

2006 Chevrolet HHR LT

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SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Hold-Down Retainer Bolt	25 N.m	18 lb ft
Generator Bolt	22 N.m	16 lb ft
Generator Terminal Nut	20 N.m	15 lb ft
Junction Block Terminal Nut	15 N.m	11 lb ft
Negative Battery Cable Bolt	20 N.m	15 lb ft
Negative Battery Cable Nut	15 N.m	11 lb ft
Positive Battery Cable Nut	15 N.m	11 lb ft
Positive/Negative Battery Cable Ground Nut	10 N.m	89 lb in
Starter Bolt	40 N.m	30 lb ft
Starter Solenoid Nut	17 N.m	13 lb ft
Starter Solenoid S Terminal Nut	3 N.m	27 lb in

BATTERY USAGE

Battery Usage

Application	Specification
2.2L (L61), 2.4L (LE5)	
Cold Cranking Amperage	600 A
Amp Hour Rating	55 AH
Reserve Capacity Rating	90 Minutes
Replacement Battery Number	90-6YR

GENERATOR USAGE

Generator Usage

Application	Specification
2.2 L (L61), 2.4 L (LE5)	
Generator Model	Denso SC0
Rated Output	130 A
Load Test Output	91 A

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SCHEMATIC AND ROUTING DIAGRAMS

STARTING AND CHARGING SCHEMATICS

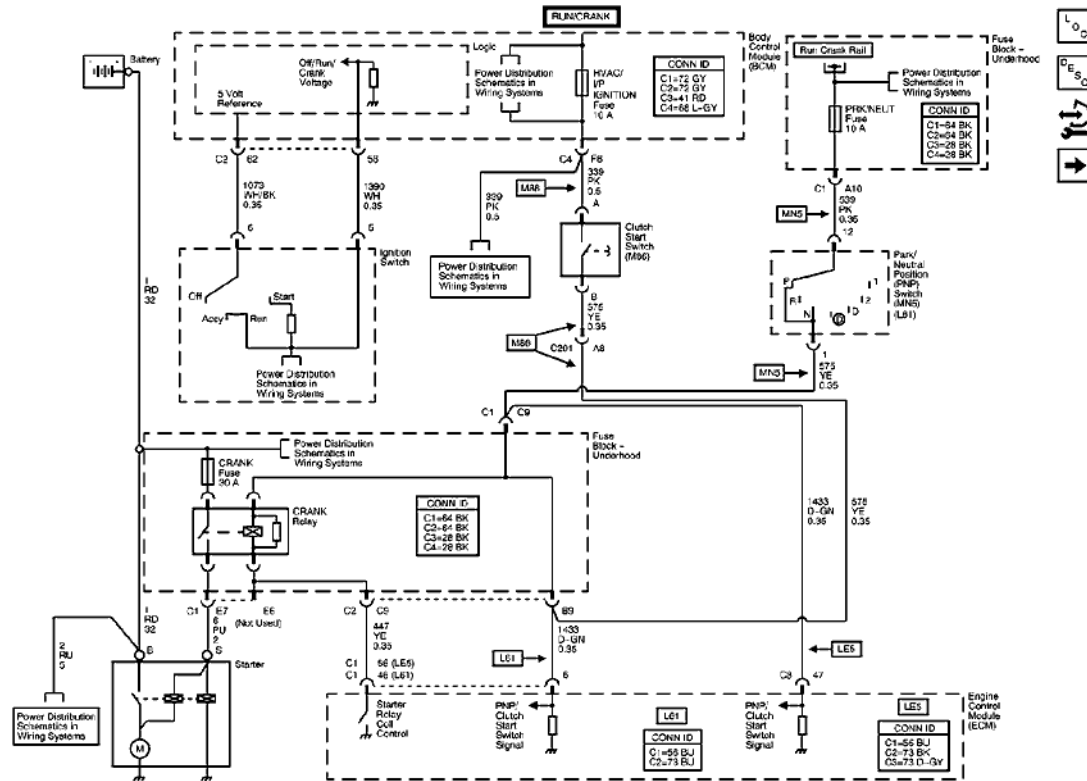


Fig. 1: Starting Schematic
Courtesy of GENERAL MOTORS CORP.

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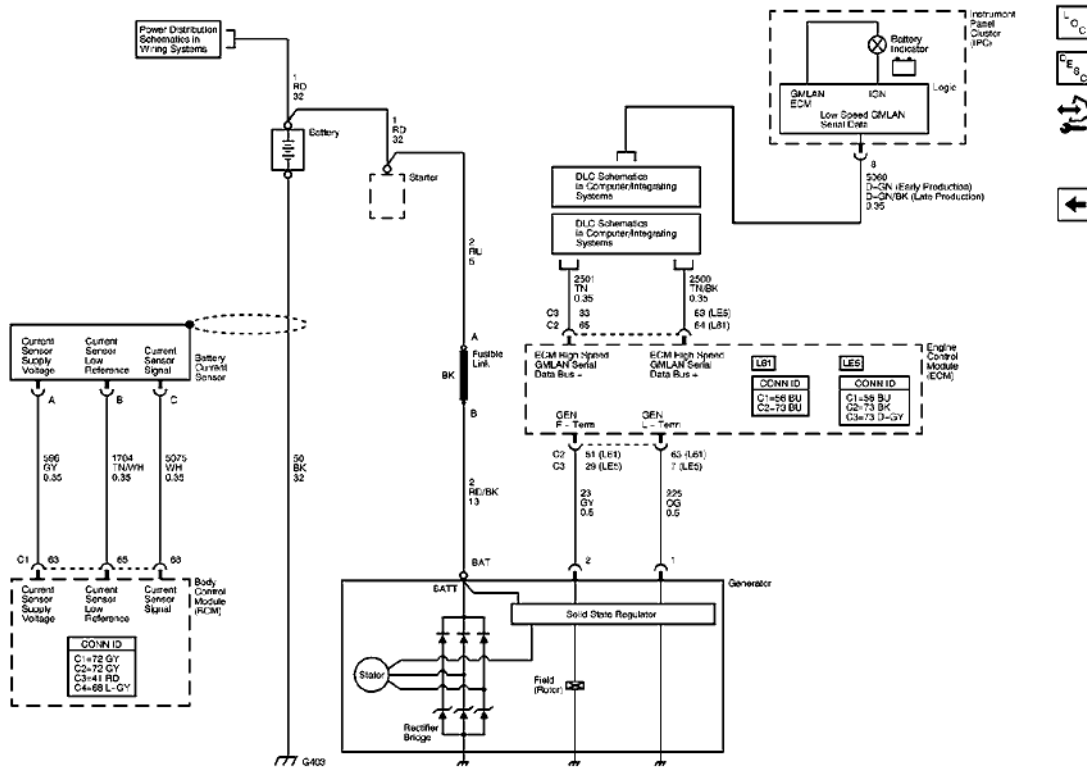


Fig. 2: Charging Schematic
 Courtesy of GENERAL MOTORS CORP.

COMPONENT LOCATOR

ENGINE ELECTRICAL COMPONENT VIEWS

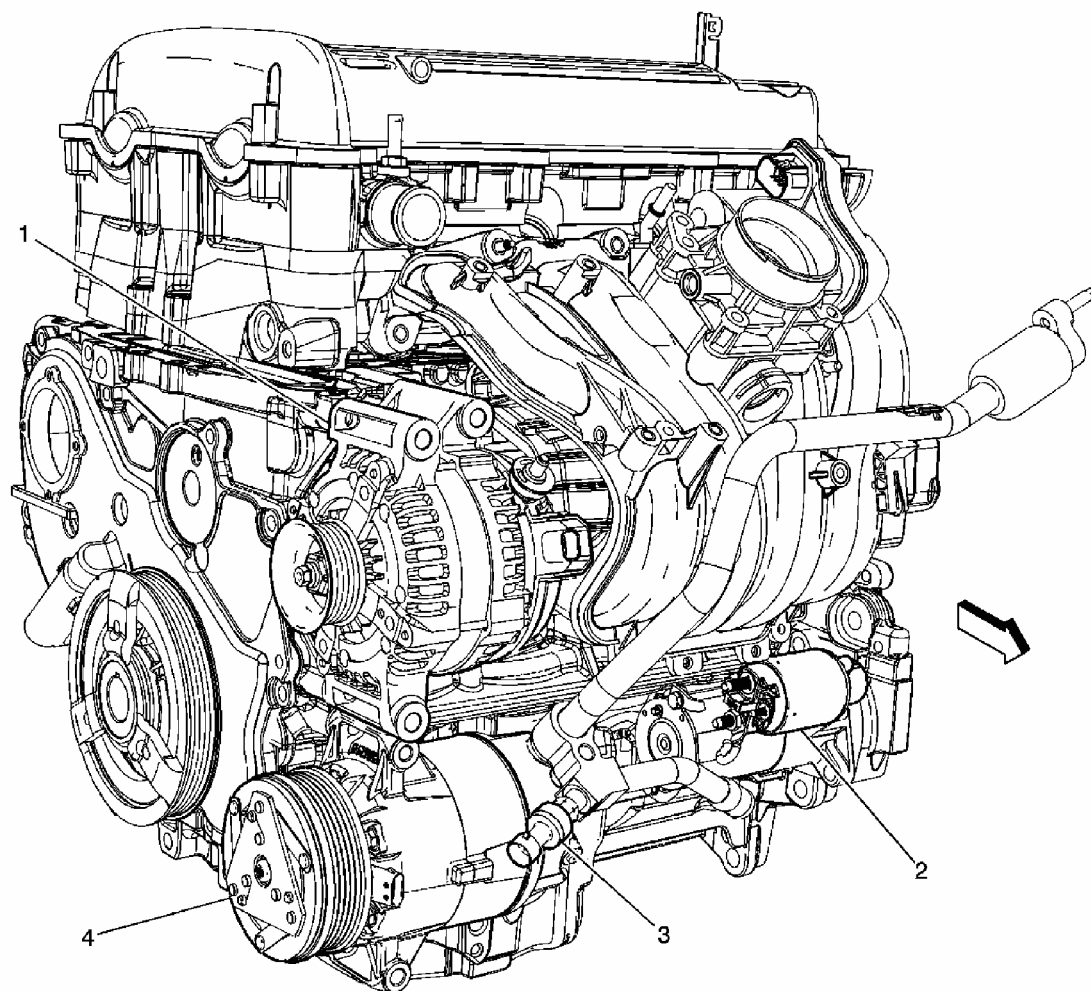


Fig. 3: Lower Front of the Engine
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 3

Callout	Component Name
1	Generator
2	Starter
3	A/C Refrigerant Pressure Sensor
4	A/C Compressor Clutch

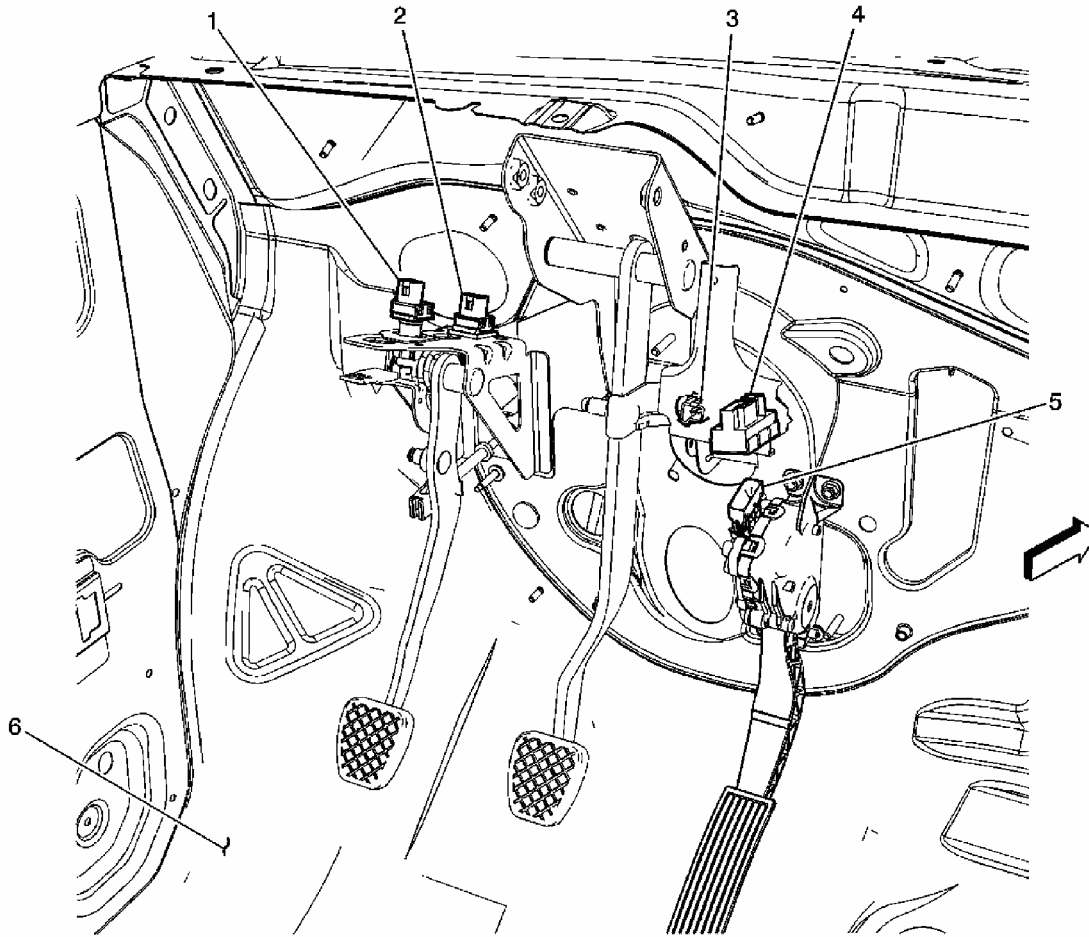


Fig. 4: Pedal Assemblies
 Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 4

Callout	Component Name
1	Clutch Pedal Position (CPP) Switch (M86)
2	Clutch Start Switch (M86)
3	Stop Lamp Switch
4	Stop Lamp / Torque Converter Clutch (TCC) Switch / Cruise Release Switch
5	Accelerator Pedal Position (APP) Sensor
6	Floor Panel

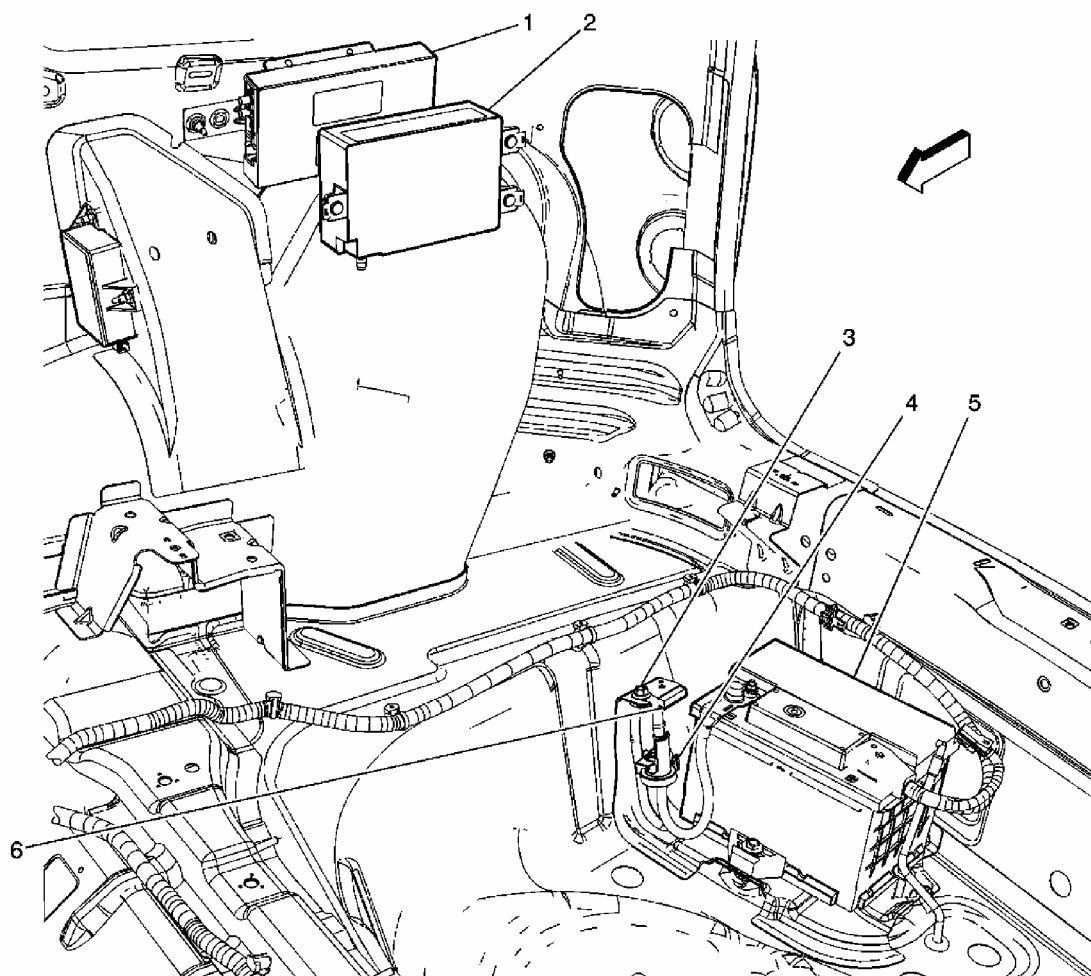


Fig. 5: RR of the Passenger Compartment
Courtesy of GENERAL MOTORS CORP.

Callouts For Fig. 5

Callout	Component Name
1	Digital Radio Receiver (U2K)
2	Vehicle Communication Interface Module (VCIM) (UE1)
3	G403
4	Battery Current Sensor
5	Battery
6	Floor Pan

ENGINE ELECTRICAL CONNECTOR END VIEWS

Battery Current Sensor

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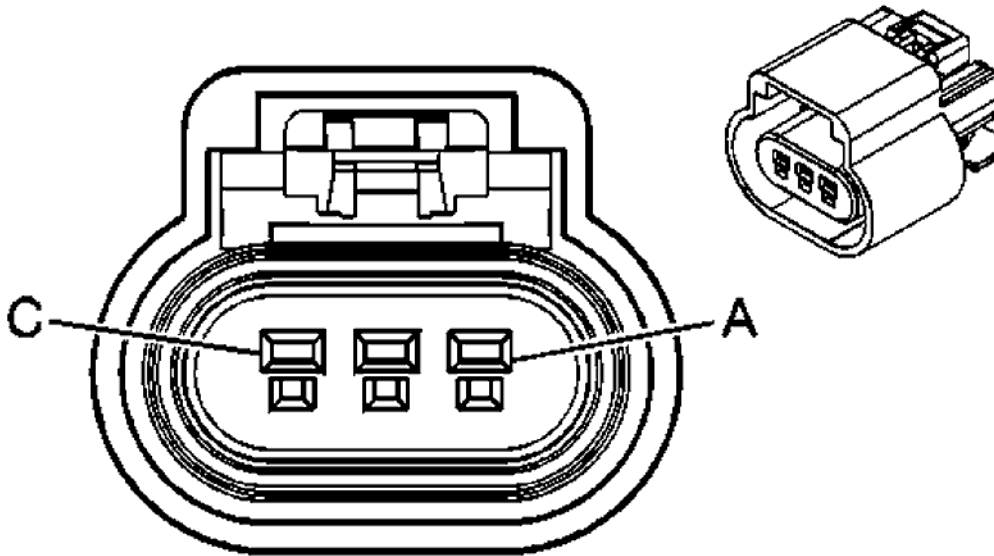


Fig. 6: Battery Current Sensor Connector
Courtesy of GENERAL MOTORS CORP.

Engine Electrical Connector End Views

Connector Part Information

- OEM: 15326808
- Service: 15306388
- Description: 3-Way F GT 150 Series Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Battery Current Sensor

Pin	Wire Color	Circuit No.	Function
A	GY	596	5-Volt Reference
B	TN/WH	1704	Sensor Low Reference
C	WH	5075	Current Sensor Signal

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Clutch Start Switch (M86)

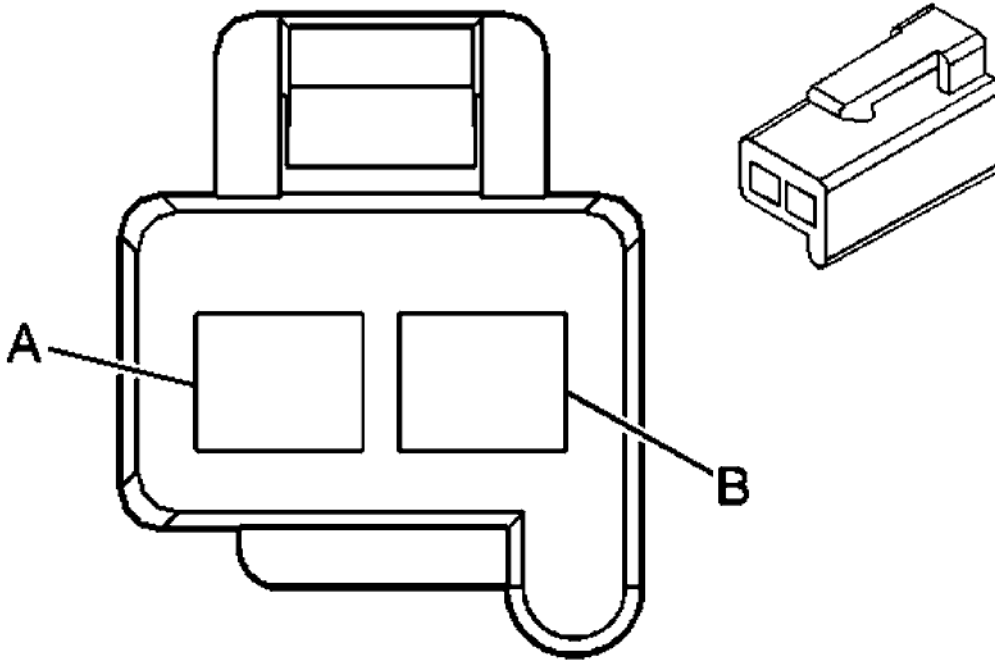


Fig. 7: Clutch Start Switch (M86) Connector
Courtesy of GENERAL MOTORS CORP.

Engine Electrical Connector End Views

Connector Part Information

- OEM: 12041433
- Service: 12126463
- Description: 2-Way F Metri-Pack 280 Series (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

Clutch Start Switch (M86)

Pin	Wire Color	Circuit No.	Function

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A	PK	339	Run/Crank Ignition 1 Voltage
B	YE	575	Starter Enable Relay Contact Control

Generator

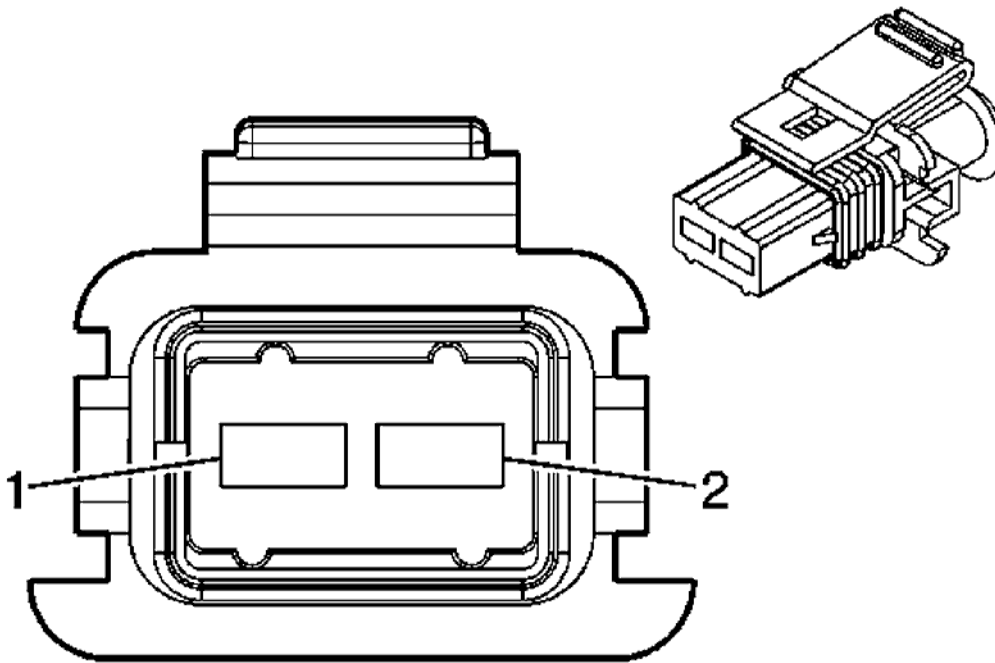


Fig. 8: Generator Connector

Courtesy of GENERAL MOTORS CORP.

Engine Electrical Connector End Views

Connector Part Information

- OEM: 12186308
- Service: 89046837
- Description: 2-Way F JPT, Sealed (BK)

Terminal Part Information

- Pins:
- Terminal:
- Core/Insulation Crimp:
- Release Tool/Test Probe:

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Generator

Pin	Wire Color	Circuit No.	Function
1	OG	225	Generator Turn On Signal
2	GY	23	Generator Field Duty Cycle Signal

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B1325	Device Power 1 Circuit
DTC B1516	** DESCRIPTION NOT COLLECTED **
DTC B1517	Battery Voltage (signal or 1) Voltage
DTC P0562	System Voltage Low
DTC P0563	System Voltage High
DTC P0621	Generator L-Teminal Circuit
DTC P0622	Generator F-Terminal Circuit
DTC P1668	Generator L-Terminal Control Circuit

DIAGNOSTIC STARTING POINT - ENGINE ELECTRICAL

Begin the system diagnosis with **Diagnostic System Check - Vehicle** in Vehicle DTC Information. 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

L61/LE5 Engine Control Module (ECM)

Scan Tool Output Control	Additional Menu Selection(s)	Description
GEN L-Terminal	Body and Accessories, Theft Deterrent, Special Function, ECM	The engine control module (ECM) commands the generator OFF when off is selected. The generator will then stop generating an output voltage.
	Body and	

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Display Test	Accessories, Instrument Panel, Special Function, IPC	The instrument panel cluster (IPC) illuminates all indicators to test for an inoperative indicator.
Starter Relay Command	Body and Accessories, Theft Deterrent, Special Function, ECM	Commands Starter Relay ON and OFF.

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

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON/Engine OFF			
Battery Voltage Signal	BCM/Power Mode	Volts	12.6 Volts
Idle Boost Level	BCM/Power Mode	Amps	0 Amps
Run/Crank Relay	BCM/Power Mode	Active/Inactive	Inactive
Run/Crank Relay Command	BCM,Keyless/Remote Start	On/Off	On

L61/LE5 Engine Control Module (ECM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON/Engine OFF			
Crank Request Signal	Engine Electrical, ECM	Yes/No	No
GEN F-Terminal Signal	Engine Electrical, ECM	%	0 %
GEN L-Terminal Command	Engine Electrical, ECM	%	0 %
GEN L-Terminal Circuit Status	Engine Electrical, ECM	Incomplete, Short Gnd / Open, Short to B+, OK	OK
Ignition 1 Signal	Engine Electrical, ECM	Volts	12.6 Volts
Ignition Accessory Signal	Engine Electrical, ECM	On/Off	On
Starter Relay Command	Engine Electrical, ECM	On/Off	Off
Stoplamp Pedal Switch	Engine	Applied/Released	Released

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Electrical, ECM

Transmission Control Module (TCM)

Scan Tool Parameter	Data List	Units Displayed	Typical Data Value
Ignition ON/Engine OFF			
TR Sw.	Transmission Data, Data Display	Park, Reverse, Neutral, Drive 5, Drive 4, Drive 3, Drive 2, Drive 1	Park

SCAN TOOL DATA DEFINITIONS

Battery Voltage Signal

The scan tool displays 0-20 Volts. The scan tool displays the voltage as received on the battery positive voltage circuit of the body control module (BCM).

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 scan tool displays the percentage of the field current on the GEN F-Terminal circuit.

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.

GEN L-Terminal Command

The scan tool displays 0-100%. The scan tool displays the percentage of the GEN L-terminal signal.

Idle Boost Level

The scan tool displays amps. The scan tool displays the current engine idle boost level as commanded by the ECM.

Ignition 1 Signal

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

Ignition Accessory Signal

The scan tool displays On and Off. The scan tool displays if the ignition 0 signal is On or Off.

Run/Crank Relay

The scan tool displays On or Off. The scan tool display actual state of the Run/Crank relay.

Run/Crank Relay Command

The scan tool displays On or Off. The scan tool displays the commanded state of the Run/Crank relay.

Starter Relay Command

The scan tool displays ON/OFF. The scan tool displays Off until engine start has been requested, then it reads On.

Stoplamp Pedal Switch

The scan tool displays Applied/Released. The scan tool displays Applied when the brake pedal is pressed and Released when the brake pedal is not pressed.

TR Sw.

The scan tool displays Park, Reverse, Neutral, Drive 5, Drive 4, Drive 3, Drive 2, Drive 1. The scan tool displays the position of the transmission range switch.

DTC B1325

Circuit Description

The control modules on this vehicle monitor the battery voltage through the battery positive voltage circuits.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1325 Device Power 1 Circuit

This vehicle has DTCs that include DTC symptoms. For more information on DTC

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symptoms, refer to **DTC Symptom Description** in Vehicle DTC Information.

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 is in the range of 7-26 volts.

Conditions for Setting the DTC

B1325 03

The control module detects a system voltage below 9 volts and the condition is present at least 5 seconds.

B1325 07

The control module detects a system voltage above 18 volts and the condition is present at least 5 seconds.

Action Taken When the DTC Sets

- The control module immediately disables all outputs when a high voltage condition is 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.
- 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
Schematic Reference: <u>Body Control System Schematics</u> in Computer/Integrating Systems				
Connector End View Reference: <u>Computer/Integrating Systems Connector End Views</u> in Computer/Integrating Systems				
1	Did you perform the Diagnostic	-		Go to Diagnostic System Check

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	System Check - Vehicle?		Go to Step 2	- Vehicle in Vehicle DTC Information
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Battery Voltage Signal parameter in the data list of the module setting the DTC. Is the Battery Voltage Signal parameter displayed in the specified range?	9-18 V	Go to Step 3	Go to Step 4
3	Is the DTC set as a current DTC?	-	Go to Step 7	Go to Testing for Intermittent Conditions and Poor Connections in Wiring Systems
4	1. Disconnect the harness connector of the module setting the DTC. 2. Measure the voltage between the battery positive voltage circuit at the module harness connector and a good ground. Is the measured value in the specified range?	9-18 V	Go to Step 6	Go to Step 5
5	Test the battery positive voltage circuit for the following: • A short to ground • An open • A high resistance Refer to Circuit Testing and Wiring Repairs in Wiring Systems. Did you find and correct the	-	Go to Step	Go to Battery

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	condition?		9	Inspection/Test
6	Test all ground circuits of the module for an open or high resistance. Refer to Circuit Testing and Wiring Repairs in Wiring Systems. Did you find and correct the condition?	-	Go to Step 9	Go to Step 7
7	Inspect for poor connections at the harness connector of the affected module. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs in Wiring Systems. Did you find and correct the condition?	-	Go to Step 9	Go to Step 8
8	Replace the affected module. Refer to Control Module References in Computer/Integrating Systems for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 9	-
9	Operate the system in order to verify the repair. Did you find and correct the condition?	-	System OK	Go to Step 2

DTC B1516**DTC Descriptor****DTC B1516 08**

Battery Current Sensor Performance Signal Invalid

Diagnostic Fault Information

IMPORTANT: Always perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

DTC B1516

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Current Sensor Supply Voltage	B1516	B1516	-	B1516

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Circuit/System Description

The battery current sensor supplies a pulse width modulation (PWM) input signal to the body control module (BCM).

Conditions for Running the DTC

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

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

The SERVICE VEHICLE SOON warning message will be illuminated in the driver information center (DIC).

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.
- Using the scan tool Clear DTC Information function can clear the DTC.

Reference Information

Schematic Reference

- Starting and Charging Schematics
- Body Control System Schematics

Connector End View Reference

- Engine Electrical Connector End Views
- Computer/Integrating Systems 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

Circuit/System Testing

1. Ignition ON and the battery current sensor harness disconnected, with a DMM measure the voltage of the current sensor supply voltage, harness side and ground. The voltage should read 5 volts.
 - If the voltage is less than 5 volts test the current sensor supply voltage for a short to ground, a high resistance, an open circuit.
 - If the circuit tests good replace the BCM.
2. Ignition ON and the battery current sensor harness disconnected, with a DMM measure the voltage of the current sensor signal circuit, harness side and ground. The voltage should read 5 volts.
 - If the voltage is less than 5 volts test the current sensor signal circuit for a short to ground, a high resistance, an open circuit.
 - If the circuit tests good replace the BCM.
3. Ignition ON and the battery current sensor harness disconnected, with a DMM measure the voltage of the current sensor supply voltage and current sensor low reference circuit, harness side. The voltage should read 5 volts.
 - If the voltage is less than 5 volts test the current sensor low reference circuit for a high resistance, an open circuit.
 - If the circuit tests good replace the BCM.
4. If all 3 circuits test good replace the battery current sensor.

Repair Instructions

IMPORTANT: Always perform the Diagnostic Repair Verification after completing the diagnostic procedure.

- **Control Module References** for BCM replacement, setup, and programming.
- **Battery 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 3 volts, DTC B1517 will set. Other modules also monitor system voltage. The system voltage message is sent to the other

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modules and will default to 12.9 volts.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC B1517 Battery Voltage (signal or 1) Voltage

This vehicle has DTCs that include DTC symptoms. For more information on DTC symptoms, refer to **DTC Symptom Description**.

DTC B1517

DTC Symptom	DTC Symptom Descriptor
52	Compare 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

The battery voltage differs by 3 volts on the BCM battery sense circuits for 15 seconds.

Action Taken When the DTC Sets

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 circuits of the BCM.

5: This step tests for the proper voltage of the 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.

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DTC B1517

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

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	Does the voltage measure greater than the specified value?		Go to Step 9	Go to Step 6
6	Measure the voltage between the battery positive voltage circuit of BCM and a good ground. Does the voltage measure greater than the specified value?	3 V	Go to Step 8	Go to Step 7
7	Test the battery positive voltage circuits of BCM for a high resistance or an open. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	-	Go to Step 11	Go to Step 9
8	Test the ground sense circuits for a high resistance or an open. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	-	Go to Step 11	Go to Step 9
9	Inspect for poor connections at the harness connector of the BCM. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	-	Go to Step 11	Go to Step 10
10	Replace the BCM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 11	-
11	1. Use the scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text. Does the DTC reset?	-	Go to Step 2	System OK

DTC P0562

Circuit Description

The engine control module (ECM) checks the system voltage to make sure that the voltage stays within the proper range. Damage to components and incorrect input can occur when the voltage is out of range. The ECM monitors the system voltage over an extended length of time. If the ECM detects an excessively low system voltage, DTC P0562 will set.

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DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0562 System Voltage Low

Conditions for Running the DTC

System voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects a system voltage below 10.5 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the charge indicator.
- 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.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0562

Step	Action	Values	Yes	No
Connector End View Reference: <u>Inline Harness Connector End Views</u> , <u>Engine Control Module (ECM) Connector End Views</u> for the 2.2L (L61) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 2.4L engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
	1. Install a scan tool. 2. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text.			

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2	3. Using the scan tool, observe the specific DTC Information for DTC P0562 until the test runs. Does the scan tool indicate that DTC P0562 has passed this ignition cycle?	-	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Start the engine. 2. Turn OFF all accessories. 3. With a scan tool, observe the Ignition 1 Signal parameter in the engine control module (ECM) data list. Does the scan tool indicate that the Ignition 1 Signal parameter is greater than the specified range?	10.5 V	Go to Step 7	Go to Step 4
4	Measure the voltage at the battery terminals and compare it with the Ignition 1 Signal parameter in the ECM data list. Are the battery voltage and the Ignition 1 Signal parameter readings different by more than the value specified?	0.5 V	Go to Step 5	Go to Charging System Test
5	Test the battery positive voltage circuit of the ECM for a high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	-	Go to Step 8	Go to Step 6
6	Inspect for poor connections at the harness connector of the ECM. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs. Did you find and correct the condition?	-	Go to Step 8	Go to Step 7
7	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 8	-
	1. Review and record the scan tool			

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8	Failure Records data.			
	2. Use the scan tool in order to clear the DTC.			
	3. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text.			
	4. Using the scan tool, observe the Specific DTC Information for DTC P0562 until the test runs.	-		
	Does the scan tool indicate that DTC P0562 failed this ignition?		Go to Step 3	System OK

DTC P0563**Circuit Description**

The engine control module (ECM) checks the system voltage to make sure that the voltage stays within the proper range. Damage to components and incorrect input can occur when the voltage is out of range. The ECM monitors the system voltage over an extended length of time. If the ECM detects an excessively high system voltage, DTC P0563 will set.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0563 System Voltage High

Conditions for Running the DTC

System voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects a system voltage above 17.5 volts for 10 seconds.

Action Taken When the DTC Sets

- The ECM will not illuminate the charge indicator.
- 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

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- 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.
- The DTC can be cleared by using the scan tool Clear DTC Information function.

DTC P0563

Step	Action	Values	Yes	No
Connector End View Reference: <u>Inline Harness Connector End Views</u> , <u>Engine Control Module (ECM) Connector End Views</u> for the 2.2L (L61) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 2.4L engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	1. Install a scan tool. 2. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text. 3. Using the scan tool, observe the specific DTC Information for DTC P0563 until the test runs. Does the scan tool indicate that DTC P0563 has passed this ignition cycle?	-	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	1. Start the engine. 2. With a scan tool, observe the Ignition 1 Signal parameter in the engine control module (ECM) data list. Does the scan tool indicate that the Ignition 1 Signal parameter is less than the specified range?	17.5 V	Go to Step 5	Go to Step 4
4	Measure the voltage at the battery terminals and compare it with the Ignition 1 Signal parameter in the ECM data list. Are the battery voltage and ECM	0.5 V		

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	Ignition 1 Signal parameter readings different by more than the value specified?		Go to Step 5	Go to Charging System Test
5	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 6	-
6	1. Review and record the scan tool Failure Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text. 4. Using the scan tool, observe the Specific DTC Information for DTC P0563 until the test runs. Does the scan tool indicate that DTC P0563 failed this ignition?	-	Go to Step 3	System OK

DTC P0621**Circuit 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. When the ECM turns ON the high side driver, the voltage regulator turns ON the field circuit. When the ECM turns OFF the high side driver, the voltage regulator turns OFF the field circuit.

The ECM monitors the state of the generator turn ON signal circuit. With the engine running, the ECM should detect a high generator turn ON signal circuit, or when the charging system malfunctions. If the ECM detects a low generator turn ON signal circuit, DTC P0621 will set. When the DTC sets, the ECM will send a serial data message to the instrument panel cluster (IPC) to illuminate the charge indicator.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P0621 Generator L-Teminal Circuit

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Conditions for Running the DTC

- No generator, crankshaft position (CKP) sensor, or camshaft position (CMP) sensor DTCs are set.
- The engine is running.

Conditions for Setting the DTC

The ECM detects a low signal voltage on the generator turn on signal circuit for at least 5 seconds.

Action Taken When the DTC Sets

- The ECM sends a serial data message to the IPC to illuminate the charge indicator.
- 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.

DTC P0621

Step	Action	Values	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u> for the 2.2L (L61) engine or <u>Engine Controls Schematics</u> for the 2.4L engine Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u> for the 2.2L (L61) engine or <u>Engine Control Module (ECM) Connector End Views</u> for the 2.4L engine				
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text. 3. Using the scan tool, observe the specific DTC Information for	-	Go to Testing for	

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	DTC P0621 until the test runs. Does the scan tool indicate that DTC P0621 has passed this ignition cycle?		<u>Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	1. Start the engine. 2. With a scan tool, while observing the Ignition 1 Signal parameter in the engine control module (ECM) data list, command the Generator L-Terminal ON and OFF. Does the scan tool indicate a change in voltage each time the generator L-terminal is commanded ON and OFF?	-	Go to Step 6	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Start the engine. 4. Measure the voltage between the generator turn ON signal circuit of the generator harness connector and a good ground. Is the voltage within the specified range?	4.5-5.5 V	Go to Step 7	Go to Step 5
5	Test the generator turn ON signal circuit for a short to ground or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	-	Go to Step 10	Go to Step 8
6	Test the generator battery voltage output circuit for a high resistance or open. Refer to <u>Circuit Testing</u> and <u>Wiring Repairs</u> . Did you find and correct the condition?	-	Go to Step 10	Go to Charging System Test
7	Inspect for poor connections at the harness connector of the generator. Refer to <u>Connector Repairs</u> . Did you find and correct the	-		Go to Charging

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	condition?		Go to Step 10	System Test
8	Inspect for poor connections at the harness connector of the ECM. Refer to Connector Repairs . Did you find and correct the condition?	-	Go to Step 10	Go to Step 9
9	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 10	-
10	1. Review and record the scan tool Failure Records data. 2. Use the scan tool in order to clear the DTC. 3. Operate the vehicle within the Conditions for Running DTC P0621, as specified in the supporting text. 4. Using the scan tool, observe the Specific DTC Information for DTC P0621 until the test runs. Does the scan tool indicate that DTC P0621 failed?	-	Go to Step 3	System OK

DTC P0622**Circuit 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 the high side of the field winding in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field winding 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 state 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 5-100 percent. The ECM monitors the PWM signal. If the ECM detects an out of range PWM signal, DTC P0622 will set. When the DTC sets, the ECM will send a serial data message to the instrument panel cluster (IPC) to illuminate the charge indicator.

DTC Descriptor

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This diagnostic procedure supports the following DTC:

DTC P0622 Generator F-Terminal Circuit

Conditions for Running the DTC

Key ON Test

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

Run Test

- No generator, CKP sensor, or CMP sensor DTCs are set.
- The engine speed is less than 3,000 RPM.

Conditions for Setting the DTC

- During the key ON test, the ECM detects a PWM signal greater than 65 percent for at least 5 seconds.

OR

- During the RUN test, the ECM detects a PWM signal less than 5 percent for at least 15 seconds.

Action Taken When the DTC Sets

- The ECM sends a serial data message to the IPC to illuminate the charge indicator.
- 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.

DTC P0622

Step	Action	Values	Yes	No
Schematic Reference: <u>Engine Controls Schematics</u> for the 2.2L (L61) engine or <u>Engine Controls Schematics</u> for the 2.4L engine				

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Connector End View Reference: Engine Control Module (ECM) Connector End Views for the 2.2L (L61) engine or **Engine Control Module (ECM) Connector End Views** for the 2.4L engine

1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Install a scan tool. 2. Start the engine. 3. With a scan tool, observe the GEN-F Terminal Signal parameter in the engine control module (ECM) data list. Does the scan tool indicate that the GEN-F Terminal Signal parameter is within the specified range?	5-95%	Go to Step 3	Go to Step 4
3	With the scan tool command the generator OFF. Does the GEN-F Terminal signal parameter change?	-	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 4
4	1. Turn OFF the ignition. 2. Disconnect the generator harness connector. 3. Connect the test lamp to the battery positive voltage. 4. Turn ON the ignition, with the engine OFF. 5. Probe the F-Terminal in the generator connector. 6. Observe the GEN-F Terminal Signal parameter in the ECM data list. Is the GEN-F Terminal Signal parameter near the specified value?	100%	Go to Charging System Test	Go to Step 5
	Test the generator field duty cycle signal circuit for a short or open.			

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5	Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	-	Go to Step 8	Go to Step 6
6	Inspect for poor connections at the harness connector of the ECM. Refer to Connector Repairs . Did you find and correct the condition?	-	Go to Step 8	Go to Step 7
7	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 8	-
8	1. Review and record the scan tool Failure Records data. 2. Clear any DTCs. 3. Operate the vehicle within the Failure Records conditions as noted. 4. Using a scan tool, monitor the Specific DTC info for this DTC. Does the scan tool indicate that this DTC failed this ignition?	-	Go to Step 2	System OK

DTC P1668**Circuit Description**

The engine control module (ECM) uses the generator turn-on signal circuit to control the voltage output of the generator. When a different voltage is desired, the ECM will change the pulse width modulation (PWM) signal to the voltage regulator via the generator turn-on signal circuit. This causes the voltage regulator to the voltage output of the generator. The ECM has fault detection circuitry which monitors the state of the generator turn-on signal circuit. If the fault detection circuit senses a voltage other than what is expected, this DTC will set. The voltage regulator also contains fault detection circuitry. If the regulator detects a problem, the regulator will ground the generator turn-on signal circuit, pulling the voltage low. This also causes the ECM to set the DTC.

DTC Descriptor

This diagnostic procedure supports the following DTC:

DTC P1668 Generator L-Terminal Control Circuit

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Conditions for Running the DTC

Key ON Test

- The Key is in the ON position for 5 seconds.
- The engine is OFF.

Engine Run Test

- The engine is running.
- The engine speed is less than 3,000 RPM.

Conditions for Setting the DTC

Key ON Test

- The ECM detects a high signal voltage on the generator turn on signal circuit for at least 5 seconds.
- The engine must be started.

During the RUN test, the ECM detects a low signal voltage on the generator turn on signal circuit for at least 5 seconds.

Action Taken When the DTC Sets

- The ECM sends a class 2 message to the instrument panel cluster (IPC) to illuminate the charge indicator and/or turn on a message.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store the conditions present when the DTC set as Fail 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.

DTC P1668

Step	Action	Values	Yes	No
Schematic Reference: Starting and Charging Schematics Connector End View Reference: <u>Engine Control Module (ECM) Connector End Views</u>				
1	Did you perform the Diagnostic System Check - Vehicle?	-		Go to <u>Diagnostic System</u>

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			Go to Step 2	Check - Vehicle
2	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. Wait 5 seconds. 4. Start the engine. 5. With a scan tool, monitor the DTC information for DTC P1668 in Engine Controls. Does the scan tool indicate that DTC P1668 has passed?	-	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Turn Off the engine. 2. Disconnect the generator harness connector. 3. Start the engine. 4. With a DMM, measure the pulse width modulation (PWM) signal between the generator turn on signal circuit and ground. Is the PWM signal within the specified value?	15-87%	Go to Step 5	Go to Step 4
4	Test the generator turn on signal circuit for a short or open. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	-	Go to Step 10	Go to Step 7
5	Test the generator battery positive voltage output circuit for a high resistance or open. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	-	Go to Step 10	Go to Step 6
6	Inspect for poor connections at the harness connector of the generator. Refer to Connector Repairs . Did you find and correct the condition?	-	Go to Step 10	Go to Step 8

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7	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to <u>Testing for Intermittent Conditions and Poor Connections</u> and <u>Connector Repairs</u> . Did you find and correct the condition?	-	Go to Step 10	Go to Step 9
8	Replace the generator. Refer to <u>Generator Replacement</u> . Did you complete the replacement?	-	Go to Step 10	-
9	Replace the ECM. Refer to <u>Control Module References</u> for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 10	-
10	1. Use the scan tool in order to clear the DTCs. 2. Operate the vehicle within the Conditions for Running the DTC, as specified in the supporting text. Does the DTC reset?	-	Go to Step 3	System OK

SYMPTOMS - ENGINE ELECTRICAL

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

- Perform **Control Module References** in Computer/Integrating Systems 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**
 - **Starting System Description and Operation**
 - **Charging System Description and Operation**
 - **Load Shed System Description and Operation**

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- Inspect for aftermarket devices which could affect the operation of the starting and charging systems. Refer to **Checking Aftermarket Accessories** in Wiring Systems.
- 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** in Wiring Systems.

Symptom List

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

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

BATTERY INSPECTION/TEST

Tools Required

J 42000 Battery Tester. See **Special Tools**.

Diagnostic Aids

IMPORTANT:

- 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.
- If testing an AGM battery with the J 42000 , add 100 to the CCA rating of the battery and enter that amount into the tester when prompted for the CCA rating. See **Special**

Tools. For instance, if the AGM batteries CCA rating is 500 amps, enter 600 into the J 42000 . See Special Tools. Perform this modification only if the J 42000 does not ask if you are testing an AGM battery. See Special Tools. If these instructions are not followed when testing an AGM battery, an invalid test result and invalid test code will be obtained on the J 42000 . See Special Tools.

- The battery test using the J 42000 requires correct connections to the battery terminals. See Special Tools. A failure to obtain the correct connections during the test may result in a failed test on a good battery.

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 J 42000 clips on the terminal bolt. See Special Tools. This may cut through any coating or through any oxidation that may be present on the bolt.

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

- If correct connections to the battery terminal bolts in the vehicle are in doubt, perform the following steps:
 1. Disconnect the negative battery cable.
 2. Disconnect the positive battery cable.
 3. Install the test adapters on the terminals.
 4. Follow the instructions for an Out-of-Vehicle test.
- If the tester displays a REPLACE BATTERY or BAD CELL-REPLACE 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.
 3. Install the tester adapters.
 4. Follow the instructions for an Out-of-Vehicle test.
 5. Replace the battery only if the Out-of-Vehicle test shows a REPLACE BATTERY or BAD CELL-REPLACE result. This prevents battery replacements that are due only to faulty battery cable connections.
- Use the correct terminal adapters.

Do not use any common bolts or a combination of bolts, nuts, and or washers as adapters when testing the battery.

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Use the test adapters that are provided with the **J 42000** or P/N 12303040 terminal adapters. See **Special Tools**. If the adapters that are provided with the **J 42000** require replacement, use P/N 12303040. See **Special Tools**. Any other adapter may not contact the correct areas of the battery terminal, causing a resistance that may result in an invalid battery test result.

Battery Inspection/Test

Step	Action	Values	Yes	No
CAUTION: Refer to Battery Disconnect Caution in Cautions and Notices . IMPORTANT: Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. If the battery is replaced due to failing the test, only an Out-of-Vehicle test code is valid for warranty purposes.				
1	Inspect the battery for a cracked, broken, or damaged case, which may be indicated by battery acid leakage. Is the battery OK?	-	Go to Step 2	Go to Step 15
2	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. Refer to Battery Usage . Does the battery meet or exceed the specifications?	-	Go to Step 3	Go to Step 15
3	1. Turn OFF the ignition. 2. Attempt to rotate the negative battery cable connector clockwise with light finger pressure. Does the negative connector rotate?	-	Go to Step 4	Go to Step 5
4	Use a torque wrench in order to verify the torque to loosen the negative battery terminal bolt. Is the torque above the specified value?	10 N.m (88 lb in)	Go to Step 9	Go to Step 8
	Attempt to rotate the positive battery			

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5	cable connector clockwise with light finger pressure. Does the positive connector rotate?	-	Go to Step 7	Go to Step 6
6	IMPORTANT: Ensure that all of the electrical loads are turned OFF. 1. Install the J 42000 Battery Tester. See Special Tools. 2. Follow the directions supplied with the tester for an In-Vehicle test. 3. Follow any directions displayed on the tester. 4. If the tester calls for charging the battery, refer to Battery Charging. Did the tester pass the battery?	-	Go to Step 14	Go to Step 8
7	Use a torque wrench in order to verify the torque to loosen the positive battery terminal bolt. Is the torque above the specified value?	10 N.m (88 lb in)	Go to Step 10	Go to Step 8
8	1. Disconnect the negative battery cable. 2. Disconnect the positive battery cable. 3. Clean and wire brush the lead face of both battery terminals and the metal contact rings in both cable connectors. 4. Remove the bolts from the cable connectors in order to provide access to the connector rings as needed. 5. If either of the battery terminals or the cable rings are excessively damaged or corroded, replace as needed. Did you complete the repair?	-	Go to Step 11	-

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9	1. Disconnect the negative battery cable. 2. Inspect for the following conditions and repair as needed: • The cable bolt is too long or deformed at the end • There is foreign material present inside the nut in the battery terminal • Damage to the battery terminal face or cable connector ring Did you complete the repair?	Go to Step 10			-
10	1. Disconnect the positive battery cable. 2. Inspect for the following conditions and repair as needed: • The cable bolt is too long or deformed at the end • There is foreign material present inside the nut in the battery terminal • Damage to the battery terminal face or cable connector ring Did you complete the repair?	-	Go to Step 11	-	
11	IMPORTANT: Ensure that both battery cables are disconnected and proper adapters are installed in the battery terminals. 1. Install the J 42000 . See Special Tools. 2. Follow the directions supplied with the tester for an Out-of-Vehicle test. 3. Follow any directions displayed on the tester. 4. If the tester calls for charging	-			

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	the battery, refer to Battery Charging .		Go to Step 12	Go to Step 15	
	Did the tester pass the battery?				
12	1. Press the CODE button on the J 42000 . See Special Tools. 2. For warranty purposes, write the displayed code on the repair order.				
	Did you complete this action?		Go to Step 13		-
13	1. Connect the positive battery cable to the batteries positive terminal. - NOTE: Refer to Fastener Notice in Cautions and Notices. 2. Tighten the positive battery cable bolt to the specified value. 3. Connect the negative battery cable to the battery negative terminal. 4. Tighten the negative battery cable bolt to the specified value.	17 N.m (13 lb ft)			
	Are the cable bolts properly tightened?		Battery OK	-	
14	1. Press the CODE button on the J 42000 . See Special Tools. 2. For warranty purposes, write the displayed code on the repair order.				
	Did you complete the replacement?		Battery OK		-
15	Replace the battery. Refer to Battery Replacement .	-			
	Did you complete the replacement?		Battery OK	-	

BATTERY CHARGING

Tools Required

J 42000 Battery Tester. See **Special Tools**.

- 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 **J 42000** 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 battery's 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 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 SOC:

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 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 SOC according to the estimated battery temperature:

Battery Charging

Battery Voltage	% Charge at 0°C (32°F)	% Charge at 25°C (75°F)
-----------------	------------------------	-------------------------

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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 SOC information as follows:

- A battery with a SOC that is below 65 percent must always be recharged before returning it to service or continuing storage.
- A battery with a SOC 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:

1. The battery charger capacity. The higher the charger amperage, the less time it will take to charge the battery.
2. 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 manufacturer's instructions for operating this circuitry.
3. 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 in Cautions and Notices.

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 the remote jumper stud 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

Tools Required

J 38758 Parasitic Draw Test Switch. See **Special Tools**.

Diagnostic Aids

- Rule out any possible obvious influences, such as customer error or aftermarket equipment.
- Check customer driving habits, such as regular short trips. This does not allow enough time to properly charge the battery. Refer to **Battery Description and Operation**.

- Verify that the battery and charging system are in proper working order. Refer to **Battery Charging** and **Charging System Test**.
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar®, and regulated voltage control (RVC), if equipped, are designed to wake-up, perform a task, and go back asleep at regular intervals. Refer to **Control Module References** in Computer/Integrating Systems for the system or modules description and operation.
- Some systems and modules such as theft or remote keyless entry (RKE) will wake up due to an outside input. Refer to **Control Module References** in Computer/Integrating Systems for the system or modules description and operation.

IMPORTANT: The battery specification listed below is a generic specification. Refer to Battery Usage chart when testing the battery.

- The battery run down time will vary depending on cold cranking amperage (CCA) and reserve capacity (RC). If the CCA and RC are higher, then the battery run down time would be longer. If the CCA and RC are lower, then the battery run down time would be shorter. The graph below indicates roughly how many days a 690 CCA battery with at 110 minutes RC (60.5 AH) starting at 80 percent state of charge will last with a constant current draw until it reaches 50 percent state of charge. Differences in battery rating and temperature will affect the results.

Battery Electrical Drain/Parasitic Load Test

Current Drain	Days
25 mA	30.5
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Load Test

CAUTION: Refer to Battery Disconnect Caution in Cautions and Notices.

NOTE: Do not turn the parasitic draw test switch to the OFF position with the engine running. Damage will occur to the vehicle's electrical system.

NOTE: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

IMPORTANT: The switch knob on the J 38758 is marked ON and OFF. See Special Tools. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.

1. Disconnect the battery negative cable from the battery negative terminal.
2. Install the male end of the **J 38758** to the battery ground terminal. See Special Tools.
3. Turn the **J 38758** knob to the OFF position. See Special Tools.
4. Install the battery negative cable to the female end of the **J 38758**. See Special Tools.
5. Turn the **J 38758** knob to the ON position. See Special Tools.
6. Road test the vehicle and activate ALL of the accessories, including the radio and air conditioning. This may take up to 30 minutes.

IMPORTANT: Leaving the key in the ignition on some vehicles may cause a parasitic drain that is above the recommended amount. Refer to Body Control System Description and Operation in Computer/Integrating Systems.

7. Park the vehicle. Turn the ignition switch to the OFF position and remove the ignition switch key.
8. Connect a 10-amp fused jumper wire to the test switch tool terminals.
9. Turn the **J 38758** knob to the OFF position. See Special Tools. The current now flows through the jumper wire.
10. Wait 1 minute. If the fuse blows, install an inductive ammeter and go to step 20.
11. Remove the fused jumper wire.
12. Set a DMM to the 10A scale.
13. Connect the DMM to the test switch tool terminals.
14. Turn the **J 38758** knob to the OFF position. See Special Tools. The current flows now through the DMM.
15. Wait 1 minute. Inspect and record the current reading.

1. When there is a current reading on 2A or less, turn the **J 38758** knob to the ON position. See **Special Tools**. The electrical current will now pass through the switch.
2. Then switch the DMM down to the 2A scale for a more accurate reading when the **J 38758** knob is turned OFF. See **Special Tools**.
16. Turn the **J 38758** knob to the OFF position. See **Special Tools**. Wait 15 minutes for most vehicles.
17. Inspect and record the current reading.
18. Note the battery reserve capacity (amp hour rating). Refer to **Battery Usage**.
 1. Divide the reserve capacity by 4 (amp hour rating by 2.4).
 2. Compare this to the multimeter milliamp reading taken in the previous step. The parasitic current drain should not exceed this number. Example: If a battery has a reserve capacity of 100 minutes, (60 A/H) the current drain should not exceed 25 mA.
19. If excessive current drain is not found at this time and there are no other apparent causes, complete the following:
 1. Using the MIN/MAX function of the DMM, monitor the parasitic drain overnight or during the day. This will determine if something has been activated during that time frame.

NOTE: The test switch must be in the ON position when removing the fuses in order to maintain continuity in the electrical system. This avoids damaging the digital multimeter due to accidental overloading, such as a door being opened to change a fuse.

IMPORTANT: Removing fuses, relays, and connectors to determine the failure area may wake up modules. You must wait for these modules to go to sleep or use the sleep function on the scan tool.

2. When the vehicle has an unacceptable amount of parasitic current drain, remove each fuse one at a time until the current drain falls to an acceptable level. This will indicate which circuit is causing the drain. Refer to **Power Distribution Schematics** in Wiring Systems to diagnose exactly which part of the suspect circuit is causing the parasitic drain. In some cases a non-fused circuit or component, such as a relay, is the cause of excessive parasitic current drain. If it has been determined that the OnStar® system is the source of parasitic load.
3. Repeat the parasitic current drain test procedure after any repair has been completed to make sure that the parasitic current drain is at an acceptable level.
4. When the cause of the excessive current drain has been located and repaired,

remove the **J 38758** . See **Special Tools**.

20. Connect the battery negative cable to the battery negative terminal.

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 Procedures** in Wiring Systems.

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°C (-65°F). However, a battery with a low state of charge may freeze at temperatures as high as -7°C (20°F). Since freezing may ruin a battery, the battery should be protected against freezing by keeping it properly charged. As long as the green eye is visible in the hydrometer, the freezing point of the battery will be somewhere below -32°C (-25°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:

1. Ensure that the green dot is visible in the built-in hydrometer.

CAUTION: Refer to Battery Disconnect Caution in Cautions and Notices.

2. 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.

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4. Turn OFF the ignition on both vehicles.

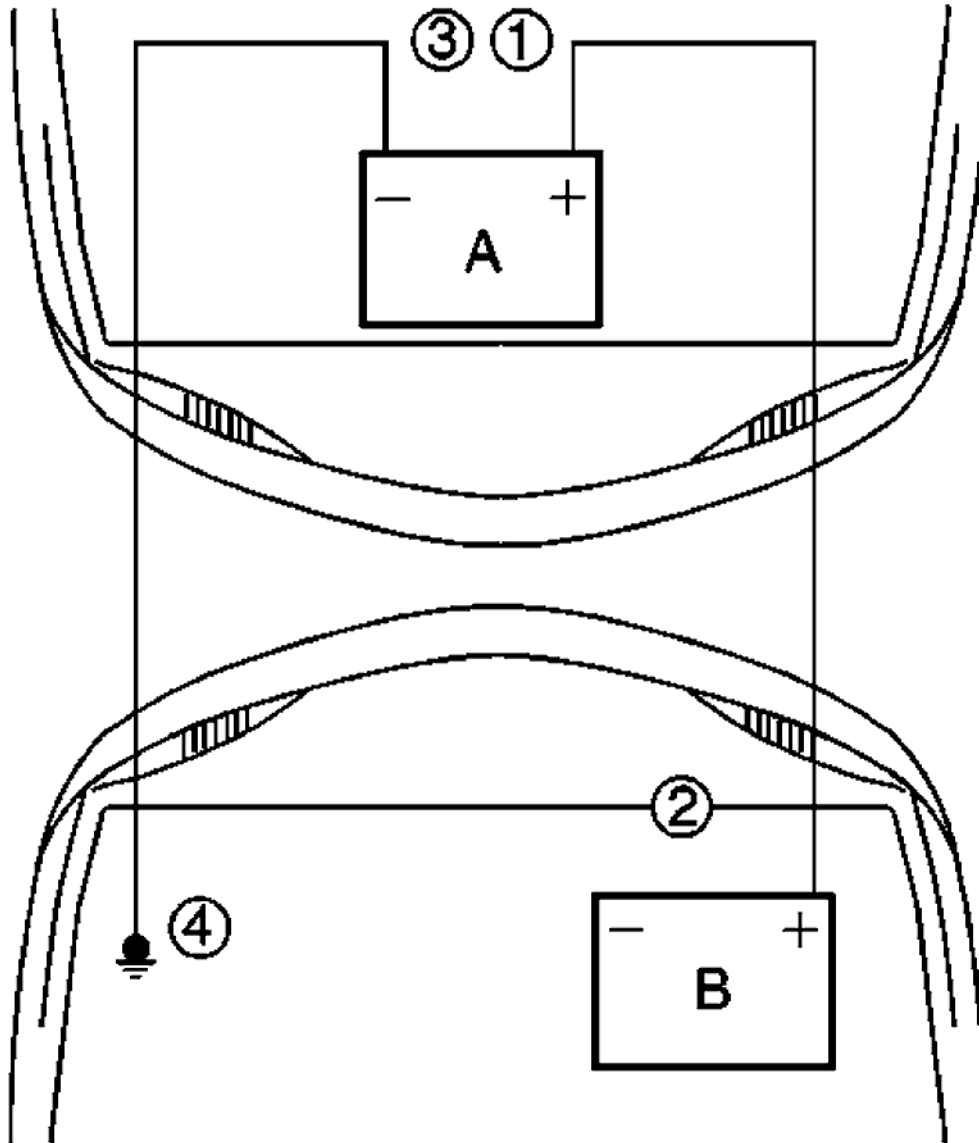


Fig. 9: Identifying Proper Jumper Cable Connection
Courtesy of GENERAL MOTORS CORP.

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

Step	Action	Value(s)	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step	Go to Diagnostic System Check

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			2	- Vehicle
2	IMPORTANT: The battery must be above a 70 percent state of charge. Did you perform the Battery Inspection Test?	-	Go to Step 3	Go to Battery Inspection/Test
3	1. Install a scan tool. 2. Start the engine. 3. With a scan tool, command the GEN-L Terminal OFF and ON. 4. Observe the Ignition 1 Signal parameter. Does the voltage change with each command?	-	Go to Step 4	Go to Step 8
4	1. Turn ON the following accessories: • Headlights-High beams • A/C-ON Max • Blower fan-ON high • Heated seats, if equipped 2. With a scan tool, observe the ignition 1 signal parameter in the engine data list. 3. Increase engine speed to 2,500 RPM. Is the voltage within the specified value?	12-15.5 V	Go to Step 5	Go to Step 6
	1. Turn OFF all accessories. 2. Turn OFF the ignition. CAUTION: 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.			

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5	3. Connect a carbon pile tester to the vehicle. IMPORTANT: When measuring generator output current, be sure the inductive probe encircles the generator output wire. 4. Connect an inductive ammeter probe to the output circuit of the generator. 5. Start the engine. 6. With a scan tool, command the GEN-L Terminal ON. 7. Increase engine speed to 2,500 RPM. 8. Adjust the carbon pile as necessary in order to obtain the maximum current output. Is the generator output greater than or equal to the load test value as specified in Generator Usage ?	-		
				System OK Go to Step 7
6	Is the voltage measured greater than the voltage specified?	15.5 V	Go to Step 12	Go to Step 7
7	1. Leave the vehicle accessories ON or maintain load test value. 2. Maintain engine speed at 2,500 RPM. 3. Measure the voltage between the generator output terminal and the generator metal housing. Is the voltage measured equal to the specified value?	B+	Go to Step 14	Go to Step 9
8	1. Turn ON the ignition, with the engine OFF. 2. Disconnect the generator harness connector. 3. Measure the voltage between the generator turn ON signal circuit and ground.	4.7 V		

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	4. With a scan tool, command the GEN-L Terminal ON and OFF. Does the voltage measure greater than the first value ON and near the second value OFF?	0 V	Go to Step 14	Go to Step 11
9	1. Maintain the engine speed at 2,500 RPM and continue to operate the generator at the load test value. 2. Measure the voltage drop from the battery negative terminal to the metal housing of the generator. Refer to Circuit Testing and Wiring Repairs. Is the voltage measured less than the specified value?	0.5 V	Go to Step 10	Go to Step 15
10	1. Maintain the engine speed at 2,500 RPM and continue to operate the generator at the load test value. 2. Measure the voltage drop from the output terminal of the generator to the positive terminal on the battery. Refer to Circuit Testing and Wiring Repairs. Is the voltage measured less than the specified value?	0.5 V	Go to Step 14	Go to Step 16
11	Test the generator turn on signal circuit for a short or open. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	-	Go to Step 19	Go to Step 13
12	Test the generator battery voltage sense circuit, if equipped, for an open or high resistance. Refer to Circuit Testing and Wiring Repairs. Did you find and correct the condition?	-	Go to Step 19	Go to Step 14

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13	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	-	Go to Step 19	Go to Step 17
14	Inspect for poor connections at the generator. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	-	Go to Step 19	Go to Step 18
15	Repair the high resistance or open in the ground circuit of the generator. Refer to Wiring Repairs . Did you complete the repair?	-	Go to Step 19	-
16	Repair the high resistance or open in the generator output circuit. Refer to Wiring Repairs . Did you complete the repair?	-	Go to Step 19	-
17	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	-	Go to Step 19	-
18	Replace the generator. Refer to Generator Replacement . Did you complete the replacement?	-	Go to Step 19	-
19	Operate the vehicle in order to verify the repair. Did you correct the condition?	-	System OK	Go to Step 2

CHARGE INDICATOR ALWAYS ON

Charge Indicator Always On

Step	Action	Value(s)	Yes	No
Connector End View Reference: Engine Control Module (ECM) Connector End Views for the 2.2L (L61) engine or Engine Control Module (ECM) Connector End Views for the 2.4L engine				
				Go to Diagnostic

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1	Did you perform the Diagnostic System Check - Vehicle?	-	Go to Step 2	System Check - Vehicle
2	1. Start the engine. 2. Turn OFF all accessories. Does the battery charge indicator remain illuminated?	-	Go to Step 3	Go to Testing for Intermittent Conditions and Poor Connections
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) data list, and the instrument panel cluster (IPC) data list. 6. Compare the voltages. Are all of the voltages within the specified range?	0.9-1.1 V	Go to Step 4	Go to Step 5
4	Are the voltages displayed within the specified range?	11-16 V	Go to Step 5	Go to Charging System Test
5	Test the battery positive voltage and ground circuits of the affected module for a high resistance or open. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	-	Go to Step 8	Go to Step 6
6	Inspect for poor connections at the harness connector of the affected module. Refer to Connector Repairs . Did you find and correct the condition?	-	Go to Step 8	Go to Step 7
7	Replace the affected module. Refer to Control Module References for replacement, setup, and programming.	-		-

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	Did you complete the replacement?		Go to Step 8	
8	Operate the system in order to verify the repair. Did you correct the condition?	-	System OK	Go to Step 2

CHARGE INDICATOR INOPERATIVE

Charge Indicator Inoperative

Step	Action	Yes	No
Connector End View Reference: Engine Control Module (ECM) Connector End Views for the 2.2L (L61) engine or Engine Control Module (ECM) Connector End Views for the 2.4L engine			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Turn ON the ignition, with the engine OFF. Does the battery charge indicator illuminate?	Go to Testing for Intermittent Conditions and Poor Connections	Go to Step 3
3	1. Install a scan tool. 2. With a scan tool, command the lamp and gages ON and OFF. Does the charge indicator turn ON and OFF with each command?	Go to Step 4	Go to Step 7
4	Test the generator turn on signal circuit for a short to ground or open. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 8	Go to Step 5
5	Inspect for poor connections at the harness connector of the engine control module (ECM). Refer to Connector Repairs . Did you find and correct the condition?	Go to Step 8	Go to Step 6
6	Replace the ECM. Refer to Control Module References for replacement, setup, and programming. Did you complete the replacement?	Go to Step 8	-
7	Replace the instrument panel cluster (IPC). Refer to Control Module References for replacement, setup, and programming.		

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	Did you complete the replacement?	Go to Step 8	-
8	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

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	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Test the generator for proper operation using the Generator Tester. Refer to Charging System Test . Is the generator operating properly?	Go to Step 3	Go to Step 12
3	1. Start the engine. Verify that the noise can be heard. 2. Turn OFF the engine. 3. Disconnect the harness connector from the generator. 4. Start the engine. 5. Listen for the noise. Has the noise stopped?	Go to Step 12	Go to Step 4
4	1. Turn OFF the engine. 2. Remove the drive belt. Refer to Drive Belt Replacement for the 2.2L (L61) engine or Drive Belt Replacement for the 2.4L engine. 3. Spin the generator pulley by hand.		

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	Does the generator shaft spin smoothly and without any roughness or grinding noise?	Go to Step 5	Go to Step 12
5	Inspect the generator for a loose pulley and/or pulley nut. Is the generator pulley or pulley nut loose?	Go to Step 12	Go to Step 6
6	1. Loosen all of the generator mounting bolts. 2. Tighten the generator mounting bolts to specifications and in the proper sequence, if necessary. Refer to Generator Replacement. 3. Install the drive belt. Refer to Drive Belt Replacement for the 2.2L (L61) engine or Drive Belt Replacement for the 2.4L engine. 4. Start the engine. Has the noise decreased or stopped?	System OK	Go to Step 7
7	Inspect the generator for the following conditions: • Strained or stretched electrical connections • Hoses or other vehicle equipment resting on the generator, which may cause the noise to be transmitted into the passenger compartment Are any electrical connections pulling on the generator or are any hoses, etc. resting on the generator?	Go to Step 8	Go to Step 9
8	1. Reroute the electrical connections to relieve the tension. 2. Reroute the hoses, etc. away from the generator. 3. Start the engine. Has the noise decreased or stopped?	System OK	Go to Step 9
	Inspect the drive belt for proper tension. Refer to Drive Belt Tensioner Diagnosis		

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9	for the 2.2L (L61) engine or Drive Belt Tensioner Diagnosis for the 2.4L engine. Is the drive belt loose?	Go to Step 10	Go to Step 11
10	1. Replace the drive belt tensioner. Refer to Drive Belt Tensioner Replacement for the 2.2L (L61) engine or Drive Belt Tensioner Replacement for the 2.4L engine. 2. Start the engine. Has the noise decreased or stopped?	System OK	Go to Step 12
11	Compare the vehicle with a known good vehicle. Do both vehicles make the same noise?	System OK	Go to Step 12
12	IMPORTANT: 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 Generator Replacement . Did you complete the replacement?	Go to Step 13	-
13	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

STARTER SOLENOID DOES NOT CLICK

Starter Solenoid Does Not Click

Step	Action	Yes	No
Schematic Reference: Connector End View Reference:			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	1. Turn the ignition switch to the START position. 2. If equipped with a manual transmission, fully depress the clutch	Go to Testing for Intermittent Conditions and	

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	pedal.		
	Does the engine crank?	Poor Connections	Go to Step 3
3	1. Install a scan tool. 2. Turn ON the ignition, with the engine OFF. 3. With a scan tool, observe the Starter Relay Command parameter in the engine control module (ECM) data list. 4. Turn the ignition switch to the START position. 5. If equipped with a manual transmission, fully depress the clutch pedal.		Go to Step 4 Automatic Transmission Go to Step 5 Manual Transmission
	Does the scan tool display ON?	Go to Step 5	
4	1. Turn ON the ignition, with the engine OFF. 2. Verify that the transmission is in Park or Neutral. 3. With a scan tool, observe the TR Sw. parameter in the transmission control module (TCM) data list.		Go to Shift Indicator Indicates Wrong Gear Selection
	Does the scan tool display Park or Neutral?	Go to Step 5	
5	1. Turn the ignition to the START position. 2. If equipped with a manual transmission, fully depress the clutch pedal.		
	Do you hear the crank relay click?	Go to Step 8	Go to Step 6
6	IMPORTANT: This circuit feeds the crank relay coil. 1. Turn OFF the ignition. 2. Disconnect the crank relay. 3. Turn ON the ignition, with the engine OFF.		

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	- Fully depress the clutch pedal on a manual transmission. - Connect a test lamp between the battery positive voltage circuit of the crank relay coil and a good ground. Does the test lamp illuminate?	Go to Step 7	Go to Step 16
7	IMPORTANT: This circuit feeds the crank relay coil. - Connect a test lamp between the battery positive voltage circuit of the crank relay coil and the control circuit of the crank relay. - Fully depress the clutch pedal on a manual transmission. - Apply the brake and press the Start button. Does the test lamp illuminate?	Go to Step 13	Go to Step 12
8	- Turn OFF the ignition. - Disconnect the crank relay. - Connect a test lamp between the battery positive voltage circuit of the crank relay switch circuit and a good ground. Does the test lamp illuminate?	Go to Step 9	Go to Step 17
9	IMPORTANT: Ensure the parking brake is applied and the transmission is in park equipped with an automatic transmission or neutral on a manual transmission. 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?	Go to Step 13	Go to Step 10
10	Does the fuse in the jumper open?	Go to Step 18	Go to Step 11
	Test the supply voltage circuit of the starter solenoid for a high resistance or open.		

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11	Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 22	Go to Step 14
12	Test the crank relay control circuit of the ECM for a high resistance or open. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 22	Go to Step 15
13	Inspect for poor connections at the crank relay. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 22	Go to Step 19
14	Inspect for poor connections at the starter solenoid. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 22	Go to Step 20
15	Inspect for poor connections at the harness connector of the ECM. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 22	Go to Step 21
16	Repair an open or high resistance in the battery positive voltage circuit of the crank relay coil. Refer to Wiring Repairs . Did you complete the repair?	Go to Step 22	-
17	Repair the open or high resistance in the battery positive voltage circuit of the crank relay switch. Refer to Wiring Repairs . Did you complete the repair?	Go to Step 22	-
18	Repair the short to ground in the supply voltage circuit of the starter solenoid. Refer to Wiring Repairs . Did you complete the repair?	Go to Step 22	-
19	Replace the crank relay. Did you complete the replacement?	Go to Step 22	-
20	Replace the Starter Motor. Refer to Starter Motor Replacement . Did you complete the replacement?	Go to Step 22	-
21	Replace the ECM. Refer to Control Module References for replacement, setup, and programming.		

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	Did you complete the replacement?	Go to Step 22	-
22	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 2

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

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

4: When testing the circuit for a high resistance, ensure to use the voltage drop test in the Circuit Testing procedure. If the circuit has more than a 0.5-volt drop when the starter is engaged then there is a high resistance.

5: When testing the circuit for a high resistance, ensure to use the voltage drop test in the Circuit Testing procedure. If the circuit has more than a 0.5-volt drop when the starter is engaged, then there is a high resistance. Ensure when testing the engine ground to battery to connect the engine ground lead to the base of the starter.

Starter Solenoid Clicks, Engine Does Not Crank

Step	Action	Yes	No
Schematic Reference: Starting and Charging Schematics			
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to Diagnostic System Check - Vehicle
2	Turn the ignition to the START position. Did the starter solenoid click?	Go to Step 3	Go to Starter Solenoid Does Not Click
3	Inspect the engine and belt drive system for mechanical binding, e.g. seized engine, seized generator. Does the engine move freely?	Go to Step 4	Go to Engine Will Not Crank - Crankshaft Will Not Rotate for the 2.2L (L61) engine or Engine Will Not Crank - Crankshaft Will Not Rotate for the 2.4L engine

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4	Test the battery positive cable between the battery and the starter solenoid for high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 8	Go to Step 5
5	Test the ground circuit between the battery and the engine for a high resistance. Refer to Circuit Testing and Wiring Repairs . Did you find and correct the condition?	Go to Step 8	Go to Step 6
6	Inspect for poor connections at the starter. Refer to Testing for Intermittent Conditions and Poor Connections and Connector Repairs . Did you find and correct the condition?	Go to Step 8	Go to Step 7
7	Replace the starter. Refer to Starter Motor Replacement . Did you complete the replacement?	Go to Step 8	-
8	Operate the system for which the symptom occurred. Did you correct the condition?	System OK	Go to Step 2

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** , and **Connector Repairs** in Wiring Systems.
- 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.
- Shim the starter as required.
- In order to add pinion to ring gear clearance, a full size shim must be used. Do not shim only one starter mounting bolt. There are 3 shims available in different shapes for

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clearance. All are 1 mm (0.039 in) thick.

Starter Motor Noise Diagnosis

Step	Action	Yes	No
1	Did you perform the Diagnostic System Check - Vehicle?	Go to Step 2	Go to <u>Diagnostic System Check - Vehicle</u>
2	Start the engine. Does the starter operate normally?	Go to <u>Testing for Intermittent Conditions and Poor Connections</u>	Go to Step 3
3	Start the engine while listening to the starter motor turn. Is there a loud "whoop" it 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?	Go to Step 6	Go to Step 4
4	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?	Go to Step 7	Go to Step 5
5	IMPORTANT: This is often diagnosed as a starter drive gear hang-in or a weak solenoid. When the engine is cranked, do you hear a high-pitched whine after the engine cranks and starts normally?	Go to Step 8	Go to Step 7
6	Inspect the flywheel ring gear for the following: • Chipped gear teeth • Missing gear teeth • Milled teeth Is the flywheel bent, or does it have damaged teeth?	Go to Step 9	Go to Step 10
	1. Remove the starter motor. Refer to <u>Starter Motor Replacement</u> .		

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7	2. Inspect the starter motor bushings and clutch gear. Does the clutch gear have chipped or milled teeth or worn bushings?	Go to Step 10	Go to Step 9
8	Shim the starter motor away from the flywheel by adding shims between the starter motor and the engine block one at a time. Flywheel runout may make this noise appear to be intermittent. Did you complete the repair?	Go to Step 11	-
9	Replace the flywheel. Refer to Engine Flywheel Replacement for the 2.2L (L61) engine or Engine Flywheel Replacement for the 2.4L engine. Did you complete the replacement?	Go to Step 11	-
10	Replace the starter motor. Refer to Starter Motor Replacement . Did you complete the replacement?	Go to Step 11	-
11	Operate the system in order to verify the repair. Did you correct the condition?	System OK	Go to Step 3

REPAIR INSTRUCTIONS**BATTERY NEGATIVE CABLE DISCONNECT/CONNECT PROCEDURE****Disconnect Procedure**

CAUTION: Refer to **SIR Caution** .

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

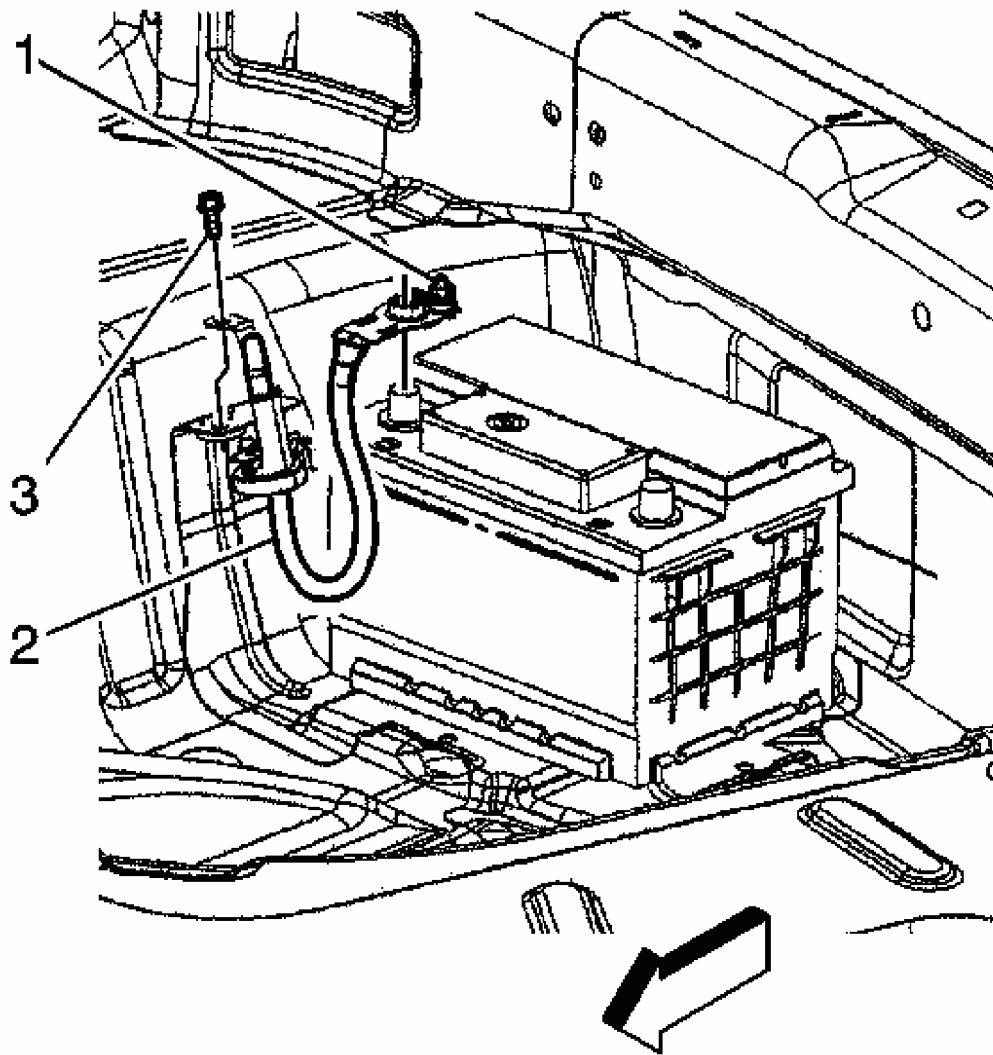


Fig. 10: Battery Negative Cable
Courtesy of GENERAL MOTORS CORP.

1. Record all of the vehicle preset radio stations.
2. Turn OFF all the lamps and the accessories.
3. Make sure the ignition switch is in the OFF position.
4. Remove the rear floor trim plate. Refer to **Floor Trim Plate Replacement - Rear** .
5. Remove the rear compartment trim panel. Refer to **Compartment Trim Panel Replacement - Rear** .
6. Loosen the negative battery cable nut (1).

7. Remove the negative battery cable from the battery.

Connect Procedure

IMPORTANT: Clean any existing oxidation from the contact face of the battery terminal and battery cable using a wire brush before installing the battery cable to the battery terminal.

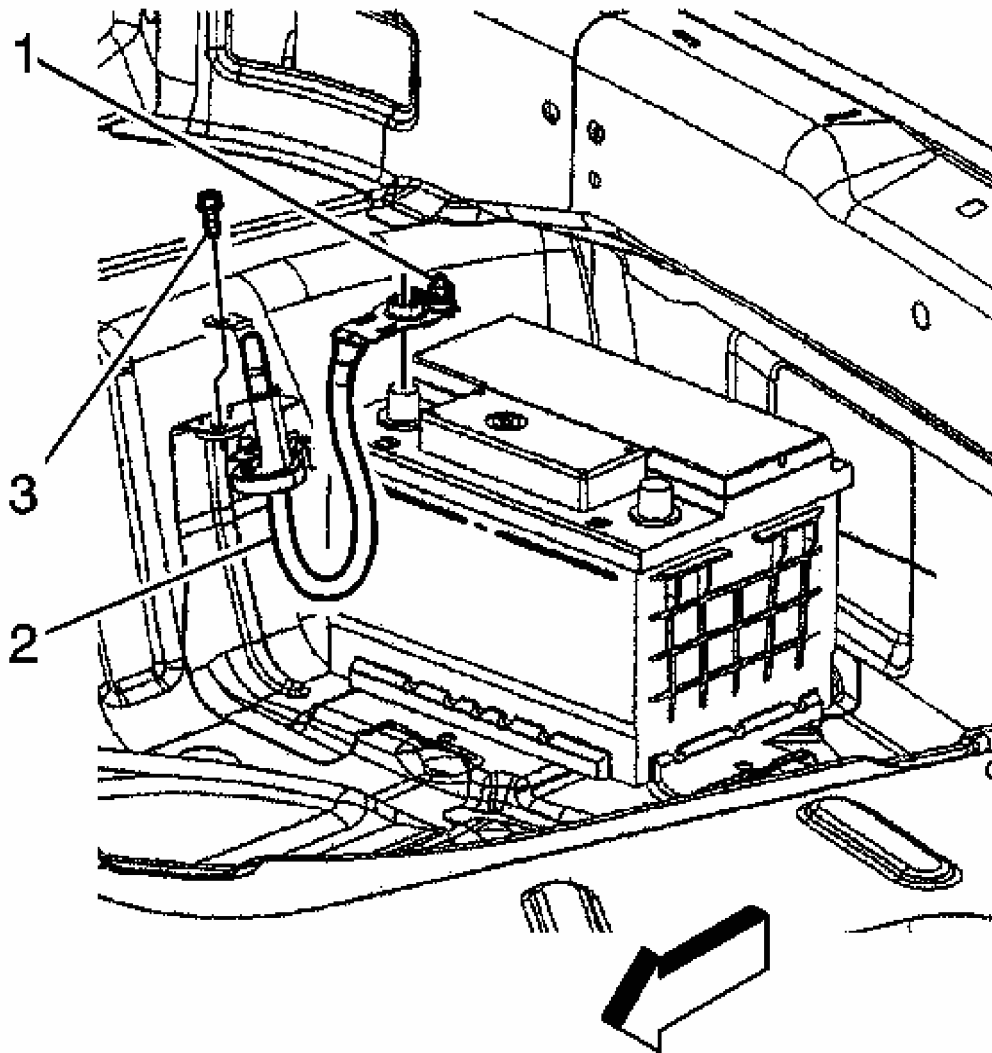


Fig. 11: Battery Negative Cable
Courtesy of GENERAL MOTORS CORP.

1. Install the negative battery cable to the battery.

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NOTE: Refer to Fastener Notice in Cautions and Notices.

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

Tighten: Tighten the nut to 15 N.m (11 lb ft).

3. Install the rear compartment trim panel. Refer to Compartment Trim Panel Replacement - Rear .
4. Install the rear floor trim plate. Refer to Floor Trim Plate Replacement - Rear .
5. Reset the radio stations and the clock.

BATTERY CURRENT SENSOR REPLACEMENT

Removal Procedure

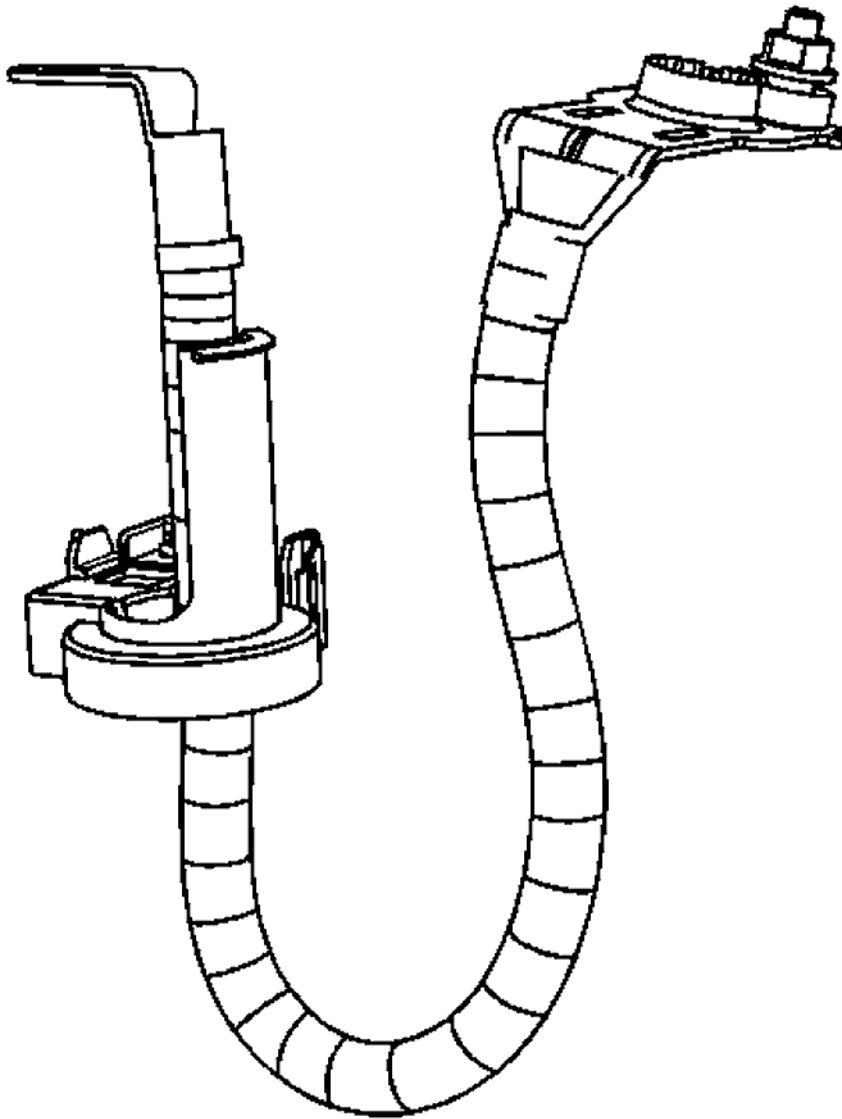


Fig. 12: Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Remove the negative battery cable. Refer to **Battery Negative Cable Replacement**.
2. Remove the tape securing the battery current sensor to the negative battery cable.

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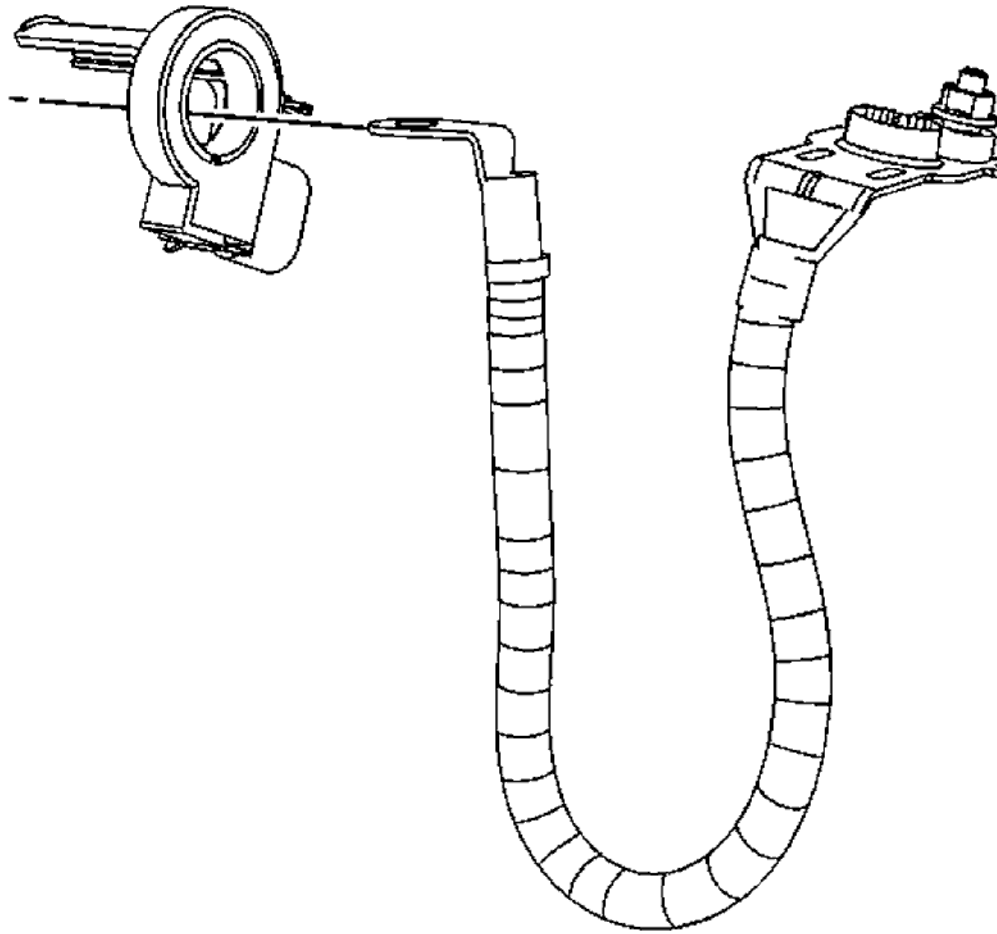


Fig. 13: Battery Current Sensor
Courtesy of GENERAL MOTORS CORP.

3. Remove the battery current sensor from the negative battery cable.

Installation Procedure

2006 Chevrolet HHR LT

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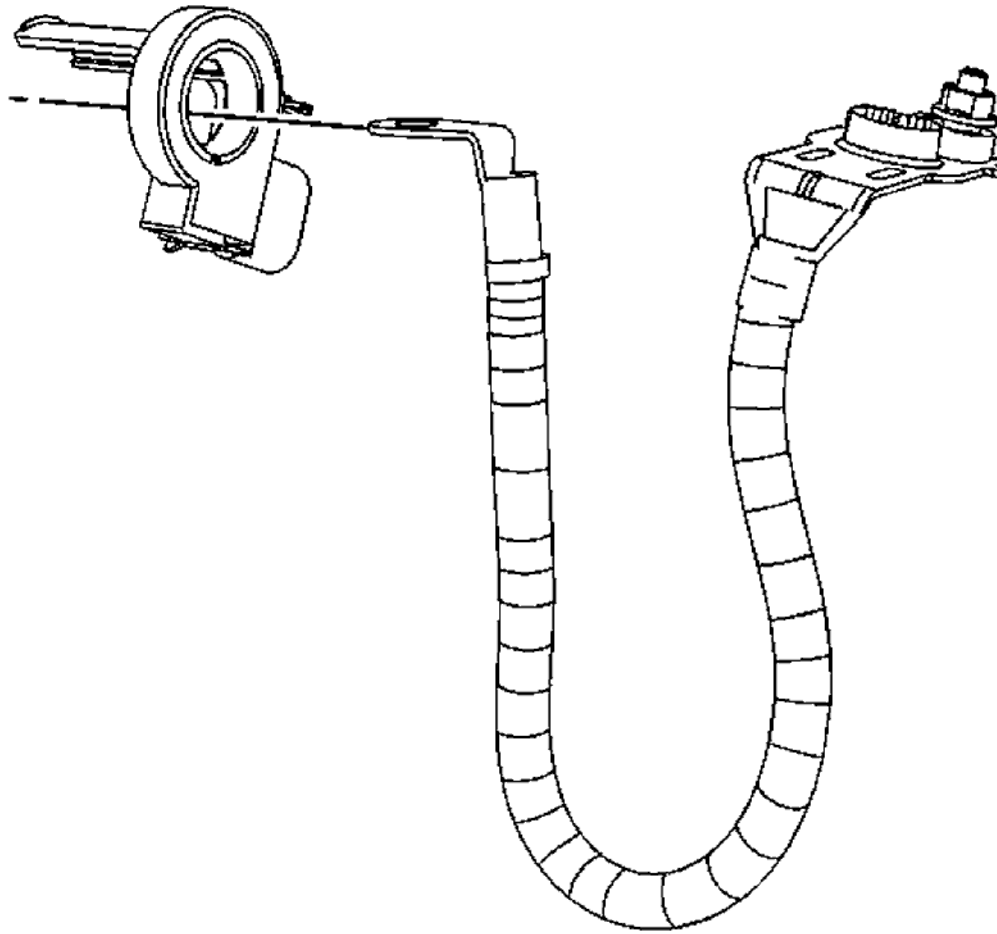


Fig. 14: Battery Current Sensor
Courtesy of GENERAL MOTORS CORP.

1. Install the battery current sensor by passing the ground end of the negative battery cable through the sensor.

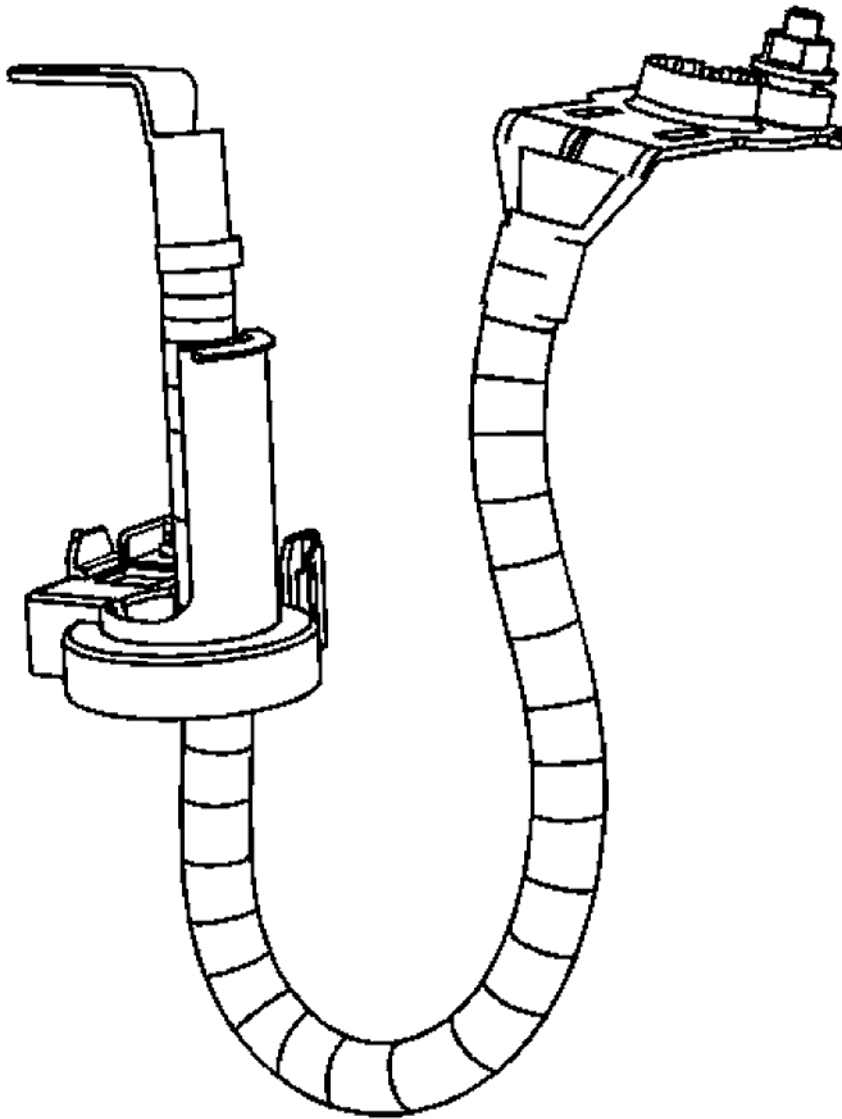


Fig. 15: Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Ensure the battery current sensor is installed in the correct direction and location on the negative battery cable.

2. Wrap electrical tape around the battery current sensor in order to secure the battery current sensor to the negative battery cable.
3. Install the negative battery cable. Refer to **Battery Negative Cable Replacement**.

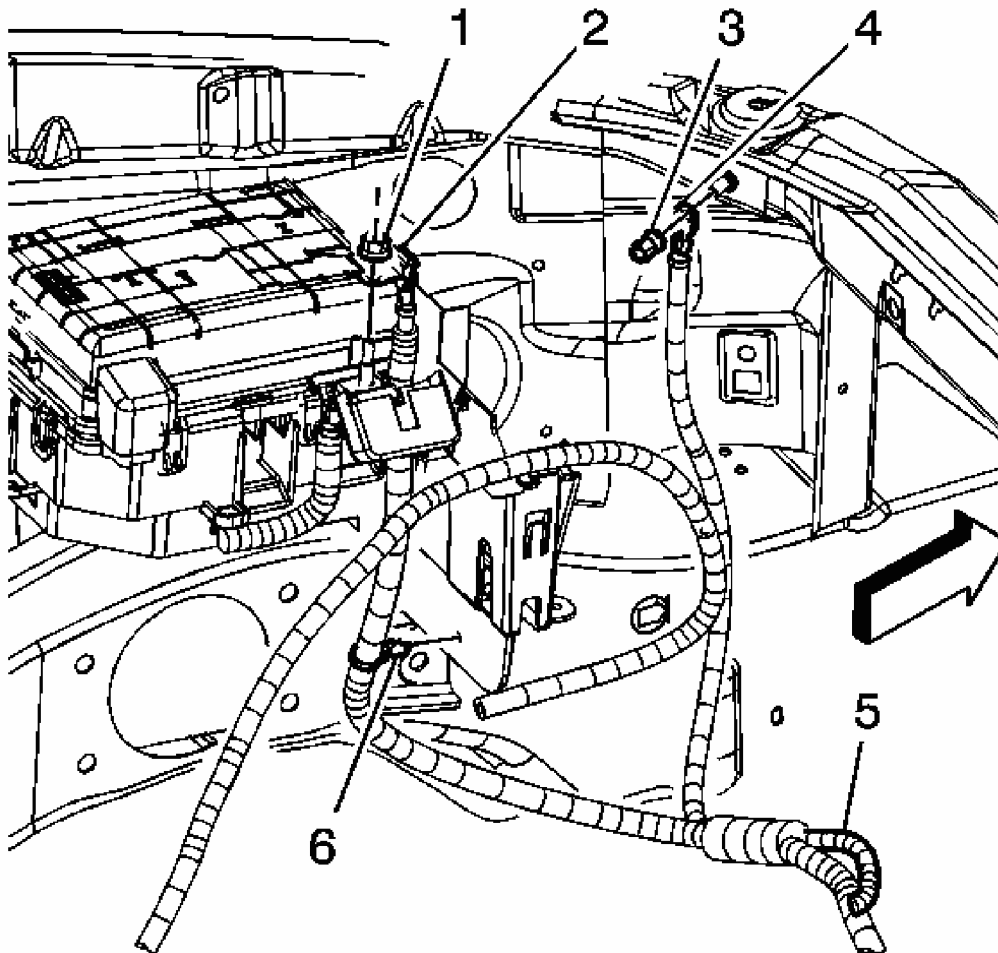
BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT**Removal Procedure**

Fig. 16: Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Open the junction block terminal cover.
3. Remove the junction block terminal nut (1).
4. Remove the positive/negative battery cable terminal (2) from the junction block terminal stud.
5. Remove the positive/negative ground nut (3) from the tie bar stud.

6. Remove the positive/negative ground terminal (4) from the tie bar stud.
7. Remove the positive/negative battery cable clip (6) from the engine control module (ECM)/transaxle control module (TCM) bracket.
8. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

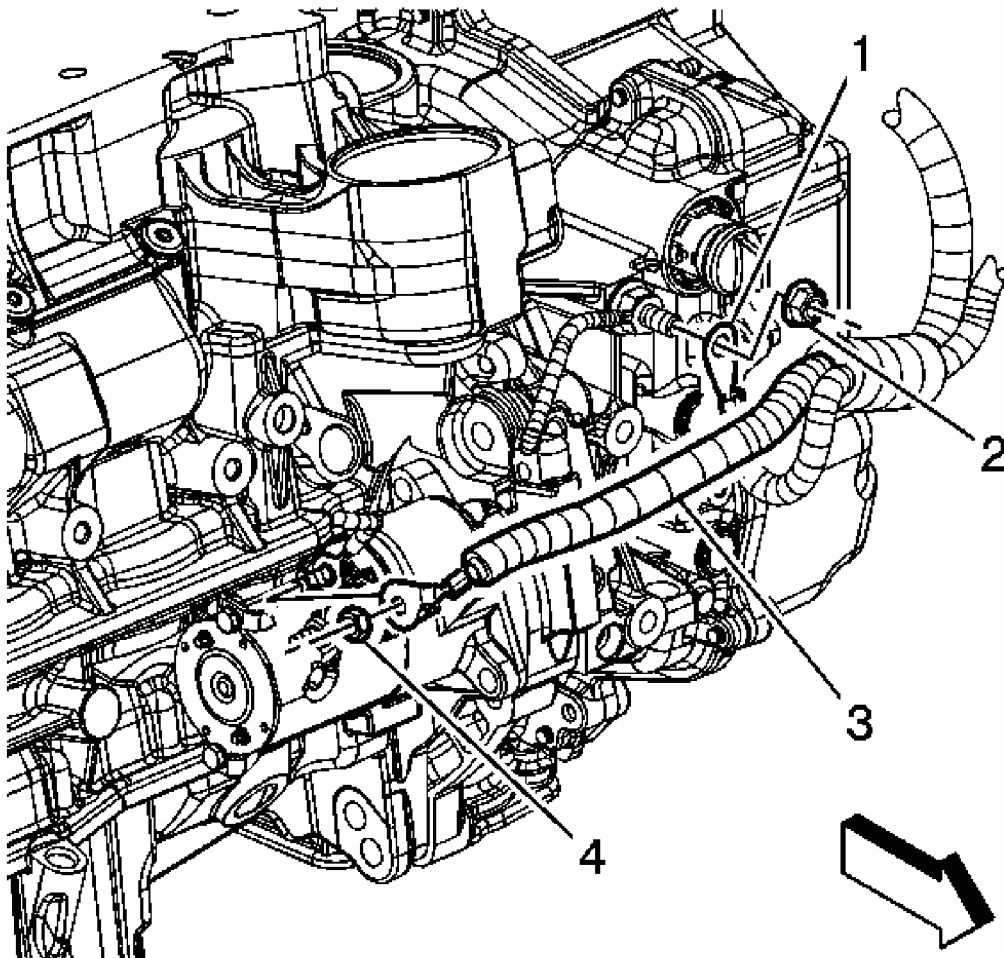


Fig. 17: Positive/Negative Cable Ground Terminal
Courtesy of GENERAL MOTORS CORP.

9. If equipped with a automatic transaxle, perform the following steps, remove the positive/negative battery cable ground nut (2).
10. Remove the positive/negative cable ground terminal (1) from the transaxle stud.
11. Remove the starter solenoid nut (4).
12. Remove the positive/negative battery cable (3) from the starter.

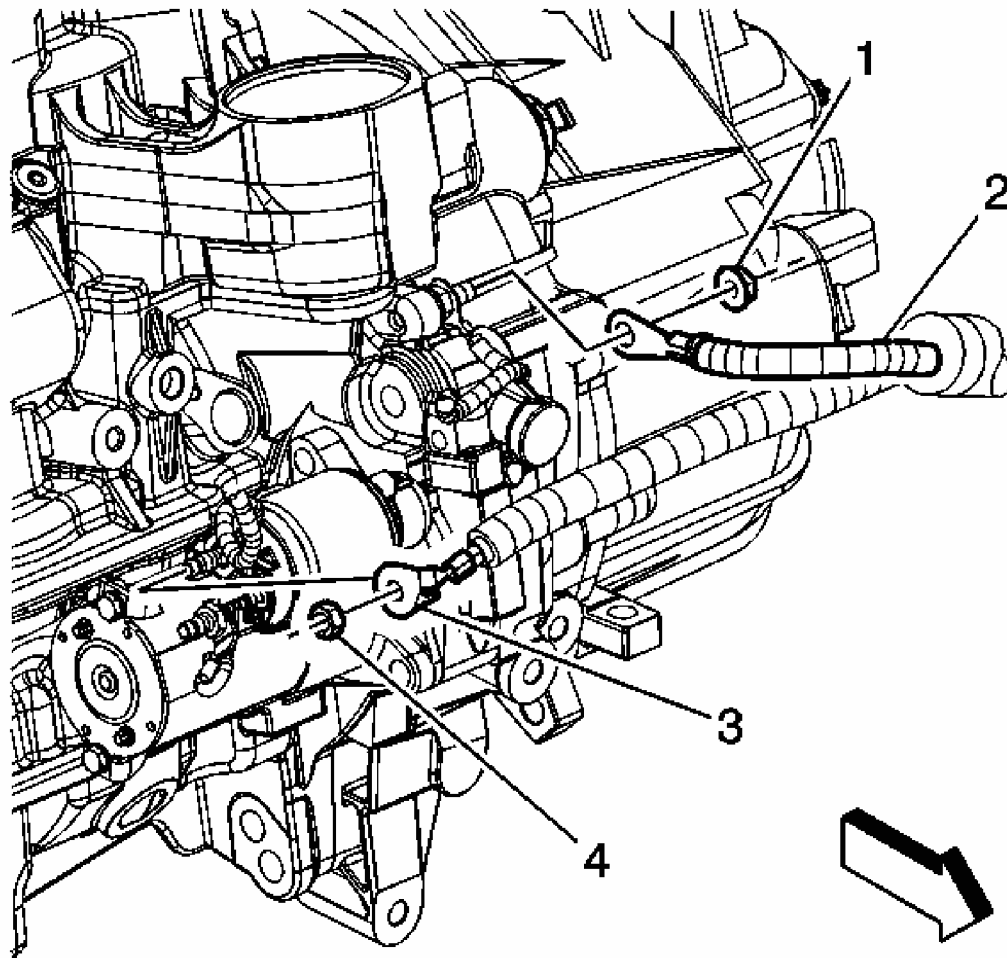


Fig. 18: Positive/Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

13. If equipped with a manual transaxle, perform the following steps, remove the positive/negative battery cable ground nut (1).
14. Remove the positive/negative cable ground terminal (2) from the transaxle stud.
15. Remove the starter solenoid nut (4).
16. Remove the positive/negative battery cable (3) from the starter.

Installation Procedure

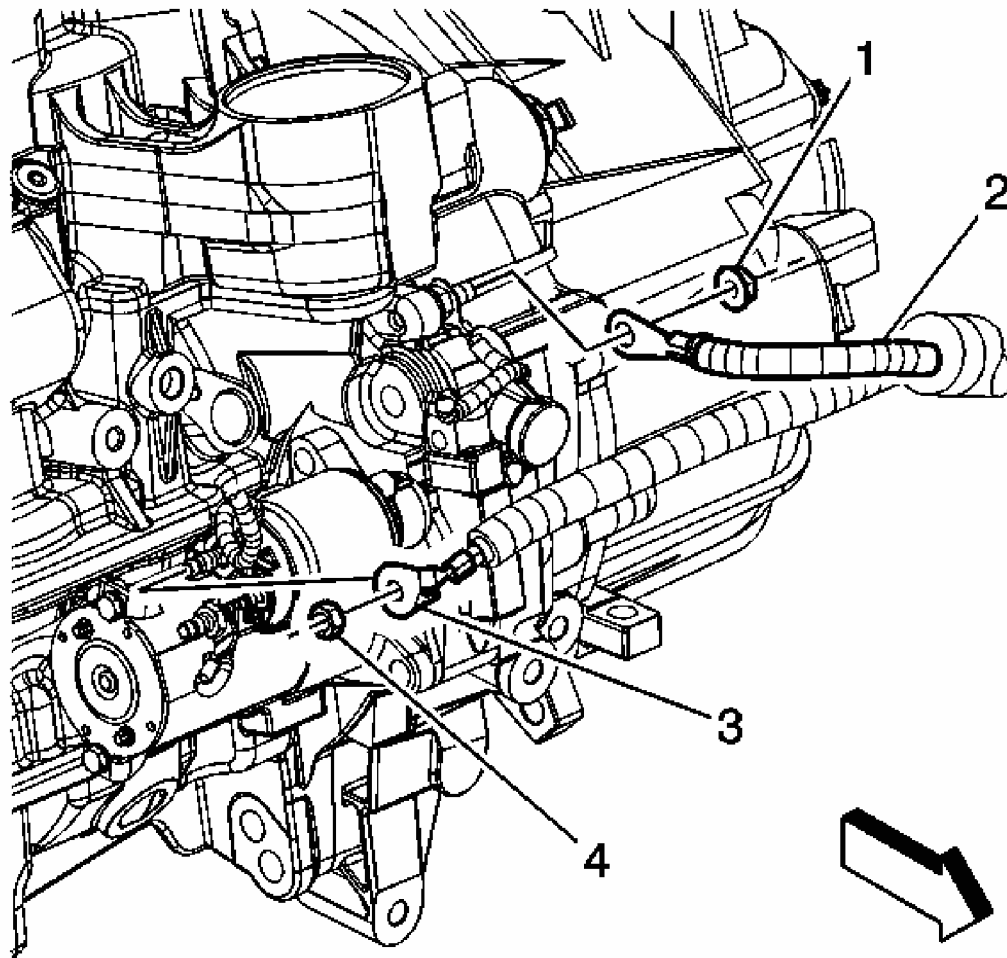


Fig. 19: Positive/Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. If equipped with a manual transaxle, perform the following steps, install the positive/negative battery cable (3) to the starter.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the starter solenoid nut (4).

Tighten: Tighten the nut to 17 N.m (13 lb ft).

3. Install the positive/negative cable ground terminal (2) to the transaxle stud.
4. Install the positive/negative battery cable ground nut (1).

Tighten: Tighten the nut to 10 N.m (89 lb in).

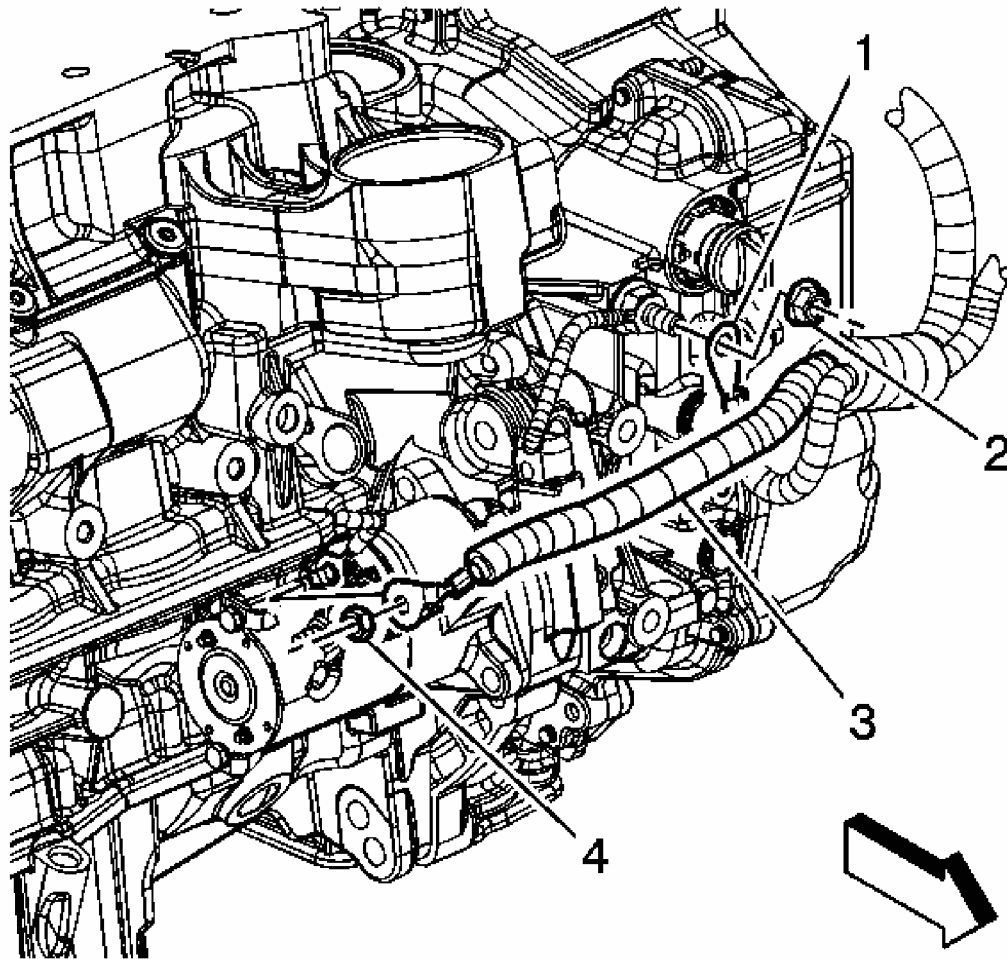


Fig. 20: Positive/Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

5. If equipped with a automatic transaxle, perform the following steps, install the positive/negative battery cable (3) to the starter.
6. Install the starter solenoid nut (4).

Tighten: Tighten the nut to 17 N.m (13 lb ft).

7. Install the positive/negative cable ground terminal (1) to the transaxle stud.
8. Install the positive/negative battery cable ground nut (2).

Tighten: Tighten the nut to 10 N.m (89 lb in).

9. Lower the vehicle.

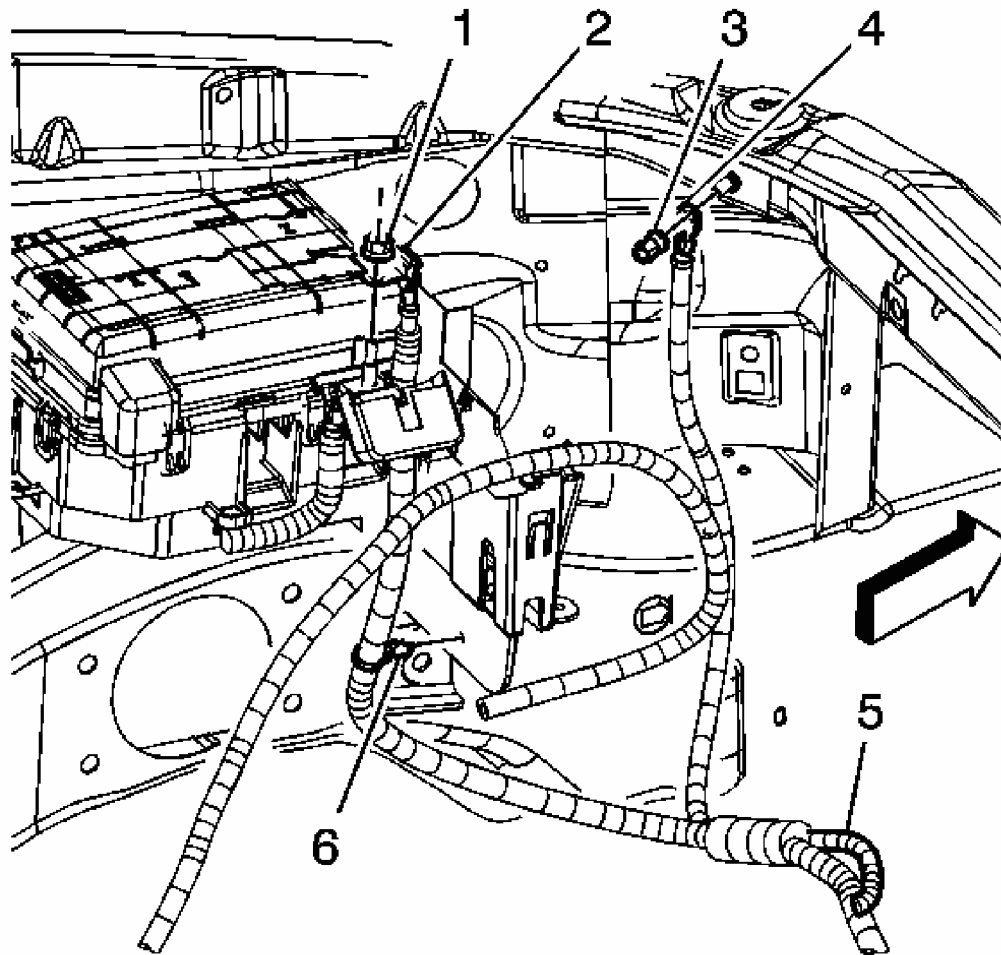


Fig. 21: Positive/Negative Battery Cable Clip
Courtesy of GENERAL MOTORS CORP.

10. Install the positive/negative battery cable clip (6) to the ECM/TCM bracket.
11. Install the positive/negative ground terminal (4) to the tie bar stud.
12. Install the positive/negative ground nut (3) to the tie bar stud.
13. Install the positive/negative battery cable terminal (2) to the junction block terminal stud.
14. Install the junction block terminal nut (1).

Tighten: Tighten the nut to 15 N.m (11 lb ft).

15. Close the junction block terminal cover.
16. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

BATTERY NEGATIVE CABLE REPLACEMENT

Removal Procedure

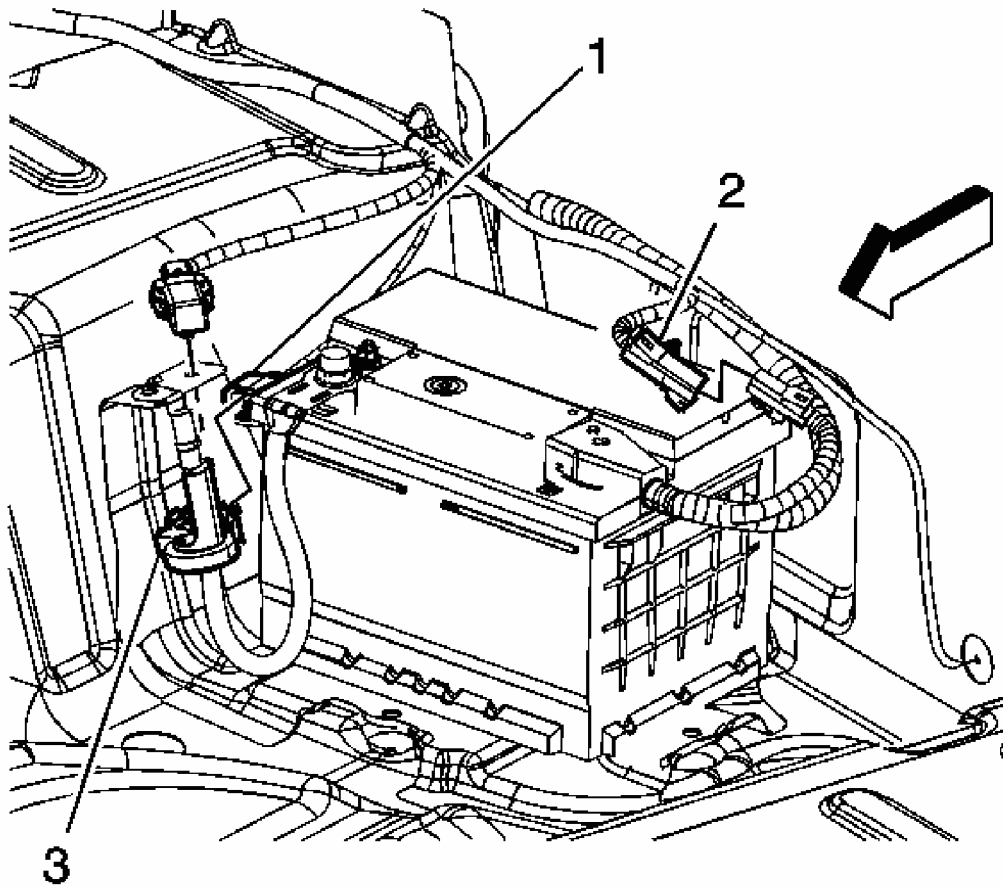


Fig. 22: Body Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Disconnect the body harness electrical connector (1) from the battery current sensor (3).

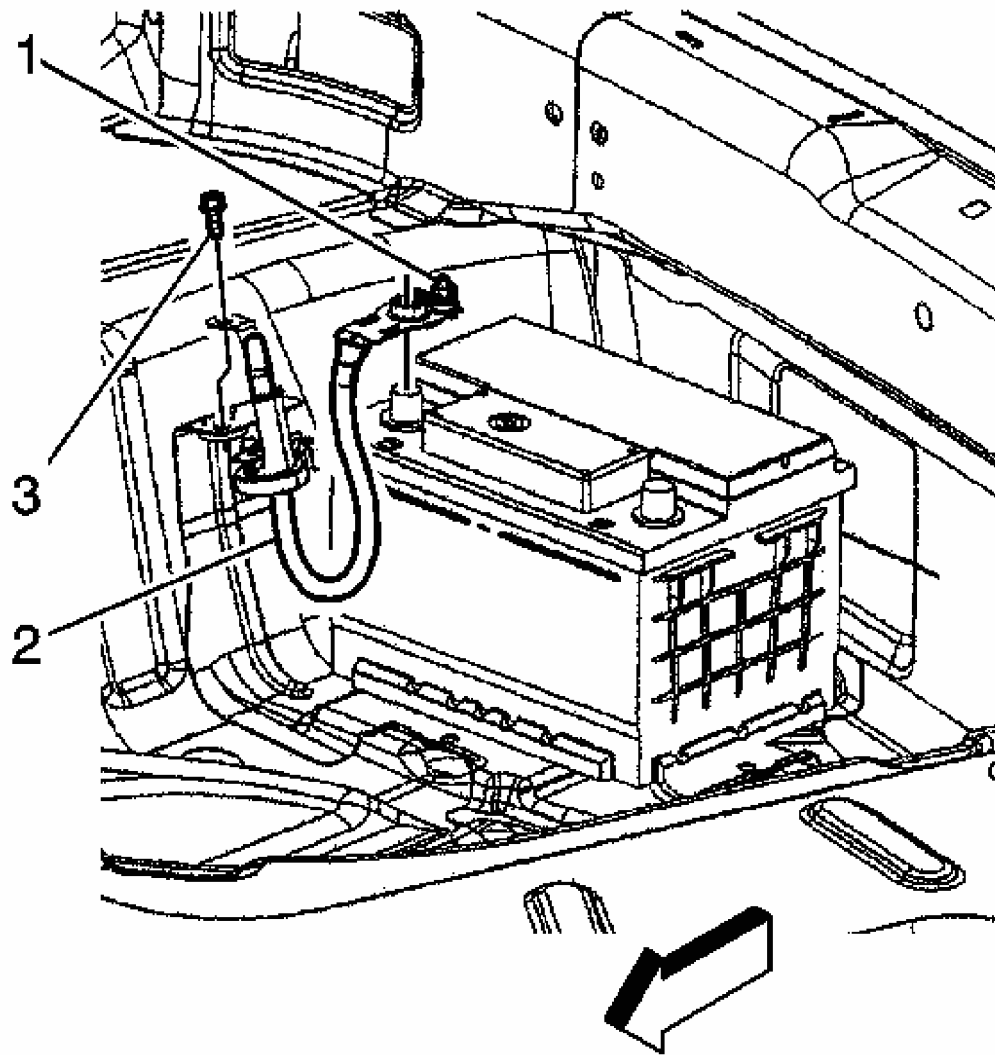


Fig. 23: Negative Battery Cable Bolt
Courtesy of GENERAL MOTORS CORP.

3. Remove the negative battery cable bolt (3) at the support.
4. Remove the negative battery cable (2).

Installation Procedure

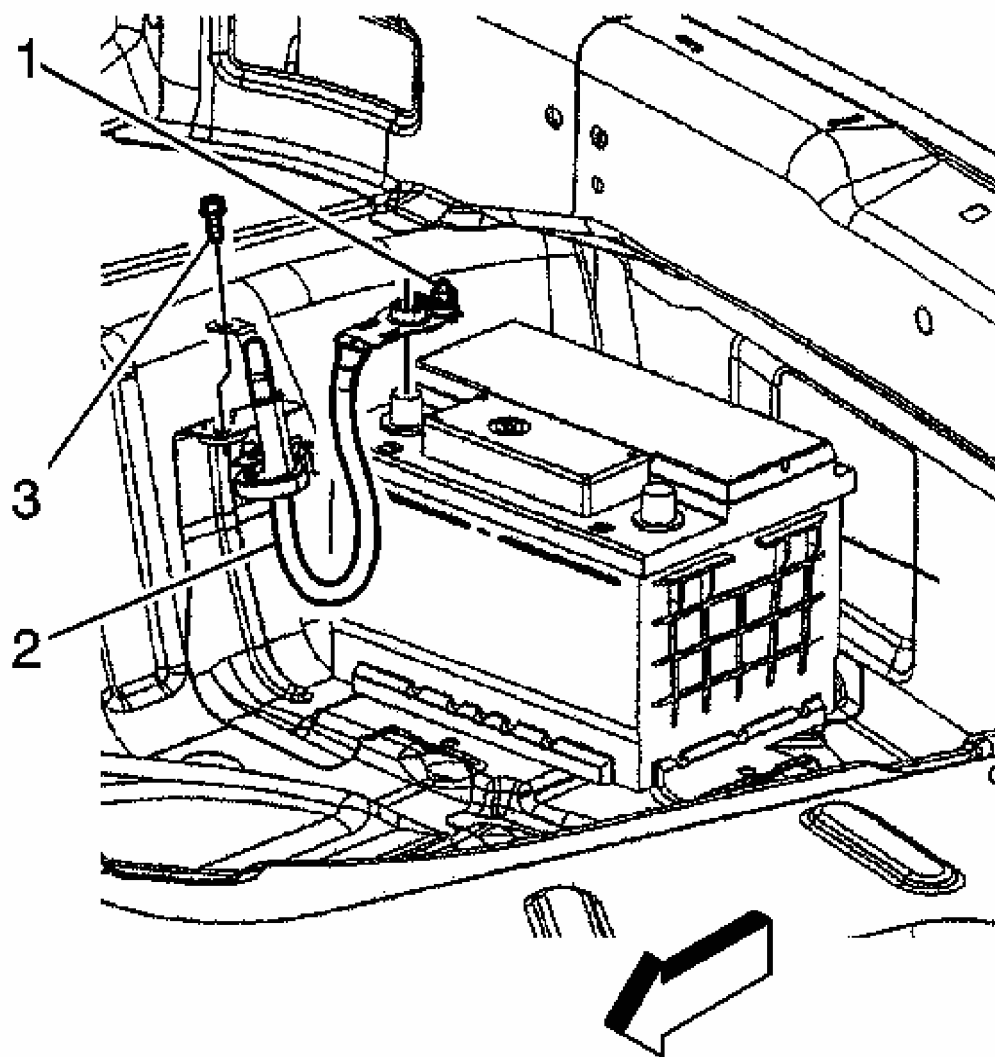


Fig. 24: Negative Battery Cable Bolt
Courtesy of GENERAL MOTORS CORP.

1. Install the negative battery cable (2).

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the negative battery cable bolt (3) at the support.

Tighten: Tighten the bolt to 20 N.m (15 lb ft).

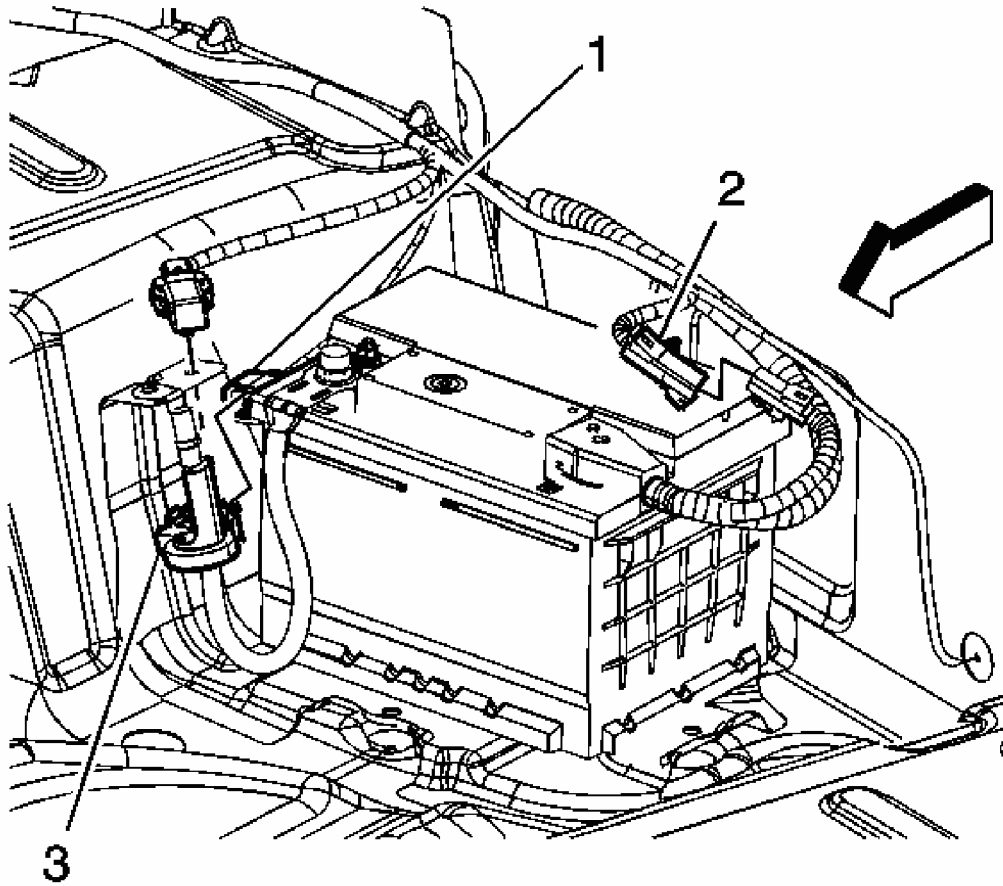


Fig. 25: Body Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

3. Connect the body harness electrical connector (1) to the battery current sensor (3).
4. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

BATTERY POSITIVE CABLE REPLACEMENT

Removal Procedure

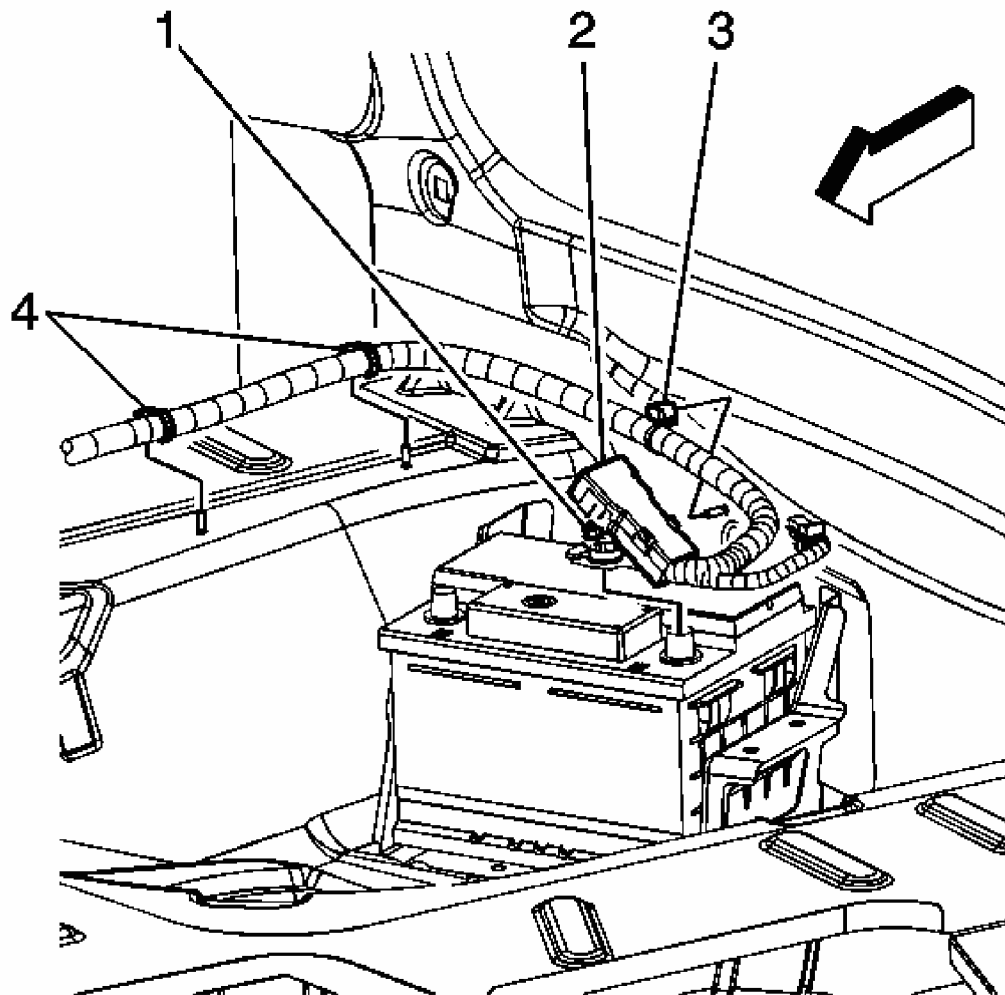


Fig. 26: Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Remove the carpet. Refer to **Carpet Replacement**.
3. Open the positive battery cable cover (2).
4. Loosen the positive battery cable nut (1).
5. Remove the positive battery cable from the battery.
6. Remove the positive battery cable clips (3, 4) from the studs.

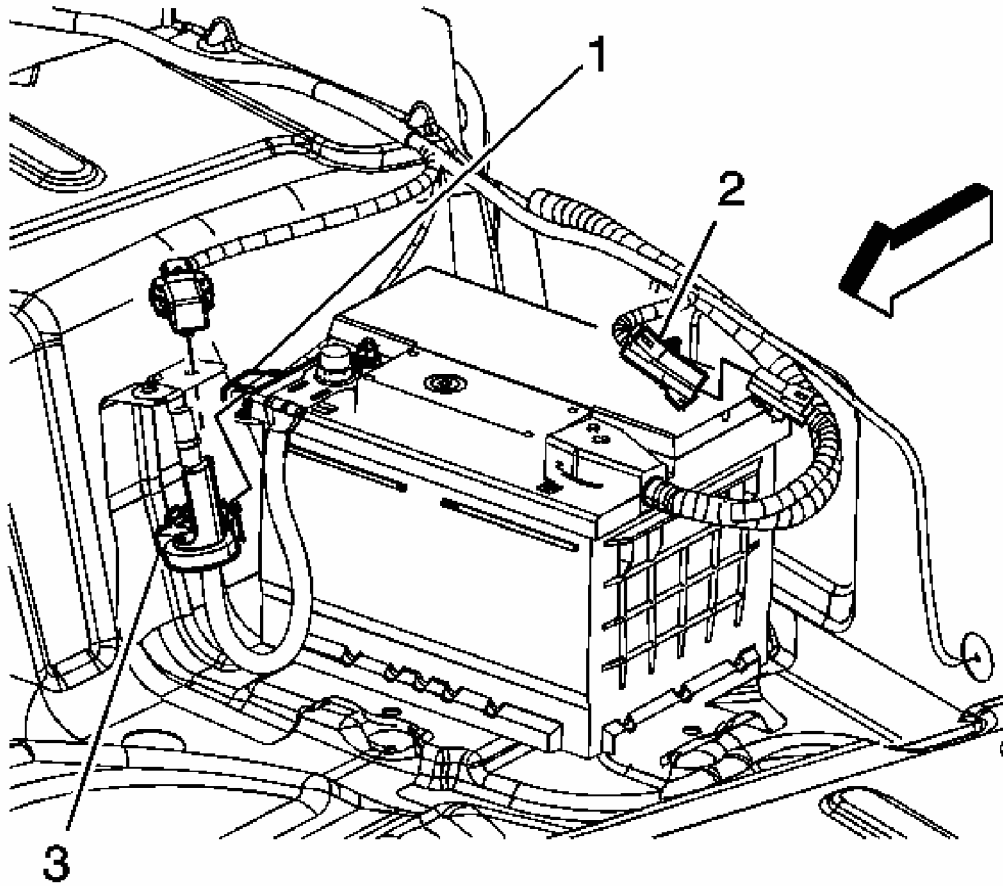


Fig. 27: Body Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

7. Disconnect the body harness electrical connector (2) from the positive battery cable connector.

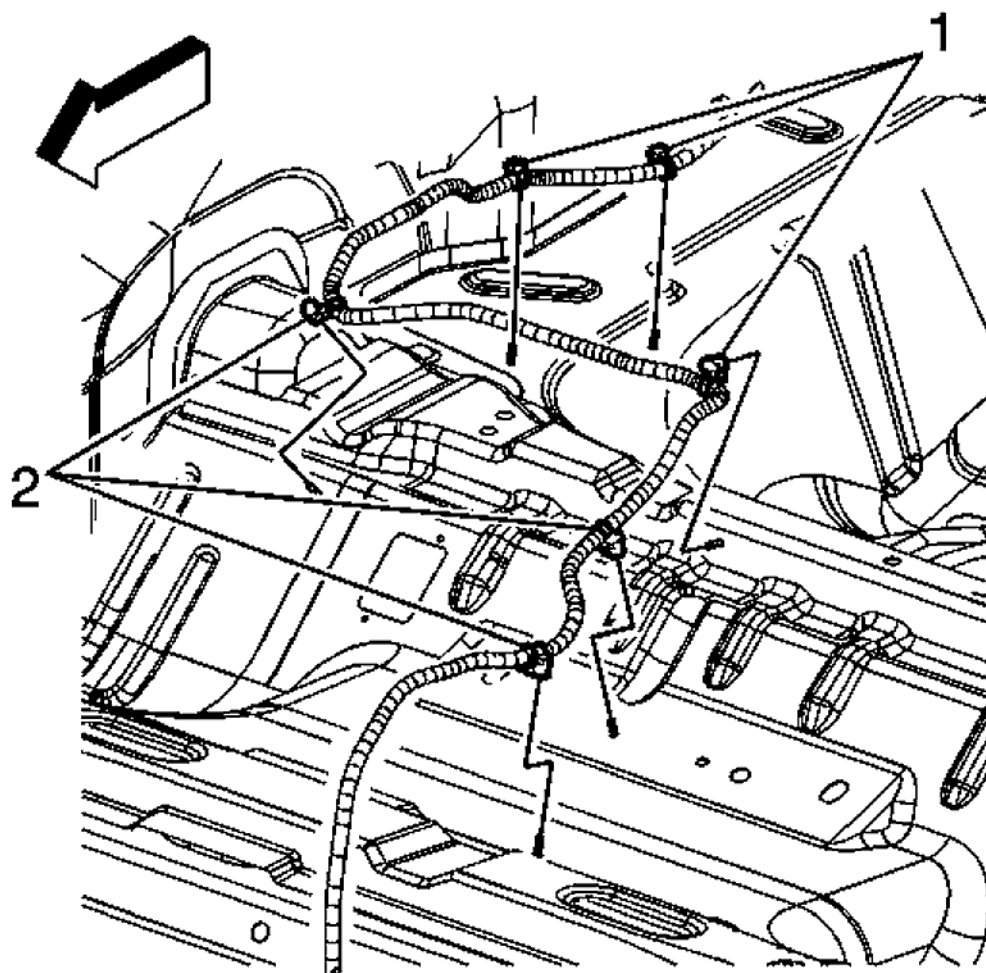


Fig. 28: Positive Battery Cable Clips
Courtesy of GENERAL MOTORS CORP.

8. Remove the positive battery cable clips (1, 2) from the rear compartment panel studs.

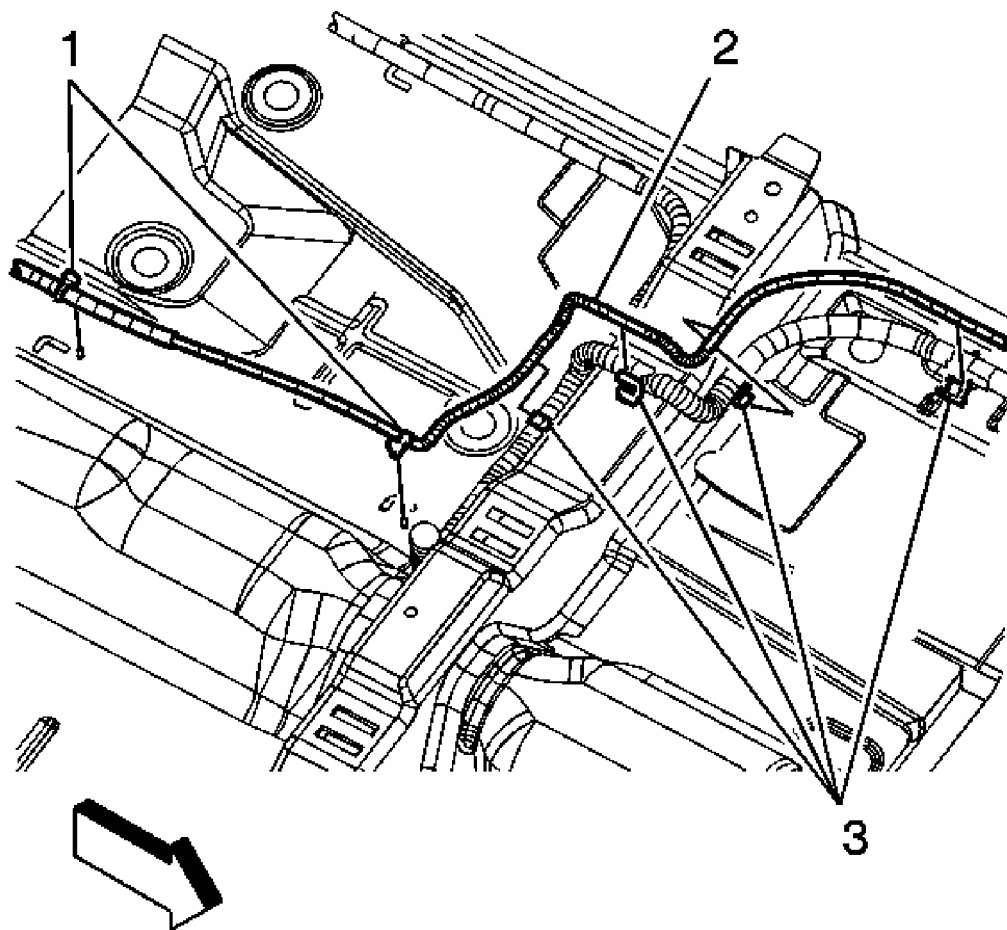


Fig. 29: Positive Battery Cable

Courtesy of GENERAL MOTORS CORP.

9. Remove the positive battery cable (2) from the clips (3) on the body harness.
10. Remove the positive battery cable clips (1) from the floor panel studs.

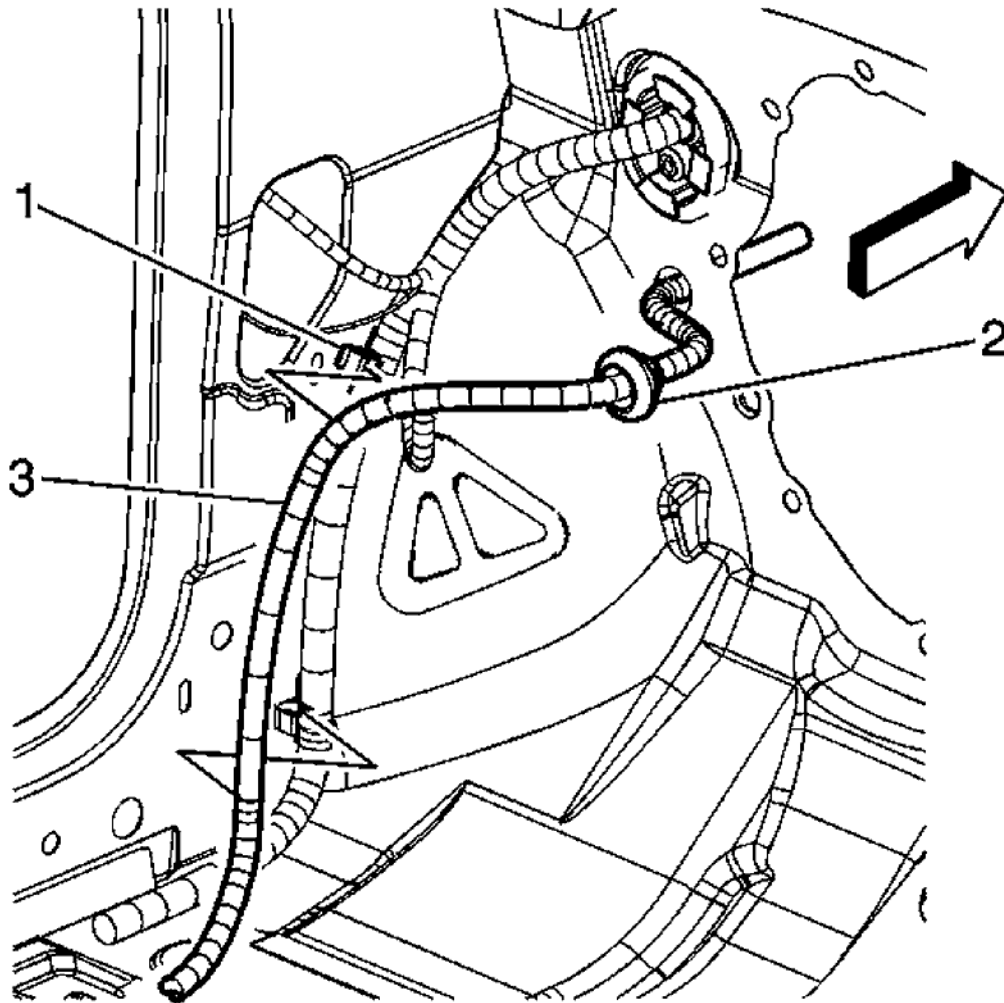


Fig. 30: Positive Battery Cable Clips
Courtesy of GENERAL MOTORS CORP.

11. Remove the positive battery cable (3) from the clips (1) on the body harness.
12. Remove the rubber grommet (2) from the front of dash.

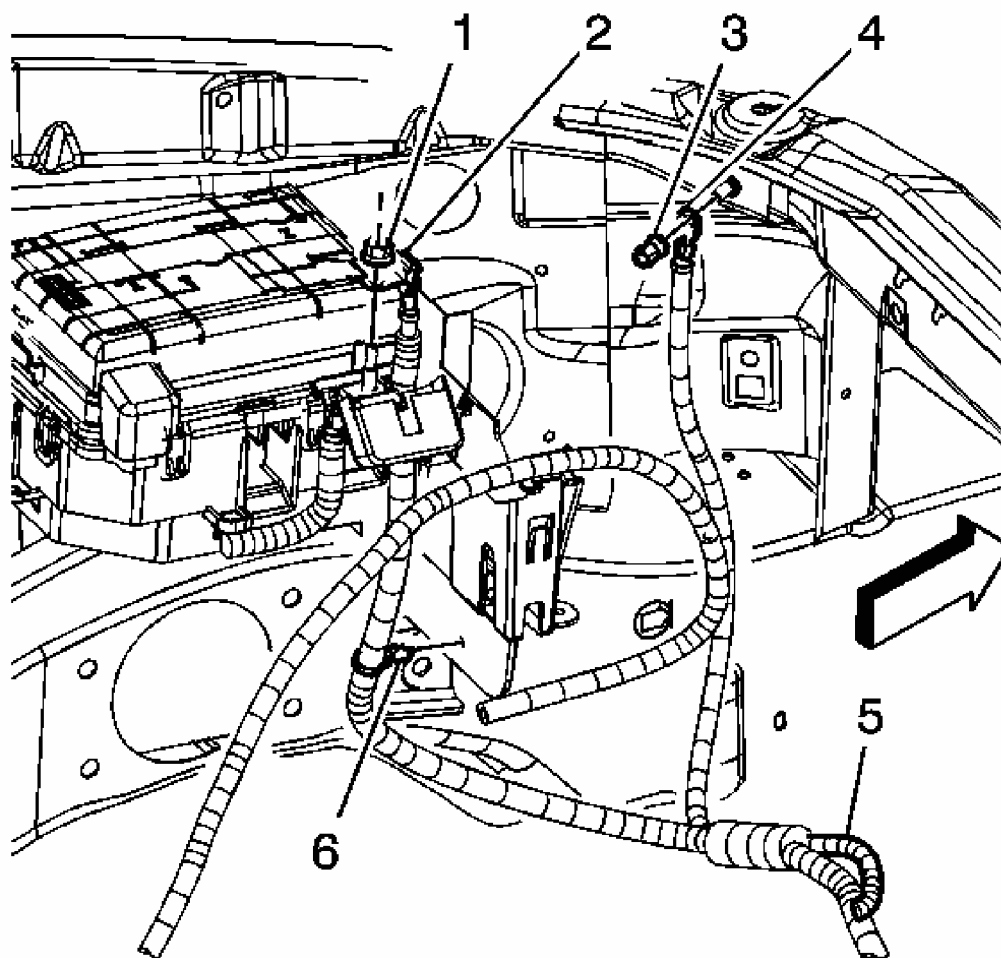


Fig. 31: Junction Block Terminal Cover
Courtesy of GENERAL MOTORS CORP.

13. Open the junction block terminal cover.
14. Remove the junction block terminal nut (1).
15. Remove the positive/negative battery cable terminal (2) from the stud.

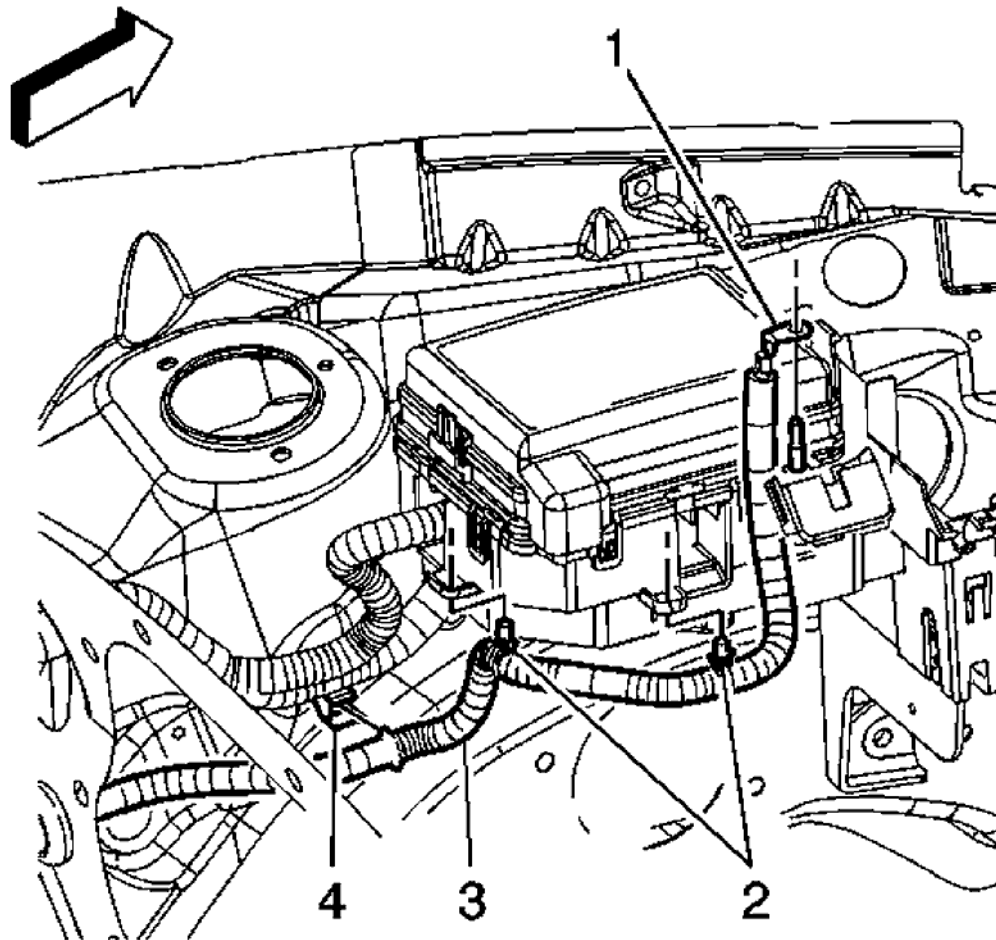


Fig. 32: Positive Battery Cable Terminal From Junction Block Stud
Courtesy of GENERAL MOTORS CORP.

16. Remove the positive battery cable terminal (1) from the junction block stud.
17. Remove the positive battery cable clips (2) from the engine control module (ECM)/transaxle control module (TCM) bracket.
18. Remove the positive battery cable from the body harness clip (4).
19. From inside the vehicle, remove the engine compartment portion of the positive battery cable through the front of dash.
20. Remove the positive battery cable from inside the vehicle.

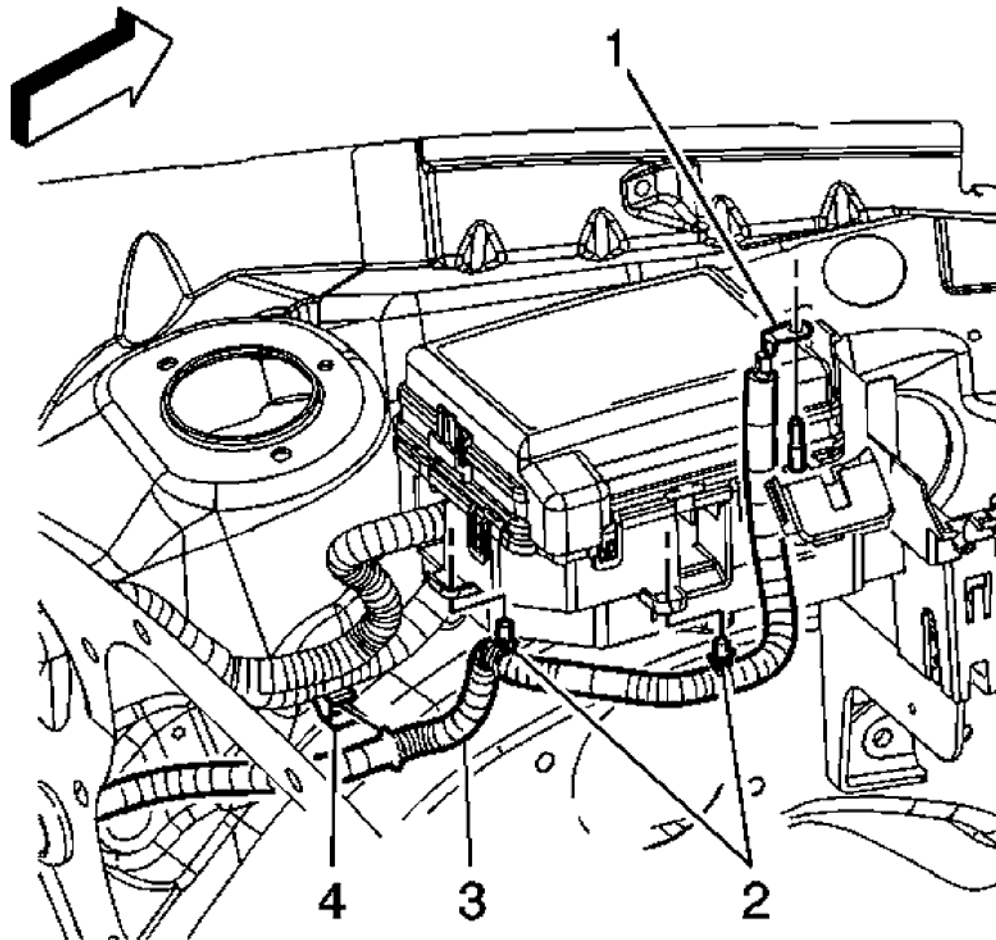


Fig. 33: Positive Battery Cable Terminal From Junction Block Stud
Courtesy of GENERAL MOTORS CORP.

1. Install the positive battery cable to the inside the vehicle.
2. From inside the vehicle, route the engine compartment portion of the positive battery cable through the front of dash.
3. Install the positive battery cable to the body harness clip (4).
4. Install the positive battery cable clips (2) to the ECM/TCM bracket.
5. Install the positive battery cable terminal (1) to the junction block stud.

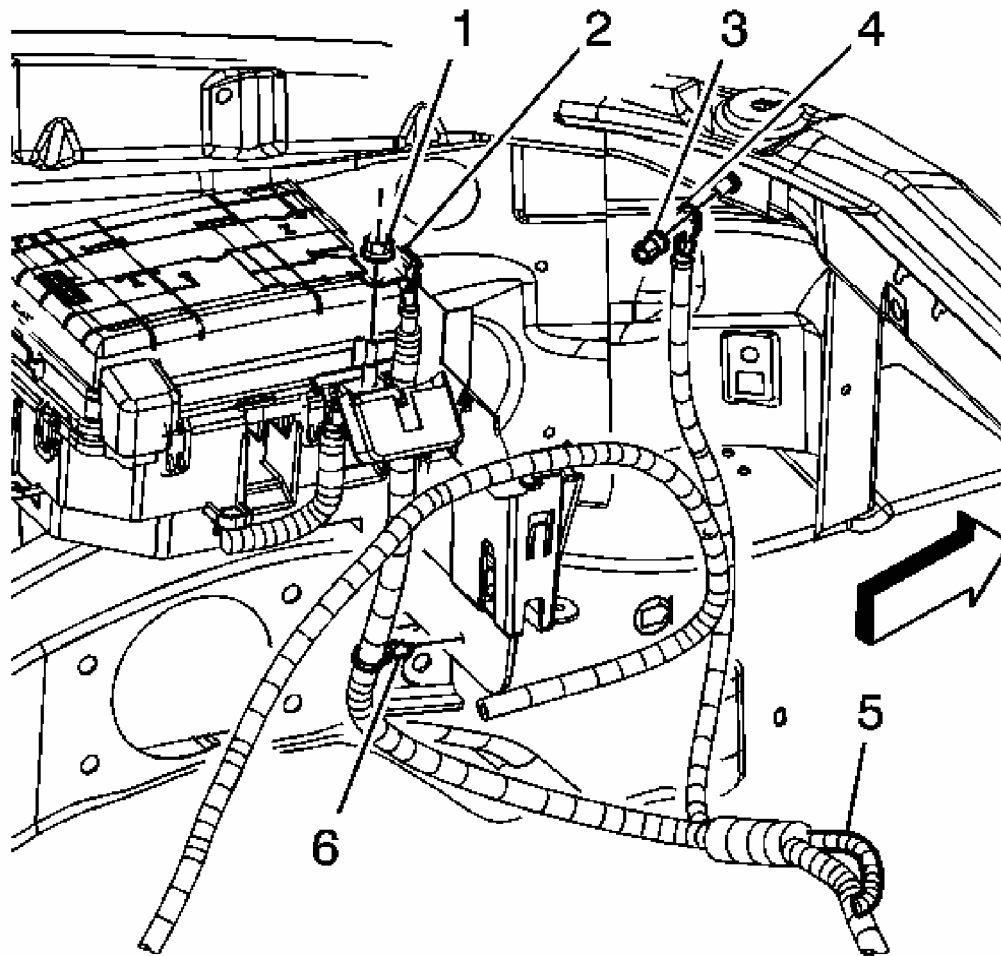


Fig. 34: Positive/Negative Battery Cable Terminal
 Courtesy of GENERAL MOTORS CORP.

6. Install the positive/negative battery cable terminal (2) to the stud.

NOTE: Refer to Fastener Notice in Cautions and Notices.

7. Install the junction block terminal nut (1).

Tighten: Tighten the nut to 15 N.m (11 lb ft).

8. Close the junction block terminal cover.

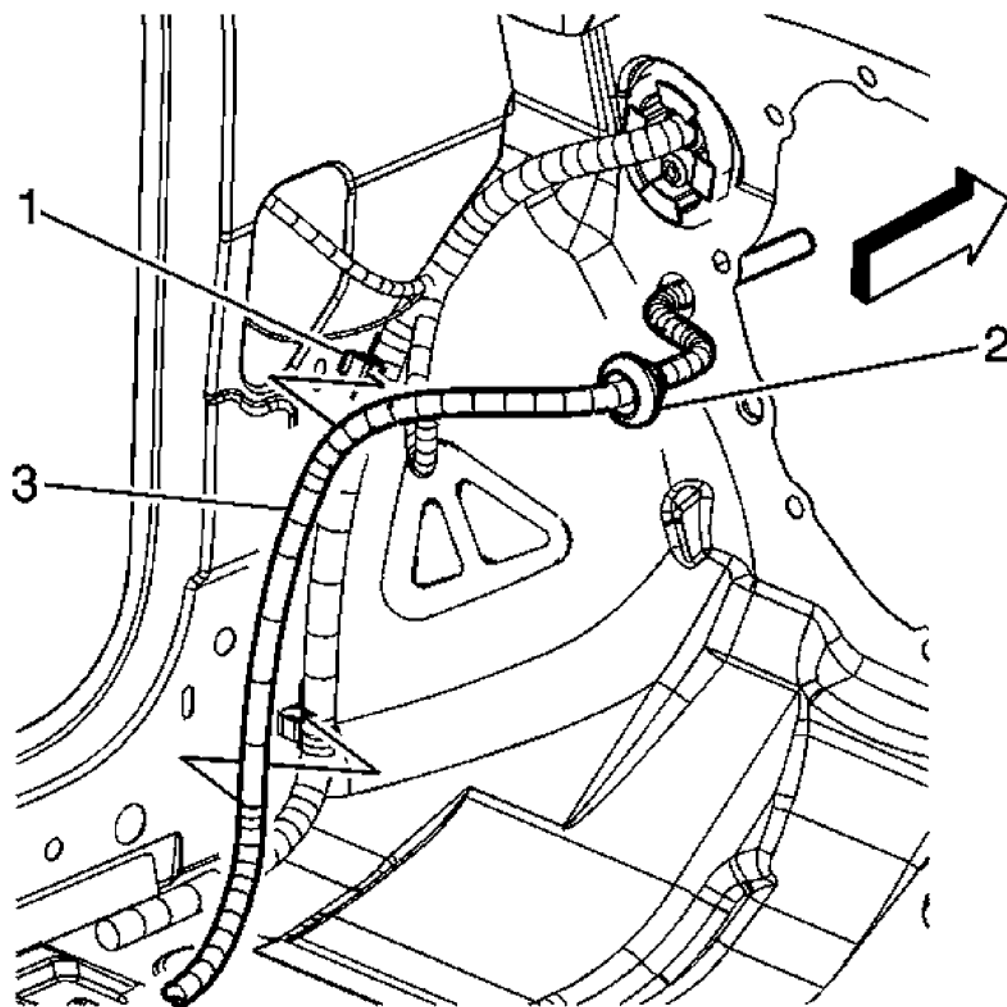


Fig. 35: Rubber Grommet

Courtesy of GENERAL MOTORS CORP.

9. Install the rubber grommet (2) to the front of dash.
10. Install the positive battery cable (3) to the clips (1) on the body harness.

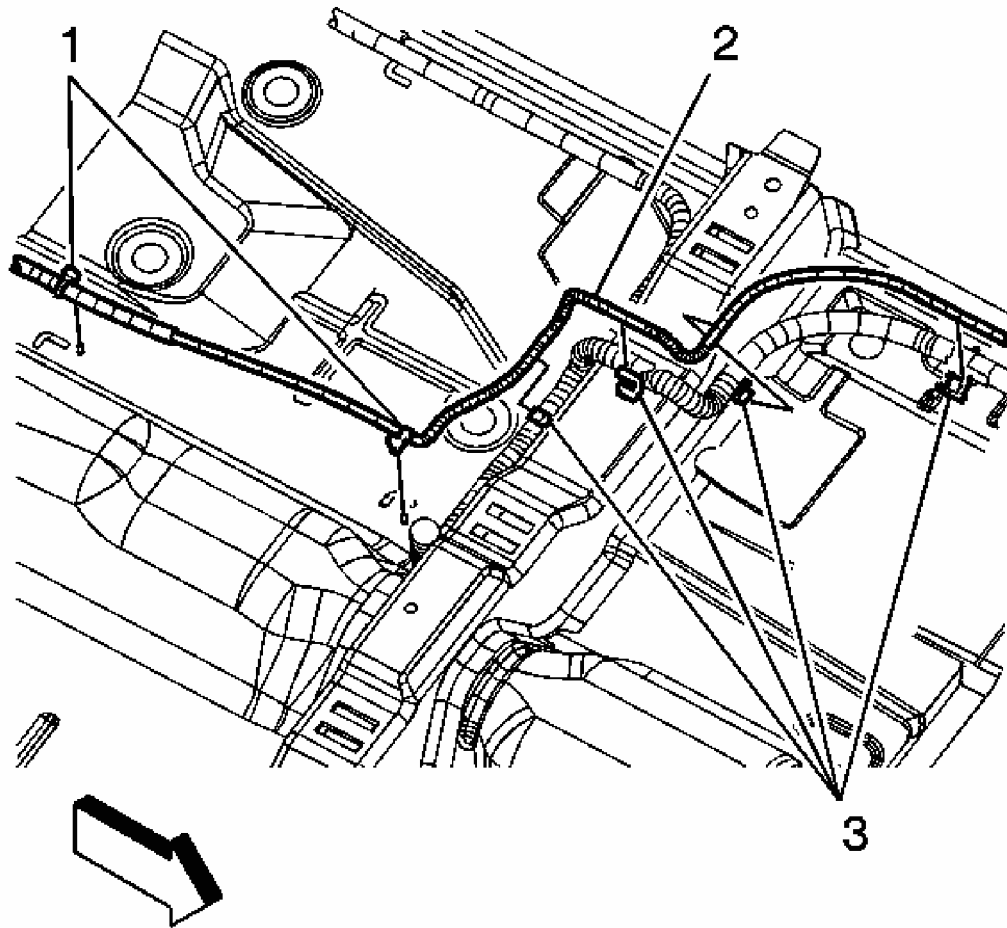


Fig. 36: Positive Battery Cable
Courtesy of GENERAL MOTORS CORP.

11. Install the positive battery cable clips (1) to the floor panel studs.
12. Install the positive battery cable (2) to the clips (3) on the body harness.

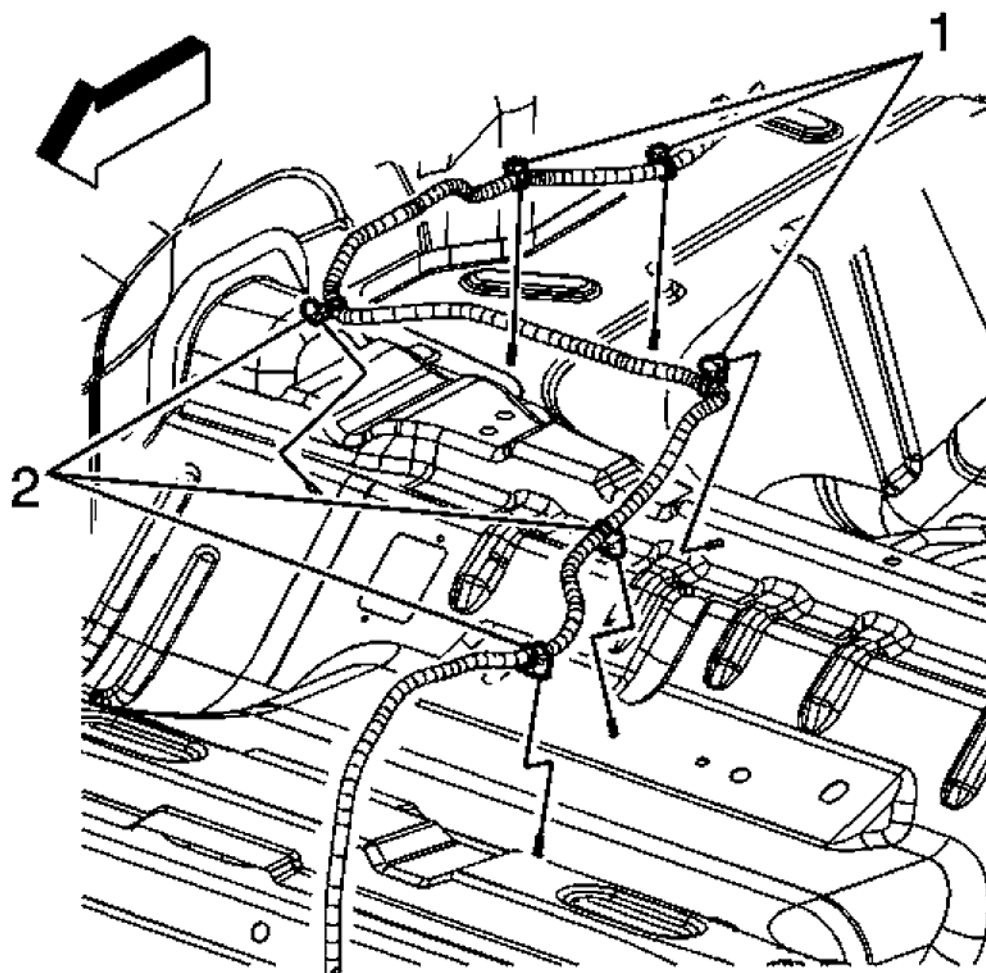


Fig. 37: Positive Battery Cable Clips
Courtesy of GENERAL MOTORS CORP.

13. Install the positive battery cable clips (1, 2) to the rear compartment panel studs.

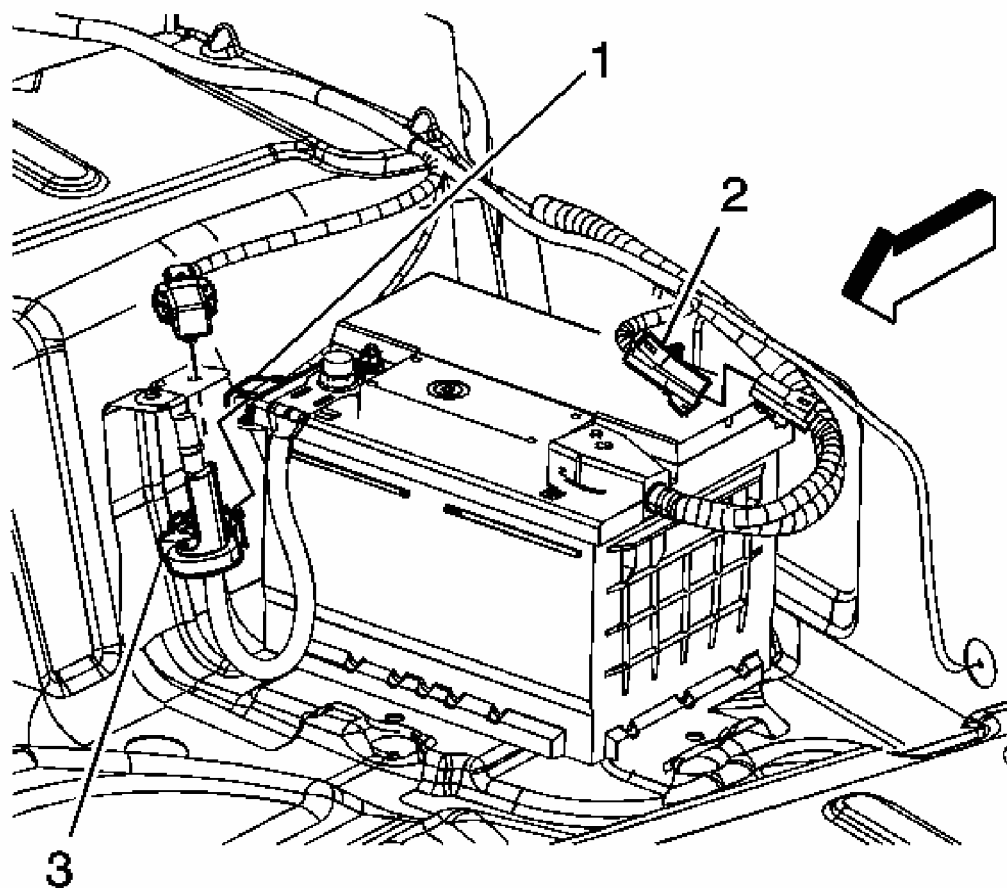


Fig. 38: Body Harness Electrical Connector
Courtesy of GENERAL MOTORS CORP.

14. Connect the body harness electrical connector (2) to the positive battery cable connector.

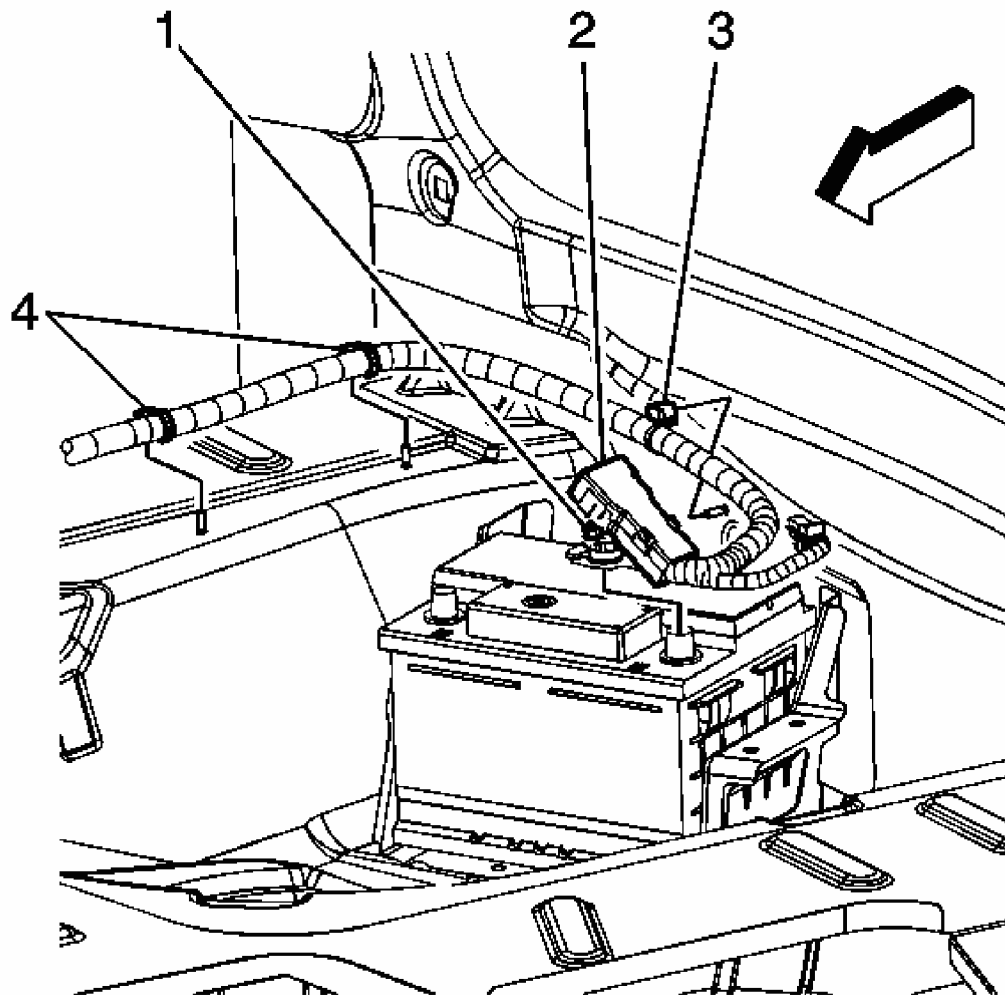


Fig. 39: Positive Battery Cable Clips
Courtesy of GENERAL MOTORS CORP.

15. Install the positive battery cable clips (3, 4) to the studs.
16. Install the positive battery cable from the battery.
17. Tighten the positive battery cable nut (1).

Tighten: Tighten the nut to 15 N.m (11 lb ft).

18. Close the positive battery cable cover (2).
19. Install the carpet. Refer to **Carpet Replacement**.
20. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

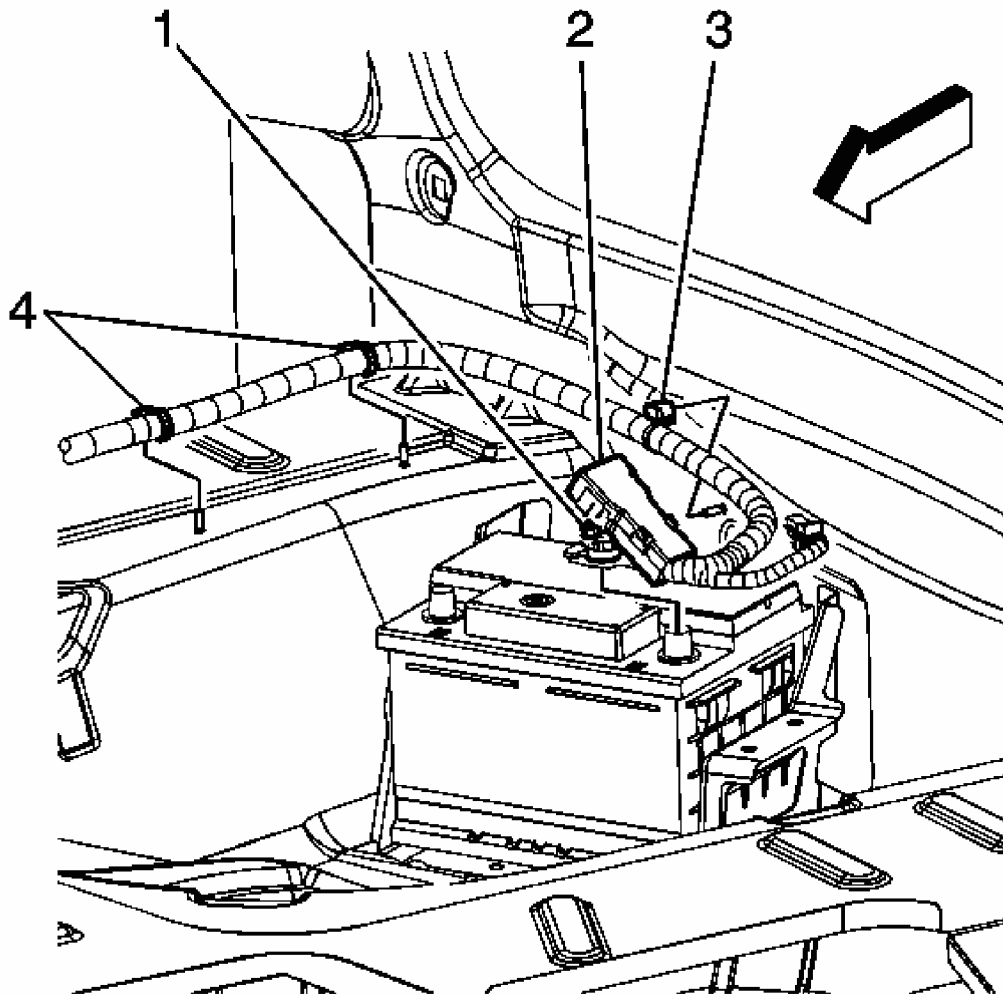
BATTERY REPLACEMENT**Removal Procedure**

Fig. 40: Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Open the positive battery cable cover (2).
3. Loosen the positive battery cable nut (1).
4. Remove the positive battery cable from the battery.

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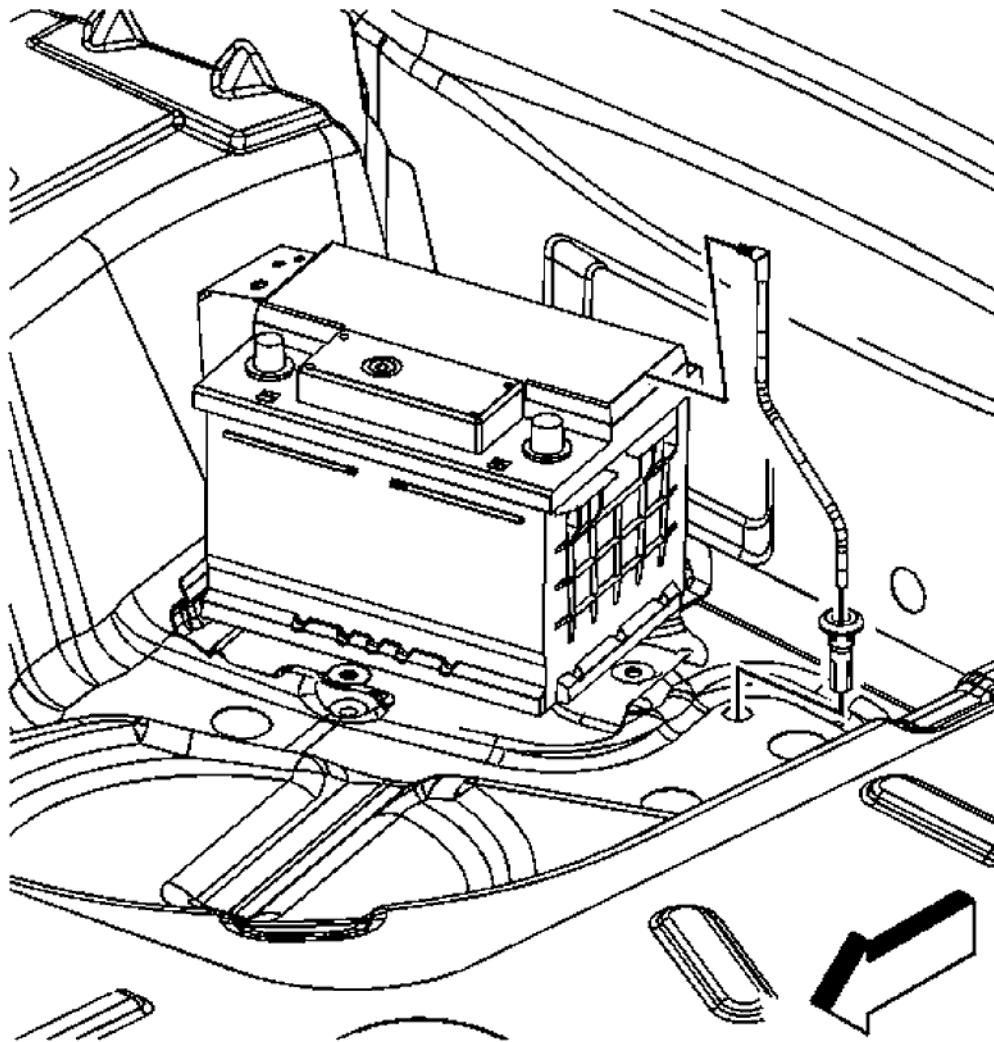


Fig. 41: Battery Vent Tube
Courtesy of GENERAL MOTORS CORP.

5. Disconnect the battery vent tube from the battery.

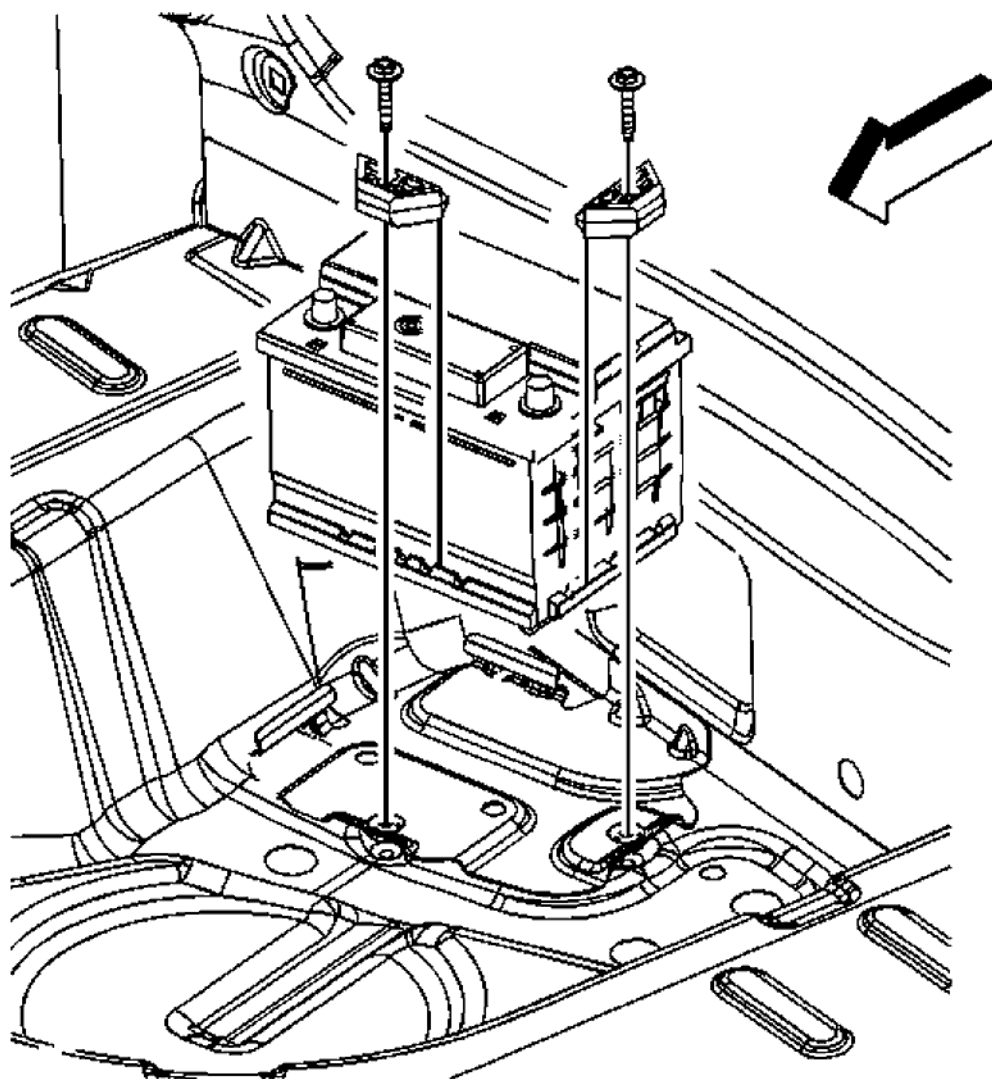


Fig. 42: Battery Hold Down
Courtesy of GENERAL MOTORS CORP.

6. Remove the battery hold down retainer bolts.
7. Remove the battery hold down retainers.

IMPORTANT: Do not tip the battery more than 40 degrees during removal.

8. Remove the battery.

Installation Procedure

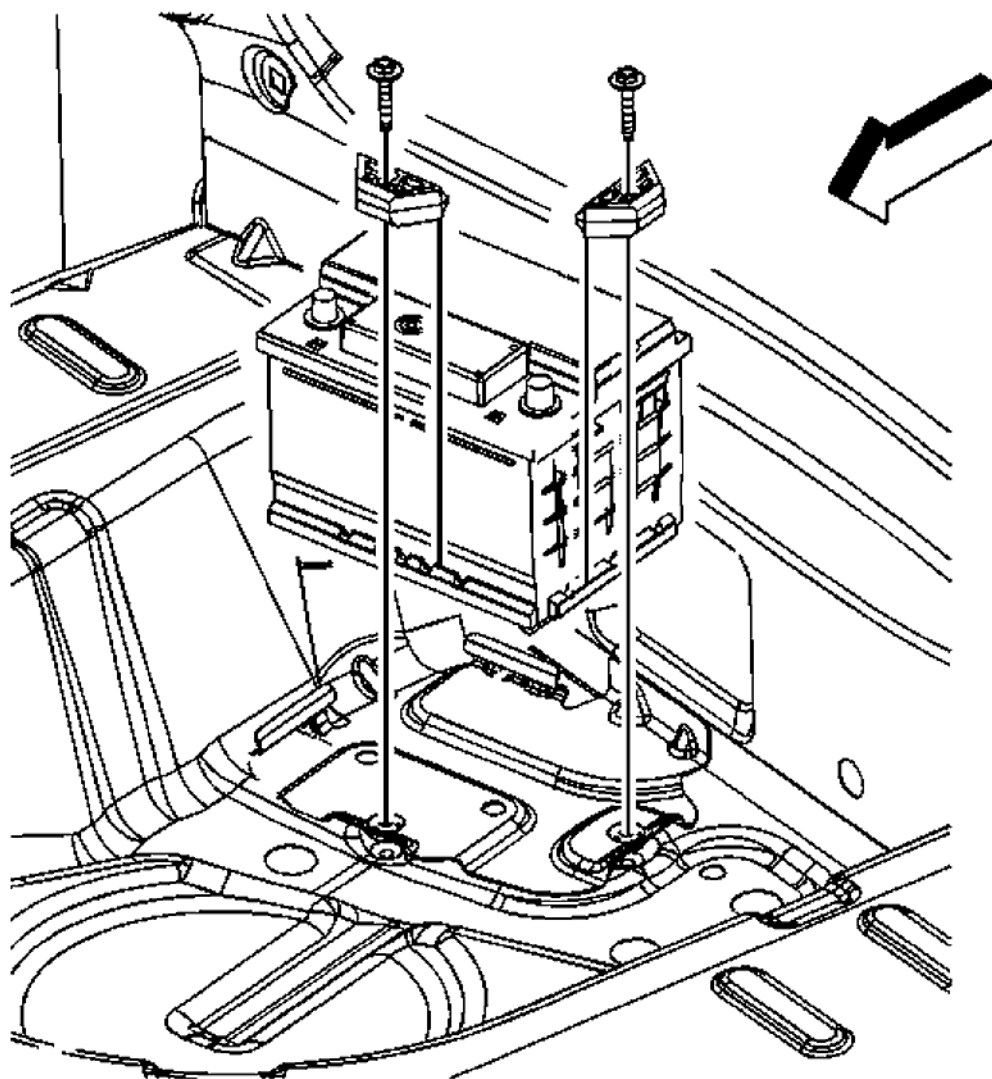


Fig. 43: Battery Hold Down
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Do not tip the battery more than 40 degrees during battery installation.

1. Install the battery.
2. Install the battery hold down retainers.

NOTE: Refer to Fastener Notice in Cautions and Notices.

3. Install the battery hold down retainer bolts.

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

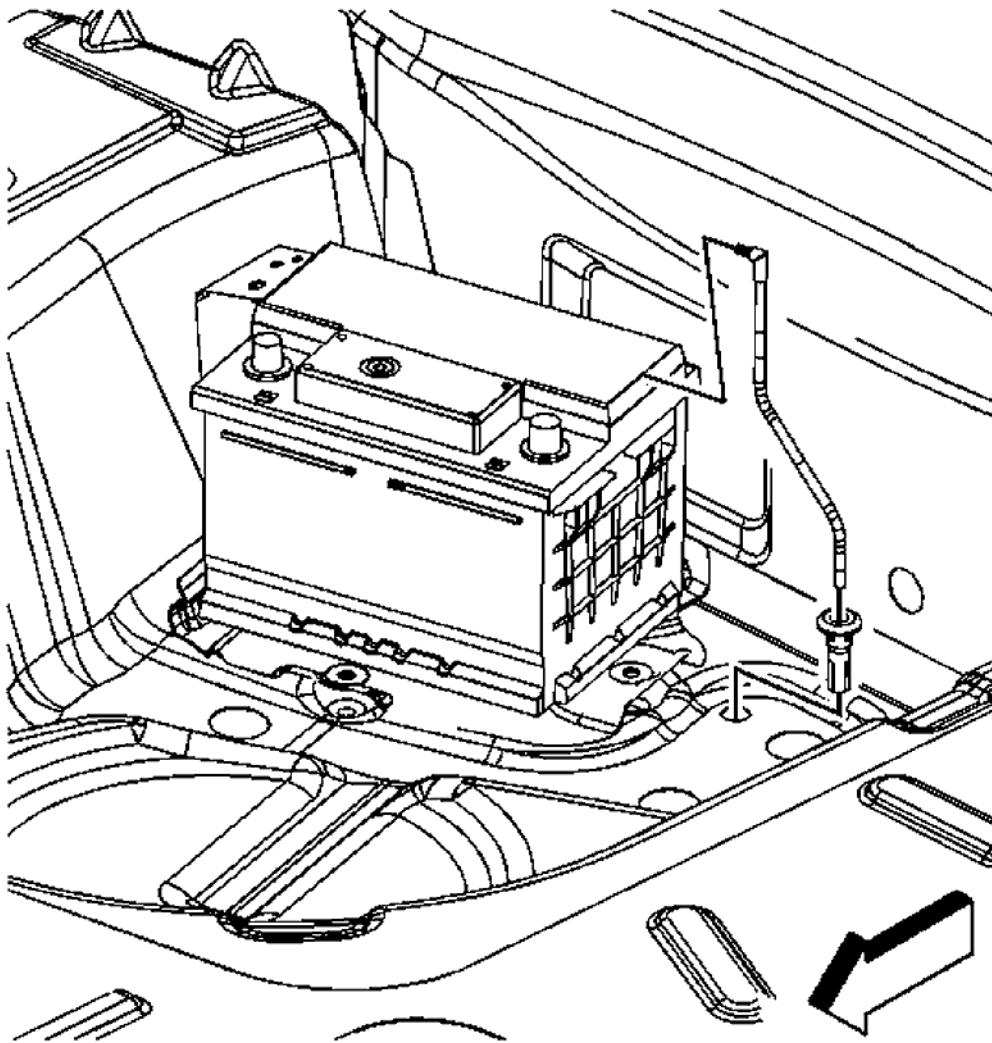


Fig. 44: Battery Vent Tube
Courtesy of GENERAL MOTORS CORP.

4. Connect the battery vent tube to the battery.

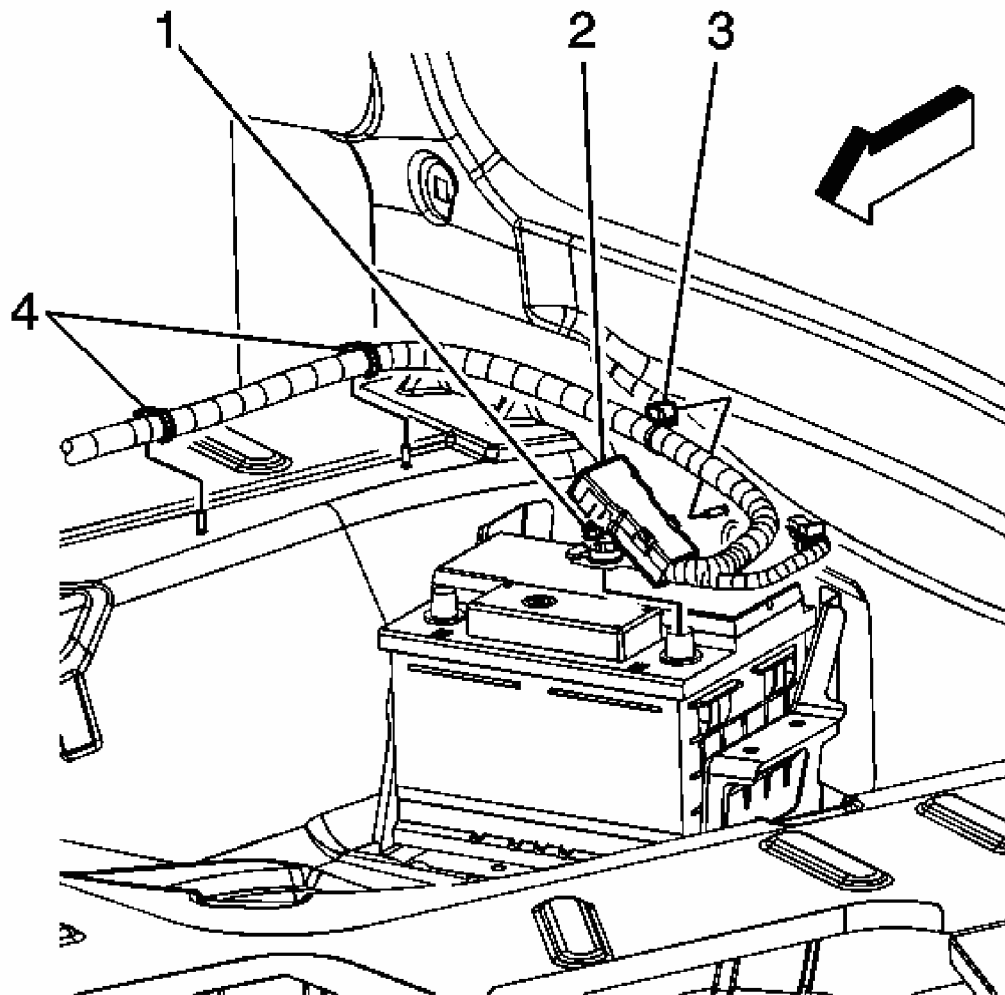


Fig. 45: Positive Battery Cable
Courtesy of GENERAL MOTORS CORP.

5. Install the positive battery cable from the battery.
6. Tighten the positive battery cable nut (1).

Tighten: Tighten the nut to 15 N.m (11 lb ft).

7. Close the positive battery cable cover (2).
8. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.
3. Remove the starter solenoid nut (4).

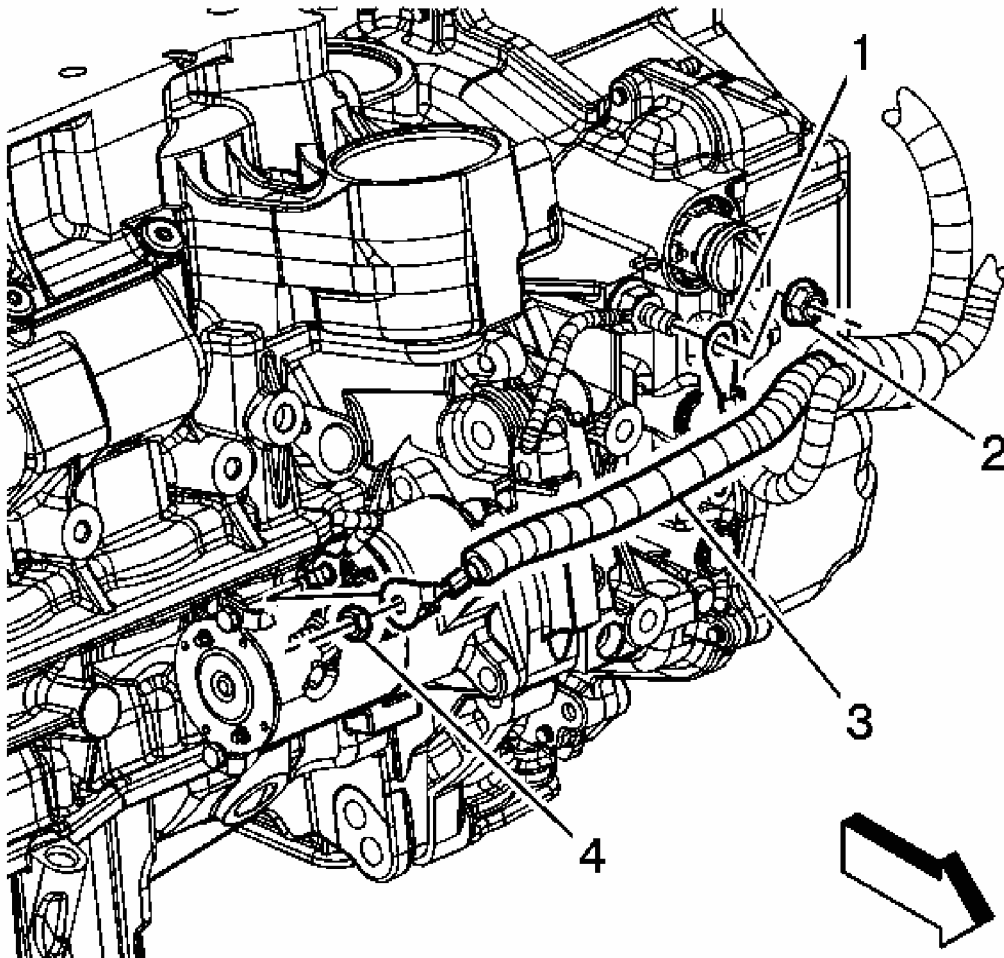
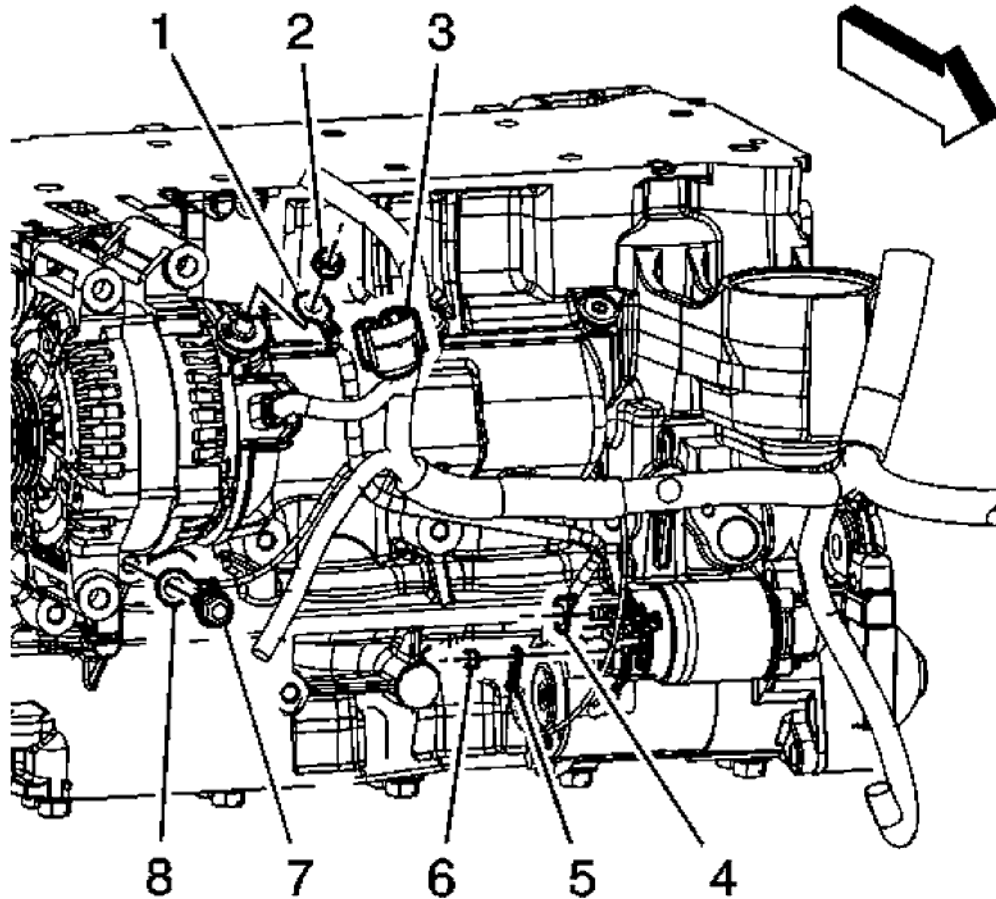


Fig. 46: Positive/Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

4. Remove the positive/negative battery cable (3) terminal from the starter.



**Fig. 47: View Of Engine Harness Terminal,Terminal Nut, & Engine Harness Boot
Courtesy of GENERAL MOTORS CORP.**

5. Remove the engine harness terminal (4) from the starter.
6. Remove the starter solenoid "S" terminal nut (6).
7. Remove the engine harness terminal (5) from the starter solenoid.

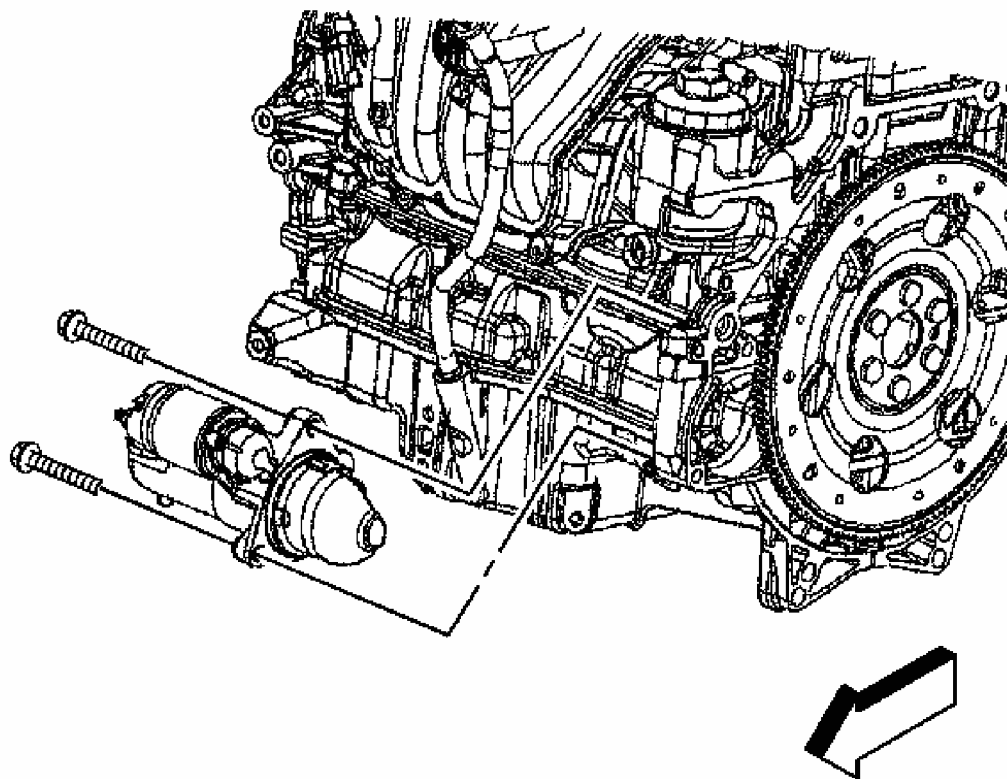


Fig. 48: Starter Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the starter bolts.
9. Remove the starter.

Installation Procedure

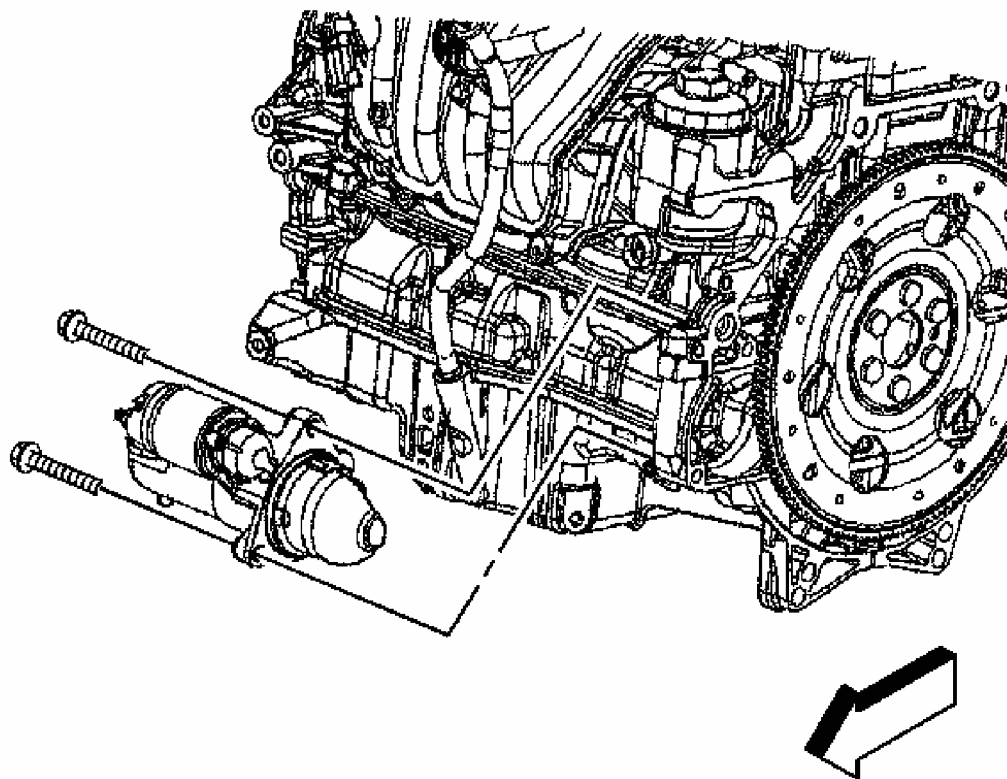


Fig. 49: Starter Bolts
Courtesy of GENERAL MOTORS CORP.

1. Position the starter to the engine.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the starter bolts.

Tighten: Tighten the bolts to 40 N.m (30 lb ft).

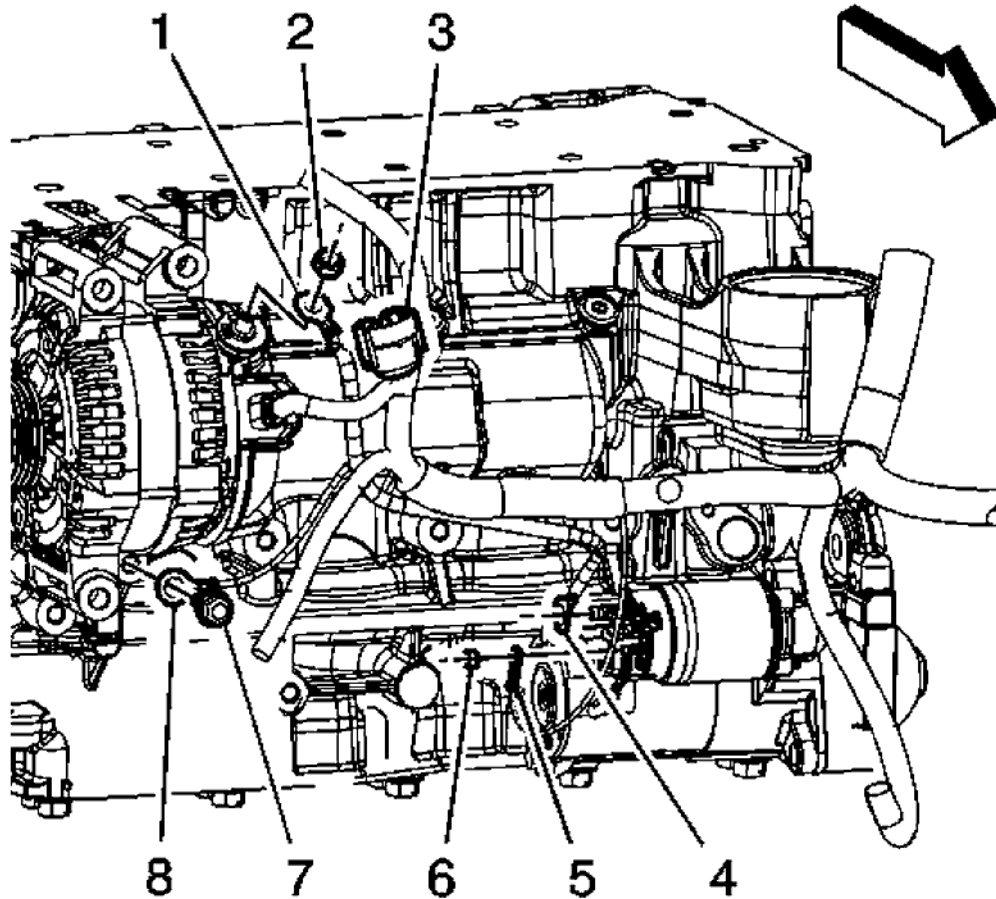


Fig. 50: View Of Engine Harness Terminal, Terminal Nut, & Engine Harness Boot
Courtesy of GENERAL MOTORS CORP.

3. Install the engine harness terminal (5) to the starter solenoid.
4. Install the starter solenoid "S" terminal nut (6).

Tighten: Tighten the nut to 3 N.m (27 lb in).

5. Install the engine harness terminal (4) to the starter.

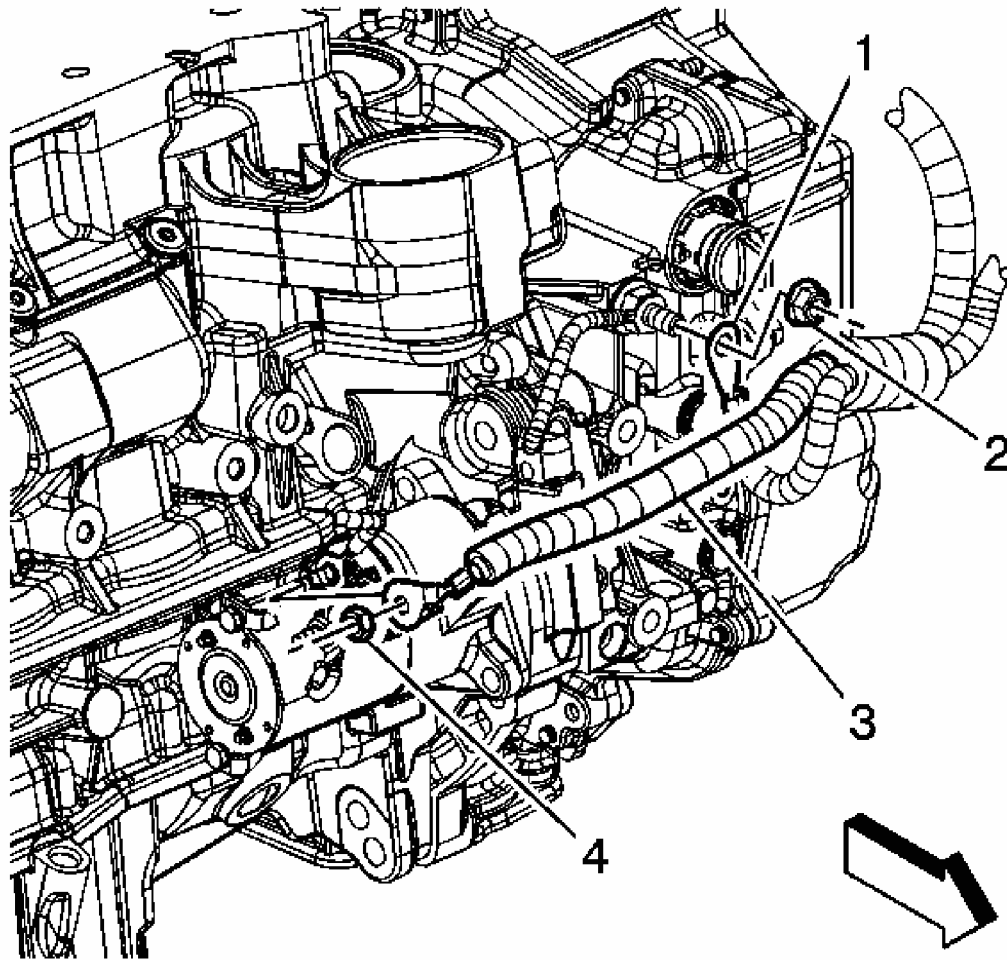


Fig. 51: Positive/Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

6. Install the positive/negative battery cable (3) terminal to the starter.
7. Install the starter solenoid nut (4).

Tighten: Tighten the nut to 17 N.m (13 lb ft).

8. Lower the vehicle.
9. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

GENERATOR REPLACEMENT

Removal Procedure

1. Disconnect negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.
2. Remove the drive belt. Refer to **Drive Belt Replacement** or **Drive Belt Replacement** .
3. Remove the air cleaner assembly, if necessary. Refer to **Air Cleaner Assembly Replacement** or **Air Cleaner Assembly Replacement** .

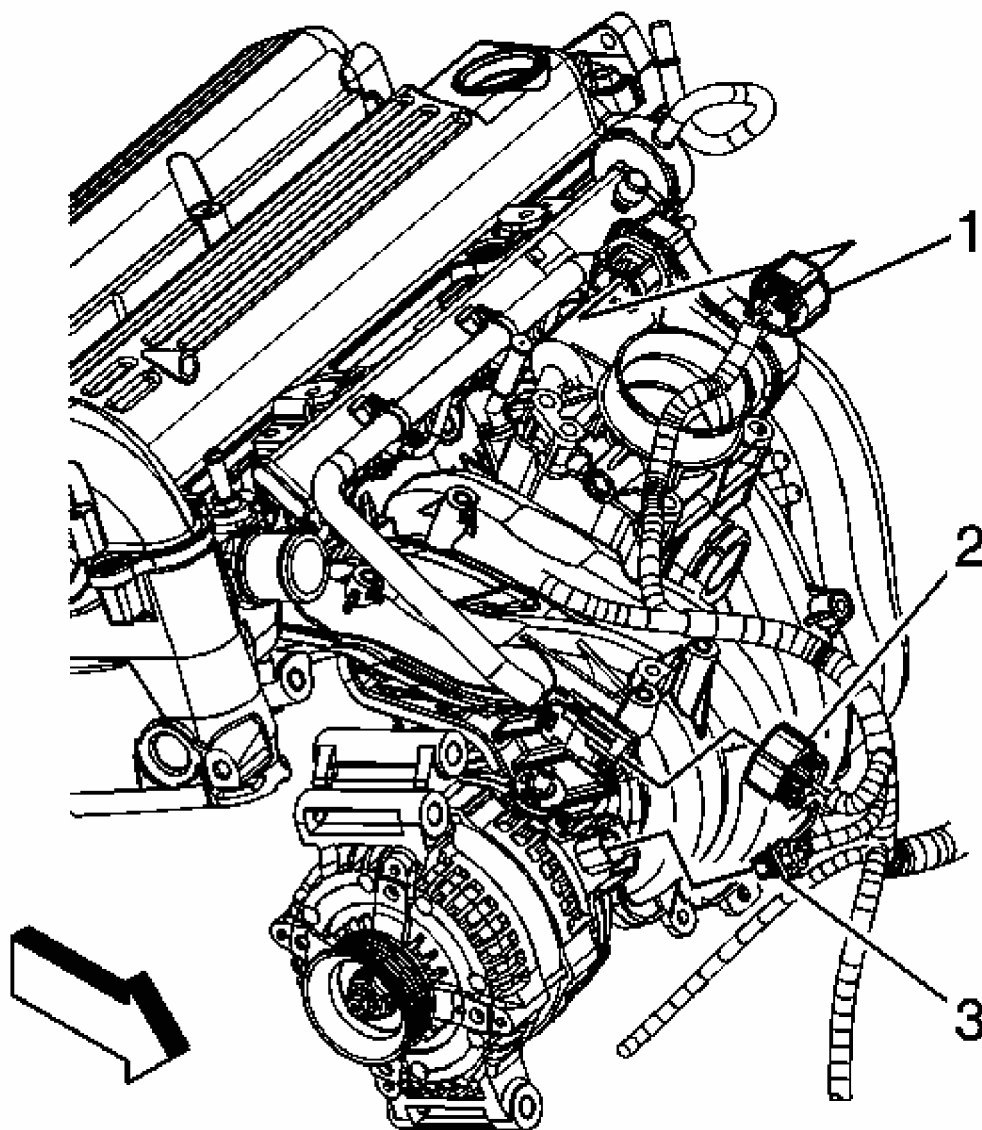


Fig. 52: TAC,Fuel Injector Harness & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

4. Disconnect the generator electrical connector (3).

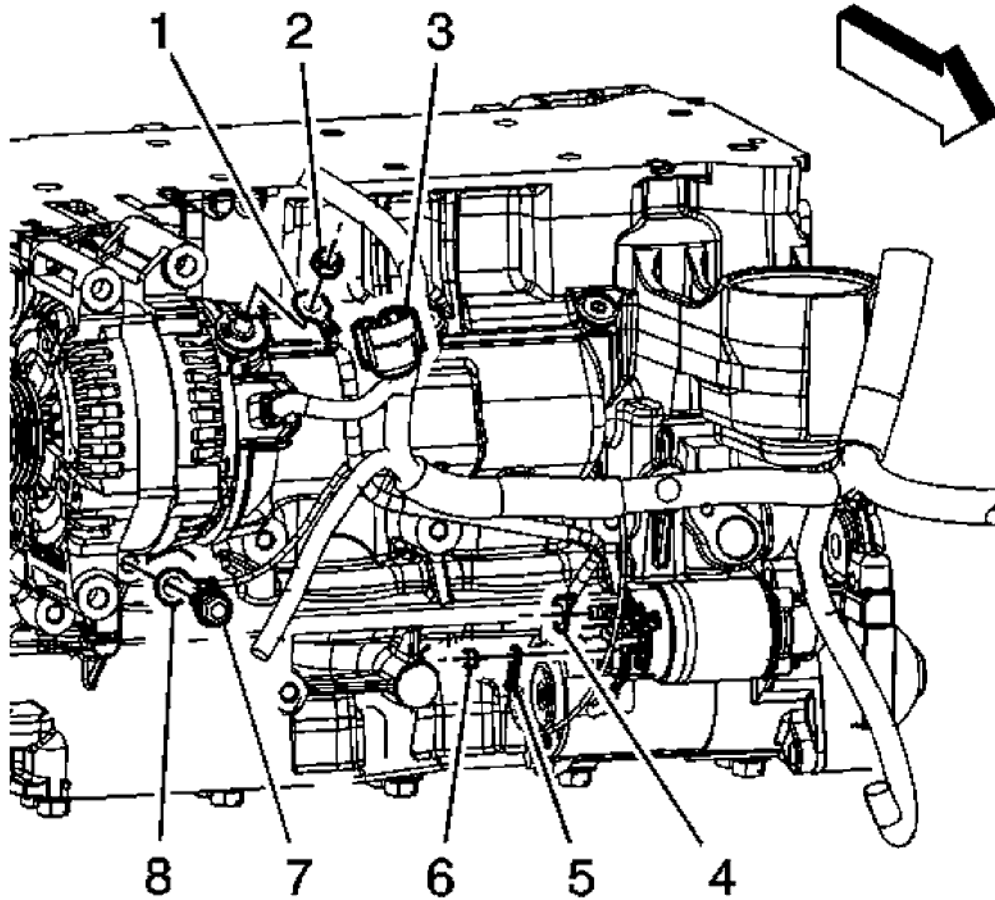


Fig. 53: View Of Engine Harness Terminal,Terminal Nut, & Engine Harness Boot
Courtesy of GENERAL MOTORS CORP.

5. Reposition the engine harness boot (3).
6. Remove the generator terminal nut (2).
7. Remove the engine harness terminal (1) from the generator.

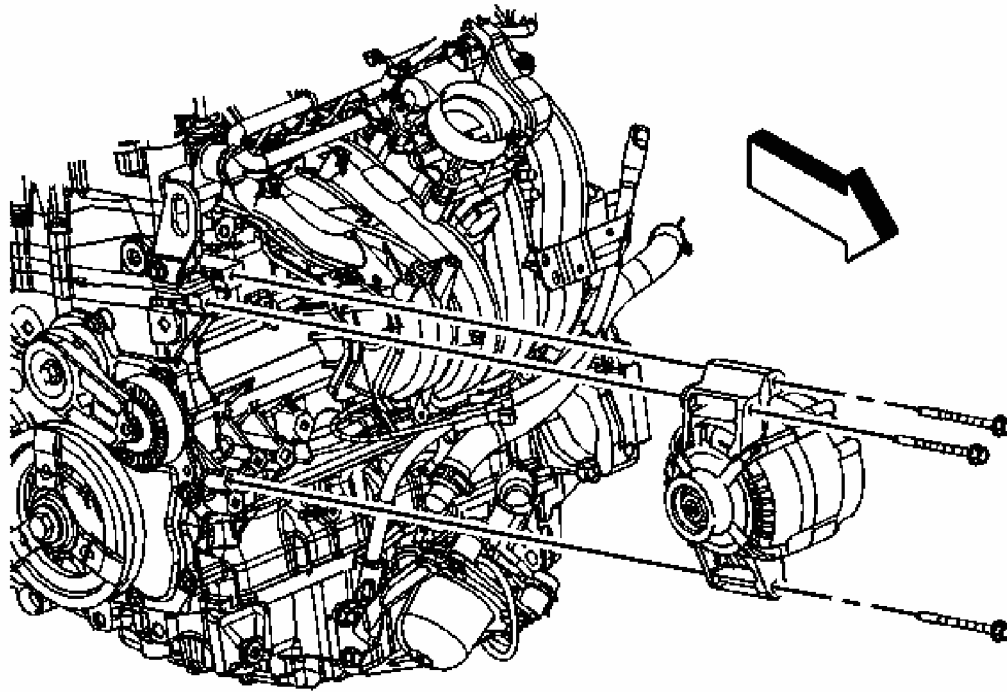


Fig. 54: Generator & Bolts
Courtesy of GENERAL MOTORS CORP.

8. Remove the generator bolts.
9. Remove the generator.

Installation Procedure

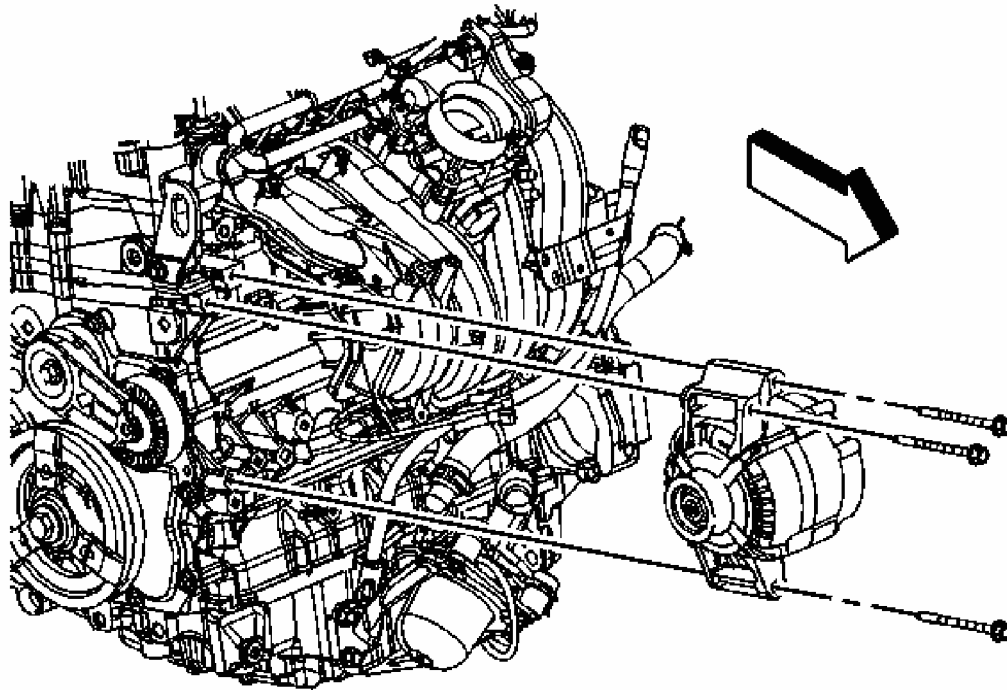


Fig. 55: Generator & Bolts

Courtesy of GENERAL MOTORS CORP.

1. Position the generator to the engine block.

NOTE: Refer to Fastener Notice in Cautions and Notices.

2. Install the generator bolts.

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

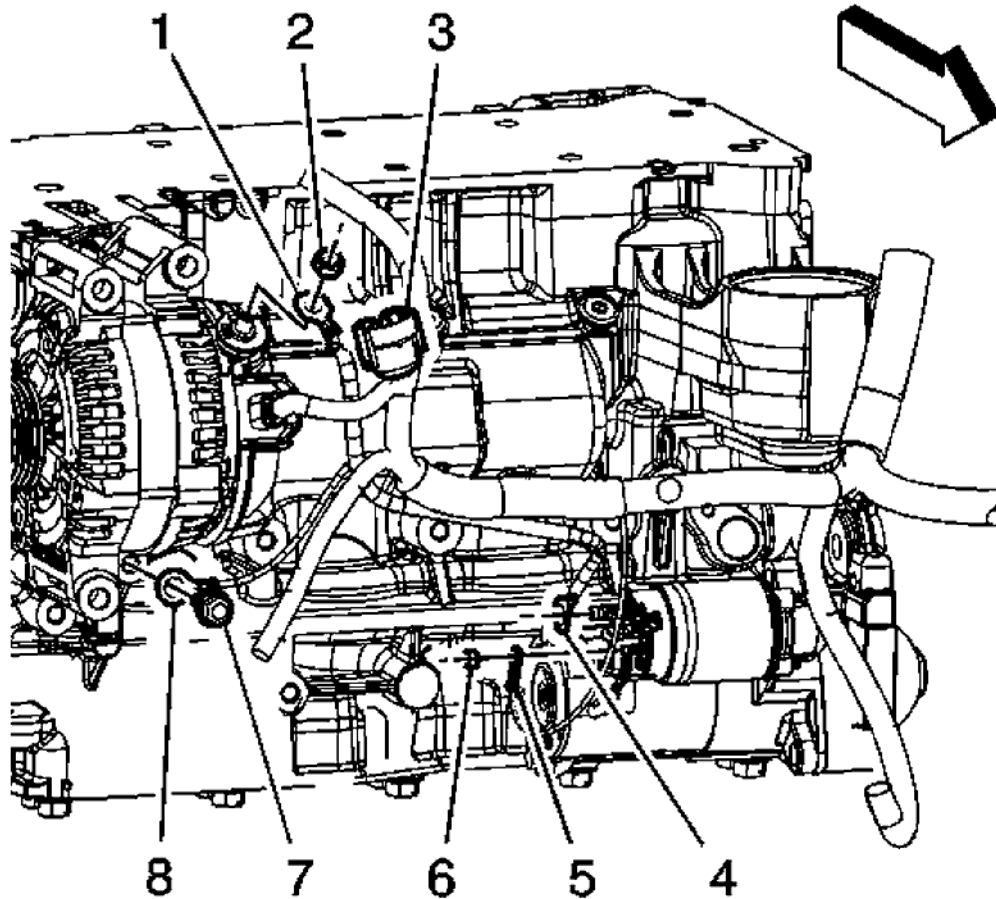


Fig. 56: View Of Engine Harness Terminal, Terminal Nut, & Engine Harness Boot
Courtesy of GENERAL MOTORS CORP.

3. Install the engine harness terminal (1) to the generator.
4. Install the generator terminal nut (2).

Tighten: Tighten the nut to 20 N.m (15 lb ft).

5. Position the engine harness boot (3).

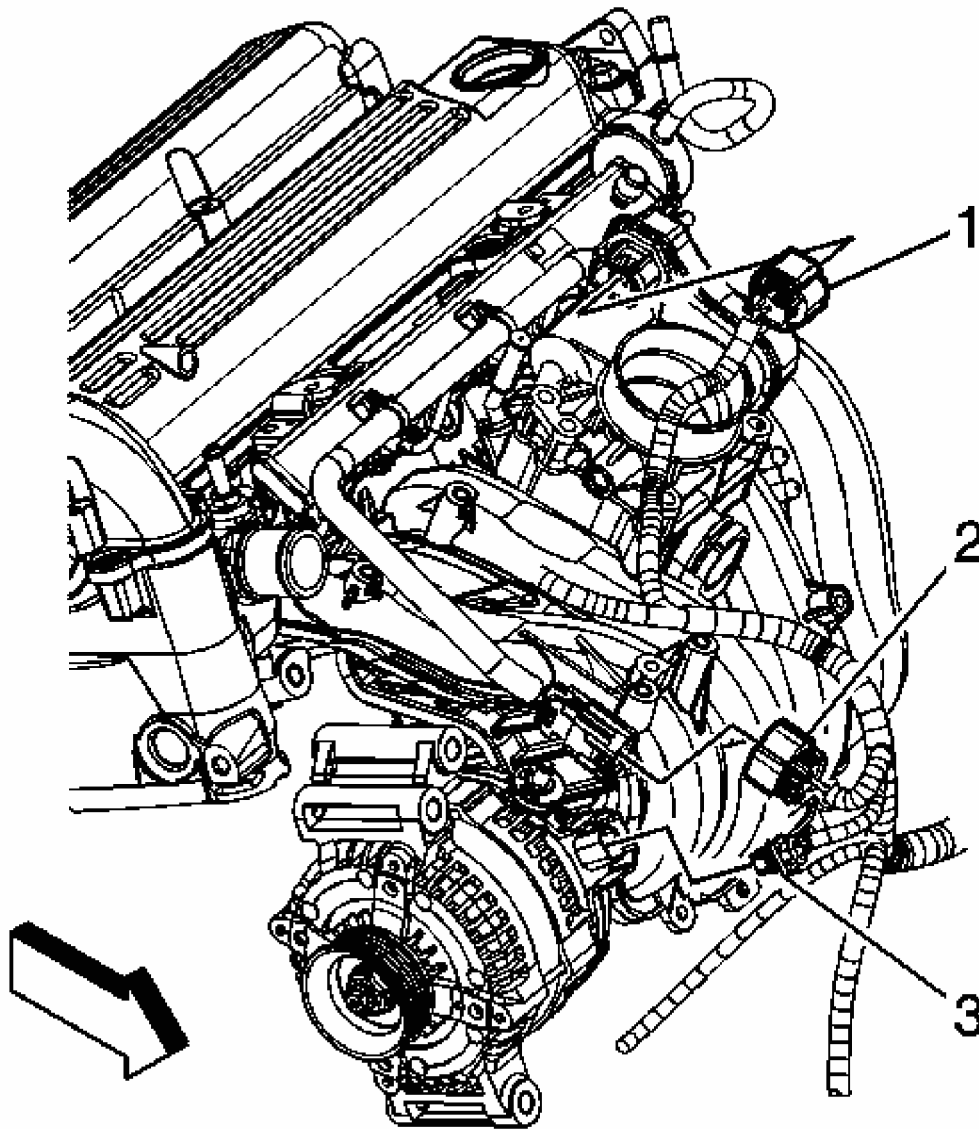


Fig. 57: TAC,Fuel Injector Harness & Generator Electrical Connectors
Courtesy of GENERAL MOTORS CORP.

6. Connect the generator electrical connector (3).
7. Install the air cleaner assembly, if necessary. Refer to **Air Cleaner Assembly Replacement** or **Air Cleaner Assembly Replacement** .
8. Install the drive belt. Refer to **Drive Belt Replacement** or **Drive Belt Replacement** .
9. Connect negative battery cable. Refer to **Battery Negative Cable Disconnect/Connect Procedure**.

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

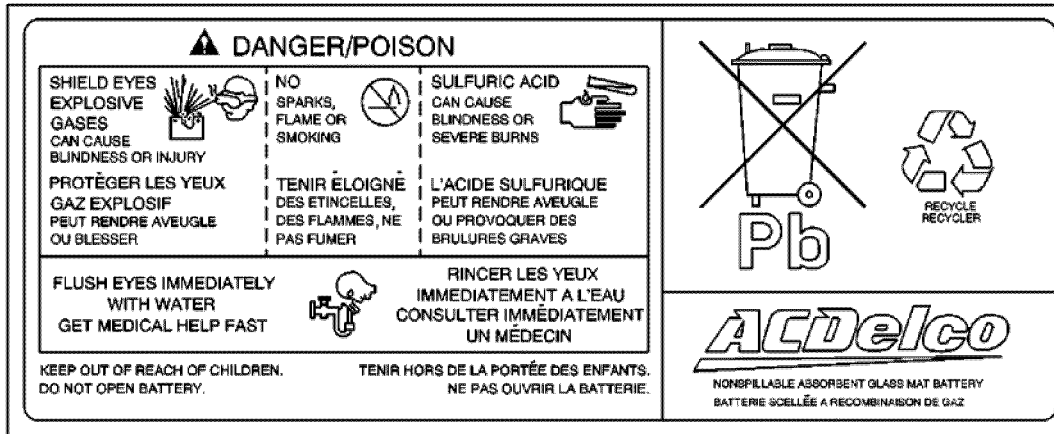


Fig. 58: Battery Warning Label
 Courtesy of GENERAL MOTORS CORP.

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.

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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

CCA 770	LOAD TEST 380
REPLACEMENT MODEL 100 – 6YR	

Fig. 59: 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 (SOC) 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 adjusting the regulated voltage.
- It performs diagnostics and driver notification.

The battery's condition is estimated during key-off and during key-on. During key-off the 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 key-on, the algorithm continuously estimates SOC based on adjusted net amp hours, battery capacity, initial SOC, and temperature.

While running, the battery's 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's 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 GM LAN 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 and load management operations.

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. It

monitors the generators generator field duty cycle signal circuit and sends the information to the BCM. The ECM will override the BCM control of the generator when one of the following conditions are met:

- The engine cooling fans are on high speed.
- There is a high fuel demand.
- The calculated ambient air temperature is less than 0°C (32°F).

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 CHARGING SYSTEM and CHARGING SYSTEM FAULT.

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:

- Charge Mode
- Fuel Economy Mode
- Voltage Reduction Mode
- Start-up Mode
- Windshield Deice Mode
- Battery Sulfation Mode

The engine control module (ECM) controls the generator through the generator L-terminal 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

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

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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 12-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.

Charge Mode

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

- The interpreted fuel rate is greater than 21 g/s and the throttle position is greater than 90 percent.
- The headlamps are ON, low or high beam.
- The wipers are ON for more than 8 seconds.
- The electric cooling fans are on high speed.
- The rear defogger is ON.

Once one of these conditions are met, the generator battery control module will set the targeted generator output voltage to 13.4 volts and then ramp that voltage up to 14.5 volts at a rate of 50 mV per second.

Fuel Economy Mode

The BCM will enter Fuel Economy Mode when the calculated ambient air temperature is above 0°C (32°F), the calculated battery current is less than 15 amps and greater than -8 amps, and the battery state-of-charge (SOC) is greater than 80 percent. Its targeted generator output voltage is 13 volts. The BCM will exit this mode once the criteria are met for Charge Mode.

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 2 amps and greater than -7 amps, 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.

Start-up Mode

After the engine has started, the BCM sets a targeted generator output voltage of 14.5 volts for 20 seconds.

Windshield Deice Mode

After the engine has run for more than 10 seconds, the BCM sets a targeted generator output voltage of 13.8 volts if the calculated ambient air temperature is less than 0°C (32°F). The BCM will stay in this mode until the engine coolant temperature (ECT) reaches 75°C (167°F) for 10 minutes.

Battery Sulfation Mode

The BCM will enter this mode when the interpreted generator output voltage is less than 13.2 volts for 45 minutes. Once in this mode, the BCM will set a targeted output voltage of 13.8 volts for 5 minutes. The BCM will then determine which mode to enter depending on voltage requirements.

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

The instrument panel cluster (IPC) illuminates the charge indicator in the message center 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 serial data 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 serial data message from the body control module (BCM) indicating there is a system voltage range concern.
- 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.

Charging System Failure

The BCM and the ECM will send a serial data message to the IPC for the CHARGING SYSTEM FAILURE 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.

Battery Voltage

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

Battery Saver Active

The BATTERY SAVER ACTIVE message will display on the driver information center (DIC) when the vehicle enters a load shed 2 event. Refer to for load shed 2 setting criteria.

STARTING SYSTEM DESCRIPTION AND OPERATION

The PG 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 CRANK relay opens and 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

Moving the ignition switch to the START position signals the body control module (BCM) through discrete inputs from the ignition transducer that engine crank has been requested. The BCM verifies that theft is not active and sends a serial data message to the engine control module (ECM) requesting engine start. The ECM receives a 12-volt signal from the park/neutral position (PNP) switch or clutch pedal start switch notifying that it is safe to start the engine. There is a splice on this circuit in the fuse block-underhood that supplies power for the CRANK relay coil. The starter relay coil control circuit is then grounded by the ECM closing the switch in the CRANK relay supplying 12 volts to the S-terminal of the starter. Ground is supplied through the engine block. For remote vehicle start (RVS) information refer to **Keyless Entry System Description and Operation** in Keyless Entry.

LOAD SHED SYSTEM DESCRIPTION AND OPERATION

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, and manages system electrical loads.

The load shed operation is a means of reducing electrical loads during a low voltage or low battery SOC condition.

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

Each EPM function, either idle boost or load-shed, is discrete. No 2 functions are active at the same time. 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:

Load Shed System Description and Operation

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C ($+5^{\circ}\text{F}$)	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
Idle Boost 1 Start	-	Less Than 10.9 V	-	First level idle boost requested
Idle Boost 1 End	Greater Than -15°C ($+5^{\circ}\text{F}$)	Greater Than 12 V	Battery has a net loss less than 0.2 AH	First level idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 AH	Rear defrost, heated mirrors, heated seats cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 10.9 V	-	Rear defrost, heated mirrors, heated seats cycled OFF for 20% of their cycle
Load Shed 1		Greater Than 12	Battery has a net	Clear Load Shed

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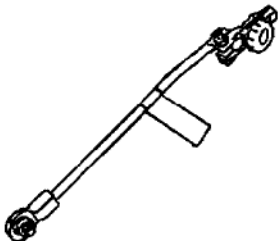
End	-	V	loss of less than 2 AH	1
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 AH	Second level idle boost requested
Idle Boost 2 Start	-	Less Than 10.9 V	-	Second level idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 AH	Second level idle 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 10.9 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
Load Shed 2 Start	-	Less Than 10.9 V	Battery has a net loss greater than 12 AH	Rear defrost, heated mirrors, heated seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC.
Load Shed 2 Start	-	Less Than 10.9 V	-	Rear defrost, heated mirrors, heated seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC.

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Load Shed 2 End	-	Greater Than 12.6 V	Battery has a net loss of less than 10.5 AH	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20 AH	Rear defrost, heated mirrors, heated seats cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC.
Load Shed 3 End	-	Greater Than 12.6 V	Battery has a net loss of less than 15 AH	Clear Load Shed 3

SPECIAL TOOLS AND EQUIPMENT**SPECIAL TOOLS****Special Tools**

Illustration	Tool Number/Description
	J 38758 Parasitic Draw Test Switch
	J 42000 Battery Tester

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