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ELECTRICAL

12 V Starting and Charging - Escalade, Suburban, Tahoe, Yukon

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Air Conditioning Tube Bracket Fastener	22 N.m	16 lb ft
Auxiliary Battery Hold Down Retainer Fastener (9C1)	9 N.m	80 lb in
Auxiliary Battery Negative Cable Clamp to Battery Post Fastener (9C1)	5 N.m	44 lb in
Auxiliary Battery Negative Cable to Engine Block (9C1)	45 N.m	33 lb ft
Auxiliary Battery Positive Cable Clamp to Battery Post Fastener (9C1)	5 N.m	44 lb in
Auxiliary Battery Positive Cable to Relay Fastener (9C1)	9 N.m	80 lb in
Battery Hold Down Retainer Fastener	25 N.m	18 lb ft
Battery Negative Cable Clamp to Battery Post Fastener	5 N.m	44 lb in
Battery Negative Cable to Engine Block	22 N.m	16 lb ft
Battery Negative Cable to Right Side Body Mount Fastener	9 N.m	80 lb in
Battery Negative Strap to Engine Block	22 N.m	16 lb ft
Battery Negative Strap to Plenum	9 N.m	80 lb in
Battery Positive Cable Clamp to Battery Post Fastener	5 N.m	44 lb in
Battery Positive Cable to Battery Fuse Block Fastener	9 N.m	80 lb in
Battery Positive Cable to Underhood Fuse Block Fastener	15 N.m	11 lb ft
Battery Tray Fastener	22 N.m	16 lb ft
Battery Tray Support Fastener (9C1)	9 N.m	80 lb in
Generator Battery Control Wiring Harness Cable to Starter Fastener	14 N.m	124 lb in
Generator Battery Control Wiring Harness to Front Engine Block Fastener	45 N.m	33 lb ft
Generator Battery Control Wiring Harness to Side Engine Block Fastener	22 N.m	16 lb ft
Generator Bracket Fastener	58 N.m	43 lb ft
Generator Mounting Fasteners	50 N.m	37 lb ft
Starter Mounting Fastener	50 N.m	37 lb ft
Starter Shield Lower Shield Fastener	9 N.m	80 lb in
Starter Shield Upper Shield Fastener	22 N.m	16 lb ft
Support Cross Brace Fastener	9 N.m	80 lb in

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starting System

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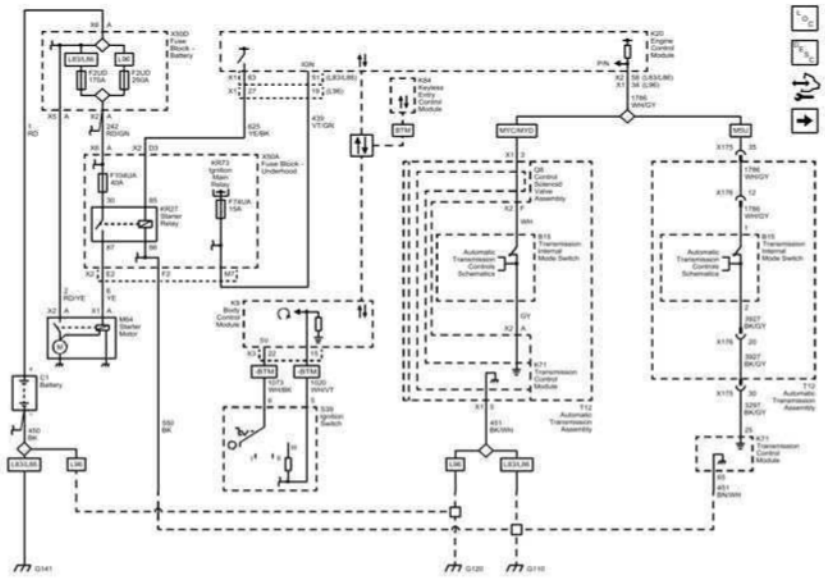
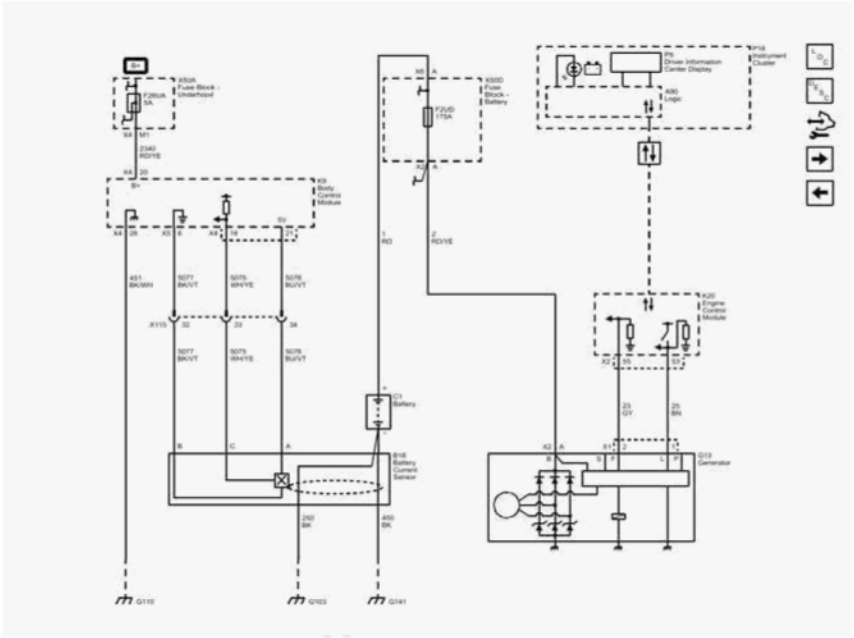


Fig. 1: Starting System
Courtesy of GENERAL MOTORS COMPANY

Charging (L83 or L86)



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Fig. 2: Charging (L83 or L86)
Courtesy of GENERAL MOTORS COMPANY

Charging (L96)

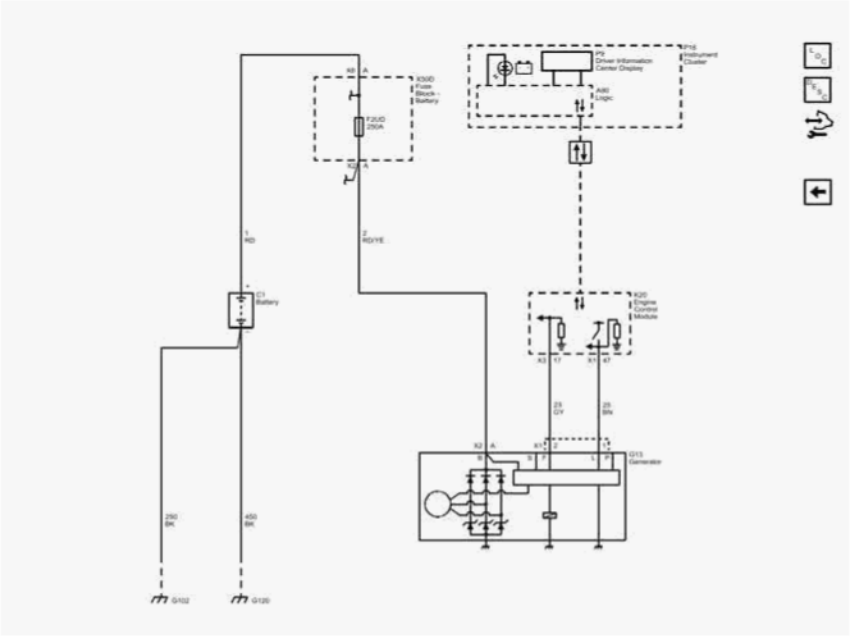


Fig. 3: Charging (L96)
Courtesy of GENERAL MOTORS COMPANY

AUXILIARY BATTERY WIRING SCHEMATICS

Auxiliary Battery Relays (5W4 or 9C1)

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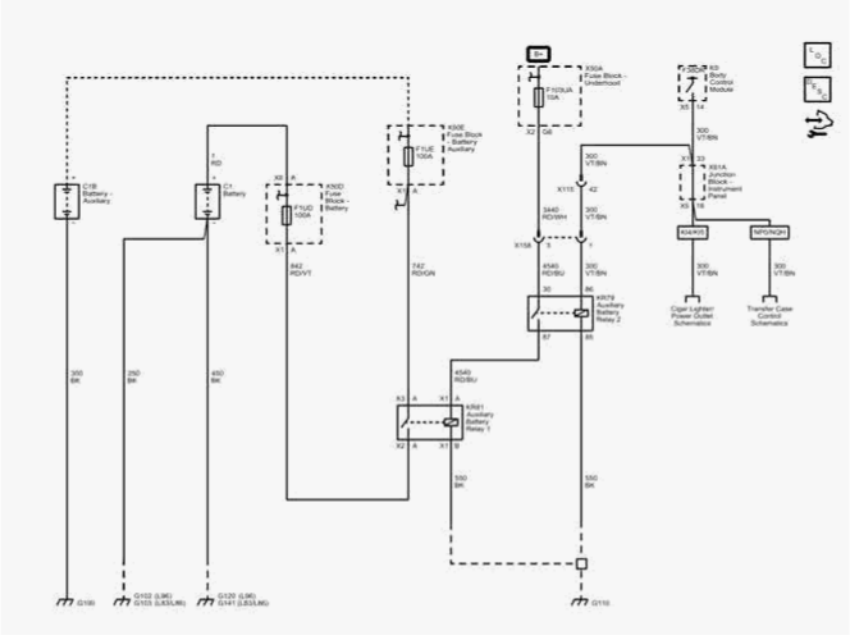


Fig. 4: Auxiliary Battery Relays (5W4 or 9C1)
Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1325, B1327-B1330, B1395, B1415, B1424, B1425, B1439, B1517, C0800, C0805, C0870, C0880, C0895, C0899, C0900, P0560, P0562, P0563, P0611, P129B, P129C, P15AE, OR P15AF: DEVICE POWER/DEVICE VOLTAGE/CONTROL MODULE/BATTERY VOLTAGE/SYSTEM VOLTAGE/FUEL INJECTOR CONTROL MODULE SYSTEM

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

Device Power Circuit Voltage

DTC B1327

Device Voltage Circuit

DTC B1328

Device Voltage Circuit

DTC B1330

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Device Power 2 Circuit

DTC B1390

Control Module Supply Circuit 1

DTC B1395

Control Module Voltage Reference Output 1

DTC B1400

Control Module Supply Circuit 2

DTC B1410

Control Module Supply Circuit 3

DTC B1415

Control Module Voltage Reference Output 3

DTC B1424

Control Module Power Circuit

DTC B1425

Control Module Power Circuit

DTC B1439

Intermittent Device Voltage

DTC B1517

Battery Voltage

DTC C0800

Device Power 1 Circuit Voltage

DTC C0805

Control Module Power 2 Circuit

DTC C0870

Control Module Voltage Reference

DTC C0880

Control Module Voltage Reference

DTC C0895

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Device Voltage

DTC C0899

Device Voltage

DTC C0900

Device Voltage

DTC P0560

System Voltage Low

DTC P0561

System Voltage Performance

DTC P0562

System Voltage Low

DTC P0563

System Voltage High

DTC P0611

Fuel Injector Control Module Performance

DTC P129B

System Voltage Low

DTC P129C

System Voltage High

DTC P15AE

Fuel Injector Control Module System Voltage Low Voltage

DTC P15AF

Fuel Injector Control Module System Voltage High Voltage

For symptom byte information refer to **Symptom Byte List** .

Circuit/System Description

The vehicle control modules or sensors monitor the system voltage to verify the system voltage is within the normal operating range.

Conditions for Running the DTC

The engine is running.

Conditions for Setting the DTC

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The control module or sensor detects a system voltage of less than approximately 9 V or greater than 15 V for approximately 5 s.

Action Taken When the DTC Sets

- A driver information center message and/or warning indicator may be displayed.
- The control module may be temporarily disabled.

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

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

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging 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

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
    - **If battery voltage is less than 12.4 V or more than 12.8 V**

      Refer to **Battery Inspection/Test**.

    - **If battery voltage is between 12.4 and 12.8 V**

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3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.
   - **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

     Refer to **Charging System Test**.

   - **If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
5. Verify the appropriate control module battery voltage and ignition voltage parameters are available in the scan tool.
   - **If parameters are not available in the scan tool**

     Refer to Circuit/System Testing

   - **If parameters are available in the scan tool**
6. Verify the appropriate control module scan tool battery voltage and ignition voltage parameters are within 1 V of the battery voltage.
   - **If not within 1 V of the battery voltage**

     Refer to Circuit/System Testing

   - **If within 1 V of the battery voltage**
7. All OK.

Circuit/System Testing

NOTE: **Use the schematic to identify the following:**

- **Control modules the vehicle is equipped with**
- **The control module's ground, B+, and Ignition circuit terminal IDs and connectors**

NOTE: **Some control module ground circuits may require up to 20 min after the ignition is turned off before achieving a resistance reading of less than 5 Ω. In most cases the readings will drop below 20 Ω within 1 min indicating the control module is going to sleep.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the ground circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, repair the open/high resistance in the ground connection.
   - **If less than 10 Ω**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**

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1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the appropriate control module.

- **If the test lamp illuminates**

4. Ignition ON.
5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.

- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 Ω in the ignition circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the ignition circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the appropriate control module.

- **If the test lamp illuminates**

6. Replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup.

DTC B1516: BATTERY CURRENT SENSOR

Diagnostic Instructions

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

DTC Descriptors

DTC B1516 08

Battery Current Sensor Signal Invalid

DTC B1516 66

Battery Current Sensor Wrong Mounting Position

Diagnostic Fault Information

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

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

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The body control module (BCM) supplies 5 V 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.

Conditions for Running the DTC

B1516 08

The BCM is awake.

B1516 66

- The BCM is awake.
- The engine is OFF.

Conditions for Setting the DTC

B1516 08

The battery current signal is less than 4 % or greater than 96 % duty cycle for 2 min.

B1516 66

The battery current polarity is positive for 2 min.

Action Taken When the DTC Sets

The regulated voltage control is disabled.

Conditions for Clearing the DTC

The DTC passes when the battery current returns to the normal range for 15 s.

Diagnostic Aids

DTC B1516 08 could be set by overcharging with a battery charger or jump starting.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

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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 and all vehicle systems OFF, disconnect the harness connector at the B18 Battery Current Sensor. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 30 Ω between the low reference circuit terminal B and ground.
    - **If 30 Ω or greater**
    1. Ignition OFF, disconnect the X5 harness connector at the K9 Body Control Module.
    2. Test for less than 2 Ω in the low reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.
    - **If less than 30 Ω**
3. Ignition ON.
4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the 5 V reference circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the 5V reference circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the K9 Body Control Module.
    - **If greater than 5.2 V**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
    2. Test for less than 1 V between the 5 V reference circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K9 Body Control Module.
    - **If between 4.8-5.2 V**
5. Test for 4.8-5.2 V between the signal circuit terminal C and ground.
    - **If less than 4.8 V**
    1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.

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- If infinite resistance

3. Test for less than 2 Ω in the signal circuit end to end.
   - If 2 Ω or greater, repair the open/high resistance in the circuit.
   - If less than 2 Ω, replace the K9 Body Control Module.

- **If greater than 5.2 V**

1. Ignition OFF, disconnect the X4 harness connector at the K9 Body Control Module, ignition ON.
2. Test for less than 1 V between the signal circuit and ground.
   - If 1 V or greater, repair the short to voltage on the circuit.
   - If less than 1 V, replace the K9 Body Control Module.

- **If between 4.8-5.2 V**

6. Test or replace the B18 Battery Current Sensor.

B1516 66

1. Verify that the B18 Battery Current Sensor is installed securely around the negative battery cable, with the tape tab pointing away from the negative terminal on the C1 Battery.
   - **If the B18 Battery Current Sensor is not installed correctly**

     Remove and reinstall the B18 Battery Current Sensor properly.

   - **If the B18 Battery Current Sensor is installed correctly**
2. Replace the B18 Battery Current Sensor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Current Sensor Replacement (L83, L86)**
- **Control Module References** for BCM replacement, programming, and setup.

DTC B151A: LOW BATTERY CAPACITY DETECTED

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 B151A 58

Low Battery Capacity Detected

Circuit/System Description

The body control module (BCM) monitors the battery voltage level during an engine crank event to detect a low battery voltage condition.

Conditions for Running the DTC

The vehicle is ON

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Conditions for Setting the DTC

A minimum crank battery voltage is less than the minimum crank battery voltage threshold for 16 consecutive crank events.

Action Taken When the DTC Sets

A driver information center message is displayed.

Conditions for Clearing the DTC

The DTC will clear if the minimum crank voltage is greater than the minimum crank voltage threshold during a crank event.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

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

- Refer to the **Battery Inspection/Test**.
- Refer to the **Charging System Test**.

DTC B1527: PARASITIC LOAD

Diagnostic Instructions

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

DTC Descriptor

DTC B1527 00

Parasitic Load

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Circuit/System Description

The body control module (BCM) monitors the state of charge of the electrical system.

Conditions for Running the DTC

The ignition is in Accessory or Run mode.

Conditions for Setting the DTC

The state of charge at ignition ON is 30% lower than when the engine was running and battery drain is more than 2 A.

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

- The DTC will clear if the fault does not return after 50 consecutive ignition cycles.
- The DTC will clear when run state of charge is greater than or equal to 80%.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

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

Refer to **Battery Electrical Drain/Parasitic Load Test**.

DTC P0561: SYSTEM VOLTAGE PERFORMANCE

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.

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

DTC Descriptors

DTC P0561

System Voltage Performance

For symptom byte information, refer to **Symptom Byte List** .

Circuit/System Description

The control module requires a switched ignition voltage input to operate. The module continuously monitors the ignition voltage.

Conditions for Running the DTC

The engine speed is 400 RPM or greater.

Conditions for Setting the DTC

The control module detects ignition voltage 6.5 V or less. or a variation in ignition voltage 10 V or greater.

Action Taken When the DTC Sets

- DTC P0561 is a Type C DTC.

Conditions for Clearing the DTC

DTC P0561 is a Type C DTC.

Diagnostic Aids

- A defective vehicle battery may allow this code to set.
- A defective vehicle charging system may allow this code to set.
- You may have to drive the vehicle in order to experience a condition.
- Although this DTC could indicate an internal voltage condition within the ECM, in most cases, the ECM is not at fault. Investigate thoroughly prior to replacing the ECM.

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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

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- **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
2. Engine running, accessories OFF
3. Test for 12.6-15.0 V between the battery positive terminal and negative terminal.
   - **If not within 12.6-15.0 V**

     Refer to **Charging System Test**.

   - **If within 12.6-15.0 V**
4. Verify the scan tool BCM Battery Voltage parameter is within a value of 2 V of the battery terminal voltage.
   - **If not within a value of 2 V**

     Refer to Circuit/System Testing.

   - **If within a value of 2 V**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: **Use the schematic to identify the following:**

- **Control modules the vehicle is equipped with**
- **The control modules ground, B+, and Ignition circuit terminal IDs and connectors**

NOTE: **Some control module ground circuits may require up to 20 minutes after the ignition is turned off before achieving a resistance reading of less than 5 Ω. In most cases the readings will drop below 20 Ω between 1 minute indicating the control module is going to sleep.**

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 minutes for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
   - **If 10 Ω or greater**
   1. Ignition OFF.

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2. Test for less than 2 Ω in the ground circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, repair the open/high resistance in the ground connection.
- **If less than 10 Ω**

3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the appropriate control module.
    - **If the test lamp illuminates**
4. Ignition ON.
5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ignition circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the ignition circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the appropriate control module.
    - **If the test lamp illuminates**
6. Replace the control module.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup.

DTC P0615, P0616, OR P0617: STARTER RELAY CONTROL

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.

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DTC Descriptors

DTC P0615

Starter Relay Control Circuit

DTC P0616

Starter Relay Control Circuit Low Voltage

DTC P0617

Starter Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0616	P0615	P0617	-
Ground	-	P0615	-	-

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 clutch pedal is depressed or the transmission is in Park/Neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter solenoid.

Conditions for Running the DTC

- The ignition is in the START position.
- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0615, P0616, and P0617 are C type DTCs.

Conditions for Clearing the DTC

DTC P0615, P0616, and P0617 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

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Electrical Information Reference

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- **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 and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 86 and ground.
    - **If 10 Ω or greater**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
    - **If the test lamp does not illuminate and the circuit fuse is good**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is OK and there is voltage at the fuse.
    - **If the test lamp does not illuminate and the circuit fuse is open**
    1. Ignition OFF.
    2. Test for infinite resistance between the B+ circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance,
    3. Disconnect X1 harness connector at the M64 Starter Motor
    4. Test for infinite resistance between the control circuit terminal 87 and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the M64 Starter Motor.
    - **If the test lamp illuminates**
5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
6. Verify the test lamp turns ON and OFF when commanding the Starter Relay ON and OFF with a scan tool.

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- **If the test lamp is always OFF**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the control circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Test for less than 2 Ω in the control circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, replace the K20 Engine Control Module.

- **If the test lamp is always ON**

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
2. Test for less than 1 V between the control circuit and ground.
    - If 1 V or greater, repair the short to voltage on the circuit.
    - If less than 1 V, replace the K20 Engine Control Module.

- **If the test lamp turns ON and OFF**

7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
8. Verify the M64 Starter Motor is activated.
    - **If the M64 Starter Motor does not activate**

    1. Ignition OFF, disconnect the harness connector at the M64 Starter Motor.
    2. Test for infinite resistance between the control circuit terminal X2 A and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the control circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 Starter Motor.

    - **If the M64 starter motor activates**

9. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60-180 Ω between terminals 85 and 86.
    - **If less than 60 or greater than 180 Ω**

      Replace the relay.

    - **If between 60-180 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87
    - 30 and 85
    - 85 and 87

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- **If less than infinite resistance**

  Replace the relay.

- **If infinite resistance**

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
   - **If 2 Ω or greater**

     Replace the relay.

   - **If less than 2 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**
- **Starter Replacement (L83, L86)Starter Replacement (L96)**
- **Control Module References** for ECM replacement, programming, and setup.

DTC P0621: GENERATOR L-TERMINAL CIRCUIT

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	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on the generator turn on control 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 when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s)

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- The engine is running for the run test

Conditions for Setting the DTC

- Ignition ON, engine OFF - The ECM detects greater than 3.5 V on the generator control circuit for 5 s
- Engine running - The ECM detects a low voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded high
- Engine running - The ECM detects a high voltage for 15 s on the generator control circuit when the duty cycle voltage is commanded low

Action Taken When the DTC Sets

DTC P0621 is a C type DTC

Conditions for Clearing the DTC

- Ignition ON, engine OFF- Low voltage
- Engine running - A control signal duty cycle is detected

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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- **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. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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- **If the DTC does not set**

3. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1, X1 1, A or B+ X2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
   2. Test for infinite resistance between the B+ circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
   - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, ignition ON.
3. Test for 3.0- 5.5 V between the control circuit terminal 1 and ground.
   - **If less than 3.0 V**
   1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
   2. Test for infinite resistance between the control circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If greater the 2 Ω, repair the open/high resistance in the circuit.
      - If less than 2 Ω, replace the K20 Engine Control Module.
   - **If greater than 5.5 V**
   1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON.
   2. Test for less than 1 V between the control circuit and ground.
      - If greater than 1 V, repair the short to voltage on the circuit.
      - If less than 1 V, replace the K20 Engine Control Module.
   - **If between 3.0-5.5 V**
4. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement (L96)Generator Replacement (L83, L86)**
- **Control Module References** for engine control module replacement, programming, and setup

DTC P0622: GENERATOR F-TERMINAL CIRCUIT

Diagnostic Instructions

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- 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+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

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 PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is OFF, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s).
- Engine running at less than 3, 000 RPM.

Conditions for Setting the DTC

- DTC P0621 is not set.
- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s), the ECM detects a PWM signal that is greater than 65% for 5 s.
- Engine running at less than 3, 000 RPM - The ECM detects a PWM signal that is less than 5% for 30 s.

Action Taken When the DTC Sets

DTC P0622 is a type C DTC.

Conditions for Clearing the DTC

- Ignition ON, Engine OFF- Low / no PWM signal detected.
- Engine running - A 5-90% duty cycle is detected.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- **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

NOTE: **Do not have a battery charger connected during the generator testing.**

1. Engine running.
2. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is between 5-90%.
   - **If not between 5-90%**

     Refer to Circuit/System Testing.

   - **If between 5-90%**
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.
   - **If the parameter does not change**

     Refer to Circuit/System Testing.

   - **If the parameter changes**
4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
5. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

   - **If the DTC does not set**
6. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal X2 1, X2 2 or X2 A and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
   2. Test for less than 2 Ω in the B+ circuit end to end.

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- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.

- **If the test lamp illuminates**

2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
    - **If 5% or greater**
    1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the signal circuit terminal 2 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.
    - **If less than 5%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.
    - **If 95% or less**
    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit
        - If less than 2 Ω, replace the K20 Engine Control Module
    - **If greater than 95%**
6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Generator Replacement (L96)Generator Replacement (L83, L86)**
- **Control Module References** for engine control module replacement, programming and setup

SYMPTOMS - ENGINE ELECTRICAL

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

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

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- Charging System Description and Operation
- Electrical Power Management Description and Operation
- Starting System Description and Operation

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- Battery Inspection/Test
- Battery Electrical Drain/Parasitic Load Test
- 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

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

NOTE: **For Warranty repairs -**

You must use regionally required battery test equipment for warranty repairs.

For accurate test results the battery must be disconnected from the vehicle and the equipment connected directly to the battery posts. When setting up the equipment, select "Out of Vehicle" and then the correct battery type (Flooded, AGM or Stop/Start AGM) and rated CCA (both from the battery label) must be entered.

- **Failure to obtain the correct connections during the test may result in a failed test on a good battery.**
- **Use the Out of Vehicle test (battery disconnected with test equipment connected directly to the posts) for each battery when testing a vehicle with dual batteries.**

Reference Information

Schematic Reference

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Starting and Charging Schematics

Connector End View Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 50313 Battery Tester

Circuit/System Testing

WARNING: Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components.

For Vehicles equipped with OnStarÂ® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStarÂ® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStarÂ®module). Do not disconnect the main vehicle battery or remove the OnStarÂ® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStarÂ® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStarÂ® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced.

1. Verify the C1 Battery or C1B Battery - Auxiliary (if equipped) case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
   - **If there is any apparent damage**

     Replace the C1 Battery or C1B Battery - Auxiliary.

   - **If there is no damage**
2. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in **Fastener Specifications**.
   - **If the battery cables need to be cleaned or tightened**

     Clean as required and tighten as specified.

   - **If the battery cables are clean and tight**
3. Disconnect battery from the vehicle. There is no need to remove the battery from the vehicle.

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4. Connect the EL-50313 directly to the battery terminal posts.
5. Select "Charging," "Diagnostic" and "Out of Vehicle" when setting up the test.
6. Select the proper battery type, Flooded, AGM or Stop/Start AGM.
7. Enter the CCA as shown on the battery label.
8. Verify the test result is not REPLACE BATTERY or BAD CELL-REPLACE

NOTE: **Always write the test code displayed by the tester on the repair order for any warranty purposes. The number is a unique code that describes the test data for a particular battery at a particular time. The test code may occasionally repeat when you retest the same battery. More often, each test will result in a different code. Use the test code from the Out of Vehicle test.**

- **If the test result is REPLACE BATTERY or BAD CELL-REPLACE**

  Replace the C1 Battery or C1B Battery - Auxiliary.

- **If the test result is not REPLACE BATTERY or BAD CELL-REPLACE**

9. All OK.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Battery Replacement

BATTERY CHARGING

Special Tools

EL 50313 Battery Tester

For equivalent regional tools, refer to **Special Tools**.

Diagnostic Aids

- 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 EL 50313 before charging.
- An AGM battery may be damaged if charged to more than 14.5 V.
- A Flooded Cell battery may be damaged if charged to more than 16.5 V.
- Vehicles with dual batteries must be charged individually which will result in two printouts.

Battery State of Charge

NOTE: **Using voltage to determine the batteries state of charge 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 state of charge will only be an estimate.**

The maintenance-free batteries state of charge 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 state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
   - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.

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- 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 % only after the battery has been at rest for 12 hours.**

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

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

Use the state of charge information as follows:

- A battery with a state of charge that is below 65% must always be recharged before returning it to service or continuing storage.
- A battery with a state of charge that is 65% 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%, before returning it to service or continuing storage.

Charging Time Required

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

- The battery charger capacity-The higher the charger amperage, the less time it will take to charge the battery.
- The state of charge 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 V, 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.
- 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.

1. Ensure that all of the battery terminal connections are clean and tight.
2. 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.**

3. 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.

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4. Select "Charging," "PDI" and "In Vehicle" when setting up the charger.
5. Select the proper battery type, Flooded, AGM, Spiral AGM or Stop/Start AGM.
6. Enter the CCA as shown on the battery label.

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

12 V Battery

The following procedure is for the 12 V battery only.

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

Components most likely to cause a parasitic draw on the vehicles battery are switches, relays, and control modules. After the ignition is turned OFF the control modules will begin to go to sleep (shut OFF). All control modules do not go to sleep at the same time, some may take up to 30 minutes or longer after turning the ignition off before going to sleep. Others such as the ON Star and keyless entry control modules may periodically wake up then go back to sleep. These are all normal conditions.

Diagnostic Aids

- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This may cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do 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 OnStarÂ®, and regulated voltage control, if equipped, are designed to wake up, perform a task, and go back asleep at regular intervals. Refer to **Body Control System Description and Operation** for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 min. The typical current draw for this is about 1 A.
- Digital OnStar Generation 6 and later vehicle communication interface module do not "wake up" every 10 minutes for the first 48 hours as the Generation 5 and prior. Generation 6 and later vehicle communication interface module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 hours is normal.
- Some automatic climate control systems can remain in a semi awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the body control module for monitoring purposes, actual system wake up only occurs when the fobs for the vehicle are used. When other devices on the same remote keyless entry operating frequency are activated, such as the 4 tire pressure monitoring sensors and other vehicle Fobs in the vicinity, the body control module will have a 100 mA spike. These spikes are normal and occur too briefly to have a significant effect on battery drain. Competing signals may cause remote keyless entry performance issues such as jamming but should not cause excessive battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a 1-2 hour period to see if the current draw increases and stays above an unacceptable level.

NOTE: **The battery specification listed below is a generic specification. Refer to the label on the original battery when testing the battery.**

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min. reserve capacity 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 reserve capacity and temperature will affect the results.

Current Drain	Days

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Current Drain	Days
25 mA	33
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

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 38758 Parasitic Draw Test Switch

For equivalent regional tools, refer to **Special Tools**.

Circuit/System Verification

NOTE:

- **Most vehicle systems will go to sleep within 30 min, but it can take up to 2 hours before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 s.**
- **Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.**
- **Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.**
- **There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.**
  - **Ignition OFF**
  - **Key out of the ignition switch - when not equipped with keyless access and start**

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- **Retained Accessory Power OFF - open and close the driver door after ignition OFF**
- **Scan tool not communicating with a vehicle control module - in some cases it may need to be disconnected from the DLC**
- **All access doors closed**
- **Head lamps OFF - auto head lamps disabled**
- **Any delay lighting OFF**
- **If equipped with an under hood lamp disable it**
- **HVAC after blow OFF**
- **Any accessory that can work with ignition OFF inactive or OFF**
- **Wait up to 2 min or longer, after all other listed conditions are met**

Using an Inductive Pickup Probe

1. Connect an inductive pickup probe to the negative battery cable that can read down to 1 mA.
2. Ignition OFF, as the vehicle systems shut down test for less than 30 mA of parasitic current drain.
   - If greater than the specified range, refer to Circuit/System Testing.

Using the EL 38758 Parasitic Draw Test Switch

WARNING: **Refer to Battery Disconnect Warning .**

CAUTION: **When a fused jumper wire or digital multimeter is connected to the test switch terminals, always turn the test switch ON before opening any access door, turning the ignition on, or turning any accessory on. This is to prevent damaging the jumper wire or digital multimeter fuse.**

NOTE: **The switch knob on the EL 38758 switch is marked ON and OFF. 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. Ignition OFF, disconnect the battery negative cable from the battery. Refer to Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery).
2. Turn the **EL 38758** switch knob to the OFF position.
3. Install the male end of the **EL 38758** switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the **EL 38758** switch.
5. Turn the **EL 38758** switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.
   - Failed: If the jumper wire fuse is blown, refer to Circuit/System Testing.
   - Passed
10. Turn the **EL 38758** switch knob to the ON position. Remove the fused jumper wire.
11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
12. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the DMM.
13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
    - If greater than the specified range, refer to Circuit/System Testing.

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Circuit/System Testing

NOTE:

- **Removing or installing a fuse, relay, or connector, to determine the area causing high parasitic draw may wake up control modules. You must wait for the control modules to go back to sleep before retesting. It is best to install any removed or disconnected components after the diagnosis is completed.**
- **Fuses for power mode master components such as the BCM should be removed last to avoid misdiagnosis.**
- **If a scan tool is connected to the DLC, either disconnect it or subtract the scan tool current draw from the DMM reading to get the actual vehicle parasitic current draw.**

If the vehicle has an unacceptable amount of parasitic current draw, remove each fuse one at a time until the current draw falls to an acceptable level. A drop of more than 10-20 mA, when disabling a single system or circuit, is an indication of an overly high current draw that could be causing the battery drain. Refer to **Power Distribution Schematics** to diagnose exactly which circuit of the suspect system is causing the high parasitic drain. The following is a list of common components that could cause a high current draw:

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Control Module References for control module replacement, programming and setup

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.

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0621	-	-
Control - L Terminal	P0621	P0621	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator turn ON control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit ON and OFF. The ECM monitors the state of the generator turn ON control circuit. The ECM should detect low voltage on the generator turn on control 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 when the duty cycle voltage is commanded high and a low voltage when the duty cycle voltage is commanded low on the generator turn on control circuit.

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 PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is off, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Reference Information

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Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

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

Circuit/System Verification

NOTE: **Do not have a battery charger connected during the generator testing.**

1. Ignition ON.
2. Verify that no G13 Generator or B18 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** .
   - **If no DTCs are set**
3. Verify the scan tool Body Control Module Battery Voltage parameter is 12 V or greater.
   - **If less than 12 V**

     Refer to **Battery Inspection/Test**.
   - **If 12 V or greater**
4. Engine running, all accessories OFF.
5. Verify the scan tool Body Control Module Battery Voltage parameter continually increases when controlling the Body Control Module Generator Regulator Setpoint from 10% to 80% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each setpoint change.
   - **If the battery voltage does not continually increase**

     Refer to Circuit/System Testing.
   - **If the battery voltage continually increases**
6. All OK.

Circuit/System Testing

NOTE: **You must perform the Circuit/System Verification before proceeding with Circuit/System Testing.**

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2, 2 X2 or A X2 and ground.

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- **If the test lamp does not illuminate and the circuit fuse is good**

1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
2. Test for less than 2 Ω in the B+ circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, test or replace the G13 Generator.

- **If the test lamp illuminates**

2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
    - **If 5% or greater**

    1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
    2. Test for less than 1 V between the G13 Generator signal circuit terminal 2 X1 and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V, replace the K20 Engine Control Module.

    - **If less than 5%**

4. Install a 3 A fused jumper wire between the signal circuit terminal 2 X1 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.
    - **If 95% or less**

    1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the signal circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance
    3. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit
        - If less than 2 Ω, replace the K20 Engine Control Module.

    - **If greater than 95%**

6. Test or replace the G13 Generator.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

Generator Replacement (L96)Generator Replacement (L83, L86)

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.

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- **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.
3. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines, or other accessory equipment that may be incorrectly routed or be the cause of noise being transmitted into the passenger compartment.
4. Ignition OFF, remove the engine drive belt.
5. Verify the generator, A/C compressor, water pump pulley, power steering pump, idler pulley, and tensioner pulley spin freely.
   - **If any of the pulleys do not spin freely**

     Replace the affected component.

   - **If all belt driven components spin freely**
6. Start the engine. Operate the engine for no longer than 30-40 seconds.
7. Verify that the noise is no longer present.
   - **If the noise is still present**

     The generator is not the cause of the noise. Refer to **Symptoms - Engine Mechanical** for 5.3L or 6.2L engine.

   - **If noise is no longer present**
8. Inspect for worn accessory drive components or abnormalities such as severe cracking, bumps, or missing areas in the accessory drive belt and/or misalignment of system components

Repair Instructions

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

- **Drive Belt Replacement - Accessory** for the 5.3L or 6.2L engines
- **Air Conditioning Compressor Belt Replacement** for the 5.3L or 6.2L engines
- **Generator Replacement (L96)Generator Replacement (L83, L86)**

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	-	-
Park Neutral Signal (Automatic)	P0850/P0851, 2	P0850/P0852	P0850/P0852	-

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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Starter Relay Coil Control	P0616	P0615	P0617	-
Starter Solenoid Control	1	1	3	-
Ground	-	1	-	-
1. No crank 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

The engine control module (ECM) controls engine cranking based on a power mode input and the status of the B15 Transmission Internal Mode Switch or clutch pedal position sensor. The park/neutral position switch is integrated into the transmission internal mode switch. The park/neutral signal is sent from the park/neutral switch directly to the engine control module and is used only for engine start enable. This indicates to the ECM that conditions are acceptable for cranking. When a power mode crank request is seen, the ECM applies voltage to the starter relay control circuit. This energizes the coil side of the relay, which pulls the switch side of the relay closed, applying voltage to the starter terminal A X1 and engaging the starter solenoid.

Diagnostic Aids

- Inspect the fuse for an open.
- Verify if P0850, P0851, P0852 are set. Refer to **DTC P0850-P0852**
- Verify if P0615, P0616, P0617 are set. Refer to **DTC P0615, P0616, or P0617**

Reference Information

Schematic Reference

- **Starting and Charging Schematics**

Connector End View Reference

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- **Circuit Testing**
- **Wiring Repairs**
- **Connector Repairs**

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify the range selector cable is adjusted correctly. Refer to **Range Selector Lever Cable Adjustment** .
   - **If the cable adjustment is not OK**

     Adjust, repair or replace as necessary.

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- **If the cable adjustment is OK**

2. Ignition ON.
3. Verify that no ignition, KR27 Starter Relay, brake pedal position sensor, immobilizer, engine, or transmission DTCs are set that would cause the ECM to disable engine starting.
   - **If DTCs are set**

     Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**

   - **If no DTCs are set**
4. Verify the scan tool BCM 5 V Ignition Switch (vehicles without push button start) or ECM Power Mode (vehicles with push button start) parameter is Crank Request while attempting to start the vehicle.
   - **If parameter does not display Crank Request**

     Refer to **Vehicle Will Not Change Power Mode**

   - **If parameter displays Crank Request**
5. Verify the scan tool Engine Control Module Park/Neutral Position Switch parameter displays Park/Neutral when in Park or Neutral and In-Gear when in Reverse or Drive Range.
   - **If Park/Neutral or In-Gear is not displayed**

     Refer to Circuit/System Testing.

   - **If Park/Neutral or In-Gear is displayed**
6. Verify the crank relay does click and the engine begins cranking.
   - **If the KR27 Starter Relay does not click or the engine does not begin cranking**

     Refer to Circuit/System Testing.

   - **If the KR27 Starter Relay does click and the engine does begin cranking**
7. All OK

Circuit/System Testing

NOTE: **You must perform Circuit/System Verification first.**

Starter Relay Malfunction

1. Ignition ON.
2. Verify the scan tool ECM Ignition 1 Signal parameter is greater than 10 V.
   - **If 10 V or less**
   1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module.
   2. Test for infinite resistance between the ignition voltage circuits and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
      - If infinite resistance
   3. Test for less than 2 Ω in the control circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, refer to **Power Mode Mismatch (With BTM)** **Power Mode Mismatch (Without BTM)**
   - **If greater than 10 V**
3. Ignition OFF, disconnect the KR27 Starter Relay, ignition ON.
4. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.

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- **If the test lamp does not illuminate and the circuit fuse is good**

1. Ignition OFF.
2. Test for less than 2 Ω in the B+ circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.

- **If the test lamp does not illuminate and the circuit fuse is open**

1. Ignition OFF.
2. Test for infinite resistance between the B+ circuit and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance,
3. Disconnect X1 harness connector at the M64 Starter Motor.
4. Test for infinite resistance between the control circuit terminal 87 and ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance, replace the M64 Starter Motor.

- **If the test lamp illuminates**

5. Ensure the parking brake is applied and the T12 Transmission is in PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
6. Verify the M64 Starter Motor is activated.
    - **If the M64 Starter Motor does not activate**

    1. Disconnect the X1 harness connector at the M64 Starter Motor.
    2. Test for less than 2 Ω in the control circuit end to end.
        - If greater the 2 Ω, repair the open/high resistance in the circuit.
        - If less than 2 Ω, replace the M64 Starter Motor.

    - **If the M64 Starter Motor activates**

7. Test or replace the KR27 Starter Relay.

Park/Neutral Position Switch Malfunction

1. Ignition OFF, disconnect the X1 harness connector at the Q8 Control Solenoid Valve Assembly on the automatic transmission.
2. Install the **DT-47825-10** jumper harness to the X1 vehicle harness connector.
3. Test for less than 5 Ω between the ground circuit terminal 5 at the **DT-47825-10** jumper harness and ground at the transmission case.
    - **If 5 Ω or greater**

    1. Ignition OFF.
    2. Test for less than 2 Ω in the ground circuit from wire end to wire end.

    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω, repair the open/high resistance in the ground connection.
    - **If less than 5 Ω**

4. Ignition ON.
5. Test for 11-13 V between the signal circuit terminal 3 at the **DT-47825-10** jumper harness and ground at the transmission case.
    - **If not between 11-13 V**

    1. Ignition OFF, disconnect the X1harness connector at the K20 Engine Control Module.
    2. Test for infinite resistance between the Park/Neutral signal circuit terminal 3 at the **DT-47825-10** jumper harness and ground at the transmission case.
        - If less than infinite resistance, repair the short to ground in the signal circuit.

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- If infinite resistance.

3. Test for less than 2 Ω in the Park/Neutral signal circuit wire end to wire end.
- If 2 Ω or greater, repair the open/high resistance in the signal circuit.
- If less than 2 Ω, replace the K20 Engine Control Module.
- **If between 11-13 V**

6. Ignition OFF, disconnect the **DT-47825-10** jumper harness from the X1 vehicle harness connector.
7. Connect the **DT-47825-10** jumper harness to the Q8 Control Solenoid Valve Assembly harness connector at the transmission case.
8. Remove the transmission fluid pan.
9. Disconnect the B15 Transmission Internal Mode Switch electrical connector from the Q8 Control Solenoid Valve Assembly.
10. Test for less than 2 Ω between the ground circuit terminal 5 and terminal A at the B15 Transmission Internal Mode Switch connector on the Q8 Control Solenoid Valve Assembly.
    - **If 2 Ω or greater**

      Replace the Q8 control solenoid valve assembly.

    - **If less than 2 Ω**
11. Ignition OFF.
12. Connect the **DT-47825-10** jumper harness to the X1 vehicle harness connector.
13. Ignition ON.
14. Test for 11-13 V between terminal F at the B15 Transmission Internal Mode Switch connector on the Q8 Control Solenoid Valve Assembly and ground at the transmission case.
    - **If not between 11-13 V**

      Replace the Q8 control solenoid valve assembly.

    - **If between 11-13 V**
15. Connect a 3 A fused jumper wire between terminal F at the B15 Transmission Internal Mode Switch on the Q8 Control Solenoid Valve Assembly and ground at the transmission case.
16. Verify the scan tool Engine Control Module Park/Neutral Position Switch parameter displays Park/Neutral.
    - **If Park/Neutral is not displayed**

      Replace the K20 Engine Control Module.

    - **If Park/Neutral is displayed**
17. Replace the B15 Transmission Internal Mode Switch.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60-180 Ω between terminals 85 and 86.
    - **If less than 60 or greater than 180 Ω**

      Replace the relay.

    - **If between 60-180 Ω**
3. Test for infinite resistance between the terminals listed below:
    - 30 and 86
    - 30 and 87

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- 30 and 85
- 85 and 87
- **If less than infinite resistance**

  Replace the relay.

- **If infinite resistance**

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.
5. Test for less than 2 Ω between terminals 30 and 87.
   - **If 2 Ω or greater**

     Replace the relay.

   - **If less than 2 Ω**
6. All OK

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair

- **Relay Replacement (Attached to Wire Harness)** **Relay Replacement (Within an Electrical Center)**

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.

Reference Information

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

Scan Tool Reference

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Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF, measure and record the battery voltage at the C1 Battery terminals.
2. Verify the measured voltage is between 12-15 V.
   - **If voltage is less than 12 V or greater than 15 V**

     Refer to **Battery Inspection/Test**.

   - **If voltage is between 12-15 V**
3. Remove the drive belts. Refer to **Drive Belt Replacement - Accessory** for the 5.3 and 6.2 engine.
4. Verify the crankshaft rotates. Rotate the crankshaft by hand using the appropriate tools.
   - **If the crankshaft does not rotate**

     Refer to **Engine Will Not Crank - Crankshaft Will Not Rotate** for the 5.3 and 6.2 engine.

   - **If the crankshaft rotates**
5. Verify the engine does not crank when attempting to start the vehicle.
   - **If the engine cranks**

     Inspect the engine and belt drive system for mechanical binding, seized engine, or seized generator.

   - **If the engine does not crank**
6. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal 1 X2 or A X2 and ground.
   - **If the test lamp does not illuminate and the circuit fuse is good**
   1. Ignition OFF.
   2. Test for less than 2 Ω in the B+ circuit end to end.
      - If 2 Ω or greater, repair the open/high resistance in the circuit.
      - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF.
   2. Test for greater than 100 Ω between the B+ circuit and ground.
      - If 100 Ω or less, repair the short to ground on the circuit.
      - If greater than 100 Ω, replace the M64 Starter Motor.
   - **If the test lamp illuminates**
7. Test for less than 0.5 V between the positive battery post and terminal 1 X2 or A X2 at the M64 Starter Motor with the ignition in the START position.
   - **If 0.5 V or greater**

     Replace the positive battery cable.

   - **If less than 0.5 V**
8. Test for less than 0.5 V between the negative battery post and the M64 Starter Motor case with the ignition in the START position.
   - **If 0.5 V or greater**

     Replace the negative battery cable.

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- **less than 0.5 V**

9. Replace the M64 Starter Motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Positive Cable Replacement (Single Battery)**
- **Battery Negative Cable Replacement**
- **Starter Replacement (L83, L86)Starter Replacement (L96)**

ENGINE CRANKS SLOWLY

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

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- **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. Ignition OFF, measure and record the C1 Battery voltage at the terminals.
2. Verify the measured voltage is between 12.0-15.0 V.
   - **If voltage is less than 12.0 V or greater than 15.0 V**

     Refer to **Battery Inspection/Test**.

   - **If voltage is between 12.0-15.0 V**

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3. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal 1 X2 or A X2 and ground.
    - **If the test lamp does not illuminate**
    1. Ignition OFF.
    2. Test for less than 2 Ω in the B+ circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 Ω, verify the fuse is not open and there is voltage at the fuse.
    - **If the test lamp illuminates**
4. Test for less than 0.5 V between the positive battery cable and terminal 1 X2 or A X2 at the M64 Starter Motor with the ignition in the START position.
    - **If 0.5 V or greater**

      Replace the positive battery cable.

    - **If less than 0.5 V**
5. Test for less than 0.5 V between the negative battery cable and the M64 Starter Motor case with the ignition in the START position.
    - **If 0.5 V or greater**

      Replace the negative battery cable.

    - **If less than 0.5 V**
6. Remove the drive belts. Refer to **Drive Belt Replacement - Accessory** .
7. Verify the engine cranks slowly when attempting to start the vehicle.
    - **If the engine cranks at normal speed**

      Inspect the engine and belt drive system for mechanical binding, seized generator etc.

    - **If the engine cranks slowly**
8. Replace the M64 Starter Motor.

Repair Instructions

Perform the **Diagnostic Repair Verification** after completing the repair.

- **Battery Negative Cable Replacement**
- **Battery Positive Cable Replacement (Single Battery)**
- **Starter Replacement (L83, L86)Starter Replacement (L96)**

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 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

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and it cranks the engine.

Reference Information

Description and Operation

Starting System Description and Operation

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 flywheel inspection cover.
2. 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, remove the debris, tighten the flywheel bolts, or repair or replace the flywheel.
3. If all inspections were within specification, replace the starter motor.

Repair Instructions

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

- Replace the starter, refer to the affected component's procedure for service.
- Replace the engine flywheel, refer to the affected component's procedure for service.

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION (DUAL BATTERY)

Disconnect Procedure

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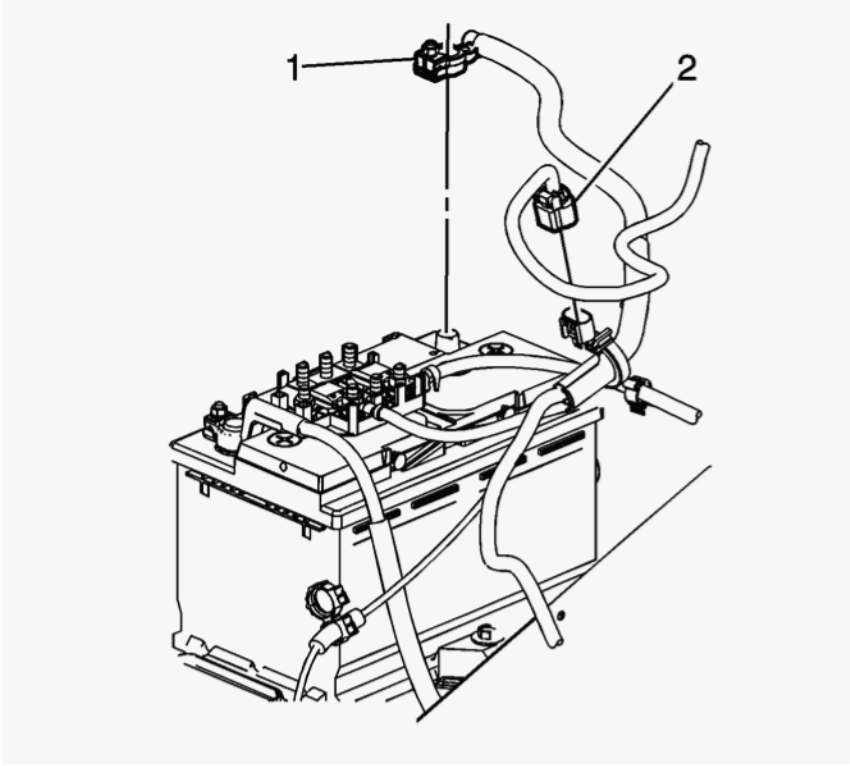


Fig. 5: Negative Battery Cable Nut
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Battery Disconnect Warning .**

1. Turn off all the lamps and accessories.
2. Turn the ignition OFF.
3. Loosen the primary negative battery cable clamp nut (1).
4. Reposition the primary negative battery cable.

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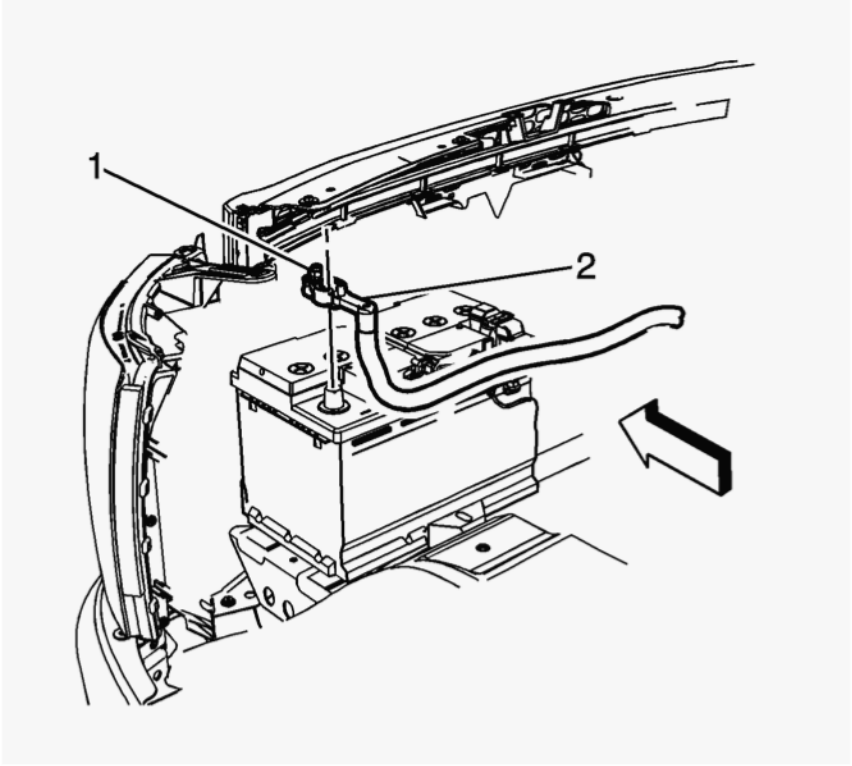


Fig. 6: Identifying Auxiliary Battery Negative Cable And Auxiliary Negative Battery Cable Clamp Nut
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the auxiliary negative battery cable clamp nut (1).
6. Reposition the auxiliary battery negative cable (2) away from the battery.

Connect Procedure

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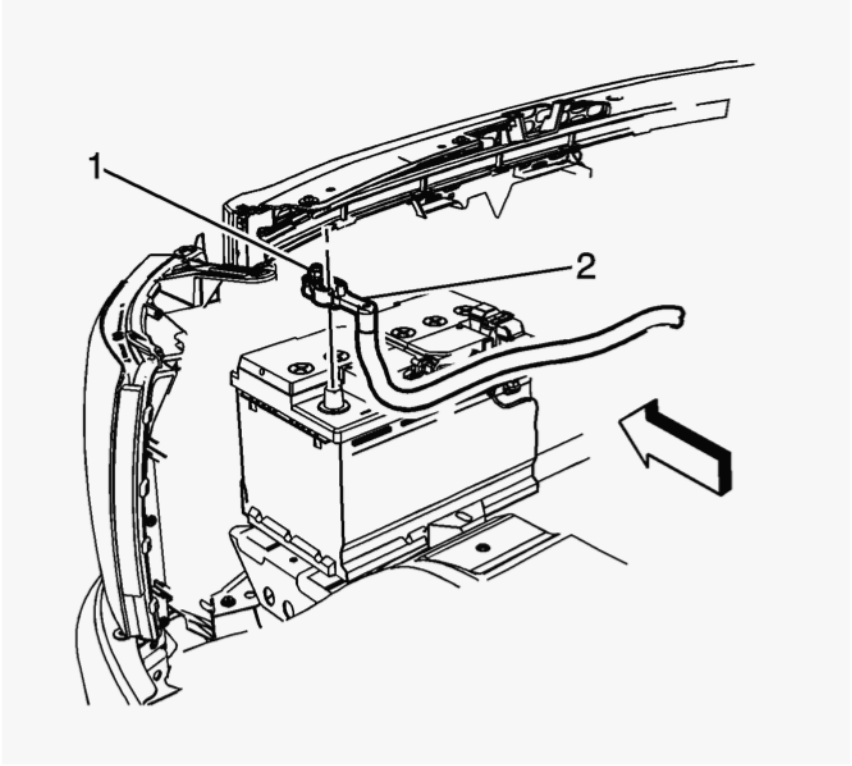


Fig. 7: Identifying Auxiliary Battery Negative Cable And Auxiliary Negative Battery Cable Clamp Nut
Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to Battery Disconnect Warning .

NOTE: Clean any existing corrosion from the battery terminal and the battery cable end.

1. Install the auxiliary negative battery cable (2) onto the auxiliary battery negative post.

CAUTION: Refer to Fastener Caution .

2. Tighten the negative battery cable nut (1) to 7 N.m (66 lb in).

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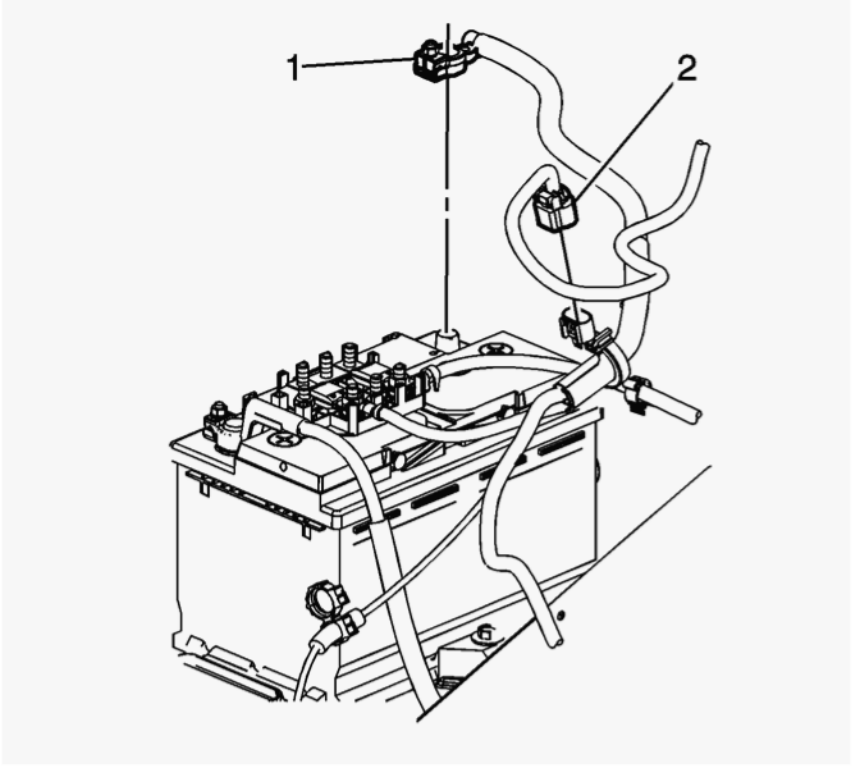


Fig. 8: Negative Battery Cable Nut
Courtesy of GENERAL MOTORS COMPANY

3. Install the primary negative battery clamp onto the battery negative post.
4. Tighten the primary negative battery cable clamp nut (1) to 7 N.m (66 lb in).

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION (SINGLE BATTERY)

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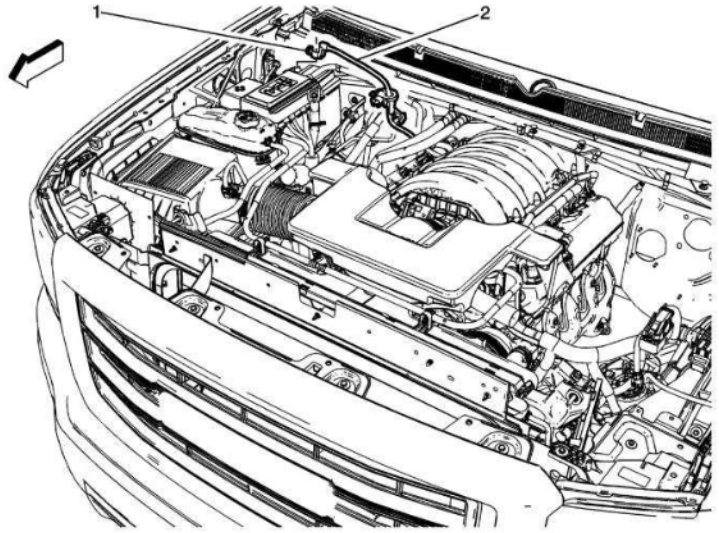


Fig. 9: Battery Negative Cable
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Battery Negative Cable Clamp Fastener **WARNING:** **Refer to** **Battery Disconnect Warning .** **Tighten** 7 N.m (62 lb in)
2	Battery Negative Cable

BATTERY CURRENT SENSOR REPLACEMENT (L83, L86)

Removal Procedure

1. Remove the battery negative cable. Refer to **Battery Negative Cable Replacement**.

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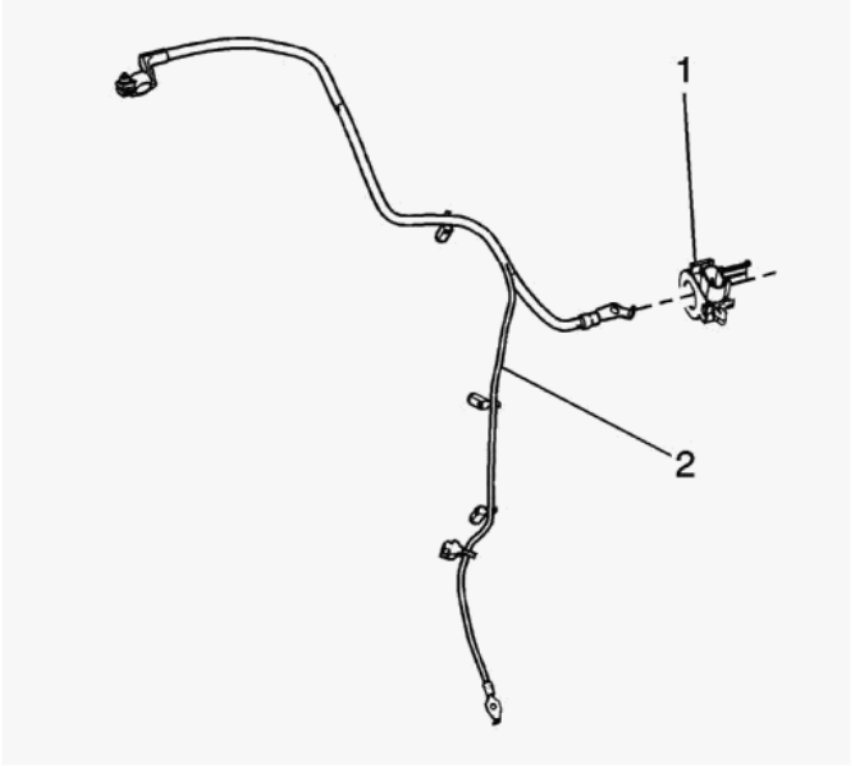


Fig. 10: Battery Current Sensor And Battery Negative Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: **Note the orientation of the battery current sensor when removing.**

2. Remove the battery current sensor (1) from the battery negative cable (2).

Installation Procedure

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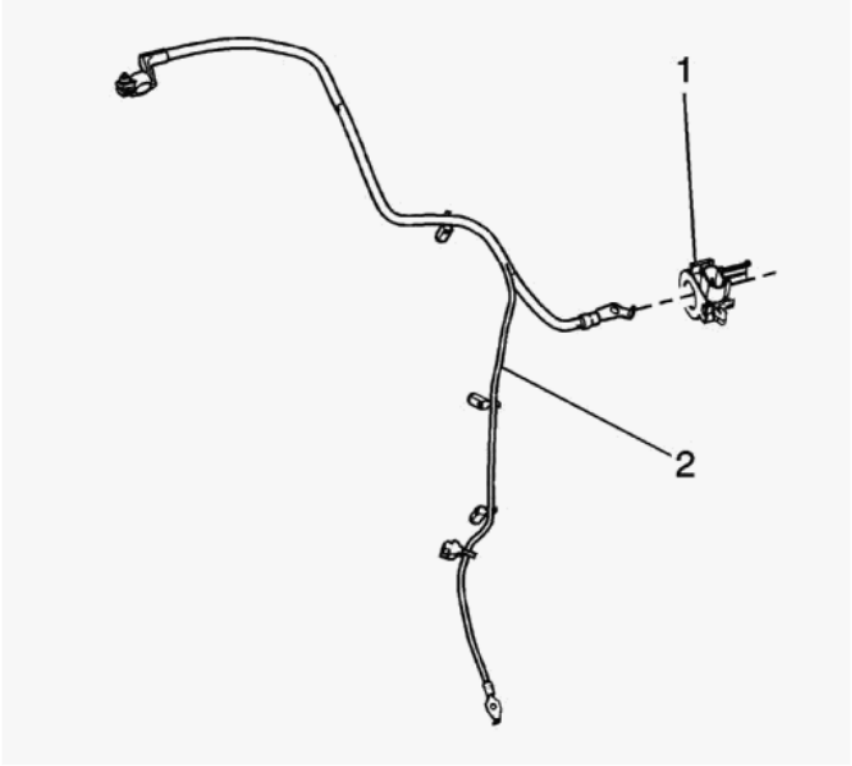


Fig. 11: Battery Current Sensor And Battery Negative Cable
Courtesy of GENERAL MOTORS COMPANY

1. Slide the NEW battery current sensor (1) onto the battery negative cable (2).
2. Install the battery negative cable. Refer to **Battery Negative Cable Replacement**.
3. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

BATTERY NEGATIVE CABLE REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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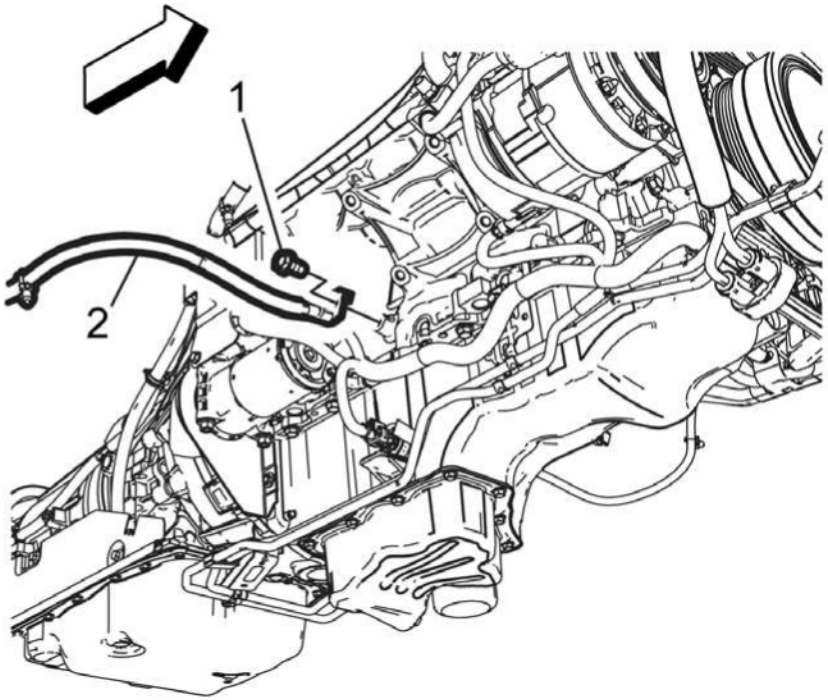


Fig. 12: Battery Negative Cable Engine Block Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the battery negative cable engine block fastener (1) and remove the battery negative cable (2) from the engine.
4. Detach the battery negative cable from the frame.
5. Lower the vehicle.

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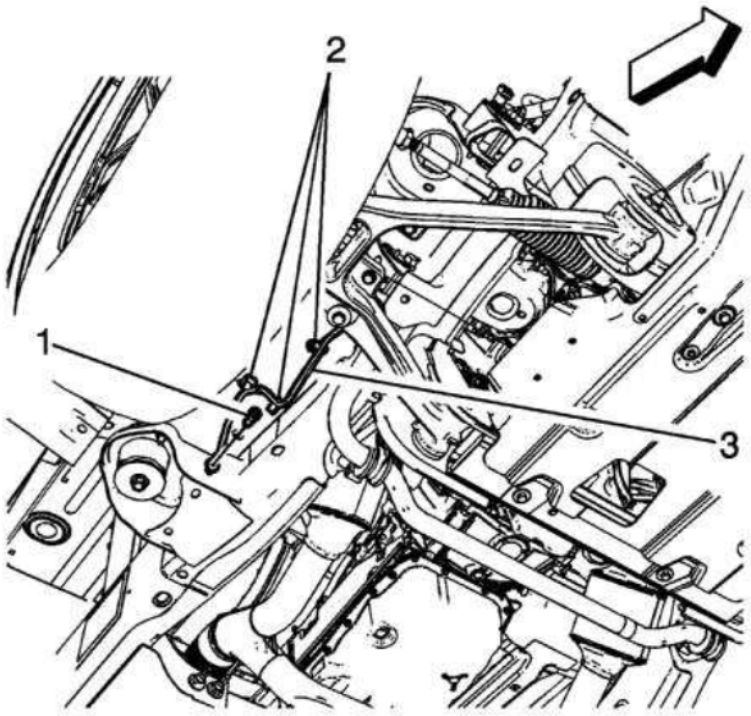


Fig. 13: Battery Negative Cable Ground Fastener And Detach Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Remove the battery negative cable ground fastener (1) and detach the retainers (2) securing the negative battery cable (3) to the lower plenum panel and wheelhouse liner.

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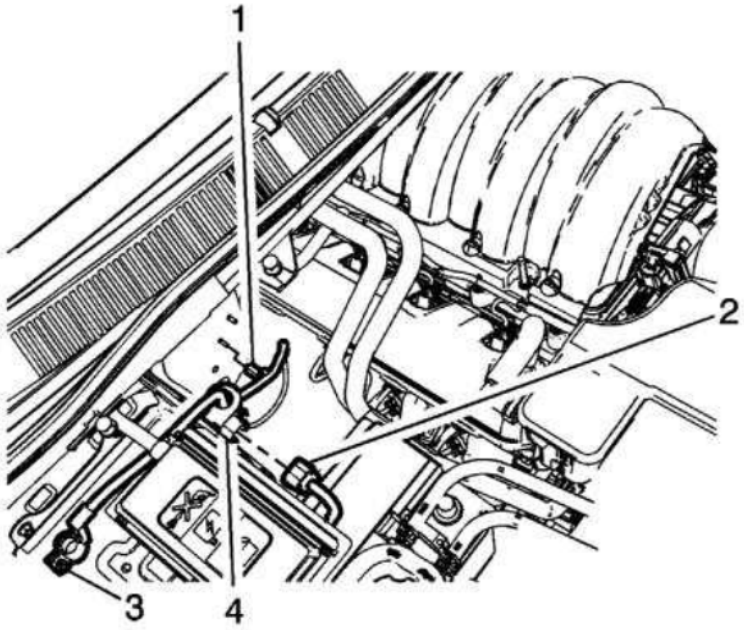


Fig. 14: Battery Negative Cable Retainer And Battery Current Sensor
Courtesy of GENERAL MOTORS COMPANY

7. Remove the battery negative cable retainer (1) from the lower front plenum panel and disconnect the engine harness connector (2) from the battery current sensor (4).

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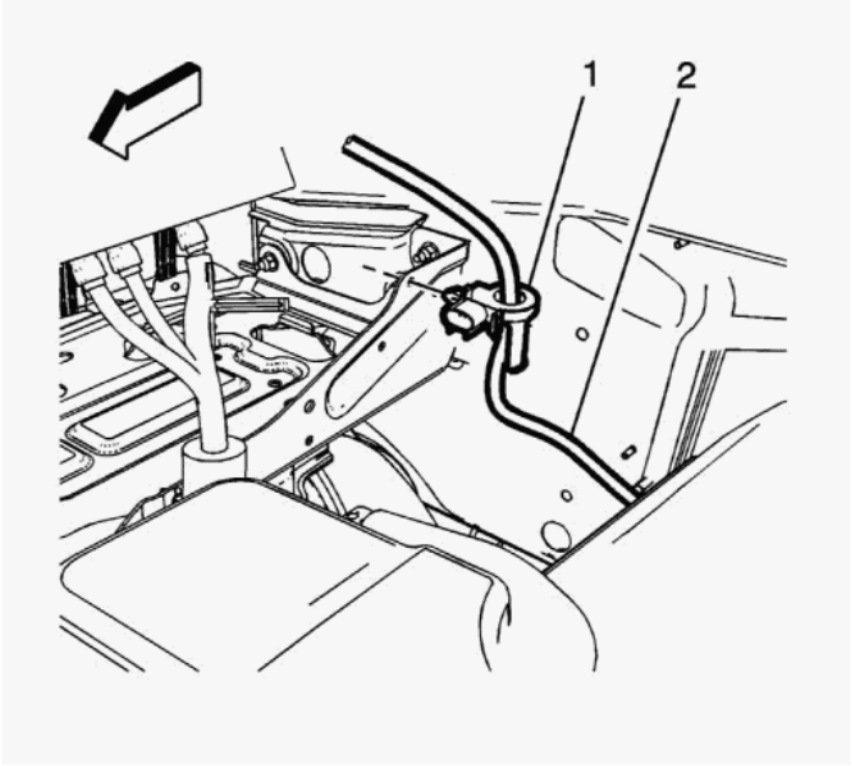


Fig. 15: Battery Current Sensor And Battery Tray
Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the battery current sensor (1) from the battery tray and remove the battery negative cable (2) from the engine compartment.
9. Transfer the battery current sensor, if necessary.

Installation Procedure

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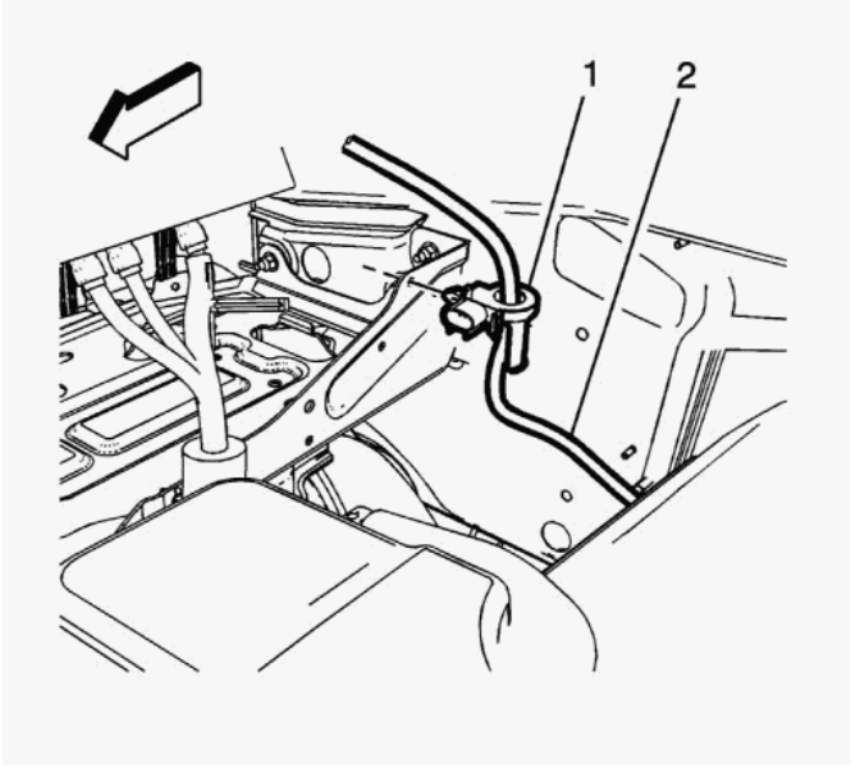


Fig. 16: Battery Current Sensor And Battery Tray
Courtesy of GENERAL MOTORS COMPANY

1. Position the battery negative cable (2) into the engine compartment and attach the battery current sensor (1) to the battery tray.

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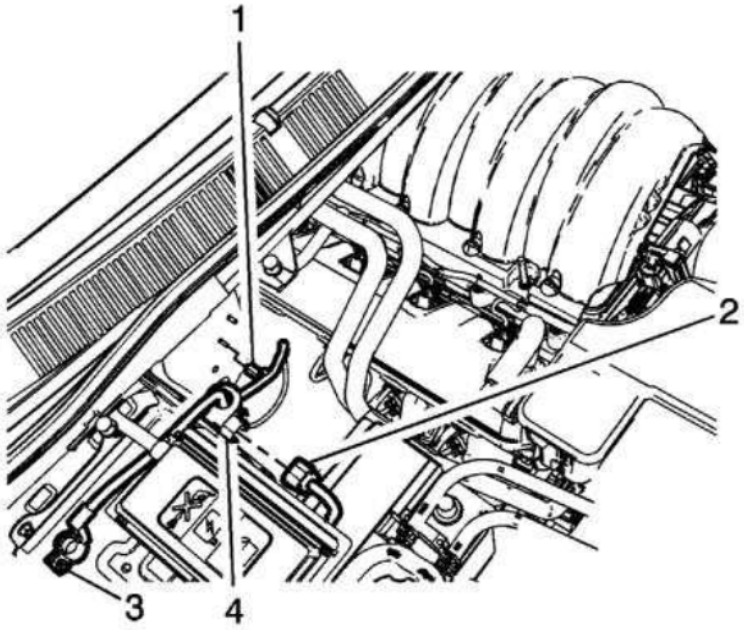


Fig. 17: Battery Negative Cable Retainer And Battery Current Sensor
Courtesy of GENERAL MOTORS COMPANY

2. Connect the engine harness connector (2) to the battery current sensor (4) and attach the battery negative cable retainer (1) to the front plenum panel.

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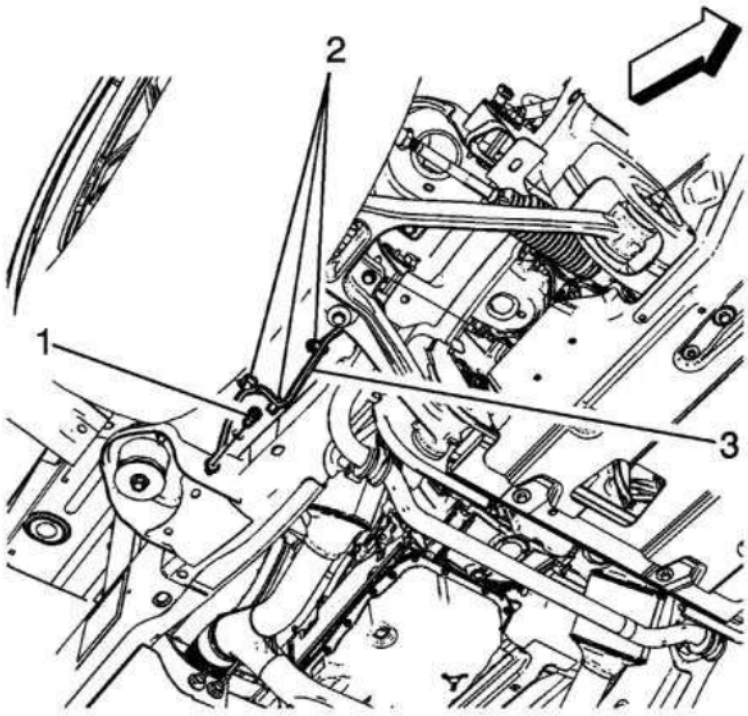


Fig. 18: Battery Negative Cable Ground Fastener And Detach Retainers
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

3. Install the battery negative cable (3) to the right side body mount bracket and tighten the fastener (1) to 9 N.m (80 lb in).
4. Attach the battery negative cable retainers (2) to the wheelhouse liner and front plenum panel.

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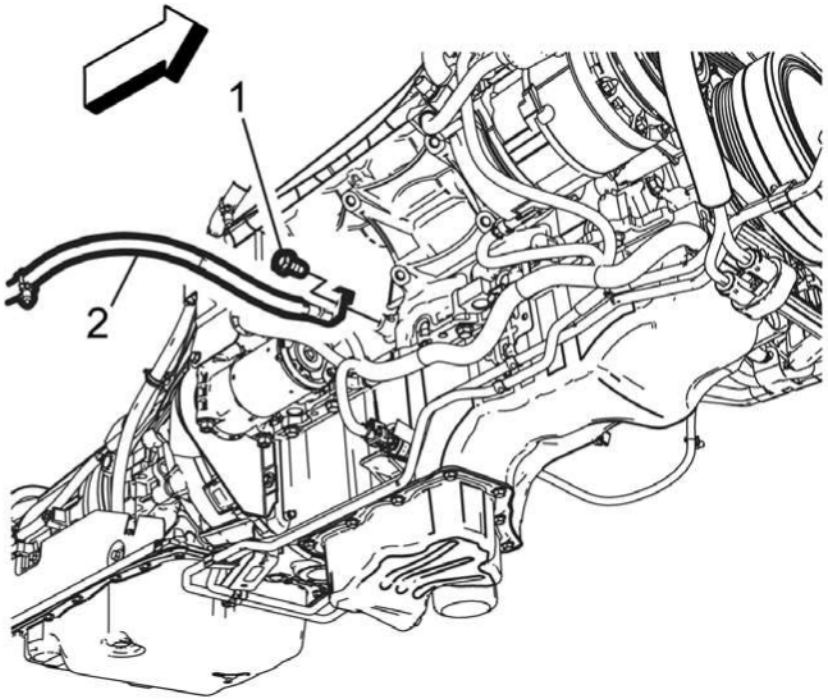


Fig. 19: Battery Negative Cable Engine Block Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Install the negative battery cable (2) to the engine block and tighten the fastener (1) to 22 N.m (16 lb ft).
6. Attach the harness retainer to the engine block.
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

AUXILIARY BATTERY NEGATIVE CABLE REPLACEMENT (9C1)

Removal Procedure

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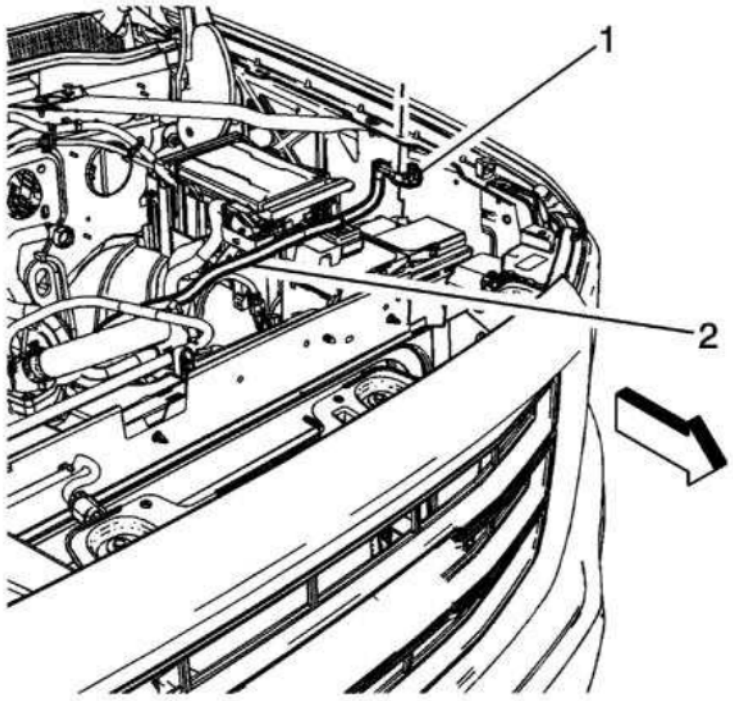


Fig. 20: Auxiliary Battery Negative Cable Clamp Fastener
Courtesy of GENERAL MOTORS COMPANY

WARNING: **Refer to Battery Disconnect Warning .**

1. Loosen the auxiliary battery negative cable clamp fastener (1) and remove the auxiliary battery negative cable (2), from the battery.

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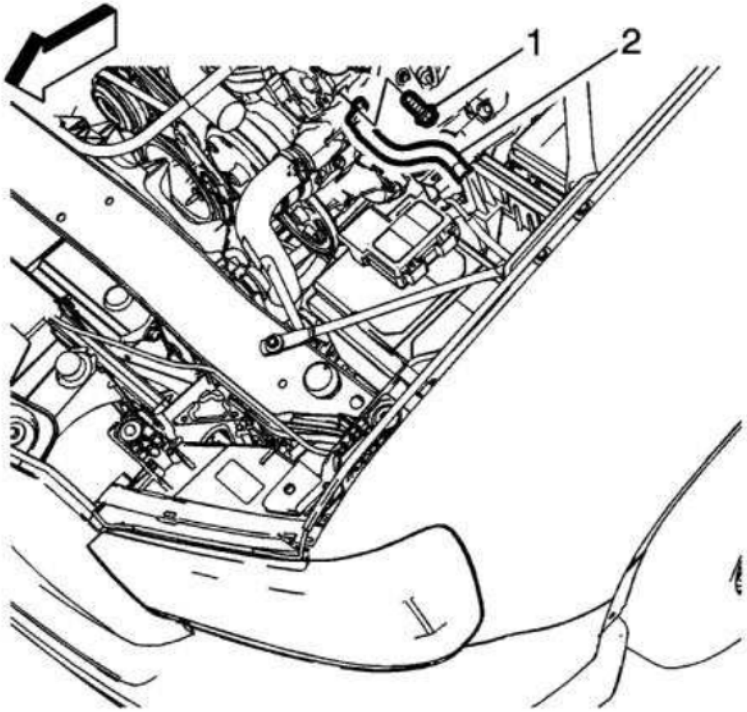


Fig. 21: Auxiliary Battery Negative Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Remove the auxiliary battery negative cable fastener (1) and remove the auxiliary battery negative cable (2), from the engine compartment.

Installation Procedure

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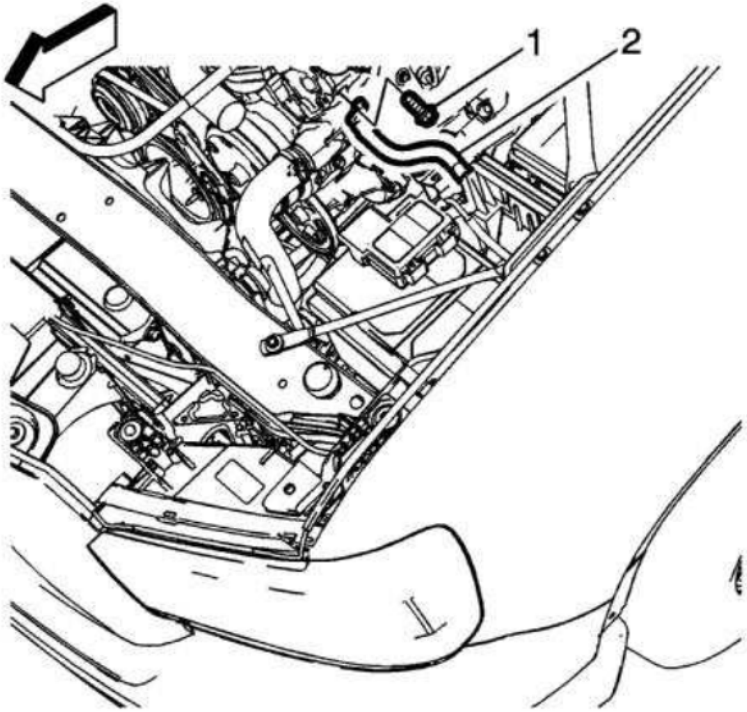


Fig. 22: Auxiliary Battery Negative Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the auxiliary negative battery cable (2) to the engine block and tighten the fastener (1) to 45 N.m (33 lb ft).

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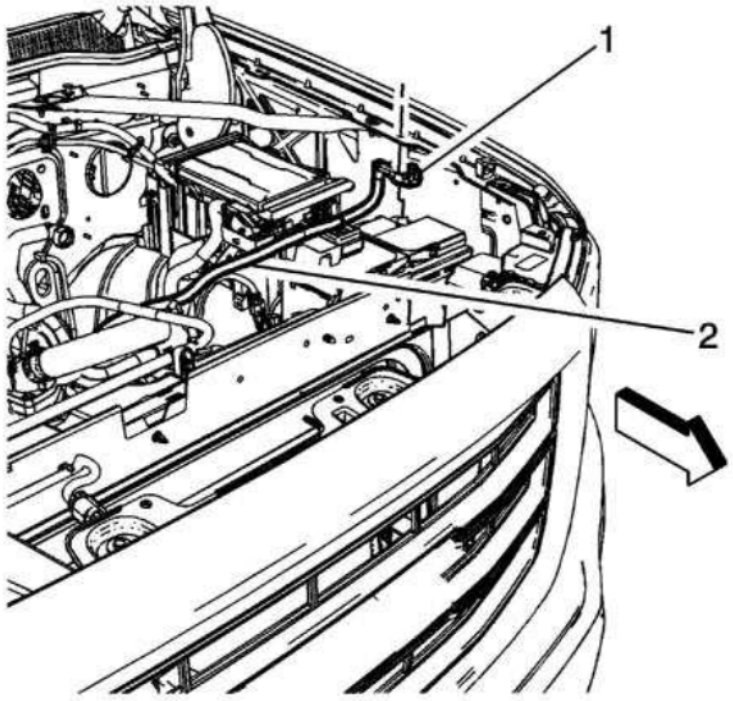


Fig. 23: Auxiliary Battery Negative Cable Clamp Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Install the auxiliary battery negative cable (2) to the battery and tighten the clamp fastener (1) to 7 N.m (62 lb in).

BATTERY POSITIVE CABLE REPLACEMENT (SINGLE BATTERY)

Removal Procedure

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

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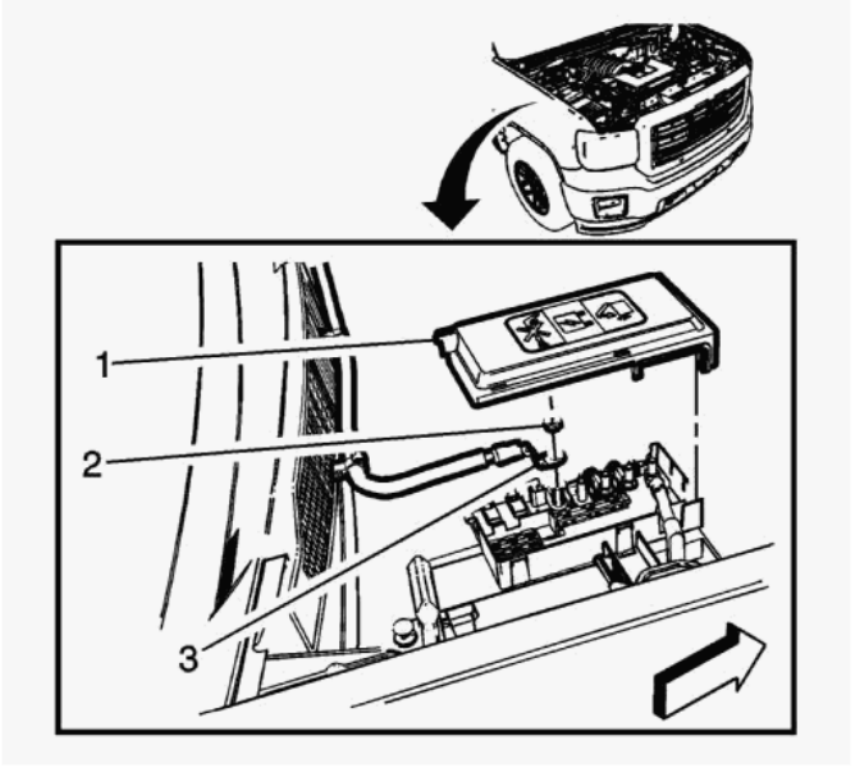


Fig. 24: Battery Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Remove the battery fuse block cover (1).
3. Remove the battery positive cable fastener (2) and remove the battery positive cable (3), from the battery fuse block stud.

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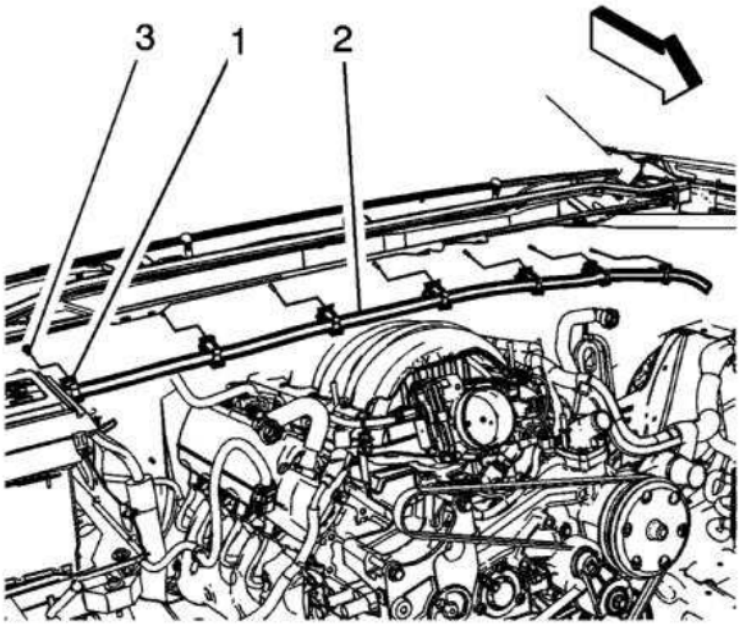


Fig. 25: Battery Positive Cable Retainers And Front Plenum Panel
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery positive cable retainers (1) from the front plenum panel (3).

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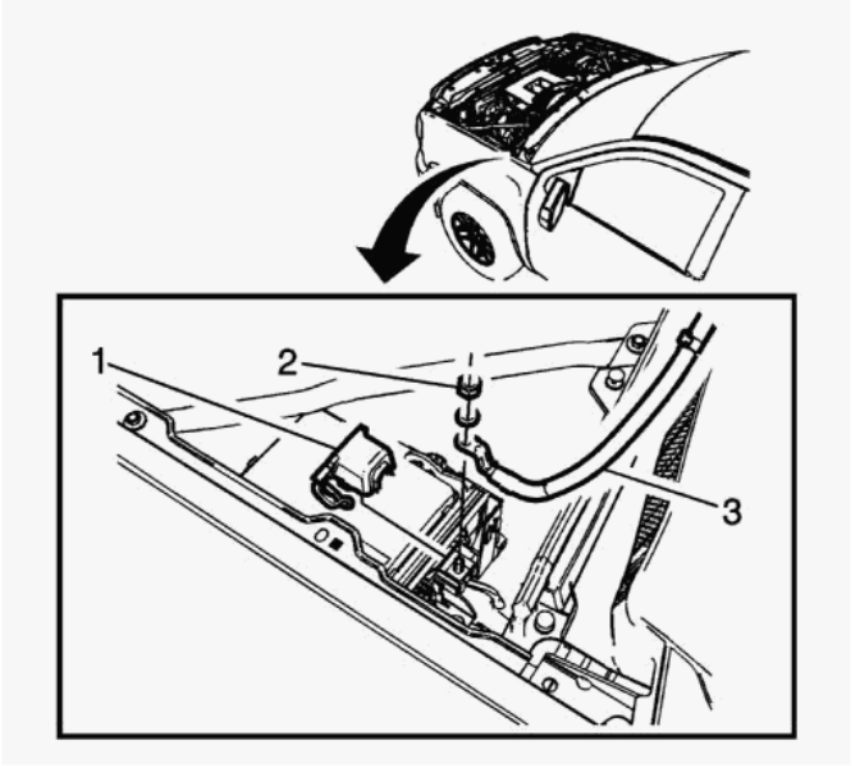


Fig. 26: Underhood Fuse Block Battery Positive Cable Cover
Courtesy of GENERAL MOTORS COMPANY

5. Remove the underhood fuse block battery positive cable cover (1).
6. Remove the battery positive cable fastener (2) and remove the battery positive cable (3) from the vehicle.

Installation Procedure

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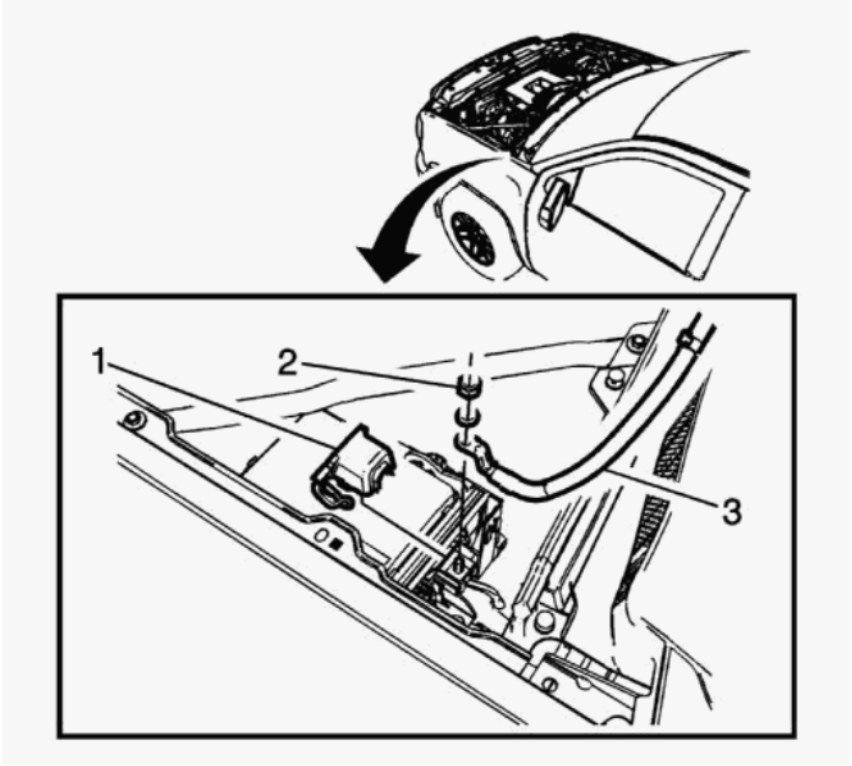


Fig. 27: Underhood Fuse Block Battery Positive Cable Cover
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the battery positive cable (3) to the underhood fuse block stud and tighten the fastener (2) to 15 N.m (133 lb in).
2. Install the underhood fuse block battery positive cable cover (1).

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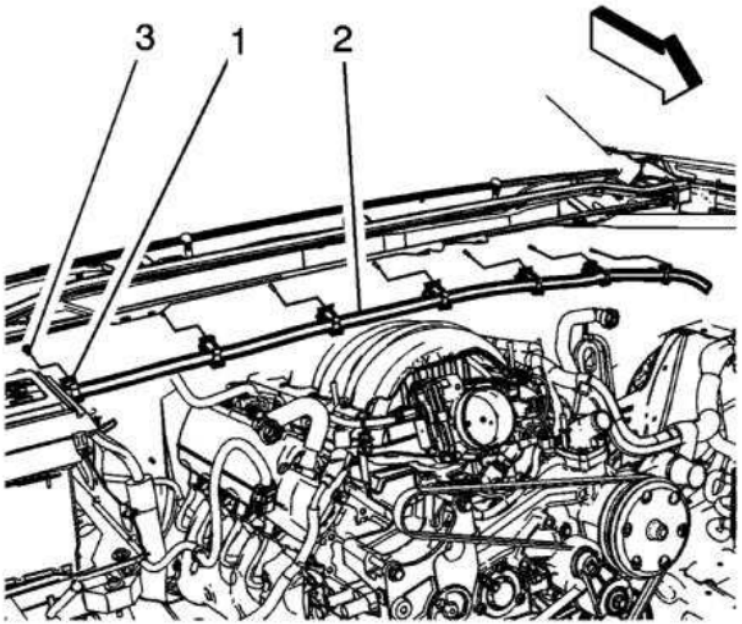


Fig. 28: Battery Positive Cable Retainers And Front Plenum Panel
Courtesy of GENERAL MOTORS COMPANY

3. Install the battery positive cable (2), along the plenum front panel (3), with the battery positive cable retainers (1).

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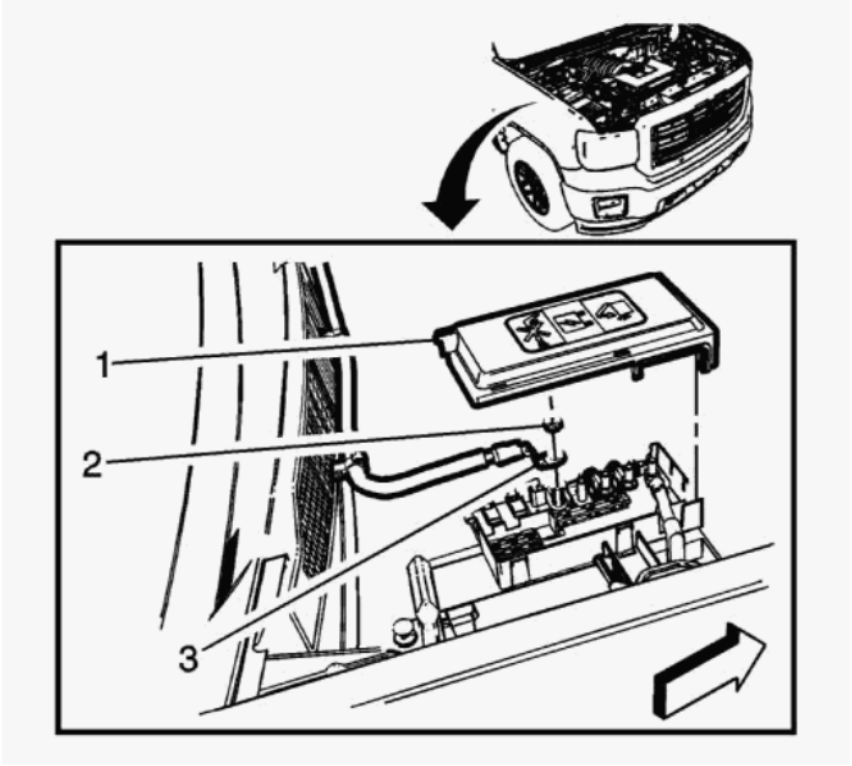


Fig. 29: Battery Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

4. Install the battery positive cable (3) to the battery fuse block stud and tighten the fastener (2) to 12 N.m (106 lb in).
5. Install the battery fuse block cover (1).
6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Single Battery)**.

AUXILIARY BATTERY POSITIVE CABLE REPLACEMENT (9C1)

Removal Procedure

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

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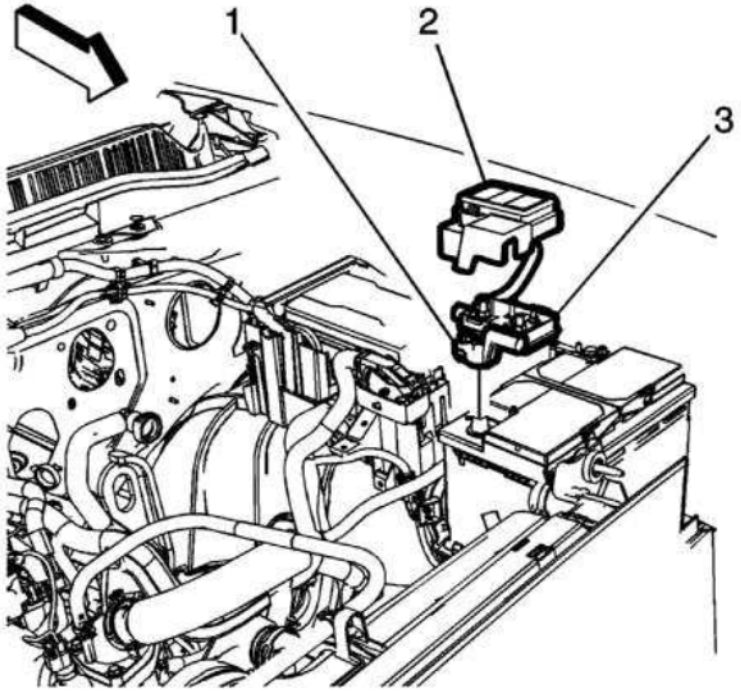


Fig. 30: Auxiliary Battery Positive Cable Cover
Courtesy of GENERAL MOTORS COMPANY

2. Remove the auxiliary battery positive cable cover (2) and loosen the auxiliary battery positive clamp fastener (1).
3. Remove the auxiliary battery positive cable (3) from the auxiliary battery positive post.

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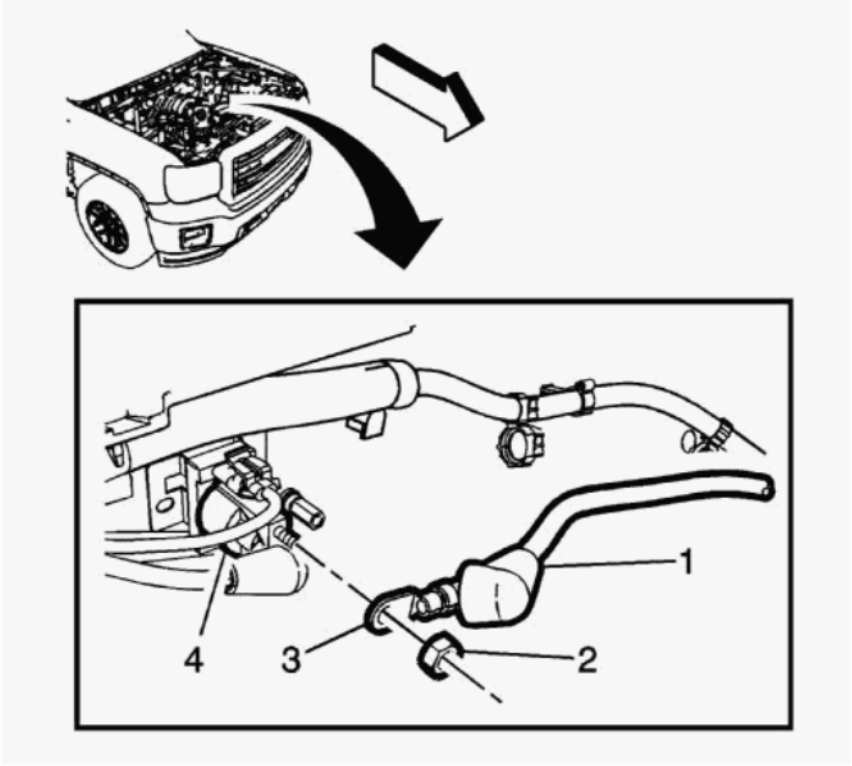


Fig. 31: Auxiliary Battery Positive Cable Protective Boot
Courtesy of GENERAL MOTORS COMPANY

4. Remove the auxiliary battery positive cable protective boot (1).
5. Remove the auxiliary battery positive cable fastener (2) and remove the auxiliary battery positive cable terminal (3) from the relay (4).

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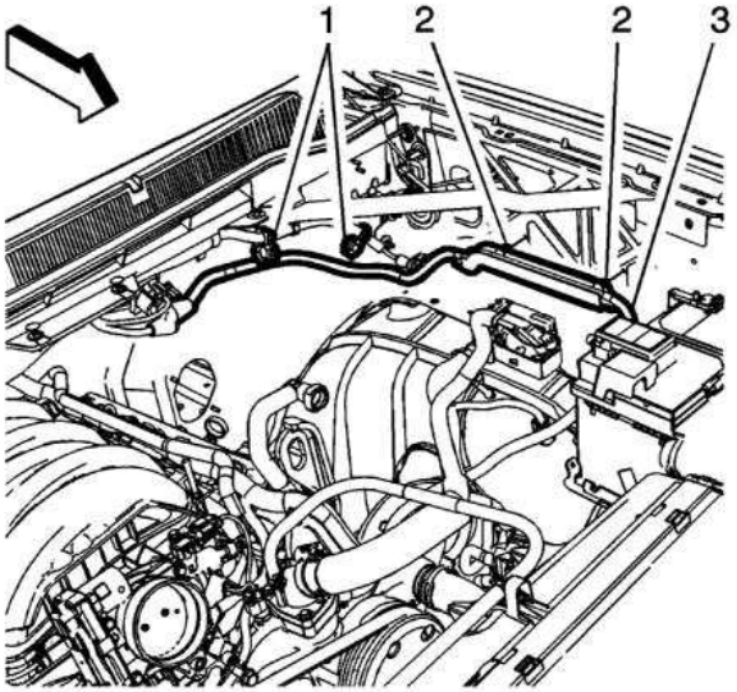


Fig. 32: Auxiliary Battery Positive Cable Conduit Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Detach the auxiliary battery positive cable conduit retainers (2) from the left front inner fender panel.
7. Detach the auxiliary battery positive cable retainer clips (1) and remove the auxiliary battery positive cable (3) from the engine compartment.

Installation Procedure

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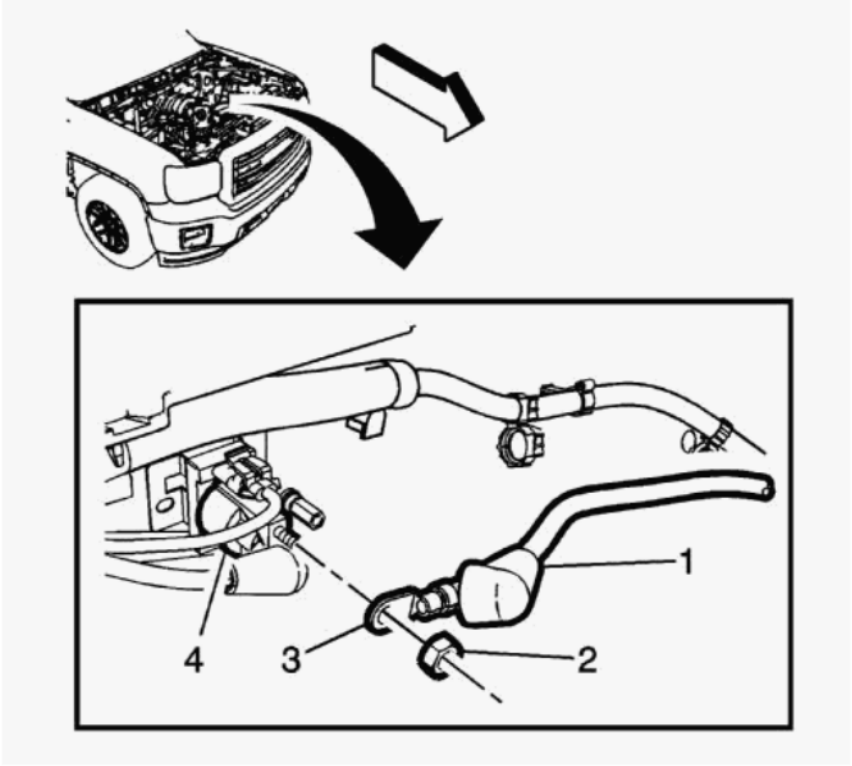


Fig. 33: Auxiliary Battery Positive Cable Protective Boot
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the auxiliary battery positive terminal (3) to the relay (4) and tighten the fastener (2) to 9 N.m (80 lb in).
2. Install the auxiliary battery positive cable protective boot (1).

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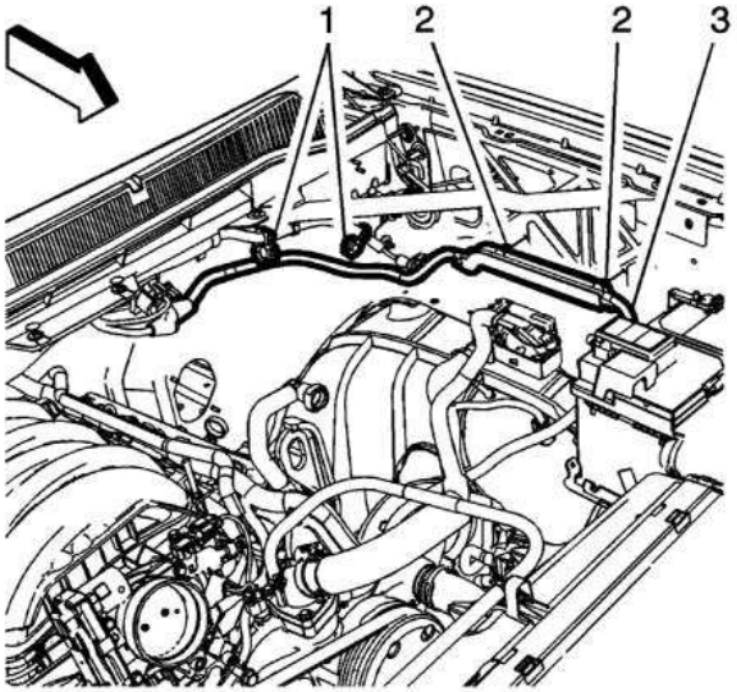


Fig. 34: Auxiliary Battery Positive Cable Conduit Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install the auxiliary battery positive cable clips (1) and the auxiliary battery positive cable conduit retainers (2).

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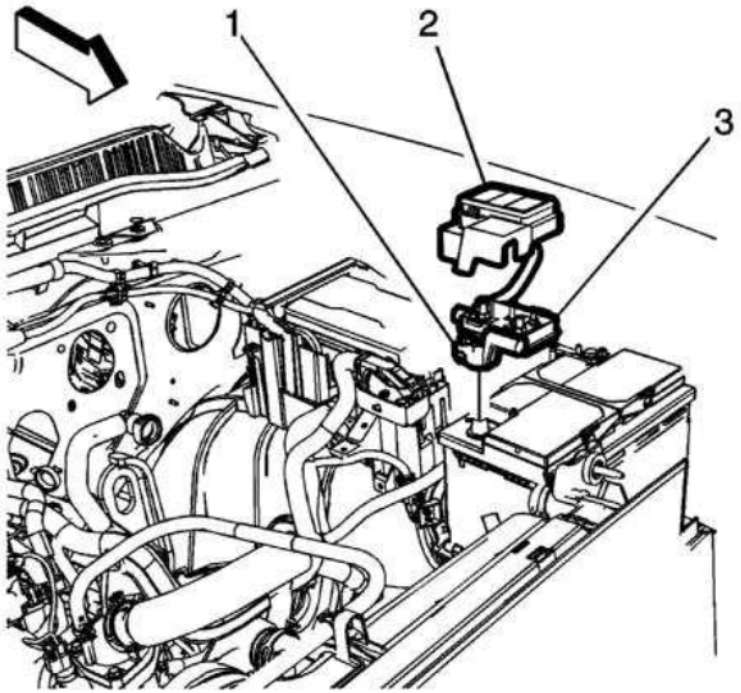


Fig. 35: Auxiliary Battery Positive Cable Cover
Courtesy of GENERAL MOTORS COMPANY

4. Install the auxiliary battery positive cable (3) to the battery positive post and tighten the clamp fastener (1) to 5 N.m (44 lb in).
5. Install the auxiliary battery positive cable protective cover (2).
6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

AUXILIARY BATTERY POSITIVE CABLE REPLACEMENT - BATTERY TO BATTERY RELAY (9C1)

Removal Procedure

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

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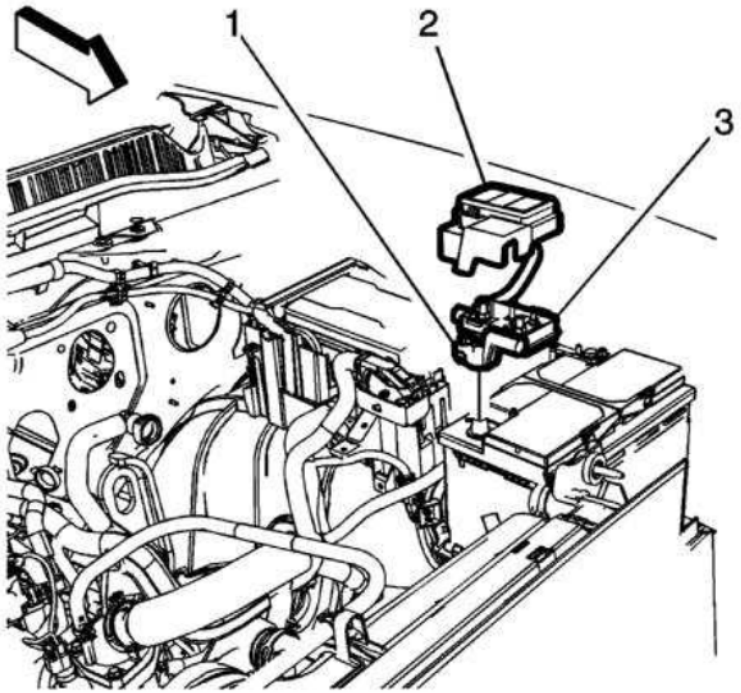


Fig. 36: Auxiliary Battery Positive Cable Cover
Courtesy of GENERAL MOTORS COMPANY

2. Remove the auxiliary battery positive cable cover (2) and loosen the auxiliary battery positive clamp fastener (1).
3. Remove the auxiliary battery positive cable (3) from the auxiliary battery positive post.

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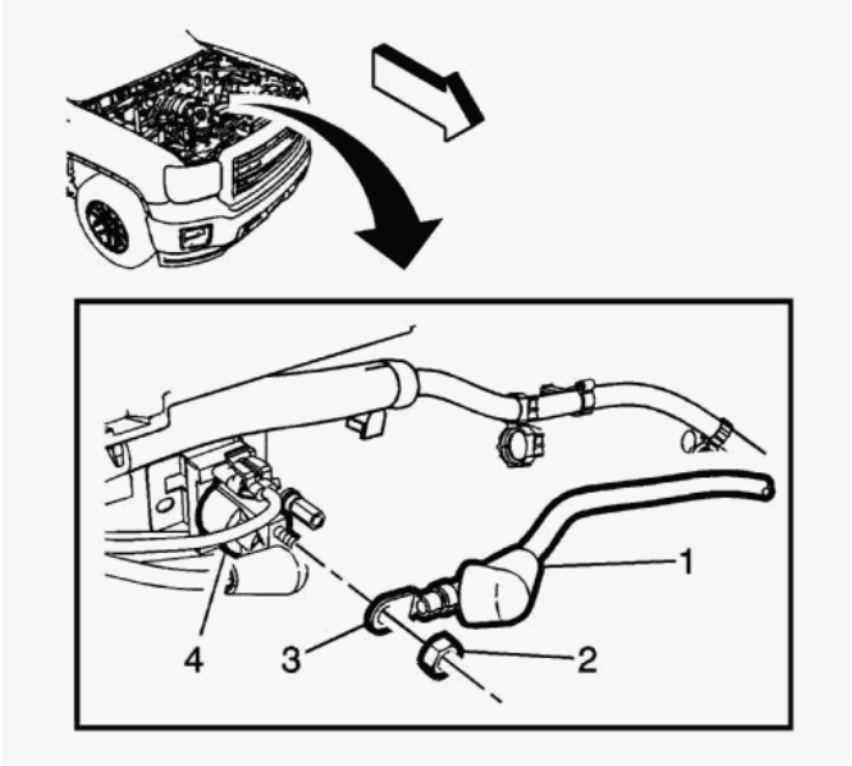


Fig. 37: Auxiliary Battery Positive Cable Protective Boot
Courtesy of GENERAL MOTORS COMPANY

4. Remove the auxiliary battery positive cable protective boot (1).
5. Remove the auxiliary battery positive cable fastener (2) and remove the auxiliary battery positive cable terminal (3) from the relay (4).

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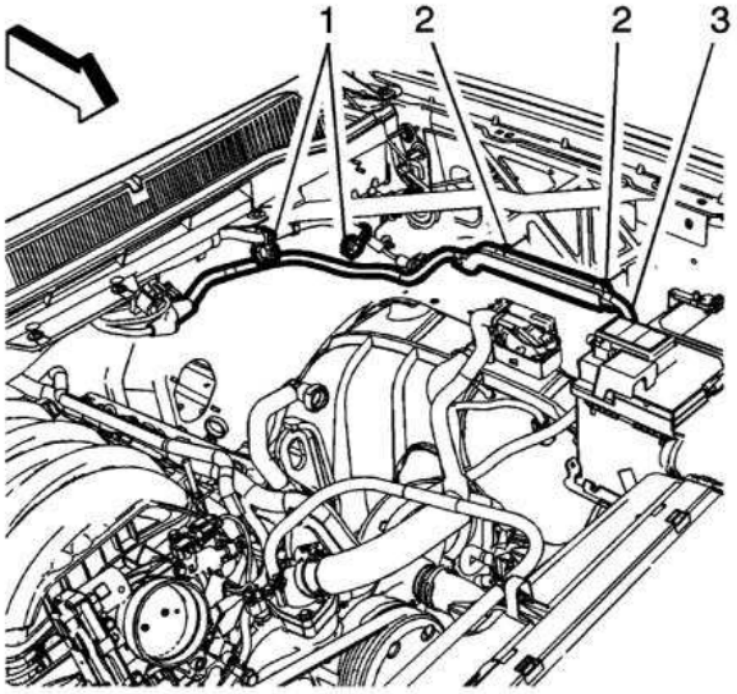


Fig. 38: Auxiliary Battery Positive Cable Conduit Retainers
Courtesy of GENERAL MOTORS COMPANY

6. Detach the auxiliary battery positive cable conduit retainers (2) from the left front inner fender panel.
7. Detach the auxiliary battery positive cable retainer clips (1) and remove the auxiliary battery positive cable (3) from the engine compartment.

Installation Procedure

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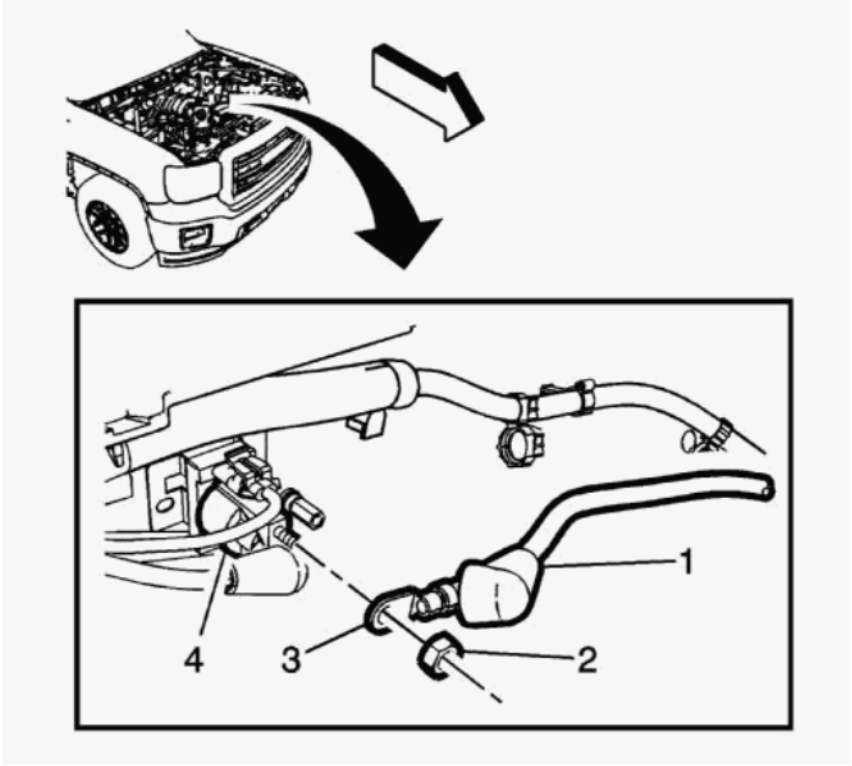


Fig. 39: Auxiliary Battery Positive Cable Protective Boot
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the auxiliary battery positive terminal (3) to the relay (4) and tighten the fastener (2) to 9 N.m (80 lb in).
2. Install the auxiliary battery positive cable protective boot (1).

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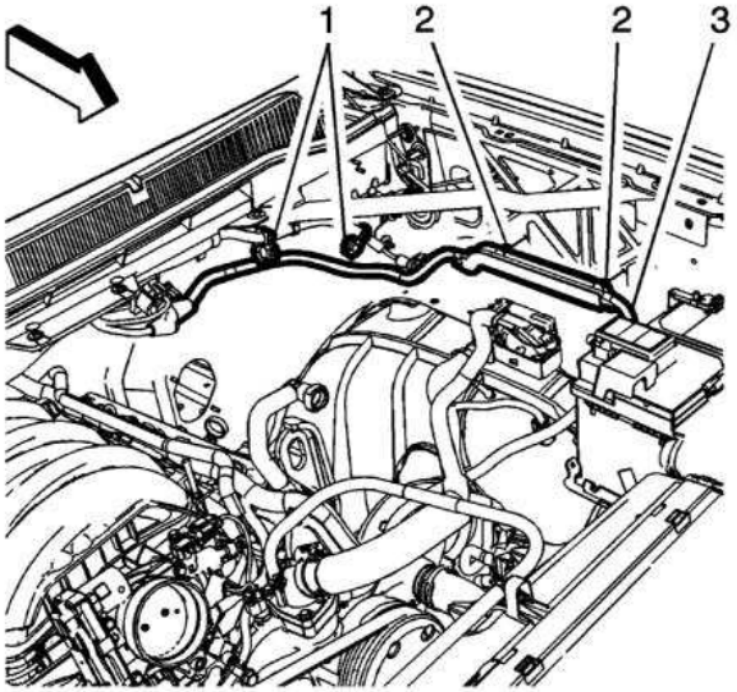


Fig. 40: Auxiliary Battery Positive Cable Conduit Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install the auxiliary battery positive cable clips (1) and the auxiliary battery positive cable conduit retainers (2).

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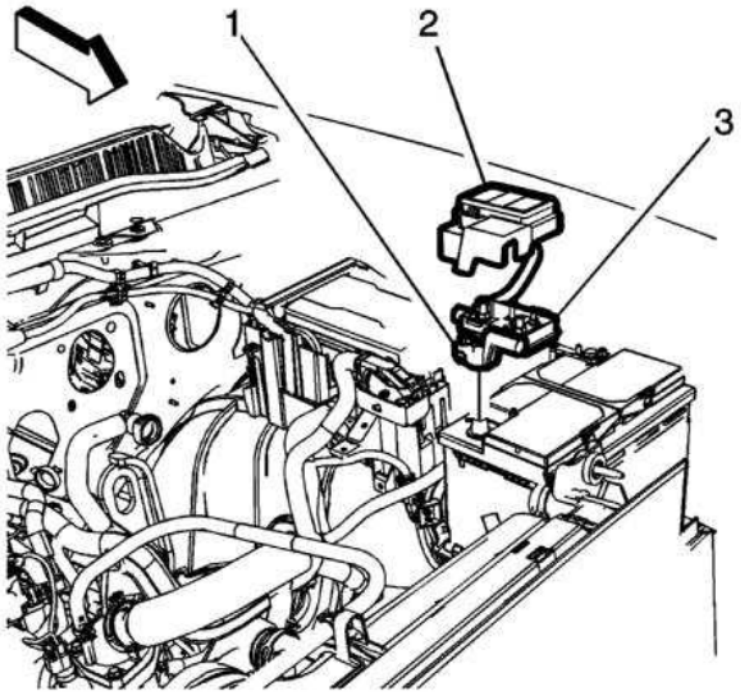


Fig. 41: Auxiliary Battery Positive Cable Cover
Courtesy of GENERAL MOTORS COMPANY

4. Install the auxiliary battery positive cable (3) to the battery positive post and tighten the clamp fastener (1) to 5 N.m (44 lb in).
5. Install the auxiliary battery positive cable protective cover (2).
6. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

GENERATOR BATTERY CONTROL WIRING HARNESS REPLACEMENT (L96)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.
2. Remove the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement** .

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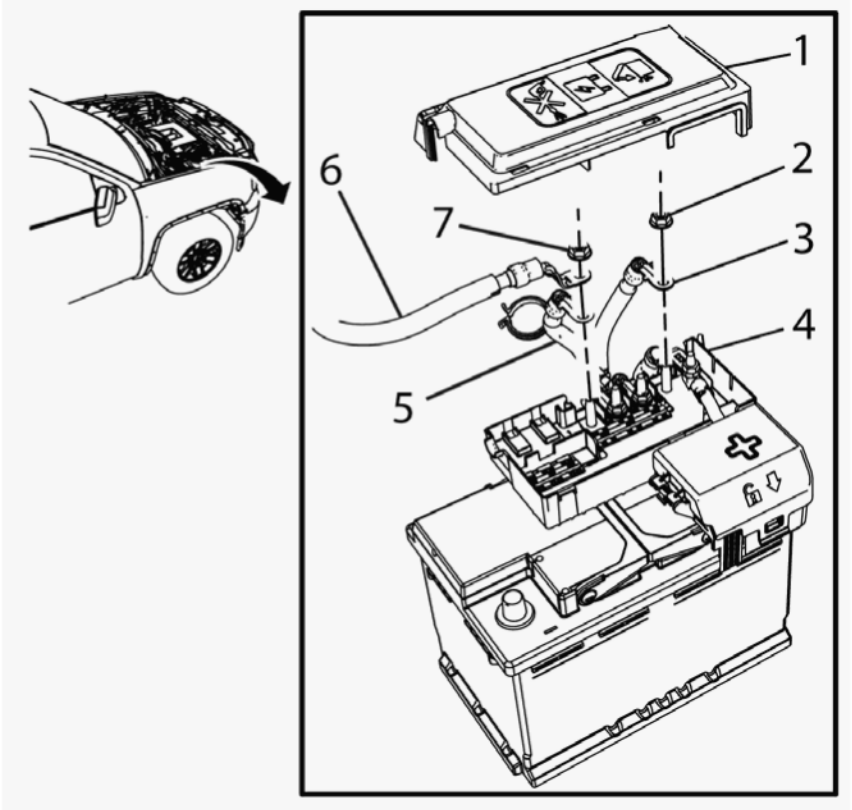


Fig. 42: Generator Battery Control Wiring Cable
Courtesy of GENERAL MOTORS COMPANY

3. Remove the battery fuse block cover (1).
4. Remove the battery fuse block fastener (2) and remove the generator battery control wiring cable (3), from the battery fuse block (4).
5. Remove the battery fuse block fastener (7).
6. Remove the battery positive cable (6) and the generator battery control wiring harness cable (5), from the battery fuse block (4).

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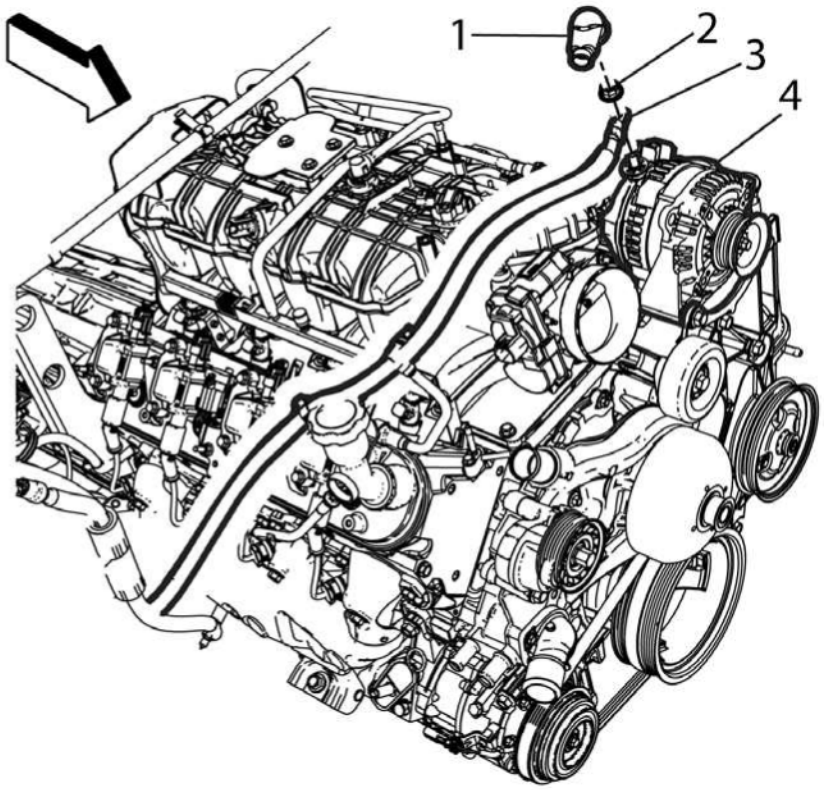


Fig. 43: Generator Battery Control Wiring Harness Cable
Courtesy of GENERAL MOTORS COMPANY

7. Remove the generator B + protective boot (1).
8. Remove the generator B + fastener (2) and remove the generator battery control wiring harness cable (3), from the generator (4).
9. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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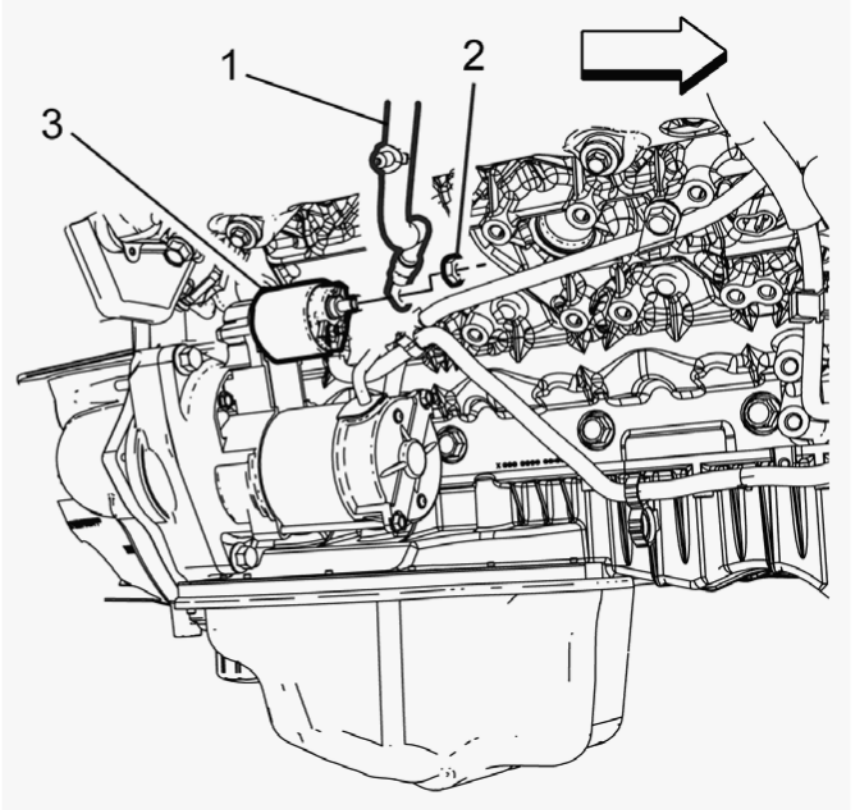


Fig. 44: Generator Battery Control Wiring Harness Cable
Courtesy of GENERAL MOTORS COMPANY

10. Remove the starter solenoid fastener (2) and remove the generator battery control wiring harness cable (1) from the starter solenoid (3).
11. Lower the vehicle.
12. Remove the generator battery control wiring harness from the engine compartment.

Installation Procedure

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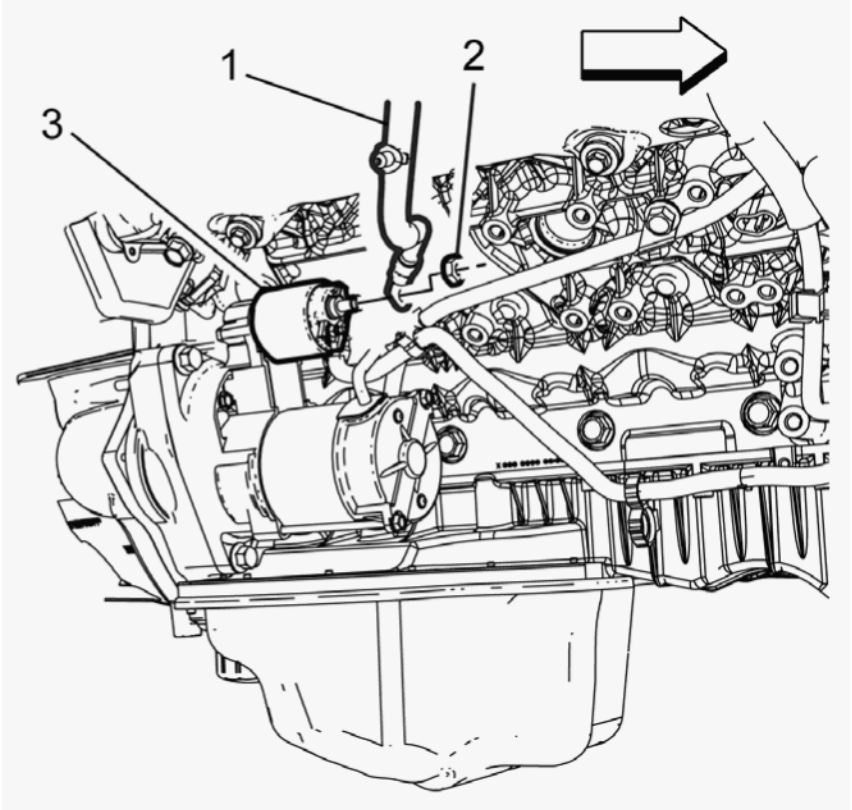


Fig. 45: Generator Battery Control Wiring Harness Cable
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the generator battery control wiring harness cable (1) to the starter solenoid (3) and tighten the fastener (2) to 9 N.m (80 lb in).

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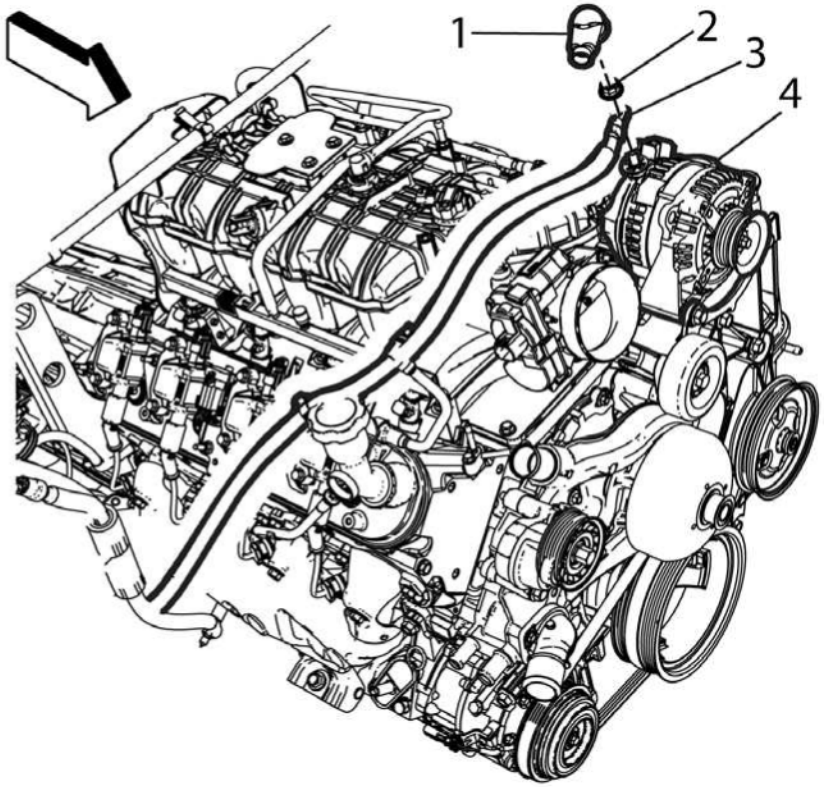


Fig. 46: Generator Battery Control Wiring Harness Cable
Courtesy of GENERAL MOTORS COMPANY

2. Connect the generator battery control wiring harness cable (3) to the generator (4) and tighten the fastener (2) to 15 N.m (11 lb ft).
3. Install the protective boot (1) over the B + generator stud.

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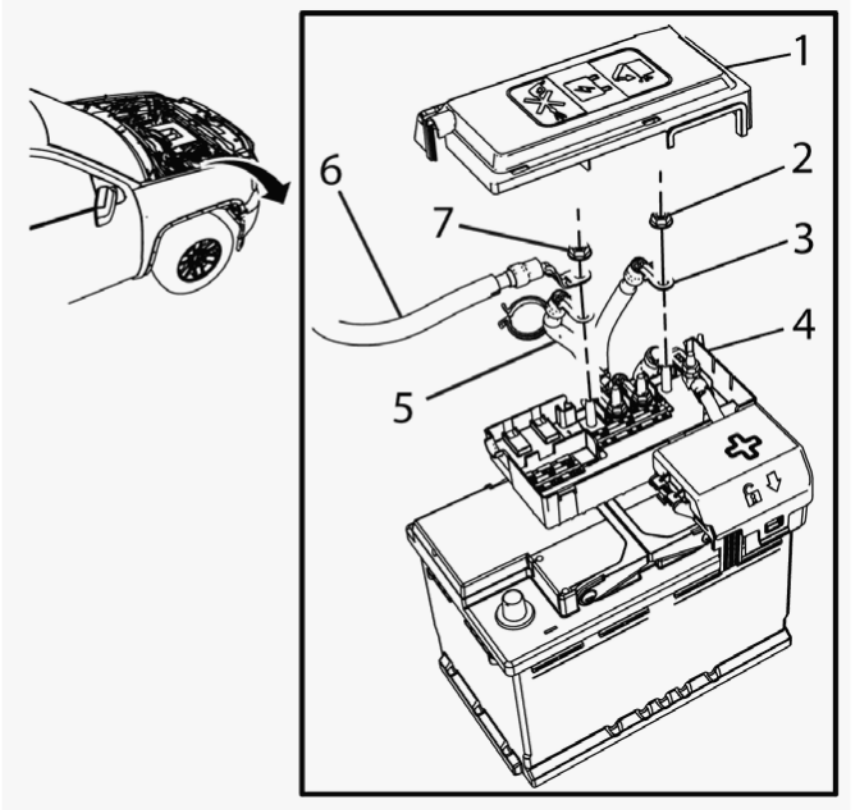


Fig. 47: Generator Battery Control Wiring Cable
Courtesy of GENERAL MOTORS COMPANY

4. Install the generator battery control wiring harness cable (3), to the battery fuse block (4), and tighten the fastener (2) to 9 N.m (80 lb in).
5. Install the generator battery control wiring harness cable (5) and the battery positive cable (6) to the battery fuse block (4). Tighten the fastener (7) to 9 N.m (80 lb in).
6. Install the battery fuse block cover (1).
7. Install the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement** .
8. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

GENERATOR BATTERY CONTROL WIRING HARNESS REPLACEMENT (L83, L86)

Removal Procedure

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

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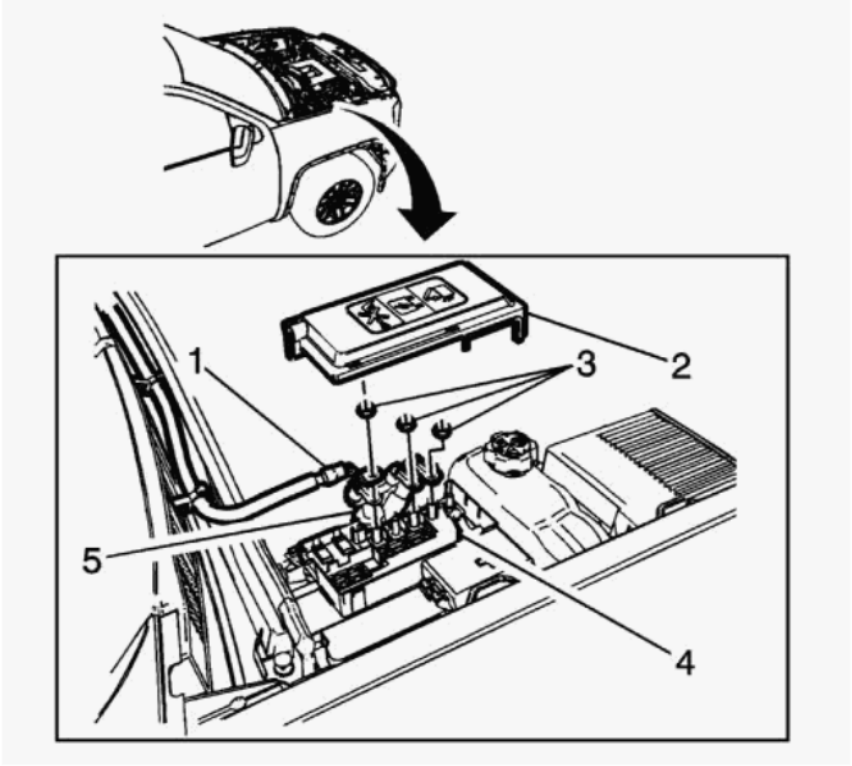


Fig. 48: Fuse Battery Distribution Unit Engine Compartment Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Remove the battery fuse block cover (2).
3. Remove the battery fuse block fasteners (3) and remove the battery positive cable (1).
4. Remove the generator battery control wiring harness cable (5) from the battery fuse block (4).

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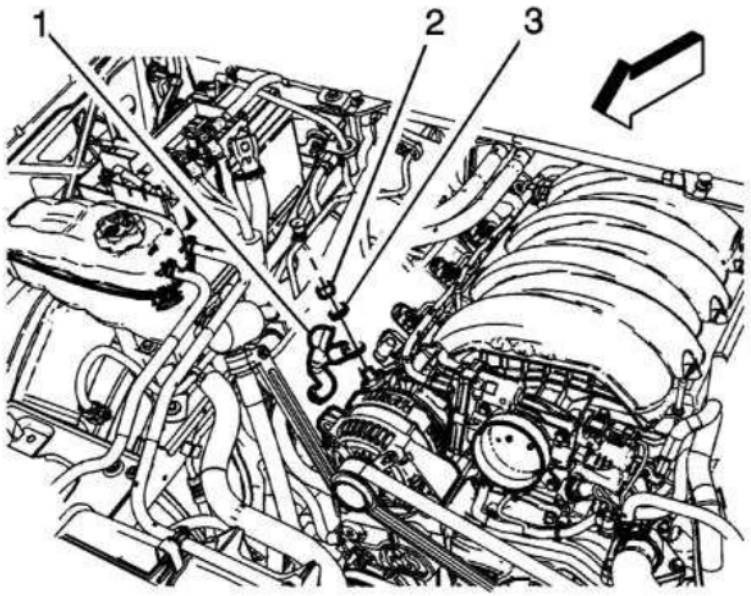


Fig. 49: Generator Battery Positive Cable Protective Boot
Courtesy of GENERAL MOTORS COMPANY

5. Remove the generator battery positive cable protective boot (1).
6. Remove the generator B + fastener (2) and remove the generator battery control wiring harness terminal (3), from the back of the generator.

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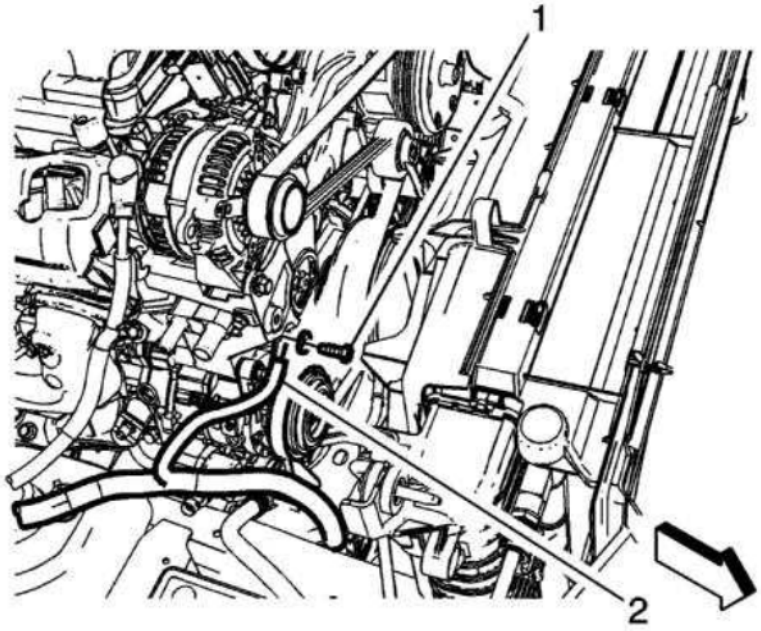


Fig. 50: Generator Battery Control Wiring Harness Ground Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Remove the generator battery control wiring harness ground fastener (1) and remove the generator battery control wiring harness terminal (2), from the front engine block.
8. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
9. Remove the steering gear skid shield. Refer to **Steering Gear Skid Shield Replacement** .

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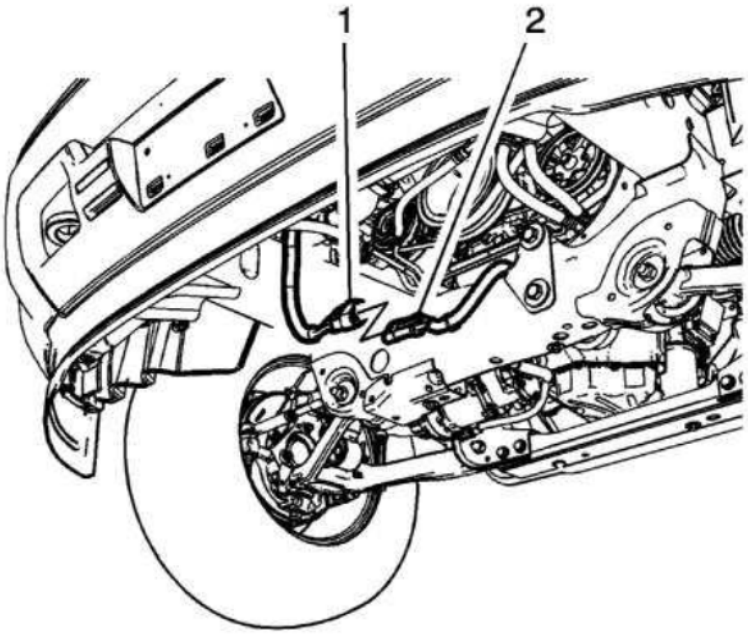


Fig. 51: Electronic Power Steering (EPS) Connector And Generator Battery Control Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

10. Disconnect the electronic power steering (EPS) connector (2) from the generator battery control wiring harness (1).

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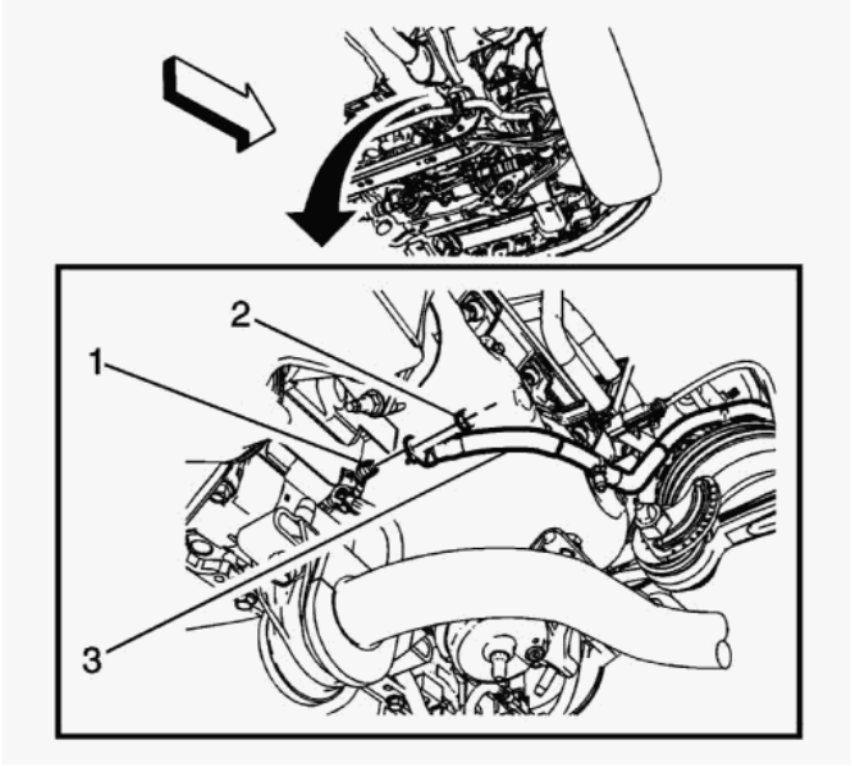


Fig. 52: Generator Battery Control Wiring Harness Cable Fastener And Starter Stud
Courtesy of GENERAL MOTORS COMPANY

11. Remove the generator battery control wiring harness cable fastener (2) from the starter stud (1) and remove the generator battery control wiring harness cable (3) from the starter.

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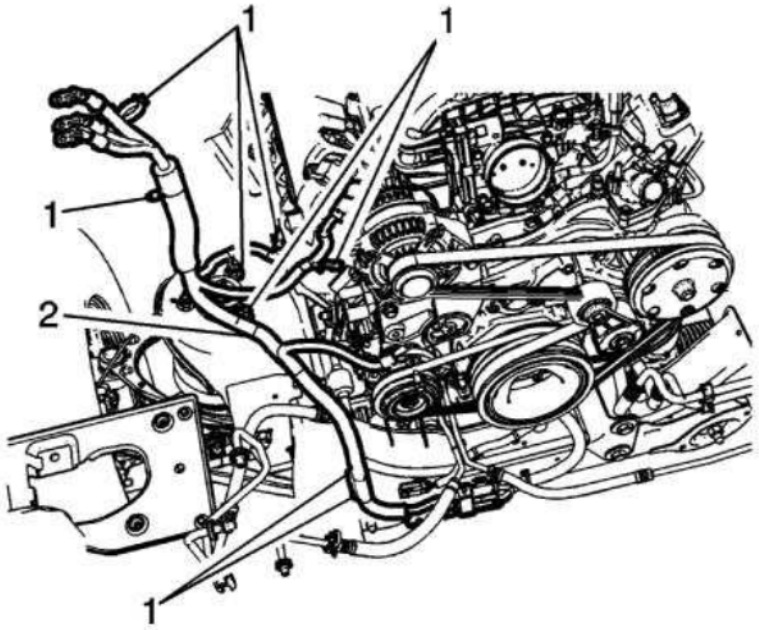


Fig. 53: Generator Battery Control Wiring Harness Retainers And Generator Battery Control Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

12. Detach the generator battery control wiring harness retainers (1) and remove the generator battery control wiring harness (2), from the vehicle.

Installation Procedure

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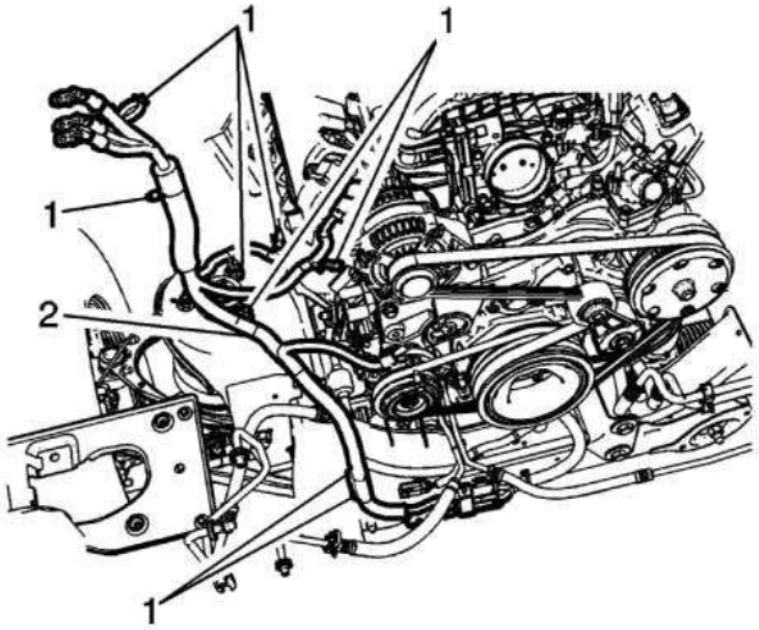


Fig. 54: Generator Battery Control Wiring Harness Retainers And Generator Battery Control Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

1. Attach the generator battery control wiring harness (2), to the engine compartment, with the retainers (1).

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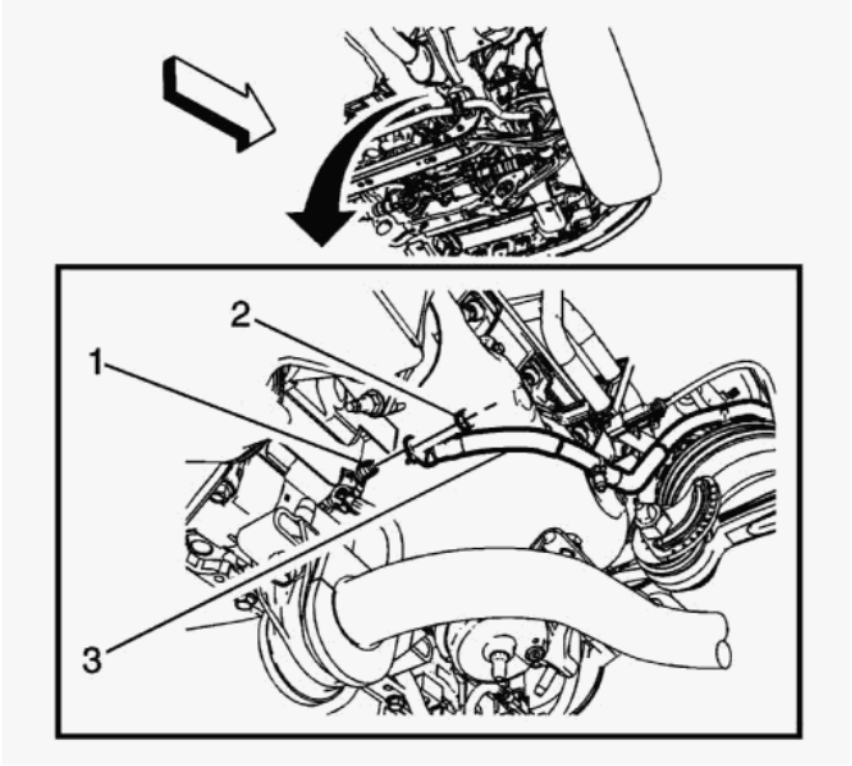


Fig. 55: Generator Battery Control Wiring Harness Cable Fastener And Starter Stud
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

2. Install the generator battery control wiring harness cable (3) to the starter stud (1) and tighten the fastener (2) to 9 N.m (80 lb in).

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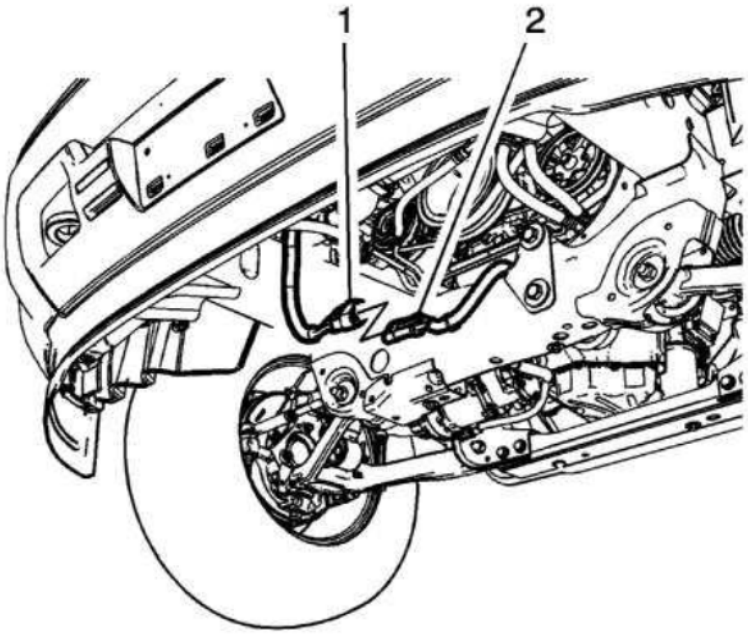


Fig. 56: Electronic Power Steering (EPS) Connector And Generator Battery Control Wiring Harness
Courtesy of GENERAL MOTORS COMPANY

3. Connect the generator battery control wiring harness connector (1) to the EPS connector (2).
4. Install the steering gear skid shield. Refer to **Steering Gear Skid Shield Replacement** .

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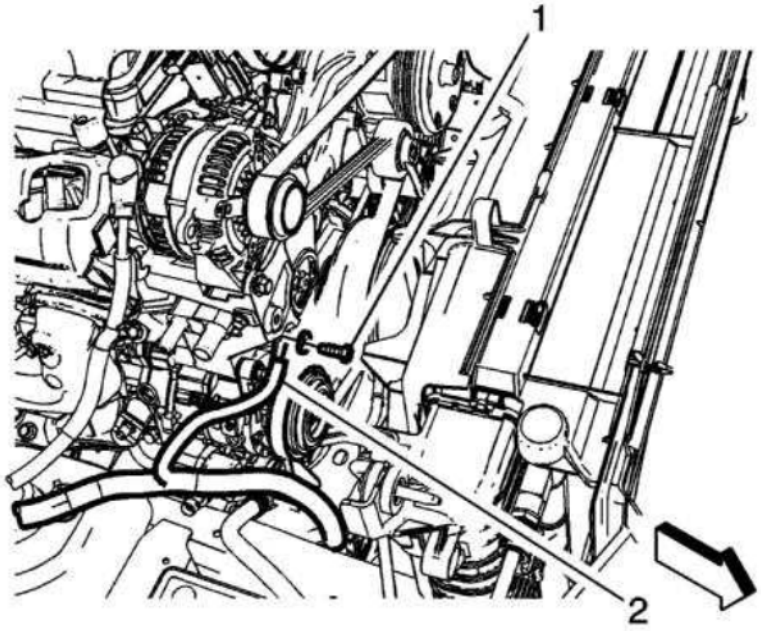


Fig. 57: Generator Battery Control Wiring Harness Ground Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Install the generator battery control wiring harness ground terminal (2), to the front of the engine block, and tighten the fastener (1) to 45 N.m (33 lb ft).

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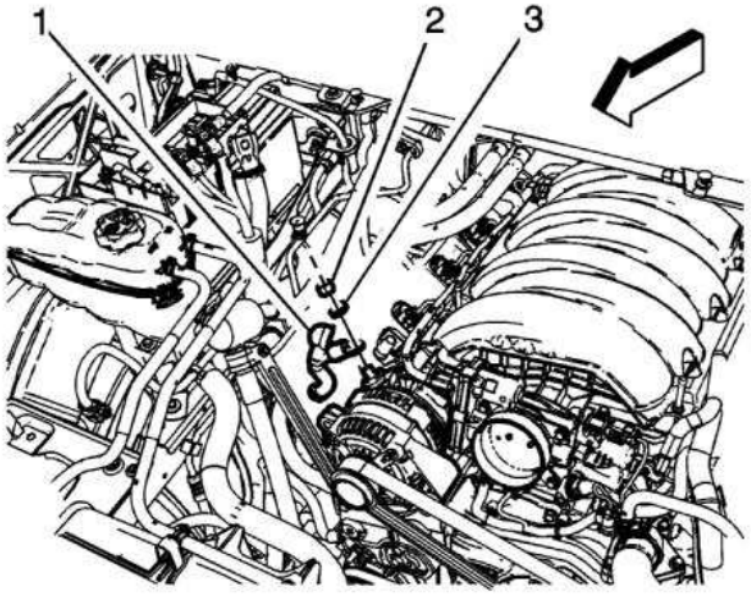


Fig. 58: Generator Battery Positive Cable Protective Boot
Courtesy of GENERAL MOTORS COMPANY

6. Install the generator battery control wiring harness terminal (3) to the generator B + stud and tighten the fastener (2) to 12 N.m (106 lb in).
7. Install the generator stud protective boot (1).

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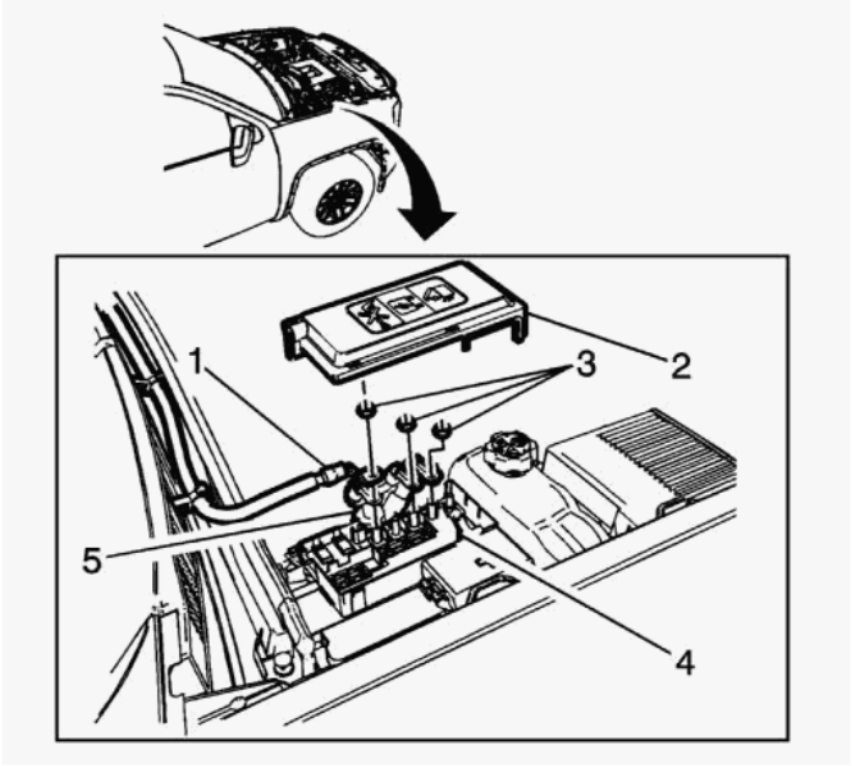


Fig. 59: Fuse Battery Distribution Unit Engine Compartment Block Cover
Courtesy of GENERAL MOTORS COMPANY

8. Install the generator battery control wiring harness terminals (5) to the battery fuse block (4).
9. Install the battery positive cable (1) to the battery fuse block and tighten the fasteners (3) to 12 N.m (106 lb in).
10. Install the battery fuse block cover (2).
11. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

BATTERY REPLACEMENT

Removal Procedure

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

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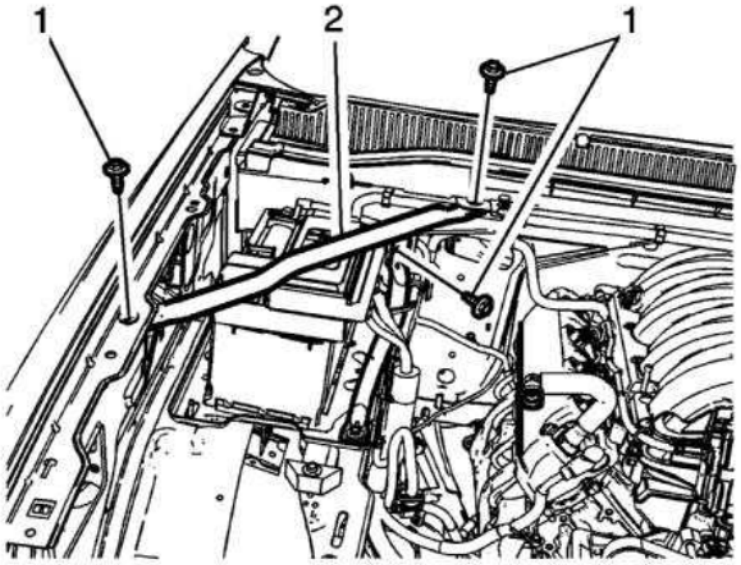


Fig. 60: Support Cross Brace Fasteners And Support Cross Brace
Courtesy of GENERAL MOTORS COMPANY

2. Remove the support cross brace fasteners (1) and remove the support cross brace (2), from above the battery.

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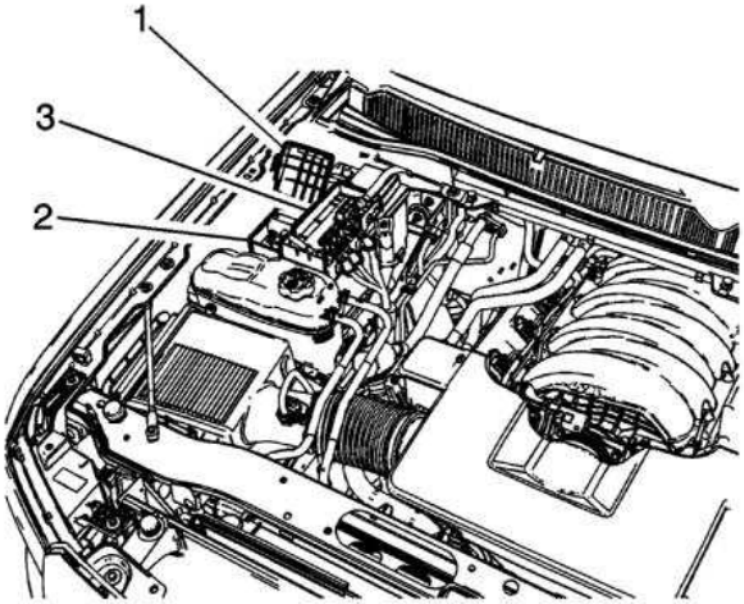


Fig. 61: Battery Positive Cable Clamp Cover And Loosen Battery Positive Cable Clamp Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Open the battery positive cable clamp cover (1) and loosen the battery positive cable clamp fastener (2).
4. Remove the battery fuse block (3) and set aside.

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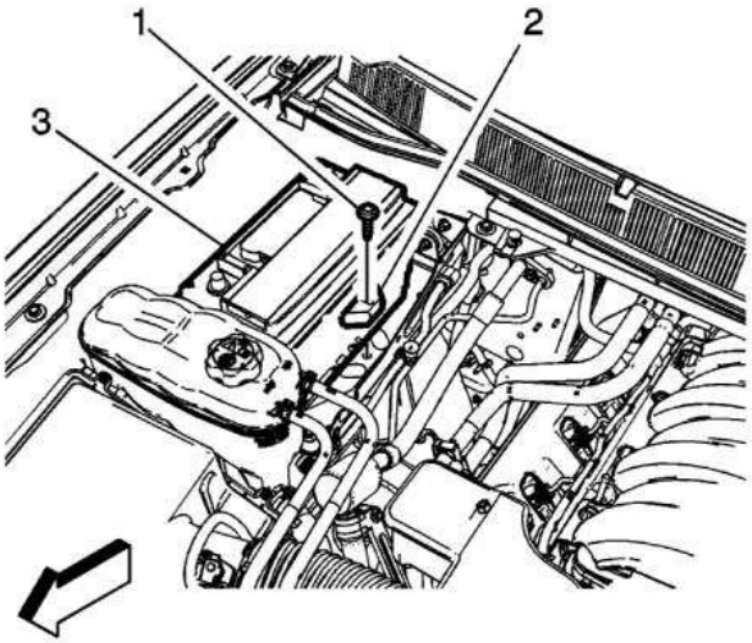


Fig. 62: Battery Retainer Fastener And Battery Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the battery retainer fastener (1) and remove the battery retainer (2).
6. Reposition the radiator surge tank without draining the coolant. Refer to **Radiator Surge Tank Replacement (L83 L86)** **Radiator Surge Tank Replacement (L96)** .
7. Remove the battery (3) from the vehicle.

Installation Procedure

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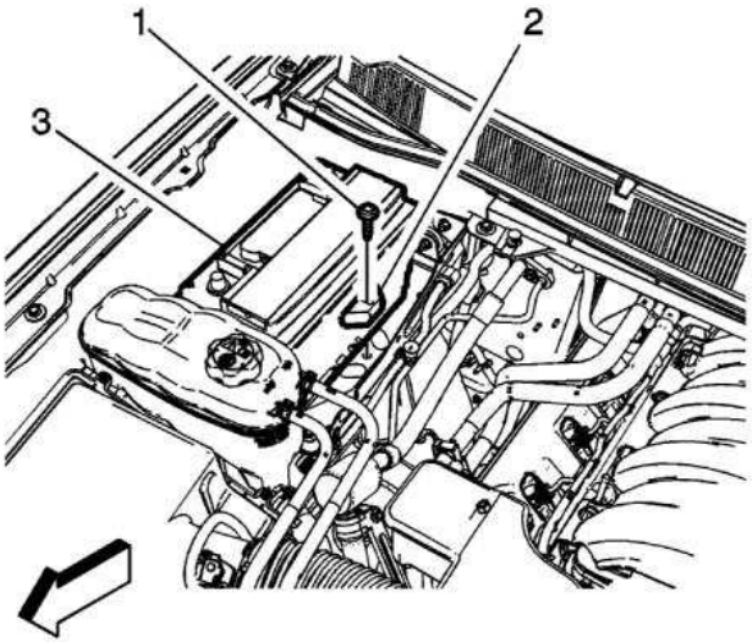


Fig. 63: Battery Retainer Fastener And Battery Retainer
Courtesy of GENERAL MOTORS COMPANY

1. Install the battery (3) into position on the battery tray.

CAUTION: **Refer to Fastener Caution .**

2. Install the battery retainer (2) and tighten the fastener (1) to 25 N.m (18 lb ft).

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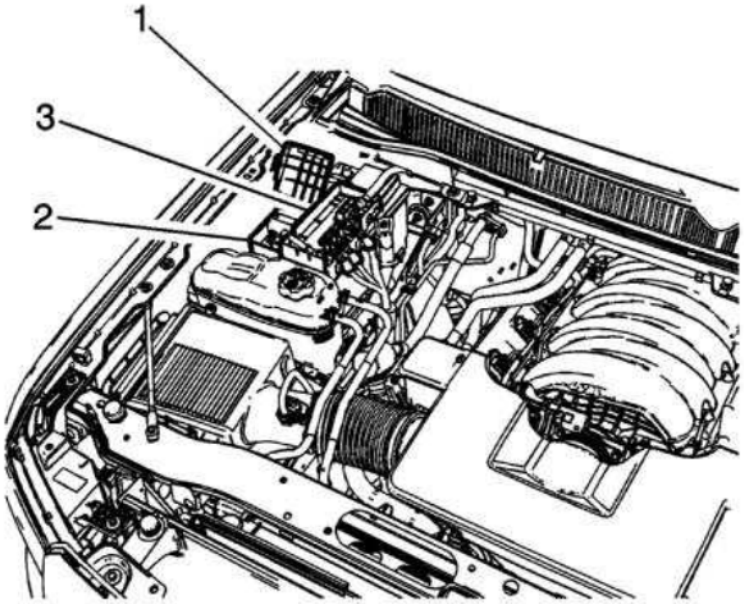


Fig. 64: Battery Positive Cable Clamp Cover And Loosen Battery Positive Cable Clamp Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Install the battery fuse block (3) to the battery positive post and tighten the fastener (2) to 7 N.m (62 lb in).
4. Close the battery positive cable cover (1).
5. Install the radiator surge tank. Refer to **Radiator Surge Tank Replacement (L83 L86)** **Radiator Surge Tank Replacement (L96)** .

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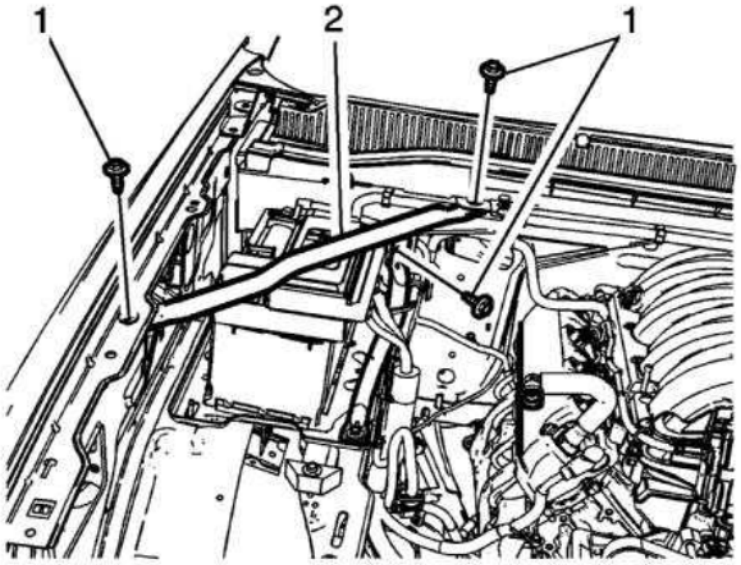


Fig. 65: Support Cross Brace Fasteners And Support Cross Brace
Courtesy of GENERAL MOTORS COMPANY

6. Install the support cross brace (2) and tighten the fasteners (1) to 9 N.m (80 lb in).
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

AUXILIARY BATTERY REPLACEMENT (9C1)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**

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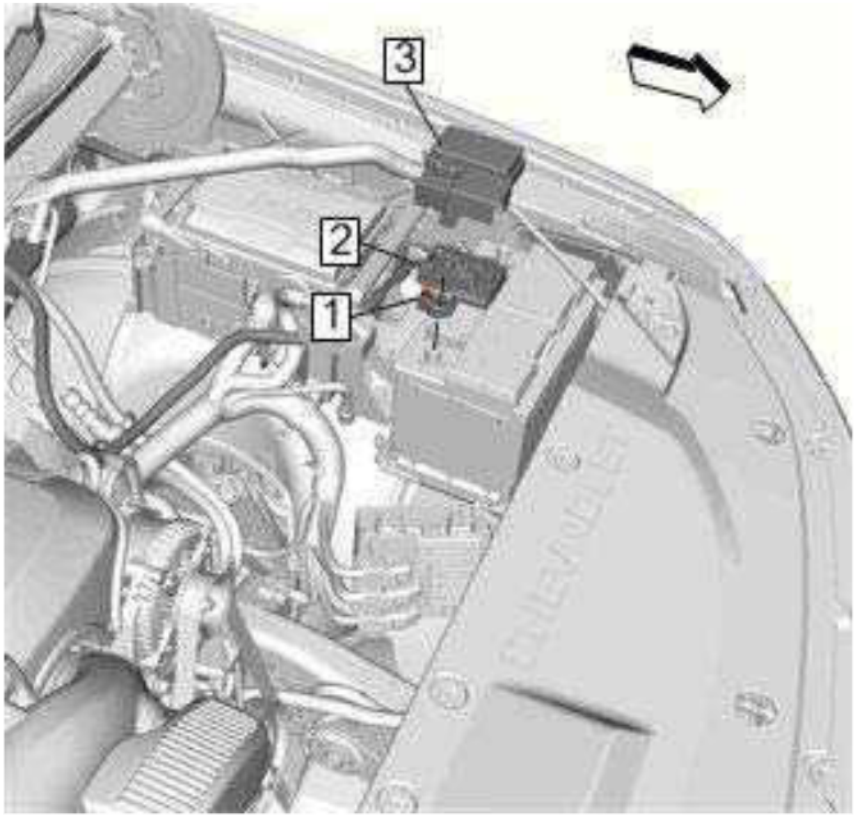
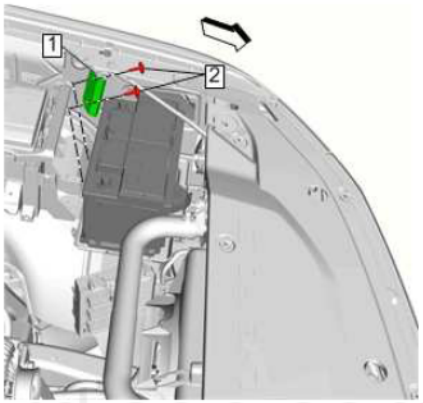


Fig. 66: Battery Fuse Block
Courtesy of GENERAL MOTORS COMPANY

2. Remove Battery Fuse Block Cover (3)
3. Loosen Auxiliary Battery Positive Clamp Nut (1)
4. Reposition away Battery Fuse Block (2)



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Fig. 67: Battery Hold Down Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Hold Down Bolt (2)
6. Remove Battery Hold Down Retainer (1)

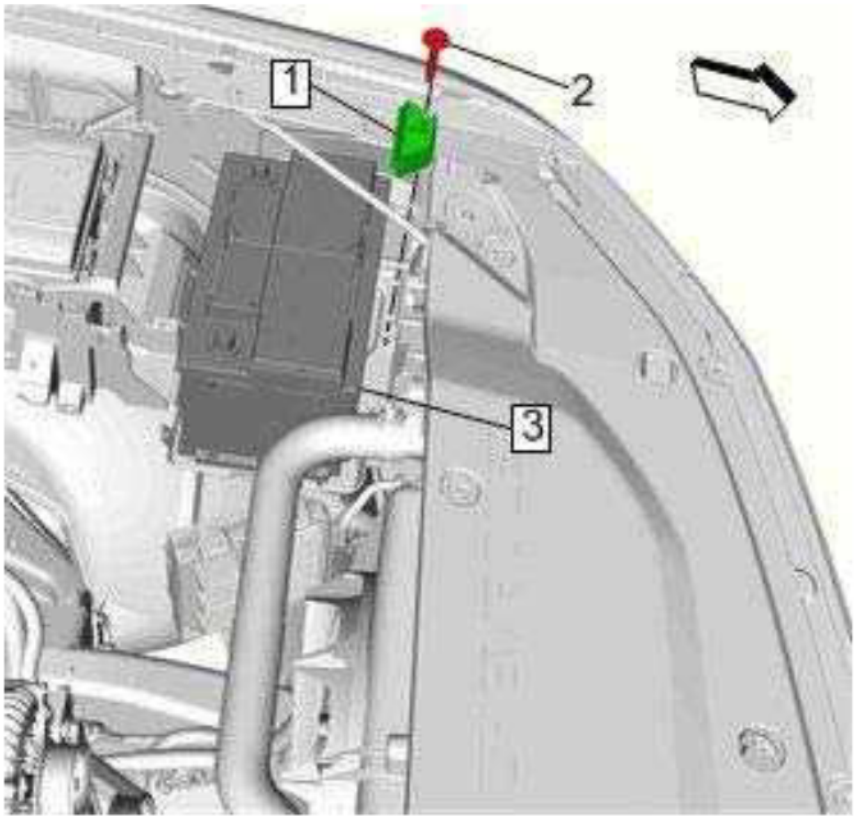


Fig. 68: Battery Hold Down Bolt
Courtesy of GENERAL MOTORS COMPANY

7. Battery Hold Down Bolt (2)
8. Battery Hold Down Retainer (1)
9. Auxiliary Battery (3)

Installation Procedure

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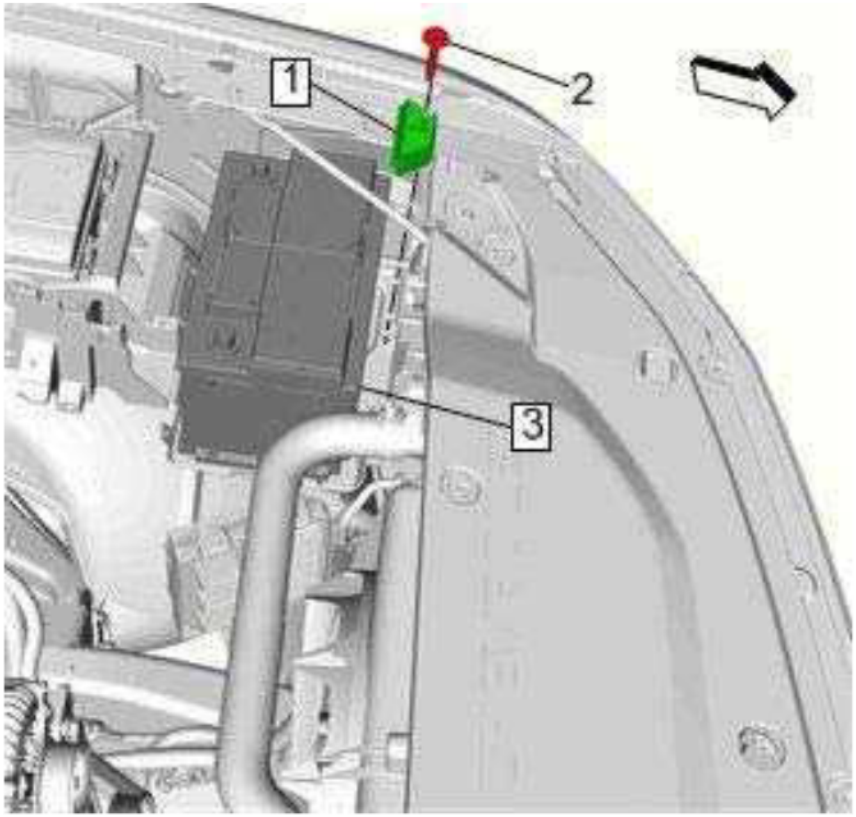


Fig. 69: Battery Hold Down Bolt
Courtesy of GENERAL MOTORS COMPANY

1. Install Auxiliary Battery (3)
2. Install Battery Hold Down Retainer (1)

CAUTION: **Refer to Fastener Caution**

3. Install Battery Hold Down Bolt (2) and tighten 25 N.m (18 lb ft)

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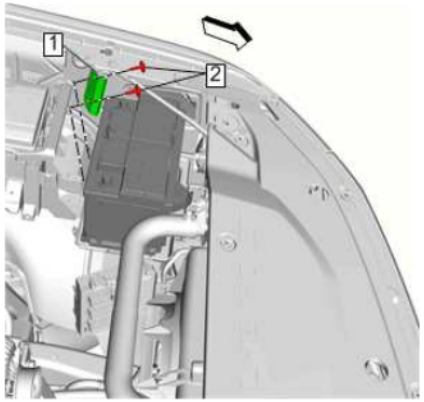
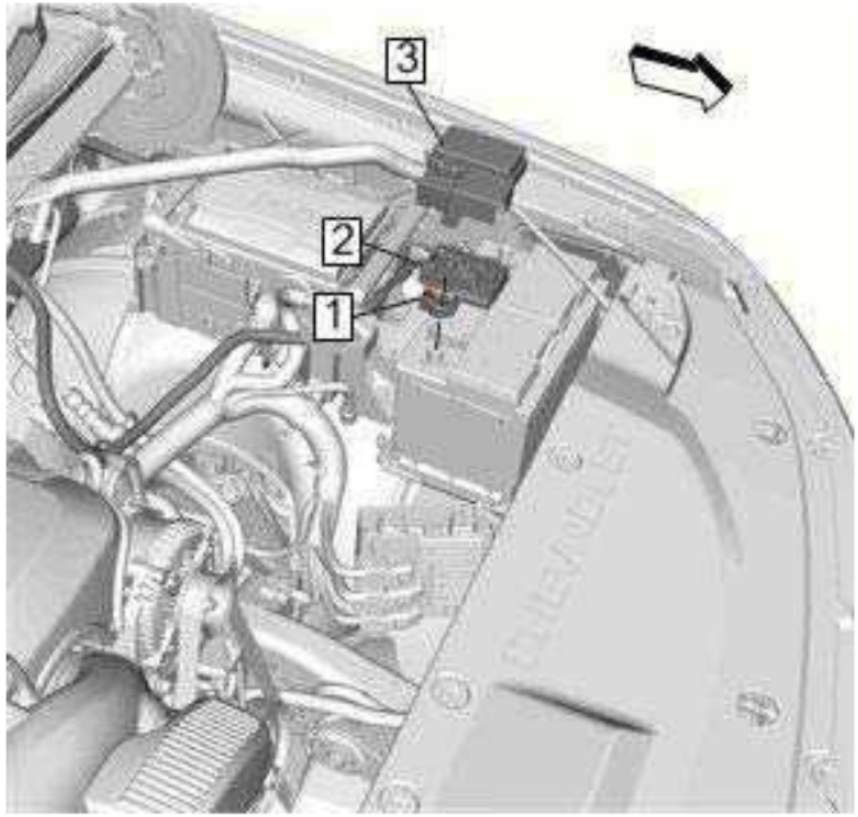


Fig. 70: Battery Hold Down Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Install Battery Hold Down Retainer (1)
5. Install Battery Hold Down Bolt (2) and tighten 9 N.m (80 lb in)



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Fig. 71: Battery Fuse Block
Courtesy of GENERAL MOTORS COMPANY

6. Install Battery Fuse Block (2)
7. Auxiliary Battery Positive Clamp Nut (1) Tighten 7 N.m (62 lb in)
8. Install Battery Fuse Block Cover (3)
9. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

BATTERY TRAY REPLACEMENT

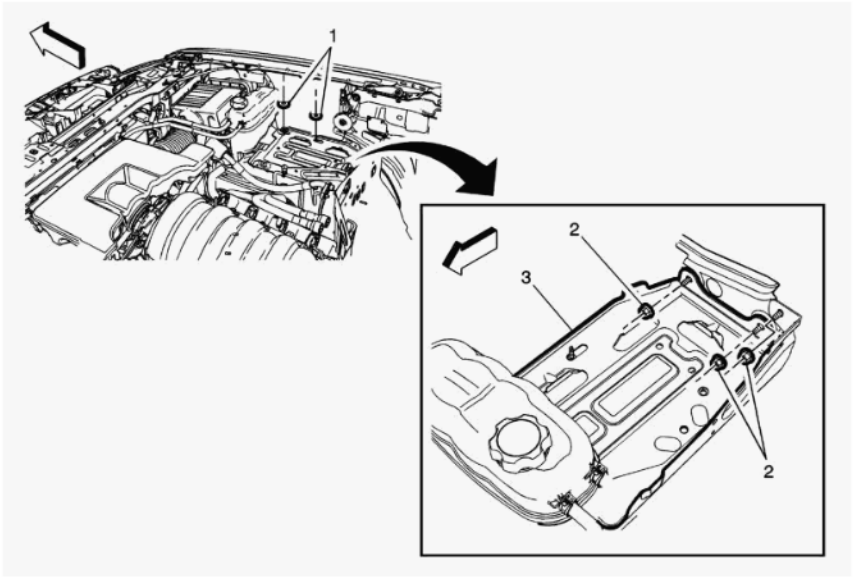


Fig. 72: Battery Tray
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the battery. Refer to **Battery Replacement**. 2. Reposition the radiator surge tank mounting bracket. Refer to **Radiator Surge Tank Replacement (L83 L86)** **Radiator Surge Tank Replacement (L96)** . 3. Disconnect any harness retainers to the battery tray.	
1	Battery Tray Nut **CAUTION:** **Refer to Fastener Caution .** **Tighten**

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Callout	Component Name
	9 N.m (80 lb in)
2	Battery Tray Nut **Tighten** 22 N.m (16 lb ft)
3	Battery Tray Bolt **Tighten** 9 N.m (80 lb in)
4	Battery Tray

AUXILIARY BATTERY TRAY REPLACEMENT (9C1)

Removal Procedure

1. Remove the auxiliary battery, if equipped. Refer to **Auxiliary Battery Replacement (9C1)**.

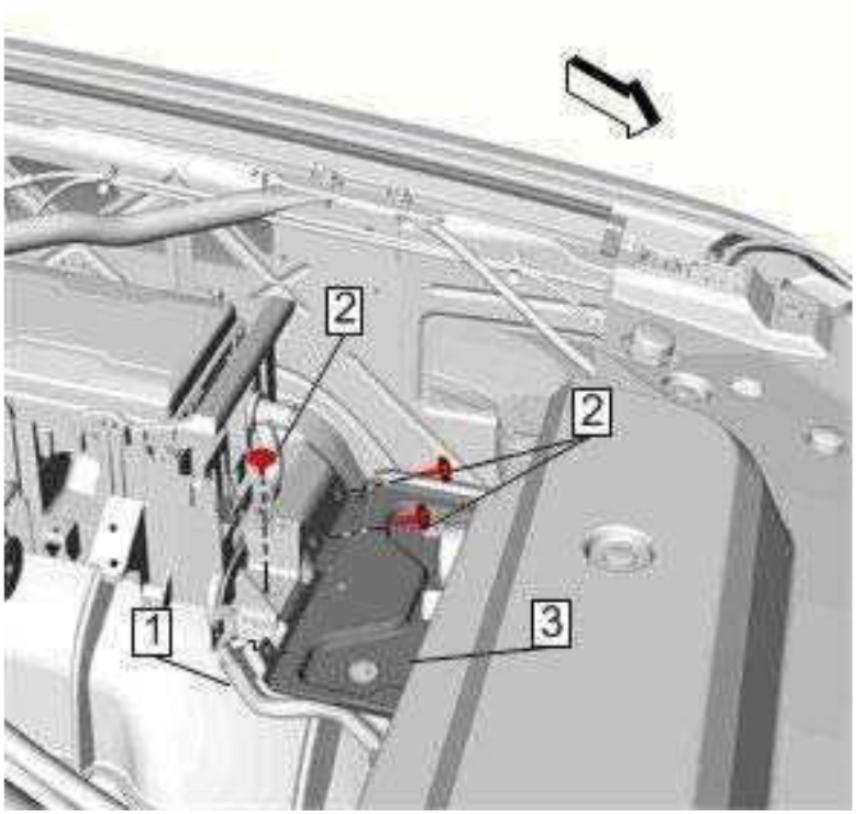


Fig. 73: Battery Tray Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the auxiliary battery tray fasteners (2) and detach the forward lamp harness retainer (1) from the auxiliary battery tray (3).
3. Detach the fuse block harness retainers from the battery tray.

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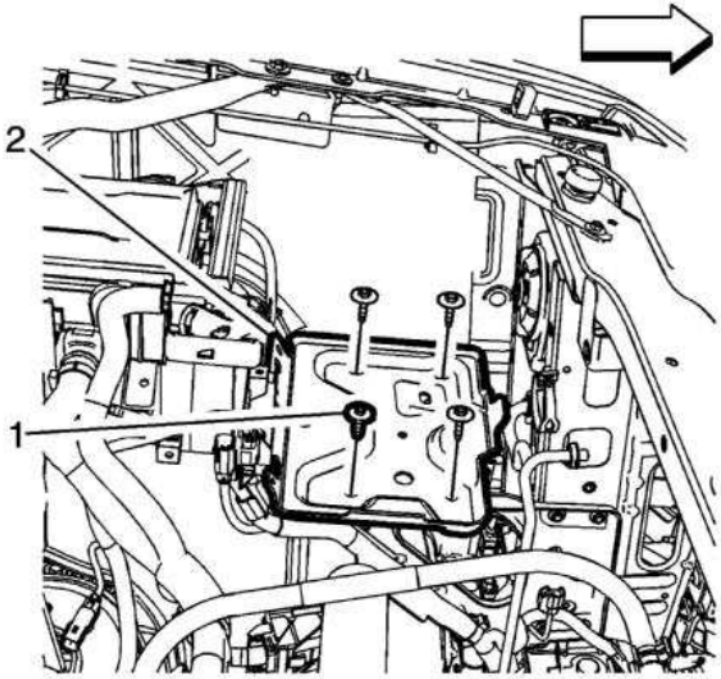


Fig. 74: Auxiliary Battery Tray And Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the auxiliary battery tray fasteners (1) and remove the auxiliary battery tray (2), from the engine compartment.

Installation Procedure

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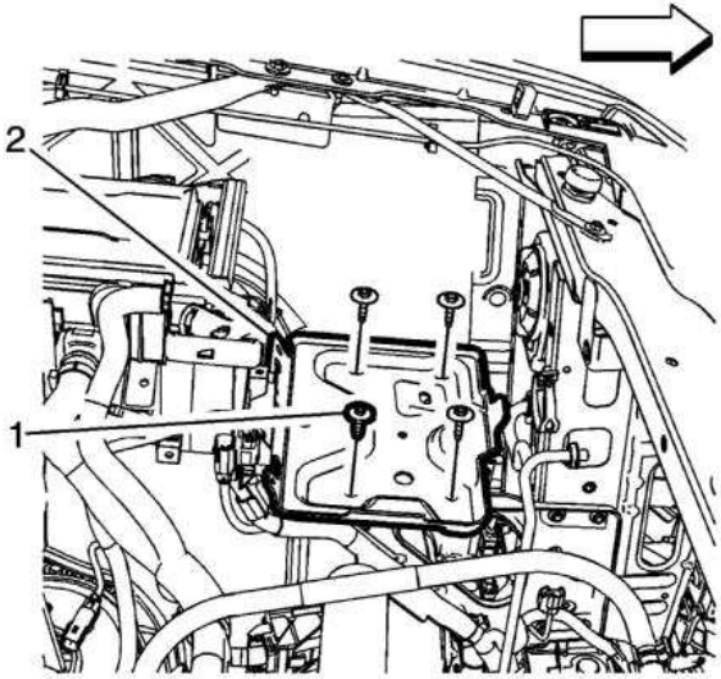


Fig. 75: Auxiliary Battery Tray And Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the auxiliary battery tray (2) into position and tighten the fasteners (1) to 9 N.m (80 lb in).

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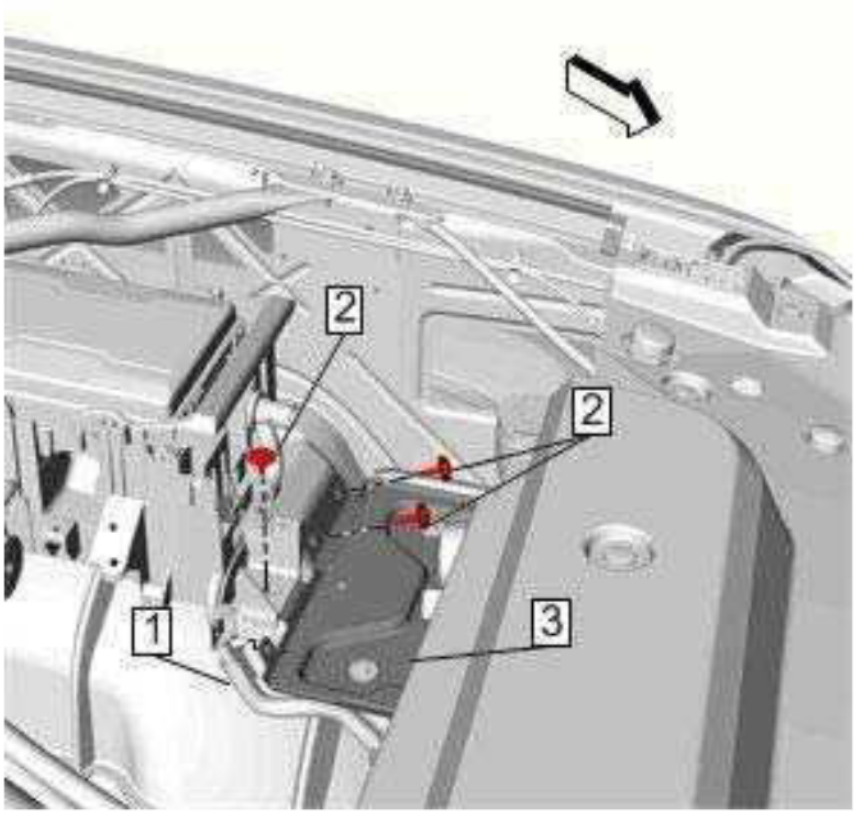


Fig. 76: Battery Tray Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install the forward lamp harness retainer (1) to the auxiliary battery tray (3) and tighten the fasteners (2) to 9 N.m (80 lb in).
3. Connect the fuse block harness retainers to the battery tray.
4. Install the auxiliary battery, if equipped. Refer to **Auxiliary Battery Replacement (9C1)**.

STARTER REPLACEMENT (L83, L86)

Removal Procedure

WARNING: Refer to **Hot Exhaust System Warning** .

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .

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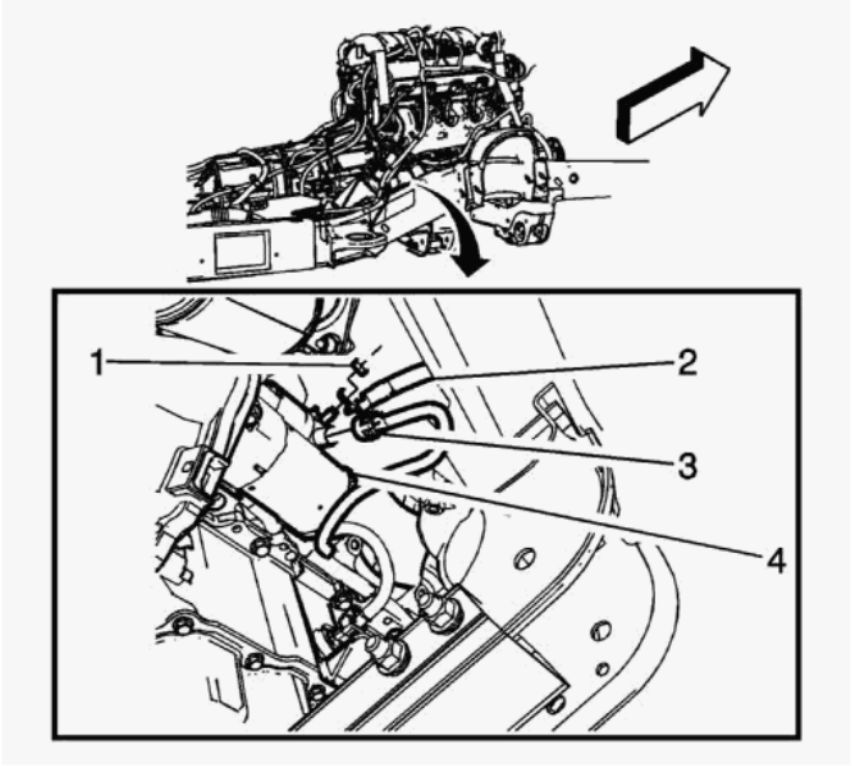


Fig. 77: Generator Battery Control Wiring Harness Cable And Starter
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fastener (1), securing the generator battery control wiring harness cable (2), to the starter (4).
4. Disconnect the engine wiring harness connector (3) from the starter (4).

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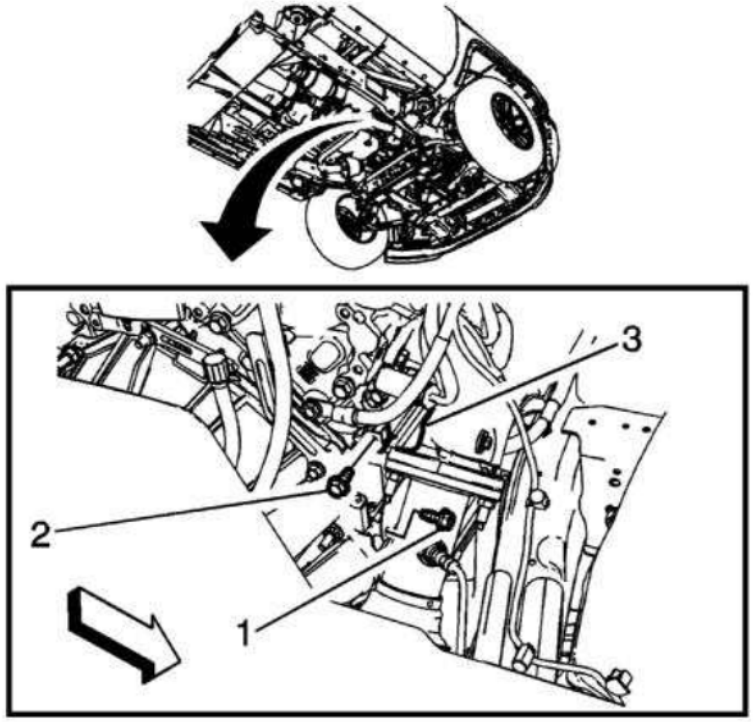


Fig. 78: Lower Fastener And Upper Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Remove the lower fastener (1) and the upper fastener (2), securing the starter shield (3).

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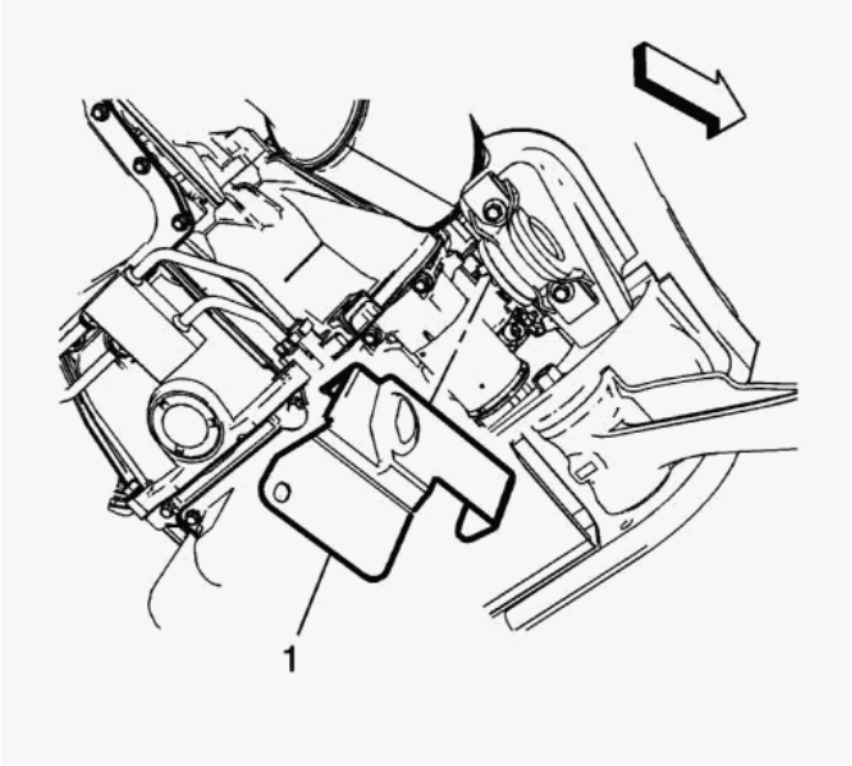


Fig. 79: Starter Shield And Starter
Courtesy of GENERAL MOTORS COMPANY

6. Remove the starter shield (1) from above the starter.

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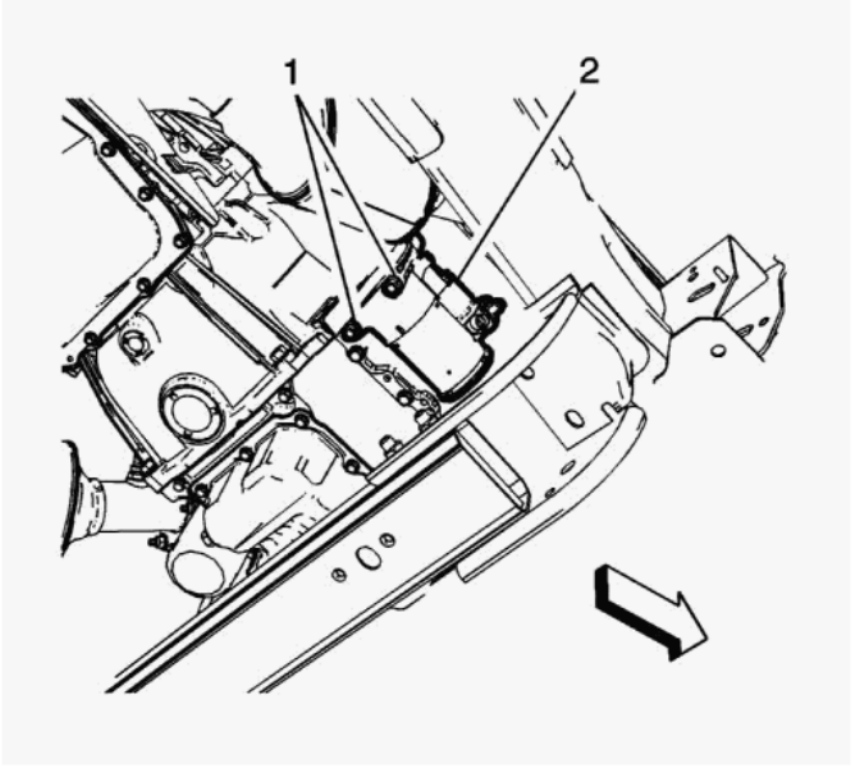


Fig. 80: Starter Mounting Fasteners And Starter
Courtesy of GENERAL MOTORS COMPANY

7. Remove the starter mounting fasteners (1) and remove the starter (2) from under the vehicle.

Installation Procedure

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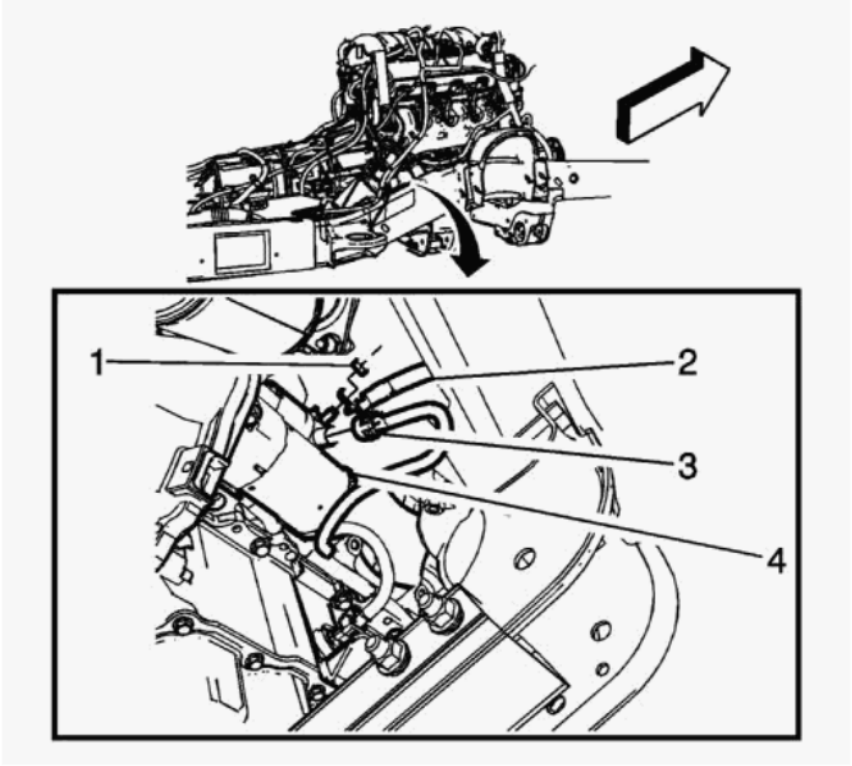


Fig. 81: Generator Battery Control Wiring Harness Cable And Starter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the fastener (1), securing the generator battery control wiring harness cable (2), to the starter (4). Tighten to 9 N.m (80 lb in).
2. Connect the engine wiring harness connector (3) to the starter (4).

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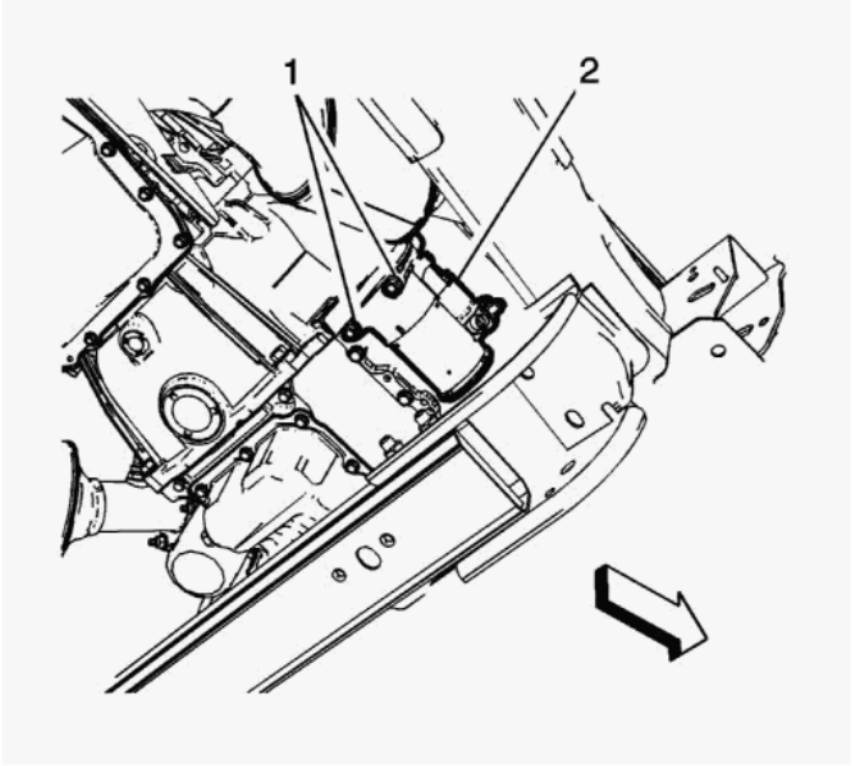


Fig. 82: Starter Mounting Fasteners And Starter
Courtesy of GENERAL MOTORS COMPANY

3. Install the starter (2) into position and tighten the starter mounting fasteners (1) to 50 N.m (37 lb ft).

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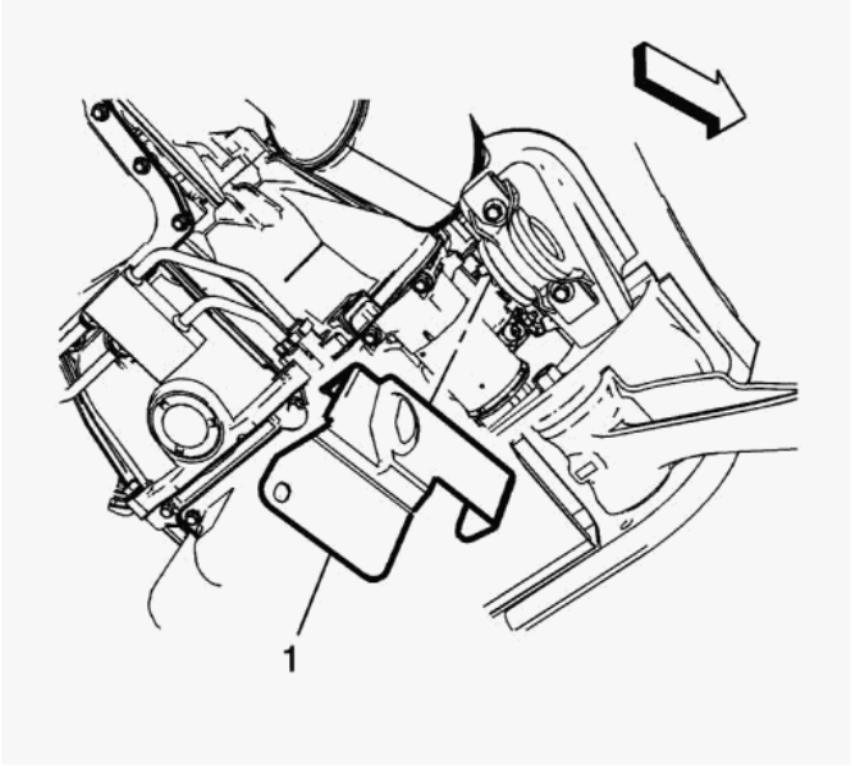


Fig. 83: Starter Shield And Starter
Courtesy of GENERAL MOTORS COMPANY

4. Position the starter shield (1) above the starter.

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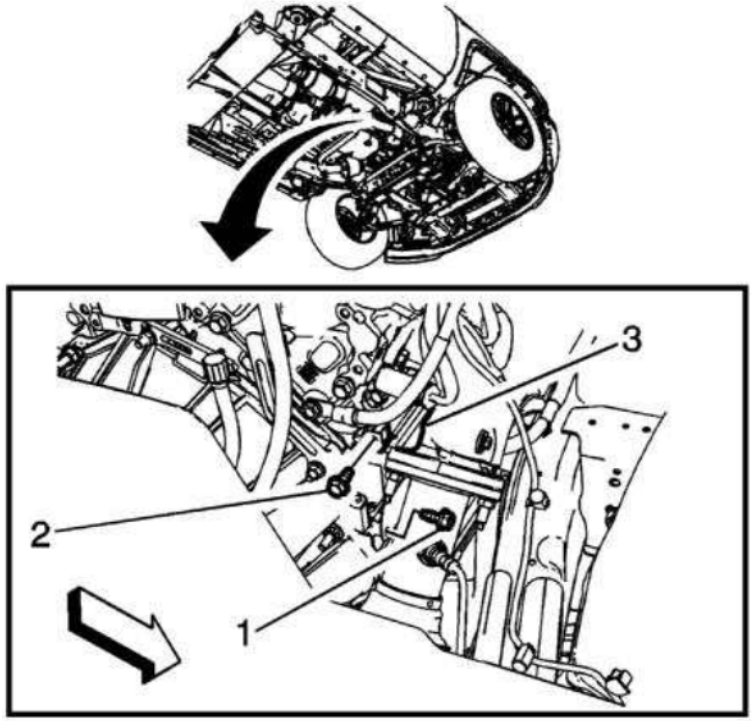


Fig. 84: Lower Fastener And Upper Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Install the starter shield (3) into position and tighten the lower starter shield fastener (1) to 9 N.m (80 lb in).
6. Install the upper starter shield fastener (2) and tighten to 22 N.m (16 lb ft).
7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

STARTER REPLACEMENT (L96)

Removal Procedure

1. Disconnect the battery negative cable. **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**
2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

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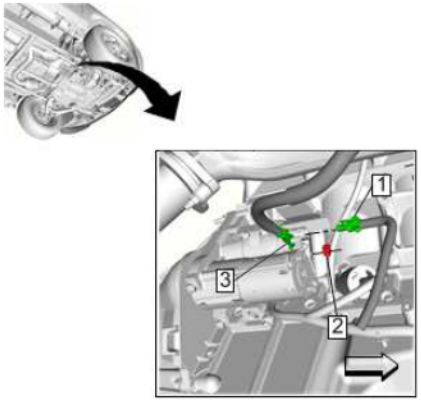


Fig. 85: Starter Solenoid Connector
Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Starter Solenoid Connector (1)
4. Remove Starter Solenoid Cable Nut (2)
5. Remove Starter Solenoid Cable (3)

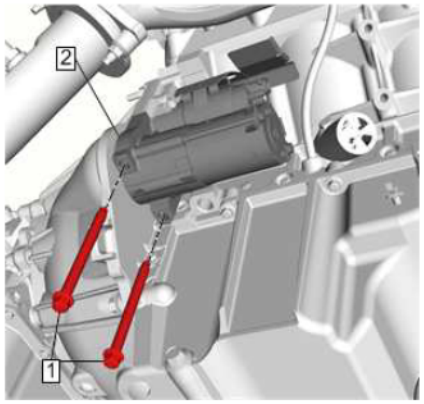


Fig. 86: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

6. Remove Starter Mounting Bolt (1)
7. Remove Starter (2)

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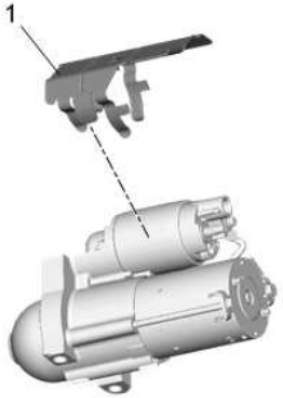


Fig. 87: Starter Heat Shield
Courtesy of GENERAL MOTORS COMPANY

8. Remove Starter Heat Shield (1)

Installation Procedure

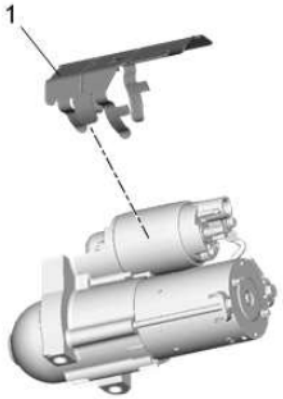


Fig. 88: Starter Heat Shield
Courtesy of GENERAL MOTORS COMPANY

1. Install Starter Heat Shield (1)

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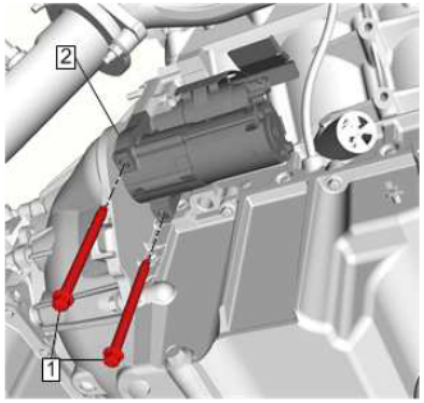


Fig. 89: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Install Starter (2)

CAUTION: **Refer to Fastener Caution**

3. Install Starter Mounting Bolt (1) and tighten 50 N.m (37 lb ft)
4. Lower the vehicle.

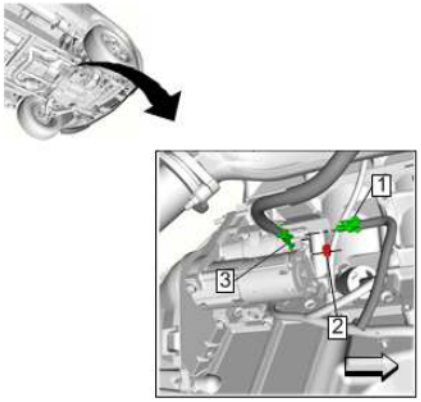


Fig. 90: Starter Solenoid Connector
Courtesy of GENERAL MOTORS COMPANY

5. Connect Electrical Connector (1)
6. Install Generator Battery Control Wiring Harness (3)
7. Install Generator Battery Control Wiring Harness Nut (2) and tighten 9 N.m (80 lb in)

STARTER SHIELD REPLACEMENT (L83, L86)

Removal Procedure

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WARNING: Refer to **Hot Exhaust System Warning** .

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.
2. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle** .
3. Remove the fastener securing the generator battery control wiring harness cable to the starter. Reposition the cable.

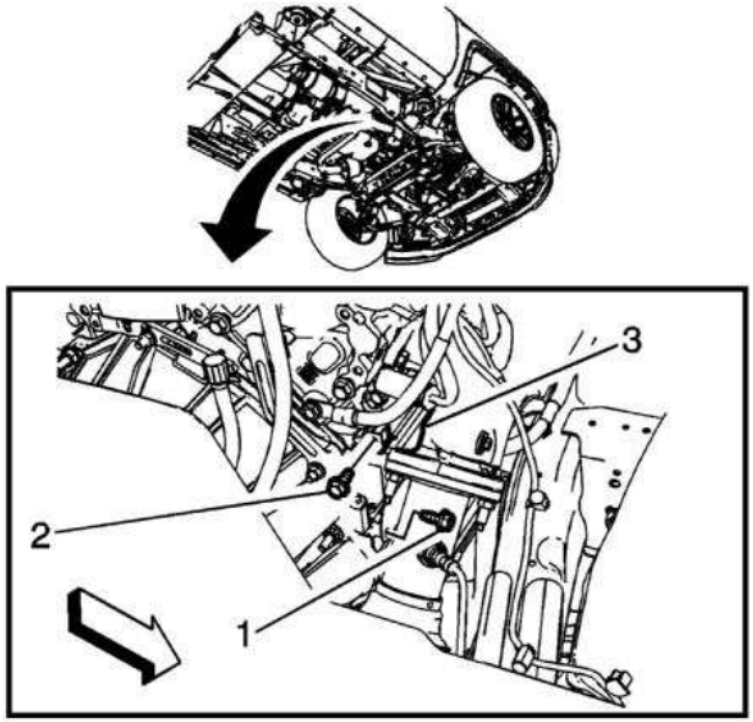


Fig. 91: Lower Fastener And Upper Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Remove the lower fastener (1) and the upper fastener (2), securing the starter shield (3).

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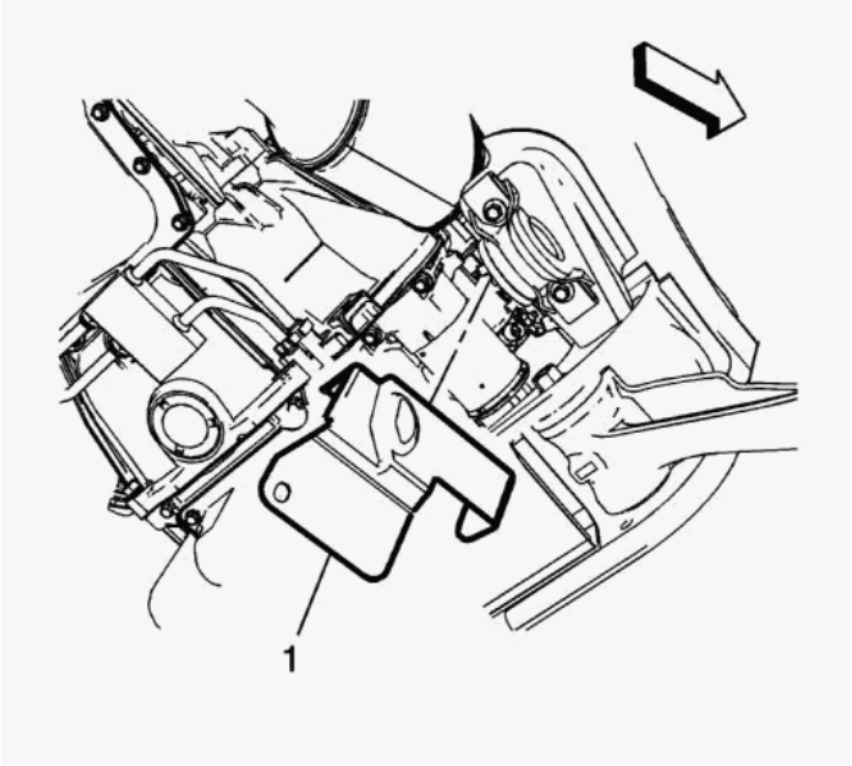


Fig. 92: Starter Shield And Starter
Courtesy of GENERAL MOTORS COMPANY

5. Remove the starter shield (1) from above the starter.

Installation Procedure

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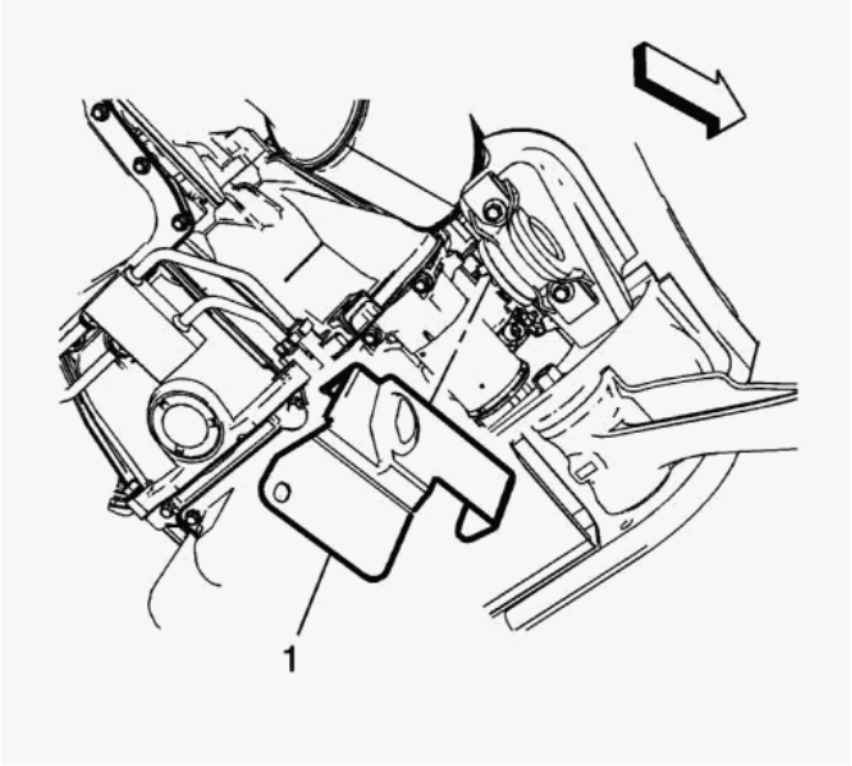


Fig. 93: Starter Shield And Starter
Courtesy of GENERAL MOTORS COMPANY

1. Position the starter shield (1) above the starter.

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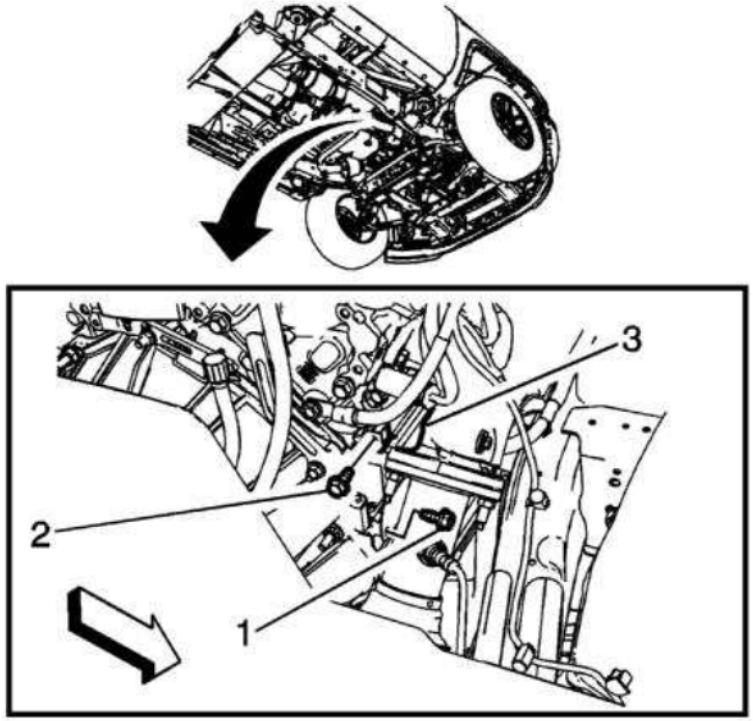


Fig. 94: Lower Fastener And Upper Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

2. Install the starter shield (3) into position and tighten the fastener (1) to 9 N.m (80 lb in).
3. Install the upper starter shield fastener (2) and tighten to 22 N.m (16 lb ft).
4. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.

GENERATOR BRACKET REPLACEMENT

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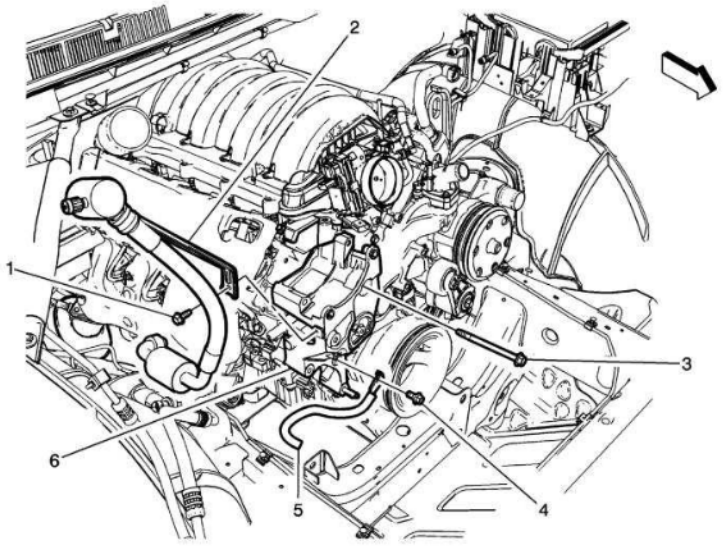


Fig. 95: Generator Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Remove the generator. Refer to **Generator Replacement (L96)Generator Replacement (L83, L86)**. 2. Reposition the air conditioning compressor from the mounted position. Refer to **Air Conditioning Compressor Replacement (L83 L86)** **Air Conditioning Compressor Replacement (L96)** .	
1	Air Conditioning Tube Bracket Fastener **CAUTION:** **Refer to** **Fastener** **Caution** . **Tighten** 22 N.m (16 lb ft)
2	Air Conditioning Tube Bracket
3	Generator Battery Control Wiring Harness Ground Cable Fastener **Tighten** 45 N.m (33 lb ft)
4	Generator Battery Control Wiring Harness Ground Cable
5	Generator Bracket Fastener **Tighten** 58 N.m (43 lb ft)
6	Generator Bracket

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GENERATOR AND POWER STEERING PUMP BRACKET REPLACEMENT (L96)

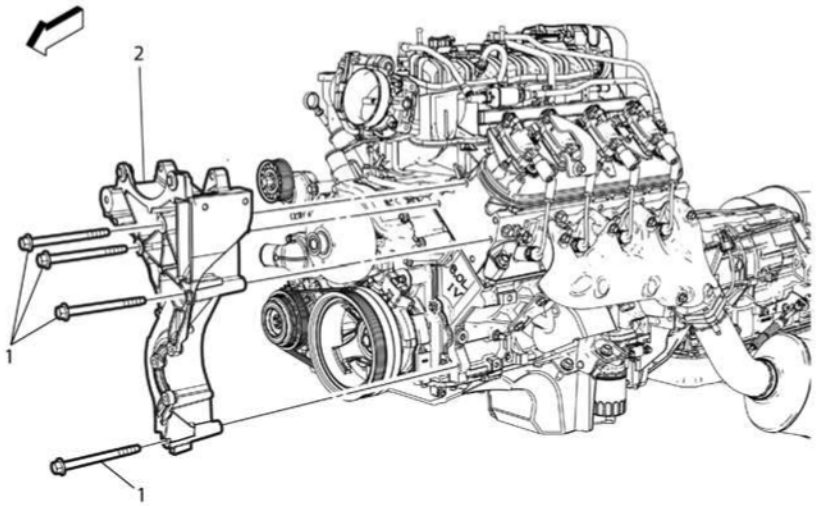


Fig. 96: Generator and Power Steering Pump Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Remove the generator. Refer to **Generator Replacement (L96)**. 2. Remove the power steering pump. Refer to **Power Steering Pump Replacement (Heavy Duty)** . 3. Remove the drive belt idler pulley, if replacing the bracket. Refer to **Drive Belt Idler Pulley Replacement** .	
1	Generator and Power Steering Pump Bracket Fasteners (Qty: 4) **CAUTION:** **Refer to Fastener Caution .** **Tighten:** 50 N.m (37 lb ft)
2	Generator and Power Steering Pump Bracket

GENERATOR REPLACEMENT (L96)

Removal Procedure

1. Disconnect the negative battery. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**.
2. Remove the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement** .

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3. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory** .

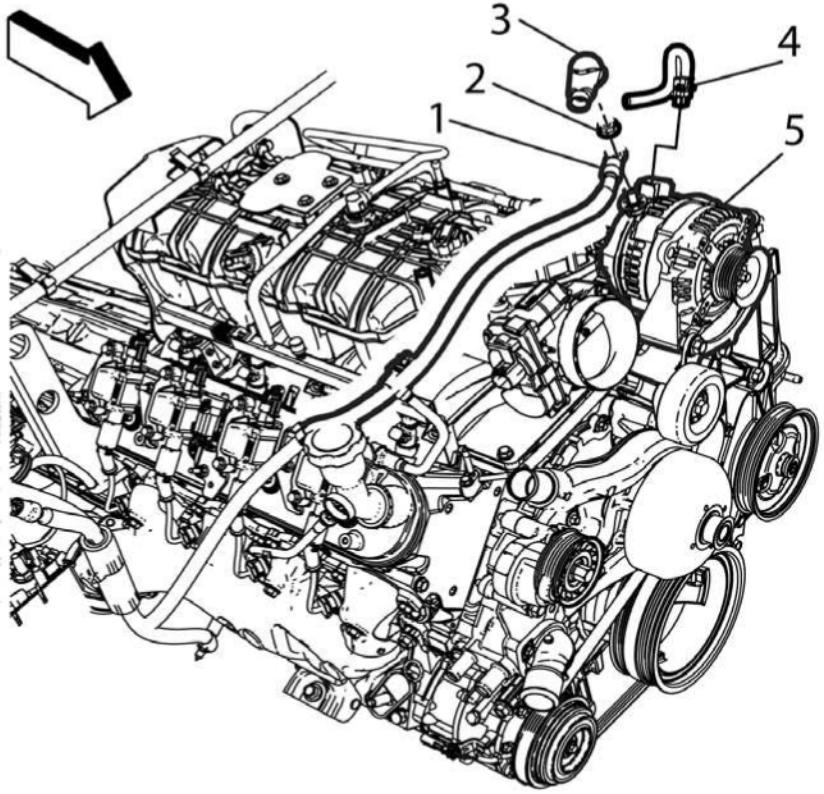


Fig. 97: Starter Solenoid Cable At Generator
Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine harness connector (4) and remove the generator B + protective boot (3).
5. Remove the generator B + fastener (2) and remove the generator battery control wiring harness cable (1), from the generator (5).

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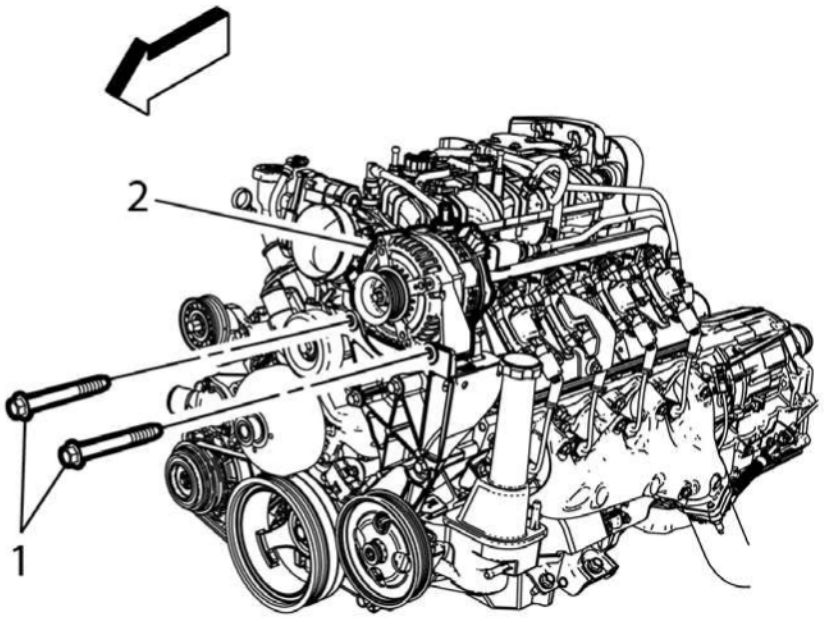


Fig. 98: Generator Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

6. Remove the generator mounting bolts (1) and remove the generator (2) from the engine compartment.

Installation Procedure

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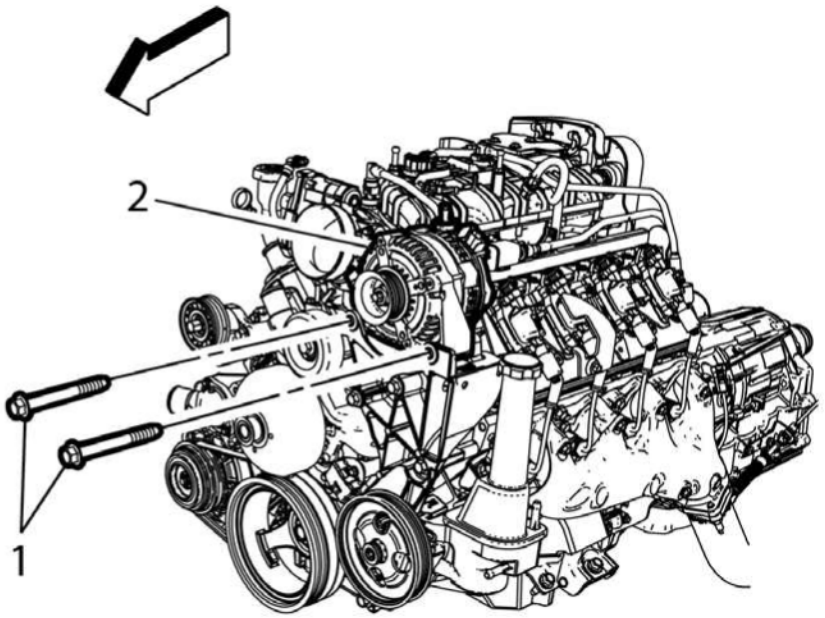


Fig. 99: Generator Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution .**

1. Install the generator (2) to the generator bracket and tighten the generator mounting bolts (1) to 50 N.m (37 lb ft).

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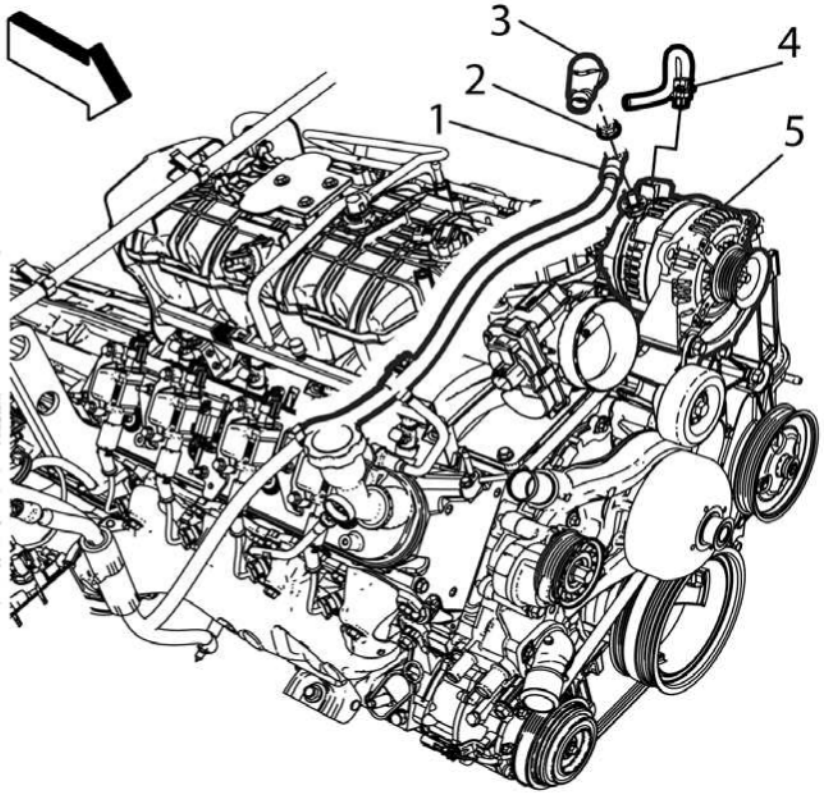


Fig. 100: Starter Solenoid Cable At Generator
Courtesy of GENERAL MOTORS COMPANY

2. Connect the generator engine harness connector (4) and install the generator battery control wiring harness cable (1) to the B + generator stud. Tighten the nut (2) to 15 N.m (11 lb ft).
3. Slide the protective boot (3) back onto the terminal stud.
4. Install the accessory drive belt. Refer to **Drive Belt Replacement - Accessory** .
5. Install the upper intake manifold sight shield. Refer to **Upper Intake Manifold Sight Shield Replacement** .
6. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**

GENERATOR REPLACEMENT (L83, L86)

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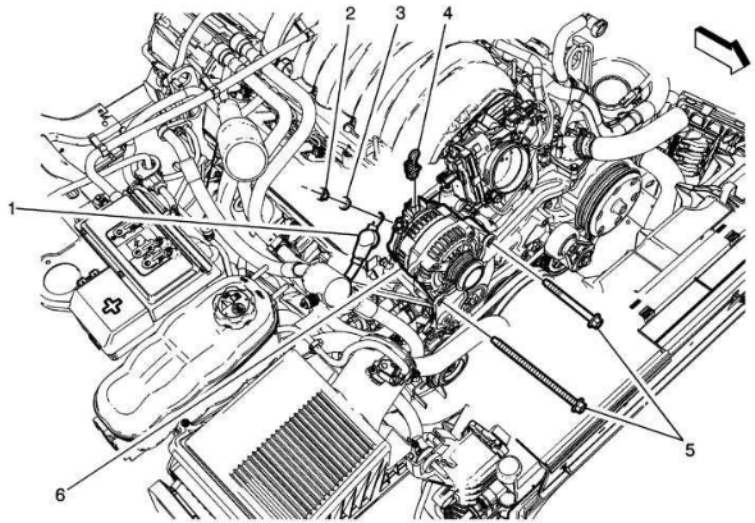


Fig. 101: Generator
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection (Dual Battery)Battery Negative Cable Disconnection and Connection (Single Battery)**. 2. Remove the accessory drive belt. Refer to **Drive Belt Replacement - Accessory** .	
1	Protective Boot
2	Generator Battery Control Wiring Harness Cable Fastener **CAUTION:** **Refer to** **Fastener Caution** . **Tighten** 12 N.m (106 lb in)
3	Generator Battery Control Wiring Harness Cable
4	Engine Wiring Harness Connector
5	Generator Mounting Fasteners **Tighten** 50 N.m (37 lb ft)
6	Generator

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DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

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.**

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

Battery Low Start Vehicle Message

The body control module (BCM) monitors battery positive voltage to determine battery state of charge. If one or more of the BCM battery positive voltage terminals measure less than approximately 11.6V compared to the BCM ground circuits, this message will display and four chimes may sound. Start the vehicle immediately. If the vehicle is not started and the battery continues to discharge, the climate controls, heated seats, and audio systems will shut off and the vehicle may require a jump start. These systems will function again after the vehicle is started.

Battery Ratings

A battery has 2 ratings:

- Cold cranking amperage
- Amperage hours

When a battery is replaced use a battery with similar ratings. See battery specification label on the original battery.

Amperage Hours

The amperage hour rating tells you how much amperage is available when discharged evenly over a 20 hour period. The amperage hour rating is cumulative, so in order to know how many constant amperage the battery will output for 20 h, you have to divide the amperage hour rating by 20. Example: If a battery has an amperage hour rating of 74, dividing by 20 = 3.75. Such a battery can carry a 3.75 A load for 20 hours before dropping to 10.5 V. (10.5 V is the fully discharged level, at which point the battery needs to be recharged.) A battery with an amperage hour rating of 55 will carry a 2.75 A load for 20 hours before dropping to 10.5 V.

Cold Cranking Amperage

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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 -18Â°C (0Â°F) while maintaining at least 7.2 V. See battery label for the cold cranking amperage rating of this battery.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management Overview

The electrical power management 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 electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

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

The battery condition is estimated during ignition-off and during ignition-on. During ignition-off the state-of-charge of the battery is determined by measuring the open-circuit voltage. The state-of-charge 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 state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

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

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the battery state-of-charge 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. The second section describes charging system operation. The third section describes the instrument panel cluster operation of the charge indicator, driver information center 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 V.

Body Control Module (BCM)

The body control module (BCM) is a GMLAN device. It communicates with the engine control module (ECM) and the instrument panel cluster for electrical power management (electrical power management) operation. The BCM determines the output of the generator and sends the information to the ECM for control of the generator turn on signal 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. The BCM performs idle boost.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to either the negative or positive 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)

When the engine is running, the generator turn-on signal is sent to the generator from the ECM, turning on the regulator. The generator's voltage regulator controls current to the rotor, thereby controlling the

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output voltage. The rotor current is proportional to the electrical pulse width supplied by the regulator. When the engine is started, the regulator senses generator rotation by detecting AC voltage at the stator through an internal wire. Once the engine is running, the regulator varies the field current by controlling the pulse width. This regulates the generator output voltage for proper battery charging and electrical system operation. The generator field duty terminal is connected internally to the voltage regulator and externally to the ECM. When the voltage regulator detects a charging system problem, it grounds this circuit to signal the ECM that a problem exists. The ECM monitors the generator field duty cycle signal circuit, and receives control decisions based on information from the BCM.

Instrument Panel Cluster

The instrument panel cluster provides the customer notification in case a concern with the charging system. There are 2 means of notification, a charge indicator and a driver information center message of SERVICE BATTERY CHARGING SYSTEM if equipped.

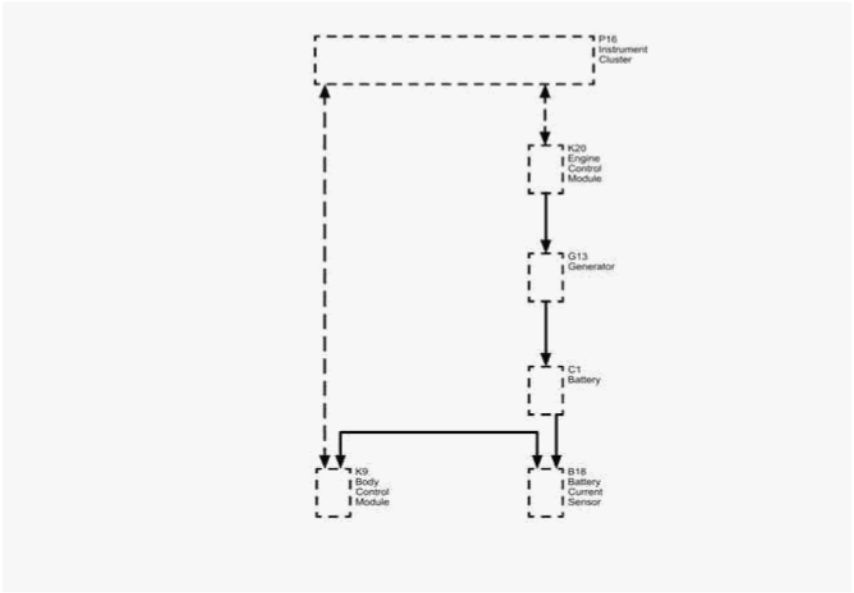


Fig. 102: Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
P16	P16 Instrument Cluster
K20	K20 Engine Control Module
G13	G13 Generator
C1	C1 Battery
B18	B18 Battery Current Sensor
K9	K9 Body Control Module

Charging System Operation

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

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Headlamp Mode

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- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance though the generator field duty cycle signal circuit. The signal is a 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 PWM signal of 128 Hz with a duty cycle of 0-100 percent. Normal duty cycle is between 5-99 percent. Between 0-5 percent and 100 percent are for diagnostic purposes.

Battery Sulfation Mode

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

Charge Mode

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

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

When any one of these conditions is met, the system will set targeted generator output voltage to a charging voltage between 13.9-15.5 V, depending on the battery state of charge and estimated battery temperature.

Fuel Economy Mode

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

Headlamp Mode

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

Start Up Mode

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

Voltage Reduction Mode

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

Instrument Panel Cluster Operation

Charge Indicator Operation

The instrument panel cluster illuminates the charge indicator and displays a warning message in the driver information center if equipped, when the one or more of the following occurs:

- The engine control module (ECM) detects that the generator output is less than 11 V or greater than 16 V. The instrument panel cluster receives a GMLAN message from the ECM requesting illumination.
- The instrument panel cluster determines that the system voltage is less than 11 V or greater than 16 V for more than 30 seconds. The instrument panel cluster receives a GMLAN message from the body control module (BCM) indicating there is a system voltage range concern.
- The instrument panel cluster performs the displays test at the start of each ignition cycle. The indicator illuminates for approximately 3 seconds.

Display Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM

The BCM and the ECM will send a serial data message to the driver information center for the BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM message to be displayed. It is commanded ON when a charging system DTC is a current DTC. The message is turned OFF when the conditions for clearing the DTC have been met.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

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

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

Each electrical power management function, either idle boost or load shed, is activated in incremental steps. For example, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

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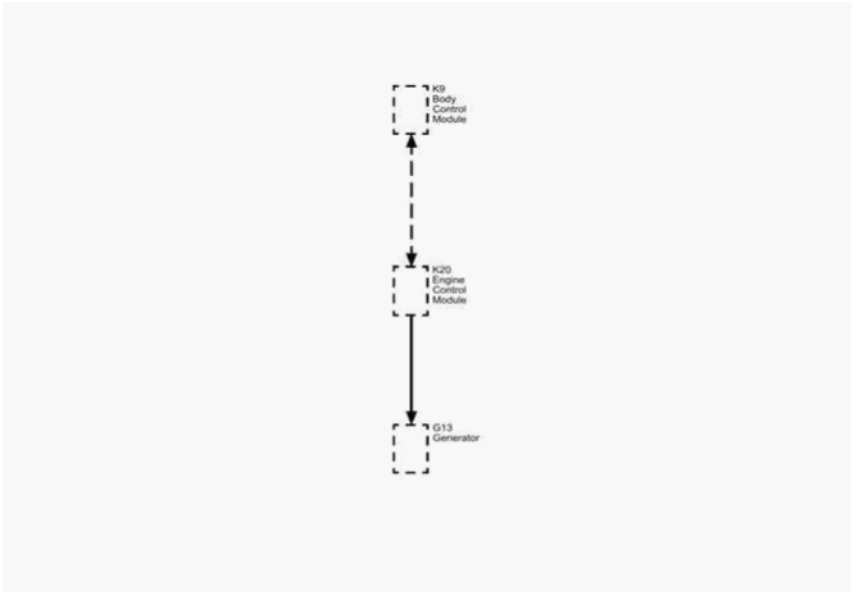


Fig. 103: Electrical Power Management Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
K9	K9 Body Control Module
K20	K20 Engine Control Module
G13	G13 Generator

Idle Boost and Load Shed With Current Sensor

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Â°C (5Â°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 Ah	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 11 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -10Â°C (14Â°F)	Greater Than 12 V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 11 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC 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

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Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 3 Start	-	-	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 11 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	-	-	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC 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 V	Battery has a net loss of less than 8 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, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC 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 13 Ah	Clear Load Shed 3

Idle Boost and Load Shed Without Current Sensor (based on battery voltage)

Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
Idle Boost 1 Start	Less Than -15Â°C (5Â°F)	Less Than 13 V	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 12.6 V	First level Idle boost requested
Idle Boost 1 End	Greater Than -15Â°C (5Â°F)	-	First level Idle boost request cancelled
Idle Boost 1 End	-	Greater Than 13 V	First level Idle boost request cancelled
Idle Boost 2 Start	-	Less Than 12.4 V	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12.5 V	Second level Idle boost request cancelled
Load Shed 1 Start	-	Less Than 12.3 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12.4 V	Clear Load Shed 1
Idle Boost 3 Start	-	Less Than 10 V	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12.3 V	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 12.1 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.2 V	Clear Load Shed 2

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Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
Load Shed 3 Start	-	Less Than 11.9 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.0 V	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

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

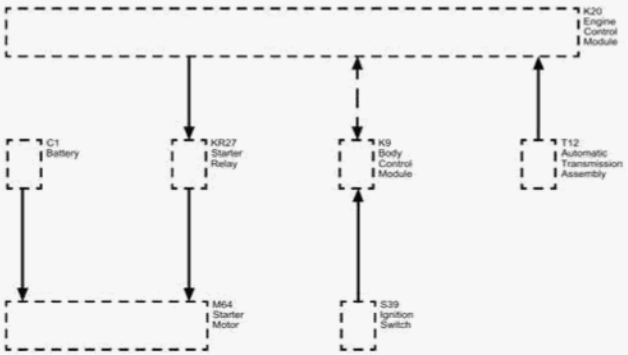
As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly, and solenoid 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 START relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

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

Circuit Description (Key Start)

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



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Fig. 104: Starting System Block Diagram
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Callout	Component Name
K20	K20 Engine Control Module
C1	C1 Battery
KR27	KR27 Starter Relay
K9	K9 Body Control Module
T12	T12 Automatic Transmission Assembly
M64	M64 Starter Motor
S39	S39 Ignition Switch

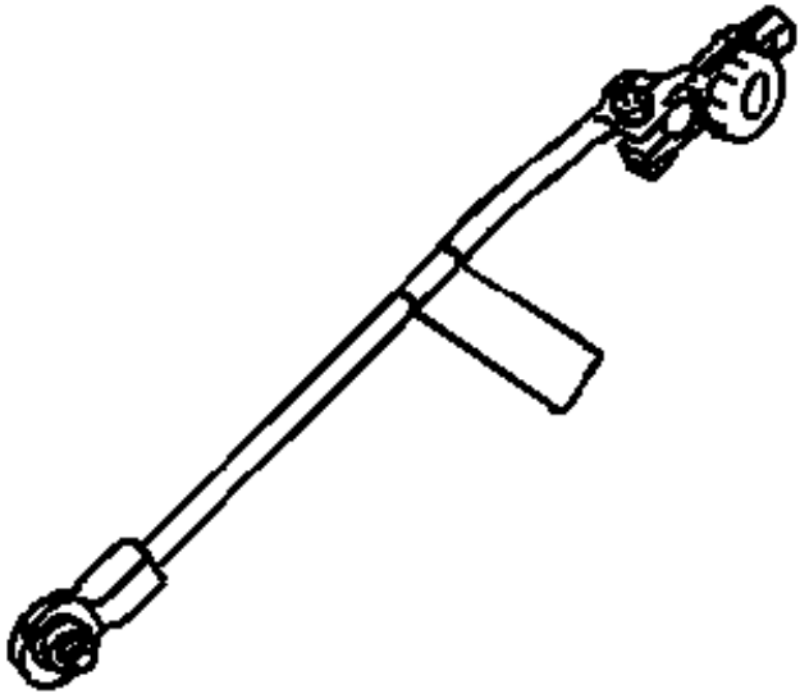
SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description

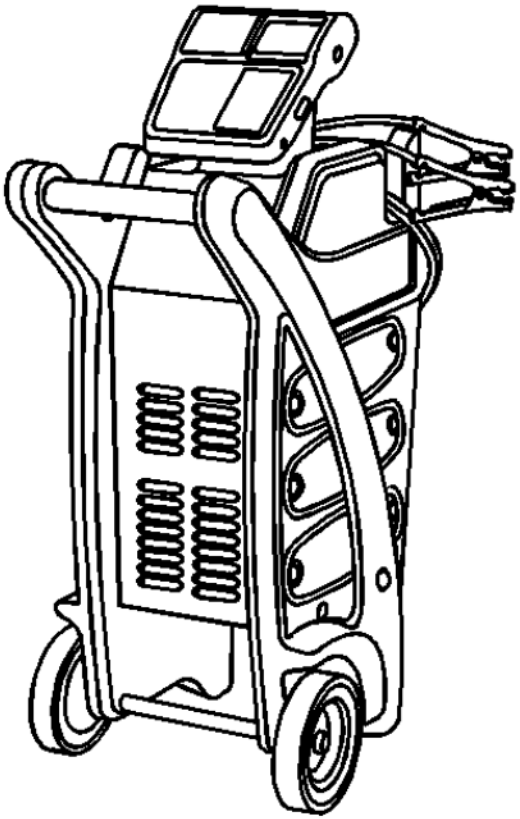
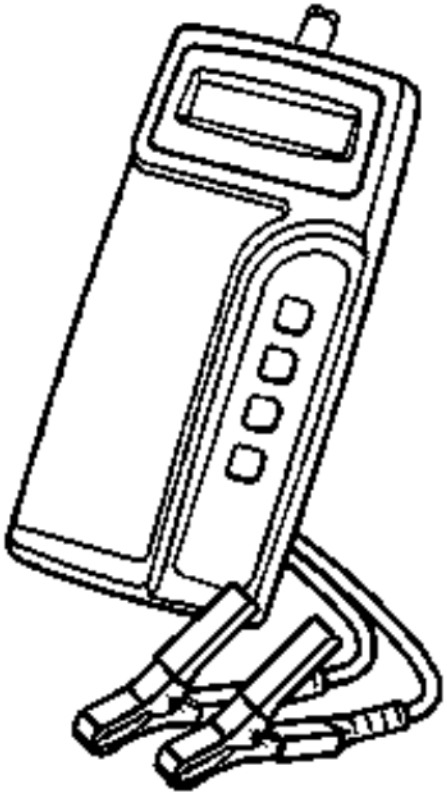
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Illustration	Tool Number/Description
	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch

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Illustration	Tool Number/Description
 	BC 800 W BC 800 WP EL 50313 EL 42000 EL 50076 J 42000 Battery Tester

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