2009 ENGINE

Engine Electrical - Cobalt & G5

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Application	Specification	
	Metric	English
Battery Cable Ground Nut	20 N.m	15 lb ft
Battery Retainer Bolt	18 N.m	13 lb ft
Engine Harness Ground Nut	17 N.m	13 lb ft
Engine Harness Ground Stud	25 N.m	18 lb ft
Generator Bolt (RPO LSJ)	25 N.m	18 lb ft
Generator Bolt (RPOs L61/LE5)	22 N.m	16 lb ft
Generator Terminal Nut	20 N.m	15 lb ft
Junction Block Nut	17 N.m	13 lb ft
Negative Battery Cable Bolt	17 N.m	13 lb ft
Positive Battery Cable Bolt	17 N.m	13 lb ft
Starter Motor Bolt (RPO LSJ)	50 N.m	37 lb ft
Starter Motor Bolt (RPOs L61/LE5)	40 N.m	30 lb ft
Starter Solenoid Terminal Nut (RPO LSJ)	11 N.m	97 lb in
Starter Solenoid Terminal Nut (RPOs L61/LE5)	17 N.m	13 lb ft

BATTERY USAGE

Application	Specification
Cold Cranking Amperage	600 A
Reserve Capacity Rating	95 Minutes
Amp Hour Rating	55 Ah

GENERATOR USAGE

Application	Specification
2.0L (LNF), 2.2L (L61), 2.4L (LE5)	
Generator Model	Denso SC0
Rated Output	130 A
Load Test Output	91 A

SCHEMATIC AND ROUTING DIAGRAMS

STARTING AND CHARGING SCHEMATICS

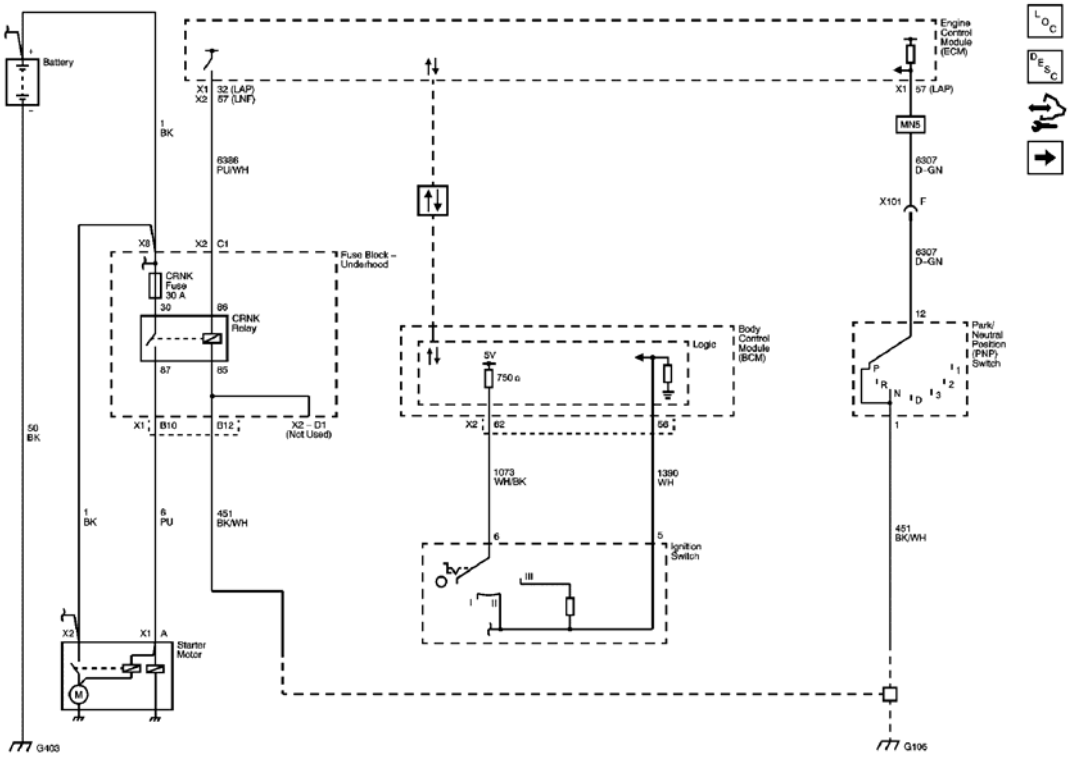


Fig. 1: Starting And Charging Schematics (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

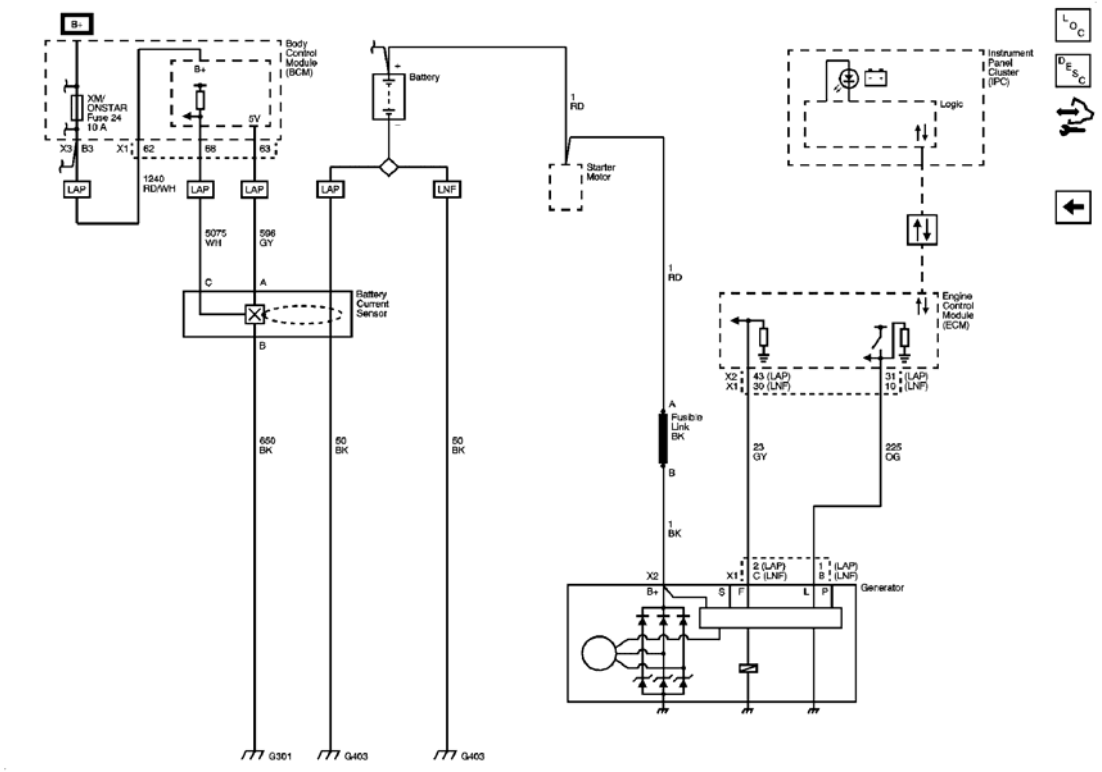


Fig. 2: Starting And Charging Schematics (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

DIAGNOSTIC INFORMATION AND PROCEDURES

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
DTC B1325	B1325 03: Device Power Circuit Voltage Below Threshold B1325 07: Device Power Circuit Voltage Above Threshold
DTC B1424	B1424 00: Device Voltage Low - TDM
DTC B1516	B1516 08: Battery Current Sensor Performance Signal Invalid B1516 66: Battery Current Sensor Performance Wrong Mounting Position
DTC B1517	B1517 5A: Battery Voltage Plausibility Failure
DTC C0895	C0895 03: Device Voltage Below Threshold - PSCM C0895 11: Device Voltage Above Maximum Threshold - PSCM C0895 12: Device Voltage Below Minimum Threshold - PSCM
DTC C0899	C0899 00: Device Voltage Low - EBCM
DTC C0900	C0900 00: Device Voltage High - EBCM
DTC P0562	P0562: System Voltage Low - ECM

DTC P0563	P0563: System Voltage High - ECM
DTC P0615	P0615: Starter Relay Control Circuit
DTC P0616	P0616: Starter Relay Control Circuit Low Voltage
DTC P0617	P0617: Starter Relay Control Circuit High Voltage
DTC P0621	P0621: Generator L-Terminal Circuit
DTC P0622	P0622: Generator F-Terminal Circuit
DTC P2500	P2500: Generator L-Terminal Circuit Low
DTC P2501	P2501: Generator L-Terminal Circuit High

DIAGNOSTIC STARTING POINT - ENGINE ELECTRICAL

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

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

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

DTC B1325

Diagnostic Instructions

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

DTC Descriptors

DTC B1325 03

Device Power Circuit Voltage Below Threshold

DTC B1325 07

Device Power Circuit Voltage Above Threshold

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1325 03	B1325 03	-	-

Ground	-	B1325 03	-	-

Circuit/System Description

The control modules on this vehicle monitor the battery voltage through the battery positive (B+) voltage circuits. The following control modules will set this DTC:

- Body control module (BCM)
- Instrument panel cluster (IPC)
- Radio
- Sensing and diagnostic module (SDM)

Conditions for Running the DTC

The battery 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 less than 9 volts for 5 seconds.

B1325 07

The control module detects a system voltage greater than 18 volts for 5 seconds.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

The DTC passes when the malfunction is no longer present.

Diagnostic Aids

- A high or low voltage value in multiple modules indicates a concern in the charging system.
- Overcharging with a battery charger or jump starting can cause this DTC to set.
- This DTC may set if the battery is disconnected for any reason.

Reference Information

Schematic Reference

- **Body Control System Schematics**
- **Instrument Cluster Schematics**
- **Radio/Navigation System Schematics**
- **SIR Schematics**

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 volts.
    - If not within the specified range, refer to **Charging System Test**.

WARNING: Refer to SIR Warning .

2. Ignition OFF, disconnect the harness connectors at the appropriate module.
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the following ground circuit terminals and ground:
    - Terminal 15 (IPC)
    - Terminal 16 (IPC)
    - Terminal 31 (SDM)
    - Terminal 8 X1 (Radio)
    - Terminal 61 X1 (BCM)
    - Terminal 64 X1 (BCM)

- Terminal E12 X4 (BCM)
  - If greater than the specified range, test the ground circuit for an open/high resistance.

4. Verify that a test lamp illuminates between the following B+ circuit terminals and ground:
   - Terminal 1 (SDM)
   - Terminal 13 (IPC)
   - Terminal 1 X1 (Radio)
   - Terminal D12 X3 (BCM)
     - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. If all circuits test normal, replace the appropriate module.

Repair Procedures

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

Control Module References for the appropriate module replacement, setup, and programming.

DTC B1424

Diagnostic Instructions

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

DTC Descriptor

DTC B1424 00

Device Voltage Low - TDM

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	B1424 00	B1424 00	-	-
Ground	-	B1424 00	-	-

Circuit/System Description

The theft deterrent module (TDM) monitors the battery positive (B+) voltage available to it. If the voltage at the TDM is between 6-9 volts, and the voltage being reported by a serial data message is greater than 9 volts, then DTC B1424 00 sets.

Conditions for Running the DTC

- The ignition switch is in Accessory or Run.
- This diagnostic runs every 100 milliseconds.

Conditions for Setting the DTC

- Voltage at the TDM B+ circuit is between 6-9 volts.
- Reported battery voltage received via serial data is valid and is greater than 9 volts.
- The above conditions have been met for 2 seconds.

Action Taken When the DTC Sets

The security indicator turns ON.

Conditions for Clearing the DTC

- A current DTC clears when the battery voltage at the TDM is greater than 9 volts, or if the voltage reported by serial data is less than 9 volts.
- A history DTC clears after 100 consecutive ignition cycles, if no failures are reported by this diagnostic.

Diagnostic Aids

- A low voltage DTC in multiple modules indicates a concern in the charging system.
- Verify that the ground terminal G201 is clean and tight.

Reference Information

Schematic Reference

- **Immobilizer Schematics**
- **Starting and Charging Schematics**
- **Ground Distribution Schematics**

Connector End View Reference

Component Connector End Views

Description and Operation

- **Immobilizer Description and Operation**
- **Charging System Description and Operation (w/RVC)**

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 volts.
    - If not within the specified range, refer to **Charging System Test**.
2. Ignition OFF, disconnect the harness connector at the TDM.
3. Ignition OFF, test for less than 5 ohms between the ground circuit terminal 3 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminal 1 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. If all circuits tests normal, replace the TDM.

Repair Procedures

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

Control Module References for TDM replacement, set up, and programming.

DTC B1516

Diagnostic Instructions

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

DTC Descriptors

DTC B1516 08

Battery Current Sensor Performance Signal Invalid

DTC B1516 66

Battery Current Sensor Performance Wrong Mounting Position

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5-Volt Reference	B1516 08	B1516 08	-	-
Signal	B1516 08	B1516 08	B1516 08	B1516 08, B1516 66
Ground	-	B1516 08	-	-

Circuit/System Description

The body control module (BCM) supplies 5 volts and ground to the battery current sensor. The battery current sensor measures the amount of current flowing to or from the battery, and supplies a pulse width modulation (PWM) signal to the BCM. The BCM monitors the battery current signal, and sets DTC B1516 08 if the signal is outside the normal range if 3-97 percent duty cycle. The BCM also monitors the current polarity, and sets DTC B1516 66 if reverse polarity is detected.

Conditions for Running the DTC

B1516 08

The BCM is awake.

B1516 66

- The BCM is awake.
- The hood, doors, and rear compartment are closed.
- The engine is not running.
- DTC B1516 08 has run and passed.
- DTC B1516 66 has not run and passed.

Conditions for Setting the DTC

B1516 08

The battery current signal is less than 3 percent or greater than 97 percent duty cycle for 1 minute.

B1516 66

The battery current polarity is positive for 2 minutes.

Action Taken When the DTC Sets

The regulated voltage control (RVC) is disabled.

Conditions for Clearing the DTC

- The DTC passes when the battery current signal returns to normal range for 5 seconds.
- A history DTC will clear after 100 ignition cycles.

Reference Information

Schematic Reference

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

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

B1516 08

1. Ignition OFF, disconnect the battery current sensor.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminal B and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Ignition ON, test for 4.8-5.2 volts between the 5-volt reference circuit terminal A and ground.
    - If less than the specified range, test the 5-volt reference circuit for a short to ground or an open/high resistance. If the circuit tests normal, then replace the BCM.
    - If greater than the specified range, test the 5-volt reference circuit for a short to voltage. If the circuit tests normal, then replace the BCM.

4. Ignition ON, test for 4.8-5.2 volts between the signal circuit terminal C and ground.
    - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the BCM.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the BCM.
5. If all circuits test normal, replace the battery current sensor.

B1516 66

1. Verify that the battery current sensor is installed securely around the negative battery cable, and positioned with the tape tab pointing away from the negative terminal of the battery and toward the chassis ground.
    - If the battery current sensor is not installed correctly, remove and reinstall the sensor.
2. Replace the battery current sensor.

Repair Procedures

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

- **Battery Current Sensor Replacement**
- **Control Module References** for BCM replacement, setup, and programming.

DTC B1517

Diagnostic Instructions

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

DTC Descriptor

DTC B1517 5A

Battery Voltage Plausibility Failure

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
BCM 2 B+	B1517 5A	B1325 03, B1517 5A	-	-
SDM or XM/ONSTAR B+	B1517 5A	B1517 5A	-	-
Ground	-	B1517 5A	-	-

Typical Scan Tool Data

Battery Voltage Signal - BCM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Key On, Engine Off. **Parameter Normal Value:** 12.60 Volts			
BCM 2 B+	0.00 Volts*	0.00 Volts*	12.60 Volts
*The BCM, EBCM, ECM, IPC, PSCM, TCM and TDM will not communicate if there is 0 volts on this circuit.			

Battery Voltage High Res. - BCM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Key On, Engine Off. **Parameter Normal Value:** 12.600 Volts			
SDM or XM/ONSTAR B+	0.000 Volts*	0.000 Volts*	12.600 Volts
*The DRR and VCIM will not communicate if there is 0 volts on this circuit.			

Circuit/System Description

The body control module (BCM) has designated B+ circuits for monitoring vehicle system voltage, fed by the BCM 2 fuse and the SDM or XM/ONSTAR fuse. Fuse 24 in the BCM will either be labeled SDM or XM/ONSTAR, depending on vehicle content. 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 5A will set. Other modules also monitor system voltage. The system voltage message is sent to the other modules and will default to 12.9 volts if DTC B1517 5A sets.

Conditions for Running the DTC

- The BCM has power and ground
- The ignition switch is not in the start position

Conditions for Setting the DTC

The battery voltage on the BCM battery sense circuits differs by 2 volts for 10 seconds.

Action Taken When the DTC Sets

The regulated voltage control (RVC) is disabled.

Conditions for Clearing the DTC

- The DTC will pass when the condition for setting the DTC is no longer present.
- A history DTC will clear after 50 consecutive ignition cycles have occurred without a malfunction.

Diagnostic Aids

- A low voltage DTC in multiple modules indicates a concern in the charging system.
- Inspect the SDM or XM/ONSTAR fuse for an open.

Reference Information

Schematic Reference

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

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 volts.
    - If not within the specified range, refer to **Charging System Test**.
2. Observe the scan tool BCM Battery Voltage Signal parameter and the Batt. Voltage High Res. parameter. The reading for both parameters should be between 12.6 and 15.0 volts, and should be within 2 volts of each other.

Circuit/System Testing

1. Verify that a test lamp illuminates between the SDM or XM/ONSTAR fuse 24 in the BCM and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high

resistance.

2. Ignition OFF, disconnect the harness connectors at the BCM.
3. Test for less than 5 ohms between the ground circuit terminal E12 X4 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminals listed below and ground.
    - Terminal D1 X3
    - Terminal D12 X3
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. Test for less than 5 ohms between the B+ circuit terminal 62 X1 and terminal B3 X3.
    - If greater than the specified range, test the B+ circuit for an open/high resistance.
6. If all circuits test normal, replace the BCM.

Repair Procedures

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

Control Module References for BCM replacement, setup, and programming.

DTC C0895

Diagnostic Instructions

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

DTC Descriptors

DTC C0895 03

Device Voltage Below Threshold - PSCM

DTC C0895 11

Device Voltage Above Maximum Threshold - PSCM

DTC C0895 12

Device Voltage Below Minimum Threshold - PSCM

Diagnostic Fault Information

	Short to	Open/High	Short to	Signal

Circuit	Ground	Resistance	Voltage	Performance
B+	C0895 00	C0895 00	-	-
Ground	-	C0895 00	-	-

Typical Scan Tool Data

Battery Voltage Signal - PSCM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** 12.60 Volts			
B+	0.00 Volts	0.00 Volts	12.60 Volts

Circuit/System Description

Voltage is supplied to the power steering control module (PSCM) by the battery positive (B+) voltage circuit. The PSCM monitors the supplied voltage to determine if it is within a valid operating range. Damage to components, and incorrect data may occur if the voltage is out of range. The PSCM disables all outputs, and sets DTC C0895 if high or low battery voltage is detected.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

Battery voltage is outside the normal range of 9.0-15.5 volts.

Action Taken When the DTC Sets

The PSCM disables all functionality.

Conditions for Clearing the DTC

- A current DTC will clear when the PSCM receives battery voltage in the normal range of 9-15.5 volts.
- A history DTC will clear if the condition does not return after 50 consecutive ignition cycles.

Diagnostic Aids

- A high or low voltage value in multiple modules indicates a concern in the charging system.
- Overcharging with a battery charger or jump starting can cause this DTC to set.

Reference Information

Schematic Reference

Power Steering Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 volts.
    - If not within the specified range, refer to **Charging System Test**.
2. Observe the scan tool PSCM Battery Voltage Signal parameter. The reading should be between 12.6 and 15.0 volts.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connectors at the PSCM.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminal 2 X1 and ground.
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Verify that a test lamp illuminates between the B+ circuit terminal 1 X1 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the PSCM.

Repair Procedures

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

Control Module References for PSCM replacement, setup and programming.

DTC C0899

Diagnostic Instructions

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

DTC Descriptor

DTC C0899 00

Device Voltage Low - EBCM

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0899 00	C0899 00	-	-
Ground	-	C0899 00	-	-

Typical Scan Tool Data

Battery Voltage Signal - EBCM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** 12.60 Volts.			
B+	0.00 Volts*	0.00 Volts*	-
*The scan tool will not communicate with the EBCM if the battery voltage is less than 7 volts.			

Circuit/System Description

The electronic brake control module (EBCM) monitors the battery voltage level available for system operation. A low voltage condition prevents the system from operating properly. If the EBCM detects low battery voltage, DTC C0899 00 will set.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

One of the following conditions exists for 0.5 seconds, or 5 seconds if the engine is cranking:

- The EBCM detects that the battery voltage is less than 9.7 volts, and the vehicle speed is greater than 0 km/h.

- The EBCM detects that the battery voltage is less than 8.45 volts, regardless of vehicle speed.

Action Taken When the DTC Sets

- The antilock brake system (ABS), traction control system (TCS), and vehicle stability enhancement system (VSES) are disabled.
- The electronic brake force distribution (EBD) is disabled, if the battery voltage is less than 8.45 volts.
- The ABS and vehicle dynamics caution (VDC) warning indicators turn ON.
- The BRAKE warning indicator turns ON, if the battery voltage is less than 8.45 volts.
- The driver information center (DIC) displays the SERVICE ESC, SERVICE TRACTION, and SVC BRAKE SYSTEM messages.
- The DIC displays the ESC OFF message 1 time.

Conditions for Clearing the DTC

- The indicators and DIC messages will turn OFF when the condition for setting the DTC is no longer present.
- The DTC will pass when the condition for setting the DTC is no longer present, and the ignition is cycled.
- The EBCM clears a history DTC when the DTC does not fail in 100 consecutive ignition cycles.

Diagnostic Aids

- A low voltage DTC in multiple modules indicates a concern in the charging system.
- The ABS, BRAKE, and VDC indicators and the DIC messages may turn ON without any DTCs set, if the EBCM detects that the battery voltage is less than 9.7 volts, and there is no vehicle speed.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- **ABS Description and Operation**
- **Charging System Description and Operation (w/RVC)**

Electrical Information Reference

- **Circuit Testing**

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 volts.
    - If not within the specified range, refer to **Charging System Test**.
2. Observe the scan tool EBCM Battery Voltage Signal parameter. The reading should be between 12.6 and 15.0 volts.

Circuit/System Testing

1. Ignition OFF. Disconnect the harness connector of the EBCM.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminals listed below and ground:
    - Terminal 16 (JL4)
    - Terminal 26 (JM4)
    - If greater than the specified range, test the ground circuit for an open/high resistance.
3. Verify that a test lamp illuminates between the B+ circuit terminals listed below and ground:
    - Terminal 1 (JL4/JM4)
    - Terminal 14 (JM4)
    - Terminal 32 (JL4)
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
4. If all circuits test normal, replace the EBCM.

Repair Procedures

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

Control Module References for EBCM replacement, setup and programming.

DTC C0900

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC C0900 00

Device Voltage High - EBCM

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	C0899 00	C0899 00	-	-
Ground	-	C0899 00	-	-

Typical Scan Tool Data

Battery Voltage Signal - EBCM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** 12.60 Volts.			
B+	0.00 Volts*	0.00 Volts*	-
*The scan tool will not communicate with the EBCM if the battery voltage is less than 7 volts.			

Circuit/System Description

The electronic brake control module (EBCM) monitors the battery positive (B+) voltage. If the voltage level is too high, damage may result in the system. When a high voltage condition is detected, DTC C0900 00 sets.

Conditions for Running the DTC

The ignition is ON.

Conditions for Setting the DTC

The EBCM detects that the battery voltage is greater than 18 volts.

Action Taken When the DTC Sets

- The antilock brake system (ABS), electronic brake force distribution (EBD), traction control system (TCS), and vehicle stability enhancement system (VSES) are disabled.
- The ABS, BRAKE, and vehicle dynamics caution (VDC) indicators turn ON.
- The driver information center (DIC) displays the SERVICE ESC, SERVICE TRACTION, and SVC BRAKE SYSTEM messages.

- The DIC displays the ESC OFF message 1 time.
- The ABS pump motor turns ON if the voltage is greater than 28 volts.

Conditions for Clearing the DTC

- The indicators and DIC messages will turn OFF when the condition for setting the DTC is no longer present.
- The DTC will pass when the condition for setting the DTC is no longer present, and the ignition is cycled.
- The EBCM clears a history DTC when the DTC does not fail in 100 consecutive drive cycles.

Diagnostic Aids

- This DTC could be set by overcharging with a battery charger or jump starting.
- A high voltage DTC in multiple modules indicates a concern in the charging system.

Reference Information

Schematic Reference

Antilock Brake System Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

- **ABS Description and Operation**
- **Charging System Description and Operation (w/RVC)**

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 volts.

- If not within the specified range, refer to **Charging System Test**.

2. Observe the scan tool EBCM Battery Voltage Signal parameter. The reading should be between 12.6 and 15.0 volts.
   - If greater than the specified range, replace the EBCM.

Repair Procedures

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

Control Module References for EBCM replacement, setup and programming.

DTC P0562

Diagnostic Instructions

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

DTC Descriptor

DTC P0562

System Voltage Low - ECM

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0562	P0562	-	-
Ground	-	P0562	-	-

Circuit/System Description

The engine control module (ECM) is supplied voltage by either the ECM/TRANS fuse, or the ECM/TCM fuse, depending on vehicle options. The ECM monitors the battery voltage to ensure that the voltage stays within the proper range. Damage to components, and incorrect data may occur if the voltage is out of range.

Conditions for Running the DTC

- The vehicle speed is greater than 8 km/h (5 mph).
- Engine speed is above 600 RPM

Conditions for Setting the DTC

* The ECM detects that the battery voltage is less than 10 V for 6 seconds.

Action Taken When the DTC Sets

The charge indicator turns ON.

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.
- A history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Diagnostic Aids

A low voltage DTC in multiple modules indicates a concern in the charging system.

Reference Information

Schematic Reference

- **Engine Controls Schematics** for the 2.0L (LNF) engine
- **Engine Controls Schematics (2.2L)** for the 2.2L (L61) and 2.4L (LE5) engines

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 V.
   - If not within the specified range, refer to **Charging System Test**.
2. Ignition OFF, disconnect the harness connectors at the ECM.
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminals listed below and ground.
   - Terminal 1 X2 (LNF)
   - Terminal 2 X2 (LNF)
   - Terminal 4 X2 (LNF)
   - Terminal 73 X2 (L61/LE5)
   - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminals listed below and ground.
   - Terminal 56 X2 (LNF)
   - Terminal 20 X1 (L61/LE5)
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. If all circuits test normal, replace the ECM.

Repair Procedures

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

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

DTC P0563

Diagnostic Instructions

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

DTC Descriptor

DTC P0563

System Voltage High - ECM

Diagnostic Fault Information

	Short to	Open/High	Short to	Signal

Circuit	Ground	Resistance	Voltage	Performance
B+	P0562	P0562	-	-
Ground	-	P0562	-	-

Circuit/System Description

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

Conditions for Running the DTC

- The engine is running.
- The vehicle speed is greater than 8 km/h (5 mph).

Conditions for Setting the DTC

The ECM detects that the system voltage is greater than 16 V for 1 second.

Action Taken When the DTC Sets

- The charge indicator turns ON.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- The ECM will command the indicator OFF after one trip in which the diagnostic test has been run and passed.
- A history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Diagnostic Aids

- A high voltage DTC in multiple modules indicates a concern in the charging system.
- This DTC could be set by overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

- **Engine Controls Schematics** for the 2.0L (LNF) engine
- **Engine Controls Schematics (2.2L)** for the 2.2L (L61) and 2.4L (LE5) engines

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Engine running, accessories OFF, measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 V.
    - If not within the specified range, refer to **Charging System Test**.
2. If all circuits test normal, replace the ECM.

Repair Procedures

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

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

DTC P0615

Diagnostic Instructions

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

DTC Descriptor

DTC P0615

Starter Relay Control Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CRNK Relay Control	-	P0615	P0615	-
Ground	-	P0615	-	-

Typical Scan Tool Data

Starter Relay Ckt Short Gnd Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition in Start. **Parameter Normal Value:** OK			
CRNK Relay Control	Fault	Not Run	Not Run

Starter Relay Ckt Open Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** OK			
CRNK Relay Control	Not Run	Fault	Not Run

Starter Relay Ckt Short Volts Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** OK			
CRNK Relay Control	Not Run	Not Run	Fault

Circuit/System Description

When the ignition switch is placed in the start position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the start position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in park or neutral. If it is, the ECM then supplies 12 volts to the control circuit of the CRNK relay. When this occurs, battery voltage is supplied through the switch of the crank relay to terminal A X1 of the starter solenoid. The ECM monitors the voltage on the CRNK relay control circuit. If the voltage is not what is expected, then DTC P0615 sets.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects improper voltage on the control circuit of the CRNK relay.

Action Taken When the DTC Sets

DTC P0615 is a type C DTC.

Conditions for Clearing the DTC

DTC P0615 is a type C DTC.

Diagnostic Aids

Inspect ground connection G105. Verify that it is clean and tight.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Observe the scan tool ECM Starter Relay Circuit Test Status parameters. Verify that the scan tool does not display any circuit faults.

Circuit/System Testing

1. Ignition OFF, disconnect the CRNK relay.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the relay ground circuit terminal 85 and ground.
    - If not within the specified range, test the ground circuit for an open/high resistance.
3. Ignition OFF, connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85. Turn the ignition to the start position. The test lamp should illuminate for a maximum of 10 seconds when the ignition is held in the start position.
    - If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the ECM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the CRNK relay.

Component Testing

CRNK Relay

1. Ignition OFF, disconnect the CRNK relay.
2. Test for 60-180 ohms between terminals 85 and 86.
    - If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified value, replace the relay.
4. Install a 20 amp fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
    - If greater than specified range, replace the relay.

Repair Procedures

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

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming.

DTC P0616

Diagnostic Instructions

- Perform the **Diagnostic System Check - Vehicle** prior to using this diagnostic procedure.

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptor

DTC P0616

Starter Relay Control Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CRNK Relay Control	P0616	P0617	P0617	-
Ground	-	P0617	-	-

Typical Scan Tool Data

Starter Relay Ckt Short Gnd Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition in Start. **Parameter Normal Value:** OK			
CRNK Relay Control	Fault	Not Run	Not Run

Starter Relay Ckt Open Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** OK			
CRNK Relay Control	Not Run	Fault	Not Run

Starter Relay Ckt Short Volts Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** OK			
CRNK Relay Control	Not Run	Not Run	Fault

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the start position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in park or neutral. If it is, the ECM then supplies 12 volts to the control circuit of the CRNK relay. When this occurs, battery voltage is supplied through the switch of the crank relay to terminal A X1 of the starter solenoid. The ECM monitors the voltage on the CRNK relay control circuit. If low voltage is detected, then DTC P0616

sets.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects low voltage on the control circuit of the CRNK relay.

Action Taken When the DTC Sets

DTC P0616 is a type C DTC.

Conditions for Clearing the DTC

DTC P0616 is a type C DTC.

Diagnostic Aids

Inspect ground connection G105. Verify that it is clean and tight.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Observe the scan tool ECM Starter Relay Circuit Status parameters. Verify that the scan tool does not display any circuit faults.

Circuit/System Testing

1. Ignition OFF, disconnect the CRNK relay.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the relay ground circuit terminal 85 and ground.
    - If not within the specified range, test the ground circuit for an open/high resistance.
3. Ignition OFF, connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85. Turn the ignition to the start position. The test lamp should illuminate for a maximum of 10 seconds when the ignition is held in the start position.
    - If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the ECM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the CRNK relay.

Component Testing

CRNK Relay

1. Ignition OFF, disconnect the CRNK relay.
2. Test for 60-180 ohms between terminals 85 and 86.
    - If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified value, replace the relay.
4. Install a 20 amp fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
    - If greater than specified range, replace the relay.

Repair Procedures

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

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming.

DTC P0617

Diagnostic Instructions

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

DTC Descriptor

DTC P0617

Starter Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
CRNK Relay Control	P0616	P0617	P0617	-
Ground	-	P0617	-	-

Typical Scan Tool Data

Starter Relay Ckt Short Gnd Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition in Start. **Parameter Normal Value:** OK			
CRNK Relay Control	Fault	Not Run	Not Run

Starter Relay Ckt Open Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** OK			
CRNK Relay Control	Not Run	Fault	Not Run

Starter Relay Ckt Short Volts Test Status - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, Engine OFF. **Parameter Normal Value:** OK			
CRNK Relay Control	Not Run	Not Run	Fault

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the start position. The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the transmission is in park or neutral. If it is, the ECM then supplies 12 volts to the control circuit of the CRNK relay. When this occurs, battery voltage is supplied through the switch of the crank relay to terminal A X1 of the starter solenoid. The ECM monitors the voltage on the CRNK relay control circuit. If high voltage is detected, then DTC P0617 sets.

Conditions for Running the DTC

- The ignition is ON.
- The system voltage is between 9.5-18 volts.

Conditions for Setting the DTC

The ECM detects high voltage on the control circuit of the CRNK relay.

Action Taken When the DTC Sets

DTC P0617 is a type C DTC.

Conditions for Clearing the DTC

DTC P0617 is a type C DTC.

Diagnostic Aids

Inspect ground connection G105. Verify that it is clean and tight.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Observe the scan tool ECM Starter Relay Circuit Status parameters. Verify that the scan tool does not display any circuit faults.

Circuit/System Testing

1. Ignition OFF, disconnect the CRNK relay.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the relay ground circuit terminal 85 and ground.
    - If not within the specified range, test the ground circuit for an open/high resistance.
3. Ignition OFF, connect a test lamp between the control circuit terminal 86 and the ground circuit terminal 85. Turn the ignition to the start position. The test lamp should illuminate for a maximum of 10 seconds when the ignition is held in the start position.
    - If the test lamp is always ON, test the control circuit for short to voltage. If the circuit tests normal, replace the ECM.
    - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the CRNK relay.

Component Testing

CRNK Relay

1. Ignition OFF, disconnect the CRNK relay.
2. Test for 60-180 ohms between terminals 85 and 86.
    - If not within the specified range, replace the relay.

3. Test for infinite resistance between the following terminals:
   - 30 and 86
   - 30 and 87
   - 30 and 85
   - 85 and 87
   - If not the specified value, replace the relay.
4. Install a 20 amp fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.
   - If greater than specified range, replace the relay.

Repair Procedures

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

- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Control Module References** for ECM replacement, setup, and programming.

DTC P0621

Diagnostic Instructions

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

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0622	P0622	-	-
Field Duty Cycle Signal	P0622	P0622	-	-
Turn On Signal	P0621*, P2500**	-	P0621*, P2501**	-
* 2.2L (L61) and 2.4L (LE5) engines only ** 2.0L (LNF) turbocharged engine only				

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

The ECM detects high or low voltage on the generator turn on signal circuit for 15 seconds.

Action Taken When the DTC Sets

- The charge indicator turns ON.
- The ECM will not illuminate the malfunction indicator lamp (MIL).
- The ECM will store conditions, which were present when the DTC set as Fail Records data only.

Conditions for Clearing the DTC

- A current DTC will clear when the conditions for setting the DTC are no longer met.
- A history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the generator.
2. Ignition ON, test for less than 1 V between the signal circuit terminal 1 and ground.
   - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
3. Engine running, command the L-Terminal ON to 85% with a scan tool. Test for greater than 3 V between the signal circuit terminal 1 and ground.
   - If less than the specified range, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the generator.

Repair Procedures

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

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

DTC P0622

Diagnostic Instructions

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

DTC Descriptor

DTC P0622

Generator F-Terminal Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0622	P0622	-	-
Field Duty Cycle Signal	P0622	P0622	-	-
Turn On Signal	P0621*, P2500**	-	P0621*, P2501**	-
* 2.2L (L61) and 2.4L (LE5) engines only ** 2.0L (LNF) turbocharged engine only				

Typical Scan Tool Data

GEN F-Terminal Signal - ECM

Circuit	Short to ground	Open	Short to voltage
Operating Conditions: Engine Running **Parameter Normal Range:** 5% to 99%			
B+	0%	0%	-
Field Duty Cycle Signal	0%	0%	99%

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings ON and OFF. The ECM uses the signal to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition switch 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 5-99 percent.

Conditions for Running the DTC

- The engine is running.
- DTCs P0621, P2500, and P2501 are not set.

Conditions for Setting the DTC

The ECM detects that the field duty cycle signal is less than 5 percent for 30 seconds.

Action Taken When the DTC Sets

The charge indicator turns ON.

Conditions for Clearing the DTC

- The DTC passes when the field duty cycle signal is greater than 5 percent for 30 seconds.

- The EBCM clears a history DTC when the DTC does not fail in 100 consecutive drive cycles.
- The charge indicator turns OFF when the DTC passes.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON, engine OFF, observe the scan tool ECM GEN-F Terminal Signal parameter. The reading should be less than 5%.
2. Engine running, observe the scan tool ECM GEN-F Terminal Signal parameter. The reading should be greater than 5%.

Circuit/System Testing

1. Verify that a test lamp illuminates between the B+ circuit ring terminal 1 X2 and ground.
    - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
2. Ignition OFF, disconnect the X1 harness connector at the generator.

3. Ignition ON, verify the scan tool ECM GEN-F Terminal Signal parameter is less than 5%.
    - If greater than the specified range, test the appropriate signal circuit terminal listed below for a short to voltage. If the circuit tests normal, replace the ECM.
        - Terminal 2 X1 (L61/LE5)
        - Terminal C X1 (LNF)
4. Install a 3A fused jumper wire between the appropriate signal circuit terminal listed below and B+. Verify the scan tool ECM GEN-F Terminal Signal parameter is greater than 95%.
    - Terminal 2 X1 (L61/LE5)
    - Terminal C X1 (LNF)
    - If less than the specified range, test the circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
5. If all circuits test normal, test or replace the generator.

Repair Procedures

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

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

DTC P2500

Diagnostic Instructions

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

DTC Descriptor

DTC P2500

Generator L-Terminal Circuit Low

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0622	P0622	-	-
Field Duty Cycle Signal	P0622	P0622	-	-
Turn On Signal	P0621*, P2500**	-	P0621*, P2501**	-

* 2.2L (L61) and 2.4L (LE5) engines only

** 2.0L (LNF) turbocharged engine only

Circuit/System Description

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

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

The ECM detects low voltage on the generator turn on signal circuit for 2 seconds.

Action Taken When the DTC Sets

The charge indicator turns ON 15 seconds after the DTC sets.

Conditions for Clearing the DTC

- The DTC will pass when the conditions for setting the DTC are no longer met for 2 seconds.
- A history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The charge indicator turns OFF 15 seconds after the DTC passes.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

- **Circuit Testing**

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the generator.
2. Ignition ON, engine OFF, test for less than 1 V between the signal circuit terminal B and ground.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
3. Engine running, test for greater than 3 V between the signal circuit terminal B and ground.
    - If less than the specified range, test the signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the generator.

Repair Procedures

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

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

DTC P2501

Diagnostic Instructions

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

DTC Descriptor

DTC P2501

Generator L-Terminal Circuit High

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	P0622	P0622	-	-
Field Duty Cycle Signal	P0622	P0622	-	-
Turn On Signal	P0621*, P2500**	-	P0621*, P2501**	-
* 2.2L (L61) and 2.4L (LE5) engines only ** 2.0L (LNF) turbocharged engine only				

Circuit/System Description

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

Conditions for Running the DTC

- The ignition is ON.
- The engine is OFF.

Conditions for Setting the DTC

the ECM detects high voltage on the generator turn on signal circuit for 2 seconds.

Action Taken When the DTC Sets

The charge indicator turns ON 5 seconds after the DTC sets.

Conditions for Clearing the DTC

- The DTC will pass when the conditions for setting the DTC are no longer met for 2 seconds.
- A history DTC will clear after 40 consecutive warm-up cycles have occurred without a malfunction.
- The charge indicator turns OFF 5 seconds after the DTC passes.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, disconnect the X1 harness connector at the generator.
2. Ignition ON, engine OFF, test for less than 1 V between the signal circuit terminal B and ground.
    - If greater than the specified range, test the signal circuit for a short to voltage. If the circuit tests normal, replace the ECM.
3. Engine running, test for greater than 3 V between the signal circuit terminal B and ground.
    - If less than the specified range, test the signal circuit for a short to ground, or an open/high resistance. If the circuit tests normal, replace the ECM.
4. If all circuits test normal, test or replace the generator.

Repair Procedures

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

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

SYMPTOMS - ENGINE ELECTRICAL

The following steps must be completed before using the symptom diagnostic procedures:

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

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- **Battery Inspection/Test**
- **Battery Electrical Drain/Parasitic Load Test**
- **Battery Common Causes of Malfunction**
- **Charging System Test**
- **Generator Noise Diagnosis**
- **Starter Solenoid Does Not Click**
- **Starter Solenoid Clicks, Engine Does Not Crank**
- **Engine Cranks Slowly**
- **Starter Noise Diagnosis**

BATTERY INSPECTION/TEST

Special Tools

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

Diagnostic Aids

NOTE:

- **A dead battery is usually a symptom of another problem. Repair the problem. Do not just charge or replace the battery.**
- **Failure to properly understand the battery and its function could lead to a misdiagnosis and unneeded repairs. Refer to Battery Description and Operation and Battery Common Causes of Malfunction for more information.**

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

- If testing the vehicle with the battery cables still connected, wiggle the **J 42000** clips on the terminal. See **Special Tools**. This may cut through any coating or through any oxidation that may be present on the terminal.
- 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.
- If the tester displays a "Bad Battery" result for a battery tested in the vehicle with the battery cables connected, perform the following steps:
  1. Disconnect the negative battery cable.
  2. Disconnect the positive battery cable.
  3. Replace the battery only if the Out-of-Vehicle test shows a "Bad Battery" result. This prevents battery replacements that are due only to faulty battery cable connections.

Circuit/System Testing

WARNING: Refer to Battery Disconnect Warning .

1. Inspect the battery for a cracked, broken, or damaged case, which may be indicated by battery acid leakage.
   - If there is any apparent damage, replace the battery.
2. Verify 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**.
   - If the battery does not meet or exceed specifications, replace the battery.
3. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in **Fastener Tightening Specifications**.
   - If the battery cable(s) need to be cleaned, clean as required and tighten as specified.
   - If the battery cable(s) are damaged, replace then tighten as specified.
4. Install the **J 42000** and follow directions supplied by the tester. See **Special Tools**.
   - If the tester calls for charging the battery, refer to **Battery Charging**.

Repair Procedures

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

- **Battery Positive Cable Replacement (Junction Block to Starter)** or **Battery Positive Cable Replacement (Battery to Underhood Junction Block)**
- **Battery Negative Cable Replacement (Battery to Battery Tray)** or **Battery Negative Cable Replacement (Engine To Chassis)**
- **Battery Replacement**

BATTERY CHARGING

Special Tools

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

Battery State of Charge

- 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**.

NOTE: 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.

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

Use the 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

CAUTION: Turn OFF the ignition when connecting or disconnecting the battery cables, the battery charger or the jumper cables. Failure to do so may damage the ECM/PCM or other electronic components.

CAUTION: Refer to Fastener Caution .

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.

CAUTION: 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

Special Tools

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

Diagnostic Aids

- Be sure to rule out any possible obvious influences, such as customer error or aftermarket equipment.
- 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** 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** for the system or modules description and operation.
- The graph below indicates roughly how many days a 690 CCA battery with at 110 min. 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 temperature and ratings will affect the results:

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

WARNING: Refer to Battery Disconnect Warning .

CAUTION: 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.

CAUTION: 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.

NOTE: 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.

NOTE: 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 .

7. Park the vehicle. Turn the ignition switch to the OFF position and remove the ignition switch key.
8. Connect a 10A 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 19.
11. Remove the fused jumper wire.
12. Set a digital multimeter to the 10A scale.
13. Connect the digital multimeter 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 digital multimeter.
15. Wait 1 minute. Check 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 digital multimeter 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. Check 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 digital multimeter, monitor the parasitic drain overnight or during the day. This will determine if something has been activated during that time frame.

CAUTION: 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.

NOTE: 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** 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 MALFUNCTION

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

- A vehicle accessory was left on overnight.
- The driving speeds have been slow with frequent stops, stop-and-go driving, with many electrical accessories in use, particularly air conditioning, headlights, wipers, heated rear window, cellular telephone, etc.
- The electrical load has exceeded the generator output, particularly with the addition of aftermarket equipment.
- Existing conditions in the charging system, including the following possibilities:
  - A slipping belt
  - A bad generator
- The battery has not been properly maintained, including a loose battery hold down or missing battery insulator if used.
- There are mechanical conditions in the electrical system, such as a short or a pinched wire, attributing to power failure. Refer to **General Electrical Diagnosis** .

Electrolyte Freezing

The freezing point of electrolyte depends on its specific gravity. A fully charged battery will not freeze until the ambient temperature gets below -54°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.

   WARNING: Refer to Battery Disconnect Warning .

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.

CHARGING SYSTEM TEST

Diagnostic Instructions

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

Circuit/System Verification

Engine ON, observe the charge indicator on the instrument panel cluster (IPC) or message in the driver information center (DIC). The charge indicator on the IPC should be turned OFF and the DIC should not display any charging system message.

- If the charge indicator is not on the IPC and a charging system message is not displayed on the DIC, refer to **Testing for Intermittent Conditions and Poor Connections** .
- If the charge indicator is ON on the IPC or a charging system message is displayed on the DIC, refer to **Circuit/System Testing**.

Circuit/System Testing

1. Ignition ON, verify that no generator or battery current sensor DTCs are set that would cause a charging system concern.
   - If DTCs are set, refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Ignition OFF, measure the voltage across the battery terminals. The voltage should read 12.0 volts or greater at room temperature.
   - If not within the specified value, refer to **Battery Inspection/Test**.
3. Connect a carbon pile tester to the battery.
4. Start the engine and increase the engine speed to 2,500 RPM. Observe the voltage reading on the tester. The voltage should read between 12.6-15.0 volts.
   - If not within specified range, replace the generator.
5. Adjust the carbon pile tester to the specified load test output value, refer to **Generator Usage**.
   - If not within specified value, replace the generator.

Repair Procedures

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

Generator Replacement

GENERATOR NOISE DIAGNOSIS

Diagnostic Instructions

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

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

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.

Circuit/System Testing

1. Start the engine. Verify the noise can be heard. Compare the concern to a similar vehicle.
2. Perform a charging system test. Verify that the generator is charging properly. Refer to **Charging System Test**.
3. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines or other accessory equipment that may be misrouted or be the cause of noise being transmitted into the passenger compartment.
4. Ignition OFF, remove the engine drive belt. Verify the generator, A/C compressor, and tensioner pulley spin freely.
    - If any of the pulleys do not spin freely, replace the affected component.
5. Start the engine, with the drive belt removed. Verify that the noise goes away.
    - If the noise is still present, the generator is not the cause of the noise.
6. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten the mounting bolts to specification, refer to **Generator Replacement**.

Repair Procedures

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

- **Drive Belt Replacement** for the 2.0L (LNF) engine
- **Drive Belt Tensioner Replacement** for the 2.0L (LNF) engine
- **Drive Belt Replacement** for the 2.2L (L61) and 2.4L (LE5) engines
- **Drive Belt Tensioner Replacement** for the 2.2L (L61) and 2.4L (LE5) engines
- **Generator Replacement**

STARTER SOLENOID DOES NOT CLICK

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
CRNK Fuse	-	1	-	-
ECM/TRANS Fuse	-	1	-	-
Park/Neutral Signal (MN5)	2	1	1	-
CRNK Relay Control	1	1	3	-
Starter Solenoid Control	1	1	3	-
Ground	-	1	-	-

1. No crank
2. Cranks in any gear
3. Cranks all the time

Typical Scan Tool Data

Ignition 1 Signal - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition ON, engine OFF. **Parameter Normal Value:** 12.6 Volts			
ECM/TRANS Ignition	0.0 Volts	0.0 Volts	12.6 Volts

PNP Switch - ECM

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Transmission in Park **Parameter Normal Value:** Park/Neutral			
Park/Neutral Signal	Park/Neutral	In Gear	In Gear

Circuit/System Description

The engine control module (ECM) controls engine cranking based on a power mode input and the status of the clutch pedal position (CPP) sensor (Getrag M86 / Saab MU3), or the park/neutral position (PNP) switch (MN5 4T45-E). With the transmission in park or neutral, voltage at the ECM PNP switch signal circuit is low, or the CPP signal circuit indicates that the clutch pedal is pressed. This indicates to the ECM that conditions are acceptable for cranking. The ECM provides voltage to the starter relay coil control circuit. The relay provides voltage to the starter terminal A X1 and engages the starter solenoid.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

Automatic Transmission (MN5)

1. Ignition ON, transmission in park, observe the scan tool ECM PNP Switch parameter. The reading should be Park/Neutral.
    - If not the specified value, refer to **Circuit/System Testing** for PNP Switch Circuit Malfunction.
2. Command the Starter Relay ON with a scan tool (L61/LNF), or turn the ignition switch to the START position (LE5). The starter solenoid should engage and the engine should crank.
    - If the solenoid engages but the engine does not crank, refer to **Starter Solenoid Clicks, Engine Does Not Crank**.
    - If the solenoid does not engage, refer to **Circuit/System Testing** for CRNK Relay Circuit Malfunction.

Manual Transmission (M86/MU3)

1. Ignition ON, observe the scan tool ECM CPP Sensor and the CPP Learn Status parameters. The scan tool CPP Sensor parameter should change when the clutch pedal is pressed and released, and the CPP Learn Status should be Complete.
    - If not the specified values, refer to the appropriate procedure listed below:
        - **Clutch Pedal Position Sensor Learn** for the Getrag (M86) transmission
        - **Clutch Pedal Position Sensor Learn** for the Saab (MU3) transmission
2. Command the Starter Relay ON with a scan tool (L61/LNF), or turn the ignition switch to the START position (LE5). The starter solenoid should engage and the engine should crank.
    - If the solenoid engages but the engine does not crank, refer to **Starter Solenoid Clicks, Engine**

Does Not Crank.

- If the solenoid does not engage, refer to **Circuit/System Testing** for CRNK Relay Circuit Malfunction.

Circuit/System Testing

PNP Switch Circuit Malfunction (MN5)

1. Inspect the PNP switch for proper adjustment. Refer to **Park/Neutral Position Switch Adjustment** .
2. Ignition OFF, disconnect the harness connector at the PNP switch.
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminal 1 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Verify that the scan tool ECM PNP Switch parameter is In Gear.
   - If not the specified value, test the signal circuit terminal 12 for a short to voltage. If the circuit tests normal, replace the ECM.
5. Install a 3 A fused jumper wire between the signal circuit terminal 12 and the ground circuit terminal 1. Verify that the scan tool ECM PNP Switch parameter is Park/Neutral.
   - If not the specified value, test the signal circuit for a short to ground or an open/high resistance. If the circuit tests normal, replace the ECM.
6. If all circuits test normal, test or replace the PNP switch.

CRNK Relay Circuit Malfunction

1. Ignition ON, observe the scan tool ECM Ignition 1 parameter. The reading should be B+ voltage.
   - If not the specified value, test the ECM/TRANS ignition circuit terminal 54 X2 (LNF) or terminal 19 X1 (L61/LE5) for a short to ground or an open/high resistance.
2. Ignition OFF, disconnect the CRNK relay. Refer to **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)** .
3. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the ground circuit terminal 85 and ground.
   - If greater than the specified range, test the ground circuit for an open/high resistance.
4. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.
   - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
5. Connect a test lamp between the ground circuit terminal 85 and the control circuit terminal 86.
6. Ignition ON, transmission in Park (MN5) or clutch pedal pressed (M86/MU3). Command the starter relay ON and OFF with a scan tool (L61/LNF), or turn the ignition switch between the start and run positions (LE5). The test lamp should turn ON and OFF when changing between the commanded states.
   - If the test lamp is always ON, test the control circuit for a short to voltage. If the circuit tests normal, replace the ECM.
   - If the test lamp is always OFF, test the control circuit for a short to ground or an open/high

resistance. If the circuit tests normal, replace the ECM.

7. Ignition OFF, connect the CRNK relay. Disconnect the X1 harness connector at the starter solenoid.
8. Ignition ON, transmission in park (MN5) or clutch pedal pressed (M86/MU3). Command the starter relay ON with a scan tool (L61/LNF), or turn the ignition switch to the START position (LE5). Verify that a test lamp illuminates between the starter terminal A X1 and ground.
    - If the test lamp does not illuminate, test the starter control circuit for an open/high resistance. If the circuit tests normal, test or replace the CRNK relay.
9. If all circuits test normal, test or replace the starter.

Component Testing

PNP Switch (MN5 4T45-E)

1. Ignition OFF, disconnect the harness connector at the PNP switch.
2. With the PNP switch in the following positions, test for infinite resistance between the ground terminal 1 and the signal terminal 12.
    - R
    - OD
    - D
    - 2
    - 1
    - If not the specified value, replace the PNP switch.
3. With the PNP switch in the following positions, test for less than 2 ohms between the ground terminal 1 and the signal terminal 12.
    - P
    - N
    - If greater than the specified range, replace the PNP switch.

CRNK Relay

1. Ignition OFF, disconnect the CRNK relay.
2. Test for 60-180 ohms between terminals 85 and 86.
    - If not within the specified range, replace the relay.
3. Test for infinite resistance between the following terminals:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87
    - If not the specified value, replace the relay.
4. Install a 20 amp fused jumper wire between relay terminal 85 and 12 volts. Install a jumper wire between relay terminal 86 and ground. Test for less than 2 ohms between terminals 30 and 87.

- If greater than specified range, replace the relay.

Repair Procedures

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

- **Clutch Pedal Position Sensor Learn** for the Getrag (M86) manual transmission.
- **Clutch Pedal Position Sensor Learn** for the Saab (MU3) manual transmission.
- **Park/Neutral Position Switch Adjustment** for the 4T45-E (MN5) automatic transmission.
- **Park/Neutral Position Switch Replacement** for the 4T45-E (MN5) automatic transmission.
- **Relay Replacement (Attached to Wire Harness)** or **Relay Replacement (Within an Electrical Center)**
- **Starter Replacement**
- **Control Module References** for ECM replacement, setup and programming.

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Diagnostic Instructions

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

Circuit/System Description

When the ignition switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a serial data message to the engine control module (ECM) that crank has been requested. The ECM monitors the park/neutral position switch, or the clutch pedal position sensor. If the transmission is in Park or Neutral, or the clutch is pressed, and there are no DTCs that inhibit engine starting, then the ECM supplies voltage to the control circuit of the CRNK relay. When this occurs, battery voltage is supplied through the CRNK relay to terminal A X1 of the starter solenoid. The starter solenoid energizes, and supplies battery voltage to the starter from the ring terminal X2 to crank the engine.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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

Circuit/System Verification

Attempt to start the engine. Verify that the starter solenoid clicks and the engine cranks.

Circuit/System Testing

1. Measure and record the battery voltage at the battery terminals. The voltage should be between 12.6 and 15.0 V.
    - If not within the specified range, refer to **Charging System Test**.
2. Ignition OFF and scan tool disconnected, open and close the driver door, and wait 1 minute. Test for less than 5 ohms between the starter motor case and the negative terminal of the battery.
    - If greater than the specified range, test the battery negative cable for an open/high resistance.
3. Verify that a test lamp illuminates between the starter solenoid B+ circuit ring terminal X2 and ground.
    - If the test lamp does not illuminate, test the battery positive cable for an open/high resistance.
4. Remove the drive belt. Refer to the appropriate procedure listed below.
    - **Drive Belt Replacement** for the 2.0L (LNF) engine
    - **Drive Belt Replacement** for the 2.2L (L61) and 2.4L (LE5) engines
5. Rotate each pulley by hand. Verify that none of the engine accessories or idler pulleys are seized.
    - If any components are seized, replace the appropriate component.
6. Attempt to rotate the crankshaft using a breaker bar, flywheel turner, or other suitable tool. Verify that the engine is not seized.
    - If the engine is seized, refer to the appropriate procedure listed below.
        - **Engine Will Not Crank - Crankshaft Will Not Rotate** for the 2.0L (LNF) engine
        - **Engine Will Not Crank - Crankshaft Will Not Rotate** for the 2.2L (L61) and 2.4L (LE5) engines
7. If all circuits test normal, test or replace the starter motor.

Repair Procedures

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

- **Battery Positive Cable Replacement (Junction Block to Starter)** or **Battery Positive Cable Replacement (Battery to Underhood Junction Block)**

- **Battery Negative Cable Replacement (Battery to Battery Tray)** or **Battery Negative Cable Replacement (Engine To Chassis)**
- **Starter Replacement**

ENGINE CRANKS SLOWLY

Inspect the following items:

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

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

STARTER NOISE DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

The PG starter motors are non-repairable. 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.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

Component Connector End Views

Description and Operation

Charging System Description and Operation (w/RVC)

Electrical Information Reference

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

Circuit/System Verification

Start the engine. Listen to the starter noise, while the engine is cranking. Compare the concern to a similar vehicle.

Circuit/System Testing

1. Remove the starter motor. Refer to **Starter Replacement**.
2. Inspect the starter motor for any signs of damage or wear.
3. Inspect the flywheel for the following:
    - Loose flywheel bolts
    - Chipped gear teeth
    - Missing gear teeth
    - Bent flywheel
    - Debris in the bell housing
    - If not within specifications, tighten the flywheel bolts, repair or replace the flywheel.
4. If all inspections were within specification, replace the starter motor.

Repair Procedures

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

- **Fastener Tightening Specifications** for the 2.0L (LNF) engine
- **Fastener Tightening Specifications (2.2L)** for the 2.2L (L61) and 2.4L (LE5) engines
- **Engine Flywheel Replacement** for the 2.0L (LNF) engine
- **Engine Flywheel Replacement** for the 2.2L (L61) and 2.4L (LE5) engines
- **Starter Replacement**

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION

Removal Procedure

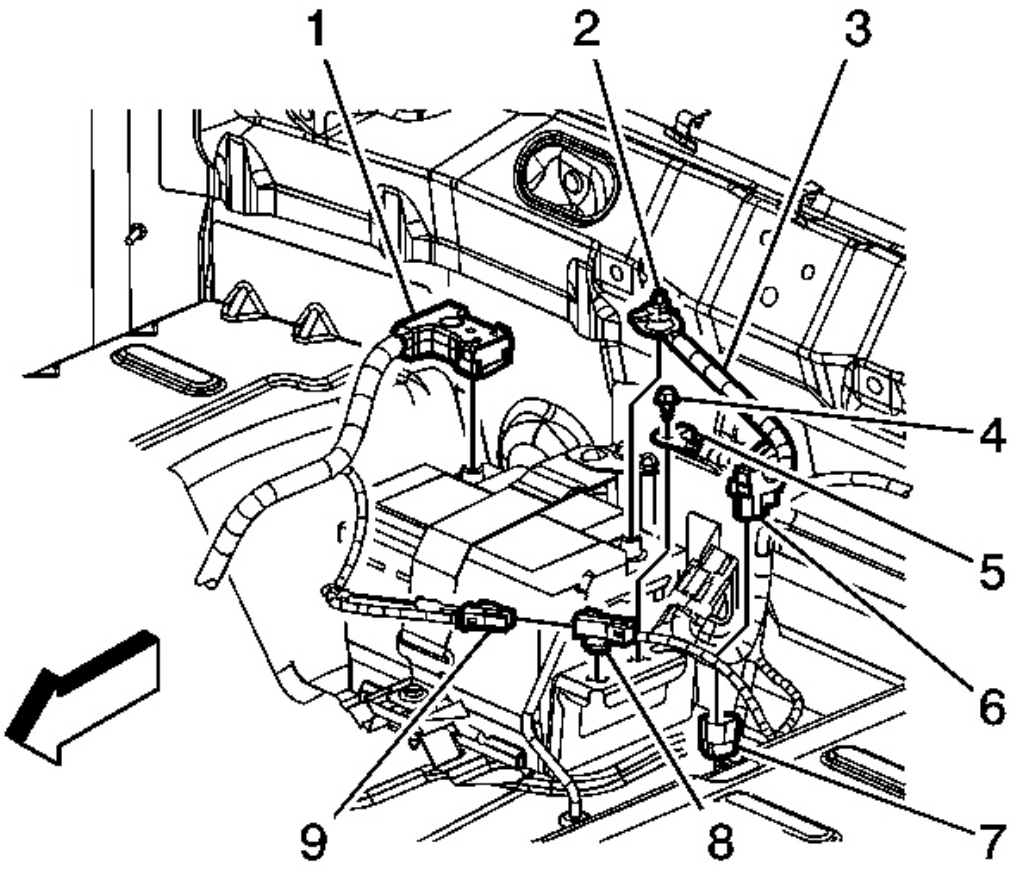


Fig. 3: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

1. Remove the rear compartment floor mat.
2. Record all of the vehicle preset radio stations.
3. Ensure that all lamps and accessories are OFF.
4. Ensure that the ignition switch is in the OFF position.
5. Loosen the negative battery cable (2) bolt.
6. Remove the negative battery cable (3) from the battery.

Installation Procedure

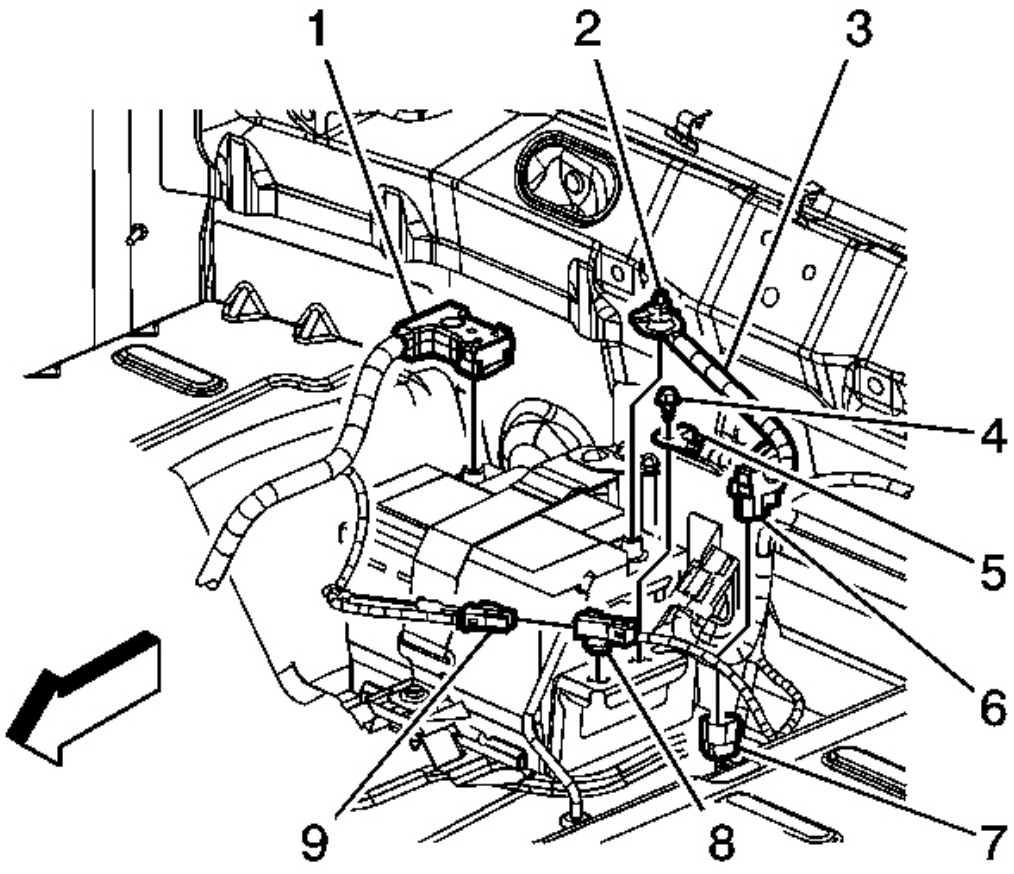


Fig. 4: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

NOTE: 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.

1. Position the negative battery cable (3) to the battery.

CAUTION: Refer to Fastener Caution .

2. Tighten the negative battery cable bolt (2) and tighten to 17 N.m (13 lb ft).
3. Install the rear compartment floor mat.

4. Reset the radio stations and the clock.

BATTERY CURRENT SENSOR REPLACEMENT

Removal Procedure

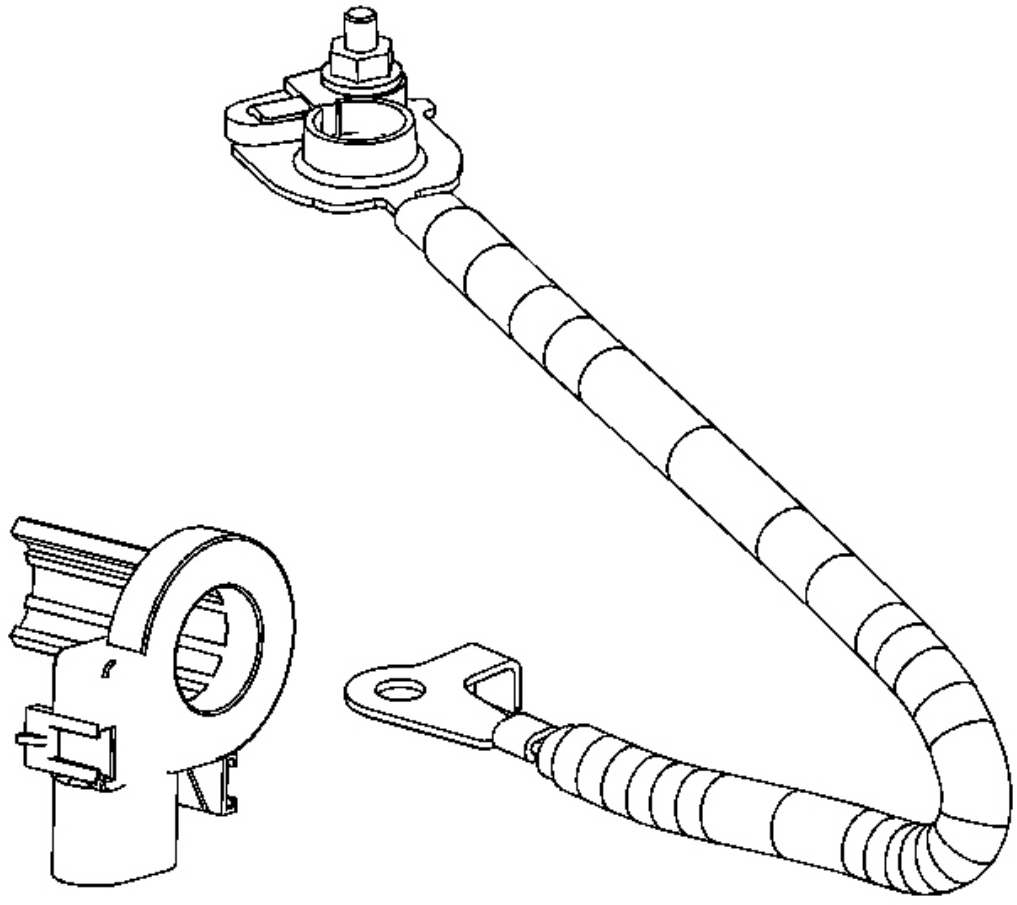


Fig. 5: View Of Battery Current Sensor
Courtesy of GENERAL MOTORS CORP.

1. Remove the battery to battery tray negative battery cable. Refer to **Battery Negative Cable Replacement (Battery to Battery Tray)** or **Battery Negative Cable Replacement (Engine To Chassis)**.
2. Remove the tape securing the battery current sensor to the negative battery cable.
3. Remove the battery current sensor from the negative battery cable.

Installation Procedure

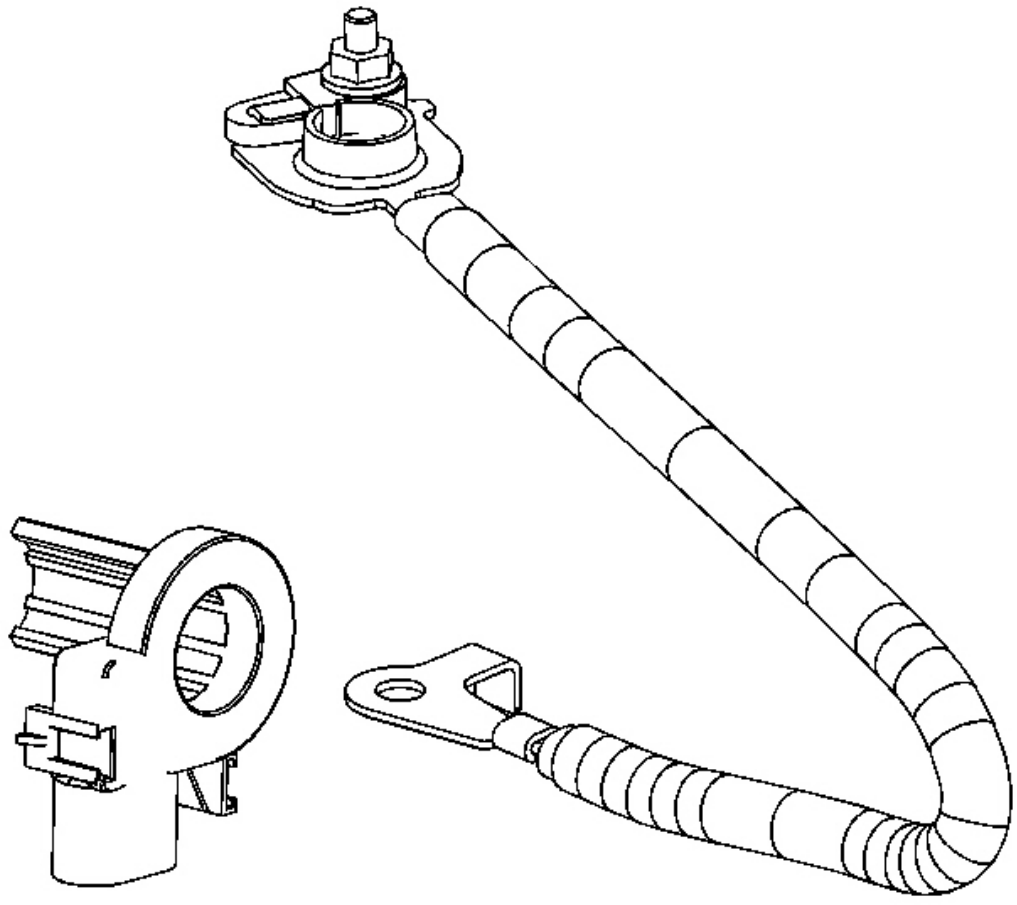


Fig. 6: View Of Battery Current Sensor
Courtesy of GENERAL MOTORS CORP.

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

NOTE: 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 battery to battery tray negative battery cable. Refer to **Battery Negative Cable Replacement (Battery to Battery Tray)** or **Battery Negative Cable Replacement (Engine To Chassis)**.

BATTERY NEGATIVE CABLE REPLACEMENT (BATTERY TO BATTERY TRAY)

Removal Procedure

NOTE:

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

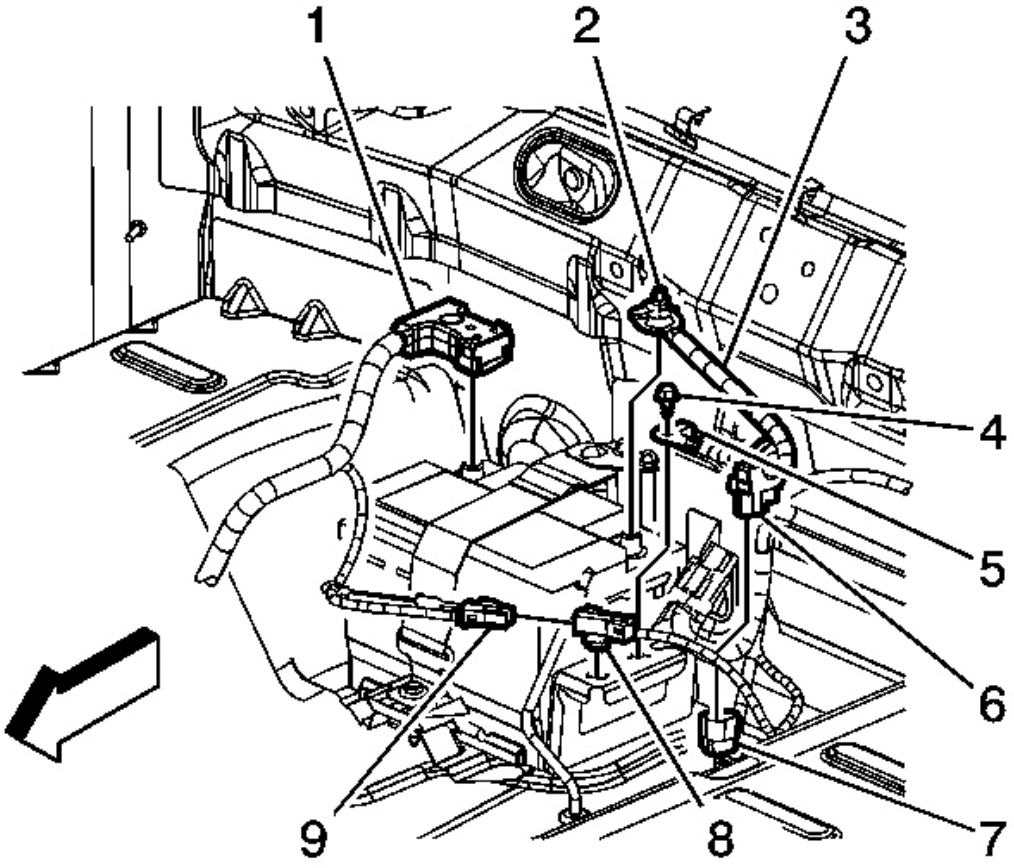


Fig. 7: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Disconnect the body harness electrical connector (7) from the battery current sensor (6).
3. Remove the negative battery cable ground bolt (4).

4. Separate the negative battery cable terminal (5) from the battery support.
5. Remove the negative battery cable (3).

Installation Procedure

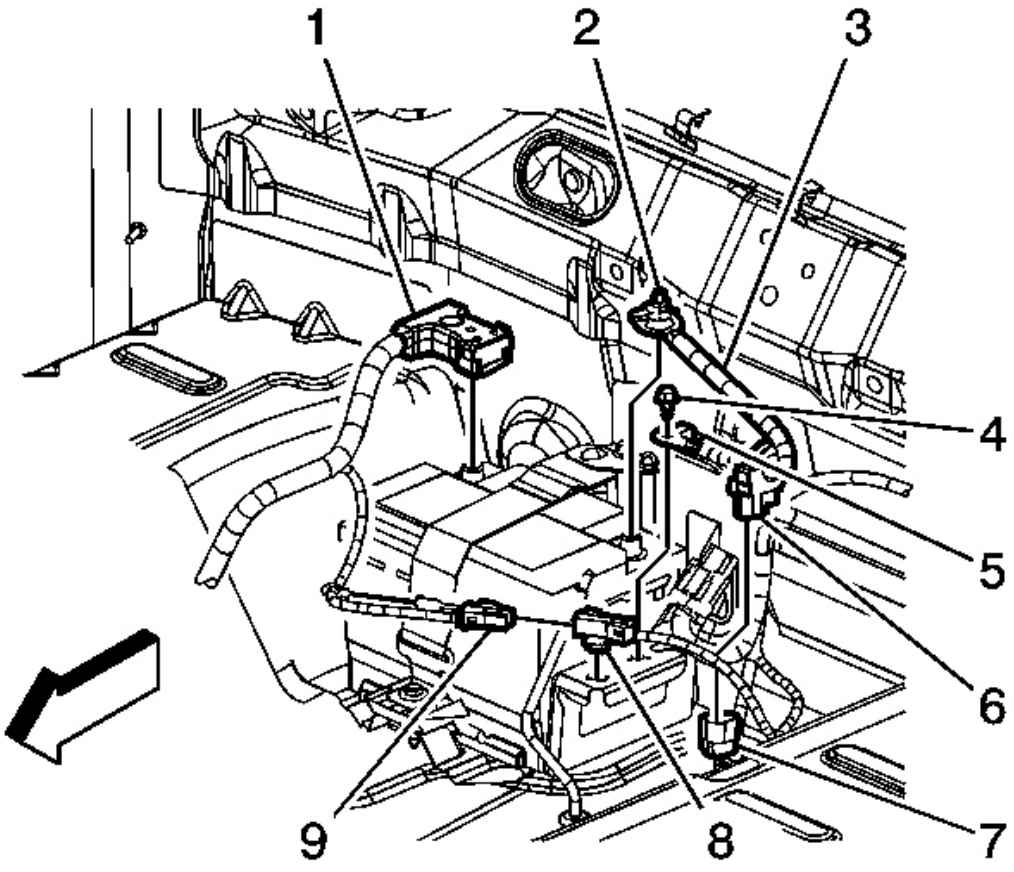


Fig. 8: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

1. Install the negative battery cable (3). Ensure that the anti-rotation tab on the terminal (5) is correctly located.

CAUTION: Refer to Fastener Caution .

2. Install the negative battery cable ground bolt (4) and tighten to 17 N.m (13 lb ft).

3. Connect the body harness electrical connector (7) to the battery current sensor (6).
4. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY NEGATIVE CABLE REPLACEMENT (ENGINE TO CHASSIS)

Removal Procedure

NOTE:

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

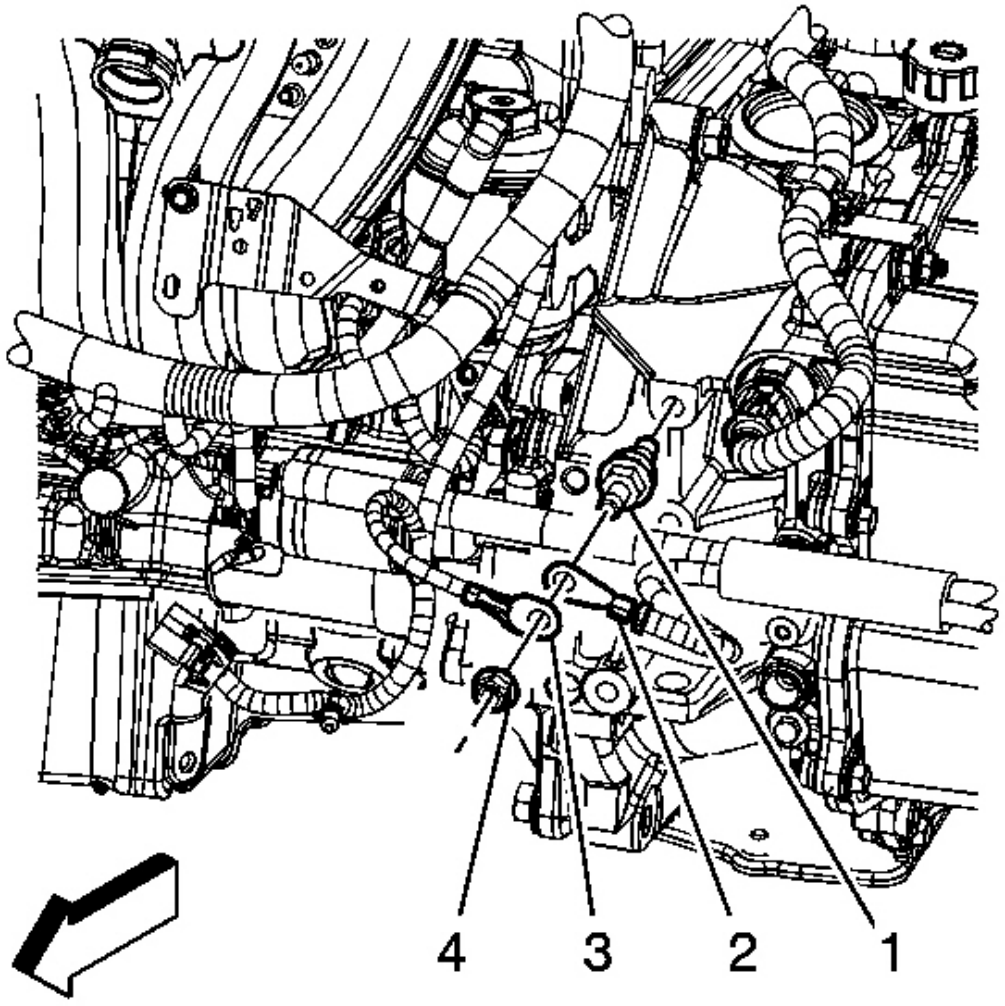


Fig. 9: Disconnecting/Connecting Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. If equipped with regular production options RPO LAP with MN5 perform the following, remove the engine harness ground nut (4).
4. Remove the engine harness ground terminal (3) from the stud (1).
5. Remove the negative battery cable ground terminal (2) from the stud (1).

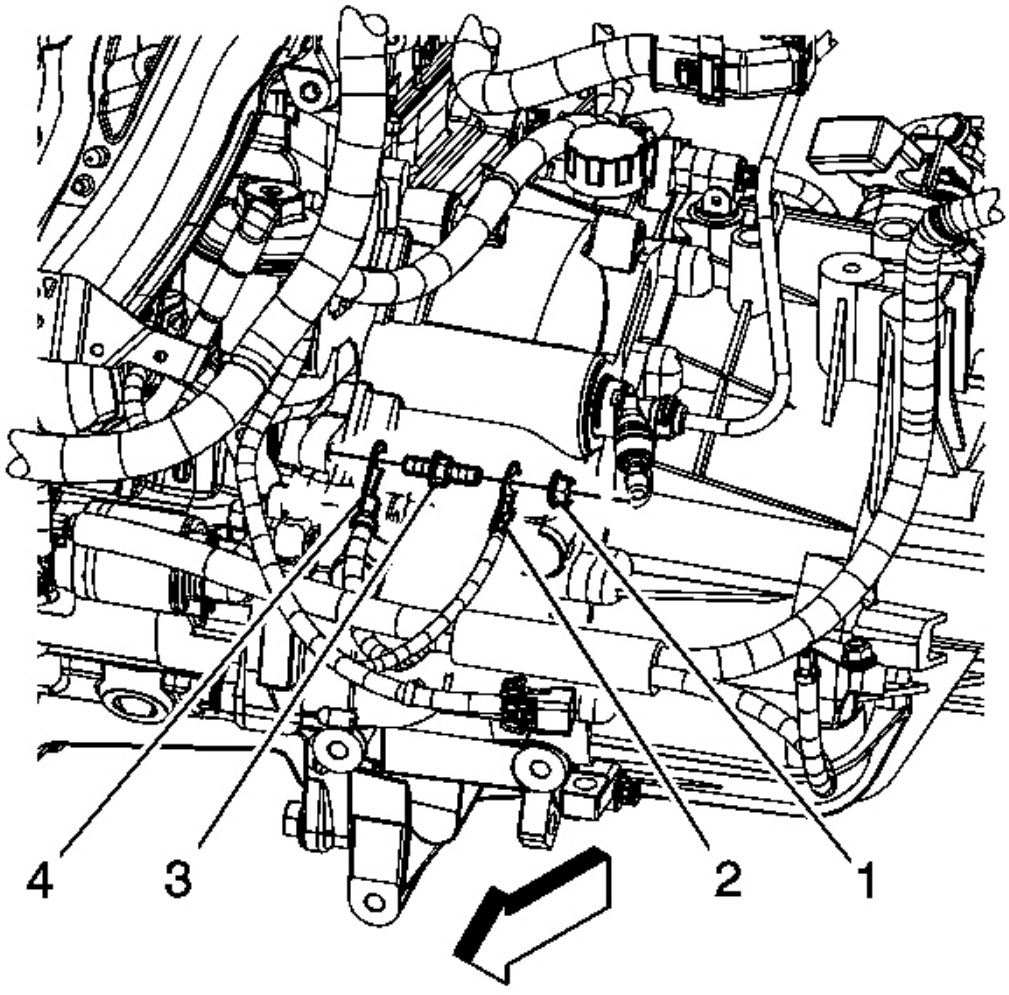


Fig. 10: View Of Engine Harness Ground Nut
Courtesy of GENERAL MOTORS CORP.

6. If equipped with RPO LAP with M86 perform the following, remove the engine harness ground nut (1).
7. Remove the engine harness ground terminal (3) from the stud (2).
8. Remove the stud (2).
9. Separate the negative battery cable ground terminal (4) from the engine block.

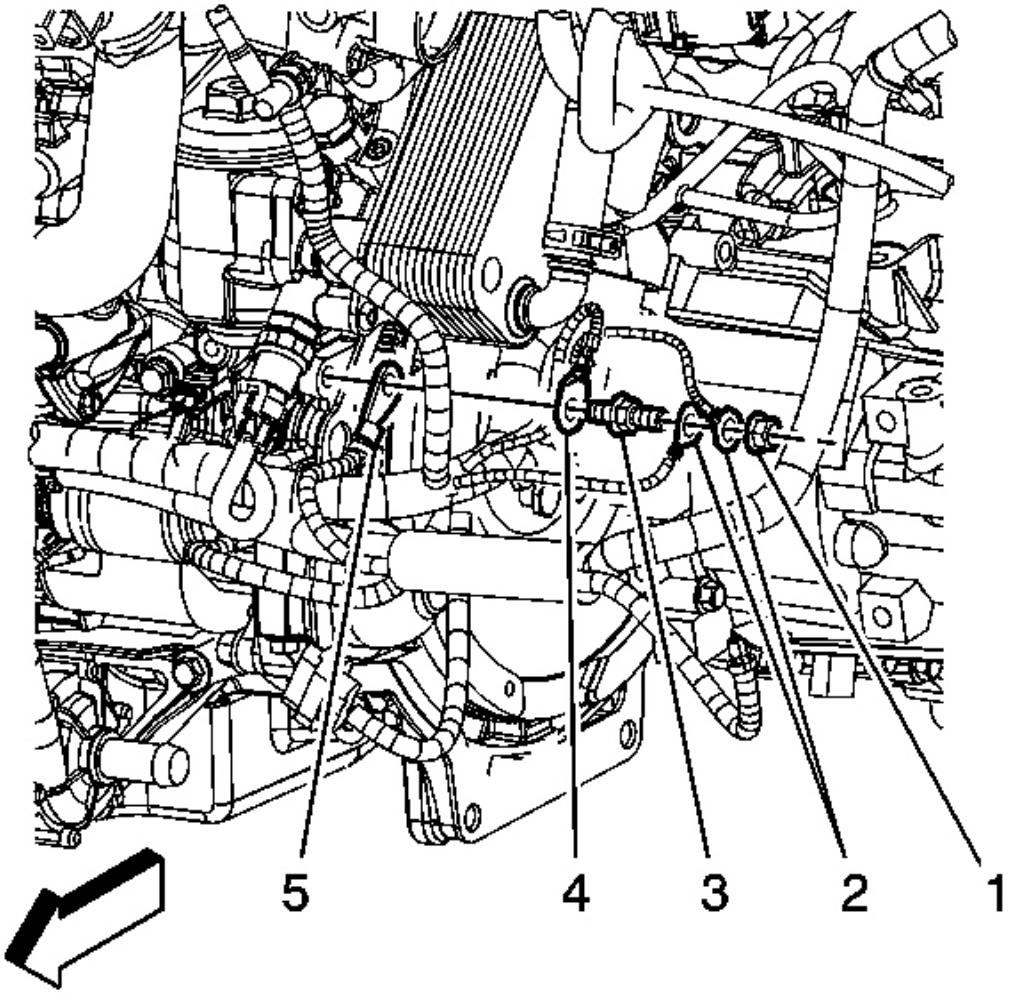


Fig. 11: View Of Engine Harness Ground Nut
Courtesy of GENERAL MOTORS CORP.

10. If equipped with RPO LAF perform the following, remove the engine harness ground nut (1).
11. Remove the engine harness grounds (2).
12. Remove the stud (2).
13. Reposition the engine harness ground (4).
14. Separate the negative battery cable ground terminal (5) from the engine block.
15. Remove the left head lamp. Refer to **Headlamp Replacement** .

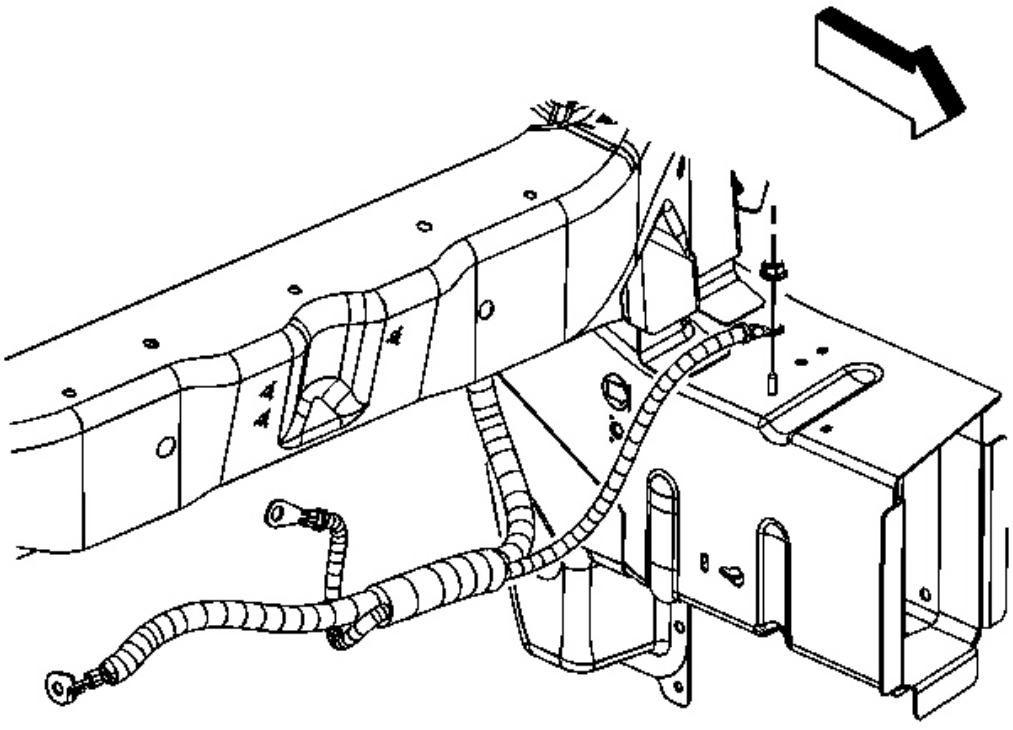


Fig. 12: View Of Negative Battery Cable Ground Nut And Stud On Side Rail
Courtesy of GENERAL MOTORS CORP.

16. Through the left head lamp opening, remove the negative battery cable ground nut from the stud on the side rail.
17. Remove the negative battery cable ground terminal from the stud.

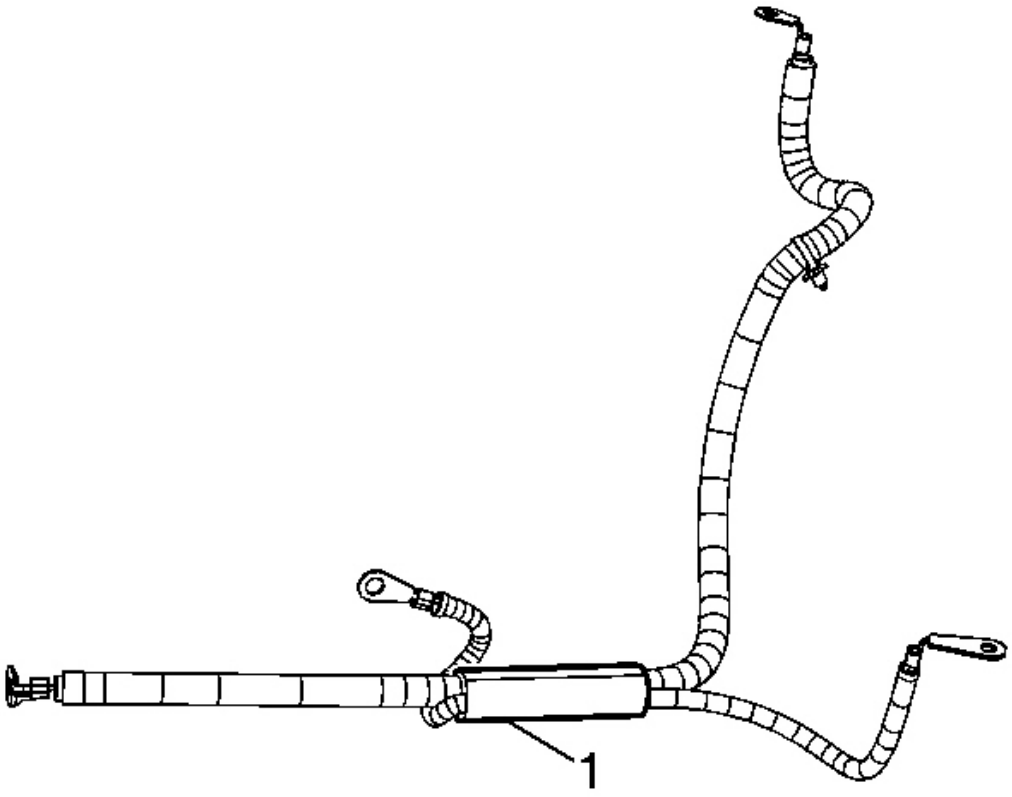


Fig. 13: Cutting Open Tape On Positive/Negative Battery Cable Conduit
Courtesy of GENERAL MOTORS CORP.

18. Cut open the tape on the positive/negative battery cable conduit (1).
19. Remove the old tape from the conduit.

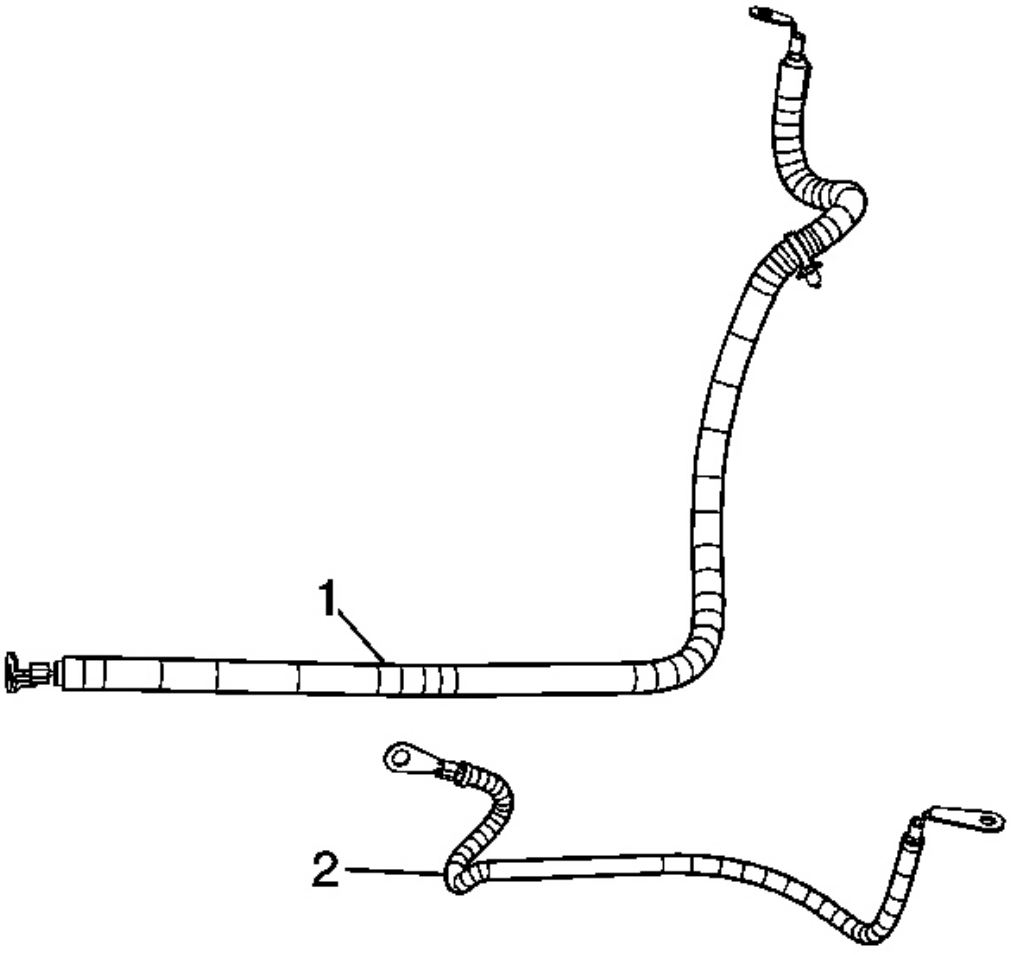


Fig. 14: View Of Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

20. Remove the negative battery cable (2).

Installation Procedure

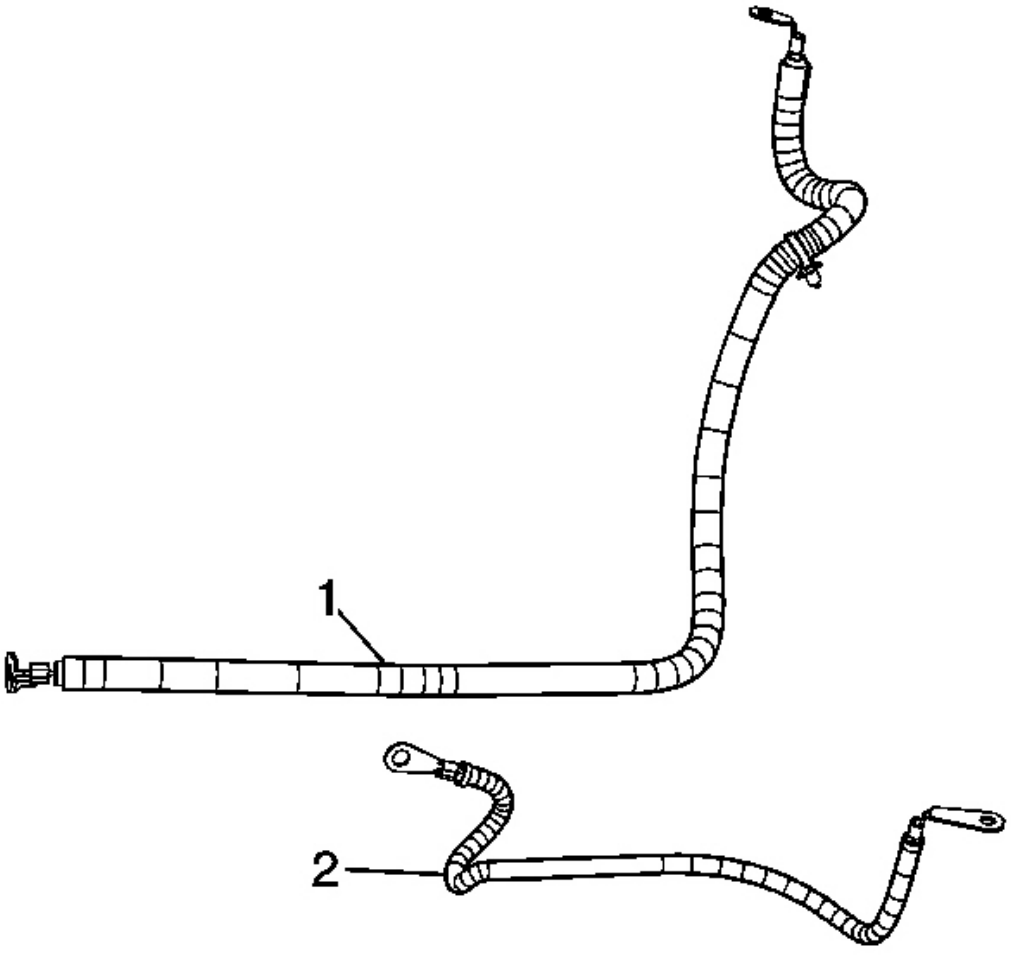


Fig. 15: View Of Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Install the negative battery cable (2) to the conduit.

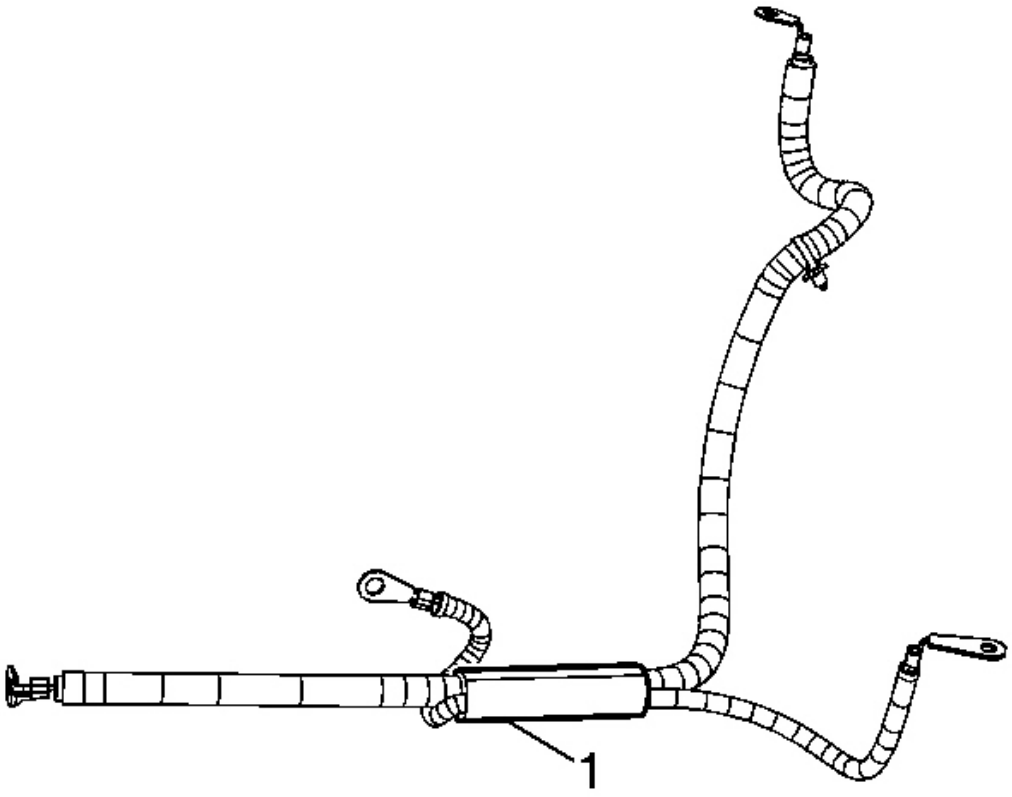


Fig. 16: Cutting Open Tape On Positive/Negative Battery Cable Conduit
Courtesy of GENERAL MOTORS CORP.

2. Wrap tape around the positive/negative battery cable conduit (1).

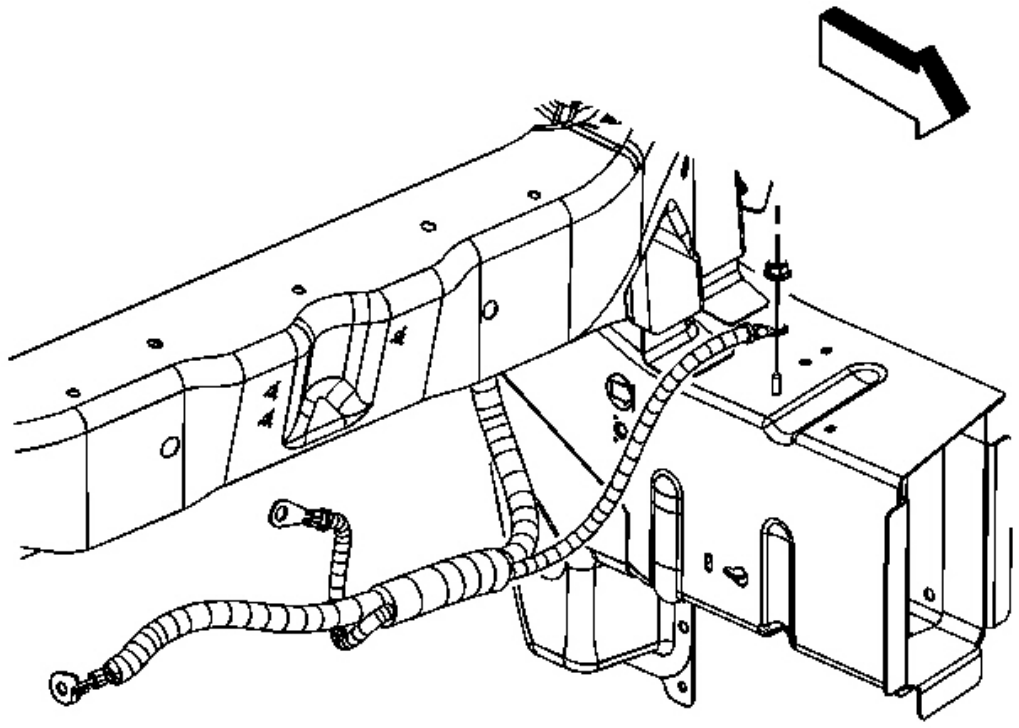


Fig. 17: View Of Negative Battery Cable Ground Nut And Stud On Side Rail
Courtesy of GENERAL MOTORS CORP.

3. Through the left head lamp opening, install the negative battery cable ground terminal to the stud.
4. Install the Left head lamp assembly. Refer to **Headlamp Replacement** .

CAUTION: Refer to Fastener Caution .

5. Install the battery cable ground nut to the stud on the side rail and tighten to 20 N.m (15 lb ft).

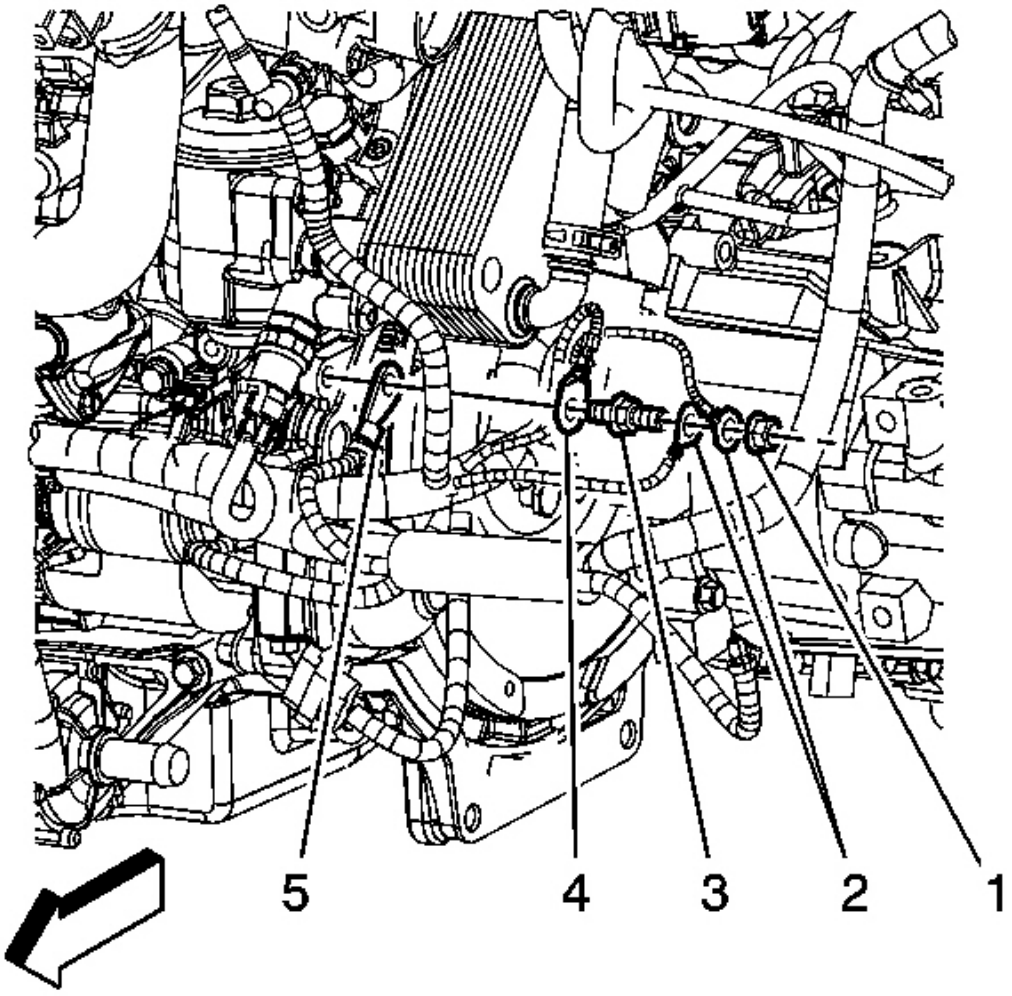


Fig. 18: View Of Engine Harness Ground Nut
Courtesy of GENERAL MOTORS CORP.

6. If equipped with RPO LAF perform the following, position the negative battery cable ground terminal (5) to the engine block.
7. Position the engine harness ground (4) on top of the ground terminal and tighten to 25 N.m (18 lb ft).
8. Install the stud (2).
9. Install the engine harness grounds (2) onto the stud.
10. Install the engine harness ground nut (1) and tighten to 17 N.m (13 lb ft.

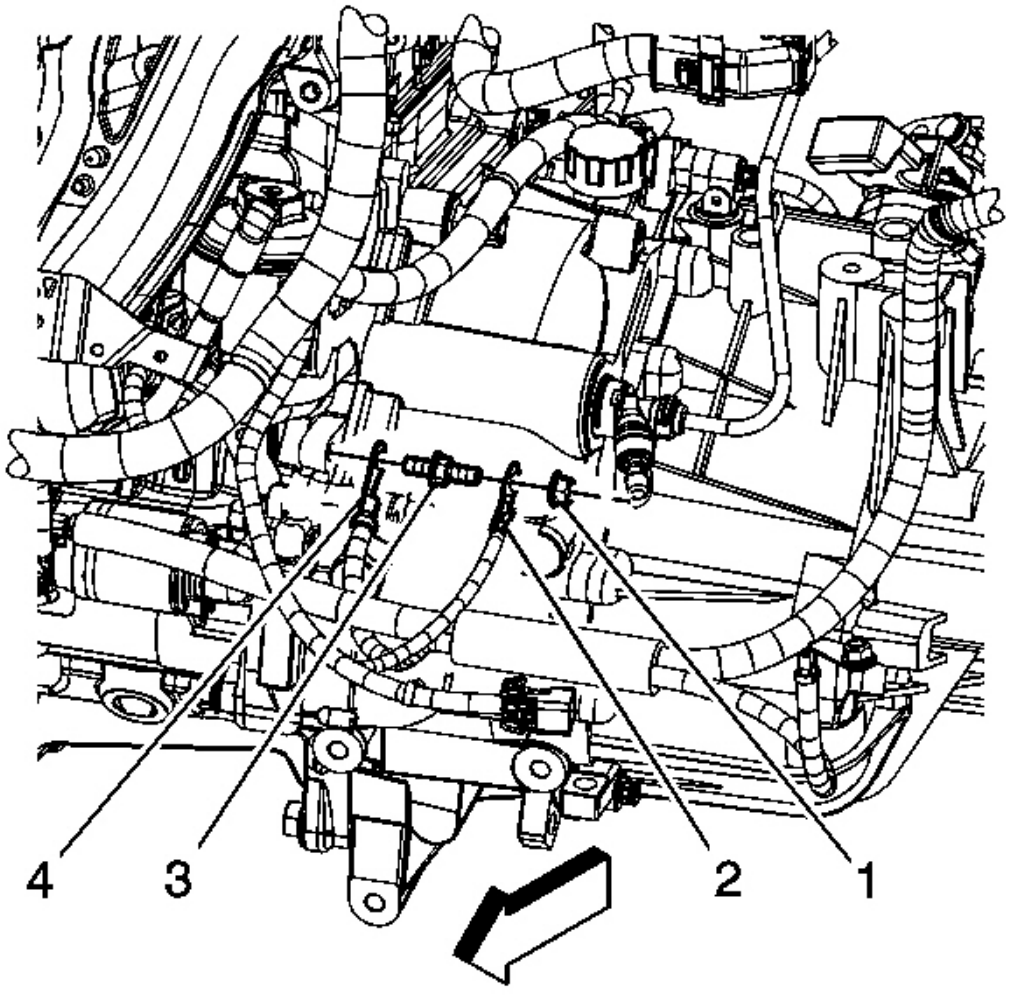


Fig. 19: View Of Engine Harness Ground Nut
Courtesy of GENERAL MOTORS CORP.

11. If equipped with RPO LAP with M86 perform the following, position the negative battery cable ground terminal (4) to the engine block.
12. Install the stud (2) and tighten to 25 N.m (18 lb ft).
13. Install the engine harness ground terminal (3) to the stud (2).
14. Install the engine harness ground nut (1) and tighten to 17 N.m (13 lb ft).

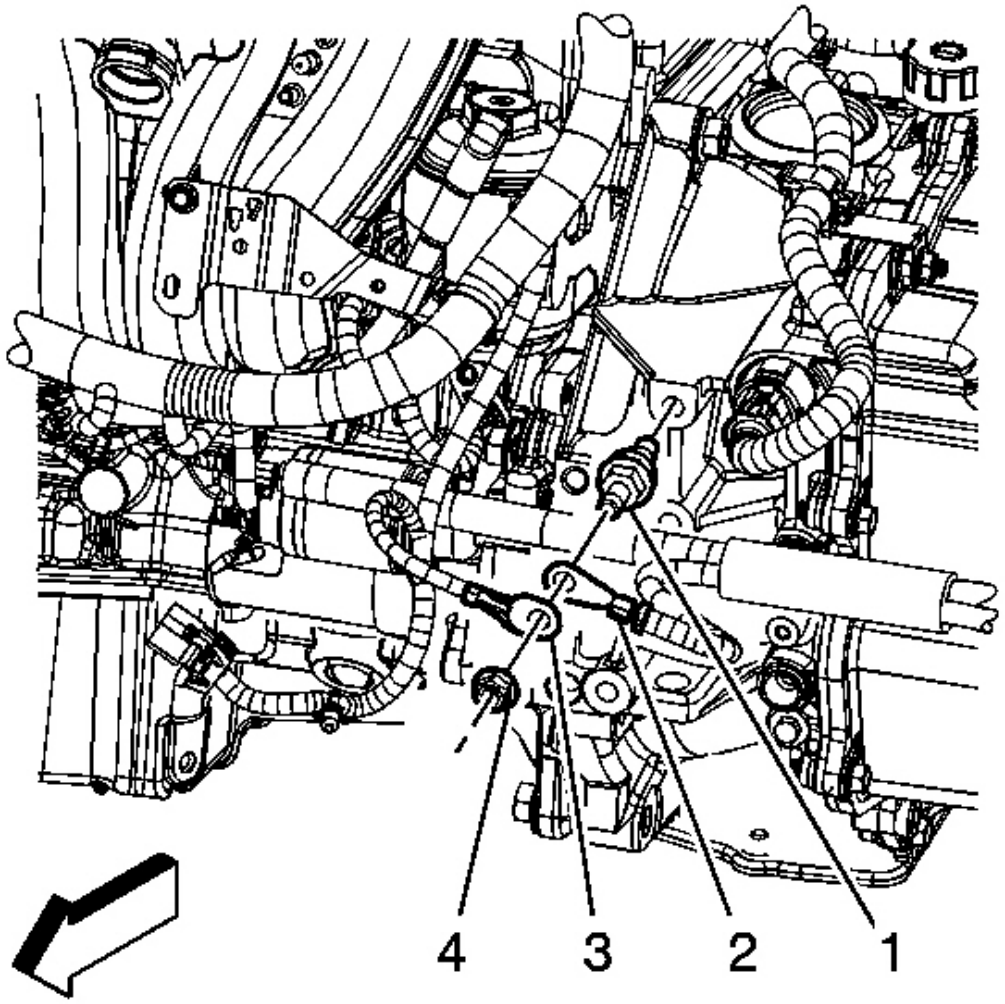


Fig. 20: Disconnecting/Connecting Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

15. If equipped with RPOs LAP with MN5 perform the following, install the negative battery cable ground terminal (2) to the stud (1).
16. Install the engine harness ground terminal (3) to the stud (1).
17. Install the engine harness ground nut (4) and tighten to 17 N.m (13 lb ft).
18. Lower the vehicle.
19. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY POSITIVE CABLE REPLACEMENT (JUNCTION BLOCK TO STARTER)

Removal Procedure

NOTE:

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

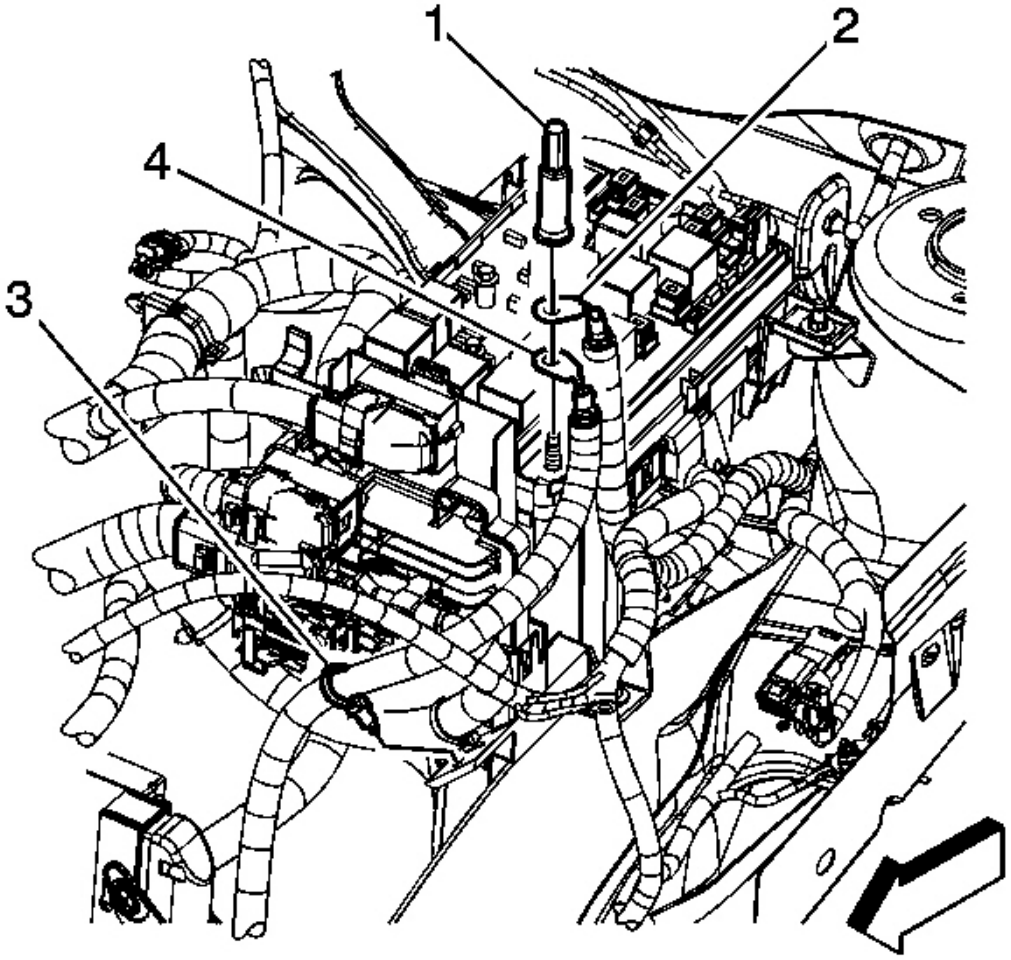


Fig. 21: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

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

2. Remove the junction block cover.
3. Remove the junction block nut (1).
4. Remove the positive battery cable terminal (2) from the junction block stud.
5. Remove the positive battery cable clip (3) from the engine control module (ECM) bracket.
6. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

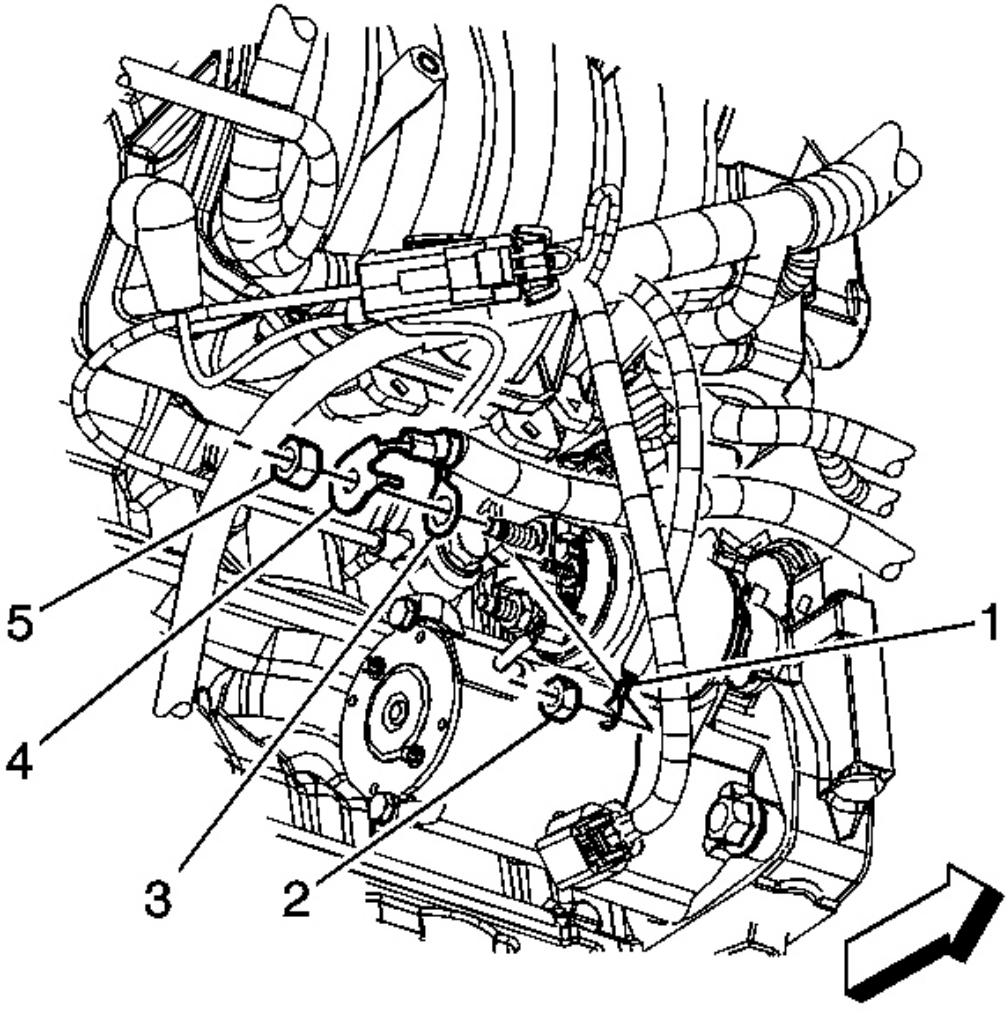


Fig. 22: View Of Engine Harness Terminal To Starter
Courtesy of GENERAL MOTORS CORP.

7. If equipped with regular production options RPO LAP, perform the following steps, remove the starter

solenoid terminal nut (5).

8. Remove the positive battery cable terminal (4) from the starter solenoid.

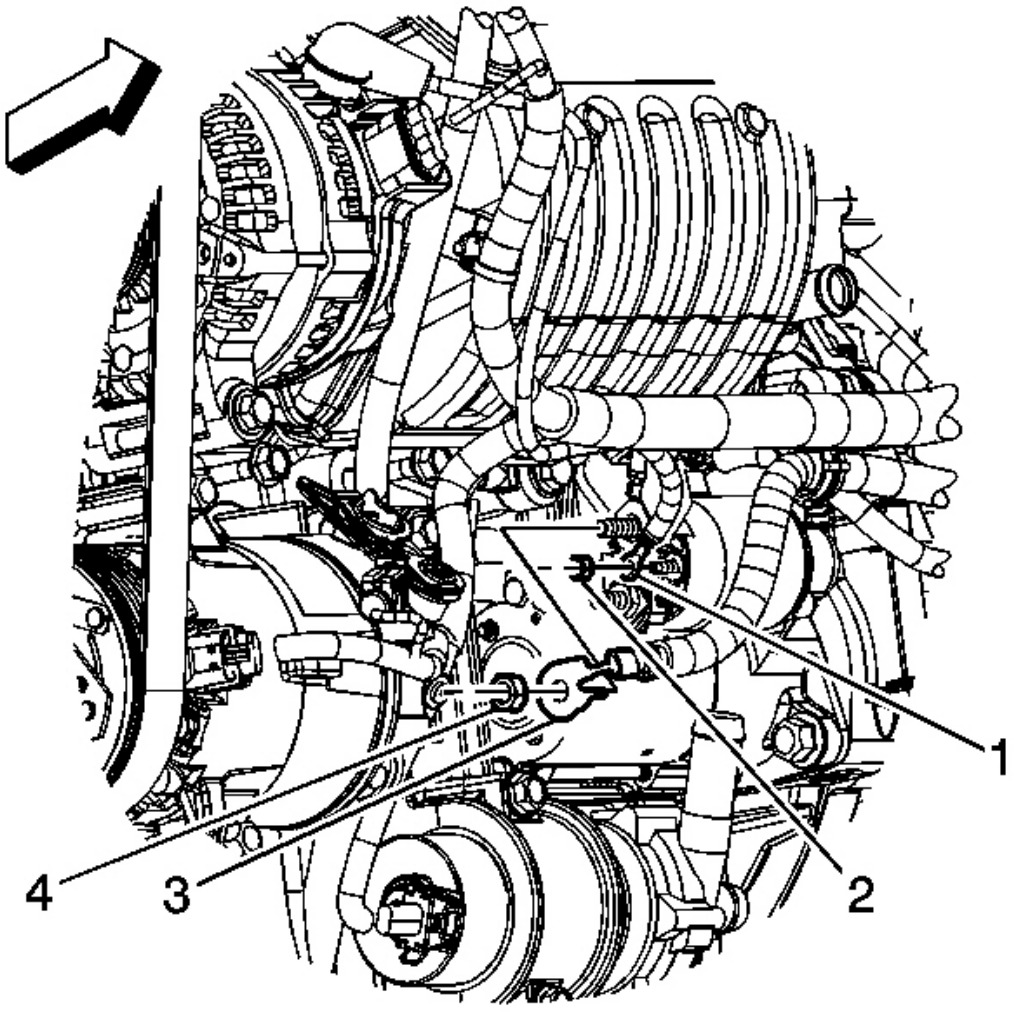


Fig. 23: Identifying Positive Battery Cable Terminal
Courtesy of GENERAL MOTORS CORP.

9. If equipped with RPO LNF, perform the following steps, remove the starter solenoid terminal nut (4).
10. Remove the positive battery cable terminal (3) from the starter solenoid.

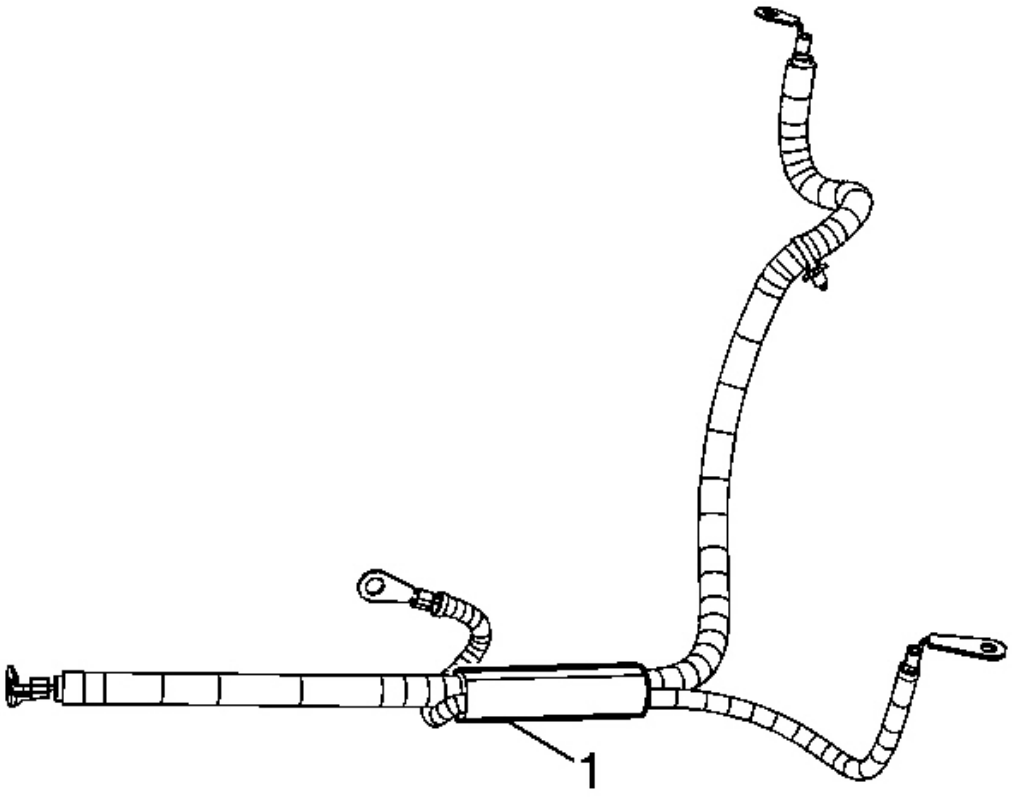


Fig. 24: Cutting Open Tape On Positive/Negative Battery Cable Conduit
Courtesy of GENERAL MOTORS CORP.

11. Cut open the tape on the positive/negative battery cable conduit (1).
12. Remove the old tape from the conduit.

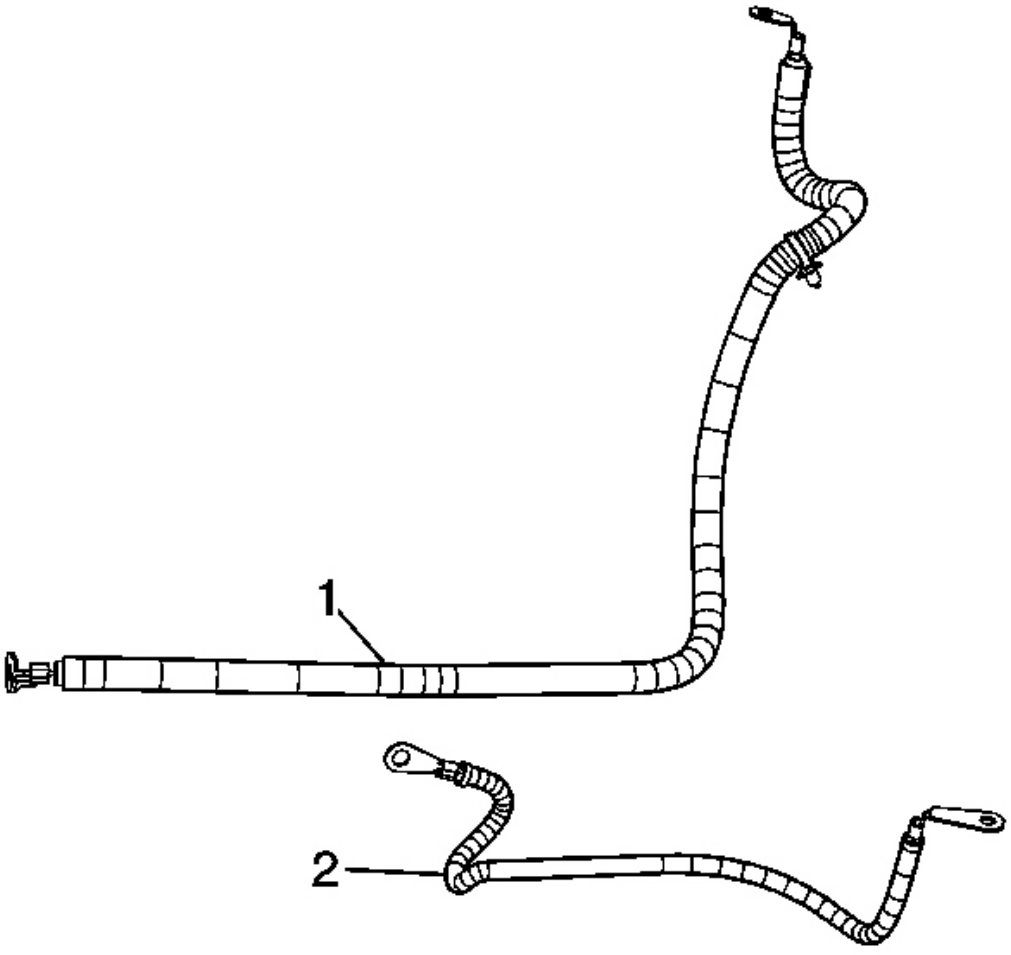


Fig. 25: View Of Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

13. Remove the positive battery cable (1).

Installation Procedure

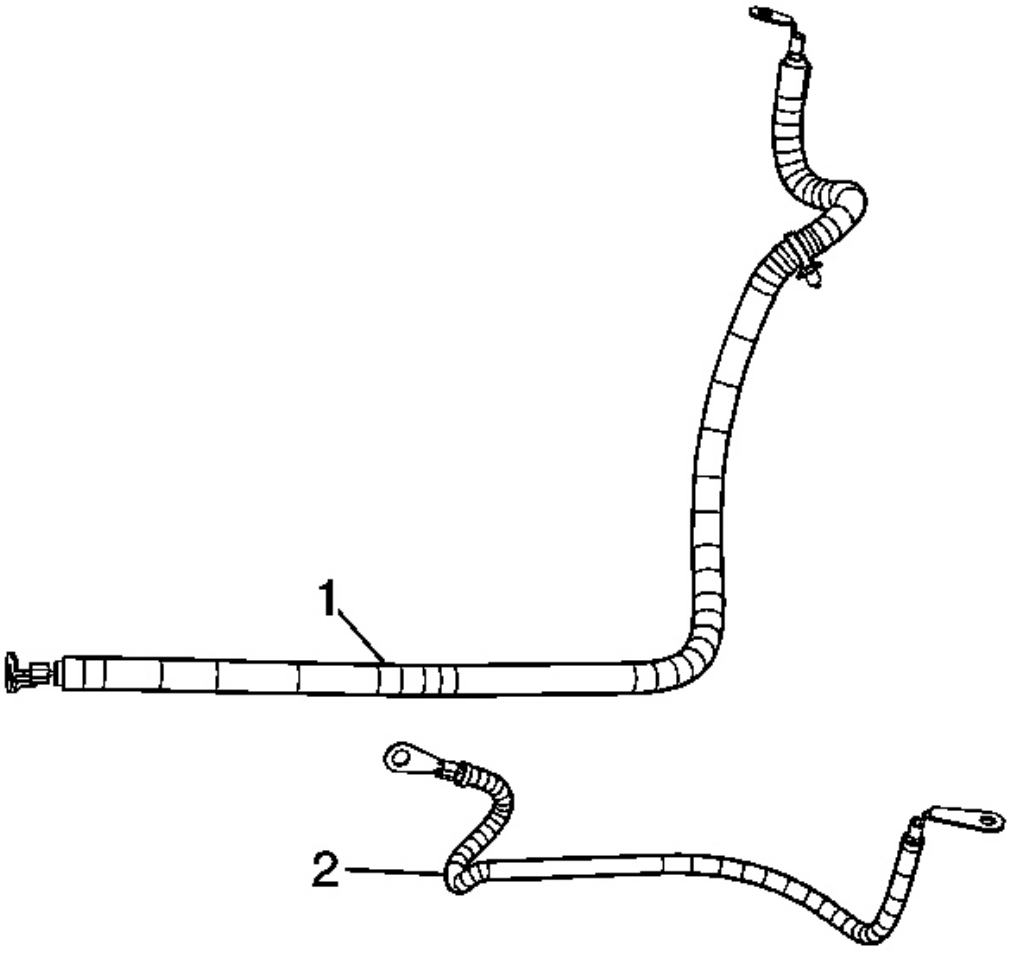


Fig. 26: View Of Negative Battery Cable
Courtesy of GENERAL MOTORS CORP.

1. Install the positive battery cable (1) to the conduit.

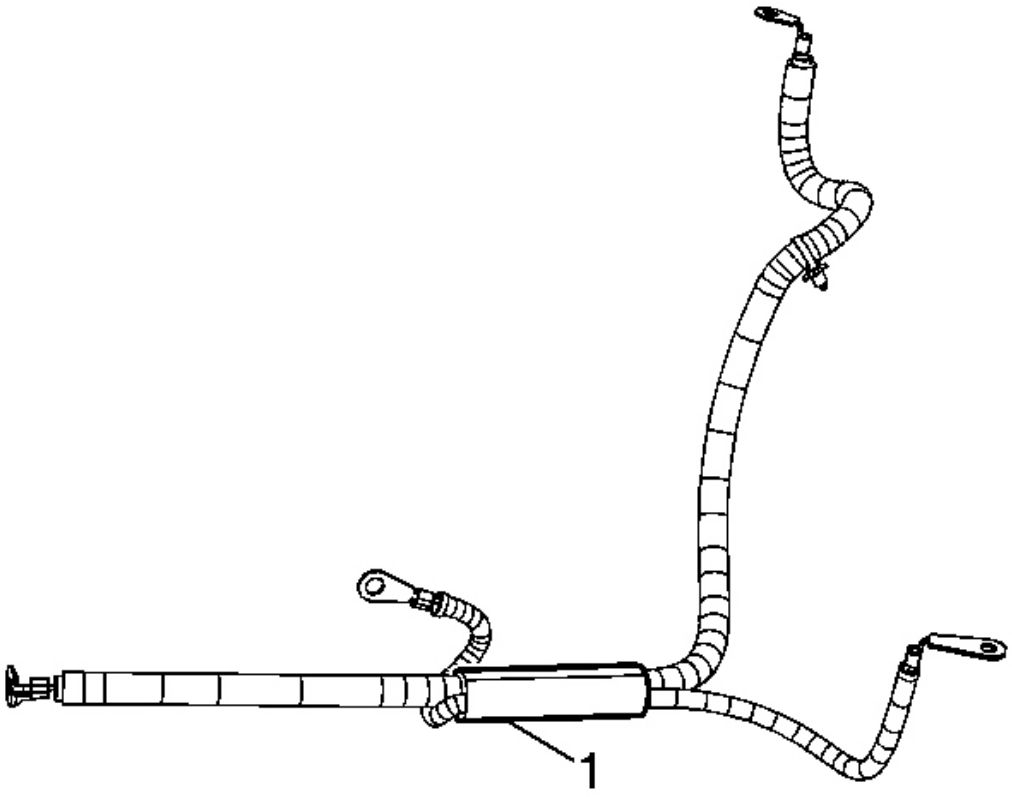


Fig. 27: Cutting Open Tape On Positive/Negative Battery Cable Conduit
Courtesy of GENERAL MOTORS CORP.

2. Wrap tape around the positive/negative battery cable conduit (1).

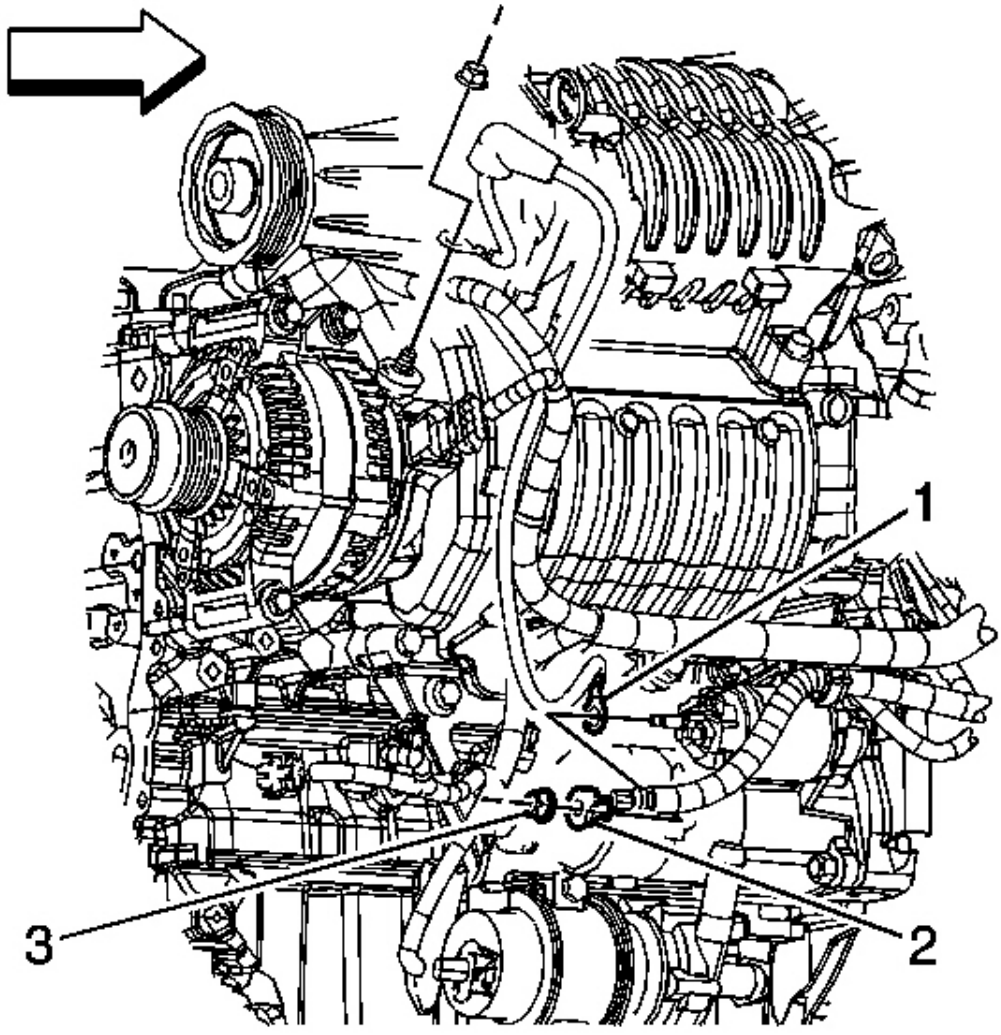


Fig. 28: Installing Positive Battery Cable Terminal To Starter Solenoid (1 Of 2)
Courtesy of GENERAL MOTORS CORP.

3. If equipped with RPO LNF, perform the following steps, install the positive battery cable terminal (2) to the starter solenoid.

CAUTION: Refer to Fastener Caution .

4. Install the starter solenoid terminal nut (3) and tighten to 17 N.m (13 lb ft).

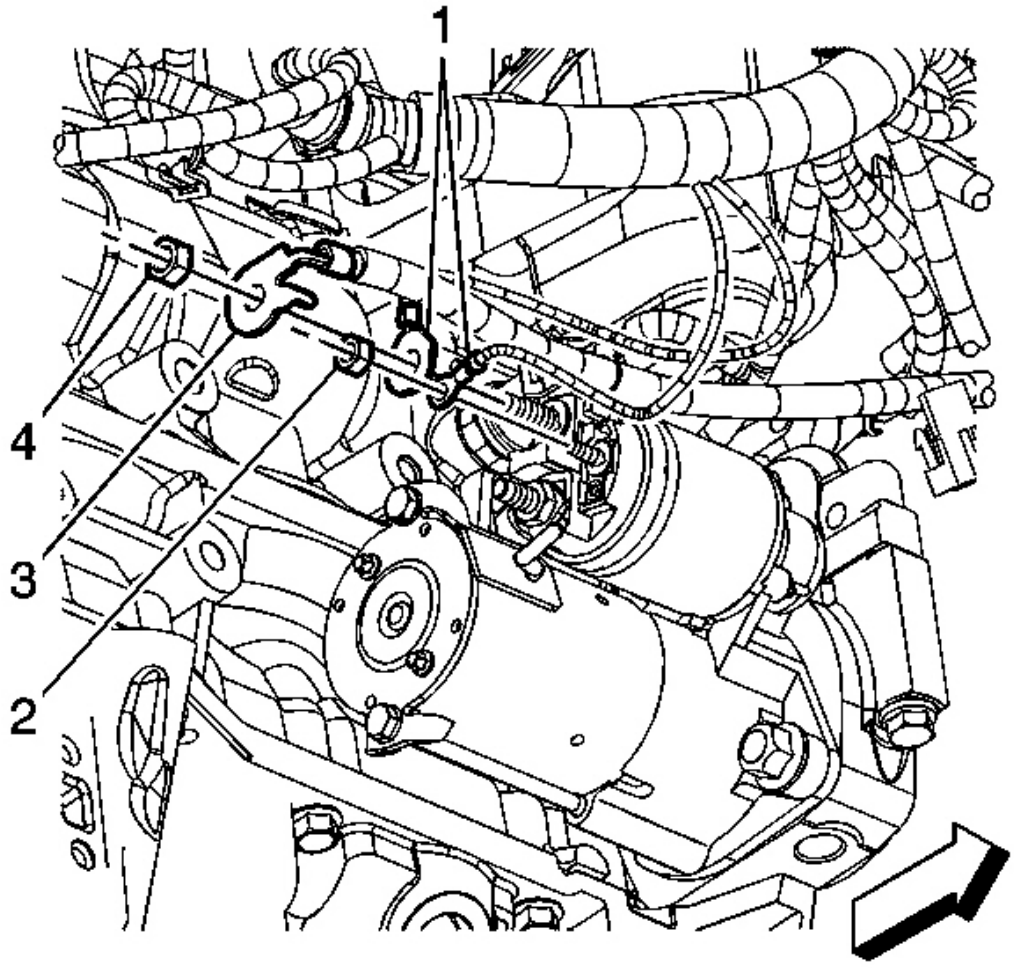


Fig. 29: Installing Positive Battery Cable Terminal To Starter Solenoid (2 Of 2)
Courtesy of GENERAL MOTORS CORP.

5. If equipped with RPO LAP, perform the following steps, Install the positive battery cable terminal (3) to the starter solenoid.
6. Install the starter solenoid terminal nut (4) and tighten to 17 N.m (13 lb ft).
7. Lower the vehicle.

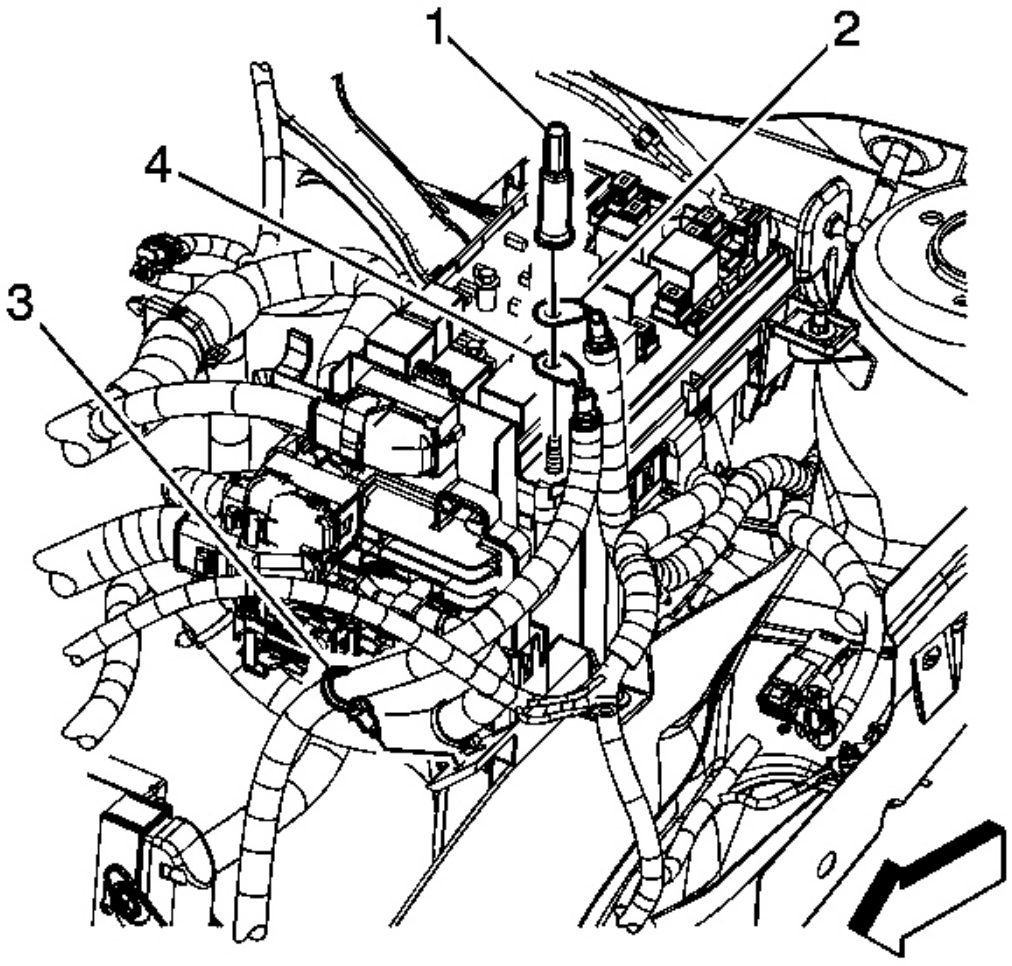


Fig. 30: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

8. Install the positive battery cable terminal (2) to the junction block stud.
9. Install the junction block nut (1) and tighten to 17 N.m (13 lb ft).
10. Install the positive battery cable clip (3) to the ECM bracket.
11. Install the junction block cover.
12. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY POSITIVE CABLE REPLACEMENT (BATTERY TO UNDERHOOD JUNCTION BLOCK)

Removal Procedure

NOTE:

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

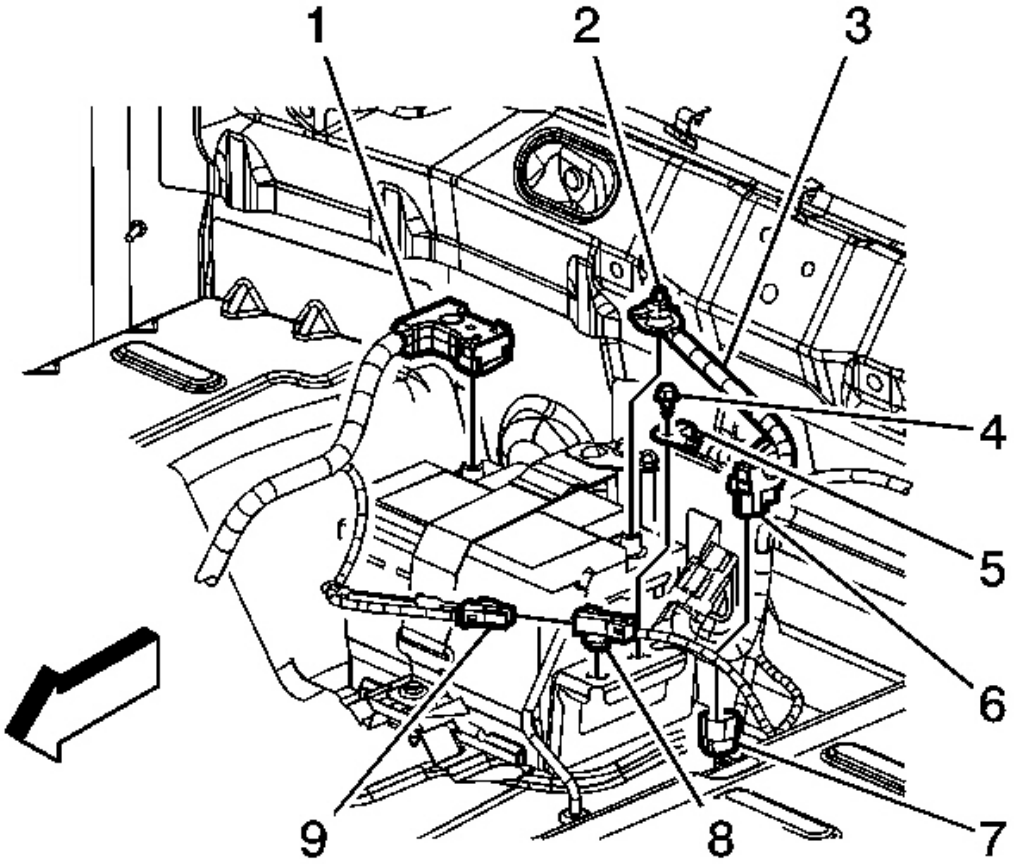


Fig. 31: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the carpet. Refer to **Floor Panel Carpet Replacement** .
3. Open the positive battery cable (1) cover.
4. Loosen the positive battery cable bolt.
5. Remove the positive battery cable from the battery.

6. Disconnect the positive battery cable electrical connector (9) from the body harness electrical connector (8).

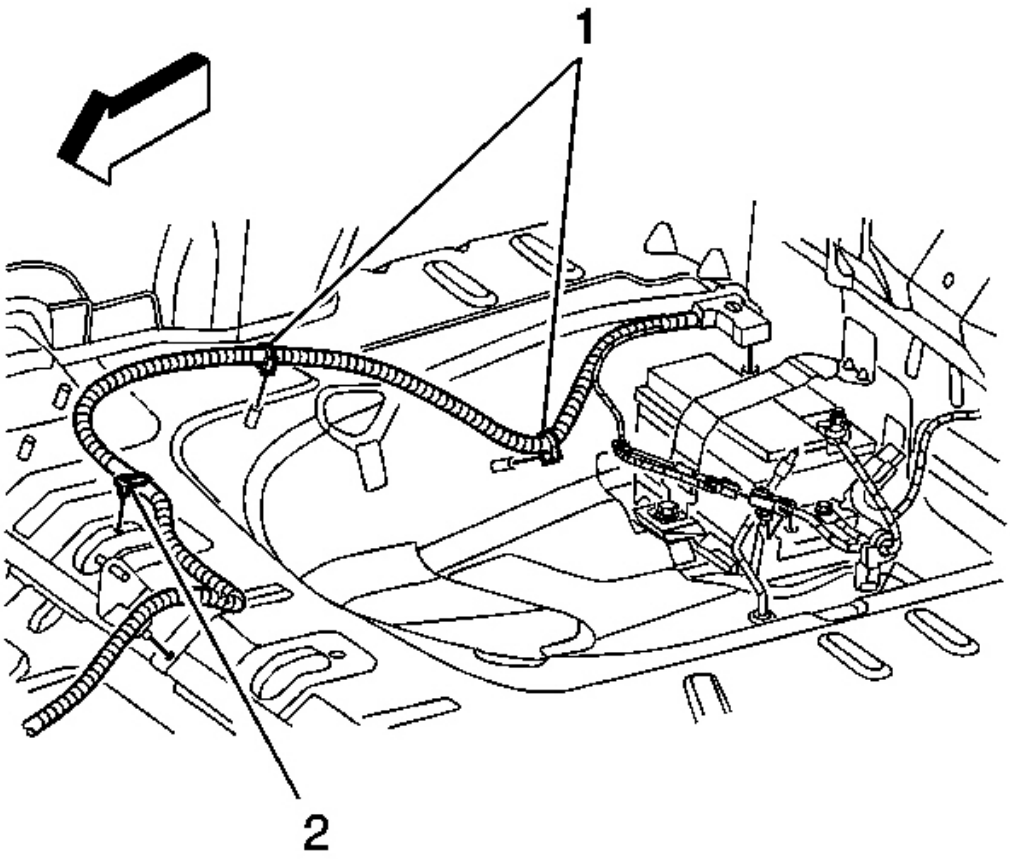


Fig. 32: Battery Cable Clip To Floor Pan
Courtesy of GENERAL MOTORS CORP.

7. From inside the vehicle, remove the positive battery cable clips (1) from the weld studs.
8. Remove the positive battery cable clip (2) from the floor pan.

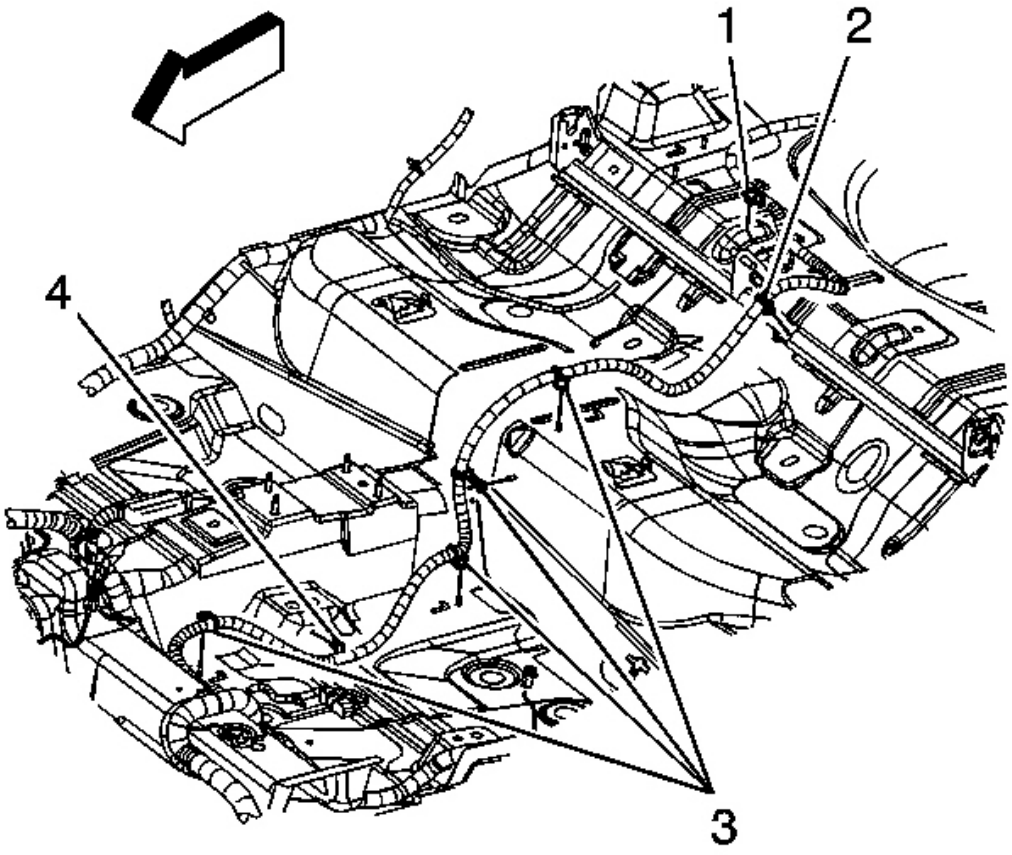


Fig. 33: View Of Positive Battery Cable Clip To Floor Pan
Courtesy of GENERAL MOTORS CORP.

9. Remove the positive battery cable clip (2) from the latch bar.
10. Remove the positive battery cable from the body clip (3). Unfold the tabs in order to remove the cable.
11. Remove the positive battery cable clips (3) from the weld studs.
12. Remove the positive battery cable clip (4) from the floor pan.

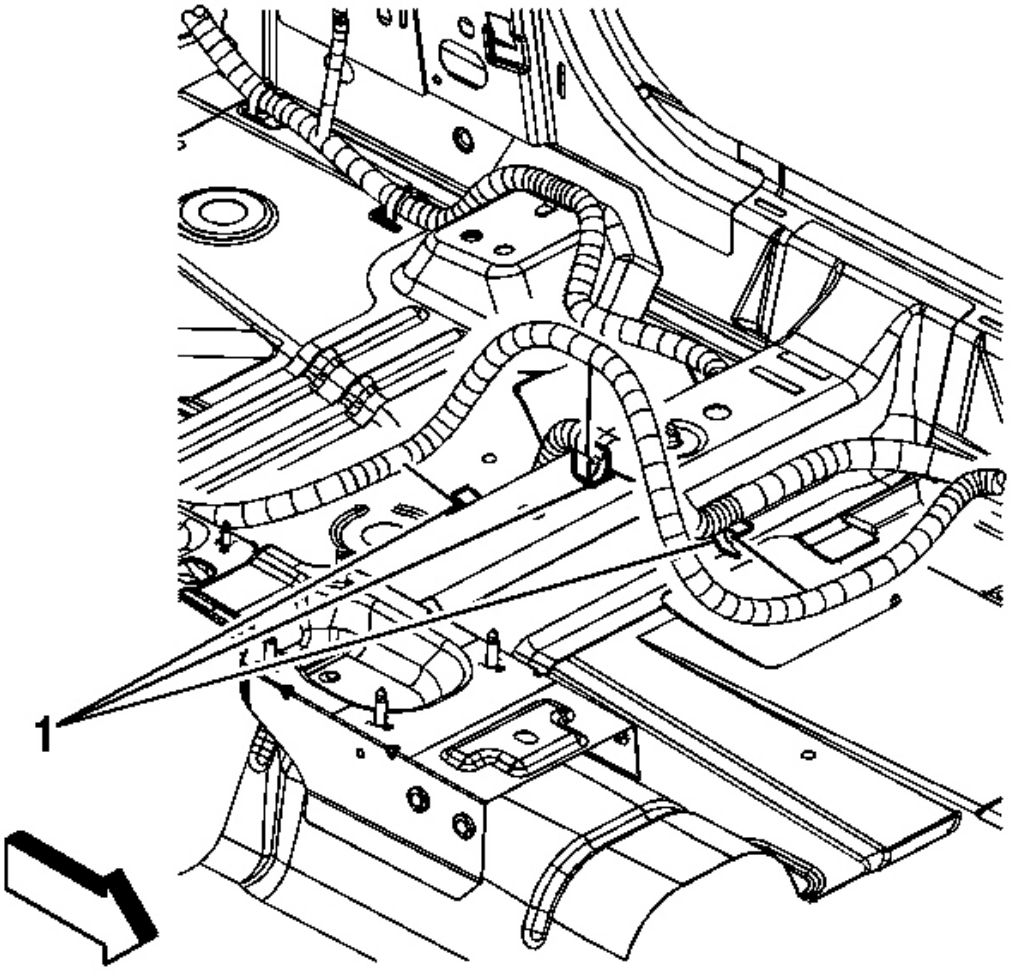


Fig. 34: View Of Positive Battery Cable To Body Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

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

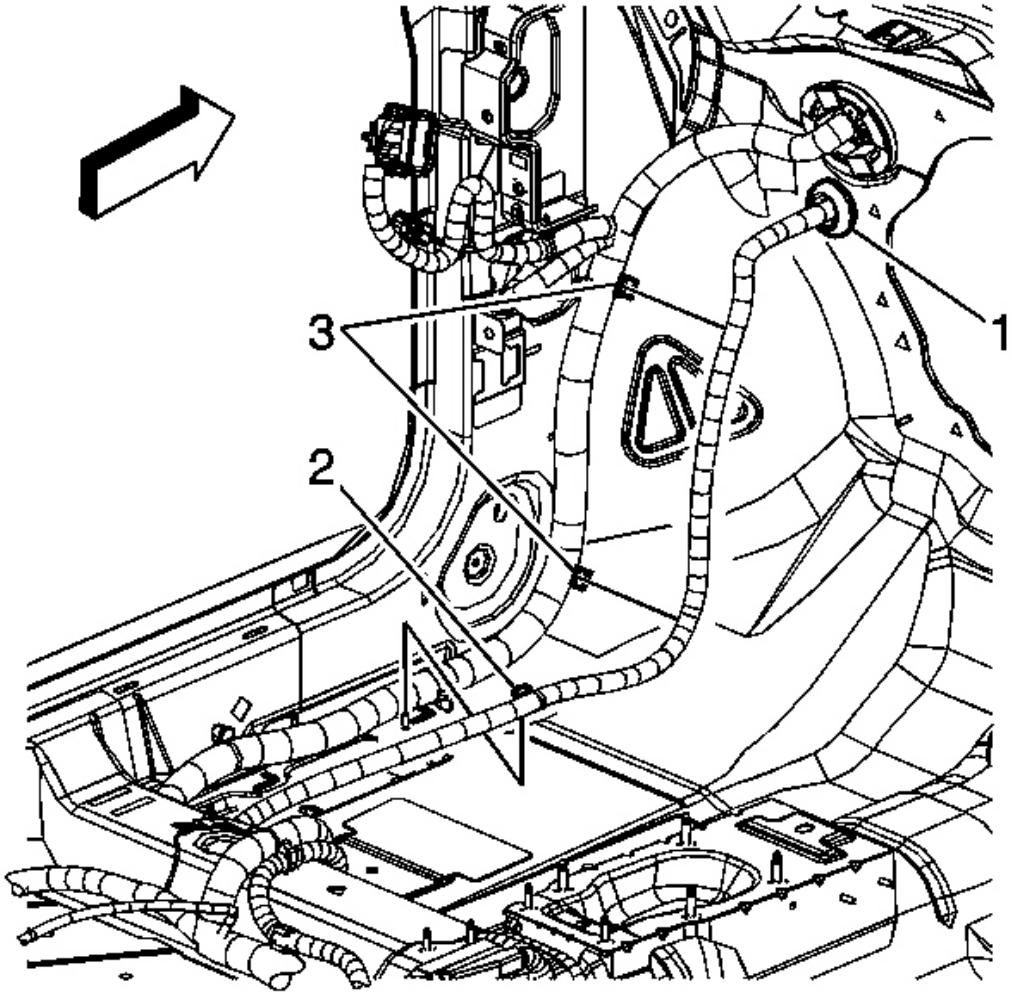


Fig. 35: View Of Positive Battery Cable Clip To Weld Stud
Courtesy of GENERAL MOTORS CORP.

14. Remove the positive battery cable clip (2) from the weld stud.
15. Remove the positive battery cable from the body wiring harness clips (3).
16. Unseat the grommet (1) from the front of dash.

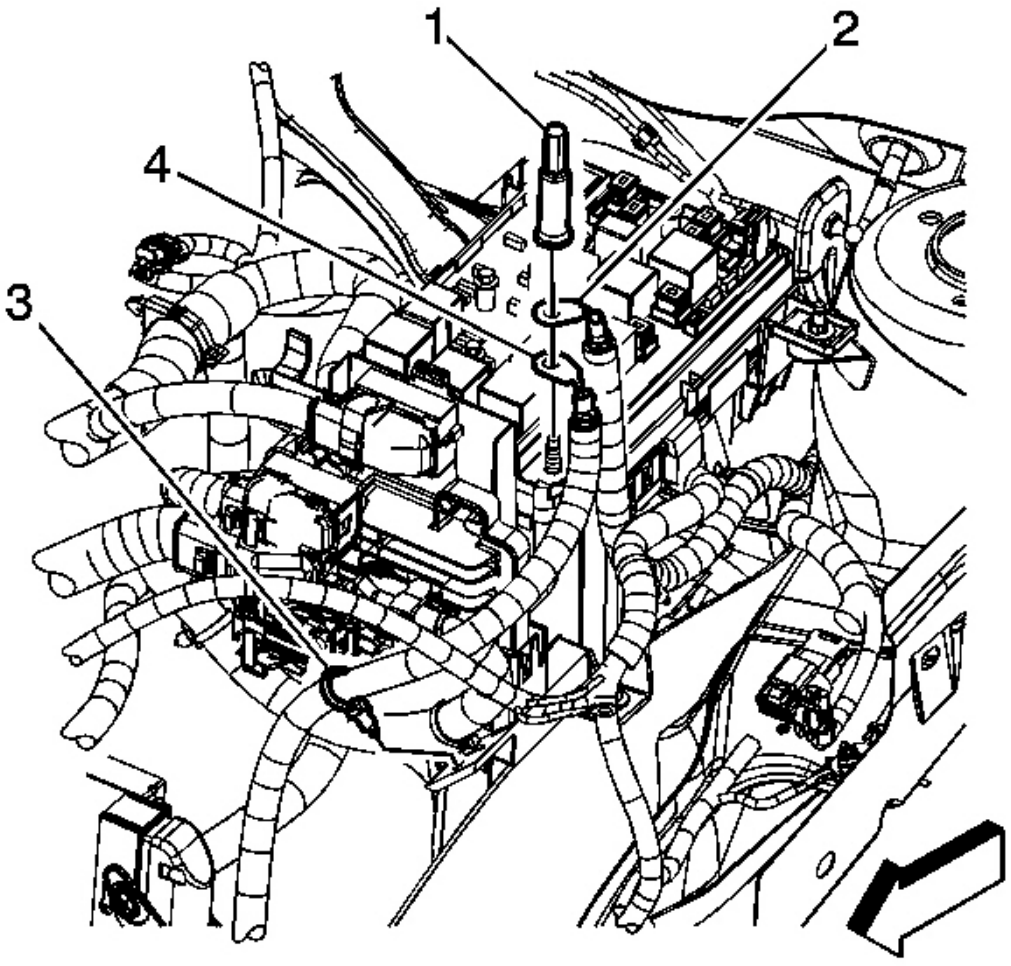


Fig. 36: View Of Junction Block Cover
Courtesy of GENERAL MOTORS CORP.

17. From under the hood, remove the junction block cover.
18. Remove the junction block nut (1).
19. Remove the positive battery cable (to starter) terminal (2) from the stud.

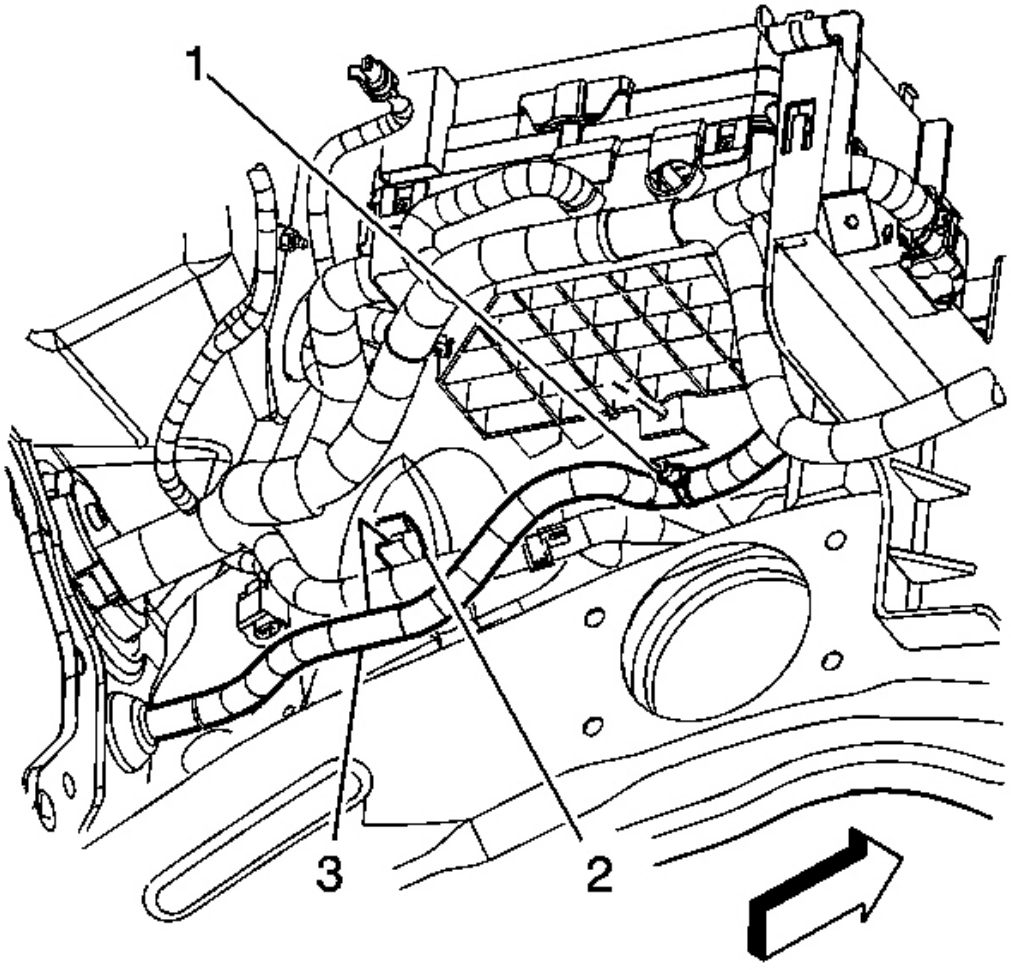


Fig. 37: View Of Battery Cable Assembly
Courtesy of GENERAL MOTORS CORP.

20. Remove the positive battery cable (3) from the body wiring harness clip (2).
21. Remove the positive battery cable clip (1) from the junction block.
22. Remove the positive battery cable from under the junction block.
23. Route the positive battery cable through the hole in the front of dash.
24. From inside the vehicle, remove the positive battery cable.

Installation Procedure

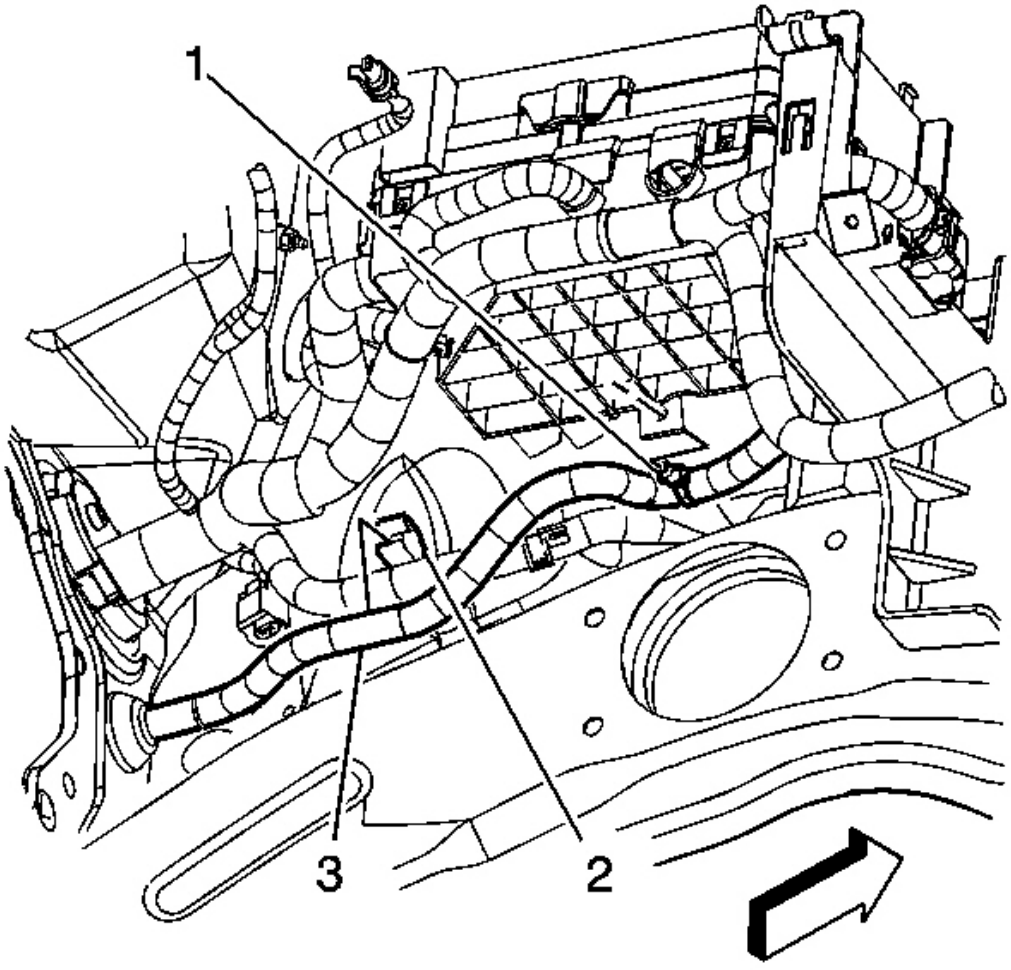


Fig. 38: View Of Battery Cable Assembly
Courtesy of GENERAL MOTORS CORP.

1. From inside the vehicle, layout the positive battery cable assembly.
2. Route the positive battery cable through the hole in the front of dash.
3. From under the hood, route the positive battery cable under the junction block.
4. Install the positive battery cable clip (1) to the junction block.
5. Install the positive battery cable (3) from the body wiring harness clip (2).

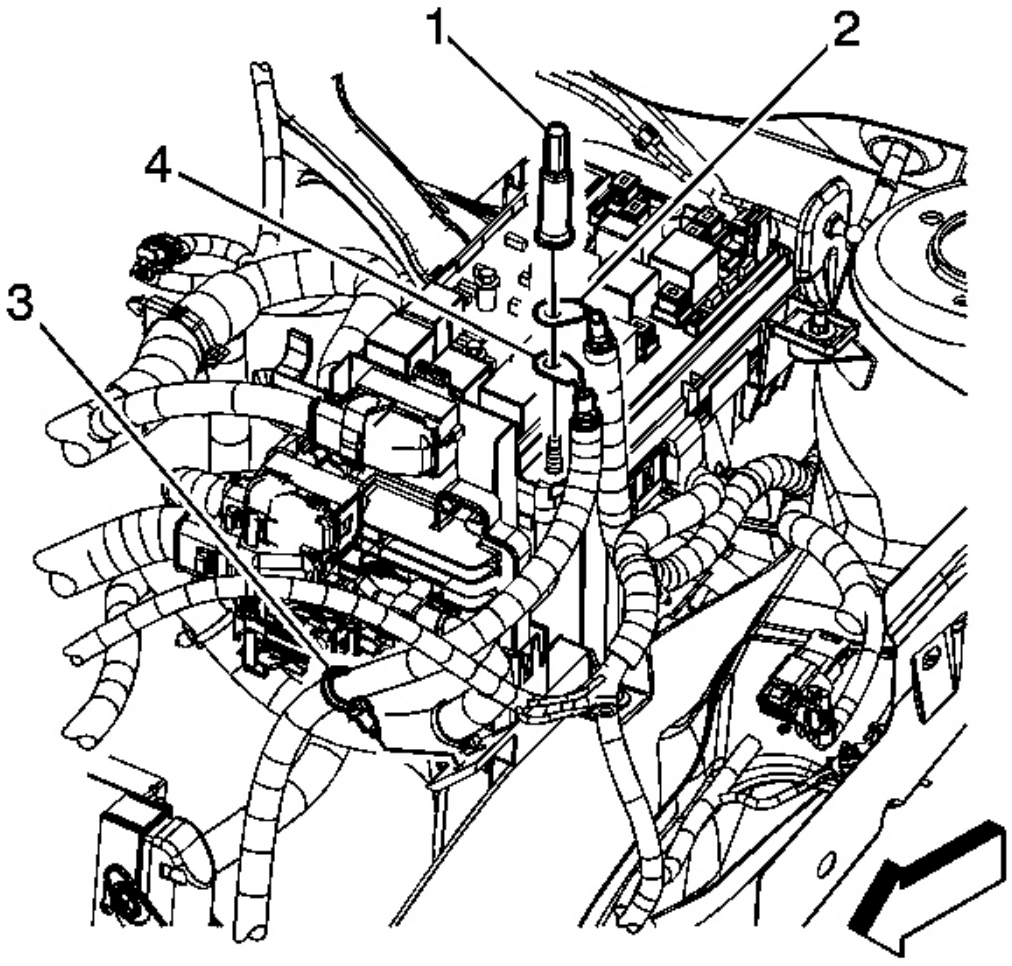


Fig. 39: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

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

CAUTION: Refer to Fastener Caution .

7. Install the junction block nut (1) and tighten to 17 N.m (13 lb ft).
8. Install the junction block cover.

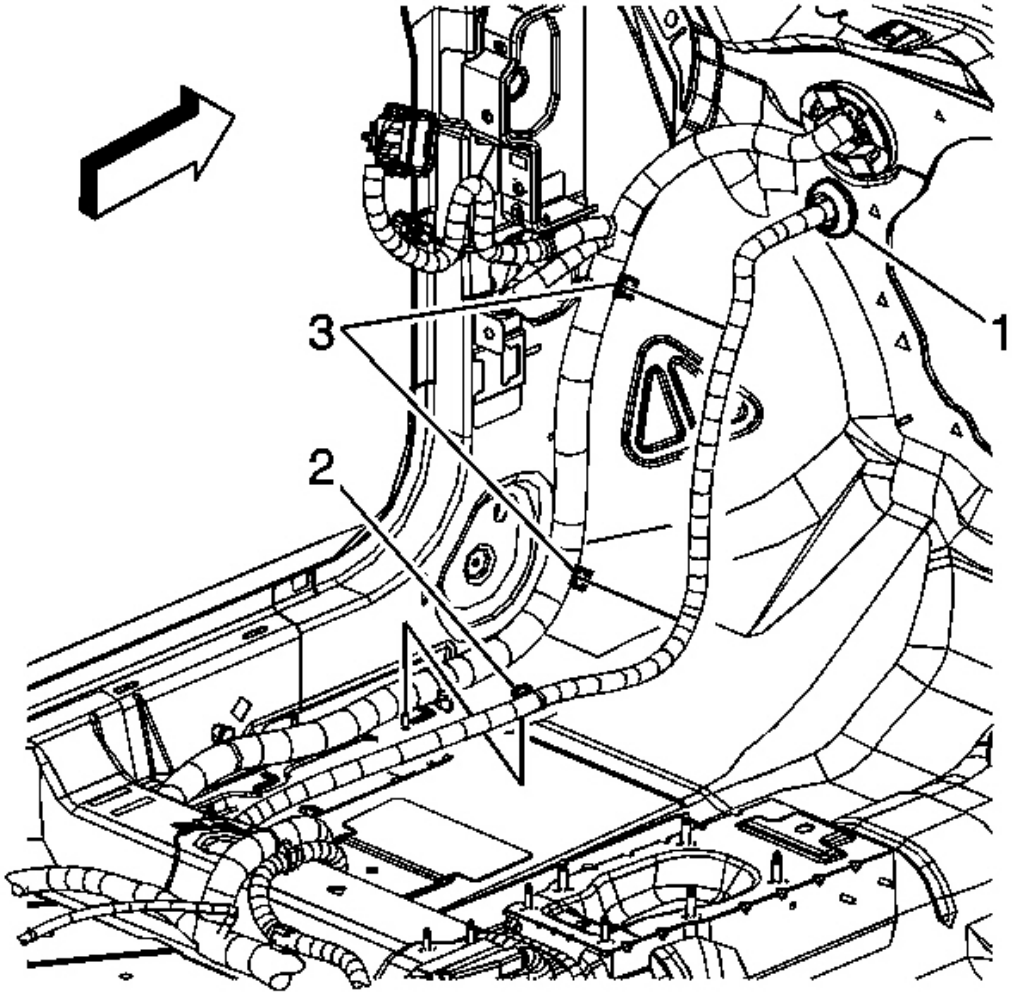


Fig. 40: View Of Positive Battery Cable Clip To Weld Stud
Courtesy of GENERAL MOTORS CORP.

9. From inside the vehicle, seat the grommet (1) to the front of dash.
10. Install the positive battery cable to the body wiring harness clips (3).
11. Install the positive battery cable clip (2) to the weld stud.

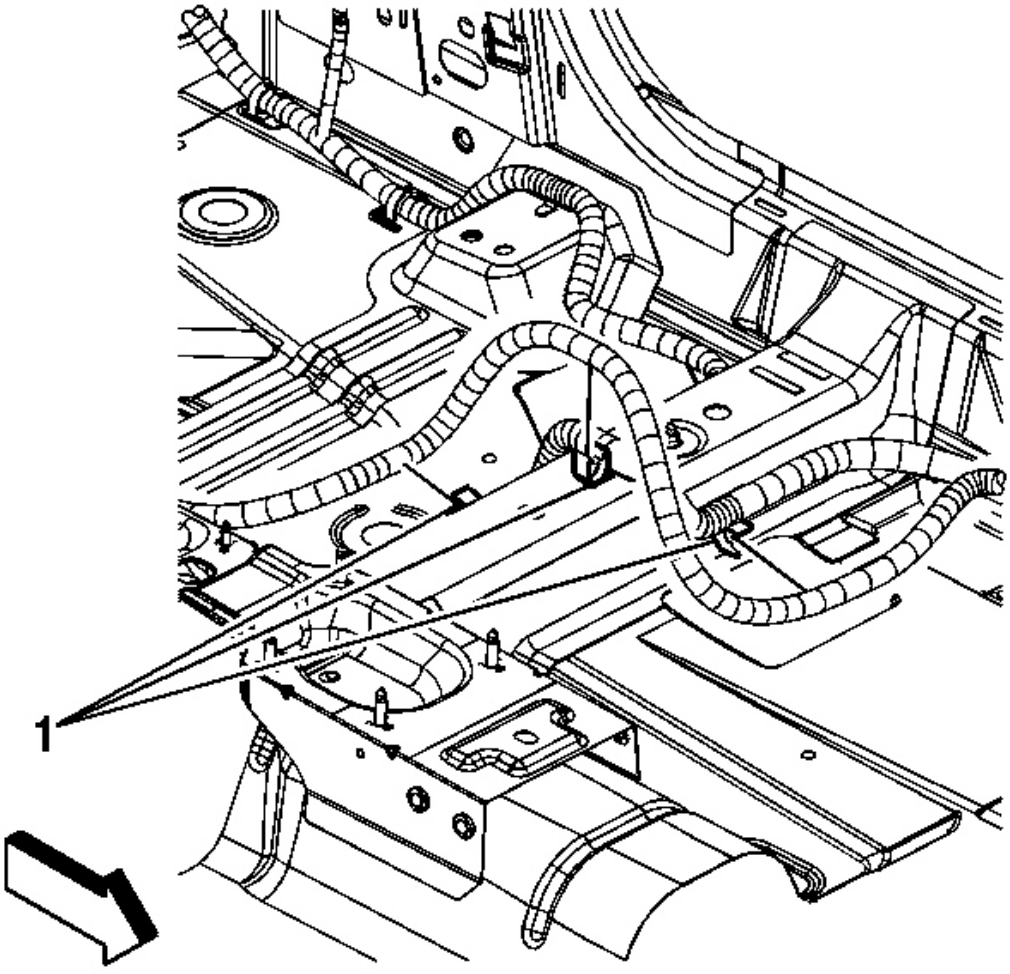


Fig. 41: View Of Positive Battery Cable To Body Wiring Harness Clips
Courtesy of GENERAL MOTORS CORP.

12. Install the positive battery cable to the body wiring harness clips (1).

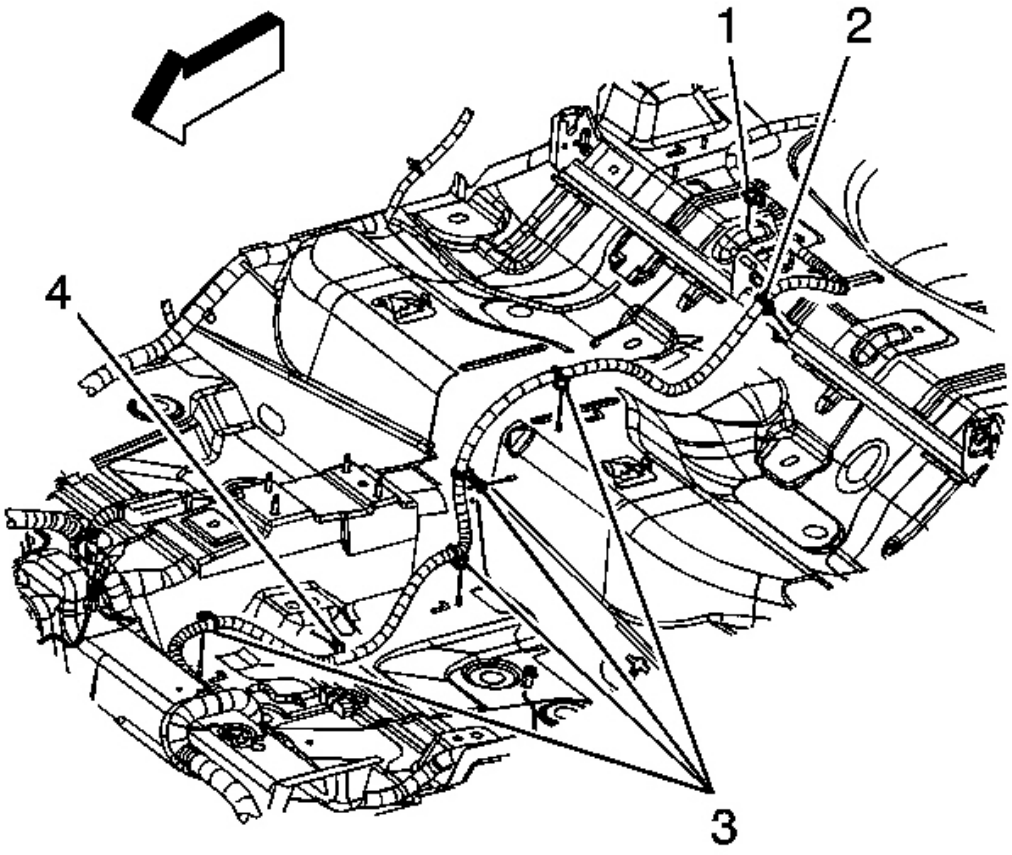


Fig. 42: View Of Positive Battery Cable Clip To Floor Pan
Courtesy of GENERAL MOTORS CORP.

13. Install the positive battery cable clip (4) to the floor pan.
14. Install the positive battery cable clips (3) to the weld studs.
15. Install the positive battery cable to the body clip (3).
16. Install the positive battery cable clip (2) to the latch bar.

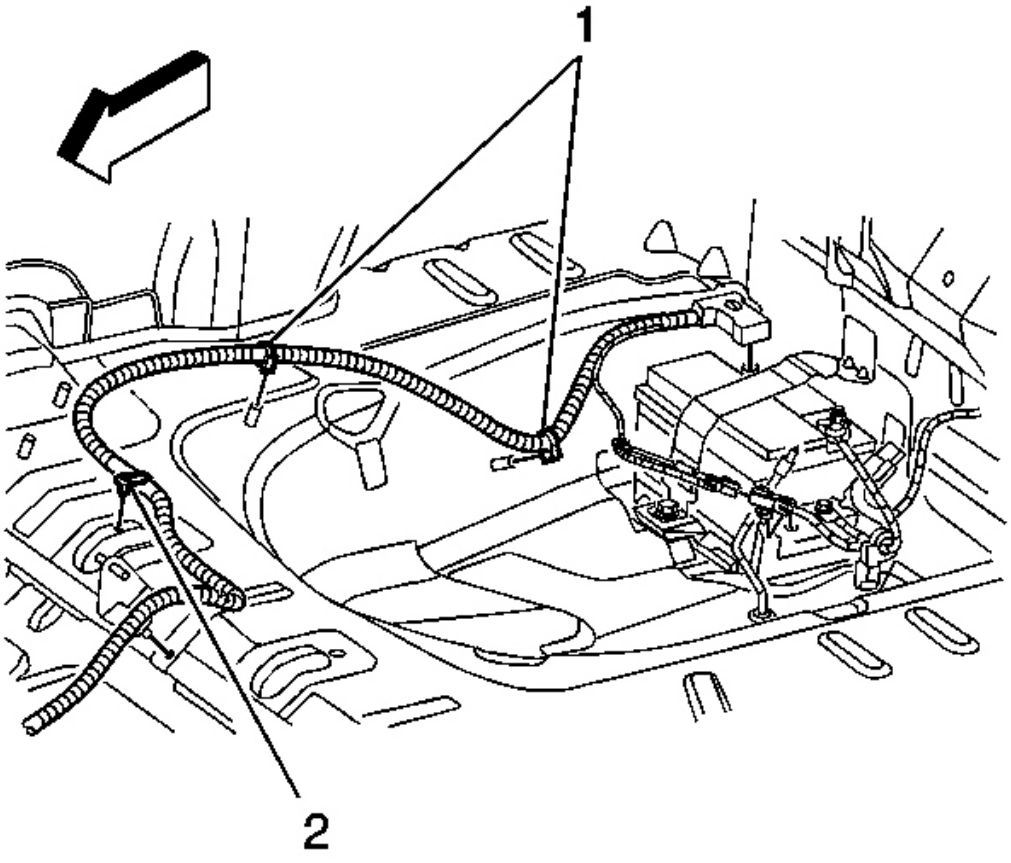


Fig. 43: Battery Cable Clip To Floor Pan
Courtesy of GENERAL MOTORS CORP.

17. Install the positive battery cable clip (2) to the floor pan.
18. Install the positive battery cable clips (1) to the weld studs.

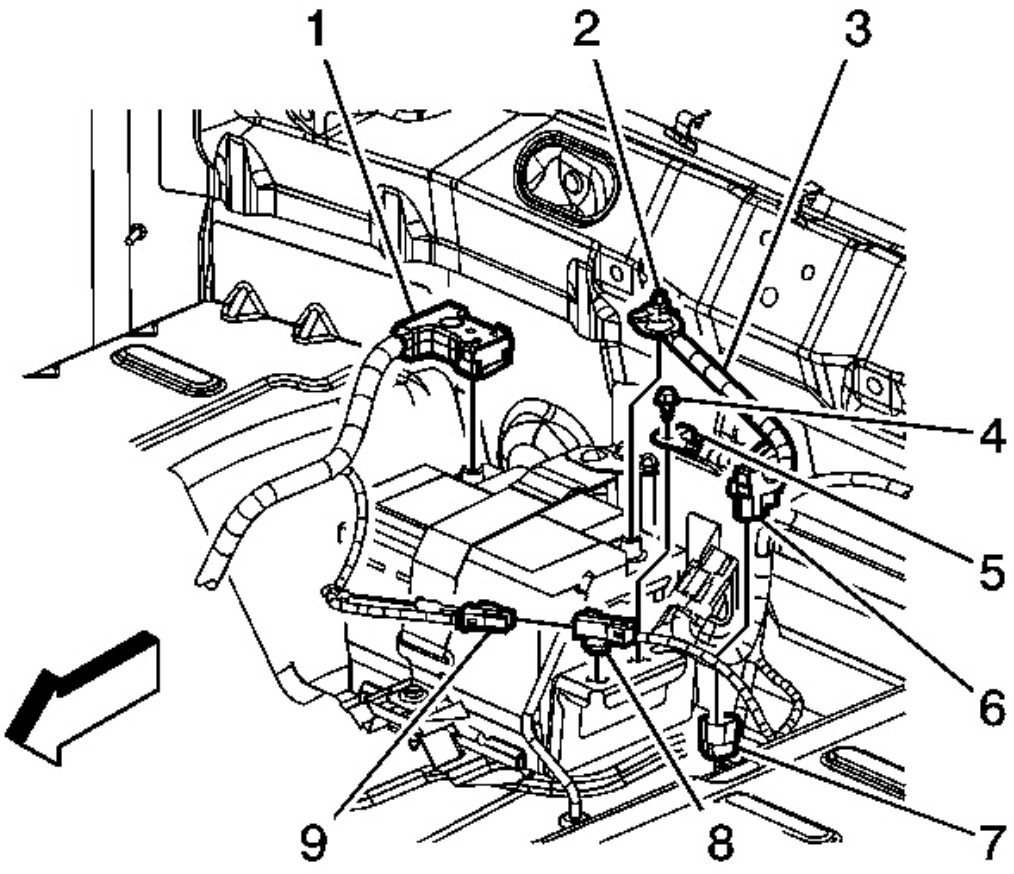


Fig. 44: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

19. Connect the positive battery cable electrical connector (9) to the body harness electrical connector (8).
20. Install the positive battery cable to the battery.
21. Tighten the positive battery cable bolt to 17 N.m (13 lb ft).
22. Close the positive battery cable (1) cover.
23. Install the carpet. Refer to **Floor Panel Carpet Replacement** .
24. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY REPLACEMENT

Removal Procedure

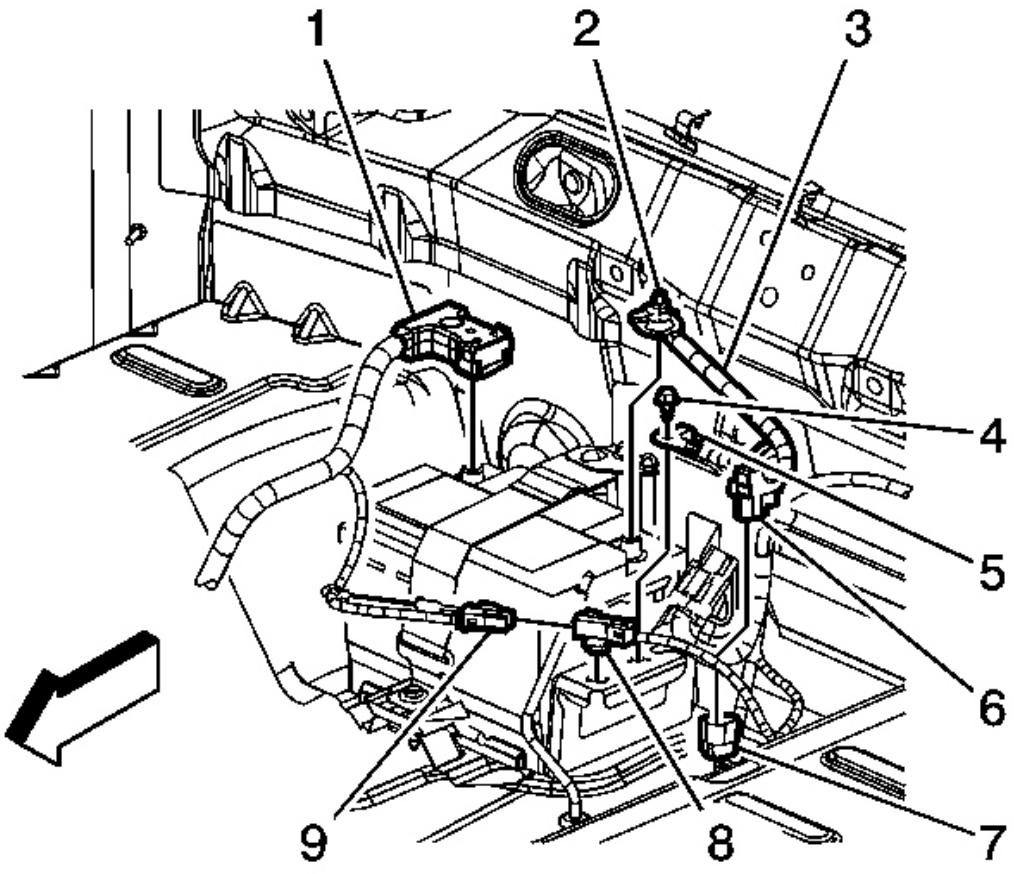


Fig. 45: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Open the positive battery cable cover.
3. Loosen the positive battery cable bolt.
4. Remove the positive battery cable (1) from the battery.

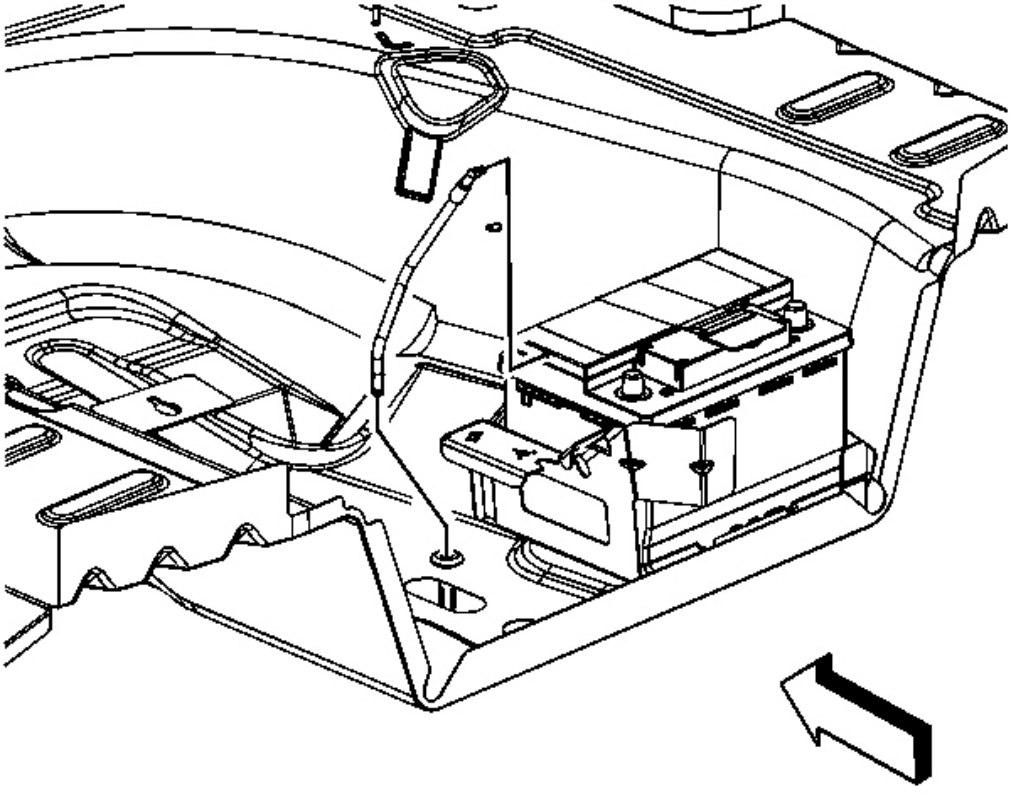


Fig. 46: View Of Battery Vent Tube At Battery
Courtesy of GENERAL MOTORS CORP.

5. Remove the battery vent tube from the battery.

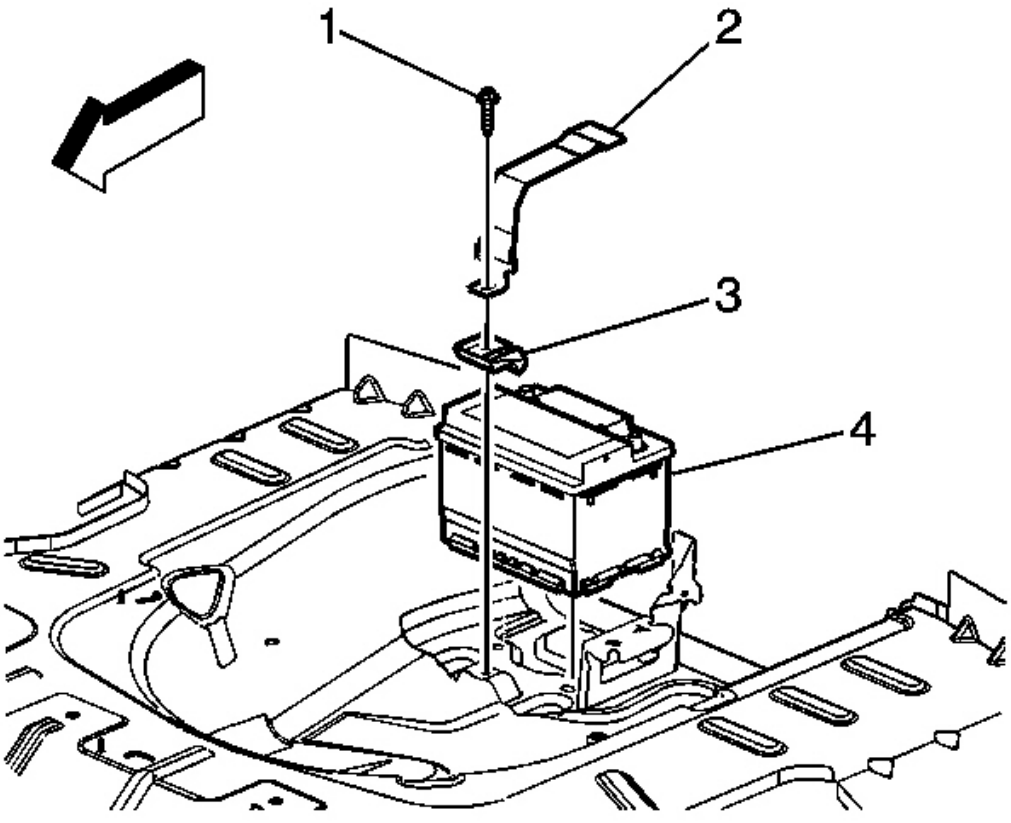


Fig. 47: Identifying Battery, Retainer, Bolt & Strap
Courtesy of GENERAL MOTORS CORP.

6. Remove the battery retainer bolt (1).
7. Remove the battery strap (2) and retainer (3).

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

8. Remove the battery (4).

Installation Procedure

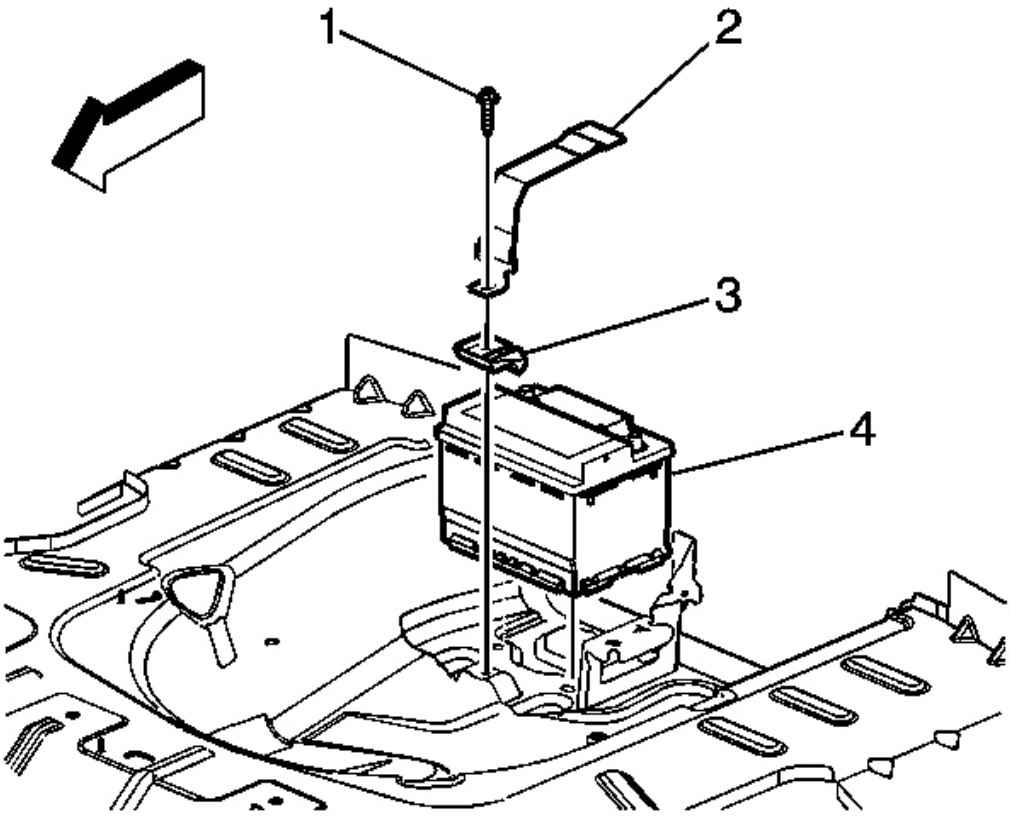


Fig. 48: Identifying Battery, Retainer, Bolt & Strap
Courtesy of GENERAL MOTORS CORP.

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

1. Install the battery (4).
2. Install the battery strap (2) and retainer (3).

CAUTION: Refer to Fastener Caution .

3. Install the battery retainer bolt (1) and tighten to 17 N.m (13 lb ft).

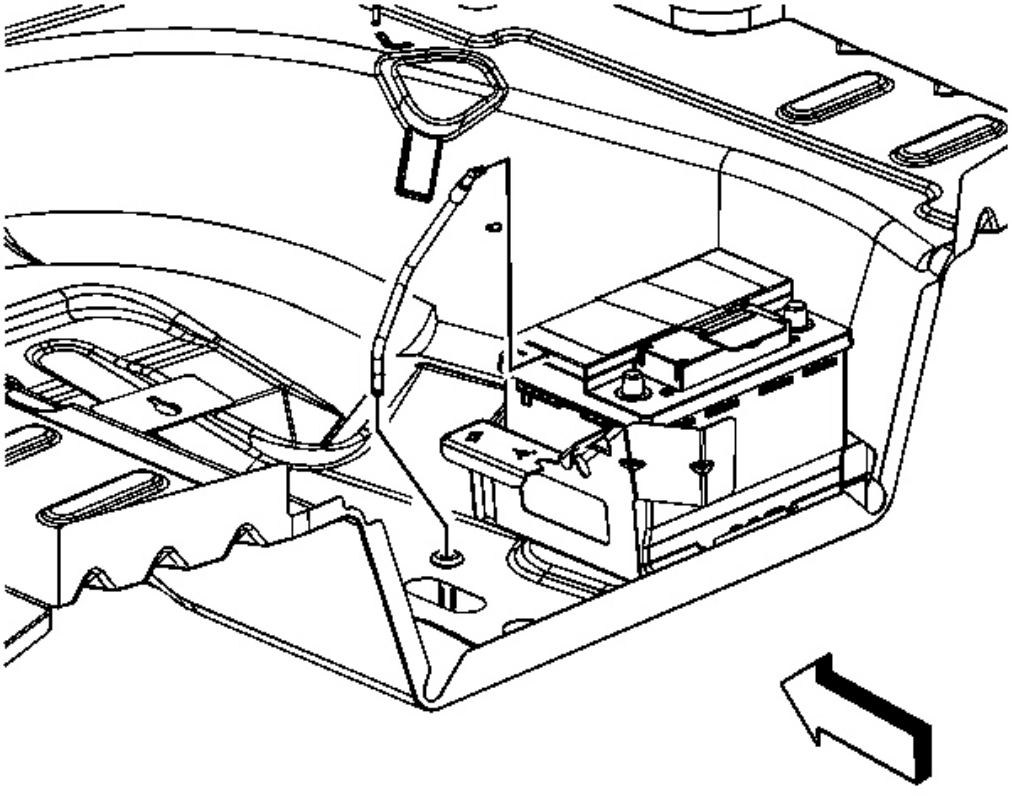


Fig. 49: View Of Battery Vent Tube At Battery
Courtesy of GENERAL MOTORS CORP.

IMPORTANT: Replacement batteries may require the vent plug in the battery vent hole to be moved from one end of the battery to the other to permit vent tube installation per original design.

4. Install the battery vent tube to the battery.

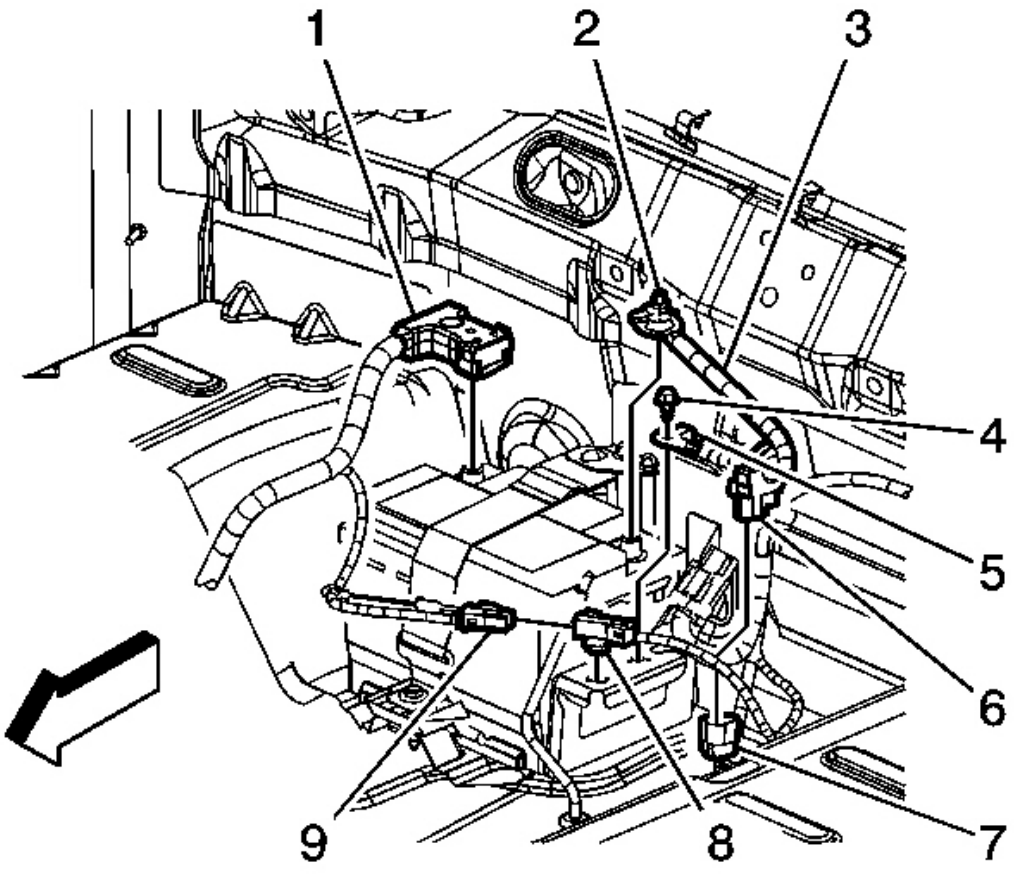


Fig. 50: View Of Battery Connections
Courtesy of GENERAL MOTORS CORP.

5. Position the positive battery cable (1) to the battery.
6. Tighten the positive battery cable bolt and tighten to 17 N.m (13 lb ft).
7. Close the positive battery cable cover.
8. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

STARTER REPLACEMENT

Removal Procedure

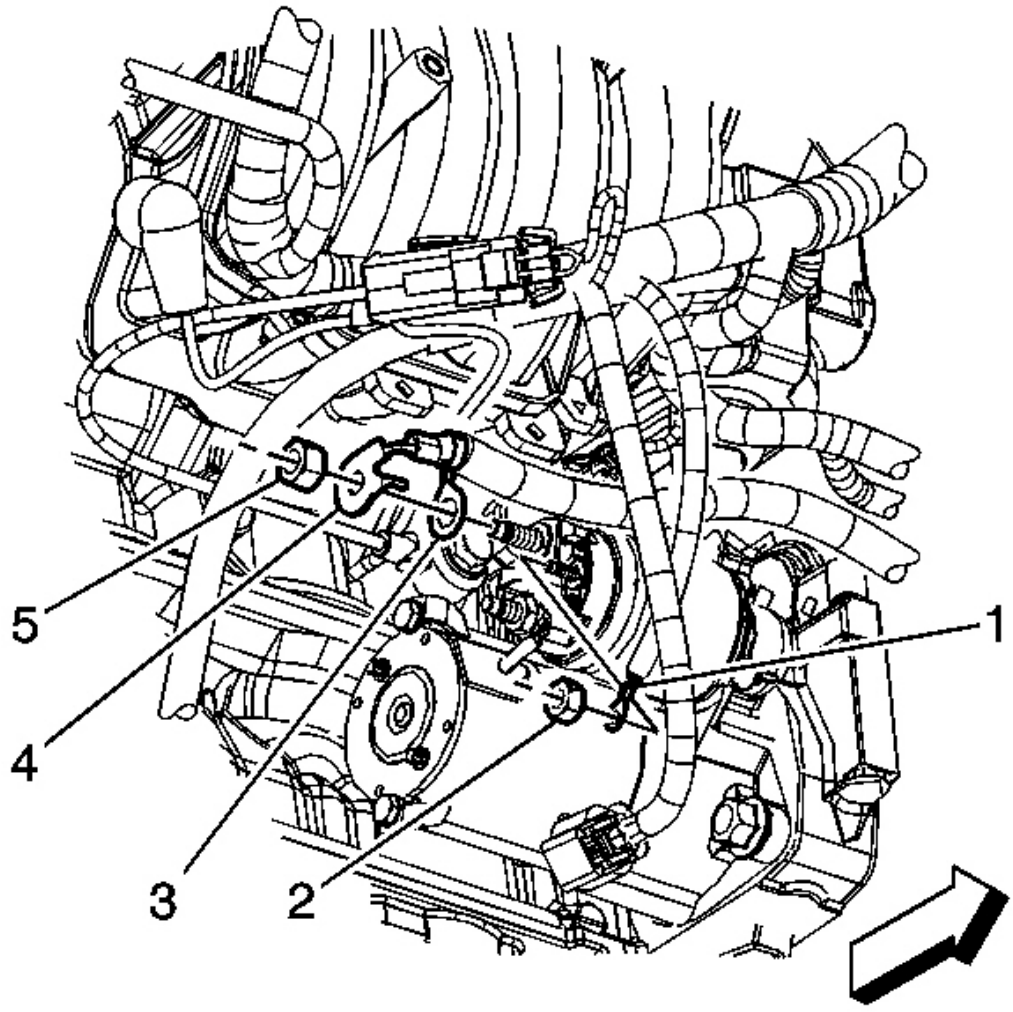


Fig. 51: View Of Engine Harness Terminal To Starter
Courtesy of GENERAL MOTORS CORP.

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the starter solenoid terminal nut (5).
4. Remove the positive battery cable terminal (4) from the starter.
5. Remove the starter solenoid wire terminal (3) from the starter.
6. Disconnect the engine harness connector (1) from the starter.

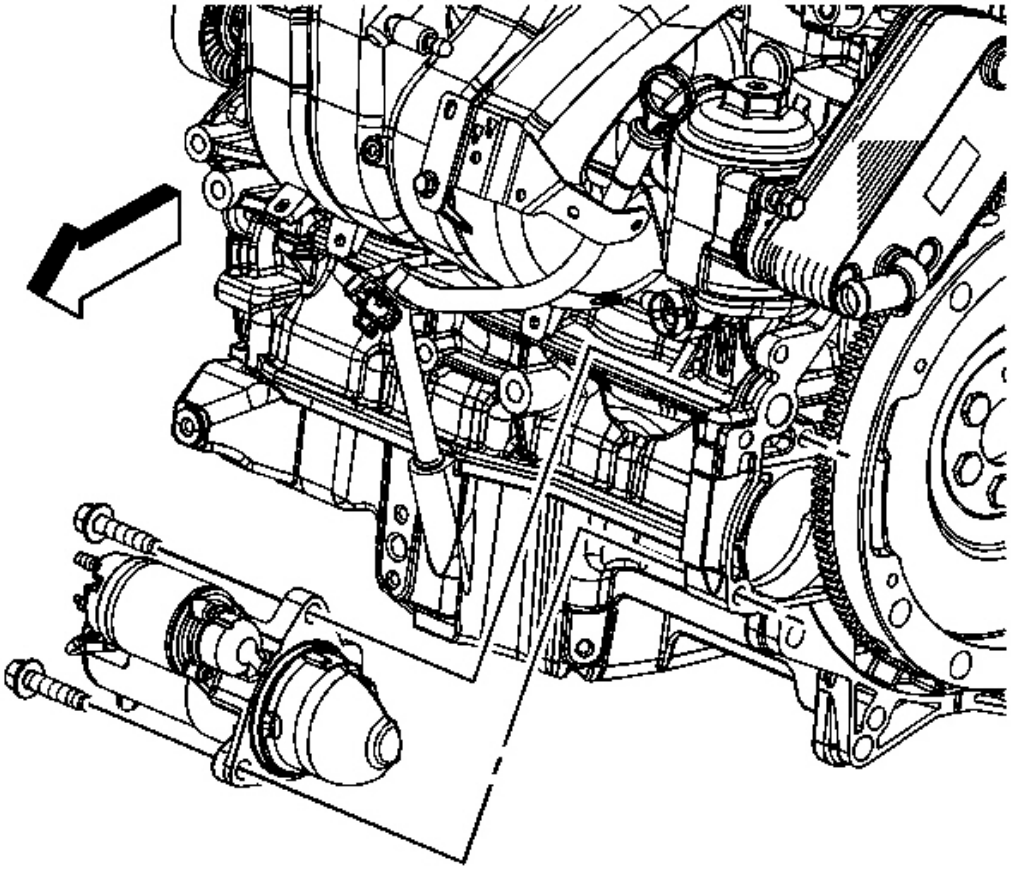


Fig. 52: Identifying Starter Bolts & Starter
Courtesy of GENERAL MOTORS CORP.

7. Remove the starter bolts.
8. Remove the starter.

Installation Procedure

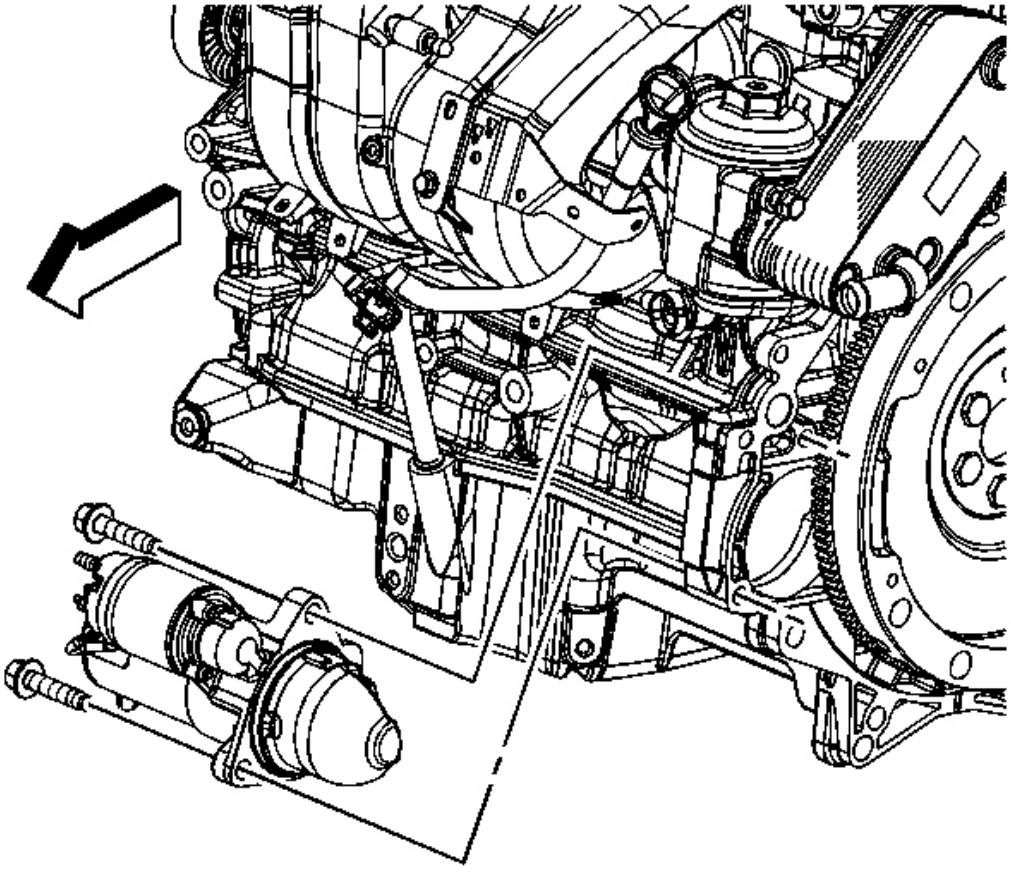


Fig. 53: Identifying Starter Bolts & Starter
Courtesy of GENERAL MOTORS CORP.

1. Position the starter to the engine.

CAUTION: Refer to Fastener Caution .

2. Install the starter bolts and tighten to 40 N.m (30 lb ft).

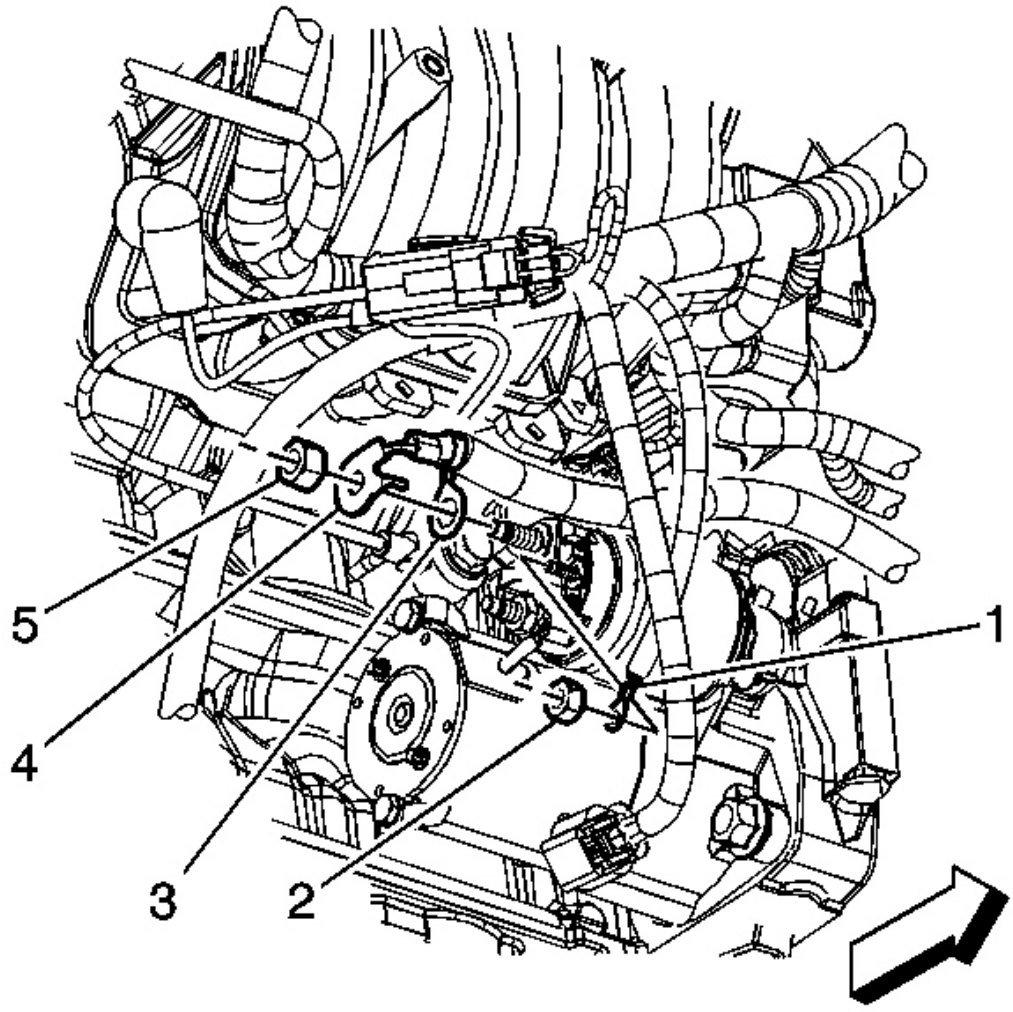


Fig. 54: View Of Engine Harness Terminal To Starter
Courtesy of GENERAL MOTORS CORP.

3. Connect the engine harness connector (1) to the starter.
4. Install the starter solenoid wire terminal (3) to the starter.
5. Install the positive battery cable terminal (4) to the starter. Ensure that the anti-rotational tab is correctly located into the indexing slot.
6. Install the starter solenoid terminal nut (5) and tighten to 17 N.m (13 lb ft).
7. Lower the vehicle.
8. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.

GENERATOR REPLACEMENT

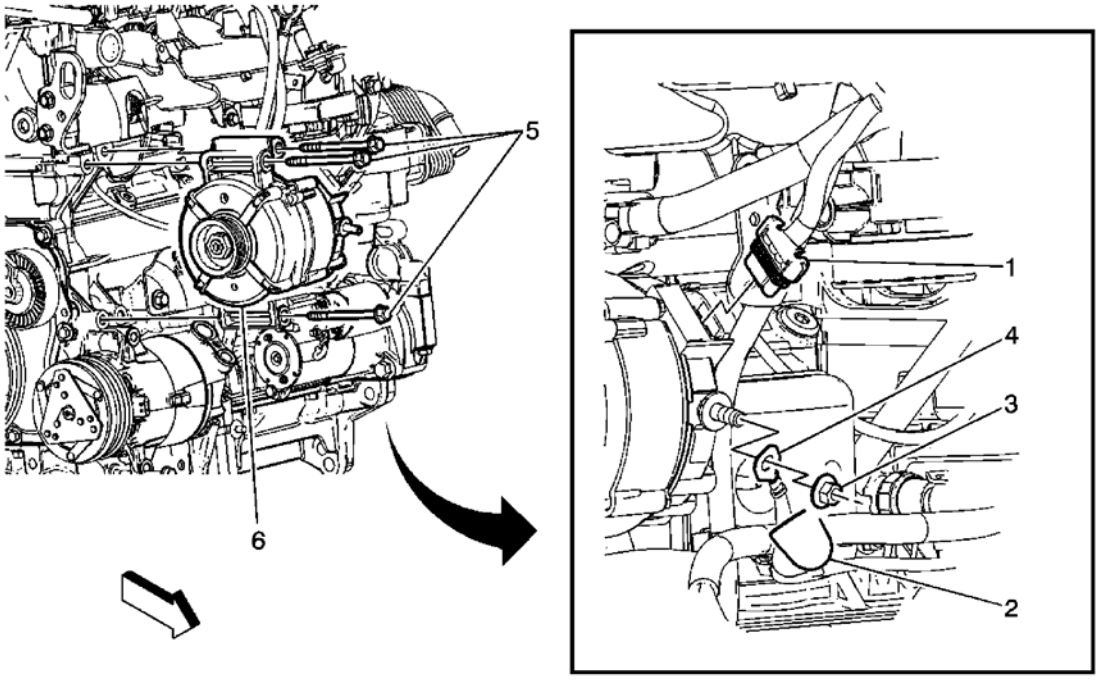


Fig. 55: View Of Generator Mounts and Attachments
Courtesy of GENERAL MOTORS CORP.

Callout	Component Name
Preliminary Procedures 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**. 2. Remove the drive belt. Refer to **Drive Belt Replacement** .	
1	Engine Harness Generator Connector
2	Engine Harness Generator Terminal Boot
3	Generator Terminal Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 20 N.m (15 lb ft)
4	Engine Harness Generator Connector
5	Generator Bolt (Qty: 3) **Tighten:** 22 N.m (16 lb ft)
6	Generator

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

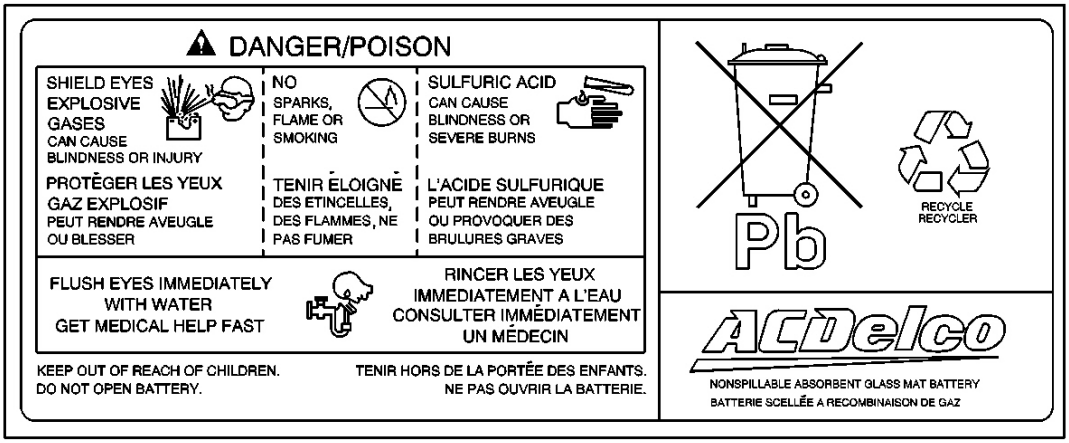


Fig. 56: Battery Warning Label
Courtesy of GENERAL MOTORS CORP.

WARNING: 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.**

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

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

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

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

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

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

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

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

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

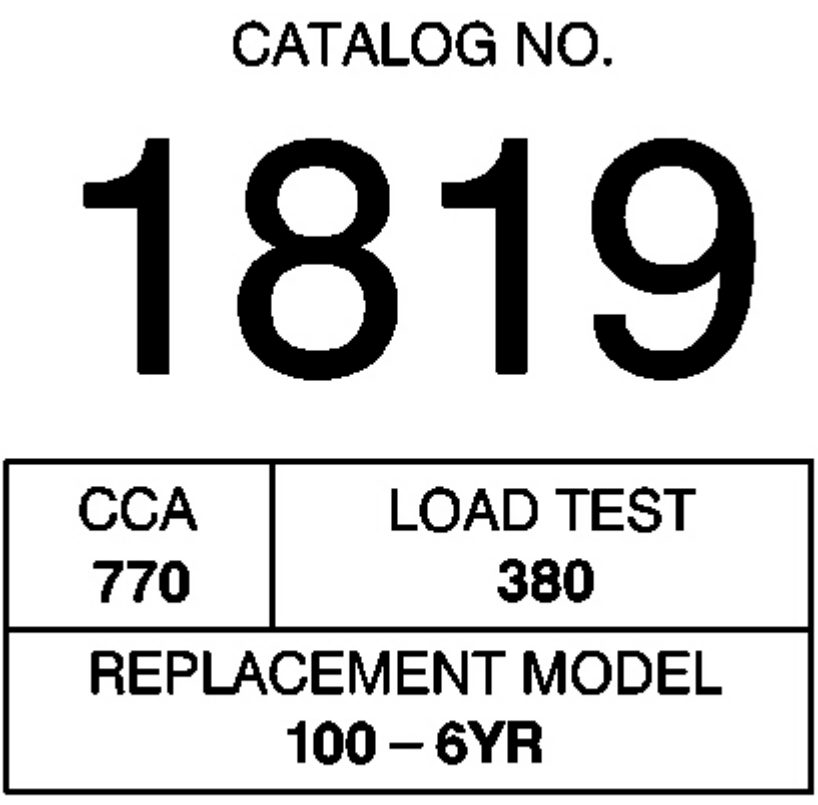


Fig. 57: View Of Battery Specification Label
Courtesy of GENERAL MOTORS CORP.

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 (W/RVC)

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 electrical power management (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 that 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:

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

The generator provides a feedback signal of the generator voltage output through the generator field duty cycle signal circuit to the ECM. This information is sent to the body control module (BCM). The signal is a 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 that 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 load shed 2 for setting criteria.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

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

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

			AH	
Idle Boost 1 Start	-	Less Than 10.9 V	-	First level idle boost requested
Idle Boost 1 End	Greater Than -15°C (+5°F)	Greater Than 12 V	Battery has a net loss less than 0.2 AH	First level idle boost request cancelled
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 End	-	Greater Than 12 V	Battery has a net loss of less than 2 AH	Clear Load Shed 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.
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

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 thorough 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 CRNK relay opens and battery voltage is removed from the starter solenoid terminal A. 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.

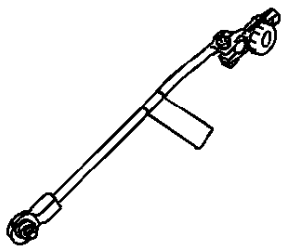
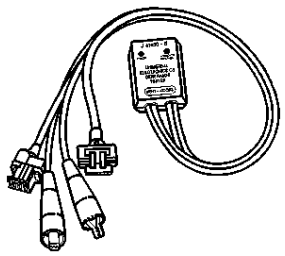
Circuit Description

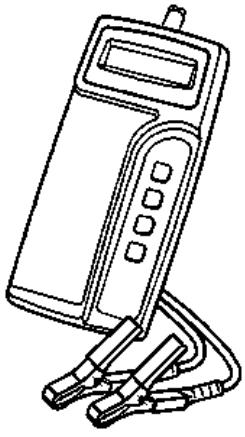
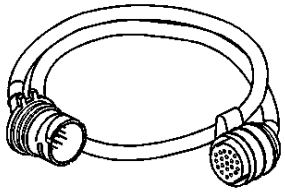
Moving the ignition switch to the start position signals the body control module (BCM) through discrete inputs

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 ground signal from the park/neutral position (PNP) switch or a signal from the clutch pedal position sensor notifying that it is safe to start the engine. Ground G105 supplies ground for the CRNK relay coil. The starter relay coil control circuit is then supplied voltage by the ECM closing the switch in the starter relay suppling 12 volts from the CRNK fuse to terminal A of the starter. Ground is supplied to the starter solenoid through the engine block.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description
	J 38758 Parasitic Draw Test Switch
	J 41450-B Universal CS Generator Tester Harness
	J 42000 Battery Tester

	
	J 45681 Jumper Harness