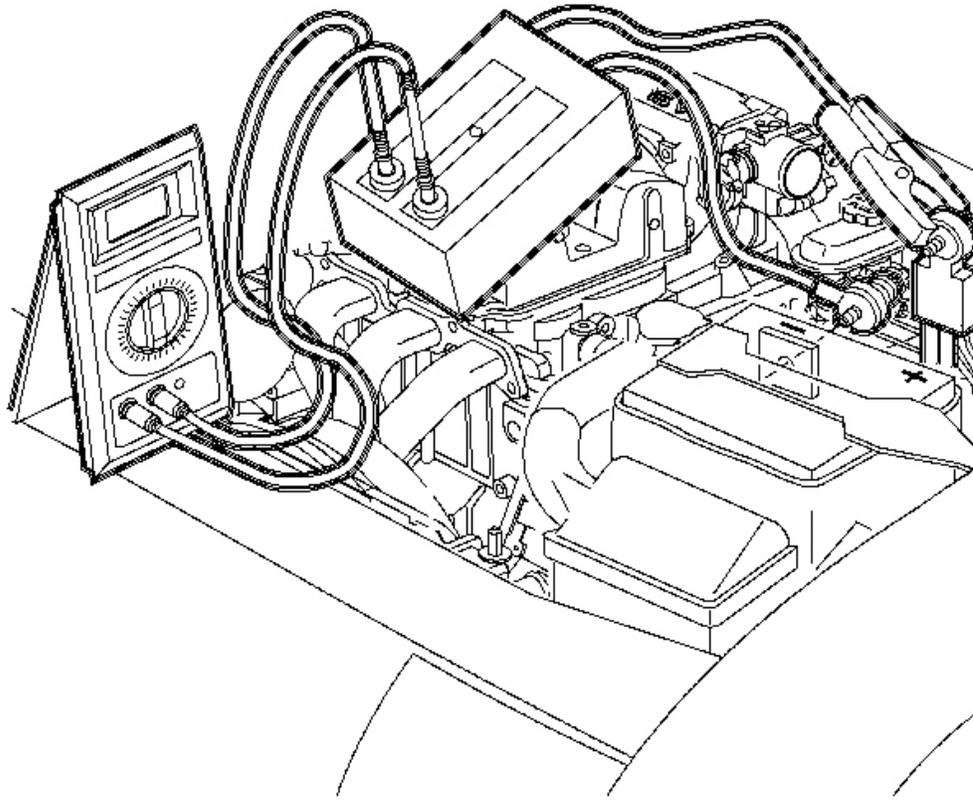
**Fig. 11: View Of Parasitic Load Tester Between Negative Cable & Negative Battery Terminal**

**Courtesy of GENERAL MOTORS CORP.**

1. Install parasitic load tester between negative cable and negative battery terminal so 1 ohm resistor of tester is in series with battery.

**IMPORTANT:** The alligator clamp on the parasitic load test device must be connected to the flat pad part on the negative battery cable. Do not connect the alligator clamp to the bolt on the negative battery cable. This will cause incorrect readings.

2. Set the multimeter to MILLIVOLT scale.



**Fig. 12: Measuring Current Across Tester**  
Courtesy of GENERAL MOTORS CORP.

3. Measure current across the tester by putting the multimeter probes in 2 terminals on the tester. The reading is obtained in volts. This reading is directly converted to milliamps. Should the parasitic load exceed 1-amp, the LED indicator on the tester will light. This may indicate that a vehicle accessory is ON.
4. To find the source of excessive load, start removing fuses and modules in a systematic way. When voltage drops across the tester, the circuit or circuits protected by that fuse is the

source of current drain. Also remove the fusible link from the generator to check for a voltage drop. If the voltage drop is greater than 2 volts, replace the generator. Repair the circuit and perform the parasitic load test again to verify the repair.

#### Parasitic Current Drain Testing With an Ammeter

1. Turn the ignition and all accessories OFF and remove the key from the ignition switch.
2. Disconnect the cable from the negative battery terminal.
3. Follow the manufacturers instructions for the multimeter or ammeter being used. This could involve plugging leads into different locations on a multimeter and changing the scale to read amperage. On some testers you should start on the 10-amp scale setting and after verifying that current drain is less than 2 milliamps, set the scale to 200 milliamps or 20 milliamps.
4. Connect the ammeter between the negative cable and the negative battery terminal so that it is in series. Read the parasitic current drain from the battery.
5. To find the source of excessive load, start removing fuses and modules in a systematic way. When voltage drops across the tester, the circuit or circuits protected by that fuse is the source of current drain. Also remove the fusible link from the generator to check for a voltage drop. If the voltage drop is greater than 2 volts, replace the generator. Repair the circuit and perform the parasitic load test again to verify the repair.

#### Typical Parasitic Loads

Typical parasitic load for this vehicle is 10-15 mA. If the vehicle does not have one of the following components, then subtract the parasitic load of the component for typical parasitic load of the vehicle (10-15 mA) to determine the parasitic load range for the vehicle being tested.

**IMPORTANT: During CD changer initialization, parasitic current draw will fluctuate between 3 mA to 1 A. The initialization period lasts up to a maximum of 90 seconds. After initialization, the CD changer parasitic current draw will stabilize at approximately 3 mA.**

If the CD changer door is open and the light is illuminated, the parasitic current draw will be approximately 65 mA. The light will remain ON for 2 minutes. After the light goes out, the CD changer parasitic current draw will stabilize at approximately 3 mA.

#### Battery Electrical Drain/Parasitic Load Test

ABS	1.0 mA
BCM	3.0 mA

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

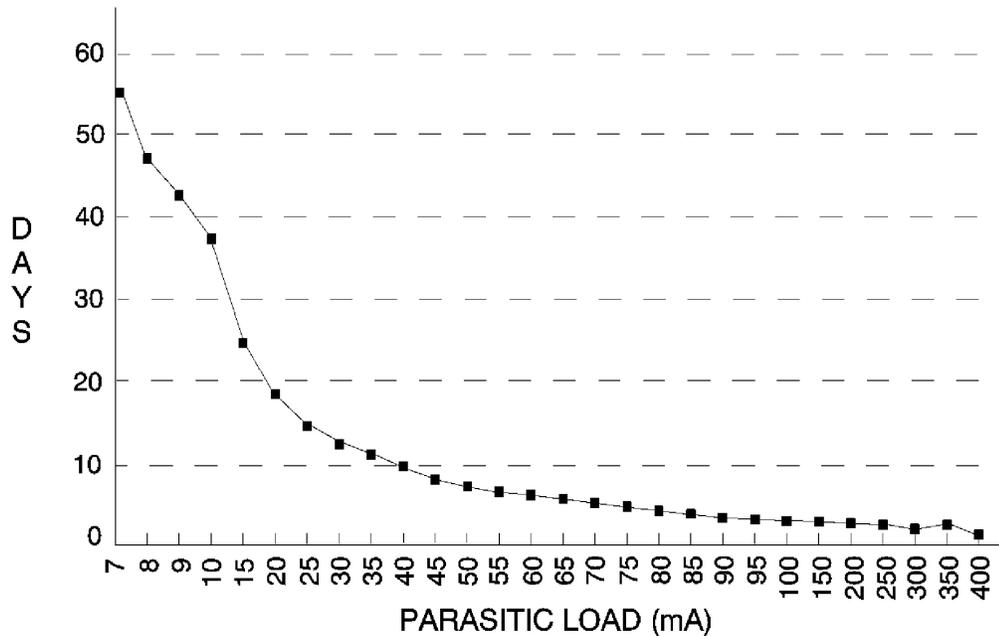
CD Changer	3.0 mA
ECM/PCM/TCM	0-1.0 mA
Generator	0-1.0 mA
HVAC Delayed Blower Control	1.0 mA
I/P Cluster w/Security Flashing "Security" Telltale	1.2 mA
On-Star	0-1.0 mA
Radio	2.8-4.3 mA

#### Typical Undesired Parasitic Loads

The following are typical undesired parasitic loads:

- Park lamps ON
- Headlamps ON
- Dome lamp ON
- Map lights ON
- Cargo lamp ON
- Radio ON
- Cigar lighter ON

## BATTERY STORAGE vs PARASITIC LOAD



IMPORTANT: Vehicle will start at  $-30\text{ C} (-22\text{ F})$  after storage days indicated.

**Fig. 13: View Of Battery Storage Versus Parasitic Load Graph**  
 Courtesy of GENERAL MOTORS CORP.

### BATTERY COMMON CAUSES OF FAILURE

A battery is not designed to last forever. With proper care, however, the battery will provide years of good service. If the battery tests good but still fails to perform well, the following are some of the more common causes:

- A vehicle accessory was left on overnight.
- The driving speeds have been slow with frequent stops, stop-and-go driving, with many electrical accessories in use, particularly air conditioning, headlights, wipers, heated rear window, cellular telephone, etc.
- The electrical load has exceeded the generator output, particularly with the addition of aftermarket equipment.
- Existing conditions in the charging system, including the following possibilities:
  - A slipping belt
  - A bad generator
- The battery has not been properly maintained, including a loose battery hold down or

missing battery insulator if used.

- There are mechanical conditions in the electrical system, such as a short or a pinched wire, attributing to power failure. Refer to **General Electrical Diagnosis** .

#### **Electrolyte Freezing**

The freezing point of electrolyte depends on its specific gravity. A fully charged battery will not freeze until the ambient temperature gets below  $-54^{\circ}\text{C}$  ( $-65^{\circ}\text{F}$ ). However, a battery with a low state of charge may freeze at temperatures as high as  $-7^{\circ}\text{C}$  ( $20^{\circ}\text{F}$ ). Since freezing may ruin a battery, the battery should be protected against freezing by keeping it properly charged above 80 percent state of charge, the freezing point of the battery will be somewhere below  $-32^{\circ}\text{C}$  ( $-25^{\circ}\text{F}$ ).

#### **Battery Protection During Vehicle Storage**

Certain devices on the vehicle maintain a small continuous current drain, parasitic load, on the battery. A battery that is not used for an extended period of time will discharge. Eventually permanent damage will result. Discharged batteries will also freeze in cold weather. Refer to **Battery Inspection/Test**.

In order to maintain the battery state of charge while storing the vehicle for more than 30 days:

**CAUTION: Refer to BATTERY DISCONNECT CAUTION .**

Disconnect the battery ground cable to protect the battery from discharge by parasitic current drains.

When the battery cannot be disconnected:

1. Maintain a high state of charge.
2. Establish a regular schedule for recharging the battery every 20-45 days.

A battery that has remained in a discharged state for a long period of time is difficult to recharge or may be permanently damaged.

#### **JUMP STARTING IN CASE OF EMERGENCY**

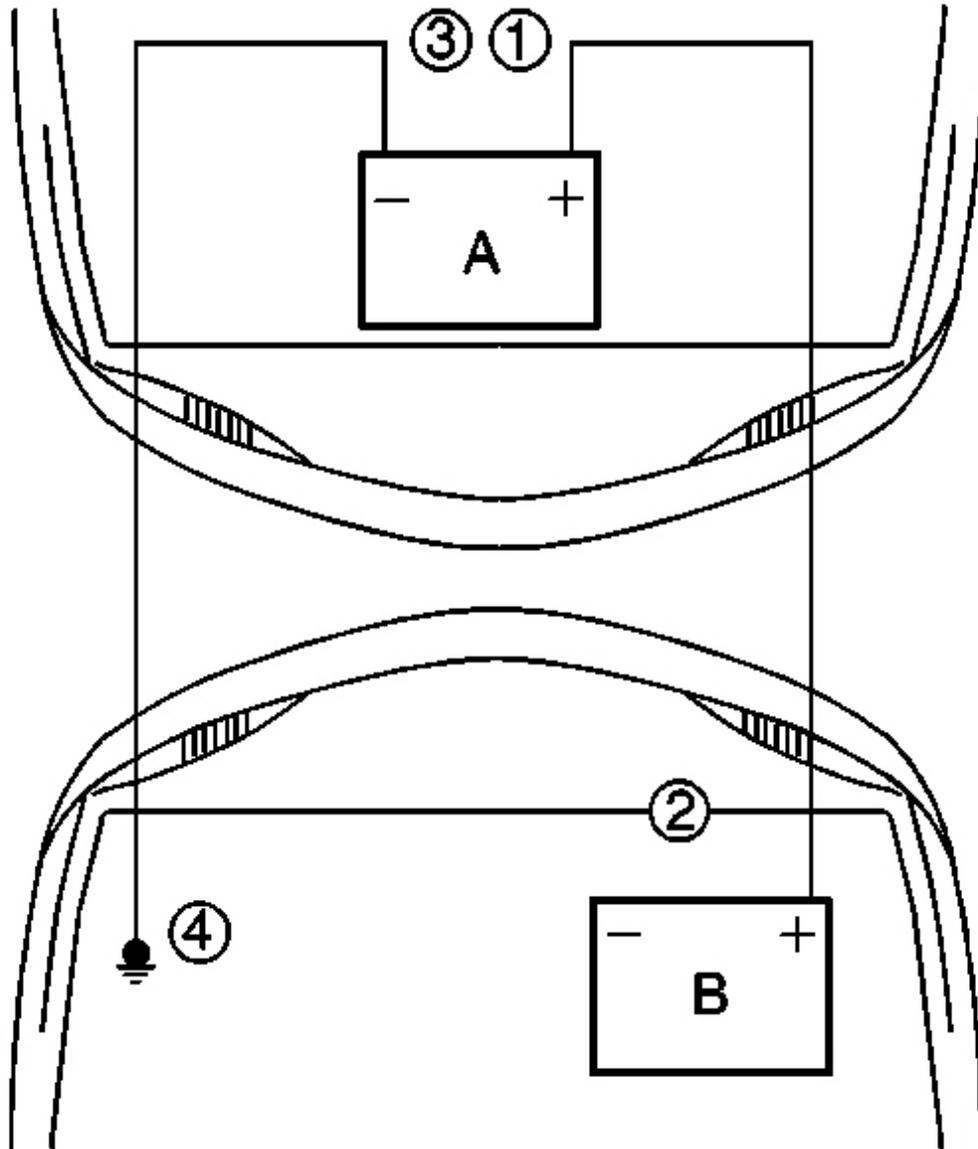
**CAUTION: Batteries produce explosive gases. Batteries contain corrosive acid. Batteries supply levels of electrical current high enough to cause burns. Therefore, in order to reduce the risk of personal injury while working near a battery, observe**

**the following guidelines:**

- **Always shield your eyes.**
- **Avoid leaning over the battery whenever possible.**
- **Do not expose the battery to open flames or sparks.**
- **Do not allow battery acid to contact the eyes or the skin.**
  - **Flush any contacted areas with water immediately and thoroughly.**
  - **Get medical help.**

**NOTE:** This vehicle has a 12 volt, negative ground electrical system. Make sure the vehicle or equipment being used to jump start the engine is also 12 volt, negative ground. Use of any other type of system will damage the vehicle's electrical components.

1. Position the vehicle with the booster battery so that the jumper cables will reach.
  - Do not let the 2 vehicles touch.
  - Make sure that the jumper cables do not have loose ends or missing insulation.
2. Place an automatic transmission in PARK. If equipped with a manual transmission, place in NEUTRAL and block the wheels.
3. Turn OFF all electrical loads on both vehicles that are not needed.
4. Turn OFF the ignition on both vehicles.



**Fig. 14: Identifying Proper Jumper Cable Connection**  
Courtesy of GENERAL MOTORS CORP.

5. Connect the red positive (+) cable to the battery positive (+) terminal (2) of the vehicle with the discharged battery.

Use a remote positive (+) terminal if the vehicle has one.

6. Connect the red positive (+) cable to the positive (+) terminal (1) of the booster battery.

Use a remote positive (+) terminal if the vehicle has one.

7. Connect the black negative (-) cable to the negative (-) terminal (3) of the booster battery.

**CAUTION: Do not connect a jumper cable directly to the negative terminal of a discharged battery to prevent sparking and possible explosion of battery gases.**

8. The final connection is made to a heavy, unpainted metal engine part (4) of the vehicle with the discharged battery.

This final attachment must be at least 46 cm (18 in) away from the dead battery.

9. Start the engine of the vehicle that is providing the boost.

**NOTE: Never operate the starter motor more than 15 seconds at a time without pausing in order to allow it to cool for at least 2 minutes. Overheating will damage the starter motor.**

10. Crank the engine of the vehicle with the discharged battery.
11. The black negative (-) cable must be first disconnected from the vehicle that was boosted (4).
12. Disconnect the black negative (-) cable from the negative (-) terminal (3) of the booster battery.

**NOTE: Do not let the cable end touch any metal. Damage to the battery and other components may result.**

13. Disconnect the red positive (+) cable from the positive (+) terminal (1) of the booster battery.
14. Disconnect the red positive (+) cable from the remote positive (+) terminal (2) of the vehicle with the discharged battery.

## CHARGING SYSTEM TEST

### Charging System Test

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

<b>Step</b>	<b>Action</b>	<b>Value(s)</b>	<b>Yes</b>	<b>No</b>
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to <b>Step 2</b>	Go to <b><u>Diagnostic System Check - Vehicle</u></b>
2	Start the engine. Observe the charge indicator on the instrument panel cluster (IPC) or message in the driver information center (DIC). Does the charge indicator illuminate or the DIC display a charging system message?	-	Go to <b>Step 3</b>	Go to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b>
3	<ol style="list-style-type: none"> <li>1. Turn OFF the ignition.</li> <li>2. Connect the red lead of the <b>SA9154Z-A</b> Starting and Charging System Tester to the battery positive terminal. See <b><u>Special Tools</u></b>.</li> <li>3. Connect the grey lead of the <b>SA9154Z-A</b> to the output circuit of the generator. See <b><u>Special Tools</u></b>.</li> <li>4. Start the engine.</li> <li>5. Turn ON the <b>SA9154Z-A</b> . See <b><u>Special Tools</u></b>.</li> <li>6. Turn OFF all vehicle accessories.</li> <li>7. Follow the <b>SA9154Z-A</b> prompts. See <b><u>Special Tools</u></b>.</li> <li>8. Press CHARGING SYSTEM TEST.</li> </ol> <p>Is the voltage displayed within the specified value?</p>	13-15.5 V	Go to <b>Step 4</b>	Go to <b>Step 5</b>
4	Is the generator output current greater than or equal to the load	-		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

	test value given in <b>Generator Usage ?</b>		Go to <b>Step 6</b>	Go to <b>Step 5</b>
5	Replace the generator. Refer to <b>Generator Replacement</b> . Did you complete the replacement?	-	Go to <b>Step 6</b>	-
6	Operate the vehicle in order to verify the repair. Did you correct the condition?	-	Generator OK	Go to <b>Step 2</b>

**CHARGE INDICATOR ALWAYS ON**

**Charge Indicator Always On**

Step	Action	Values	Yes	No
<b>Schematic Reference: <u>Starting and Charging Schematics</u></b>				
<b>Connector End View Reference: <u>Engine Electrical Connector End Views</u></b>				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to <b>Step 2</b>	Go to <b>Diagnostic System Check - Vehicle</b>
2	1. Start the engine. 2. Turn OFF all accessories.  Does the battery charge indicator remain illuminated?	-	Go to <b>Step 3</b>	Go to <b>Testing for Intermittent Conditions and Poor Connections</b>
3	1. Install a scan tool. 2. Start the engine. 3. Turn OFF all accessories. 4. Increase engine speed to 1,500 RPM. 5. With a scan tool, observe the Battery Voltage parameter in the body control module (BCM) data list, engine control module (ECM) and the instrument panel cluster (IPC)	0.9-1.1 V		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

	<p>data list.</p> <p>6. Compare the voltages.</p> <p>Are all of the voltages within the specified range?</p>			<p>Go to <b>Step 4</b></p> <p>Go to <b>Step 5</b></p>
4	<p>Are the voltages displayed within the specified range?</p>	12.8-15.5 V		<p>Go to <b>Step 5</b></p> <p>Go to <b>Step 5</b></p>
5	<p>Test the battery positive voltage and ground circuits of the affected module for a high resistance or open. Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> .</p> <p>Did you find and correct the condition?</p>	-		<p>Go to <b>Step 8</b></p> <p>Go to <b>Step 6</b></p>
6	<p>Inspect for poor connections at the harness connector of the affected module. Refer to <b><u>Connector Repairs</u></b> .</p> <p>Did you find and correct the condition?</p>	-		<p>Go to <b>Step 8</b></p> <p>Go to <b>Step 7</b></p>
7	<p>Replace the affected module. Refer to <b><u>Control Module References</u></b> for replacement, setup and programming.</p> <p>Did you complete the replacement?</p>	-		<p>Go to <b>Step 8</b></p> <p>-</p>
8	<p>Operate the system in order to verify the repair.</p> <p>Did you correct the condition?</p>	-		<p>System OK</p> <p>Go to <b>Step 2</b></p>

**CHARGE INDICATOR INOPERATIVE**

**Charge Indicator Inoperative**

Step	Action	Yes	No
1	<p>Did you perform the Diagnostic System Check - Vehicle?</p>	<p>Go to <b>Step 2</b></p>	<p>Go to <b><u>Diagnostic System Check - Vehicle</u></b></p>

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

2	<ol style="list-style-type: none"> <li>1. Turn OFF the ignition.</li> <li>2. Turn ON the ignition, with the engine OFF.</li> <li>3. Observe the battery charge indicator on the instrument cluster (IPC) during the bulb check.</li> </ol> <p>Does the battery charge indicator illuminate during the bulb check?</p>	<p>Go to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b></p>	Go to <b>Step 3</b>
3	<p>Replace the IPC. Refer to <b><u>Control Module References</u></b> for replacement, setup and programming.</p> <p>Did you complete the repair?</p>	Go to <b>Step 4</b>	-
4	<p>Operate the system in order to verify the repair.</p> <p>Did you correct the condition?</p>	System OK	Go to <b>Step 2</b>

## GENERATOR NOISE DIAGNOSIS

### Diagnostic Aids

Noise from a generator may be due to electrical or mechanical noise. Electrical noise or magnetic whine usually varies with the electrical load placed on the generator and is a normal operating characteristic of all generators. When diagnosing a noisy generator, it is important to remember that loose or misaligned components around the generator may transmit the noise into the passenger compartment and that replacing the generator may not solve the problem.

### Generator Noise Diagnosis

Step	Action	Yes	No
1	<p>Test the generator for proper operation using the Generator Tester. Refer to <b><u>Charging System Test</u></b>.</p> <p>Is the generator operating properly?</p>	Go to <b>Step 2</b>	Go to <b>Step 11</b>
	<ol style="list-style-type: none"> <li>1. Start the engine. Verify that the noise can be heard.</li> <li>2. Turn OFF all accessories.</li> <li>3. Turn OFF the Ignition.</li> </ol>		

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

2	<p><b>CAUTION:</b>  <b>Make sure that the load is completely turned off before connecting or disconnecting a carbon pile load tester to the battery. Otherwise, sparking could ignite battery gasses which are extremely flammable and may explode violently.</b></p> <ol style="list-style-type: none"> <li>4. Connect a carbon pile tester to the vehicle.</li> <li>5. Connect an inductive ammeter probe to the output circuit of the generator.</li> <li>6. Start the engine.</li> <li>7. Increase engine speed to 1,500 RPM.</li> <li>8. Increase and decrease the amount of load placed upon the generator.</li> <li>9. Listen for the noise.</li> </ol> <p>Does the noise increase and decrease with the amount of load placed upon the generator by the carbonpile tester?</p>	Go to <b>Step 11</b>	Go to <b>Step 3</b>
3	<ol style="list-style-type: none"> <li>1. Turn OFF the engine.</li> <li>2. Remove the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> .</li> <li>3. Spin the generator pulley by hand.</li> </ol> <p>Does the generator shaft spin smoothly and without any roughness or grinding noise?</p>	Go to <b>Step 4</b>	Go to <b>Step 11</b>
4	<p>Inspect the generator for a loose pulley and/or pulley nut.          Is the generator pulley or pulley nut loose?</p>	Go to <b>Step 11</b>	Go to <b>Step 5</b>
	<ol style="list-style-type: none"> <li>1. Loosen all of the generator mounting bolts.</li> <li>2. Tighten the generator mounting bolts</li> </ol>		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

5	<p>to specifications and in the proper sequence, if necessary. Refer to <b><u>Generator Replacement</u></b>.</p> <p>3. Install the drive belt. Refer to <b><u>Drive Belt Replacement</u></b> .</p> <p>4. Start the engine.</p> <p>Has the noise decreased or stopped?</p>	System OK	Go to <b>Step 6</b>
6	<p>Inspect the generator for the following conditions:</p> <ul style="list-style-type: none"> <li>• Strained or stretched electrical connections</li> <li>• Hoses or other vehicle equipment resting on the generator, which may cause the noise to be transmitted into the passenger compartment</li> </ul> <p>Are any electrical connections pulling on the generator or are any hoses, etc. resting on the generator?</p>	Go to <b>Step 7</b>	Go to <b>Step 8</b>
7	<p>1. Reroute the electrical connections to relieve the tension.</p> <p>2. Reroute the hoses, etc. away from the generator.</p> <p>3. Start the engine.</p> <p>Has the noise decreased or stopped?</p>	System OK	Go to <b>Step 8</b>
8	<p>Inspect the drive belt for proper tension. Refer to <b><u>Drive Belt Tensioner Diagnosis</u></b> .</p> <p>Is the drive belt loose?</p>	Go to <b>Step 9</b>	Go to <b>Step 10</b>
9	<p>1. Replace the drive belt tensioner. Refer to <b><u>Drive Belt Tensioner Replacement</u></b> .</p> <p>2. Start the engine.</p>		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

	Has the noise decreased or stopped?	System OK	Go to <b>Step 11</b>
10	Compare the vehicle with a known good vehicle. Do both vehicles make the same noise?	System OK	Go to <b>Step 11</b>
11	<b>IMPORTANT:</b> If no definite generator problems were found, be sure that all other possible sources of objectionable noise are eliminated before replacing the generator. Replacing the generator may not change the noise level if the noise is a normal characteristic of the generator or the generator mounting.  Replace the generator. Refer to <b>Generator Replacement</b> . Has the noise decreased or stopped?	Go to <b>Step 12</b>	-
12	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 2</b>

**STARTER SOLENOID DOES NOT CLICK**

**Starter Solenoid Does Not Click**

Step	Action	Yes	No
<b>Schematic Reference: <u>Starting and Charging Schematics</u></b>			
<b>Connector End View Reference: <u>Power and Grounding Connector End Views</u></b>			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to <b>Step 2</b>	Go to <b>Diagnostic System Check - Vehicle</b>
2	Turn the ignition switch to the start position. Does the engine crank?	Go to <b>Testing for Intermittent Conditions and Poor Connections</b>	Go to <b>Step 3</b>
	<ol style="list-style-type: none"> <li>1. Install a scan tool.</li> <li>2. Turn ON the ignition, with the engine OFF.</li> <li>3. With a scan tool, observe the starter</li> </ol>		

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

3	<p>relay Command parameter in the engine control module (ECM) data list.</p> <p>4. Turn the ignition switch to the start position.</p>		
	Does the scan tool display ON?	Go to <b>Step 5</b>	Go to <b>Step 4</b>
4	<p>1. Turn ON the ignition, with the engine OFF.</p> <p>2. Verify that the transmission is in Park or Neutral.</p> <p>3. With a scan tool, observe the PNP switch parameter in the engine control module (ECM) data list.</p>		Go to <b><u>Diagnostic Trouble Code (DTC) List - Vehicle</u></b>
	Does the scan tool display Park/Neutral?	Go to <b>Step 6</b>	
5	<p>Turn the ignition switch to the start position.</p> <p>Did the crank relay click?</p>	Go to <b>Step 8</b>	Go to <b>Step 6</b>
6	<p>1. Turn OFF the ignition.</p> <p>2. Remove the crank relay.</p> <p>3. Turn ON the ignition, with the engine OFF.</p> <p>4. Connect a test lamp between the control circuit of the crank relay coil and a good ground.</p> <p>5. Turn the ignition switch to the start position.</p>		
	Does the test lamp illuminate?	Go to <b>Step 7</b>	Go to <b>Step 15</b>
7	<p>1. Connect a test lamp between the control circuit of the crank relay coil and the ground circuit of the crank relay.</p> <p>2. Turn the ignition switch to the start position.</p>		

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

	Does the test lamp illuminate?	Go to <b>Step 8</b>	Go to <b>Step 12</b>
8	<ol style="list-style-type: none"> <li>1. Turn ON the ignition.</li> <li>2. Connect a test lamp between the battery positive voltage circuit of the crank relay switch circuit and a good ground.</li> <li>3. Turn the ignition switch to the start position.</li> </ol>		
	Does the test lamp illuminate?	Go to <b>Step 9</b>	Go to <b>Step 17</b>
9	<p><b>IMPORTANT:</b>  <b>Ensure the parking brake is applied and the transmission is in park equipped with an automatic transmission or neutral on a manual transmission.</b></p> <p>Connect a 30-amp fused jumper between the battery positive voltage circuit of the crank relay switch circuit and the supply voltage circuit of the starter solenoid. Does the engine crank?</p>		
	Does the engine crank?	Go to <b>Step 13</b>	Go to <b>Step 10</b>
10	Does the fuse in the jumper open?	Go to <b>Step 18</b>	Go to <b>Step 11</b>
11	<p>Test the supply voltage circuit of the starter solenoid for a high resistance or open. Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> .</p> <p>Did you find and correct the condition?</p>		
	Did you find and correct the condition?	Go to <b>Step 22</b>	Go to <b>Step 14</b>
12	<p>Repair the ground circuit of the crank relay. Refer to <b><u>Wiring Repairs</u></b> .</p> <p>Did you complete the repair?</p>		
	Did you complete the repair?	Go to <b>Step 22</b>	-
13	<p>Inspect for poor connections at the crank relay. Refer to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b> and <b><u>Connector Repairs</u></b> .</p> <p>Did you find and correct the condition?</p>		
	Did you find and correct the condition?	Go to <b>Step 22</b>	Go to <b>Step 19</b>
14	Inspect for poor connections at the starter solenoid. Refer to <b><u>Testing for Intermittent Conditions and Poor</u></b>		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

	<b><u>Connections</u></b> and <b><u>Connector Repairs</u></b> . Did you find and correct the condition?	Go to <b>Step 22</b>	Go to <b>Step 20</b>
15	Repair an open or high resistance in the control circuit of the crank relay coil. Refer to <b><u>Wiring Repairs</u></b> . Did you complete the repair?	Go to <b>Step 22</b>	Go to <b>Step 16</b>
16	Inspect for poor connections at the harness connector of the ECM. Refer to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b> and <b><u>Connector Repairs</u></b> . Did you find and correct the condition?	Go to <b>Step 22</b>	<b>Step 21</b>
17	Repair the open or high resistance in the battery positive voltage circuit of the crank relay switch. Refer to <b><u>Wiring Repairs</u></b> . Did you complete the repair?	Go to <b>Step 22</b>	-
18	Repair the short to ground in the supply voltage circuit of the starter solenoid. Refer to <b><u>Wiring Repairs</u></b> . Did you complete the repair?	Go to <b>Step 22</b>	-
19	Replace the crank relay. Did you complete the replacement?	Go to <b>Step 22</b>	-
20	Replace the starter motor. Refer to <b><u>Starter Motor Replacement</u></b> . Did you complete the replacement?	Go to <b>Step 22</b>	-
21	Replace the ECM. Refer to <b><u>Control Module References</u></b> for replacement, setup and programming. Did you complete the replacement?	Go to <b>Step 22</b>	-
22	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 2</b>

**STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK**

**Starter Solenoid Clicks, Engine Does Not Crank**

Step	Action	Yes	No
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**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

**Schematic Reference: Starting and Charging Schematics**

**Connector End View Reference: Master Electrical Component List**

1	Did you perform the Diagnostic System Check - Vehicle?	Go to <b>Step 2</b>	Go to <b><u>Diagnostic System Check - Vehicle</u></b>
2	Apply the brake and press the start button. Did the starter solenoid click?	Go to <b>Step 3</b>	Go to <b><u>Starter Solenoid Does Not Click</u></b>
3	Inspect the engine and belt drive system for mechanical binding, seized engine or seized generator. Does the engine move freely?	Go to <b>Step 4</b>	<b><u>Engine Will Not Crank - Crankshaft Will Not Rotate</u></b>
4	Test the battery positive cable between the battery and the starter solenoid for high resistance. Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> . Did you find and correct the condition?	Go to <b>Step 8</b>	Go to <b>Step 5</b>
5	Test the ground circuit between the battery and the starter motor for a high resistance. Refer to <b><u>Circuit Testing</u></b> and <b><u>Wiring Repairs</u></b> . Did you find and correct the condition?	Go to <b>Step 8</b>	Go to <b>Step 6</b>
6	Inspect for poor connections at the starter. Refer to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b> and <b><u>Connector Repairs</u></b> . Did you find and correct the condition?	Go to <b>Step 8</b>	Go to <b>Step 7</b>
7	Replace the starter. Refer to <b><u>Starter Motor Replacement</u></b> . Did you complete the replacement?	Go to <b>Step 8</b>	-
8	Operate the system for which the symptom occurred. Did you correct the condition?	System OK	Go to <b>Step 2</b>

**ENGINE CRANKS SLOWLY**

Inspect the following items:

- Battery-Perform the Battery Inspection/Test. Refer to **Battery Inspection/Test**.
- Wiring-Inspect the wiring for damage. Inspect all connections to the starter motor, the solenoid, the battery and all ground connections. Refer to:
  - **Circuit Testing**
  - **Wiring Repairs**
  - **Testing for Intermittent Conditions and Poor Connections**
  - **Connector Repairs**
- Engine-Verify that the engine is not seized.

If the battery, the wiring and the engine are functioning properly and the engine continues to crank slowly, replace the starter motor. Refer to **Starter Motor Replacement**.

**STARTER MOTOR NOISE DIAGNOSIS**

**Diagnostic Aids**

Inspect the flywheel ring gear for damage or unusual wear.

**Test Description**

The number below refers to the step number on the diagnostic table.

**5:** A starter motor that remains engaged after engine start up can be caused by a starter relay that hangs up or a low current short to B+ on the starter solenoid crank voltage circuit. Verify the integrity of the starter solenoid crank voltage circuit before replacing the starter motor.

**Starter Motor Noise Diagnosis**

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to <b>Step 2</b>	Go to <b><u>Diagnostic System Check - Vehicle</u></b>
2	Start the engine. Does the starter operate normally?	Go to <b><u>Testing for Intermittent Conditions and Poor Connections</u></b>	Go to <b>Step 3</b>
	Start the engine while listening to the		

**2007 Saturn Outlook XE**

2007 ENGINE Engine Electrical - Outlook

3	<p>starter motor turn.</p> <p>Is there a loud "whoop", that may sound like a siren if the engine is revved while the starter is engaged, after the engine starts, but while the starter is still held in the engaged position?</p>	Go to <b>Step 6</b>	Go to <b>Step 4</b>
4	<p>Do you hear a "rumble", a "growl", or, in some cases, a "knock" as the starter is coasting down to a stop after starting the engine?</p>	Go to <b>Step 7</b>	Go to <b>Step 5</b>
5	<p><b>IMPORTANT:</b>  <b>This is often diagnosed as a starter drive gear hang-in or a weak solenoid.</b></p> <p>When the engine is cranked, do you hear a high-pitched whine after the engine cranks and starts normally?</p>	Go to <b>Step 8</b>	Go to <b>Step 7</b>
6	<p>Inspect the flywheel ring gear for the following:</p> <ul style="list-style-type: none"> <li>• Chipped gear teeth</li> <li>• Missing gear teeth</li> <li>• Milled teeth</li> </ul> <p>Is the flywheel bent or does it have damaged teeth?</p>	Go to <b>Step 8</b>	Go to <b>Step 7</b>
7	<ol style="list-style-type: none"> <li>1. Remove the starter motor. Refer to <b><u>Starter Motor Replacement</u></b>.</li> <li>2. Inspect the starter motor bushings and clutch gear.</li> </ol> <p>Does the clutch gear have chipped or milled teeth or worn bushings?</p>	Go to <b>Step 9</b>	Go to <b>Step 10</b>
8	<p>Replace the flywheel. Refer to <b><u>Engine Flywheel Replacement</u></b>.</p> <p>Did you complete the replacement?</p>	Go to <b>Step 10</b>	-
	<p>Replace the starter motor. Refer to</p>		

## 2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook

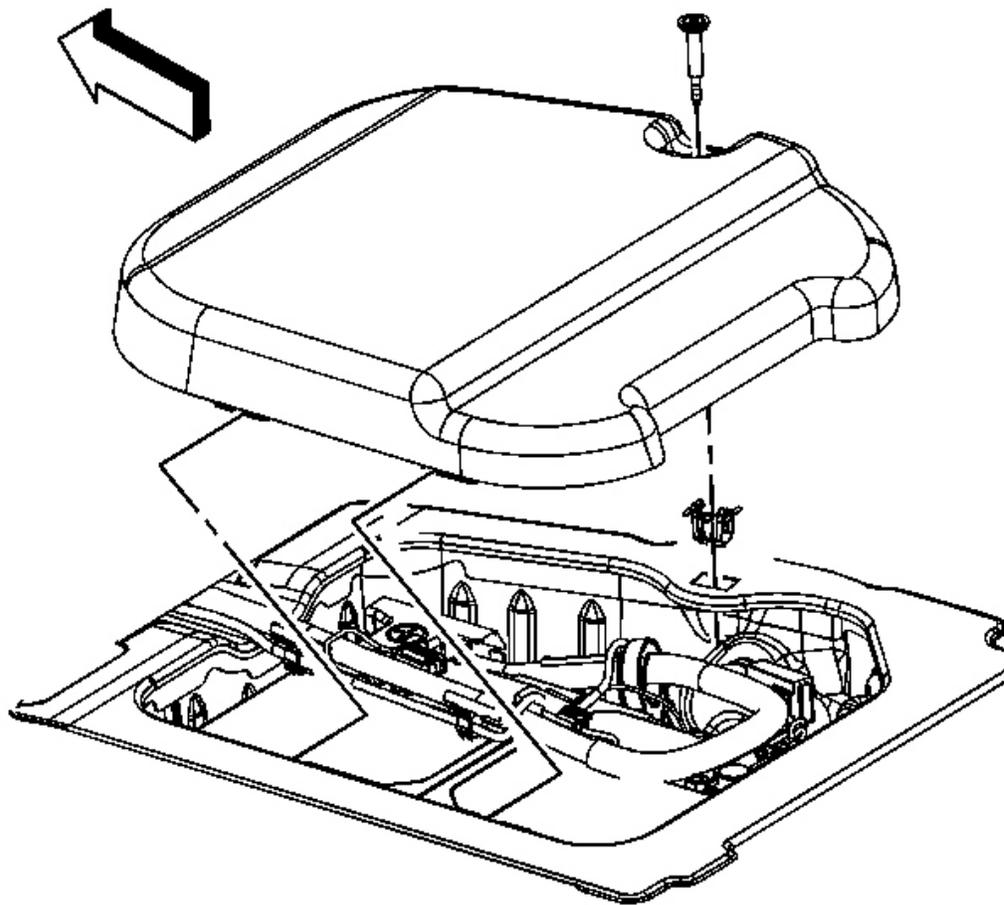
9	<b>Starter Motor Replacement.</b> Did you complete the replacement?	Go to <b>Step 10</b>	-
10	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to <b>Step 3</b>

### REPAIR INSTRUCTIONS

#### BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION

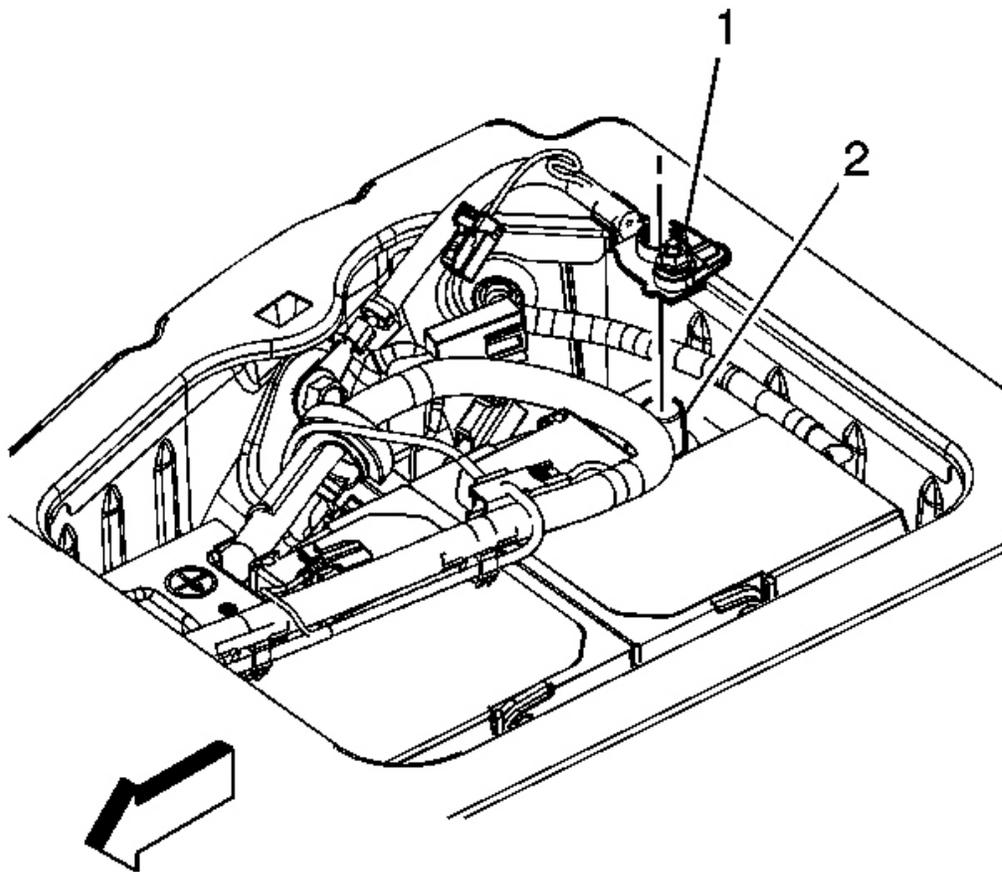
##### Removal Procedure

**CAUTION:** Refer to Battery Disconnect Caution .



**Fig. 15: Identifying Battery Cover Screw & Cover**  
**Courtesy of GENERAL MOTORS CORP.**

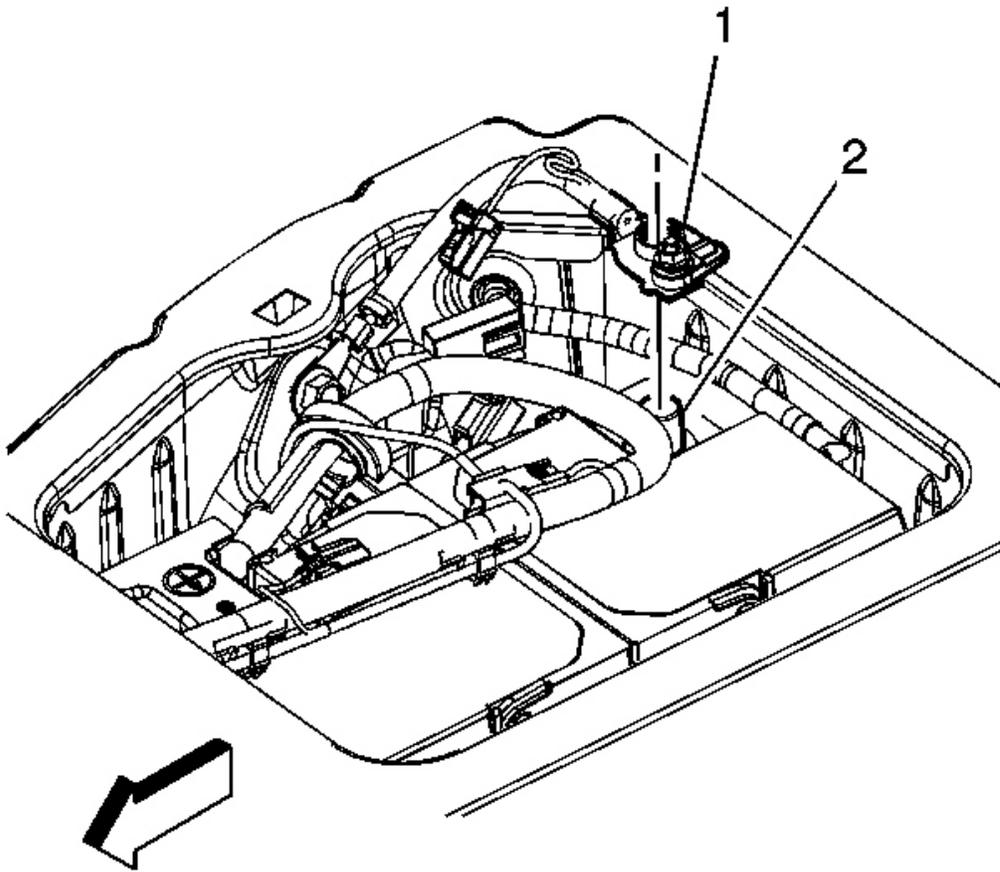
1. Record all of the customers radio station presets.
2. Turn OFF all the lamps and accessories.
3. Ensure the ignition switch is in the OFF position and the key is removed.
4. From inside the vehicle, remove the battery cover screw and cover.



**Fig. 16: View Of Negative Battery Cable Terminal And Nut**  
**Courtesy of GENERAL MOTORS CORP.**

5. Loosen the negative battery cable terminal (1) nut.
6. Remove the negative battery cable from the battery negative terminal (2).
7. Reposition the negative battery cable away from the battery negative terminal.

**Installation Procedure**



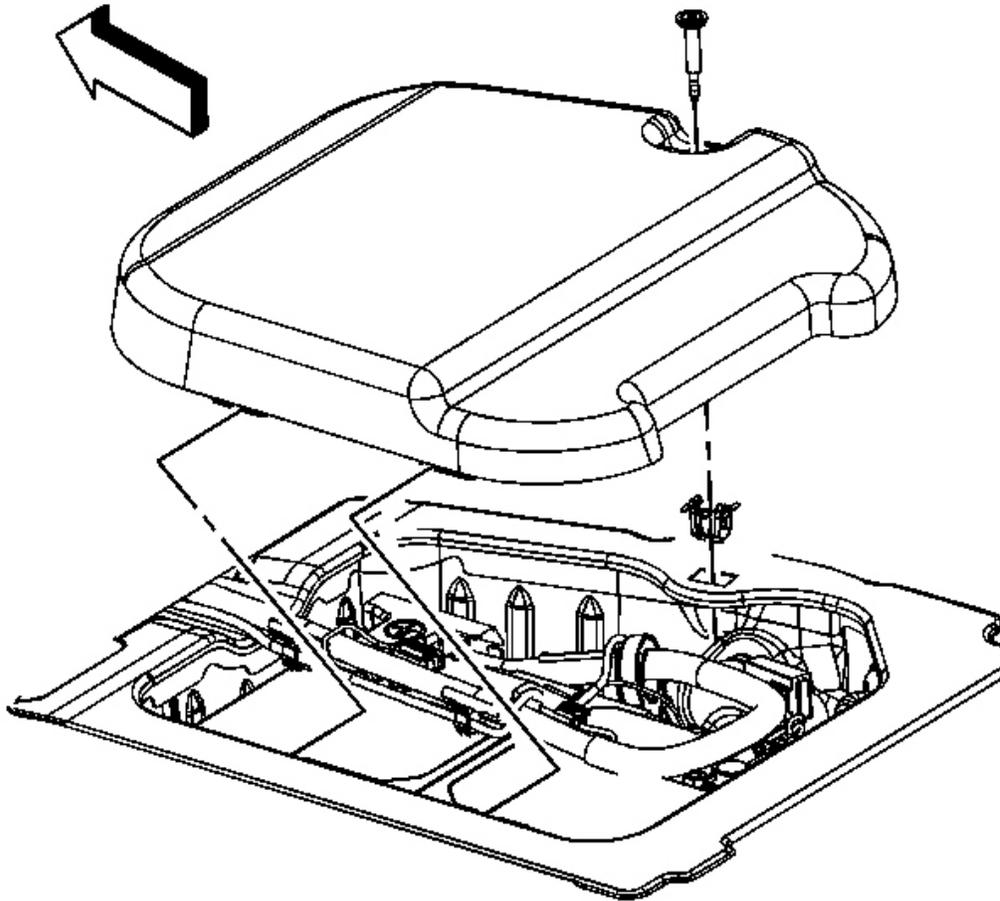
**Fig. 17: View Of Negative Battery Cable Terminal And Nut**  
Courtesy of GENERAL MOTORS CORP.

1. Position and install the negative battery cable to the battery negative terminal (2).

**NOTE:** Refer to Fastener Notice .

2. Tighten the negative battery cable terminal (1) nut.

**Tighten:** Tighten the nut to 9 N.m (80 lb in).



**Fig. 18: Identifying Battery Cover Screw & Cover**  
Courtesy of GENERAL MOTORS CORP.

3. Install the battery cover and screw.

**Tighten:** Tighten the screw to 1.6 N.m (14 lb in).

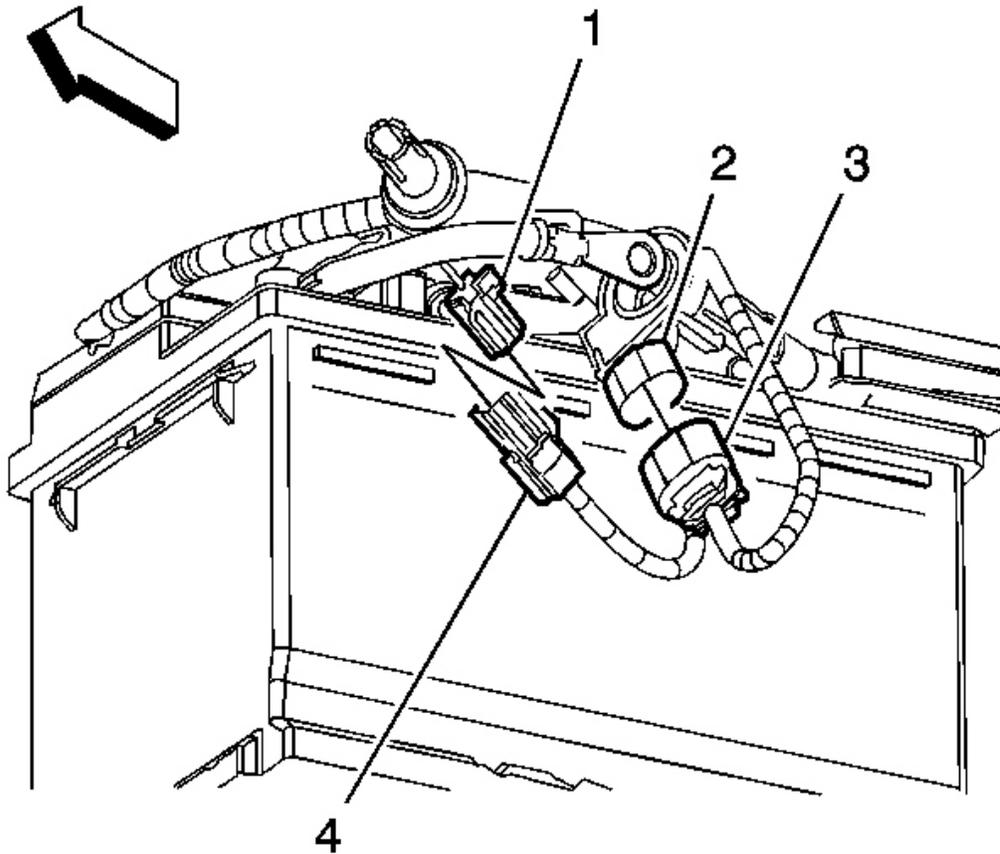
4. Reset all of the customer's radio station presets.

## BATTERY NEGATIVE CABLE REPLACEMENT

### Removal Procedure

**IMPORTANT:**

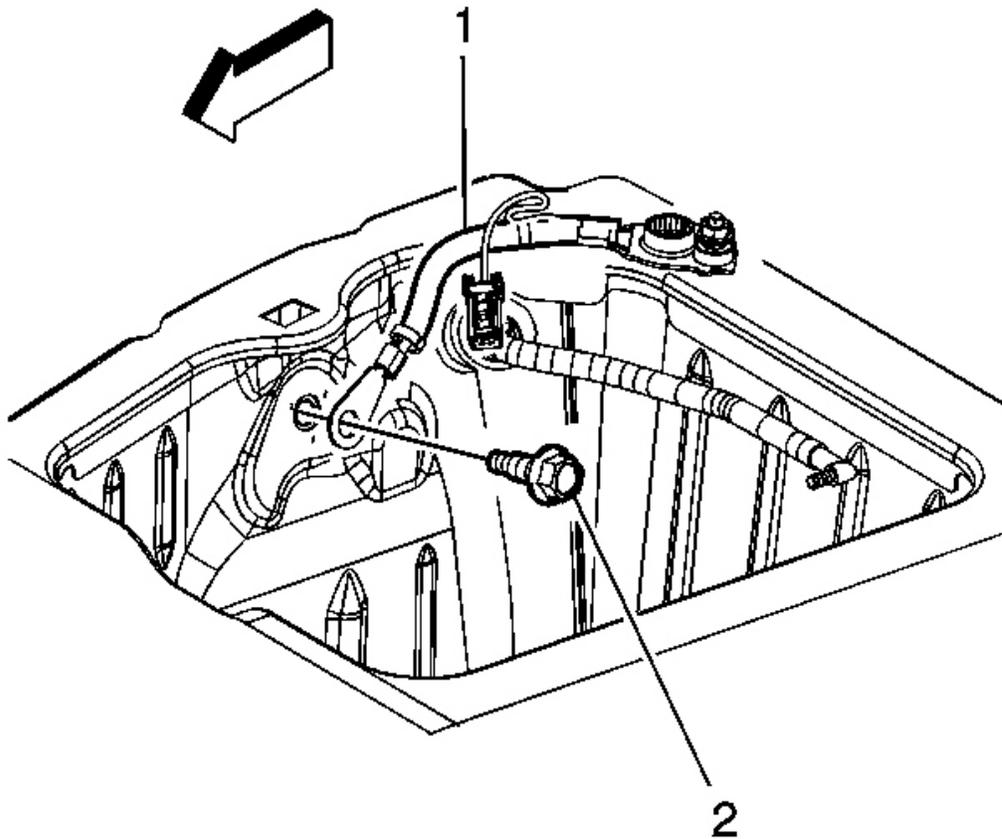
- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
- Always route the replacement cable the same way as the original cable.



**Fig. 19: Identifying Body Wiring Harness Connector & Negative Battery Cable Connector**

Courtesy of GENERAL MOTORS CORP.

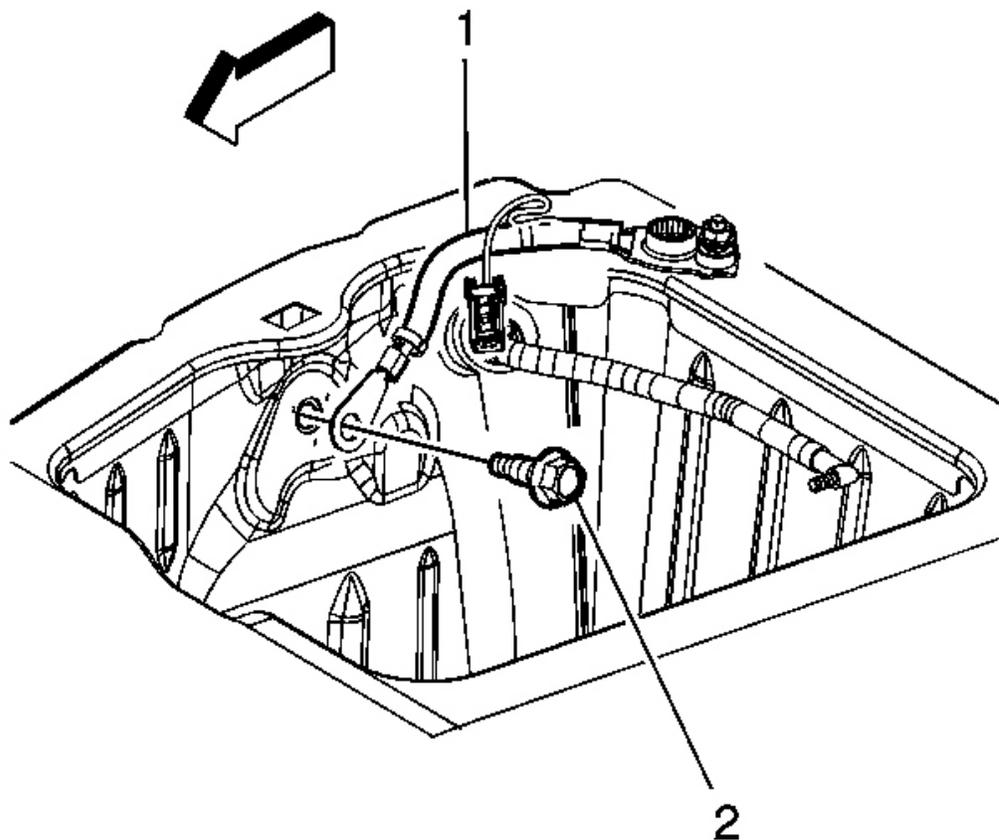
1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Disconnect the body wiring harness electrical connector (4) from the negative battery cable electrical connector (1).



**Fig. 20: View Of Negative Battery Cable Ground Bolt**  
**Courtesy of GENERAL MOTORS CORP.**

3. Remove the negative battery cable ground bolt (2). (battery shown removed for clarity).
4. Remove the negative battery cable.

**Installation Procedure**



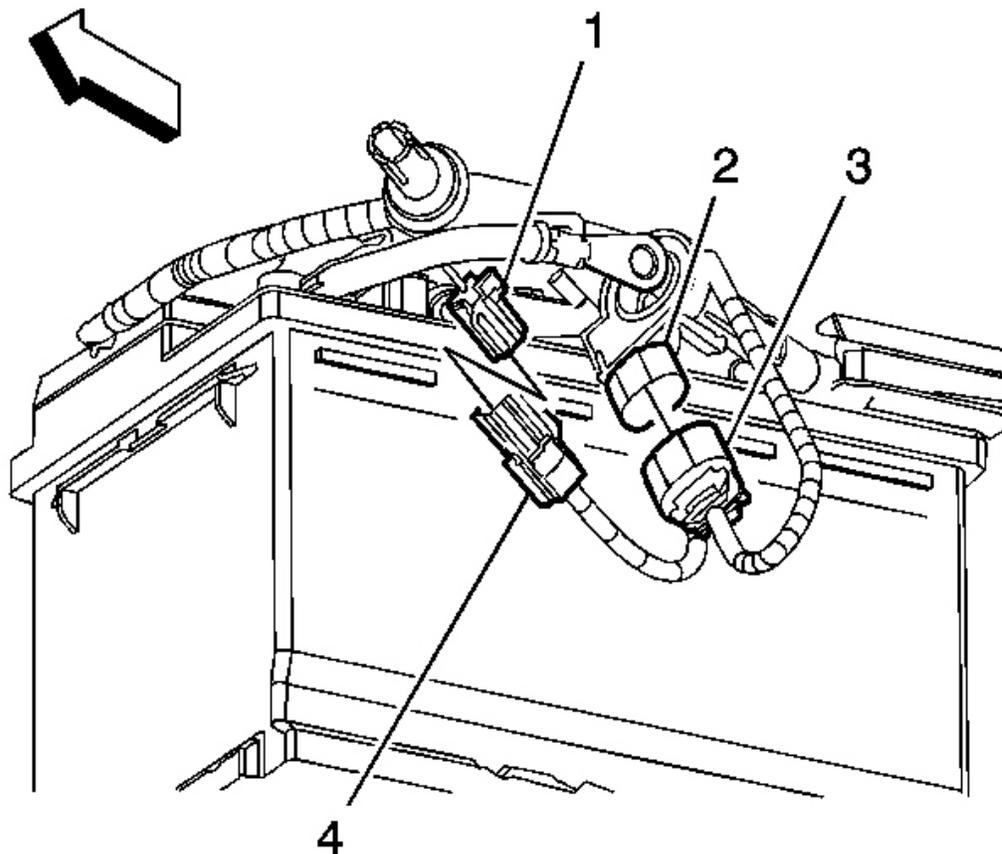
**Fig. 21: View Of Negative Battery Cable Ground Bolt**  
**Courtesy of GENERAL MOTORS CORP.**

1. Position the negative battery cable to the battery box. (battery shown removed for clarity).

**NOTE:** Refer to Fastener Notice .

2. Install the negative battery cable ground bolt (2).

**Tighten:** Tighten the bolt to 25 N.m (18 lb ft).



**Fig. 22: Identifying Body Wiring Harness Connector & Negative Battery Cable Connector**

Courtesy of GENERAL MOTORS CORP.

3. Connect the body wiring harness electrical connector (4) to the negative battery cable electrical connector (1).
4. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

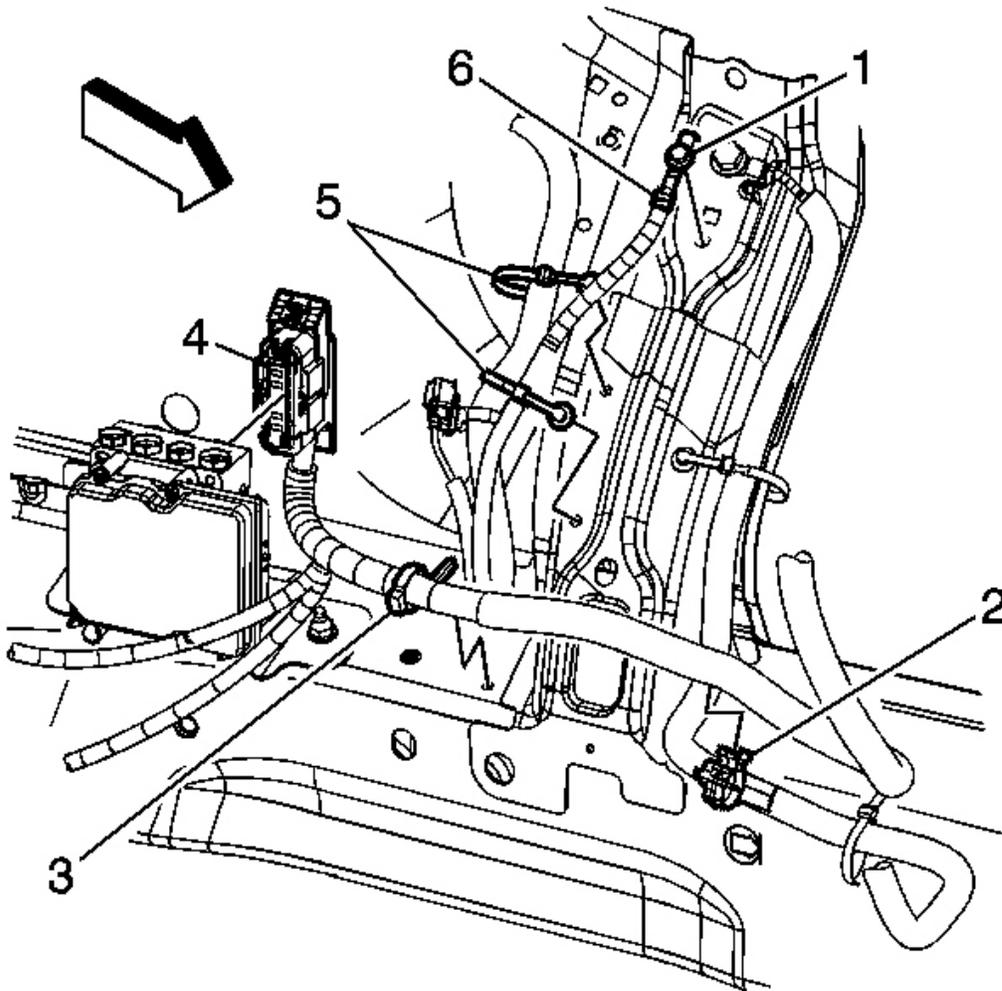
#### BATTERY NEGATIVE CABLE EXTENSION CABLE REPLACEMENT

##### Removal Procedure

**IMPORTANT:** • Always use replacement cables that are of the same type,

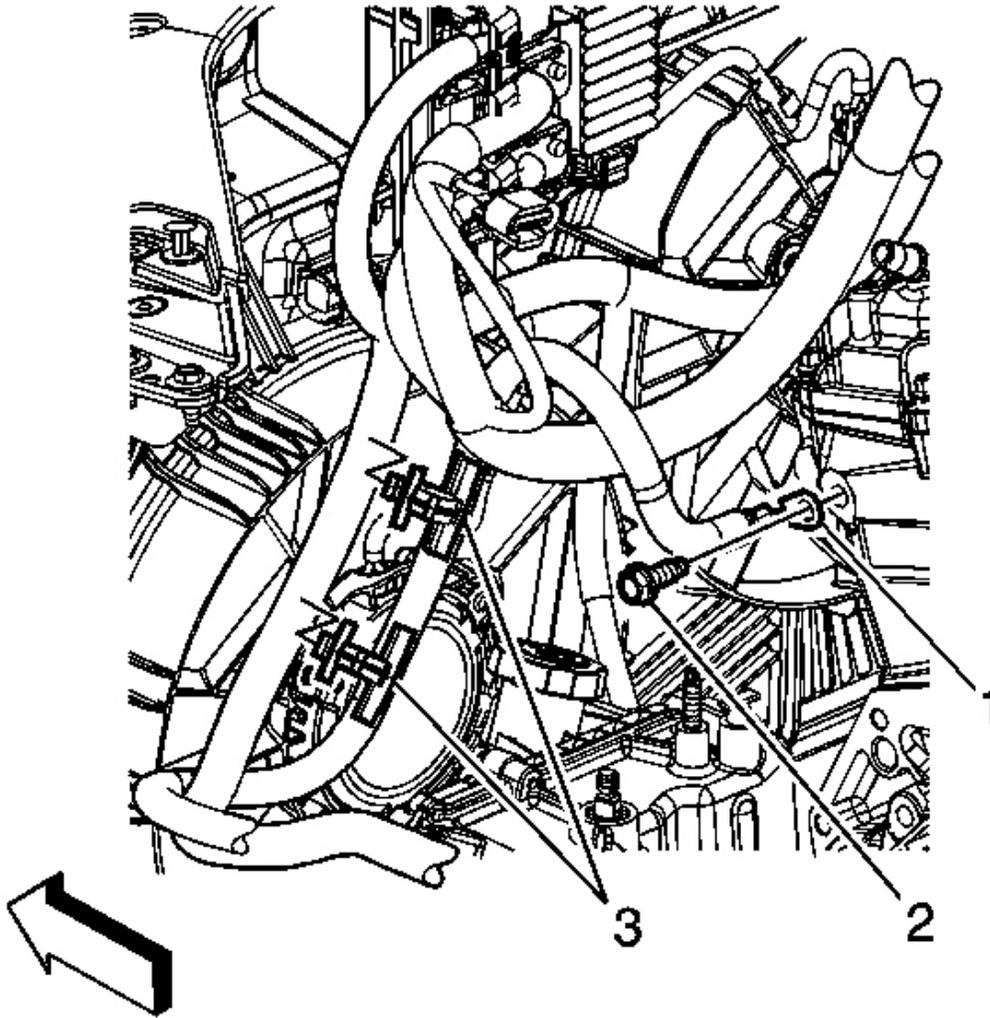
diameter and length of the cables that you are replacing.

- Always route the replacement cable the same way as the original cable.



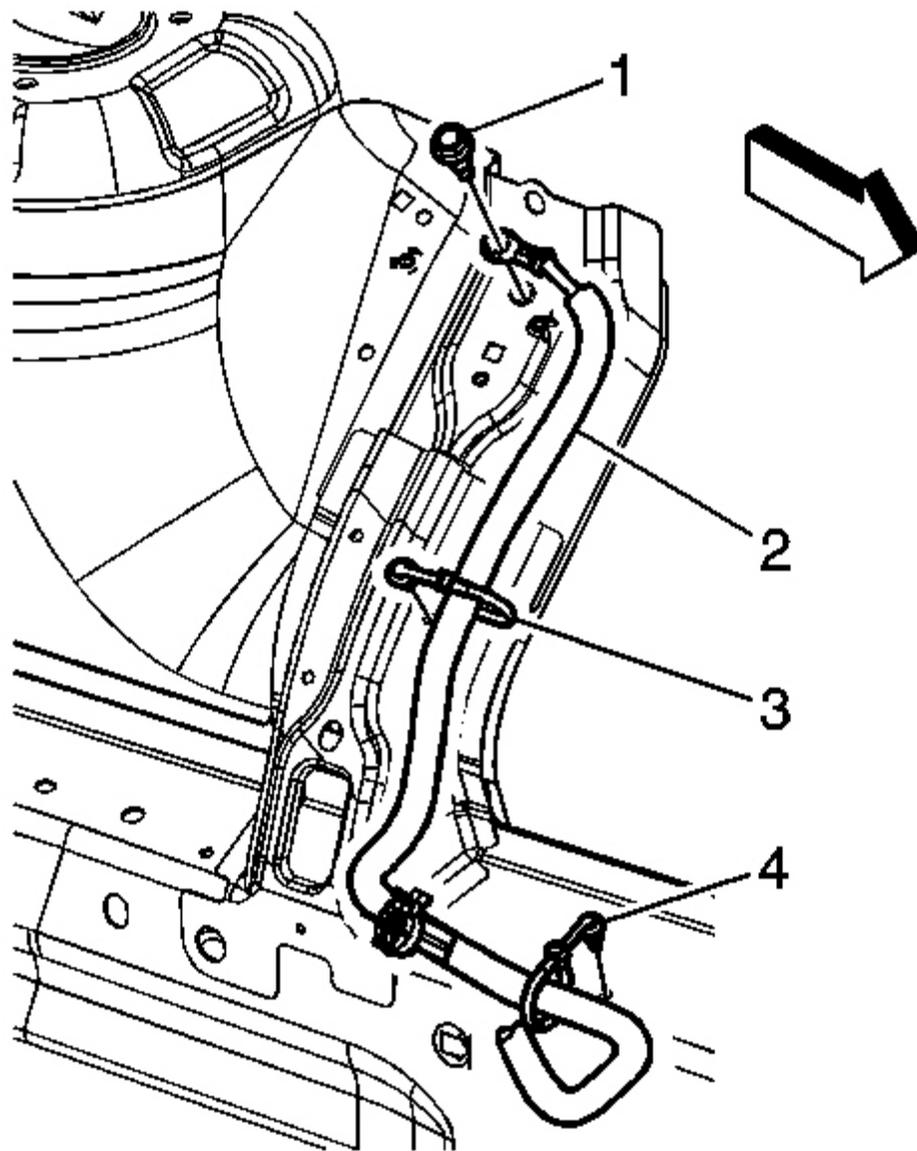
**Fig. 23: Identifying Battery Negative Cable Extension Cable Clip**  
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the engine wiring harness from the battery negative cable extension cable clip (2).



**Fig. 24: View Of Battery Negative Extension Cable Ground Bolt & Battery Negative Extension Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

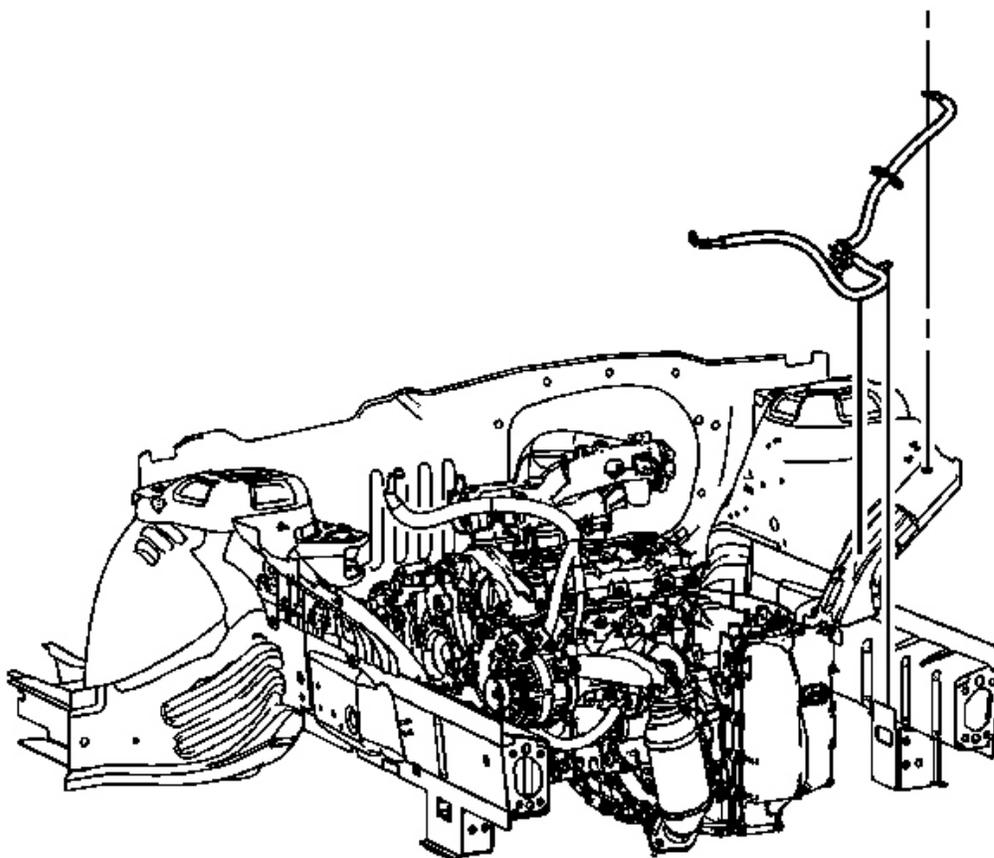
3. Remove the battery negative cable extension cable ground bolt (2) from the cylinder head.
4. Reposition the battery negative cable extension cable terminal (1) from the cylinder head.



**Fig. 25: Identifying Battery Negative Extension Cable Ground Bolt & Battery Negative Extension Cable Clip**  
Courtesy of GENERAL MOTORS CORP.

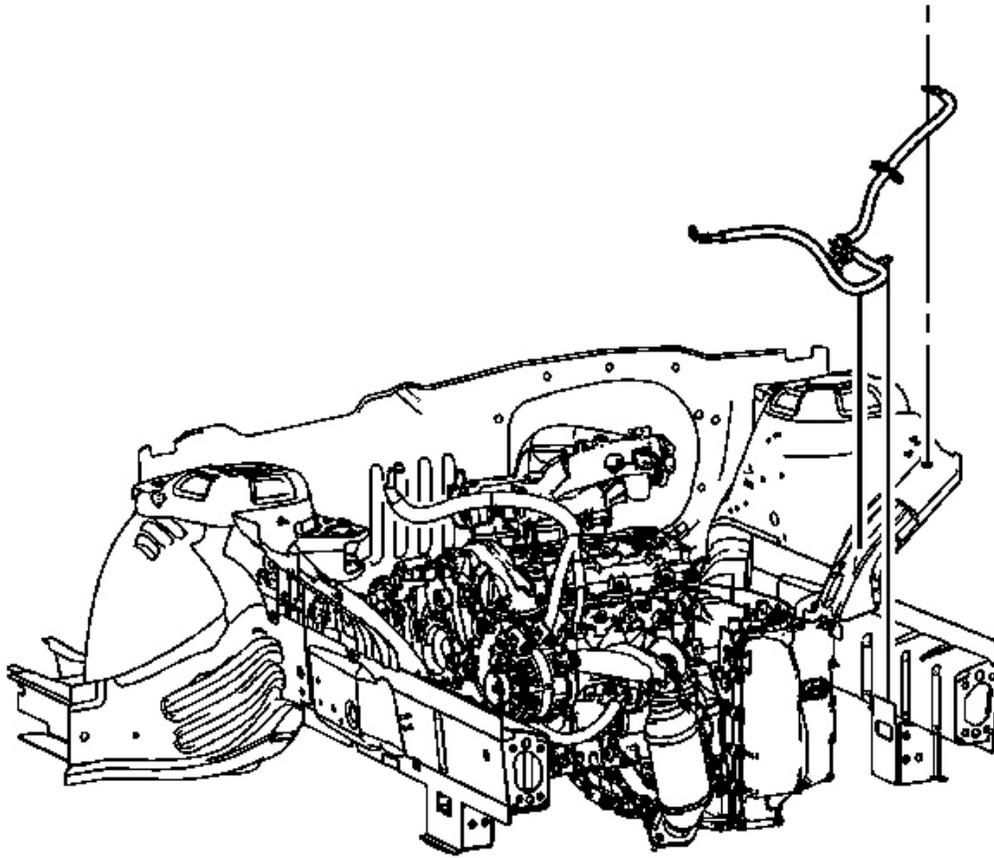
5. Remove the battery negative cable extension cable ground bolt (1) from the left wheelhouse panel upper reinforcement.

6. Remove the battery negative cable extension cable clip (3) from the left upper engine compartment support bracket.
7. Remove the battery negative cable extension cable clip (4) from the front compartment side rail.



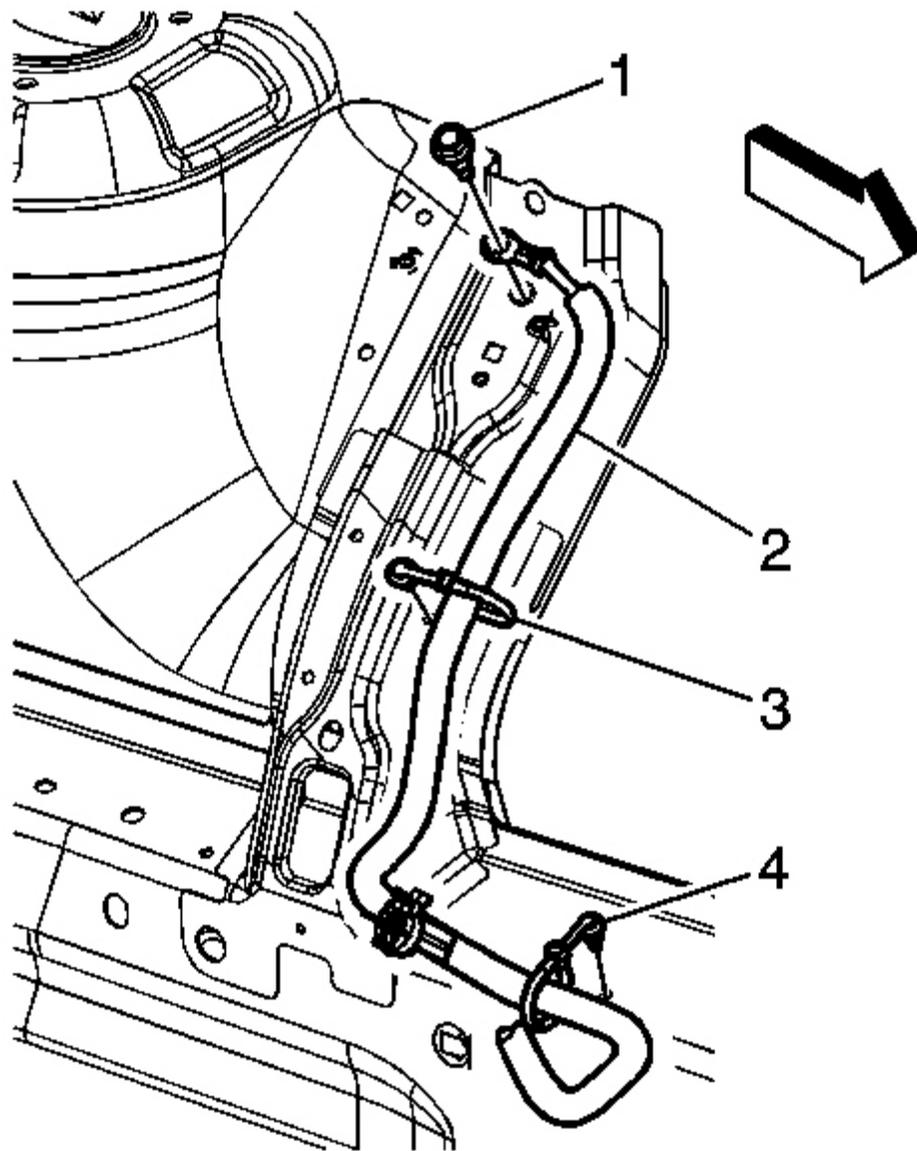
**Fig. 26: View Of Battery Negative Cable Extension Cable**  
Courtesy of GENERAL MOTORS CORP.

8. Remove the battery negative cable extension cable from the engine compartment.



**Fig. 27: View Of Battery Negative Cable Extension Cable**  
Courtesy of GENERAL MOTORS CORP.

1. Install the battery negative cable extension cable to the engine compartment.



**Fig. 28: Identifying Battery Negative Extension Cable Ground Bolt & Battery Negative Extension Cable Clip**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

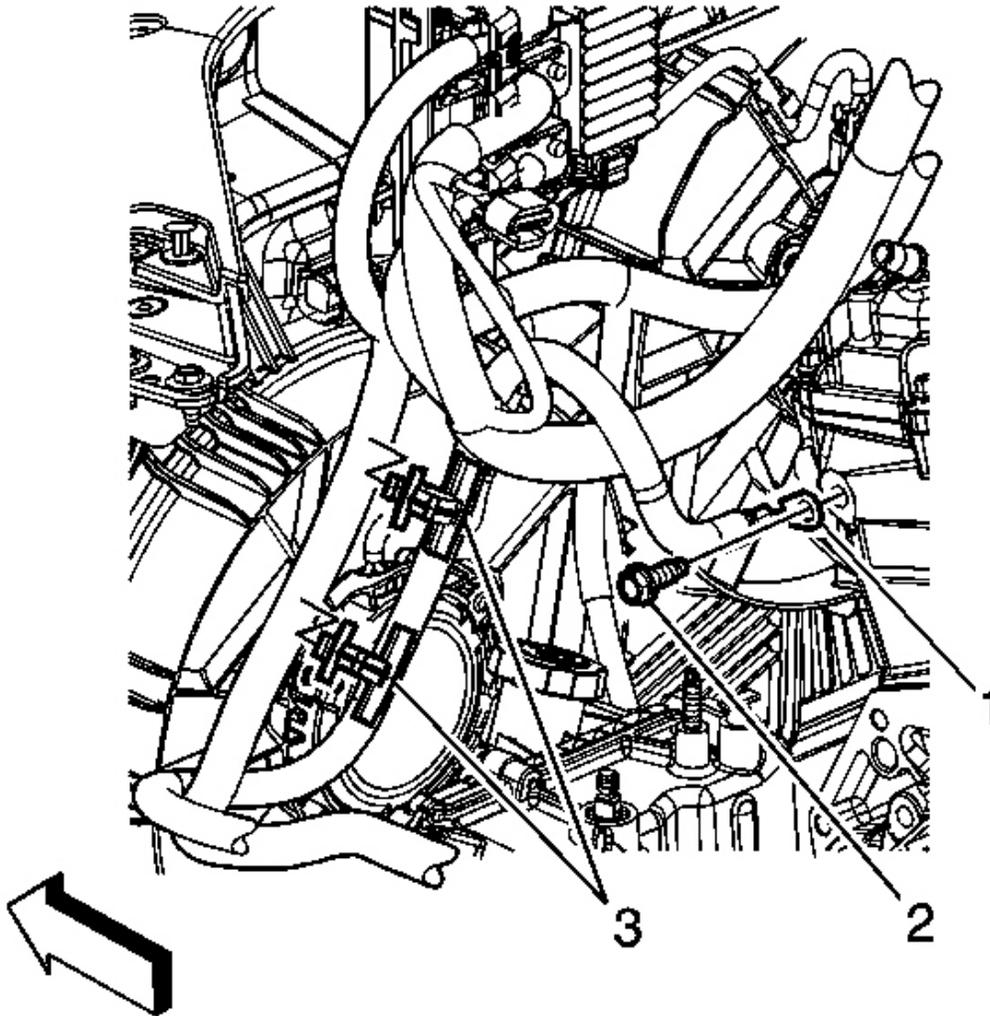
## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

2. Install the battery negative cable extension cable ground bolt (1) to the left wheelhouse panel upper reinforcement.

**Tighten:** Tighten the bolt to 58 N.m (43 lb ft).

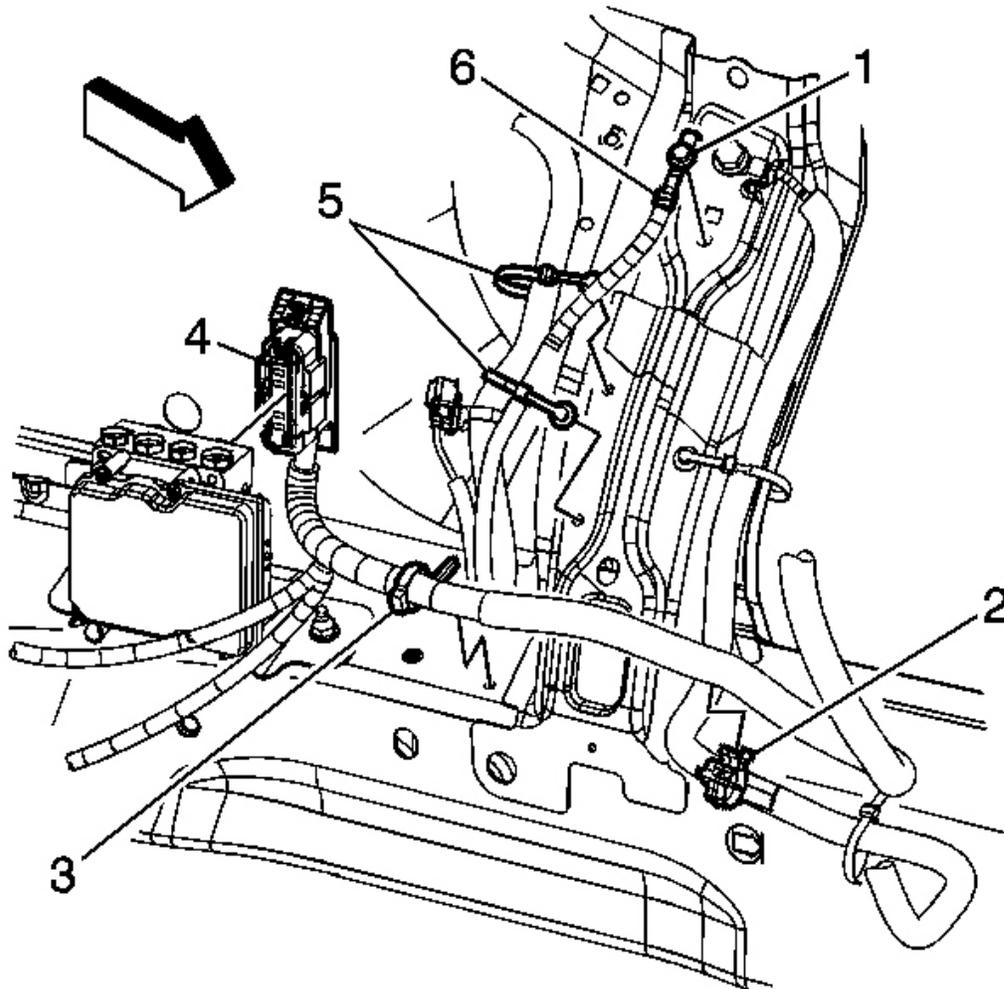
3. Install the battery negative cable extension cable clip (3) to the left upper engine compartment support bracket.
4. Install the battery negative cable extension cable clip (4) to the front compartment side rail.



**Fig. 29: View Of Battery Negative Extension Cable Ground Bolt & Battery Negative Extension Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

5. Position the battery negative cable extension cable terminal (1) to the cylinder head.
6. Install the battery negative cable extension cable ground bolt (2) to the cylinder head.

**Tighten:** Tighten the bolt to 58 N.m (43 lb ft).



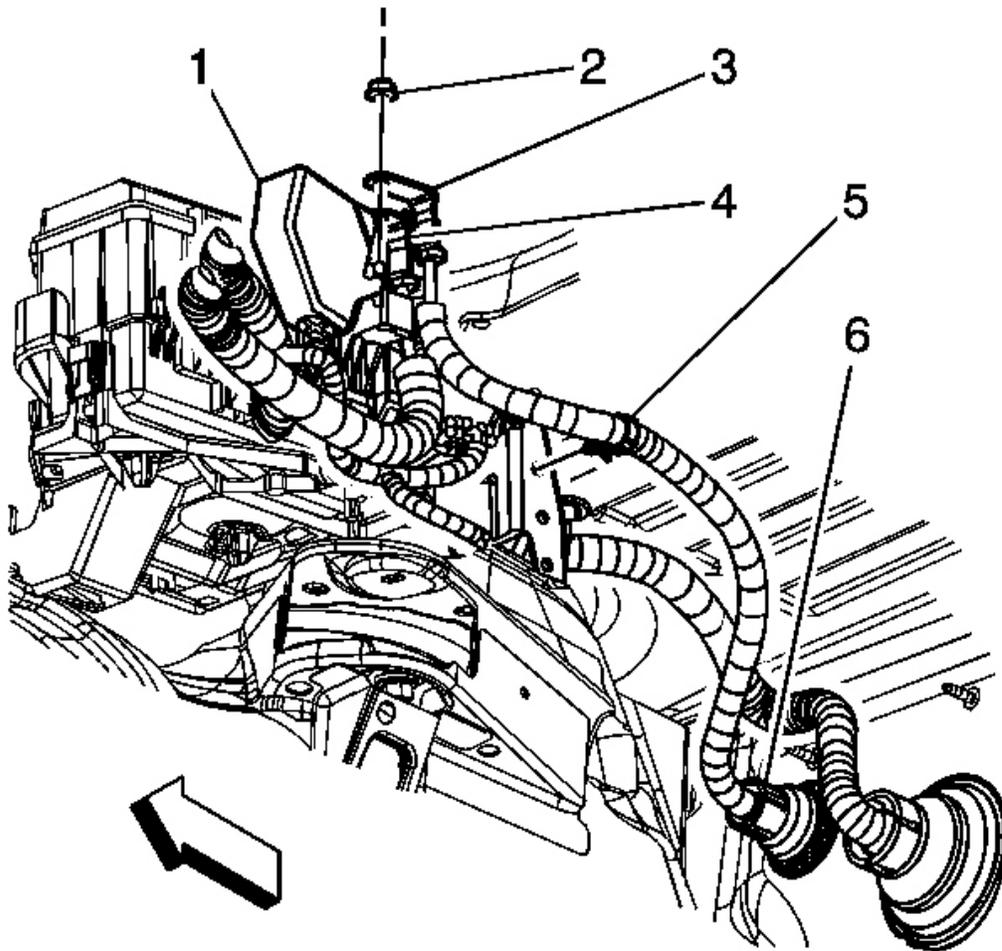
**Fig. 30: Identifying Battery Negative Cable Extension Cable Clip**  
Courtesy of GENERAL MOTORS CORP.

7. Install the engine wiring harness to the battery negative cable extension cable clip (2).
8. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

## BATTERY POSITIVE CABLE REPLACEMENT

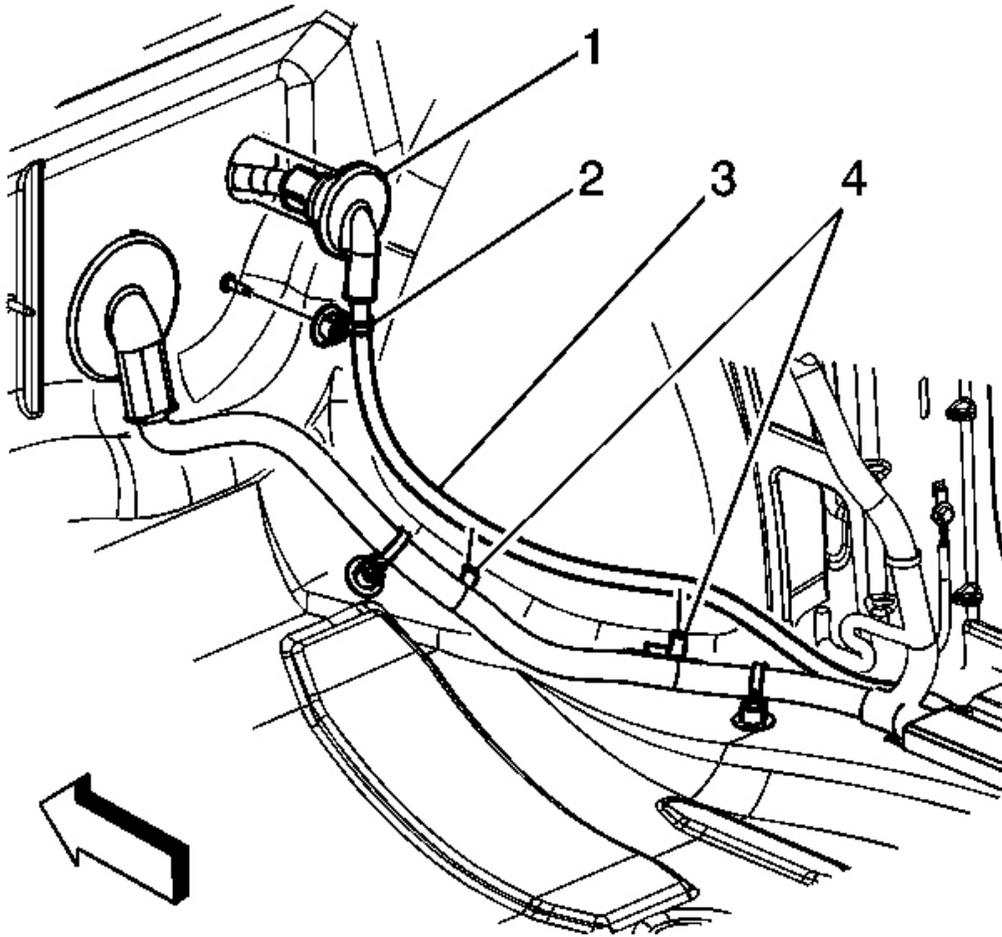
### Removal Procedure

- IMPORTANT:**
- Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.
  - Always route the replacement cable the same way as the original cable.



**Fig. 31: Identifying Accessory Wiring Junction Block Cover & Nut**  
Courtesy of GENERAL MOTORS CORP.

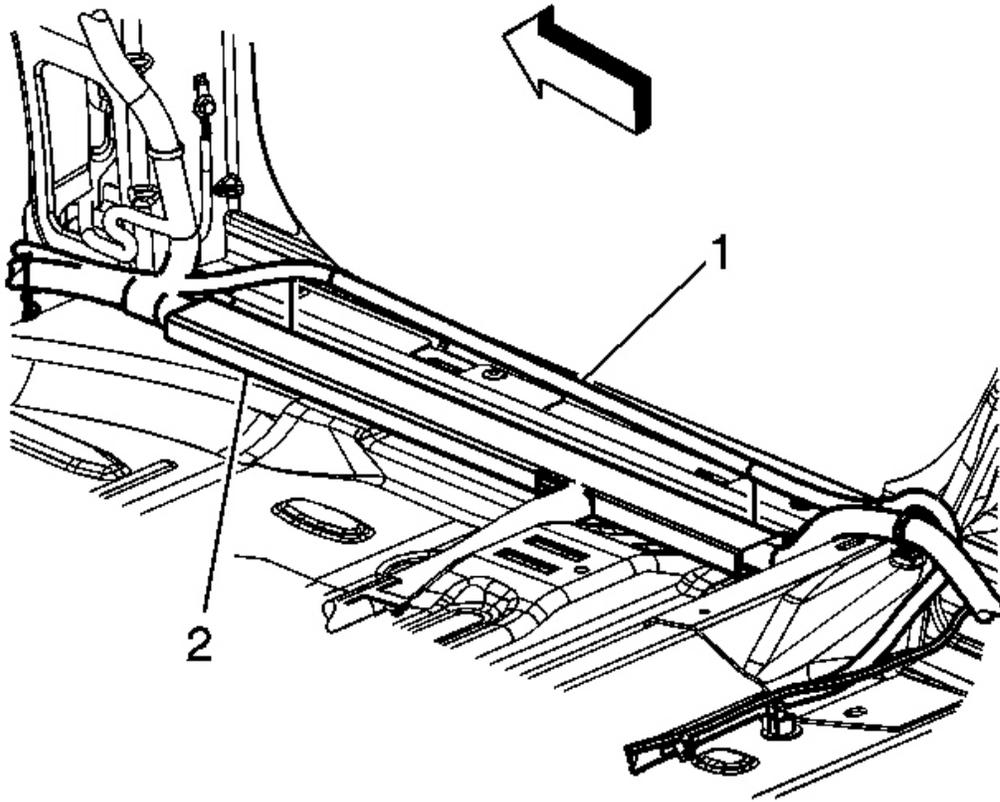
1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Open the accessory wiring junction block cover (1).
3. Remove the accessory wiring junction block nut (2).
4. Remove the positive battery cable terminal (3) from the stud.
5. Remove the positive battery cable clip (5) from the multiuse relay bracket.
6. Push the positive battery cable grommet (6) in through the dash panel.



**Fig. 32: View Of Positive Battery Cable Clip, Positive Battery Cable & Retainers**  
Courtesy of GENERAL MOTORS CORP.

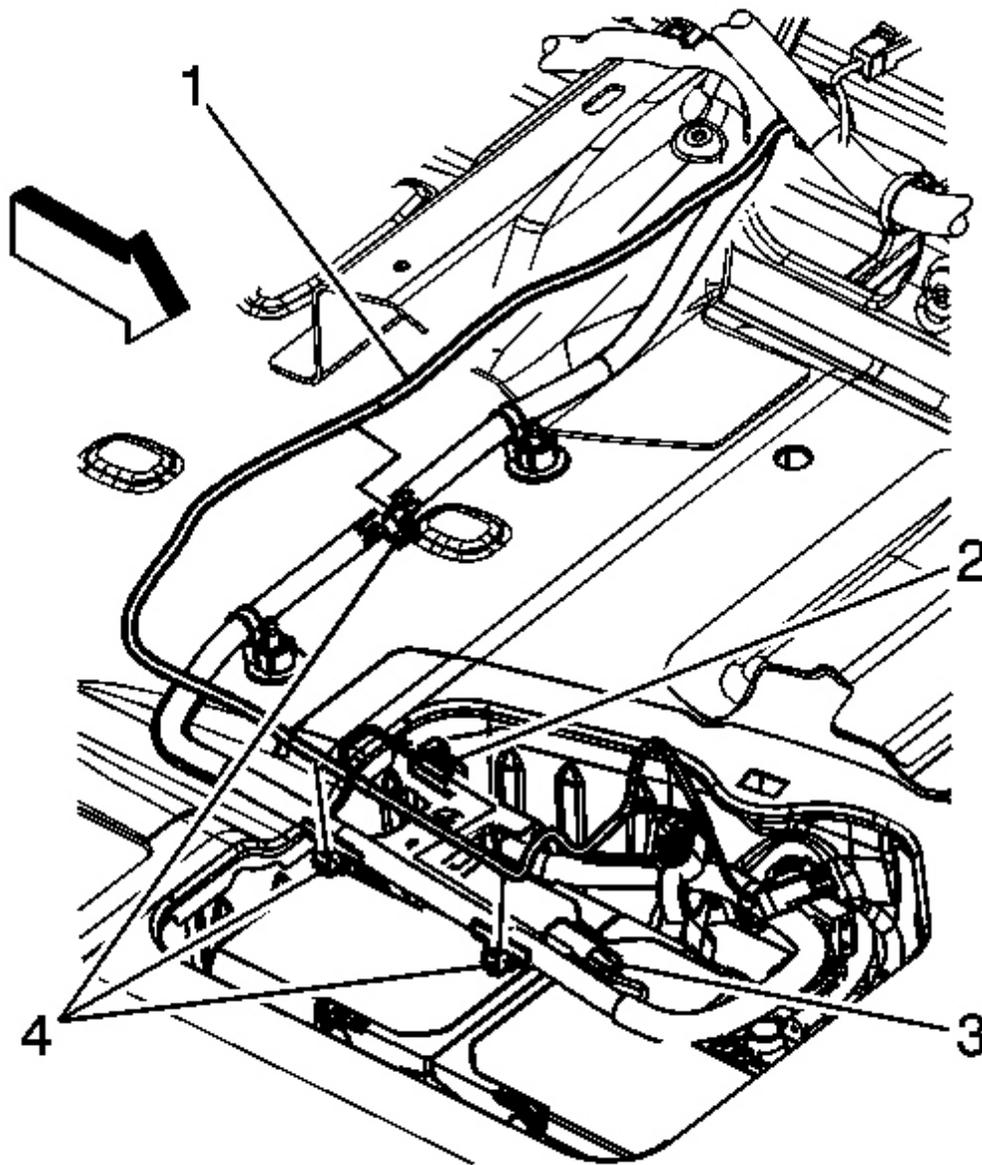
7. Remove the right side instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** .
8. Remove the passenger side carpet. Refer to **Front Floor Panel Carpet Replacement - Right Side** .
9. Pull up the passenger side corner of the dash panel sound barrier until the positive battery cable is accessible.
10. Remove the positive battery cable clip (2) from the stud on the dash panel.
11. Pull the grommet (1) from the dash panel.

12. Remove the positive battery cable (3) from the retainers (4) on the body wiring harness.



**Fig. 33: View Of Positive Battery Cable**  
**Courtesy of GENERAL MOTORS CORP.**

13. Remove the positive battery cable (1) from the body wiring harness right front sill plate (2).

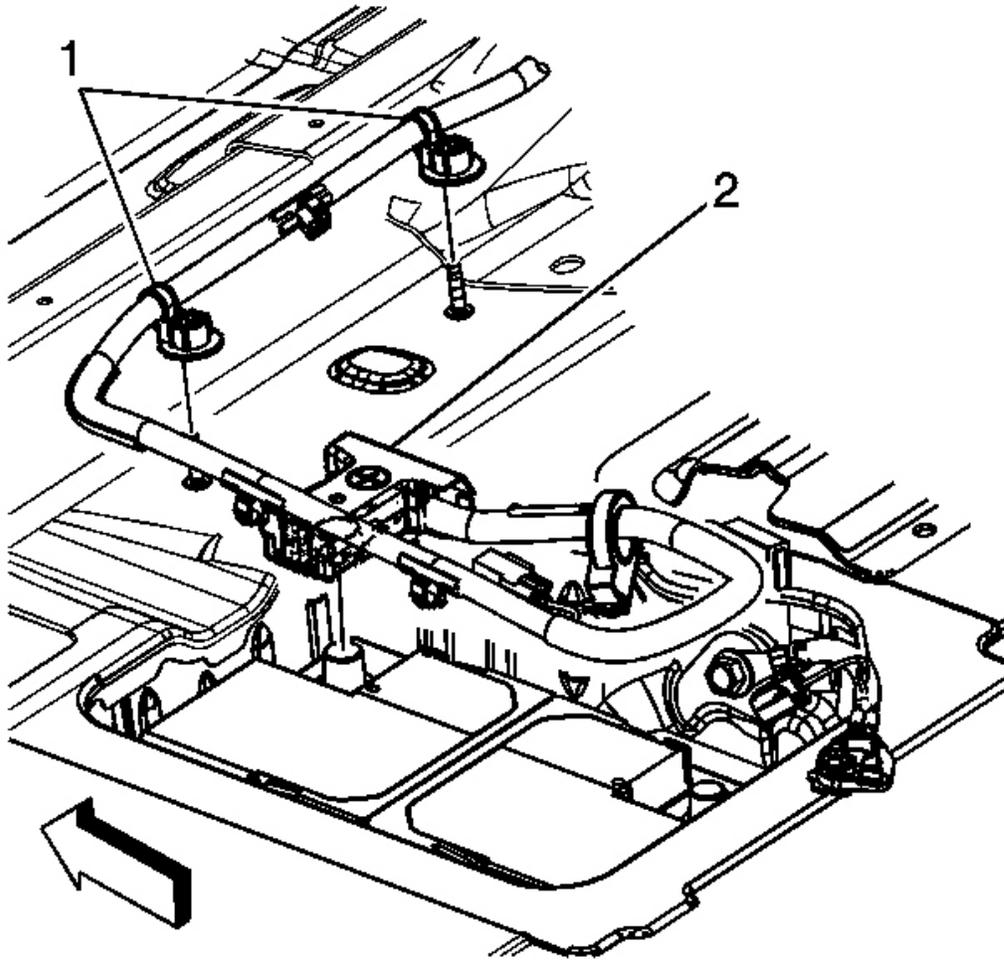


**Fig. 34: Identifying Body Wiring Harness, Electrical Connector & Positive Battery Cable Clips**

**Courtesy of GENERAL MOTORS CORP.**

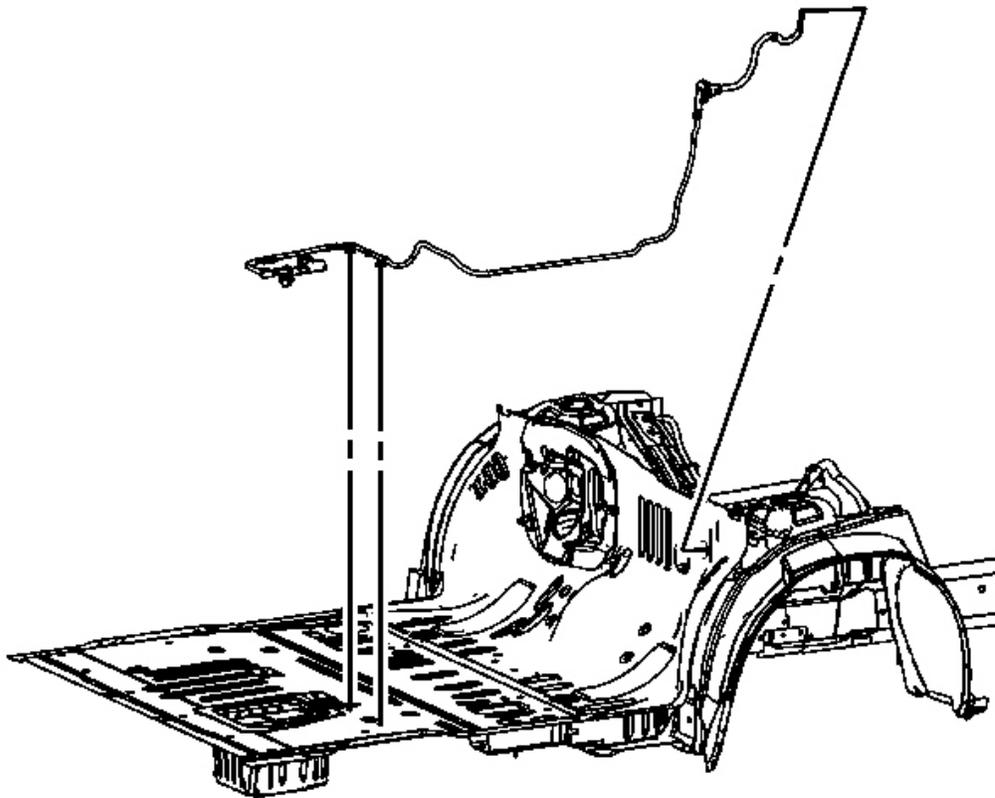
14. Remove the body wiring harness (1) from the positive battery cable clips (4).

15. Disconnect the body wiring harness electrical connector (2) from the battery cable electrical connector (3).



**Fig. 35: View Of Positive Battery Cable Clips And Positive Battery Cable Cover**  
Courtesy of GENERAL MOTORS CORP.

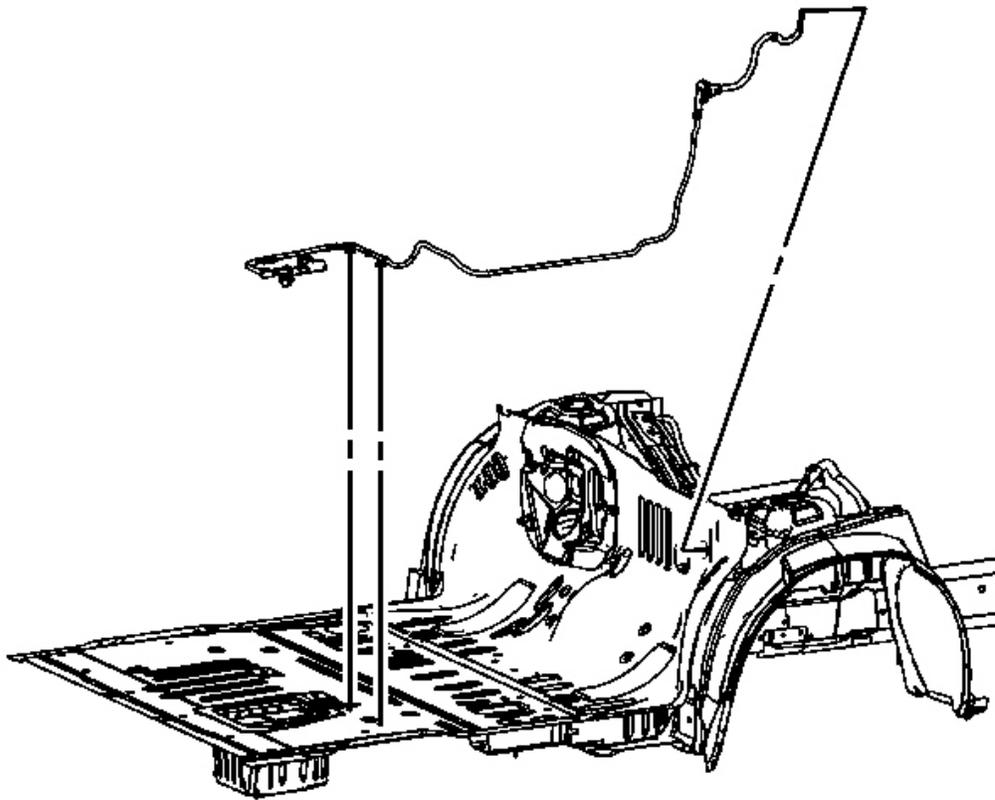
16. Remove the positive battery cable clips (1) from the floor panel studs.
17. Open the positive battery cable cover (2).
18. Loosen the positive battery cable terminal nut.



**Fig. 36: View Of Positive Battery Cable**  
**Courtesy of GENERAL MOTORS CORP.**

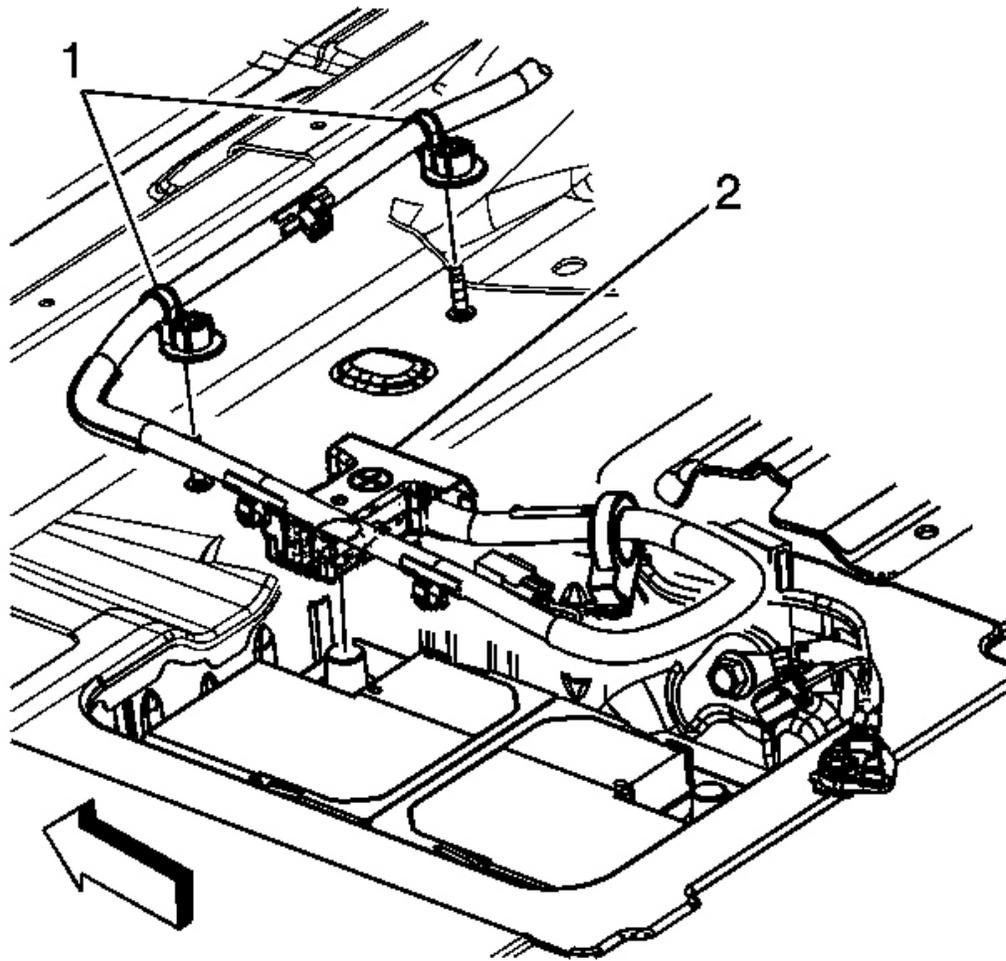
19. Remove the positive battery cable out from under the rear carpet and remove the cable from the vehicle.

**Installation Procedure**



**Fig. 37: View Of Positive Battery Cable**  
**Courtesy of GENERAL MOTORS CORP.**

1. Route the positive battery cable under the rear carpet and position the cable from the vehicle floor pan.



**Fig. 38: View Of Positive Battery Cable Clips & Positive Battery Cable Cover**  
Courtesy of GENERAL MOTORS CORP.

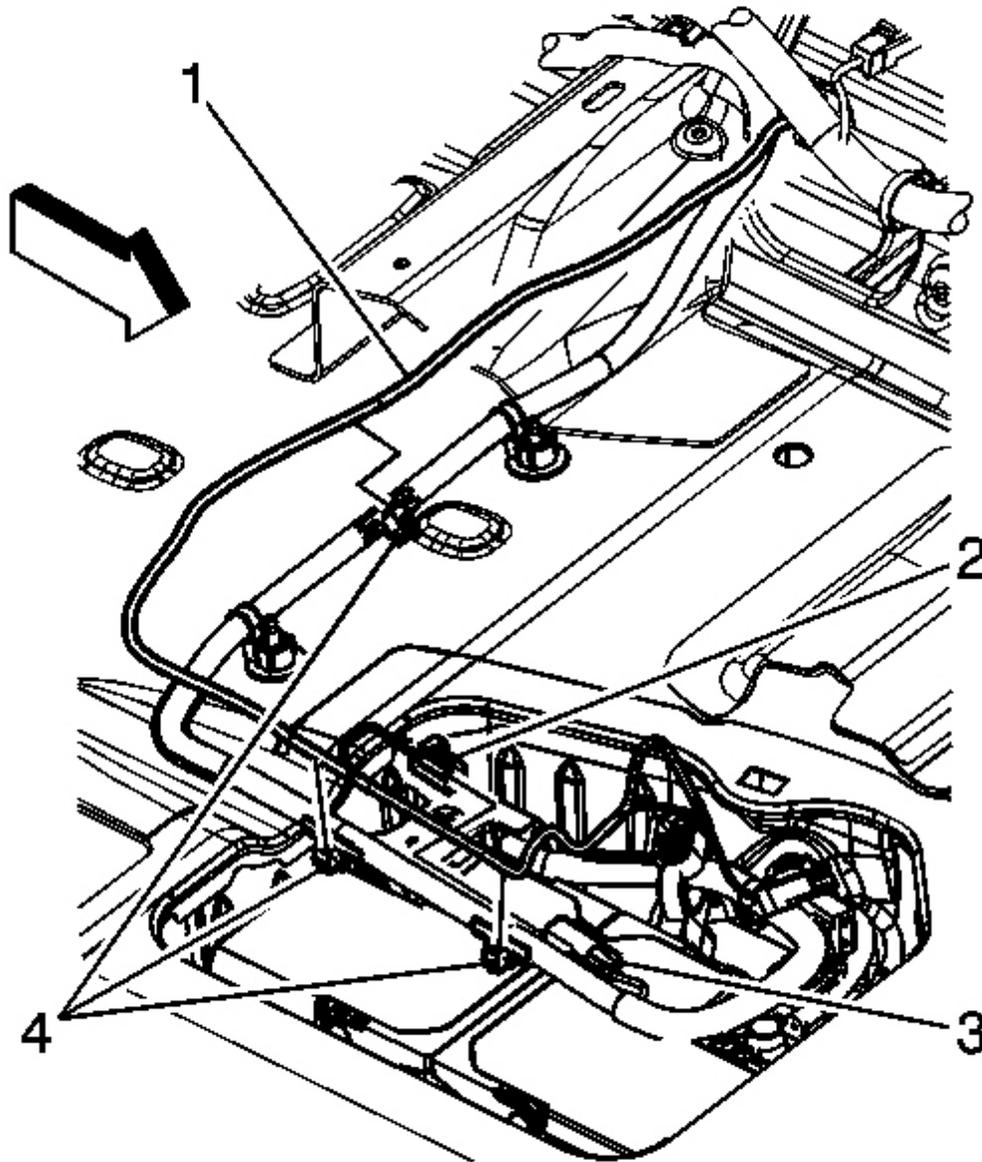
2. Install the positive battery cable clips (1) to the floor panel studs.
3. Install the positive battery cable terminal to the battery positive terminal.

**NOTE:** Refer to Fastener Notice .

4. Tighten the positive battery cable terminal nut.

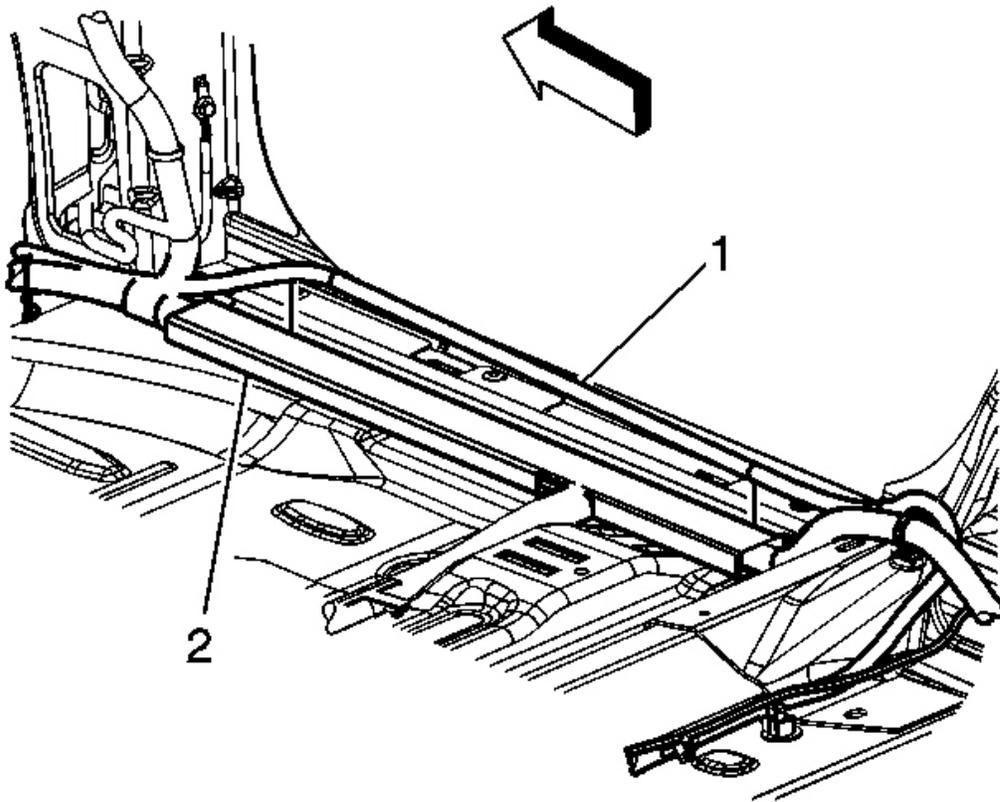
**Tighten:** Tighten the nut to 9 N.m (80 lb in).

5. Close the positive battery cable cover (2).



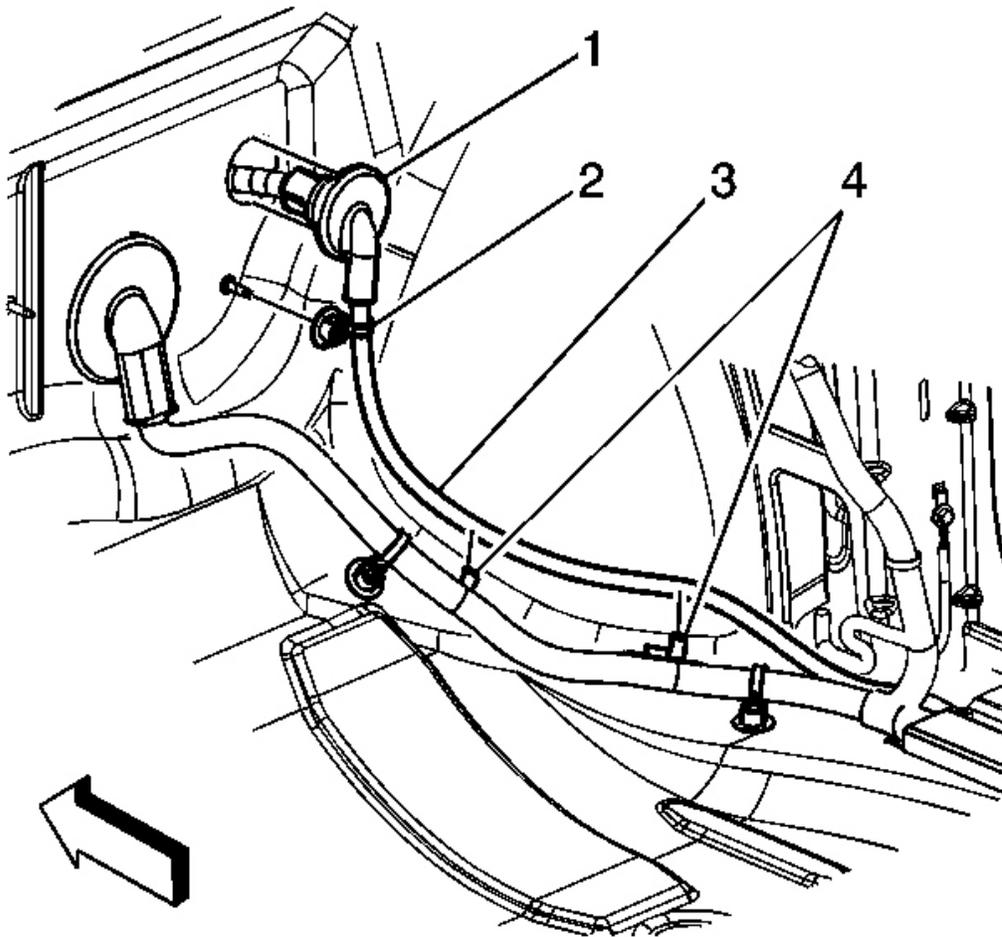
**Fig. 39: Identifying Body Wiring Harness, Electrical Connector & Positive Battery Cable Clips**  
Courtesy of GENERAL MOTORS CORP.

6. Install the body wiring harness (1) to the positive battery cable clips (4).
7. Connect the body wiring harness electrical connector (2) to the battery cable electrical connector (3).



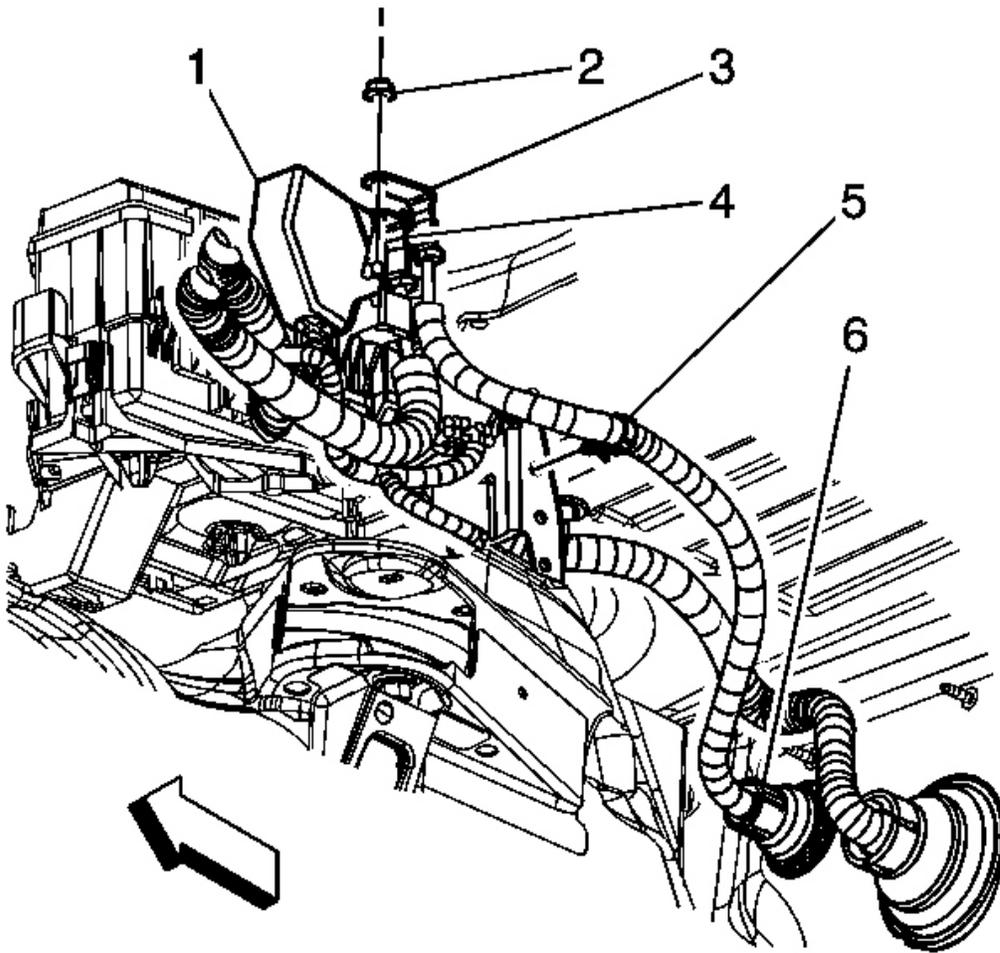
**Fig. 40: View Of Positive Battery Cable**  
**Courtesy of GENERAL MOTORS CORP.**

8. Install the positive battery cable (1) to the body wiring harness right front sill plate (2).



**Fig. 41: View Of Positive Battery Cable Clip, Positive Battery Cable & Retainers**  
Courtesy of GENERAL MOTORS CORP.

9. Push the grommet (1) through the dash panel.
10. Install the positive battery cable (3) to the retainers (4) on the body wiring harness.
11. Install the positive battery cable clip (2) to the stud on the dash panel.
12. Reposition the passenger side corner of the dash panel sound barrier.
13. Install the passenger side carpet. Refer to **Front Floor Panel Carpet Replacement - Right Side** .
14. Install the right side instrument panel insulator panel. Refer to **Instrument Panel Insulator Panel Replacement - Right Side** .



**Fig. 42: Identifying Accessory Wiring Junction Block Cover & Nut**  
Courtesy of GENERAL MOTORS CORP.

15. Ensure that the positive battery cable grommet (6) is completely seated through the dash panel.
16. Install the positive battery cable terminal (3) to the junction block stud.
17. Install the accessory wiring junction block nut (2).

**Tighten:** Tighten the nut to 22 N.m (16 lb ft).

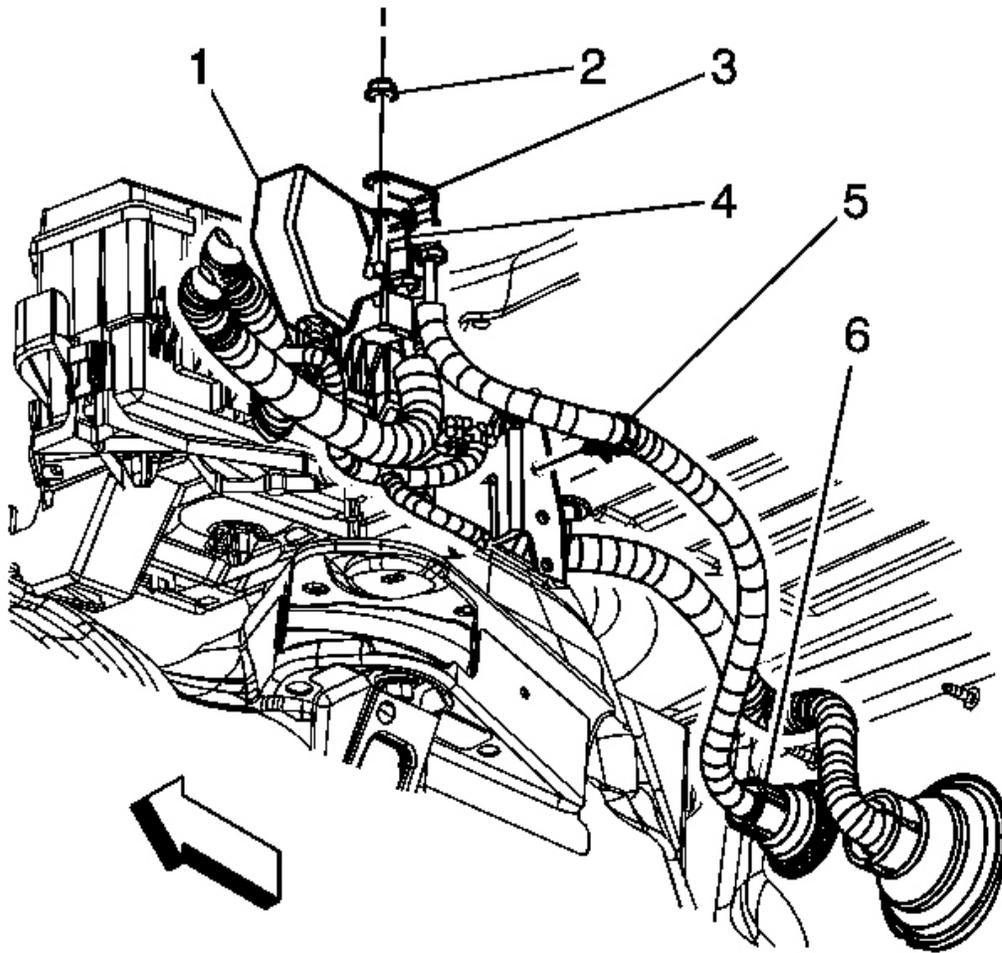
18. Close the accessory wiring junction block cover (1).

19. Install the positive battery cable clip (5) to the multiuse relay bracket.
20. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

#### **BATTERY POSITIVE JUNCTION BLOCK CABLE REPLACEMENT**

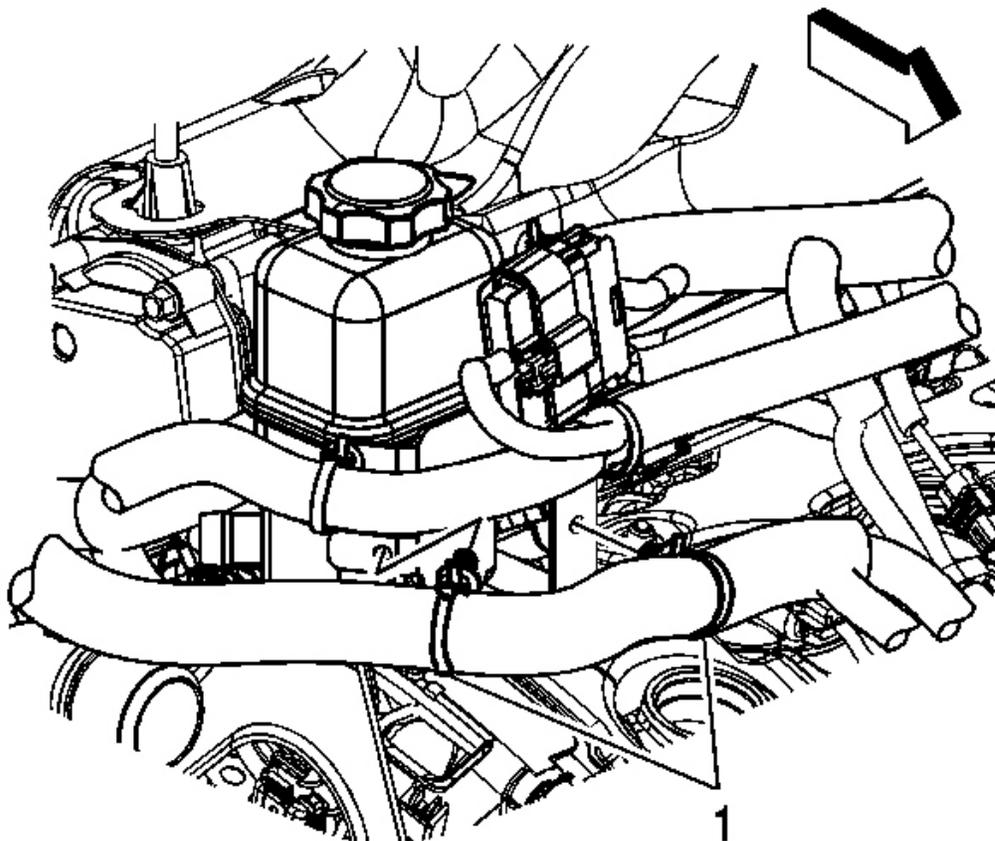
##### **Removal Procedure**

- IMPORTANT:**
- **Always use replacement cables that are of the same type, diameter and length of the cables that you are replacing.**
  - **Always route the replacement cable the same way as the original cable.**



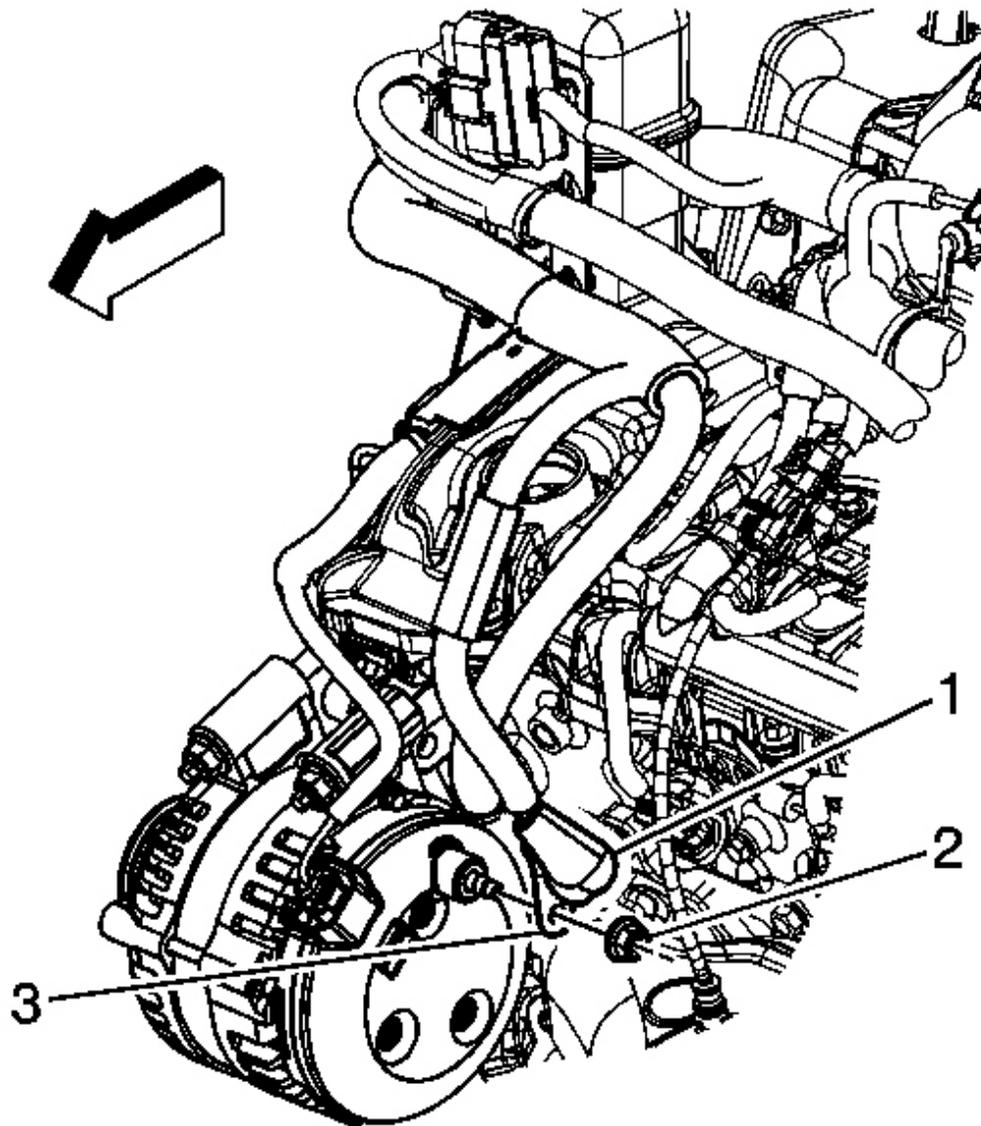
**Fig. 43: Identifying Accessory Wiring Junction Block Cover & Nut**  
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Open the accessory wiring junction block cover (1).
3. Remove the accessory wiring junction block nut (2).
4. Remove the positive battery cable terminal (3) from the stud.
5. Remove the battery positive junction block cable terminal (4) from the stud.



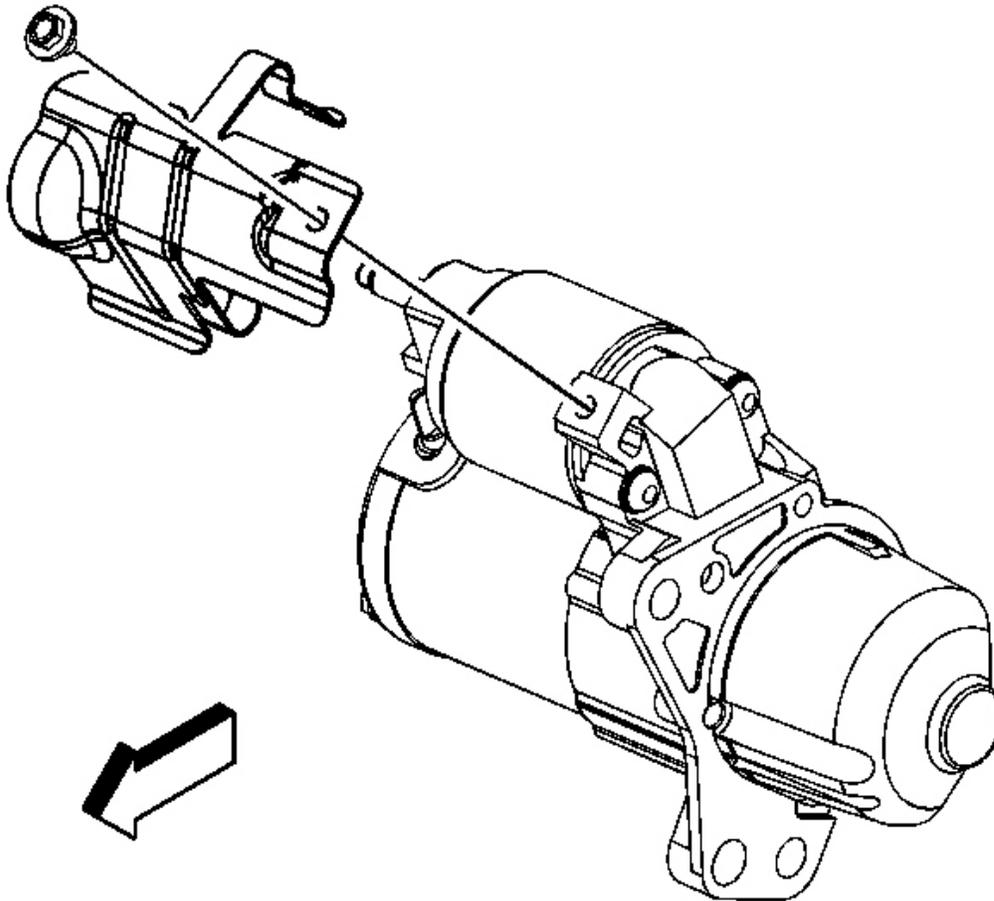
**Fig. 44: Identifying Battery Positive Junction Block Cable Clips**  
Courtesy of GENERAL MOTORS CORP.

6. Remove the battery positive junction block cable clips (1) from the power steering reservoir bracket.



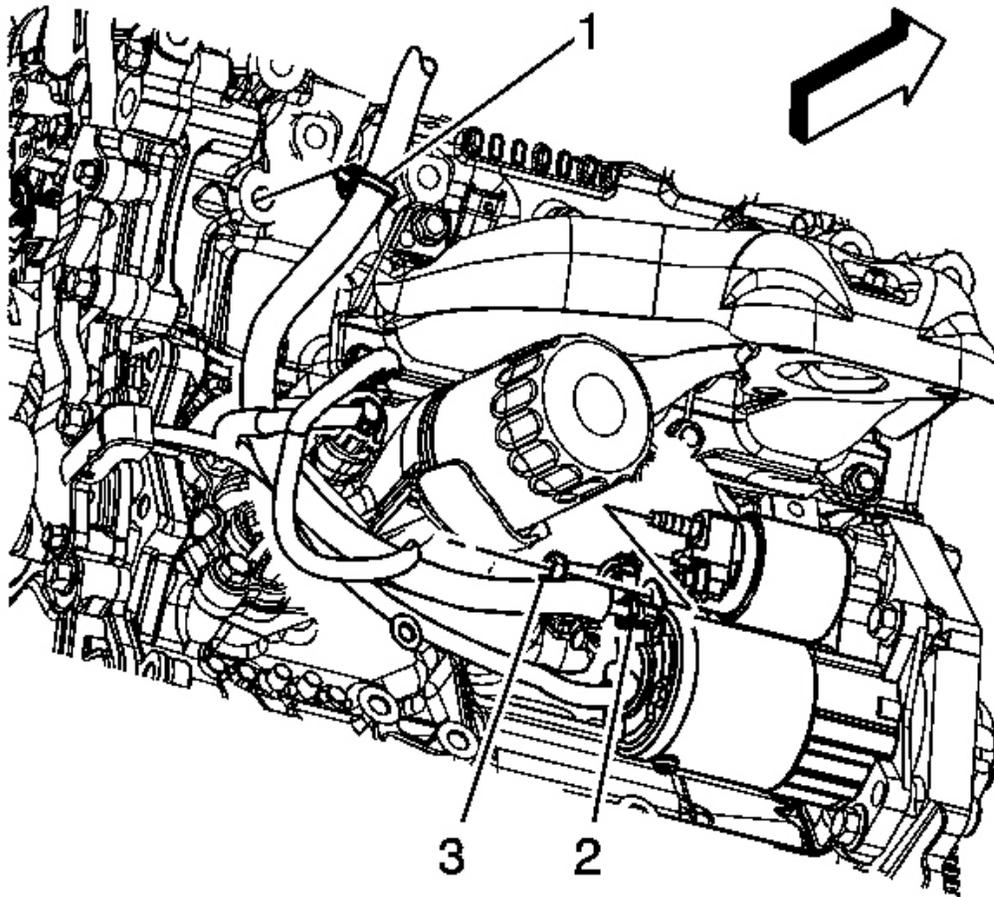
**Fig. 45: Identifying Battery Positive Junction Block Cable Boot & Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

7. Reposition the battery positive junction block cable boot (1).
8. Remove the battery positive junction block cable to generator nut (3).
9. Remove the battery positive junction block cable terminal (3) from the generator stud.



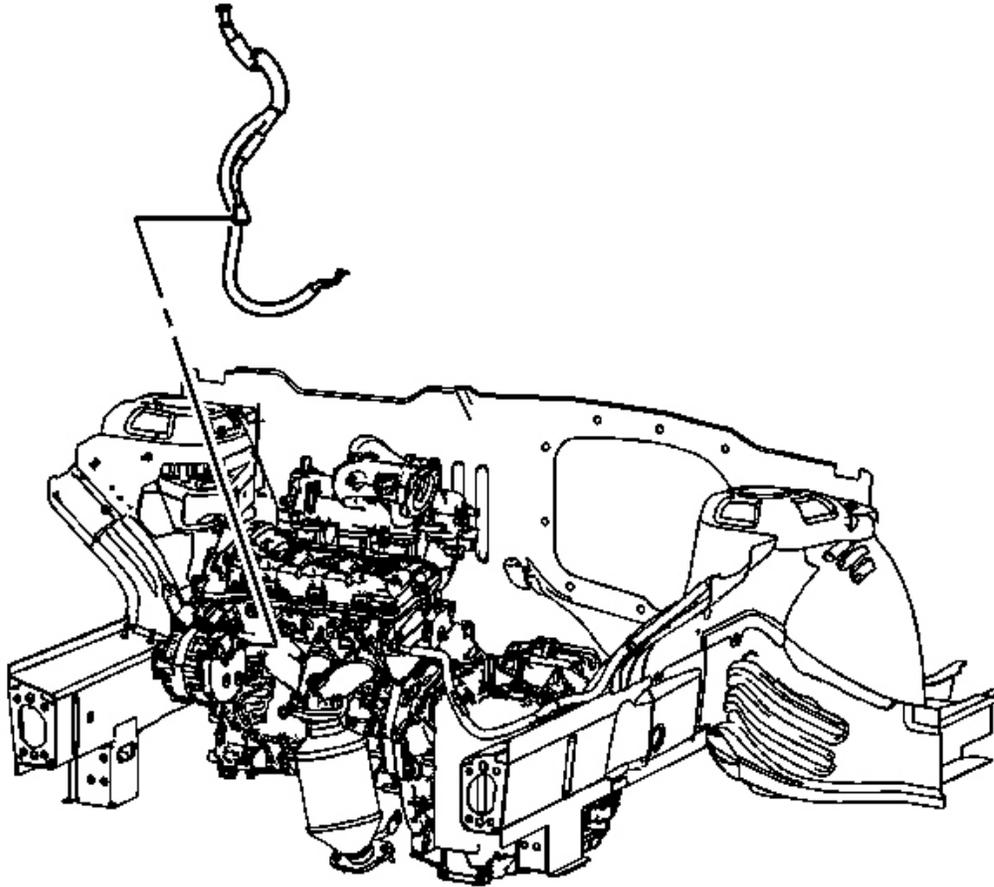
**Fig. 46: Identifying Starter Heat Shield Bolt & Shield**  
Courtesy of GENERAL MOTORS CORP.

10. Remove the left catalytic converter. Refer to **Catalytic Converter Replacement - Left Side** .
11. Remove the starter heat shield bolt and shield.



**Fig. 47: View Of Battery Positive Junction Block Cable Clip & Cable Terminal**  
**Courtesy of GENERAL MOTORS CORP.**

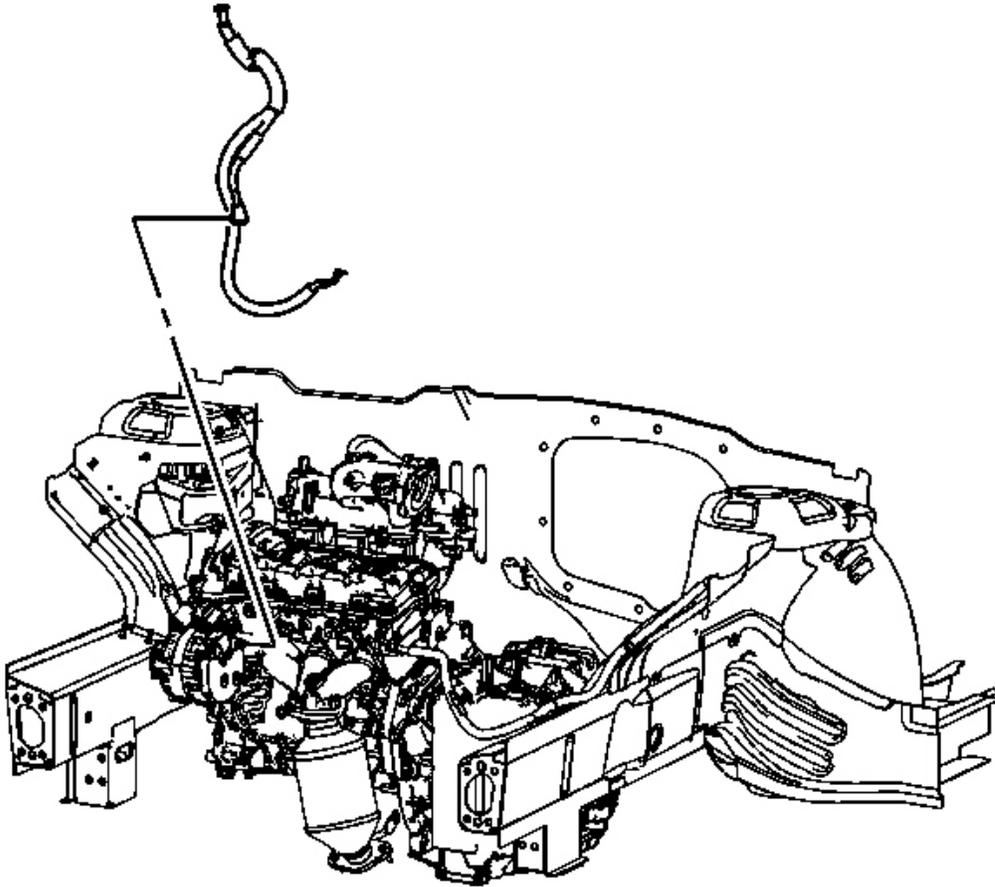
12. Remove the battery positive junction block cable clip (1) from the engine block.
13. Remove the starter solenoid BAT terminal nut (3).
14. Remove the battery positive junction block cable terminal (2) from the starter.



**Fig. 48: Identifying Battery Positive Junction Block Cable**  
Courtesy of GENERAL MOTORS CORP.

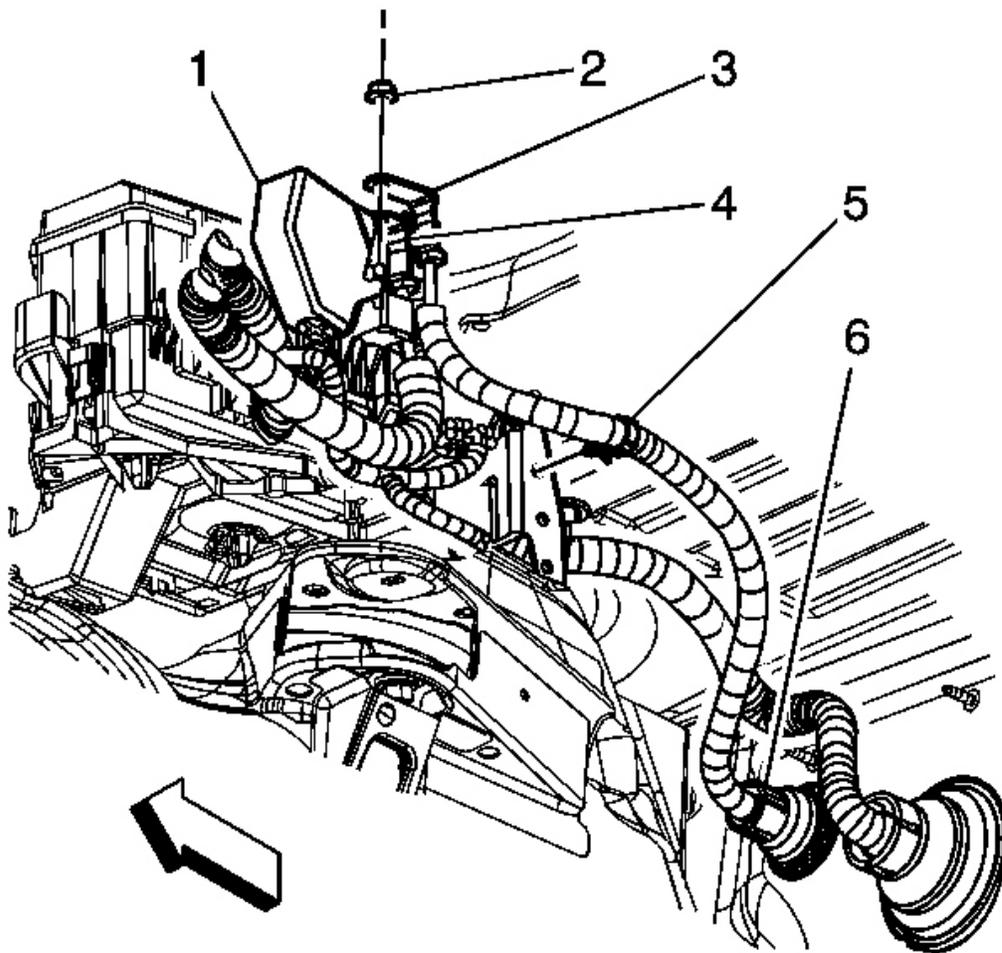
15. Lower the vehicle.
16. Remove the battery positive junction block cable from the vehicle.

**Installation Procedure**



**Fig. 49: Identifying Battery Positive Junction Block Cable**  
Courtesy of GENERAL MOTORS CORP.

1. Install the battery positive junction block cable to the vehicle.



**Fig. 50: Identifying Accessory Wiring Junction Block Cover & Nut**  
Courtesy of GENERAL MOTORS CORP.

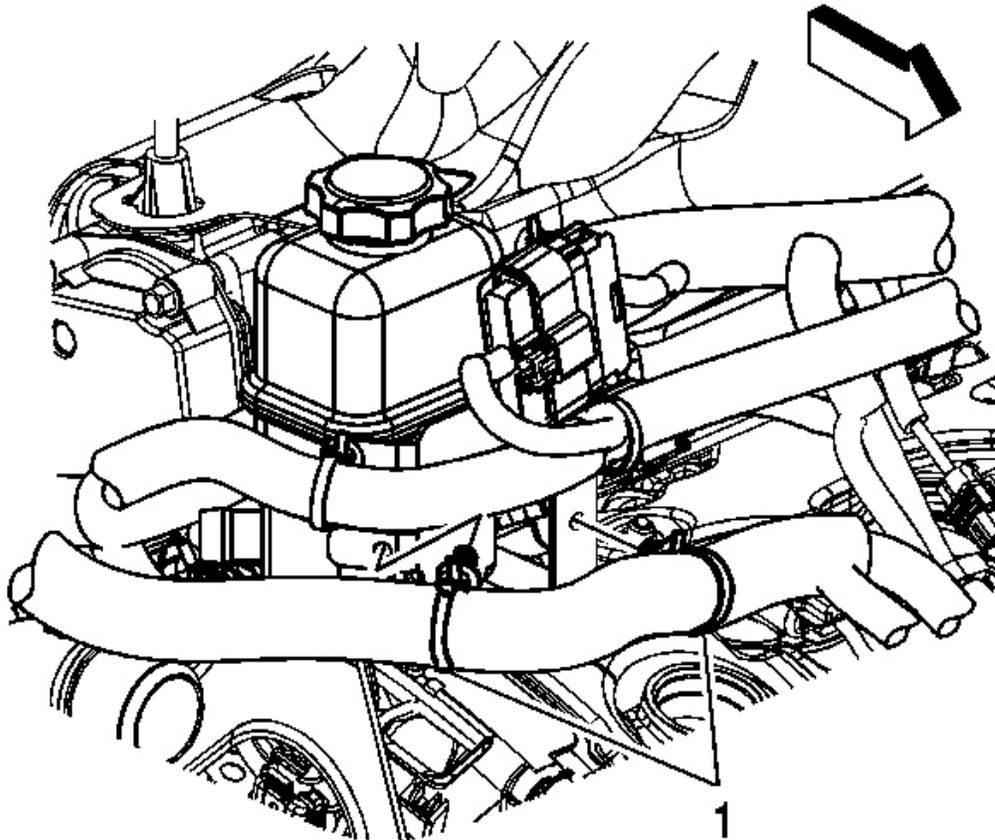
2. Install the battery positive junction block cable terminal (4) to the stud.
3. Install the positive battery cable terminal (3) to the junction block stud.

**NOTE:** Refer to Fastener Notice .

4. Install the accessory wiring junction block nut (2).

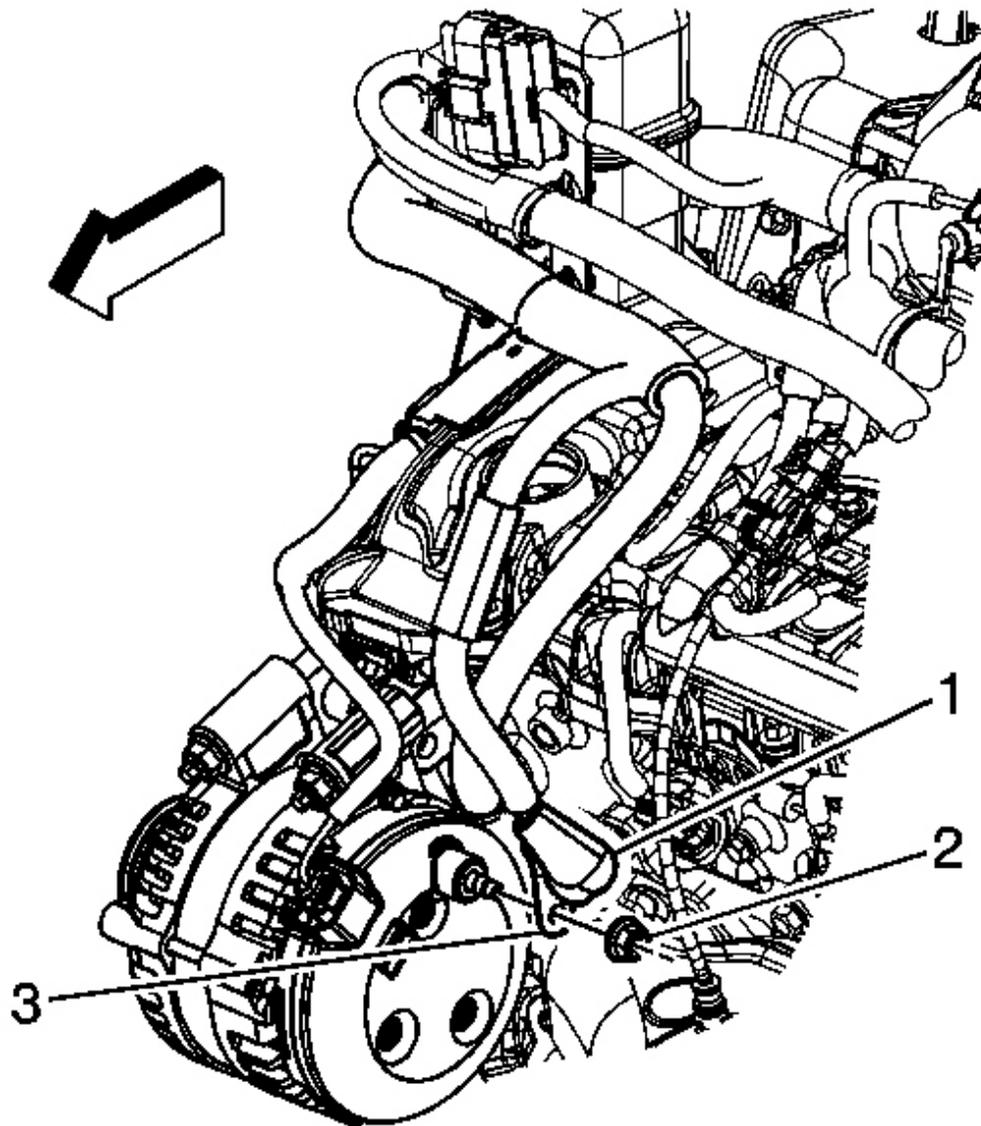
**Tighten:** Tighten the nut to 22 N.m (16 lb ft).

5. Close the accessory wiring junction block cover (1).



**Fig. 51: Identifying Battery Positive Junction Block Cable Clips**  
Courtesy of GENERAL MOTORS CORP.

6. Install the battery positive junction block cable clips (1) to the power steering reservoir bracket.

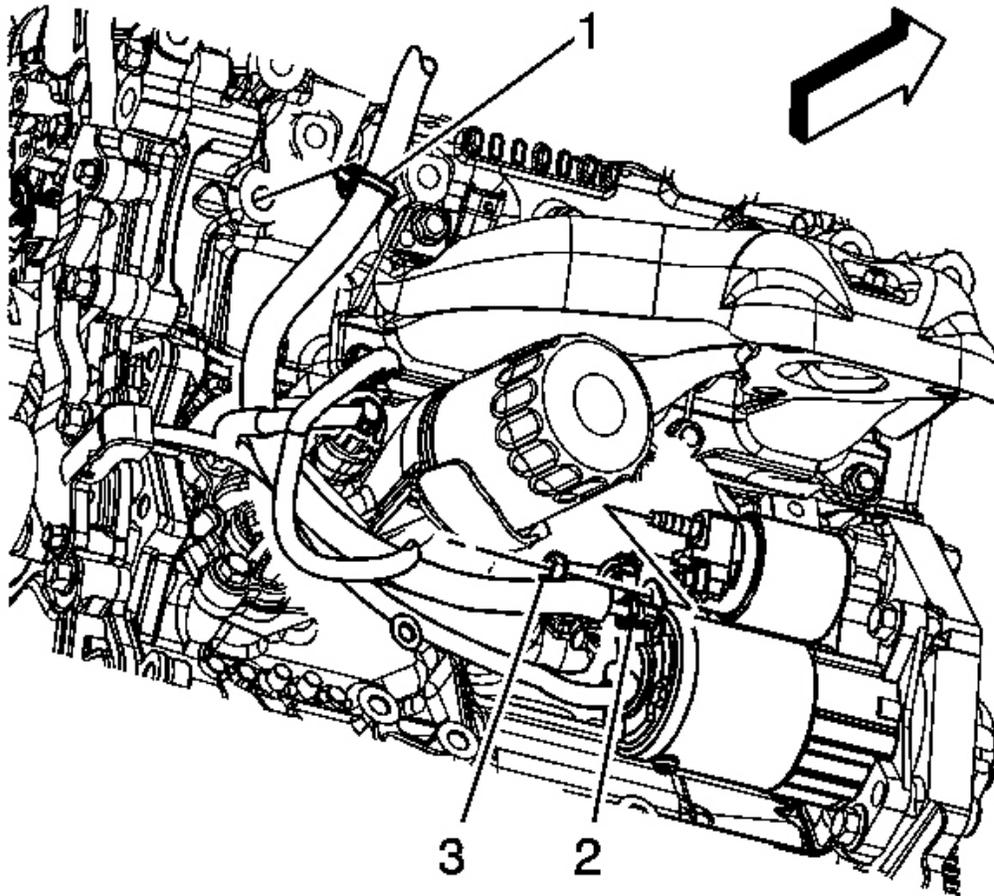


**Fig. 52: Identifying Battery Positive Junction Block Cable Boot & Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

7. Install the battery positive junction block cable terminal (3) to the generator stud.
8. Install the battery positive junction block cable to generator nut (3).

**Tighten:** Tighten the nut to 22 N.m (16 lb ft).

9. Position the battery positive junction block cable boot (1).
10. Raise and suitably support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

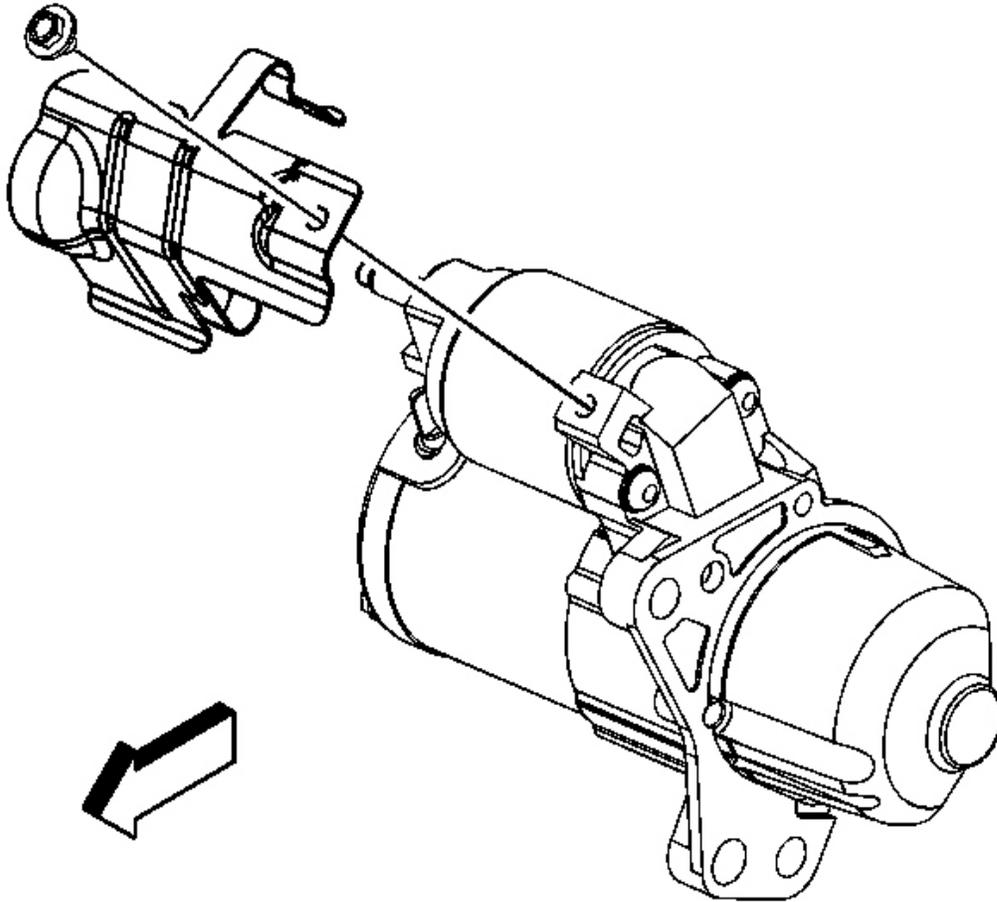


**Fig. 53: View Of Battery Positive Junction Block Cable Clip & Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

11. Install the battery positive junction block cable terminal (2) to the starter.
12. Install the starter solenoid BAT terminal nut (3).

**Tighten:** Tighten the nut to 25 N.m (18 lb ft).

13. Install the battery positive junction block cable clip (1) to the engine block.

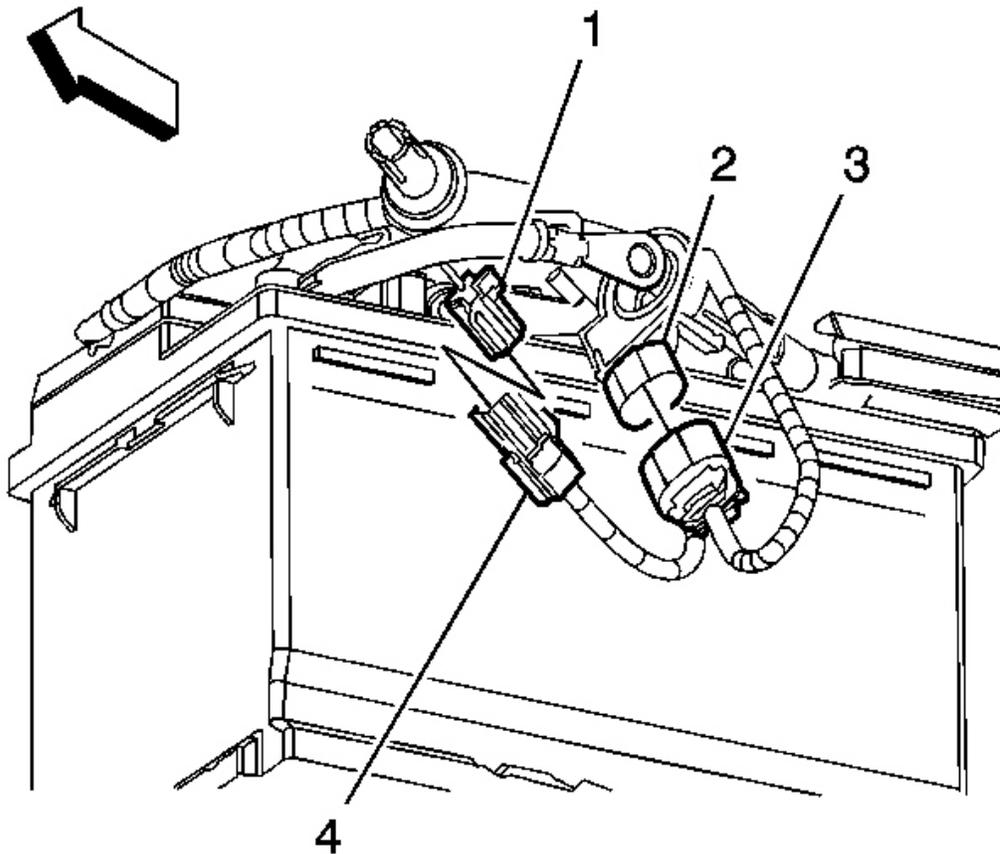


**Fig. 54: Identifying Starter Heat Shield Bolt & Shield**  
Courtesy of GENERAL MOTORS CORP.

14. Install the starter heat shield and bolt.

**Tighten:** Tighten the bolt to 7 N.m (62 lb in).

15. Install the left catalytic converter. Refer to **Catalytic Converter Replacement - Left Side**.
16. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and**

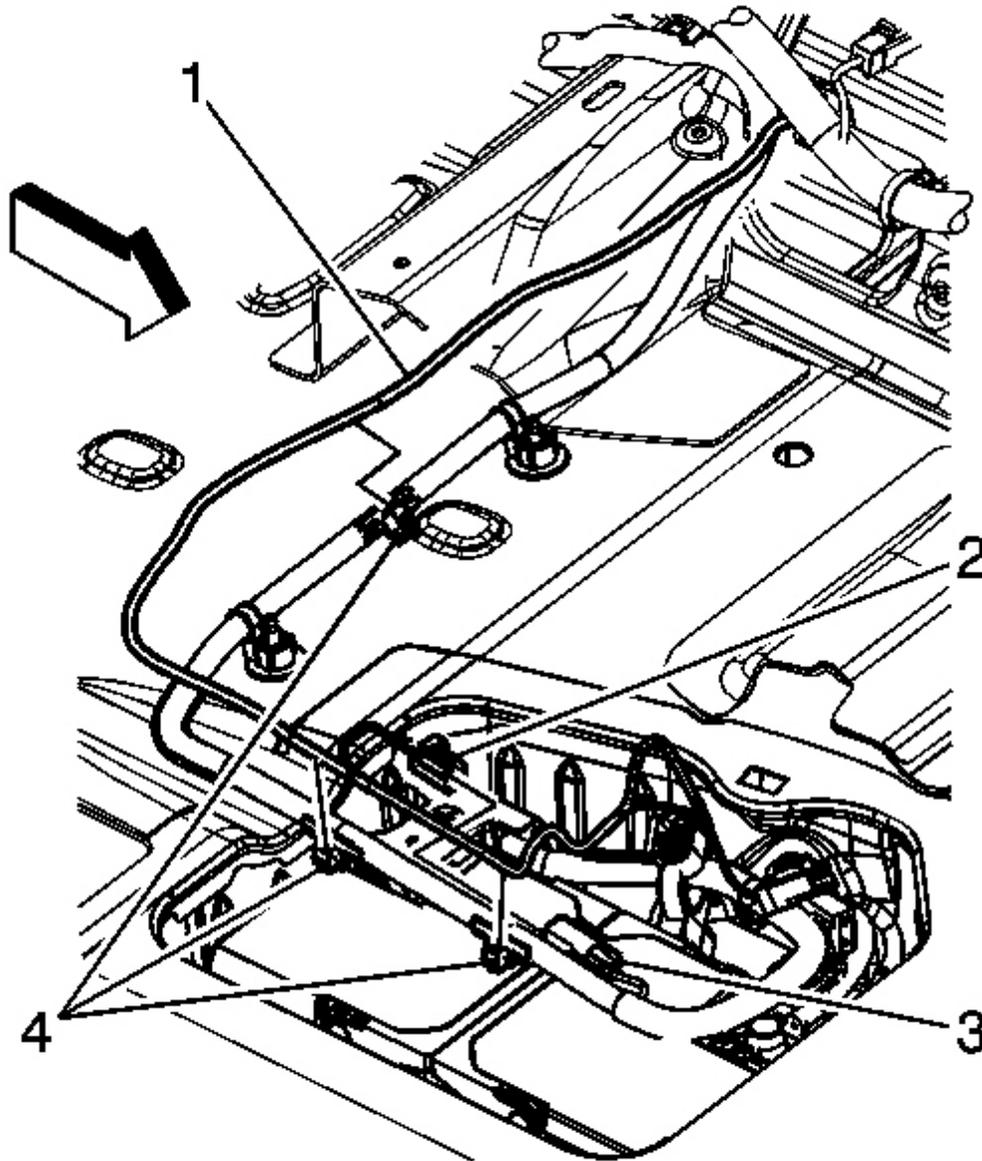
**Connection.****BATTERY REPLACEMENT****Removal Procedure**

**Fig. 55: Identifying Body Wiring Harness Connector & Negative Battery Cable Connector**

**Courtesy of GENERAL MOTORS CORP.**

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection.**
2. Disconnect the body wiring harness electrical connector (3) from the battery current sensor (2).

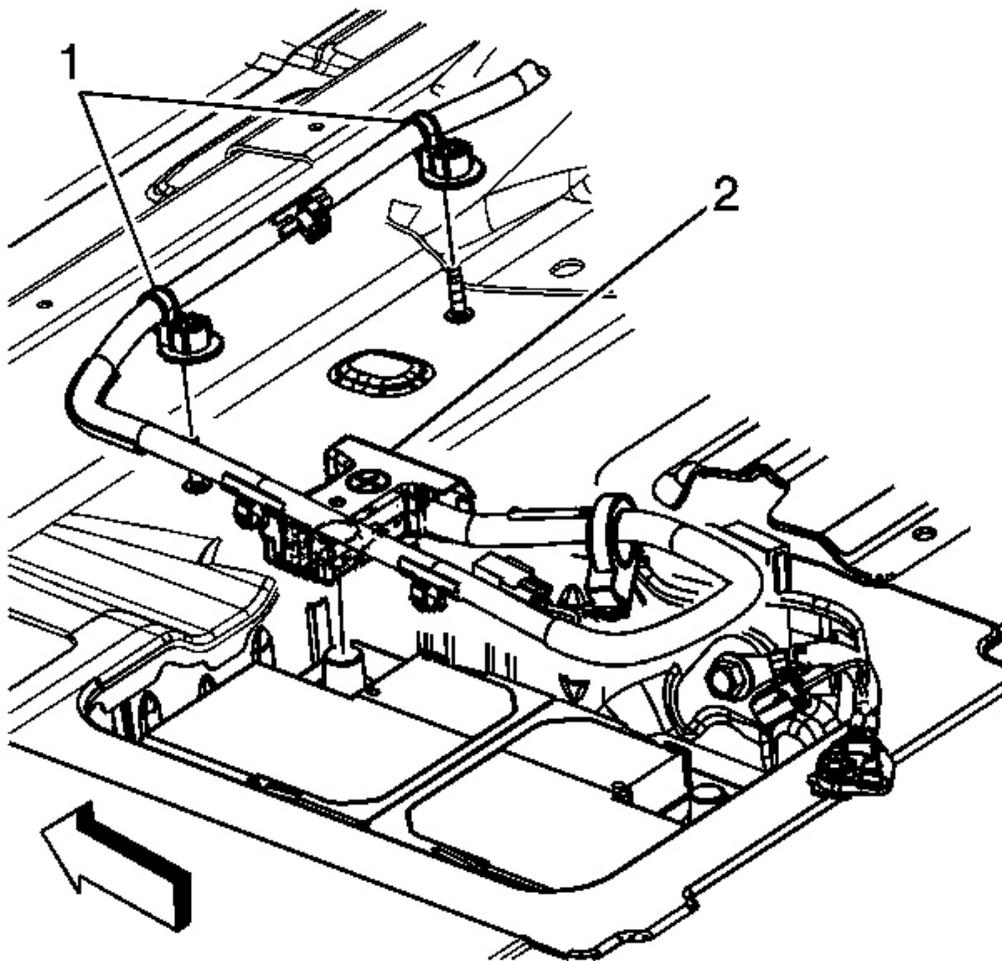
3. Disconnect the body wiring harness electrical connector (4) from the negative battery cable electrical connector (1).



**Fig. 56: Identifying Body Wiring Harness, Electrical Connector & Positive Battery Cable Clips**

Courtesy of GENERAL MOTORS CORP.

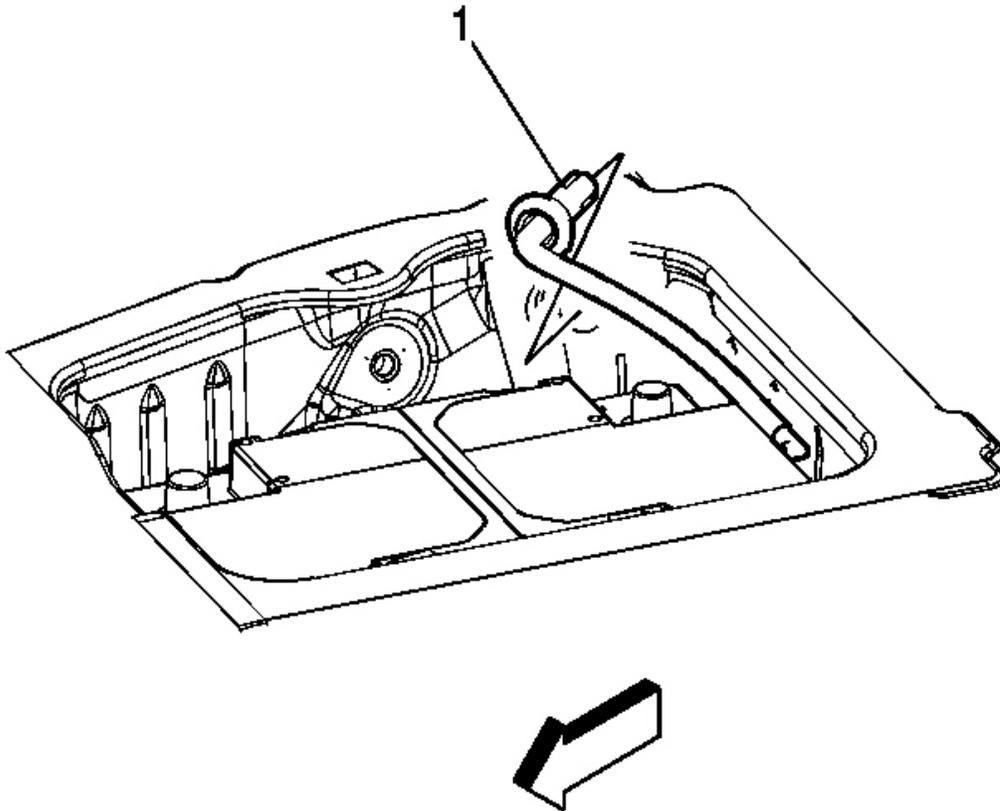
4. Disconnect the body wiring harness electrical connector (2) from the positive battery cable electrical connector (3).



**Fig. 57: View Of Positive Battery Cable Clips & Positive Battery Cable Cover**  
Courtesy of GENERAL MOTORS CORP.

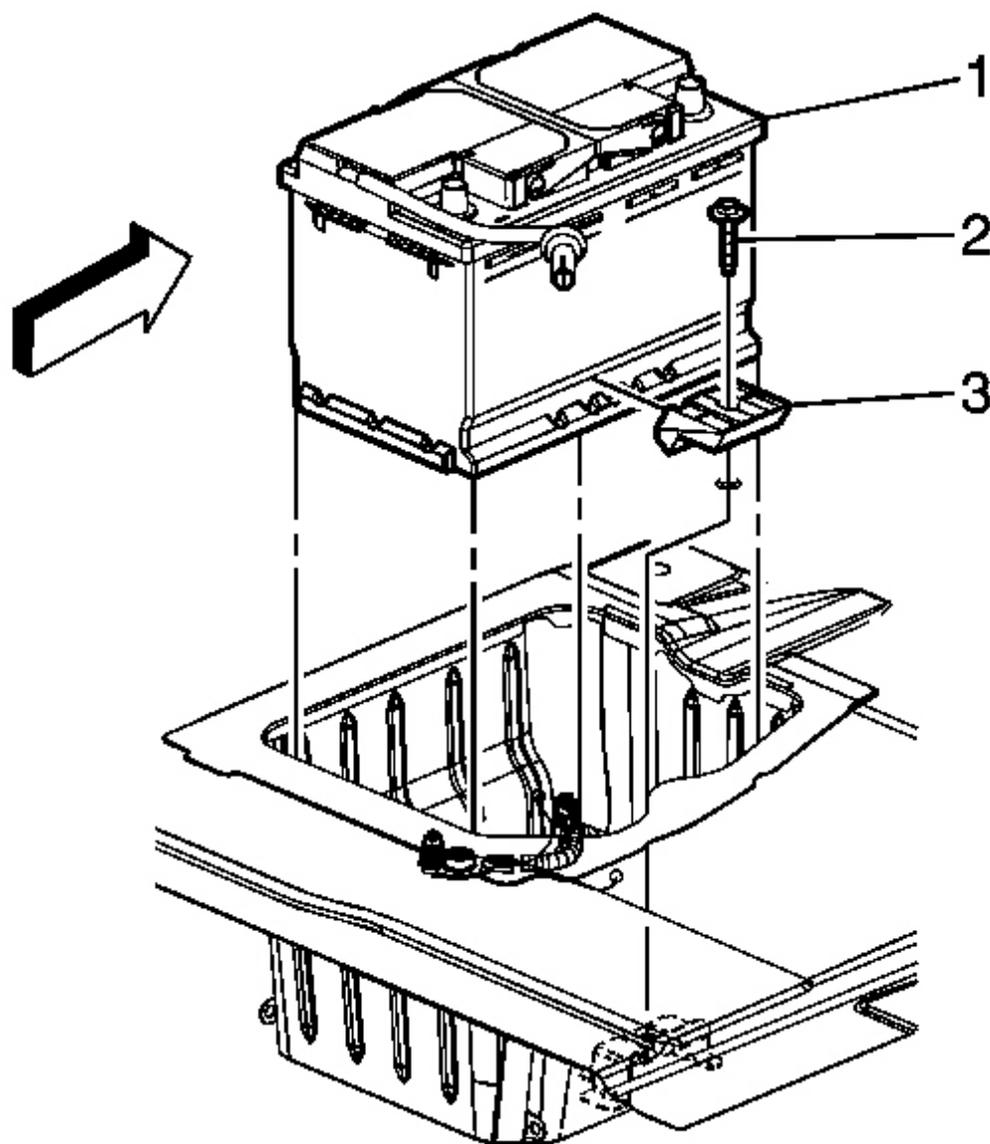
5. Open the positive battery cable cover (2).
6. Loosen the positive battery cable terminal nut.
7. Remove the positive battery cable terminal from the battery positive terminal and reposition

the cable out of the way.



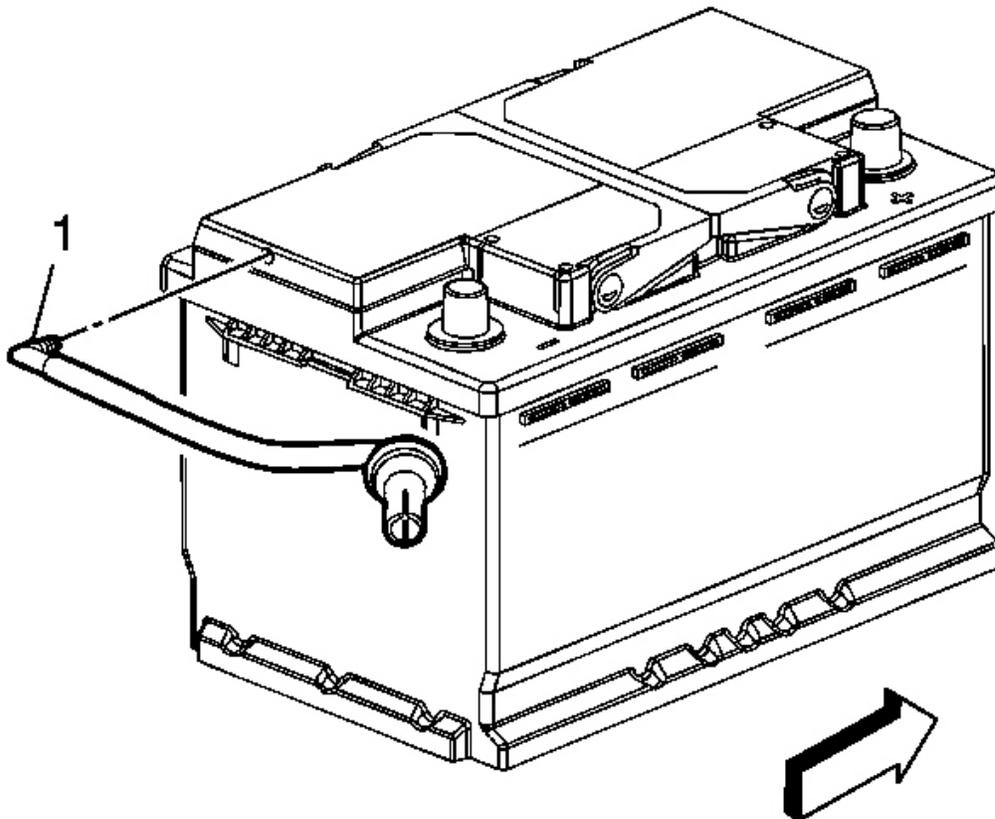
**Fig. 58: Identifying Battery Vent Hose Grommet**  
**Courtesy of GENERAL MOTORS CORP.**

8. Remove the battery vent hose grommet (1) from the battery box.



**Fig. 59: View Of Battery, Battery Hold Down & Bolt**  
**Courtesy of GENERAL MOTORS CORP.**

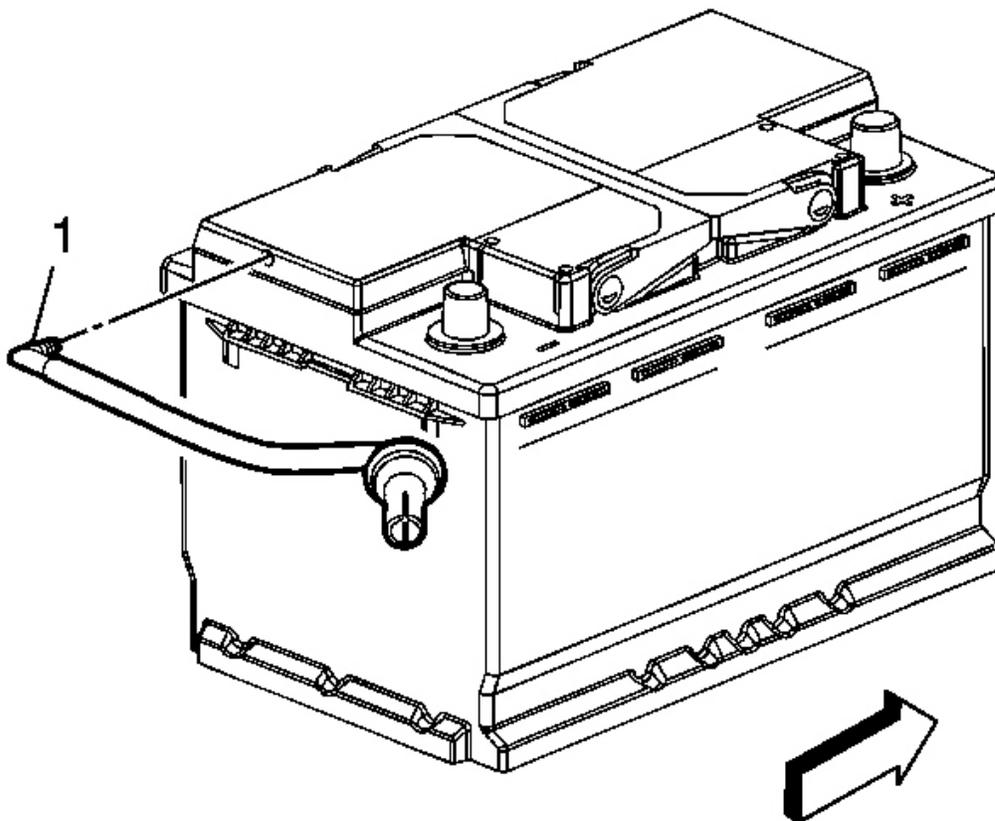
9. Remove the battery hold down bolt (2).
10. Remove the battery hold down (3).
11. Remove the battery (1).



**Fig. 60: Identifying Battery Vent Hose**  
**Courtesy of GENERAL MOTORS CORP.**

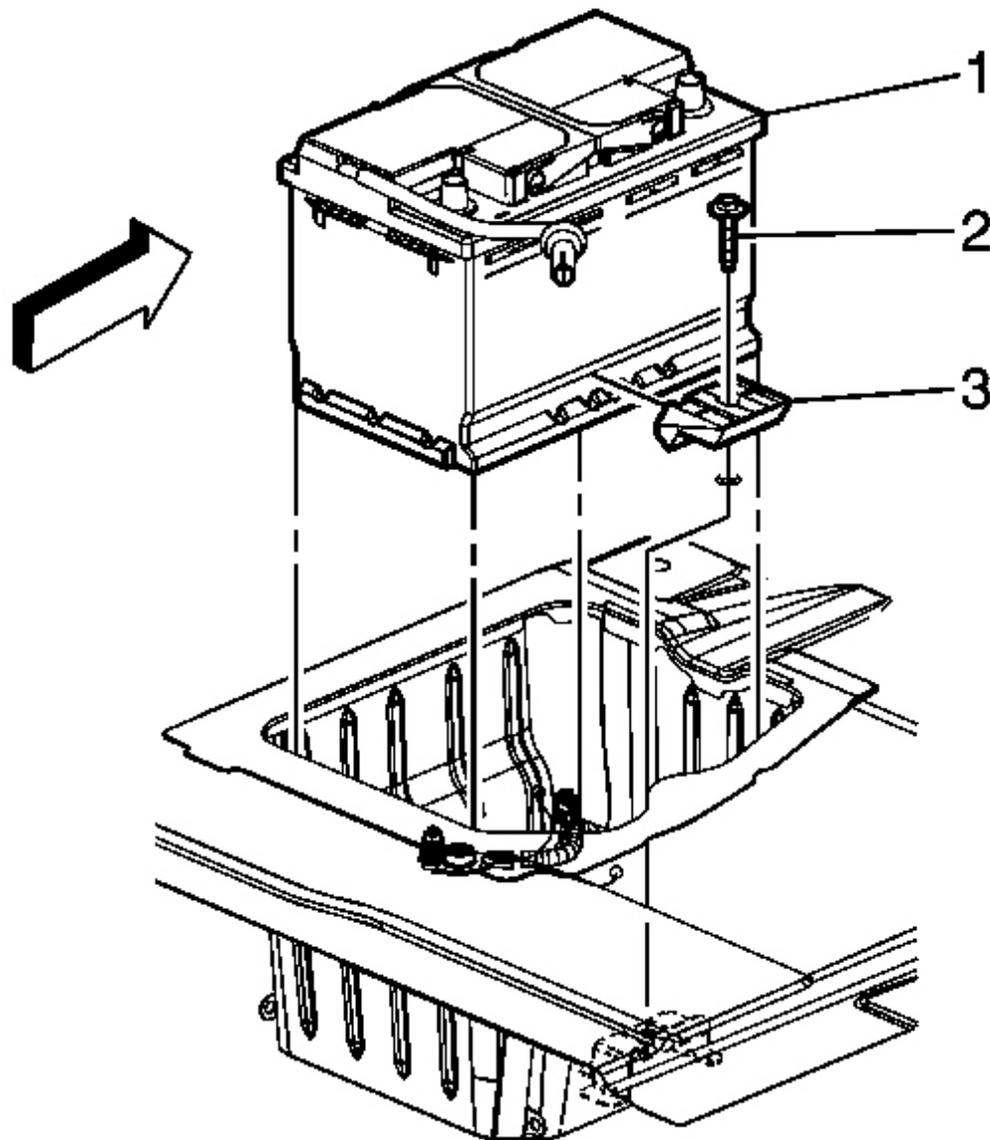
12. Remove the battery vent hose from the battery, if required.

**Installation Procedure**



**Fig. 61: Identifying Battery Vent Hose**  
Courtesy of GENERAL MOTORS CORP.

1. Install the battery vent hose to the battery, if required.



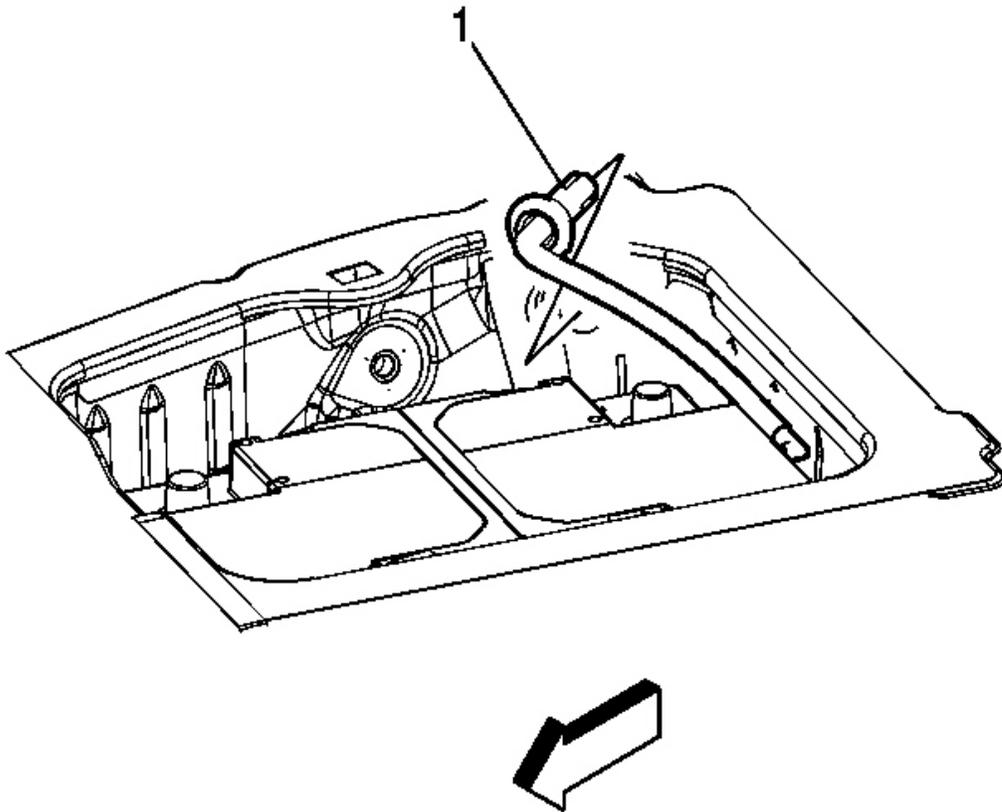
**Fig. 62: View Of Battery, Battery Hold Down & Bolt**  
Courtesy of GENERAL MOTORS CORP.

2. Install the battery (1) into the battery box.
3. Install the battery hold down (3).

**NOTE:** Refer to Fastener Notice .

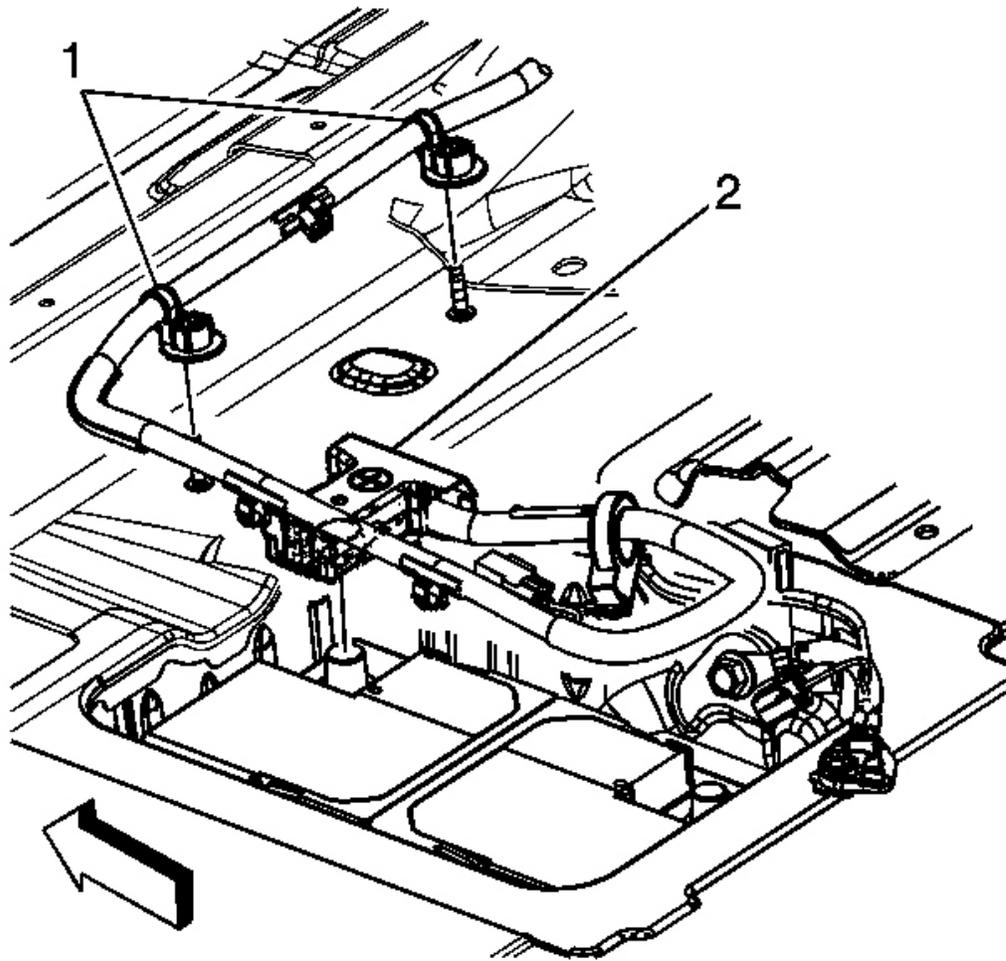
4. Install the battery hold down bolt (2).

**Tighten:** Tighten the bolt to 25 N.m (18 lb ft).



**Fig. 63: Identifying Battery Vent Hose Grommet**  
**Courtesy of GENERAL MOTORS CORP.**

5. Install the battery vent hose grommet (1) to the battery box.

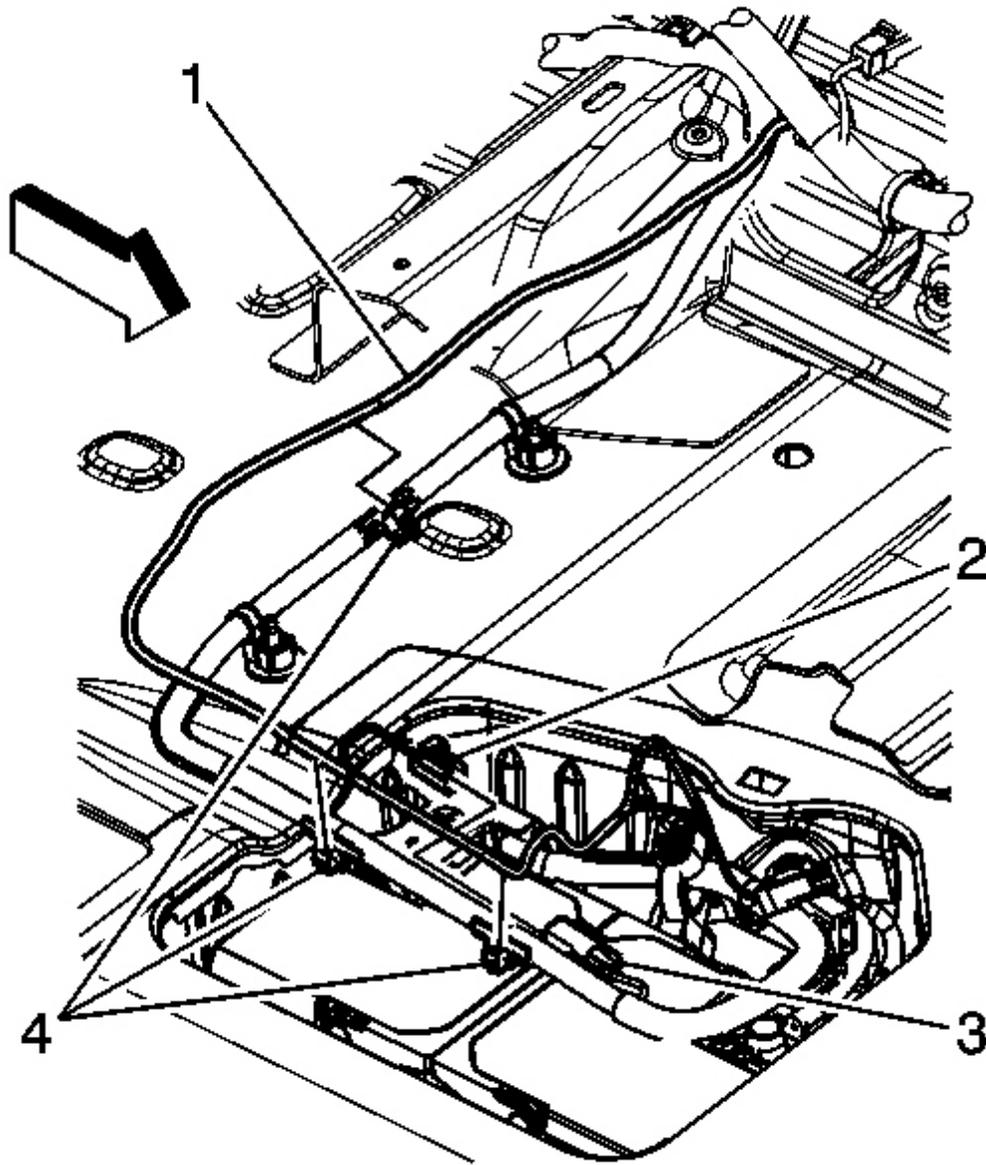


**Fig. 64: View Of Positive Battery Cable Clips & Positive Battery Cable Cover**  
Courtesy of GENERAL MOTORS CORP.

6. Position the positive battery cable and Install the cable terminal to the battery positive terminal.
7. Tighten the positive battery cable terminal nut.

**Tighten:** Tighten the nut to 9 N.m (80 lb in).

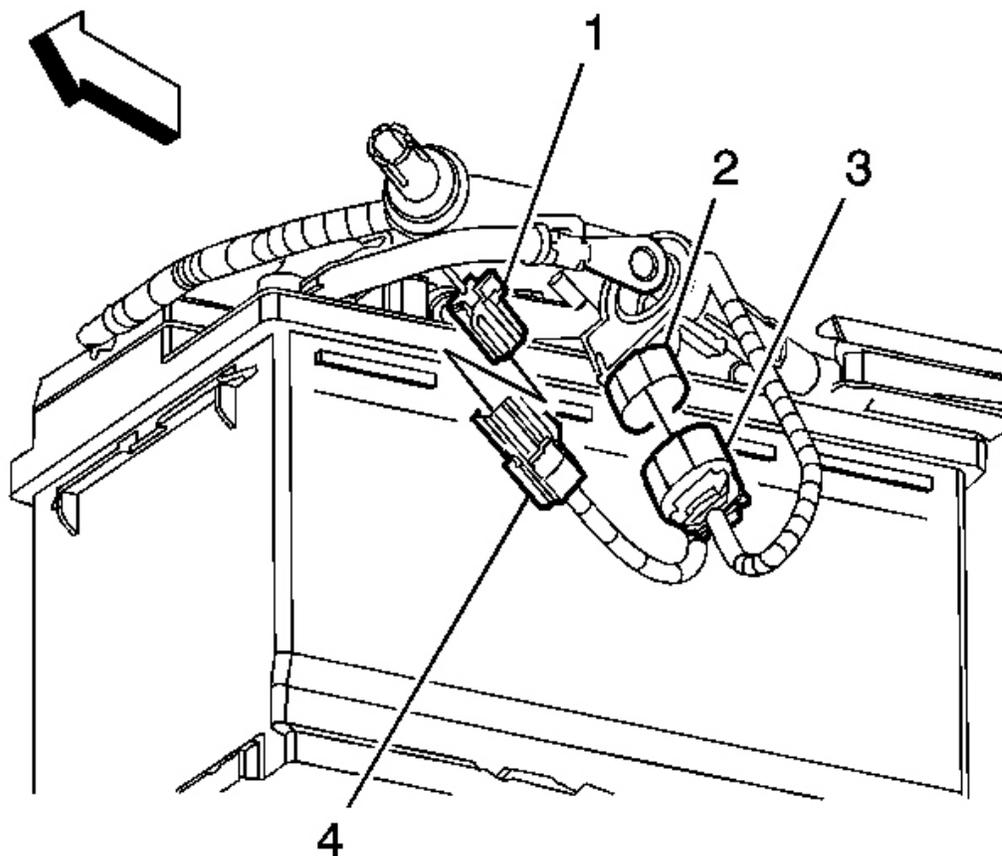
8. Close the positive battery cable cover (2).



**Fig. 65: Identifying Body Wiring Harness, Electrical Connector & Positive Battery Cable Clips**

Courtesy of GENERAL MOTORS CORP.

9. Connect the body wiring harness electrical connector (2) to the positive battery cable electrical connector (3).



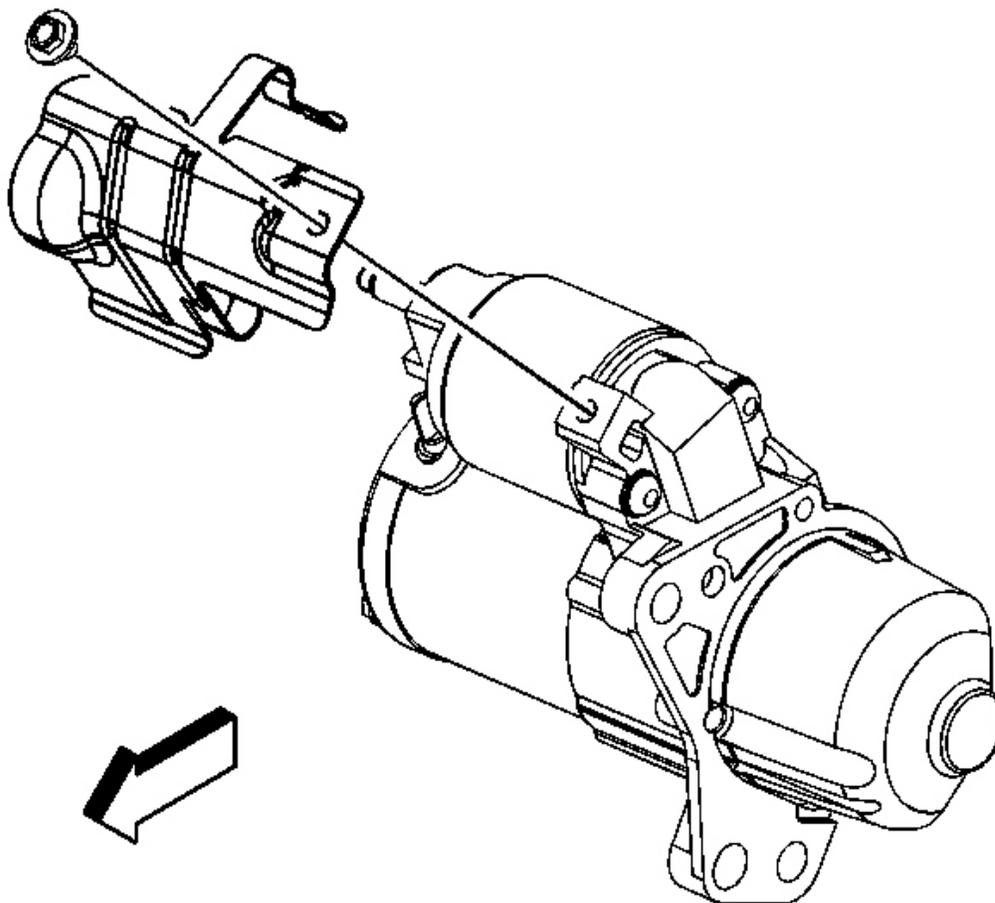
**Fig. 66: Identifying Body Wiring Harness Connector & Negative Battery Cable Connector**

Courtesy of GENERAL MOTORS CORP.

10. Connect the body wiring harness electrical connector (4) to the negative battery cable electrical connector (1).
11. Connect the body wiring harness electrical connector (3) to the battery current sensor (2).
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

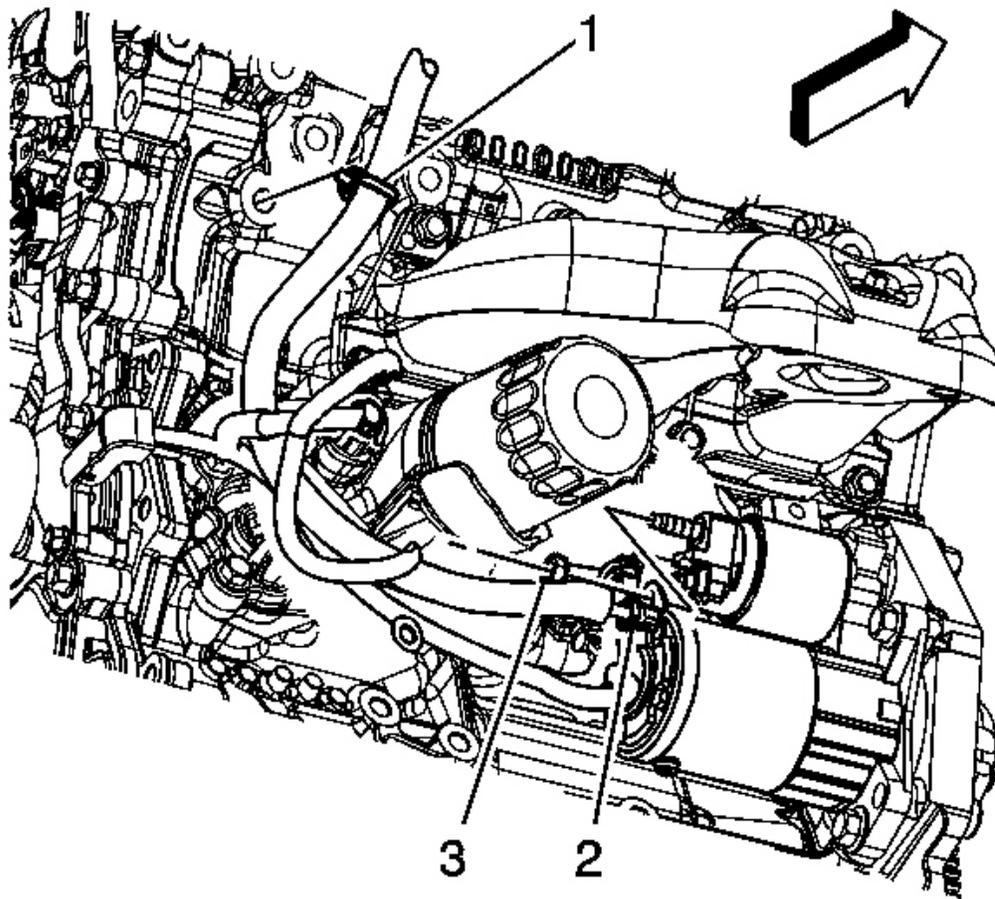
## STARTER MOTOR REPLACEMENT

### Removal Procedure



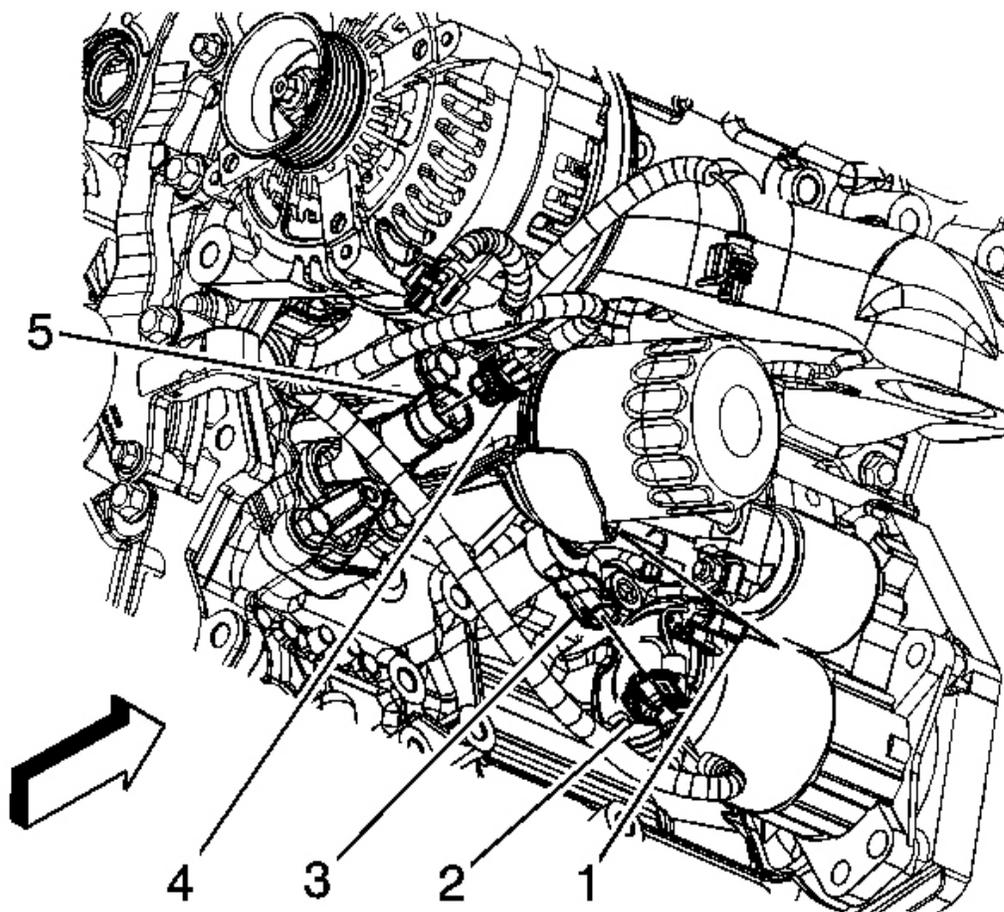
**Fig. 67: Identifying Starter Heat Shield Bolt & Shield**  
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the left catalytic convertor. Refer to **Catalytic Converter Replacement - Left Side**.
3. Remove the starter heat shield bolt and shield.



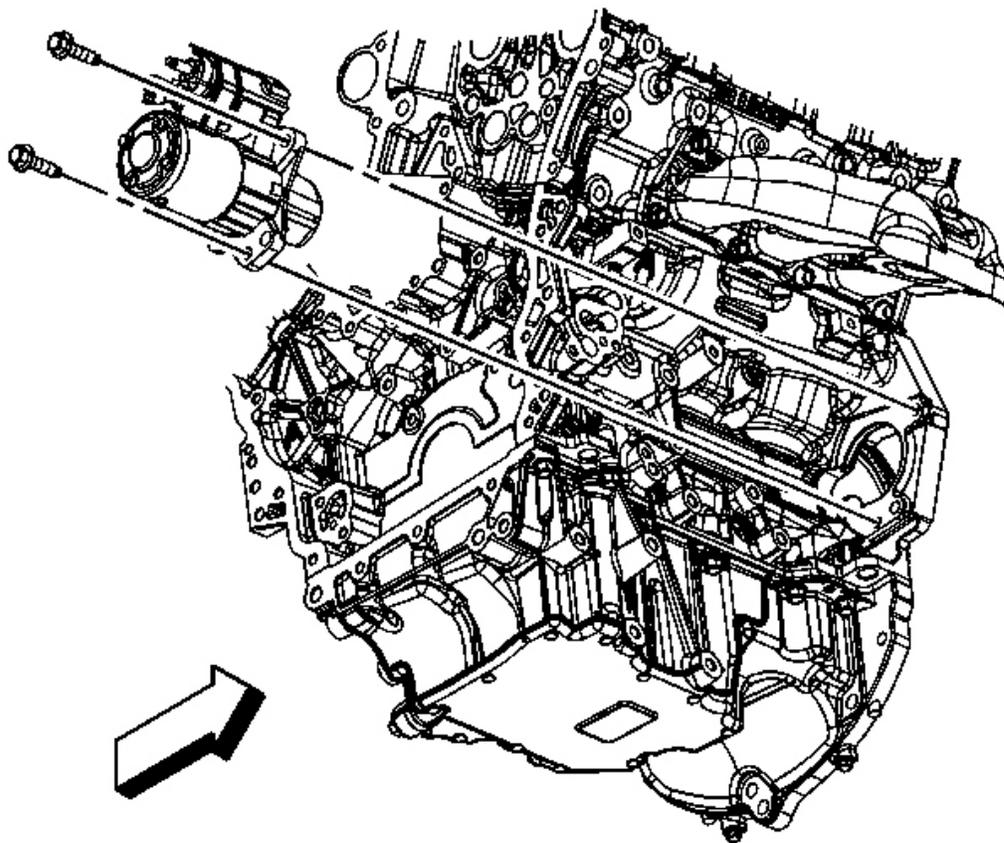
**Fig. 68: View Of Battery Positive Junction Block Cable Clip & Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

4. Remove the starter solenoid BAT terminal nut (3).
5. Remove the battery positive junction block cable terminal (2) from the starter.



**Fig. 69: Identifying Engine Wiring Harness Electrical Connector**  
Courtesy of GENERAL MOTORS CORP.

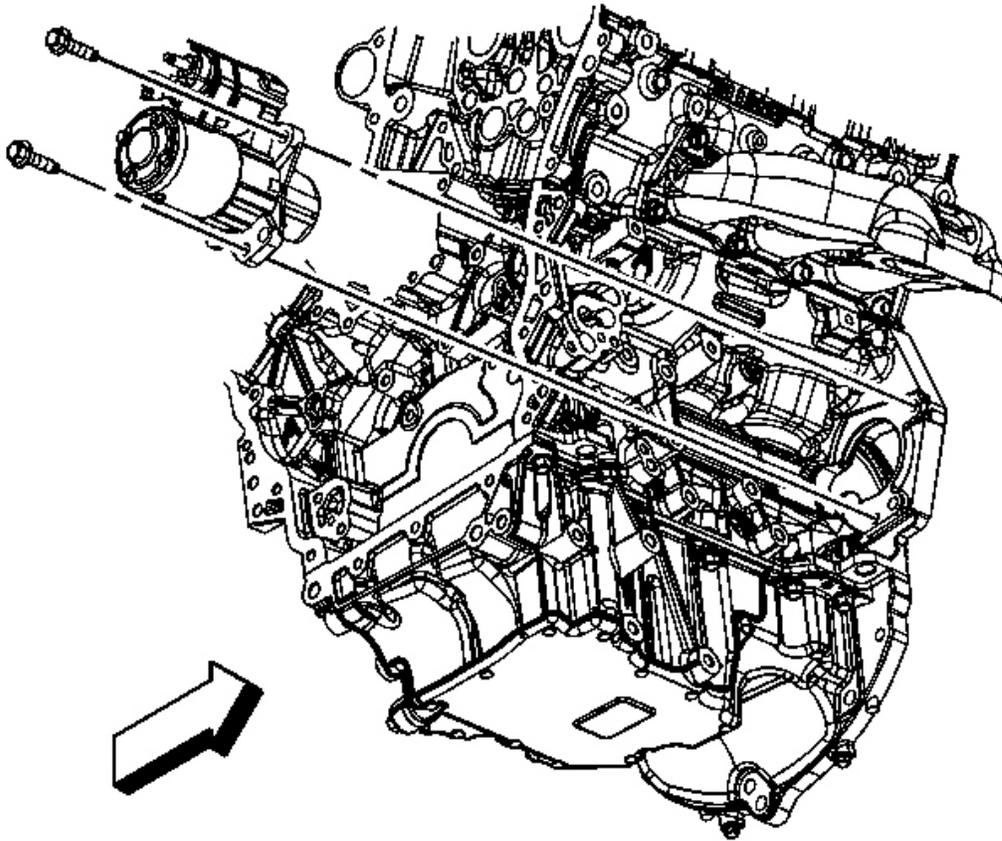
6. Disconnect the engine wiring harness electrical connector (1) from the starter.



**Fig. 70: View Of Starter Bolts & Starter**  
**Courtesy of GENERAL MOTORS CORP.**

7. Remove the starter bolts and starter.

**Installation Procedure**

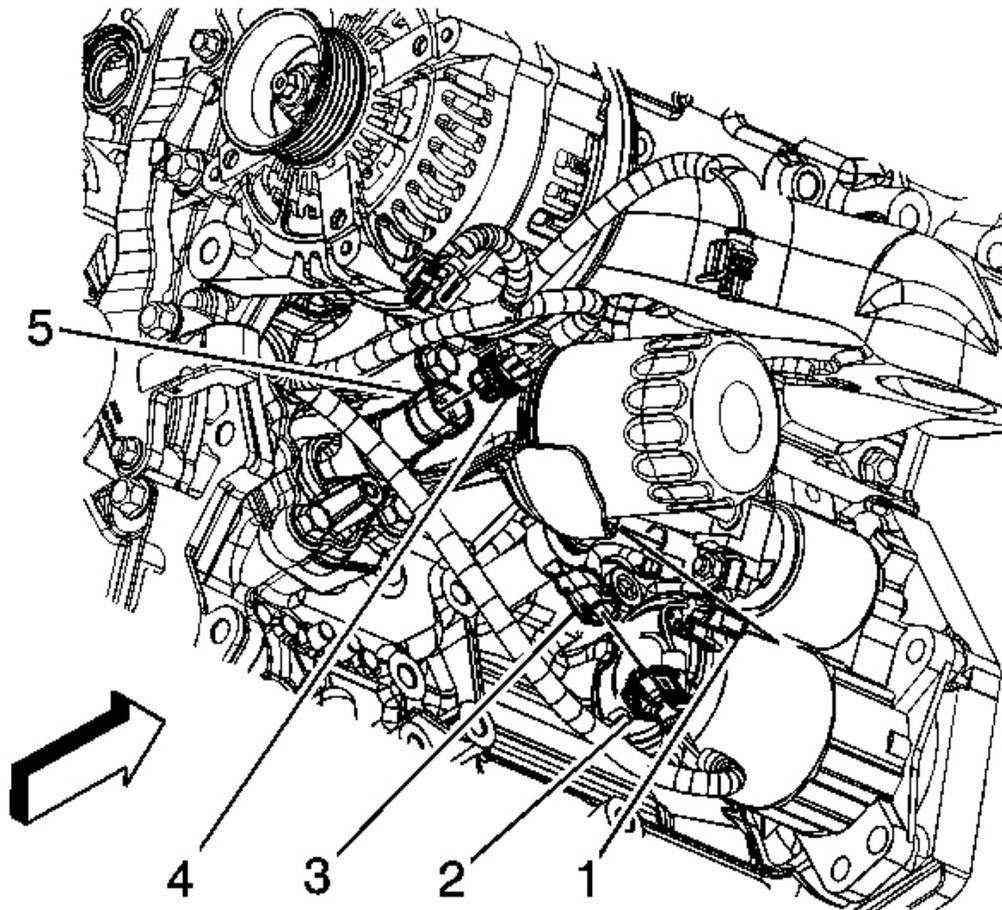


**Fig. 71: View Of Starter Bolts & Starter**  
Courtesy of GENERAL MOTORS CORP.

**NOTE:** Refer to Fastener Notice .

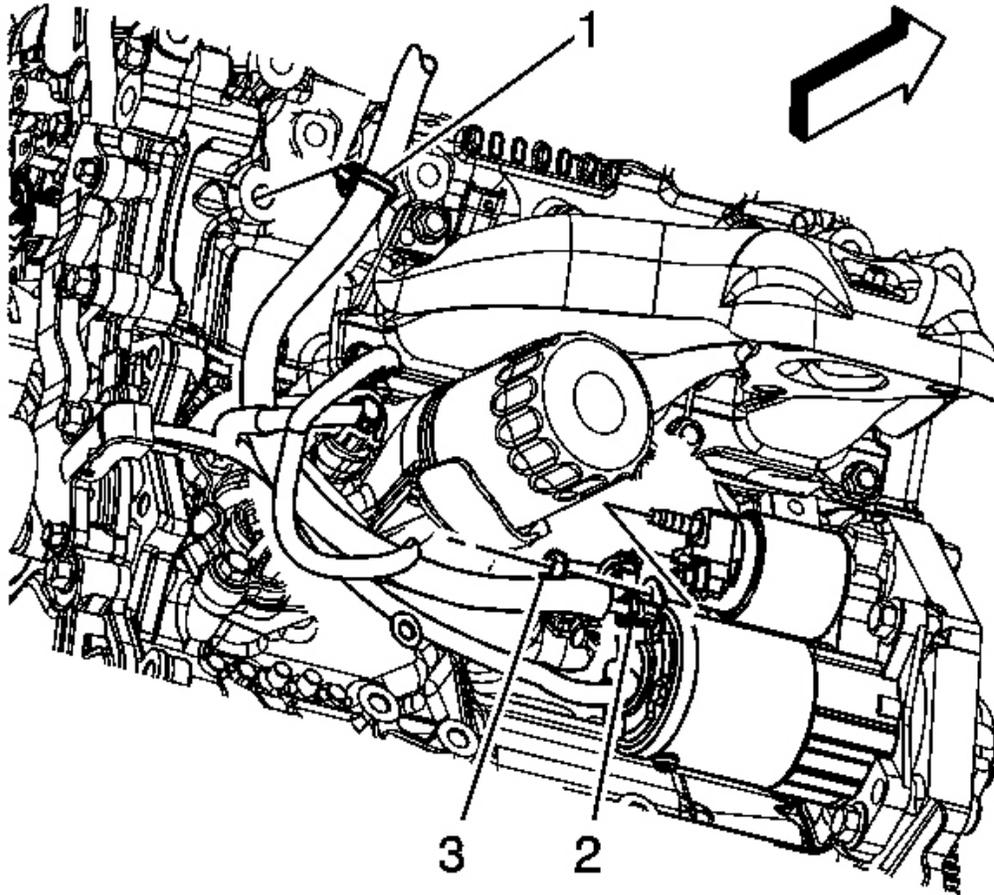
1. Install the starter and bolts.

**Tighten:** Tighten the bolts to 50 N.m (37 lb ft).



**Fig. 72: Identifying Engine Wiring Harness Electrical Connector**  
Courtesy of GENERAL MOTORS CORP.

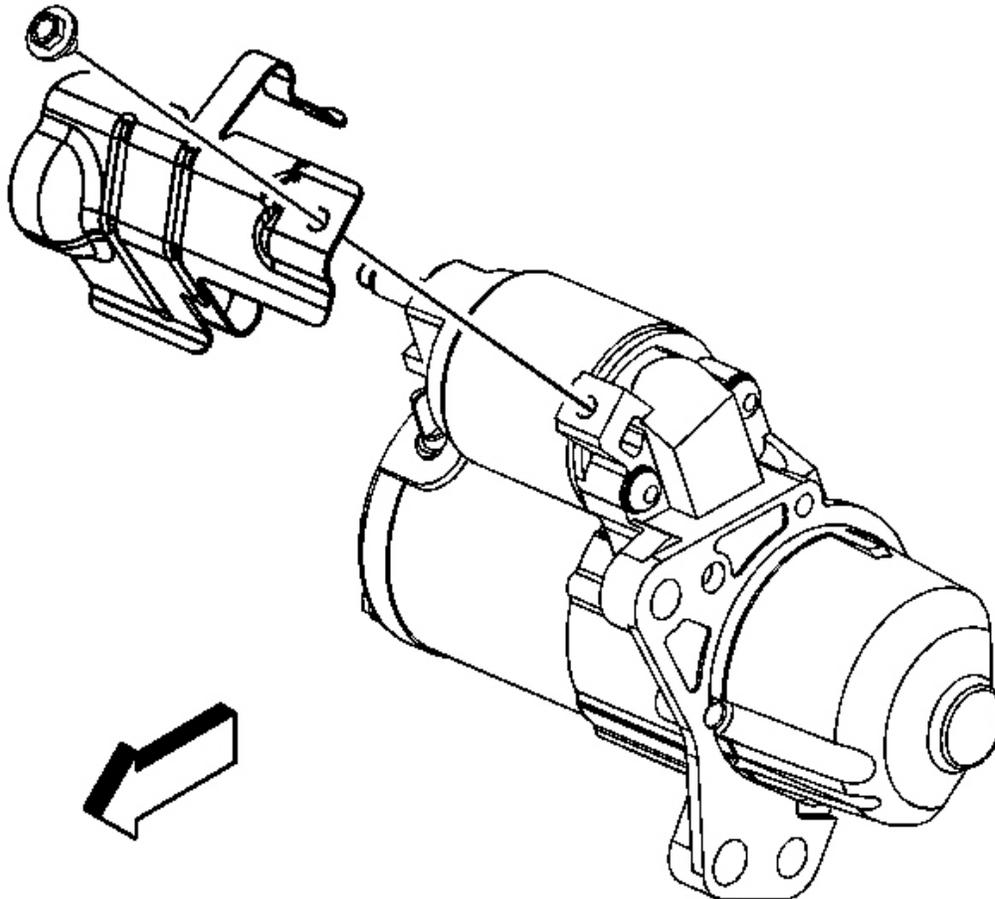
2. Connect the engine wiring harness electrical connector (1) to the starter.



**Fig. 73: View Of Battery Positive Junction Block Cable Clip & Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

3. Install the battery positive junction block cable terminal (2) to the starter.
4. Install the starter solenoid BAT terminal nut (3).

**Tighten:** Tighten the nut to 25 N.m (18 lb ft).



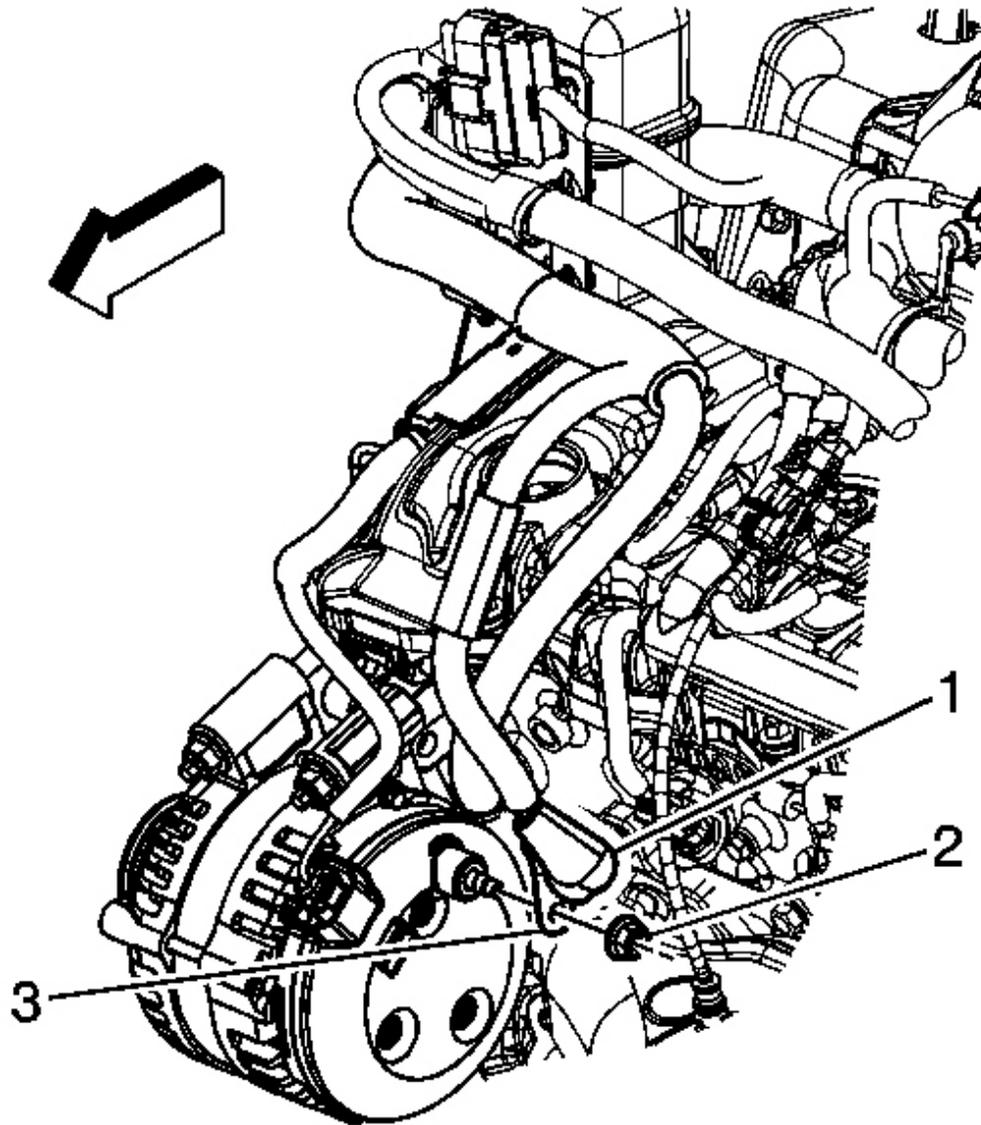
**Fig. 74: Identifying Starter Heat Shield Bolt & Shield**  
Courtesy of GENERAL MOTORS CORP.

5. Install the starter heat shield and bolt.

**Tighten:** Tighten the bolt to 7 N.m (62 lb in).

6. Install the left catalytic convertor. Refer to **Catalytic Converter Replacement - Left Side**.
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

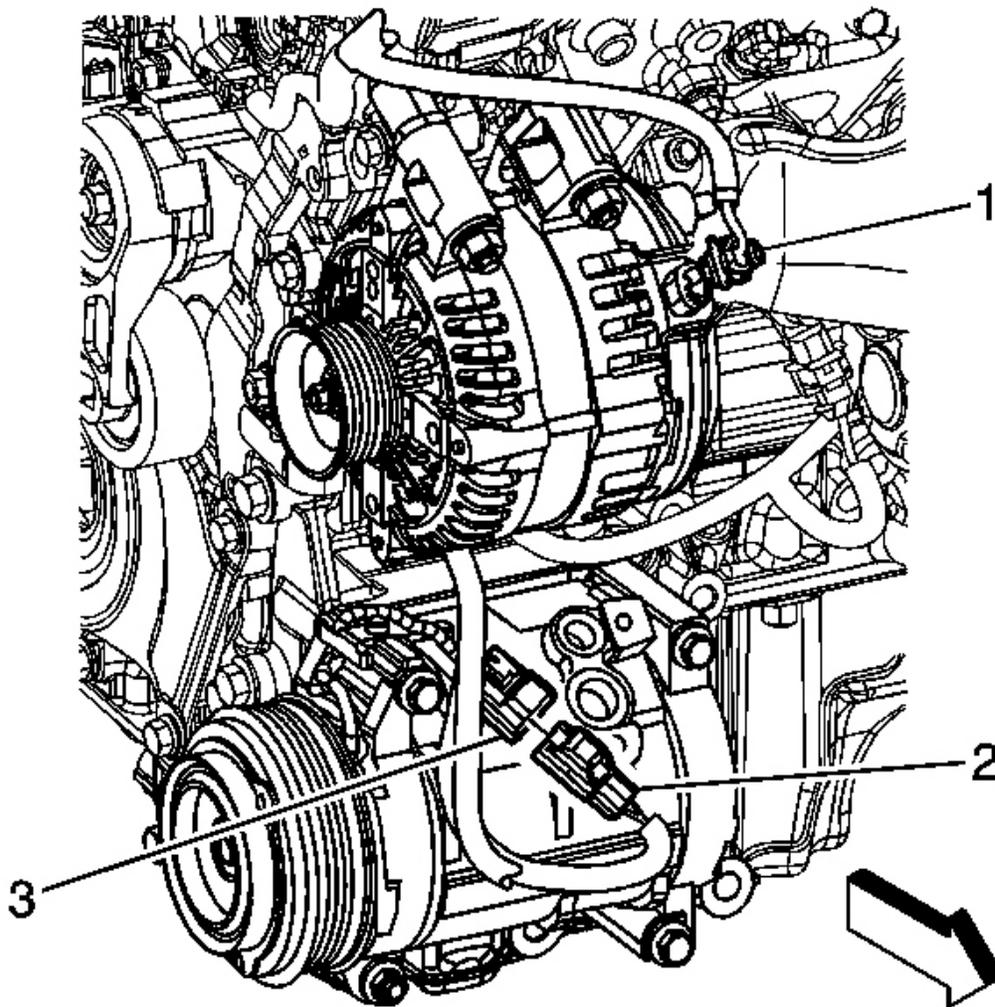
Removal Procedure



**Fig. 75: Identifying Battery Positive Junction Block Cable Boot & Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

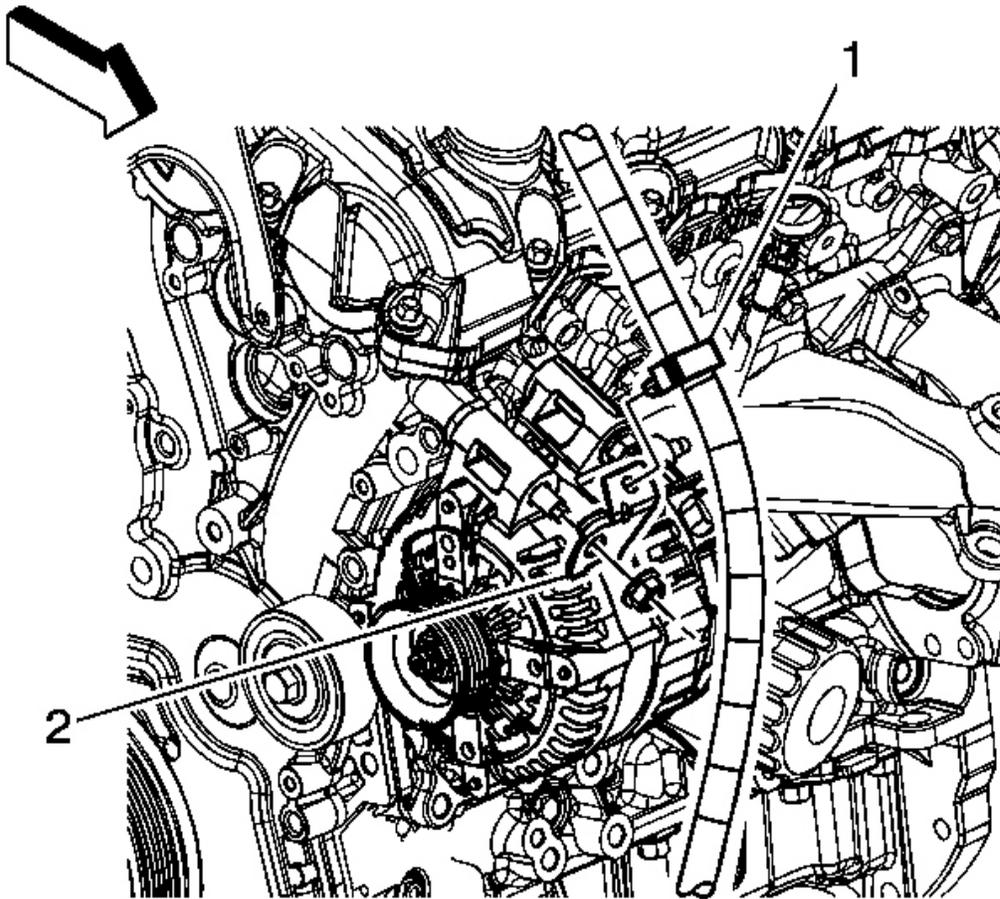
1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

2. Remove the drive belt. Refer to **Drive Belt Replacement** .
3. Reposition the battery positive junction block cable boot (1).
4. Remove the battery positive junction block cable to generator nut (2).
5. Remove the battery positive junction block cable terminal (3) from the generator stud.



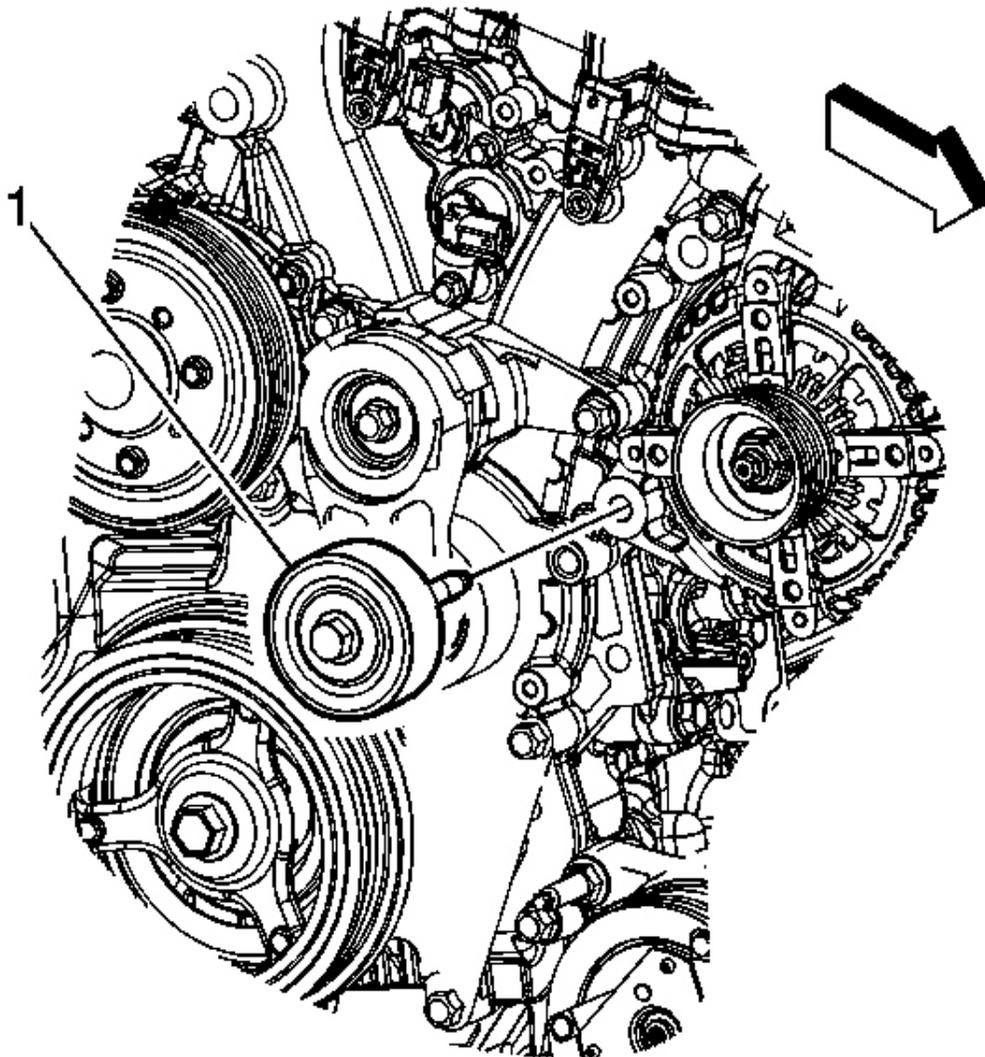
**Fig. 76: View Of Engine Wiring Harness Electrical Connector**  
Courtesy of GENERAL MOTORS CORP.

6. Disconnect the engine wiring harness electrical connector (1) from the generator.



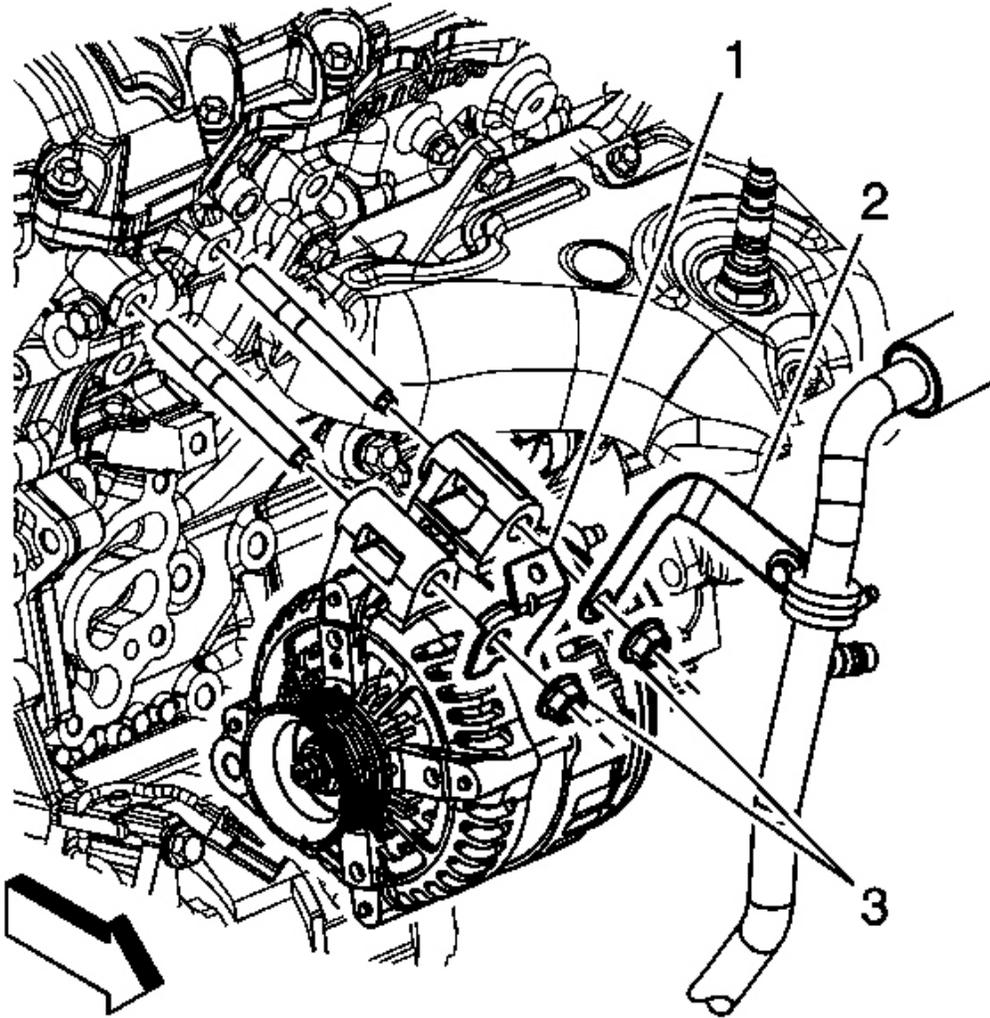
**Fig. 77: Identifying Power Steering Reservoir Inlet Hose Clip & Hose Clip Bracket**  
Courtesy of GENERAL MOTORS CORP.

7. Remove the power steering reservoir inlet hose clip (1) from the power steering fluid reservoir hose clip bracket (2).



**Fig. 78: Identifying Idler Pulley Bolt**  
Courtesy of GENERAL MOTORS CORP.

8. Loosen the idler pulley bolt (1) and slide the pulley out as far as possible.

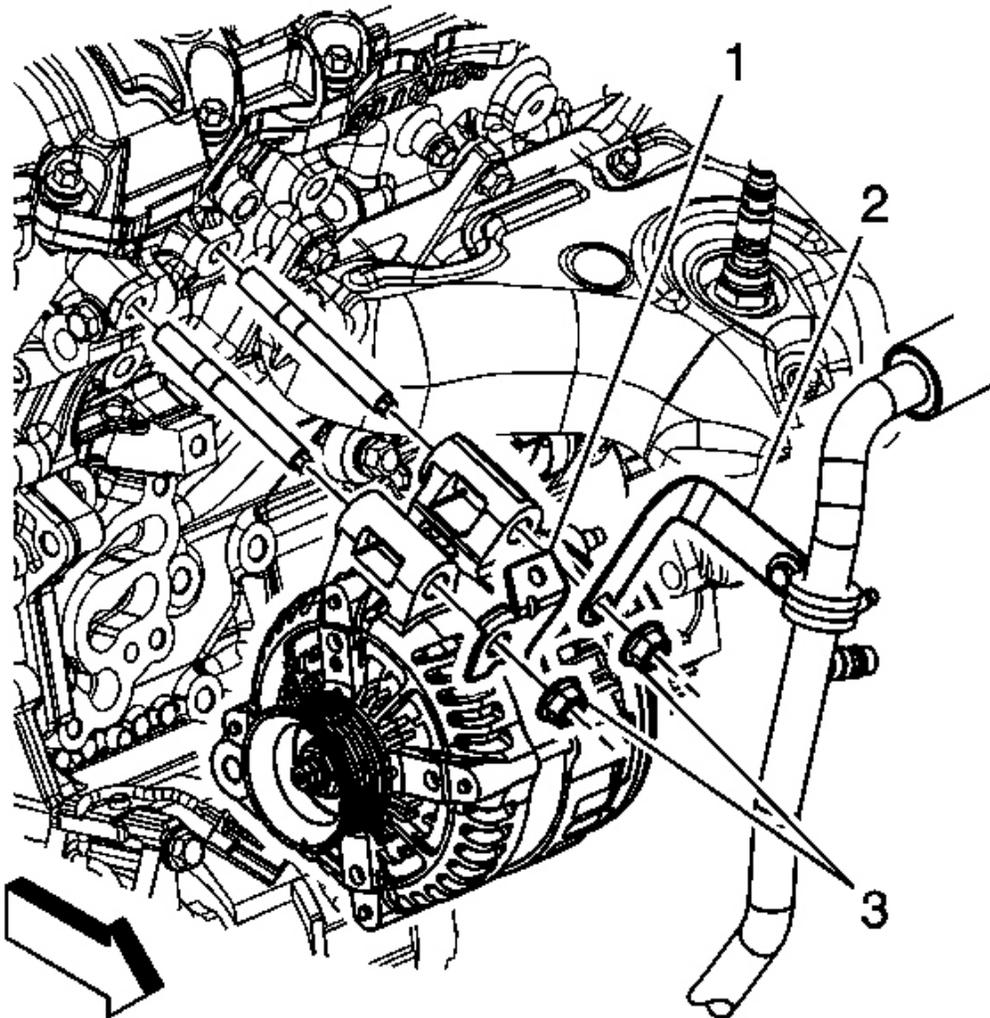


**Fig. 79: View Of Generator Nuts, A/C Compressor/Evaporator Hose Bracket & P/S Fluid Reservoir Hose Clip Bracket**  
Courtesy of GENERAL MOTORS CORP.

9. Remove the generator nuts (3).
10. Remove the air conditioning (A/C) compressor/evaporator hose bracket (2) from the left generator stud.
11. Remove the power steering fluid reservoir hose clip bracket (1) from the right generator stud.

12. Remove the generator and idler pulley together from the vehicle.
13. Remove the idler pulley from the generator.

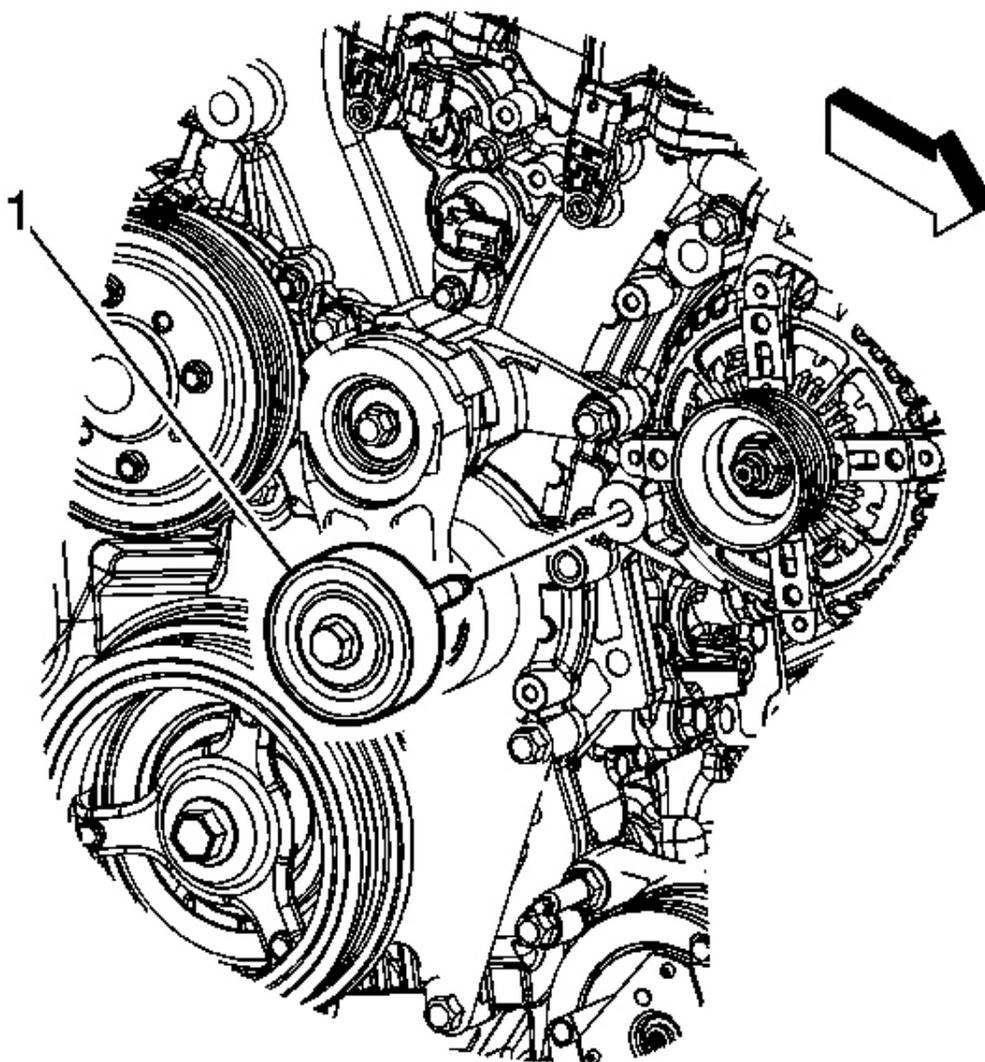
**Installation Procedure**



**Fig. 80: View Of Generator Nuts, A/C Compressor/Evaporator Hose Bracket & P/S Fluid Reservoir Hose Clip Bracket**  
Courtesy of GENERAL MOTORS CORP.

1. Install the idler pulley to the generator.

2. Install the generator and idler pulley together to the vehicle.
3. Install the generator onto the studs.
4. Install the power steering fluid reservoir hose clip bracket (1) to the left generator stud.
5. Install the A/C compressor/evaporator hose bracket (2) to the right generator stud.
6. Install the generator nuts (3) finger tight.



**Fig. 81: Identifying Idler Pulley Bolt**

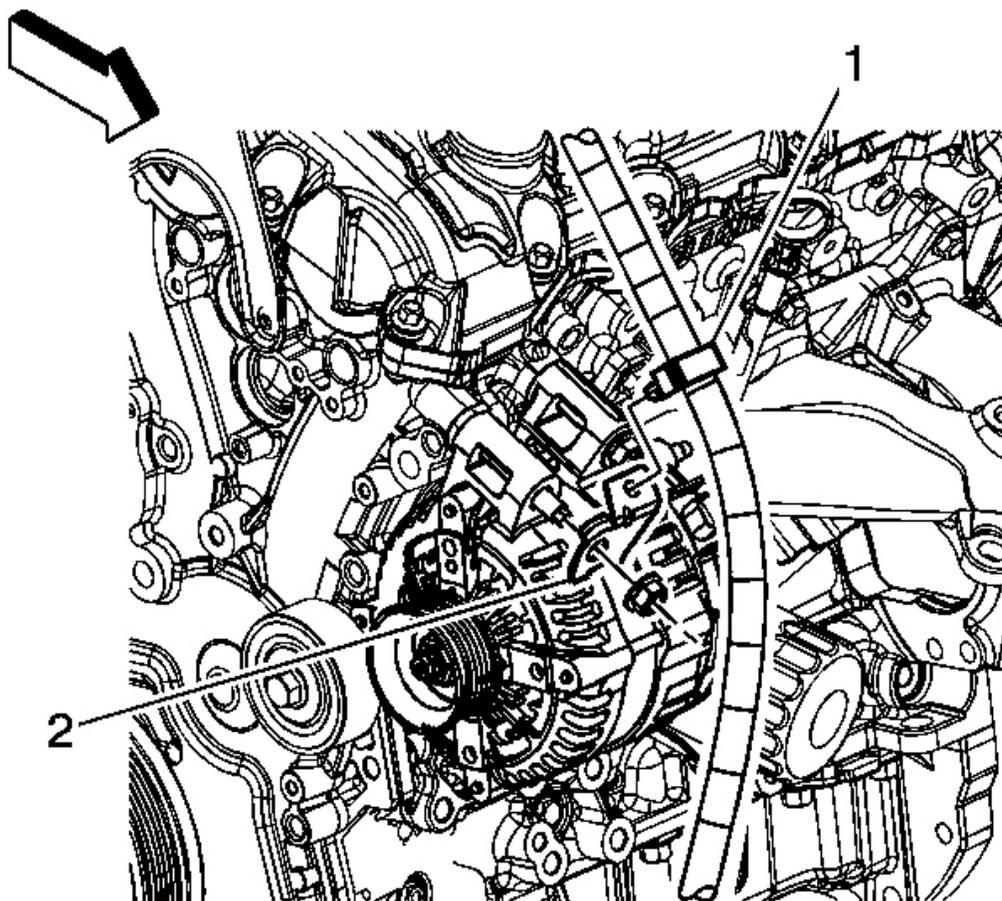
**Courtesy of GENERAL MOTORS CORP.**

7. Install the idler pulley bolt (1) finger tight.

**NOTE:** Refer to Fastener Notice .

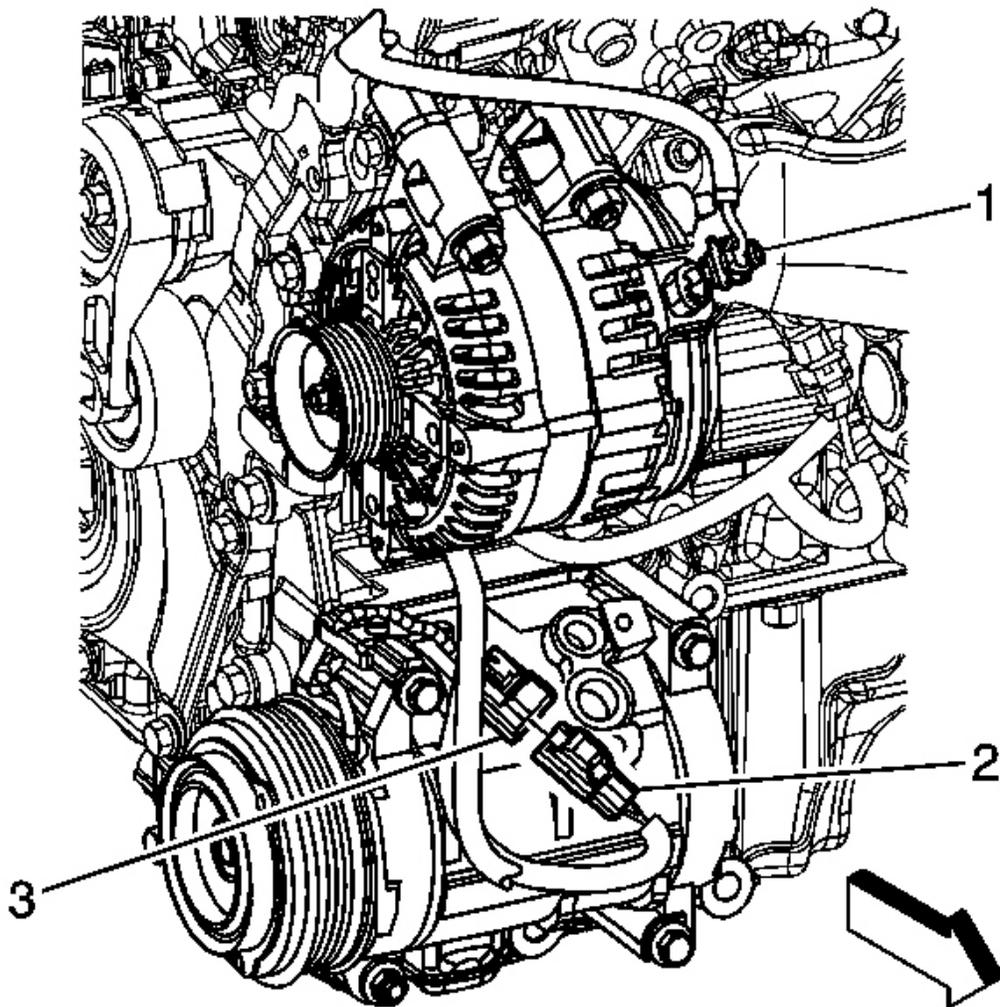
8. Tighten the generator bolt/nuts in the following sequence to specifications.
  1. Idler pulley bolt
  2. Left nut
  3. Right nut

**Tighten:** Tighten the bolt/nuts to 50 N.m (37 lb ft).



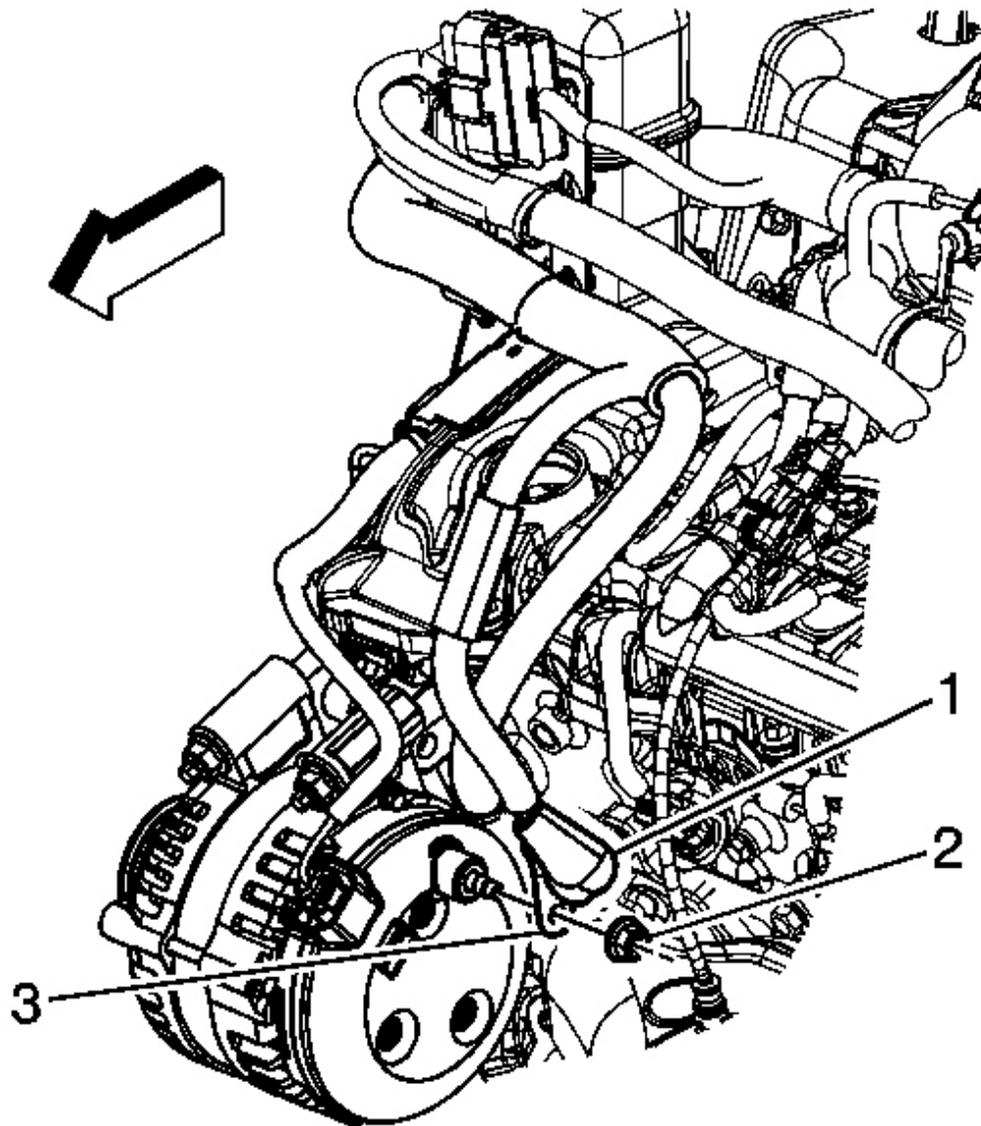
**Fig. 82: Identifying Power Steering Reservoir Inlet Hose Clip & Hose Clip Bracket**  
Courtesy of GENERAL MOTORS CORP.

9. Install the power steering reservoir inlet hose clip (1) to the power steering fluid reservoir hose clip bracket (2).



**Fig. 83: View Of Engine Wiring Harness Electrical Connector**  
**Courtesy of GENERAL MOTORS CORP.**

10. Connect the engine wiring harness electrical connector (1) to the generator.



**Fig. 84: Identifying Battery Positive Junction Block Cable Boot & Cable Terminal**  
Courtesy of GENERAL MOTORS CORP.

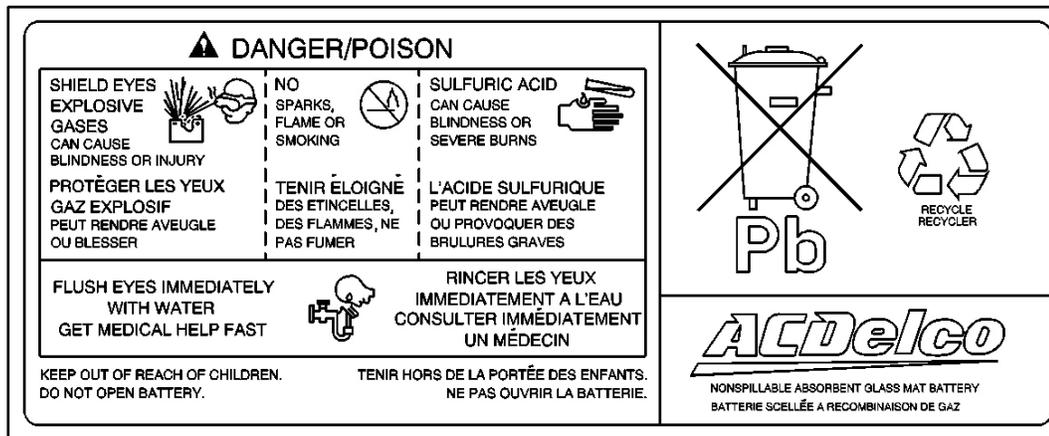
11. Install the battery positive junction block cable terminal (3) to the generator stud.
12. Install the battery positive junction block cable to generator nut (2).

**Tighten:** Tighten the nut to 22 N.m (16 lb ft).

13. Position the battery positive junction block cable boot (1) over the stud.
14. Install the drive belt. Refer to **Drive Belt Replacement** .
15. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

## DESCRIPTION AND OPERATION

### BATTERY DESCRIPTION AND OPERATION



**Fig. 85: View Of Battery Warning Label**  
Courtesy of GENERAL MOTORS CORP.

**CAUTION:** Batteries produce explosive gases, contain corrosive acid and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- Always shield your eyes and avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.
- Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.

- Follow each step of the jump starting procedure in order.
- Treat both the booster and the discharged batteries carefully when using the jumper cables.

**IMPORTANT:** Because of the materials used in the manufacture of automotive lead-acid batteries, dealers and service shops that handle them are subject to various regulations issued by OSHA, EPA, DOT and various state or local agencies. Other regulations may also apply in other locations. Always know and follow these regulations when handling batteries.

Batteries that are no longer wanted must be disposed of by an approved battery recycler and must never be thrown in the trash or sent to a landfill.

Batteries that are not part of the vehicle itself, not the battery under the hood, must only be transported on public streets for business purposes via approved hazardous material transportation procedures.

Battery storage, charging and testing facilities in repair shops must meet various requirements for ventilation, safety equipment, material segregation, etc.

The maintenance-free battery is standard. There are no vent plugs in the cover. The battery is completely sealed except for 2 small vent holes in the side. These vent holes allow the small amount of gas that is produced in the battery to escape.

The battery has 3 functions as a major source of energy:

- Engine cranking
- Voltage stabilizer
- Alternate source of energy with generator overload

The battery specification label, example below, contains information about the following:

- The test ratings
- The original equipment catalog number
- The recommended replacement model number

CATALOG NO.

**1819**

<b>CCA</b> <b>770</b>	<b>LOAD TEST</b> <b>380</b>
<b>REPLACEMENT MODEL</b> <b>100 – 6YR</b>	

**Fig. 86: View Of Battery Specification Label**  
Courtesy of GENERAL MOTORS CORP.

#### Battery Ratings

A battery may have 3 ratings:

- Amp hour
- Reserve capacity
- Cold cranking amperage

When a battery is replaced, use a battery with similar ratings. Refer to the battery specification label on the original battery or refer to **Battery Usage**.

#### Amp Hour

The amp hour rating of a battery is the amount of time it takes a fully charged battery, being discharged at a constant rate of 1 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Refer to **Battery Usage** for the amp hour rating of the original equipment battery.

**Reserve Capacity**

Reserve capacity is the amount of time in minutes it takes a fully charged battery, being discharged at a constant rate of 25 amperes and a constant temperature of 27°C (80°F), to reach a terminal voltage of 10.5 volts. Refer to **Battery Usage** for the reserve capacity rating of the original equipment battery.

**Cold Cranking Amperage**

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 volts. Refer to **Battery Usage** for the cold cranking amperage rating for this vehicle.

**CHARGING SYSTEM DESCRIPTION AND OPERATION****Electrical Power Management (EPM) Overview**

The electrical power management (EPM) system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This EPM system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life and minimize the system's impact on fuel economy. The EPM system performs 3 functions:

- It monitors the battery voltage and estimates the battery condition.
- It takes corrective actions by boosting idle speeds and adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge (SOC) of the battery is determined by measuring the open-circuit voltage. The SOC is a function of the acid concentration and the internal resistance of the battery and is estimated by reading the battery open circuit voltage when the battery has been at rest for several hours.

The SOC can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates SOC based on adjusted net

amp hours, battery capacity, initial SOC and temperature.

While running, the battery degree of discharge is primarily determined by a battery current sensor, which is integrated to obtain net amp hours.

In addition, the EPM function is designed to perform regulated voltage control (RVC) to improve battery SOC, battery life and fuel economy. This is accomplished by using knowledge of the battery SOC and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

The Charging System Description and Operation is divided into 3 sections. The first section describes the charging system components and their integration into the EPM. The second section describes charging system operation. The third section describes the instrument panel cluster (IPC) operation of the charge indicator, driver information center (DIC) messages and voltmeter operation.

### **Charging System Components**

#### **Generator**

The generator is a serviceable component. If there is a diagnosed failure of the generator it must be replaced as an assembly. The engine drive belt drives the generator. When the rotor is spun it induces an alternating current (AC) into the stator windings. The AC voltage is then sent through a series of diodes for rectification. The rectified voltage has been converted into a direct current (DC) for use by the vehicles electrical system to maintain electrical loads and the battery charge. The voltage regulator integral to the generator controls the output of the generator. It is not serviceable. The voltage regulator controls the amount of current provided to the rotor. If the generator has field control circuit failure, the generator defaults to an output voltage of 13.8 volts.

#### **Body Control Module (BCM)**

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster (IPC) for electrical power management (EPM) operation. The BCM determines the output of the generator and sends the information to the ECM for control of the generator field control circuit. It monitors the generator field duty cycle signal circuit information sent from the ECM for control of the generator. It monitors a battery current sensor, the battery positive voltage circuit and estimated battery temperature to determine battery state of charge (SOC). The BCM performs idle boost.

#### **Battery Current Sensor**

The battery current sensor is a serviceable component that is connected to the negative battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the BCM. It creates a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

**Engine Control Module (ECM)**

The ECM directly controls the generator field control circuit input to the generator. The ECM receives control decisions based on messages from the BCM. It monitors the generators generator field duty cycle signal circuit and sends the information to the BCM.

**Instrument Panel Cluster (IPC)**

The IPC provides a means of customer notification in case of a failure and a voltmeter. There are 2 means of notification, a charge indicator and a driver information center (DIC) message of SERVICE BATTERY CHARGING SYSTEM.

**Charging System Operation**

The purpose of the charging system is to maintain the battery charge and vehicle loads. There are 6 modes of operation and they include:

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator field control circuit. It monitors the generator performance though the generator field duty cycle signal circuit. The ECM controls the generator through the generator field control circuit. The signal is a 5-volt pulse width modulation (PWM) signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes. The following table shows the commanded duty cycle and output voltage of the generator:

**Charging System Description and Operation**

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## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

Commanded Duty Cycle	Generator Output Voltage
10%	11 V
20%	11.56 V
30%	12.12 V
40%	12.68 V
50%	13.25 V
60%	13.81 V
70%	14.37 V
80%	14.94 V
90%	15.5 V

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is a 5-volt PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

#### Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 volts for 45 minutes. When this condition exists the BCM will enter Charge Mode for 2-3 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

#### Charge Mode

The BCM will enter Charge Mode when ever one of the following conditions are met.

- The wipers are ON for than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80 percent.
- Vehicle Speed is greater than 145 km/h (90 mph)
- Current Sensor Fault Exists
- System Voltage was determined to be below 12.56 volts

When any one of these conditions is met, the system will set targeted generator output voltage to a

charging voltage between 13.9V and 15.5V, depending on the battery state of charge and estimated battery temperature.

**Fuel Economy Mode**

The BCM will enter Fuel Economy Mode when the estimated battery temperature is at least 0°C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is less than 15 amperes and greater than -8 amperes and the battery SOC is greater than or equal to 80 percent. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5 and 13.1 volts. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

**Headlamp Mode**

The BCM will enter Headlamp Mode when ever the headlamps are ON (high or low beams). Voltage will be regulated between 13.9 and 14.5 volts

**Start Up Mode**

When the engine is started the BCM sets a targeted generator output voltage of 14.5 volts for 30 seconds.

**Voltage Reduction Mode**

The BCM will enter Voltage Reduction Mode when the calculated ambient air temperature is above 0°C (32°F). The calculated battery current is less than 1 ampere and greater than -7 amperes and the generator field duty cycle is less than 99 percent. Its targeted generator output voltage is 12.9 volts. The BCM will exit this mode once the criteria are met for Charge Mode.

**Instrument Panel Cluster (IPC) Operation****Charge Indicator Operation**

The instrument panel cluster (IPC) illuminates the charge indicator and displays a warning message in the driver information center (DIC) when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 volts or greater than 16 volts. The IPC receives a GMLAN message from the ECM requesting illumination.
- The IPC determines that the system voltage is less than 11 volts or greater than 16 volts for more than 30 seconds. The IPC receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

- The IPC performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.
- The ignition is ON, with the engine OFF.

#### Battery Voltage

The IPC displays the system voltage as received from the BCM over the GMLAN serial data circuit. If there is no communication with the BCM then the display will read all dashes until communication is restored.

#### SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a GMLAN message to the DIC for the SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

#### ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

##### Electrical Power Management

The electrical power management (EPM) is used to monitor and control the charging system and alert the driver of possible problems within the charging system. The EPM system makes the most efficient use of the generator output, improves the battery state of charge (SOC), extends battery life.

The idle boost operation is a means of improving generator performance during a low voltage or low battery SOC condition.

Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate EPM are outlined below:

##### Electrical Power Management Description and Operation

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 AH	First level Idle boost requested

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

Idle Boost 1 Start	-	Less Than 11 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -15° C (5°F)	Greater Than 12 V	Battery has a net loss less than 0.2 AH	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 AH	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 11 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 AH	Second level Idle boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10 AH	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 11 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6 AH	Third level Idle boost request cancelled

### STARTING SYSTEM DESCRIPTION AND OPERATION

The starter motors are non-repairable starter motors. They have pole pieces that are arranged around the armature. Both solenoid windings are energized. The pull-in winding circuit is completed to the ground through the starter motor. The windings work together magnetically to pull and hold in the plunger. The plunger moves the shift lever. This action causes the starter drive assembly to rotate on the armature shaft spline as it engages with the flywheel ring gear on the engine. Moving at the same time, the plunger also closes the solenoid switch contacts in the starter solenoid. Full battery voltage is applied directly to the starter motor and it cranks the engine.

As soon as the solenoid switch contacts close, current stops flowing through the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the START relay opens and

## 2007 Saturn Outlook XE

### 2007 ENGINE Engine Electrical - Outlook

battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

The magnetic fields of the pull-in and hold-in windings now oppose one another. This action of the windings, along with the help of the return spring, causes the starter drive assembly to disengage and the solenoid switch contacts to open simultaneously. As soon as the contacts open, the starter circuit is turned off.

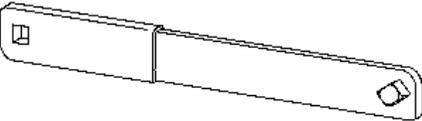
#### Circuit Description (Key Start)

When the ignition switch is placed in the Start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the Start position. The BCM then sends a message to the engine control module (ECM) notifying it that CRANK has been requested. The ECM verifies that the transmission is in Park or Neutral. If it is, the ECM then supplies 12 volts to the control circuit of the crank relay. When this occurs, battery positive voltage is supplied through the switch side of the crank relay to the S terminal of the starter solenoid.

## SPECIAL TOOLS AND EQUIPMENT

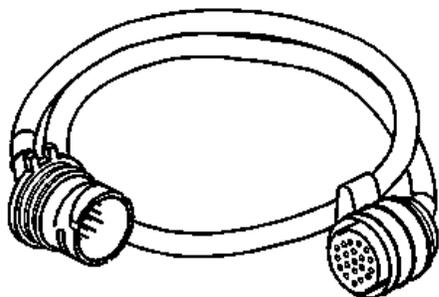
### SPECIAL TOOLS

#### Special Tools

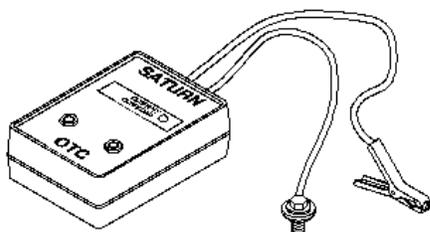
Illustration	Tool Number/Description
	J 44811 Accessory Belt Tensioner Unloader

2007 Saturn Outlook XE

2007 ENGINE Engine Electrical - Outlook



J 45681  
Jumper Harness



SA9130Z  
Parasite Load Tester

SA9154Z  
Starting and Charging System Tester

2007 Saturn Outlook XE

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