

SPECIFICATIONS

FASTENER SPECIFICATIONS

Reusable Threaded Fastener Tightening Specifications

Application	Specification
	Metric (English)
Battery Hold Down Retainer Fastener	10 N.m (89 lb in)
Battery Negative Cable Ground Fastener (Frame Rail - LCV)	12 N.m (106 lb in)
Battery Negative Cable Ground Fastener (Frame Rail - LFX)	9 N.m (80 lb in)
Battery Negative Cable to Battery Post fastener	6 N.m (53 lb in)
Battery Negative Cable to Engine Block Fastener	25 N.m (18 lb ft)
Battery Positive Cable Fastener (Battery Fuse Block)	12 N.m (106 lb in)
Battery Positive Cable Fastener (Battery Post)	4.5 N.m (40 lb in)
Battery Positive Cable Fastener to Starter (LCV)	10 N.m (86 lb in)
Battery Positive Cable Fastener to Starter (LFX)	9 N.m (80 lb in)
Battery Tray Fastener	15 N.m (11 lb ft)
Body Harness Negative Ground Fastener (Battery Post)	9 N.m (80 lb in)
Generator BAT Terminal Fastener (LCV, LFX)	15 N.m (11 lb ft)
Generator Mounting Fastener (LCV)	22 N.m (16 lb ft)
Generator Mounting Fastener (LFX)	58 N.m (43 lb ft)
Starter Motor Mounting Fastener (LCV)	22 N.m (16 lb ft)
Starter Motor Mounting Fastener (LFX)	8 N.m (43 lb ft)
Starter Solenoid Fastener	10 N.m (89 lb in)

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starting (without KL9)

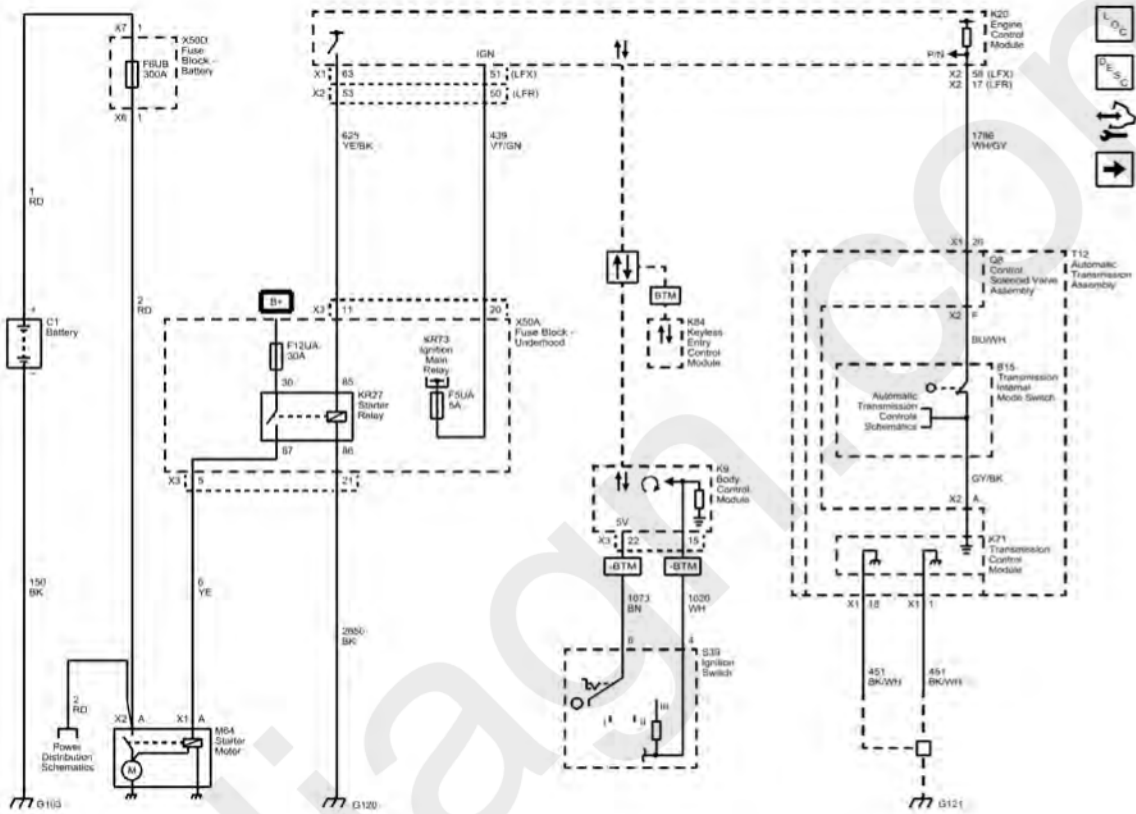


Fig. 1: Starting (without KL9)
Courtesy of GENERAL MOTORS COMPANY

Charging (without KL9)

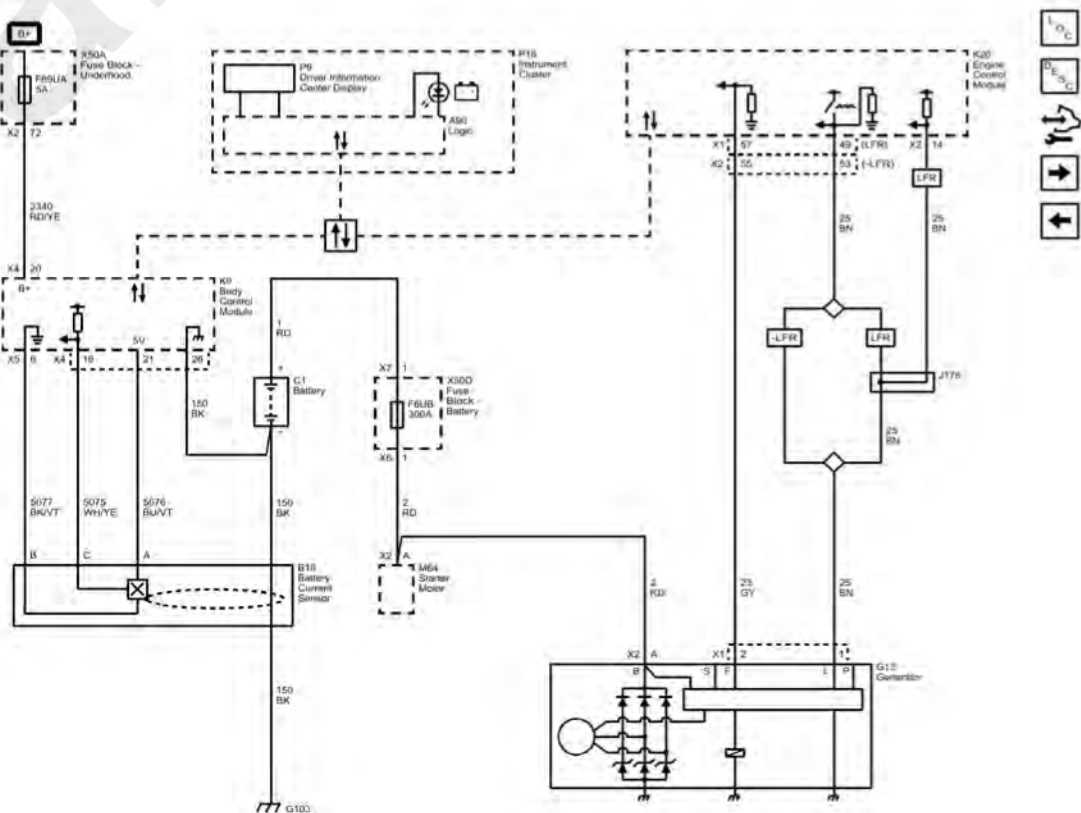


Fig. 2: Charging (without KL9)
Courtesy of GENERAL MOTORS COMPANY

Starting (KL9)

DTC C0870

Control Module Voltage Reference

DTC C0880

Control Module Voltage Reference

DTC C0895

Device Voltage

DTC C0899

Device Voltage

DTC C0900

Device Voltage

DTC P0560

System Voltage Low

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

The control module or sensor detects a system voltage of less than approximately 9 V or greater than 16 V

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

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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

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**
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
 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 Incorrect Mounting

Diagnostic Fault Information

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

Circuit/System Description

The B18 Battery Current Sensor is a 3-wire hall effect current sensor. The body control module (BCM) supplies 5 V and ground to the B18 Battery Current Sensor. The B18 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

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Starting and Charging Schematics

Connector End View Reference

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- [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 10 Ω between the low reference circuit terminal B and ground.
 - **If 10 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 10 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.
 - 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 Negative Cable Replacement \(without KL9\)](#)[Battery Negative Cable Replacement \(with KL9\)](#)
- [Control Module References](#) for K9 Body Control Module replacement, programming and setup.

DTC B151A: BATTERY CAPACITY 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.

- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC B151A 58

Battery Capacity Performance

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

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

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Starting and Charging Schematics

Connector End View Reference

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Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Verify DTC P0621 or P0622 is not set.
 - **If DTC P0621 or P0622 is set**

Refer to [DTC P0621](#), or [DTC P0622](#)
 - **If DTC P0621 or P0622 is not set**
2. Perform the [Battery Inspection/Test](#).

DTC B151C: BATTERY SENSOR MODULE INTERNAL MALFUNCTION

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](#) provide an overview of each diagnostic category.

DTC Descriptor

DTC B151C 39

Battery Sensor Module Internal Malfunction

DTC B151C 42

Battery Sensor Module Calibration Not Programmed

For symptom byte information, refer to [Symptom Byte List](#) .

Circuit/System Description

The battery sensor module is attached directly to the negative battery terminal and is used to determine the battery condition by calculating the battery state of charge, state of function, and state of health. The battery condition is used to help determine if the 12 volt stop/start system will allow a stop/start event to occur when the vehicle has come to a stop.

Conditions for Running the DTC

- The engine is not running.
- This diagnostic runs every 50 ms.

Conditions for Setting the DTC

- The battery sensor module has an internal malfunction.
- The BCM detects the battery sensor module is not programmed.

Action Taken When the DTC Sets

Start/stop is disabled.

Conditions for Clearing the DTC

The conditions for setting the DTC are no longer present.

Diagnostic Aids

DTC B151C may set if a battery charger is used.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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Description and Operation

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Electrical Information Reference

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.

2. Verify DTC B151C 39 or B151C 42 is not set.
 - **If the DTC is set**

Replace the B110 Battery Sensor Module.
 - **If the DTC is not set**

3. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

[Battery Sensor Replacement \(KL9\)](#)

[Control Module References](#) for battery sensor module replacement, programming, and setup

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

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

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Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Verification

Refer to [Battery Electrical Drain/Parasitic Load Test](#).

DTC P058B: BATTERY MONITOR MODULE CURRENT MONITORING 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.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P058B

Battery Monitor Module Current Monitoring Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Sensor Module B+ Terminal 2 X1	-	-	-	P058B
Battery Sensor Module Ground Terminal 1 X2	-	-	-	P058B
Battery Current Sensor 5 V Reference Terminal 1	-	-	-	P058B
Battery Current Sensor Signal Terminal 3	-	-	-	P058B
Battery Current Sensor Low Reference Terminal 2	-	-	-	P058B

Circuit/System Description

The B110 Battery Sensor Module (BSM) provides current data to the ECM. The ECM uses a Battery State Estimator (BSE) algorithm to determine the state of charge of the primary 12 volt battery for use in controlling the stop/start feature. The BSE monitors the current differences between the battery current sensor and the BSM.

Conditions for Running the DTC

- Vehicle in Run mode

- DTCs P118C, P118D not present

Conditions for Setting the DTC

The battery sensor module detects the difference between the battery sensor module current and the ECM measured reference current is greater than or equal to 22 A.

Action Taken When the DTC Sets

- DTC P058B is a type B DTC
- 12V start/stop is disabled

Conditions for Clearing the DTC

DTC P058B is a type B DTC.

Diagnostic Aids

Check for DTC U0140. If set, resolve those issues, clear codes.

Reference Information

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Connector End View Reference

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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 Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the X2 harness connector at the B110 Battery Sensor Module. 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 1 X2 and ground.
 - **If greater than 10 Ω**
 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. Reconnect the X2 harness connector at the B110 Battery Sensor Module.
4. Test for less than 2 Ω between terminal 1 X2 and battery negative terminal.
 - **If greater than 2 Ω**

Repair the open or high resistance in the ground connection.
 - **If less than 2 Ω**
5. Disconnect the X1 harness connector at the B110 Battery Sensor Module.
6. Verify a test lamp illuminates between B+ terminal 2 X1 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 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 good and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp
 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 B110 Battery Sensor Module.
 - **If the test lamp illuminates**
7. Disconnect the harness connector at the B18 Battery Current Sensor.
8. Test for less than 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine 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 K20 Engine Control Module.
 - **If less than 10 Ω**
9. Ignition ON.
10. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine 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 K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine 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 K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
11. Test for 11.8 - 13 V between the signal circuit terminal 3 and B+
 - **If not between 11.8 - 13 V**
 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 signal circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V

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 between 11.8 - 13 V

12. Replace B18 Battery Current Sensor

Repair Instructions

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

- **Battery Sensor Replacement (KL9)**
- **Control Module References** for control module replacement, programming, and setup

DTC P058D: BATTERY MONITOR MODULE VOLTAGE MONITORING 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.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P058D

Battery Monitor Module Voltage Monitoring Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Battery Sensor Module B+ Terminal 2 X1	-	P058D	-	P058D
Battery Sensor Module Ground 1 X2	-	P058D	-	P058D
Engine Control Module Ignition Terminal 51 X1	-	P058D	-	P058D

Circuit/System Description

The B110 Battery Sensor Module (BSM) provides primary battery voltage data to the ECM. The ECM uses a Battery State Estimator (BSE) algorithm to determine the state of charge of the primary 12 volt battery for use in controlling the stop/start feature. The BSE monitors the voltage differences between the ECM and BSM.

Conditions for Running the DTC

Vehicle in Run mode

Conditions for Setting the DTC

The difference between the ECM measured battery voltage and the battery sensor module reported battery voltage is greater than 2 V for 4 s.

Action Taken When the DTC Sets

- DTC P058D is a type B DTC
- 12V start/stop is disabled

Conditions for Clearing the DTC

DTC P058D is a type B DTC.

Diagnostic Aids

Check for DTC U0140. If set, resolve those issues, clear codes.

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Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF. Disconnect the X2 harness connector at the B110 Battery Sensor Module. 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 1 X2 and ground.
 - **If greater than 10 Ω**

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. Reconnect the X2 harness connector at the B110 Battery Sensor Module.
4. Test for less than 2 Ω between terminal 1 X2 and battery negative terminal.
 - **If greater than 2 Ω**

Repair the open or high resistance in the ground connection.
 - **If less than 2 Ω**
5. Disconnect the X1 harness connector at the B110 Battery Sensor Module.
6. Test for less than 2 V between the positive battery terminal and B+ circuit terminal 2 X1 at the B110 Battery Sensor Module.
 - **If the difference is 2 V or greater 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 good and there is voltage at the fuse
 - **If the difference is 2 V or greater 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 B110 Battery Sensor Module.
 - **If the difference is less than 2 V**

7. Engine running, measure and record the battery voltage at the battery terminals.
8. Verify the difference between the recorded value and scan tool Ignition 1 Signal parameter value in the engine control module is less than 2 V.

• If the difference is 2 V or greater

1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module.

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

3. Test for less than 2 Ω in the ignition circuit end to end at the Run/Crank IGN 1 Voltage at the K20 Engine Control Module and Run/Crank IGN 1 Voltage at the K125 Dual Battery Control Module

• If 2 Ω or greater, repair the open/high resistance in the circuit.

• If less than 2 Ω, replace the K125 Dual Battery Control Module.

• If the difference is less than 2 V

9. Replace B110 Battery Sensor Module
- Repair Instructions
- Perform the **Diagnostic Repair Verification** after completing the repair.
- **Battery Sensor Replacement (KL9)**

• **Control Module References** for control module replacement, programming, and setup
- DTC P0615, P0616, OR P0617: STARTER RELAY CONTROL (WITHOUT KL9)
- 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 P0615
- Starter Relay Control Circuit
- DTC P0616
- Starter Relay Control Circuit Low Voltage
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- Starter Relay Control Circuit High Voltage
- Diagnostic Fault Information
- | Circuit | Short to Ground | Open/High Resistance | Short to Voltage | Signal Performance |
|---|-----------------|----------------------|------------------|--------------------|
| Relay Switch B+ Terminal 30 | 1 | 2 | - | - |
| Relay Coil Ignition Terminal 85 | P0616 | P0615 | P0617 | - |
| Relay Switch Control Terminal 87 | 2 | 2 | 3 | - |
| Relay Coil Ground Terminal 86 | - | P0615 | - | - |
| 1. Opens fuse, Starter Solenoid does not click.
2. Starter Solenoid does not click.
3. Cranks all the time. | | | | |
- Circuit/System Description
- When the ignition is activated to start the vehicle, a discrete signal is supplied to the body control module (BCM). 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 pressed or the transmission is in park/neutral. If it is, the ECM then supplies 12 V to the control circuit of the KR27 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 activated to START.

• 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 KR27 Starter Relay.
- Action Taken When the DTC Sets
- DTC P0615, P0616, and P0617 are C type DTCs.
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- 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.
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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 good 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. 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.

NOTE: If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).

6. Verify the test lamp turns ON and OFF when commanding the Starter Relay ON and OFF with a scan tool.

- **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 1 X1 or A X1 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

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

DTC P0615, P0616, OR P0617: STARTER RELAY CONTROL (KL9)

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 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
Relay Switch B+ Terminal 30	1	2	-	-
Relay Coil B+ Terminal 85	1	2	-	-
Relay Switch Control Terminal 87	2	2	3	-
Relay Coil Control Terminal 86	P0616	P0615	P0617	-
1. Opens fuse, starter inop. 2. Starter inop. 3. Starter spins all the time.				

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the body control module (BCM). 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 pressed or the transmission is in park/neutral. If it is, the ECM then applies ground to the control circuit of the KR27 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 activated to START.
- 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 KR27 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.

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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 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. Ignition ON.
3. 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 good 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 the harness connectors 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**
4. Verify a test lamp illuminates between the B+ circuit terminal 85 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 good 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 KR27 Starter Relay
 - **If the test lamp illuminates**
5. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.

NOTE: If the Starter Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).

6. Verify the test lamp turns ON and OFF when commanding the Starter Relay ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 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 control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V,
 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.
 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, 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 1 X1 or A X1 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
 - **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 \(Within an Electrical Center\)](#)
- [Control Module References](#) for control module 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+	-	P0621	-	-
Control - L Terminal	P0621	-	P0621	-
Signal - F Terminal	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 on the generator turn on control circuit, a high voltage when the duty cycle voltage is commanded high, and a low voltage when the duty cycle voltage is commanded low.

Conditions for Running the DTC

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

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[Charging System Description and Operation](#)

Electrical Information Reference

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.

• **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 A X1, A X2, B X2 or 1 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 infinite resistance, replace G13 Generator.

• **If the test lamp illuminates**

2. Disconnect the X1 harness connector at the G13 Generator, engine running.

3. Test for 1 V or greater between the control circuit terminal 1 X1 and ground.

• **If less than 1 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 than 2 Ω, repair the open/high resistance in the circuit.

• If less than 2 Ω, replace the K20 Engine Control Module.

• **If 1V or greater**

4. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON

5. Test for less than 1 V between the G13 Generator control circuit terminal 1 X1 and ground.

• **If greater than 1 V**

Repair the short to voltage on the circuit.

• **If 1V or less**

6. Test or replace the G13 Generator.

[Repair Instructions](#)

Perform the [Diagnostic Repair Verification](#) after completing the repair.

• [Generator Replacement \(LFX\)Generator Replacement \(LCV\)](#)

• [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0622: GENERATOR F-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 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	-
Signal - F Terminal	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](#)

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Starting and Charging Schematics

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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 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 A X1, A X2, B X2 or 1 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 and at the M64 Starter Motor.
 - 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. Ignition Off, 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 appropriate 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 appropriate 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 \(LFX\)Generator Replacement \(LCV\)](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

DTC P0625 OR P0626: GENERATOR F-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 Descriptors

DTC P0625

Generator F-Terminal Circuit Low Voltage

DTC P0626

Generator F-Terminal Circuit High Voltage

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0625	-	-
Signal	P0625	P0625	P0626	-
Control	P0621	P0621	P0621	-

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

P0625

- The engine is running.
- The engine speed is less than 3000 RPM.

P0626

- The engine is not running.
- The ignition is in the ON position.

Conditions for Setting the DTC

P0625

The ECM detects a PWM signal less than 5% for 15 s.

P0626

The ECM detects a PWM signal greater than 65% for 15 s.

Action Taken When the DTC Sets

DTC P0625 and P0626 are C type DTCs.

Conditions for Clearing the DTC

DTC P0625 and P0626 are C type DTCs.

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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. Engine running.
2. Verify the scan tool Generator F-Terminal Signal Circuit parameter changes between 5 and 99%.
 - **If the parameter does not change**

Refer to Circuit/System Testing.
 - **If the parameter changes**
3. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2 or 1 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 and disconnect the B+ cable at the G13 Generator.
 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. 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, replace the G13 Generator.
 - **If the test lamp illuminates**
 2. Ignition OFF, disconnect the X1 harness connector at the G13 Generator.
 3. Verify the scan tool ECM Generator F-Terminal Signal parameter is less than 5%.
 - **If 5% or greater**
 1. Ignition OFF, disconnect the appropriate 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 ECM Generator F-Terminal 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 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
3. 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, replace the K20 Engine Control Module.
- **If greater than 95%.**
6. Replace the G13 Generator.

Repair Instructions

Perform the **[Diagnostic Repair Verification](#)** after completing the repair.

- **[Generator Replacement \(LFX\)Generator Replacement \(LCV\)](#)**
- **[Control Module References](#)** for ECM replacement, programming, and setup

DTC P118C OR P118D: LOW-VOLTAGE 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 P118C

Low-Voltage Battery Current Sensor Circuit Low Voltage

DTC P118D

Low-Voltage Battery Current Sensor Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P118C	P118C	P118C	-
Signal	P118C	P118C	P118D	-
Low Reference	-	P118C	-	-

Circuit/System Description

The B18 Battery Current Sensor is a 3-wire hall effect current sensor. The engine control module (ECM) supplies 5 V and ground to the B18 Battery Current Sensor. The B18 Battery Current Sensor measures the amount of current flowing to or from the battery, and supplies a variable voltage signal back to the ECM based on current flow..

Conditions for Running the DTC

P118C, P118D

The vehicle in service mode.

Conditions for Setting the DTC

P118C

The battery current sensor signal voltage is less than 0.5V for 4 s.

P118D

The battery current sensor voltage is greater than 4.5 V for 4 s.

Action Taken When the DTC Sets

DTC P118C and P118D are type A DTCs.

12V start/stop is disabled.

Conditions for Clearing the DTC

DTC P118C and P118D are type A DTCs.

Reference Information

Schematic Reference

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- **[Wiring Repairs](#)**

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Testing

12 Volt primary battery current sensor circuit checks

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 10 Ω between the low reference circuit terminal 2 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine 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 K20 Engine Control Module.
 - **If less than 10 Ω**
3. Ignition ON.
4. Test for 4.8 - 5.2 V between the 5 V reference circuit terminal 1 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine 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 K20 Engine Control Module.
 - **If greater than 5.2 V**
 1. Ignition OFF, disconnect the X1 harness connector at the K20 Engine 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 K20 Engine Control Module.
 - **If between 4.8 - 5.2 V**
5. Test for 11.8 - 13 V between the signal circuit terminal 3 and B+
- **If less than 11.8 V**
 1. 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
 2. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module.
 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 11.8 V or greater**
 - 4. 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
6. Replace the B18 Battery Current Sensor.
7. Verify that DTC P118C, P118D does not set while operating the vehicle within the Conditions for Running the DTC.
- **If the DTC sets**

Replace the K20 Engine Control Module.
 - **If the DTC does not set**
8. All OK.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Battery Current Sensor Replacement](#) for B18 Battery Current Sensor
- [Control Module References](#) for control module replacement, programming and setup

DTC P2500 OR P2501: 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 Descriptors

DTC P2500

Generator L-Terminal Circuit Low Voltage

DTC P2501

Generator L-Terminal Circuit High Voltage

For symptom byte information, refer to [Symptom Byte List](#) .

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P0625	-	-
Control	P2500	P2500	P2501	-
Signal	P0625	P0625	P0626	-

Circuit/System Description

The engine control module (ECM) uses the generator turn on control circuit, or L-terminal circuit, to control the load of the generator on the engine. A high side driver in the ECM applies a voltage to the voltage regulator. This 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 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 on the generator turn on control circuit. The ECM performs tests to determine the status of the generator turn on control circuit.

Conditions for Running the DTC

P2500

The engine is running.

P2501

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

Conditions for Setting the DTC

P2500

The ECM detects low voltage on the generator turn on control circuit for 2 s.

P2501

The ECM detects high voltage on the generator turn on control circuit for 2 s.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

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

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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**
 1. Verify the scantool parameter Generator L-Terminal Signal = 5-95 %
 - **If the expected value**
 - 2. Disconnect the connector X1 while engine running
 - **If not the expected value**
3. Verify the scantool parameter Generator L-Terminal Signal = between 89 and 92 %
 - **If not the expected value**
4. Refer to Circuit/System Testing.
 - **If the DTC does not set**
5. All OK.

[Circuit/System Testing](#)

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2 or 1 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 and at the M64 Starter Motor
 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, replace G13 Generator.
 - **If the test lamp illuminates**
2. Ignition Off, Disconnect the X1 harness connector at the G13 Generator, ignition ON.
3. Test for 1 V or greater between the control circuit terminal 1 X1 and ground.
 - **If less than 1 V**
 1. Ignition OFF, disconnect the appropriate 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 than 2 Ω, repair the open/high resistance in the circuit.
 - If less than 2 Ω, replace the K20 Engine Control Module.
 - **If 1V or greater**
4. Ignition OFF, disconnect the appropriate harness connectors at the K20 Engine Control Module, Ignition ON.
5. Test for less than 1 V between the G13 Generator control circuit terminal 1 X1 and ground.
 - **If greater than 1 V**

Repair the short to voltage on the circuit.
 - **If 1V or less**
6. Test or replace the G13 Generator.

[Repair Instructions](#)

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Generator Replacement \(LFX\)](#)[Generator Replacement \(LCV\)](#)
- [Control Module References](#) for ECM replacement, programming and setup.

DTC P2505: ENGINE CONTROL MODULE (ECM) SUPPLY VOLTAGE 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 Descriptors](#)

DTC P2505

Engine Control Module (ECM) Supply Voltage Circuit

[Circuit/System Description](#)

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

[Conditions for Running the DTC](#)

The ignition is ON.

[Conditions for Setting the DTC](#)

The control module detects an interruption of the power supply.

[Action Taken When the DTC Sets](#)

DTC P2505 is a type B DTC.

[Conditions for Clearing the DTC](#)

DTC P2505 is a type B DTC.

[Reference Information](#)

Schematic Reference

- [Engine Controls Schematics](#) for 2.5L (LCV) engine
- [Engine Controls Schematics \(LFX\)](#) [Engine Controls Schematics \(LFR\)](#) for 3.6L (LFR or LFX) engine

Connector End View Reference

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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**
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 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**
6. All OK.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the appropriate harness connector at the K20 Engine 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 listed below and ground.
 - Ground Circuit - terminal 73 X2 (2.5L LCV or 3.6L LFX engines)
 - Ground Circuit - terminal 73 X3 (2.5L LCV or 3.6L LFX engines)
 - Ground Circuit - terminal 1, 4, 2 X2 (3.6L LFR engine)
 - **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 OFF, disconnect the appropriate harness connector at the K20 Engine Control Module.
4. Verify a test lamp illuminates between each B+ circuit terminal listed below and ground.
 - B+ Circuit - terminal 52 X1 (2.5L LCV or 3.6L LFX engines)
 - B+ Circuit - terminal 86 X2 (3.6L LFR engine)
 - **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 K20 Engine Control Module.
 - **If the test lamp illuminates**
5. Ignition OFF, disconnect the appropriate harness connector at the K20 Engine Control Module, Ignition ON.
6. Verify a test lamp illuminates between each ignition circuit terminal listed below and ground.
 - Ignition Circuit - terminal 51, 73, 62 X1 (2.5L LCV engine)
 - Ignition Circuit - terminal 51, 73, 62, 67 X1 (3.6L LFX engine)
 - Ignition Circuit - terminal 50, 3, 5, 6 X2 (3.6L LFR engine)
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 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, refer to [Power Mode Mismatch](#) .
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp
 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 K20 Engine Control Module.
 - **If the test lamp illuminates**
7. Replace the K20 Engine Control Module

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

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

DTC P26E4-P26E6: STARTER DRIVE PINION 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.

DTC Descriptors

DTC P26E4

Starter Drive Pinion Relay Control Circuit

DTC P26E5

Starter Drive Pinion Relay Control Circuit Low Voltage

DTC P26E6

Starter Drive Pinion Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+ Terminal 30	1	1	-	-
Relay Coil Ignition Terminal 85	P26E5	P26E4	P26E6	-
Relay Switch Control Terminal 87	2	1	2	-
Relay Coil Ground Terminal 86	-	P26E4	-	-
1. Opens fuse, Starter pinion inop. 2. Starter pinion spins all the time.				

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the engine cotrol module (ECM). The ECM then verifies that the clutch pedal is pressed or the transmission is in park/neutral. If it is, the ECM then supplies 12 V to the control circuit of the starter drive pinion relay. When this occurs, battery voltage is supplied through the switch of the starter relay to the starter pinion.

Conditions for Running the DTC

- The ignition is activated to START.
- 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 P26E4, P26E5, and P26E6 are C type DTCs.

Conditions for Clearing the DTC

DTC P26E4, P26E5, and P26E6 are C type DTCs.

Reference Information

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- [Relay Replacement \(Attached to Wire Harness\) Relay Replacement \(Within an Electrical Center\)](#)

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 KR27C Starter Pinion Solenoid Actuator 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 good 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. 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.

NOTE: If the Starter Pinion Relay command is not available in the scan tool, verify the test lamps turns on and off when cycling the ignition between the OFF and CRANK position with the parking brake set and clutch pedal pressed (manual transmission) or the transmission in park (automatic transmission).

6. Verify the test lamp turns ON and OFF when commanding the Starter Pinion Relay ON and OFF with a scan tool.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X1 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 X1 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 X1 2 or X1 B 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 KR27C Starter Pinion Solenoid Actuator Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the appropriate relay.
2. Test for 70 - 150 Ω between terminals (85 or 1) and (86 or 2).
 - If less than 70 or greater than 150 Ω

Replace the relay.

- If between 70 - 150 Ω

3. Test for infinite resistance between the terminals listed below:

- (30 or 3) and (86 or 2)
- (30 or 3) and (87 or 5)
- (30 or 3) and (85 or 1)
- (85 or 1) and (87 or 5)
- (86 or 2) and (87 or 5)

- If less than infinite resistance

Replace the relay.

- If infinite resistance

4. Install a 3 A fused jumper wire between relay terminal (85 or 1) and 12 V. Install a jumper wire between relay terminal (86 or 2) and ground.
5. Test for less than 5.0 Ω between terminals (30 or 3) and (87 or 5).

- If 5.0 Ω or greater

Replace the relay.

- If less than 5.0 Ω

6. All OK

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

[Control Module References](#) for control module replacement, programming, and setup.

DTC P305F: DUAL BATTERY CONTROL MODULE 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.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptors

DTC P305F

Dual Battery Control Module Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	-	P305F	-	P305F
Ignition	-	P305F	-	P305F
Control	-	P305F	-	P305F
Ground	-	P305F	-	P305F

Circuit/System Description

This system uses a dual battery configuration which includes the 12 V primary battery and 12 V auxiliary battery. The dual battery control module switches the 12 V primary battery and 12 V auxiliary battery in and out at appropriate times to support vehicle loads and battery charging. During engine crank, the auxiliary battery is switched in to supply voltage to the vehicle loads (except the starter motor which receives voltage from the primary battery), and the ECM monitors the auxiliary battery voltage through the IGN input.

Conditions for Running the DTC

During CRANK.

Conditions for Setting the DTC

The Engine Control Module (ECM) identifies that the voltage during engine crank at the IGN input (auxiliary battery voltage) of the ECM is below 8.90 V for 2 out of 3 start events.

Action Taken When the DTC Sets

- P305F is a type B code.
- Auto-stop is disabled.

Conditions for Clearing the DTC

The voltage at the IGN input of the ECM is above 8.9 V for more than 3 consecutive start events.

Diagnostic Aids

It is critical that all electrical connections are clean and tight. Some of the connections to verify include:

- Main and Auxiliary battery ground connections
- Auxiliary battery cable connection
- Dual Battery Control Module connections
- All connections in the X50D Fuse Block - Battery

Reference Information

Schematic Reference

- [Starting and Charging Schematics](#)
- [Automatic Transmission Controls Schematics](#) - Refer to schematic with KL9

- [Electrical Center Identification Views](#) - Refer to X50D Fuse Block - Battery Top View (KL9)

Connector End View Reference

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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. Using the Graphical Data Display in the scan tool, verify the ECM Ignition 1 Signal is 8.9 V or greater during ignition CRANK
 - **If Ignition 1 Signal is below 8.9 V**
 1. Verify that there is no excessive parasitic current drain, refer to **Battery Electrical Drain/Parasitic Load Test**.
 - If there is excessive parasitic current drain, determine cause of the excessive parasitic current drain.
 - If there is no excessive parasitic current drain, refer to Circuit/System Testing.
 - **If Ignition 1 Signal is 8.9 V or greater**
3. All OK.

[Circuit/System Testing](#)

NOTE: You must perform Circuit/System Verification before Circuit/System Testing.

1. Ignition OFF
2. Perform a [Battery Inspection/Test](#) on the C1 Battery and C1B Battery - Auxiliary.
 - **If battery fails the battery test**

Replace the defective battery
 - **If battery passes the battery test**
3. Ignition OFF, disconnect the X1 harness connector at the K20 Engine Control Module, ignition ON.
4. Verify a test lamp illuminates between ignition circuit terminal 51 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 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, refer to [Power Mode Mismatch](#) .
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 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 K20 Engine Control Module.
 - **If the test lamp illuminates**
5. Test for less than 0.5 V between the C1B Battery - Auxiliary positive terminal and B+ circuit connector X4 terminal 1 at the X50D Fuse Block - Battery with the ignition in the START position.
 - **If 0.5 V or greater**

Replace C1B Battery - Auxiliary positive cable.
 - **If less than 0.5 V**

- CAUTION:** Do not disconnect the K125 Dual Battery Control Module harness connector with the batteries connected. Leaving the module disconnected for an extended period of time can lead to a significant increase in temperature and damage to the module.
6. Ignition OFF, disconnect the C1 and C1B battery (disconnect negative cable of each battery).
 7. Disconnect the harness connector at the K125 Dual Battery Control Module.
 8. Test for less than 10 Ω between the ground circuit terminal 4 and ground.
 - **If 10 Ω or greater**
 1. Test for less than 2 Ω in 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**
 9. Disconnect the F18UA 5A fuse.
 10. Test for infinite resistance between the ignition circuit terminal 3 and B+ terminal of the C1 Battery.
 - **If less than infinite resistance**

Repair the short to voltage on the circuit.
 - **If infinite resistance**
 11. Test for infinite resistance between the ignition circuit terminal 3 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
 12. 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**
 13. Disconnect the X2 harness connector at the K20 Engine Control Module and disconnect the KR27 Starter Relay.
 14. Test for infinite resistance between the control circuit terminal 2 at the K125 Dual Battery Control Module and B+ terminal of the C1 Battery.
 - **If less than infinite resistance**

Repair the short to voltage on the circuit.
 - **If infinite resistance**
 15. Test for infinite resistance between the control circuit terminal 2 at the K125 Dual Battery Control Module and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**

16. 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**
17. Replace the K125 Dual Battery Control Module.

Repair Instructions

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

- **Battery Negative Cable Disconnection and Connection**
- **Fuse Block Replacement** for dual battery control module replacement
- **Control Module References** for 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**
 - **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**

SYMPTOMS - STOP/START SYSTEM

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

1. Perform the **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.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to **Stop/Start System Description and Operation**.

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the Stop/Start System. Refer to **Checking Aftermarket Accessories** .
- Inspect the easily accessible or visible system components, for obvious damage or conditions, which may 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 to diagnose the symptom:

Stop/Start System Malfunction

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
- Vehicles with Stop/Start Auxiliary batteries must be charged separately from the main battery during testing. The Auxiliary battery is not connected in a manner that will allow both batteries to be charged at the same time and must be charged individually, which will result in two printouts.
- For vehicles equipped with Stop/Start, revised software is available for EL 50313 Battery Tester and should be used to test the Stop/Start Auxiliary battery.

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

Electrical Information Reference

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

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- [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 OnStar® (UE1) with Back Up Battery:

The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar®module). Do not disconnect the main vehicle battery or remove the OnStar® 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 OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® 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 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.

- **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.

4. Connect the EL-50313 directly to the battery terminal posts. There is no need to remove the battery from the vehicle.

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 (Auxiliary Battery). Spiral AGM is not used by GM.

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.

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

Use the state of charge information as follows:

- A battery with a state of charge that is below 65% 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.

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- 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.
 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 OnStar®, 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
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

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

- [Circuit Testing](#)
- [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
 - 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](#).
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.

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

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, B18 Battery Current Sensor or B110 Battery Sensor Module 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 40% to 90% 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. Ignition OFF.
2. Test for less than 2 Ω between the G13 Generator housing and C1 Battery negative terminal.
 - **If 2 Ω or greater**

Repair the open/high resistance in the circuit.
 - **If less than 2 Ω**
3. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X2, B X2, 1 X1 or 1 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 C1 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**
4. Test or replace the G13 Generator.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

[Generator Replacement \(LFX\)Generator Replacement \(LCV\)](#)

GENERATOR NOISE DIAGNOSIS

Diagnostic Instructions

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

Diagnostic Aids

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

Circuit/System Testing

1. Start the engine. Verify the noise can be heard. Compare the concern to a similar vehicle.
2. Perform a charging system test. Verify that the generator is charging properly.
3. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines, or other accessory equipment that may be misrouted or be the cause of noise being transmitted into the passenger compartment.
4. Ignition OFF, remove the engine drive belt.
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 s.
7. Verify that the noise goes away.
 - **If the noise is still present**

The generator is not the cause of the noise. Refer to [Symptoms - Engine Mechanical](#) .
 - **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 repair.

- [Drive Belt Replacement](#)
- [Drive Belt Tensioner Replacement](#)
- [Drive Belt Idler Pulley Replacement](#)
- [Generator Replacement \(LFX\)Generator Replacement \(LCV\)](#)

STOP/START SYSTEM MALFUNCTION

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 Stop/Start System is used to improve fuel efficiency in stop/start driving. The engine control module (ECM) receives the voltage and current information from the BCM to determine if the battery state of charge (SOC) is sufficient to support a Stop/Start condition. If all necessary conditions are met (e.g. vehicle speed below 5 km/h (3 MPH), brake pedal depressed to keep the vehicle at rest etc.), the vehicle automatically shuts off the engine. When the Stop/Start System has shut down the engine, the ECM activates an auxiliary component to maintain proper transmission fluid pressure. The dual battery control module isolates the main and auxiliary battery, and the vehicle loads are supported by the main battery only. The engine restarts when the driver releases the brake pedal. During engine crank, the auxiliary battery is switched in by the DBCM to supply voltage to the vehicle loads. During engine crank, the primary battery is isolated from vehicle loads and supplies voltage to the starter motor only.

Diagnostic Aids

- If the driver stops the vehicle and then allows the vehicle to slowly roll forward before coming to a complete stop, the vehicle may not enter Auto Stop mode.
- If the driver does not select economy mode (green indicator on), the vehicle may not enter Auto Stop mode.
- If the driver does not fully depress the brake pedal, the vehicle may not enter Auto Stop mode.
- Auto Stop may be deactivated if any of the following conditions are present:
 - Transmission gear selector is moved from the drive position
 - Driver removes pressure from the brake or depresses the accelerator pedal while the vehicle is in the forward Drive gear
 - HVAC function is selected that requires the A/C compressor
 - Brake booster vacuum is less than 40 kPa (6 PSI)
 - Vehicle speed is greater than 10 km/h (6 MPH)
 - HVAC inside air temperature changes greater than 3Â°C (5Â°F) (with HVAC Automatic)
 - A/C compressor request from HVAC (A/C or Defrost modes)
 - Battery voltage less than 11 V
 - Battery state of charge is less than 73% (changes with state of health)
 - Hood switch status is open
 - Autostop time exceeded 2 min
- When using a vehicle hoist to verify autostop and autostart operation, ensure the following conditions are also met:
 - Transmission gear selector is in the drive position
 - No DTCs are set
 - Traction control is off

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start 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

1. Ignition ON.
2. Test for greater than 12 V between the positive terminal and negative terminal on the C1 Battery and C1B Battery - Auxiliary.
 - **If 12 V or less**

Refer to [Battery Inspection/Test](#).
 - **If greater than 12 V**
3. Verify no DTCs are set.
 - **If any DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If no DTCs are set**
4. Verify Battery Sensor Module Battery State Information parameter reads Available (Learned) and Battery Sensor Module Reset Occurred - Using Estimated State of Charge reads No (Measured).
 - If parameters read Not Available (Not Learned) and No (Measured).
 1. Verify minimum crank voltage is above 8.7 V
 - If less than 8.7 V refer to [Battery Inspection/Test](#)
 2. Verify vehicle has not been jump started or blind charged.
 - Disconnect and Reconnect the Negative Cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
 - If parameters read Available (Learned) and No (Measured) or reads Not Available (Not Learned) and Yes (Estimated)

NOTE: If parameters read Not Available (Not Learned) and Yes (Estimated) the vehicle needs to sit for 3 hours undisturbed but is not required to have the start/stop enabled. After a 3 hour Battery Sensor Module Learn the parameters Battery Sensor Module Battery State Information and Battery Sensor Module Reset Occurred - Using Estimated State of Charge change to Available (Learned) and No (Measured) after the engine is cranked.

NOTE: A vehicle hoist can be used to verify the autostop and autostart operation.

5. Verify the autostop and autostart functions are functioning properly while operating the vehicle under the conditions for entering a start/stop event. Refer to [Stop/Start System Description and Operation](#).
 - **If the vehicle does not autostop or autostart**
 1. Observe the scan tool Autostop Disable Reason, Autostop Inhibit Reason, Autostart Inhibit, and Autostart Reason parameters while operating the vehicle under the conditions for entering a start/stop event. Refer to [Stop/Start Disable, Inhibit, and Restart Reasons](#). These parameters will identify the specific cause for the autostop or autostart disable.
 - **If the vehicle autostops and autostarts**
6. Verify the infotainment system remains active during a start/stop event.
 - **If the infotainment system turns off or restarts during a start/stop event.**

Refer to Circuit/System Testing - Dual Battery Control Module Circuit Malfunction
 - **If the infotainment system remains active during a start/stop event**
7. Verify the C1 Battery and C1B Battery - Auxiliary switch in and out at the appropriate events.
 - **If the C1 Battery and C1B Battery - Auxiliary do not switch in and out at the appropriate events**

Refer to Circuit/System Testing - Dual Battery Control Module Circuit Malfunction
 - **If the C1 Battery and C1B Battery - Auxiliary switch in and out at the appropriate events**
8. All OK.

Circuit/System Testing

Dual Battery Control Module Circuit Malfunction

1. Test for less than 0.5 V between the C1B Battery - Auxiliary positive terminal and B+ circuit connector X4 terminal 1 at the X50D Fuse Block - Battery with the ignition in the START position.
 - **If 0.5 V or greater**

Replace C1B Battery - Auxiliary positive cable.

- **If less than 0.5 V**

CAUTION: **Do not disconnect the K125 Dual Battery Control Module harness connector with the batteries connected. Leaving the module disconnected for an extended period of time can lead to a significant increase in temperature and damage to the module.**

2. Ignition OFF, disconnect the C1 and C1B battery (disconnect negative cable of each battery).
3. Disconnect the harness connector at the at the K125 Dual Battery Control Module.
4. Test for less than 10 Ω between ground circuit terminal 4 and ground.
 - **If 10 Ω or greater**

1. 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**
5. Disconnect the F18UA 5A fuse.
6. Test for infinite resistance between the ignition circuit terminal 3 and B+ terminal of the C1 Battery.
 - **If less than infinite resistance**

Repair the short to voltage on the circuit.
 - **If infinite resistance**
7. Test for infinite resistance between the ignition circuit terminal 3 and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
8. 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**
9. Disconnect the X2 harness connector at the K20 Engine Control Module and disconnect the KR27 Starter Relay.
10. Test for infinite resistance between the control circuit terminal 2 at the K125 Dual Battery Control Module and B+.
 - **If less than infinite resistance**

Repair the short to voltage on the circuit.
 - **If infinite resistance**
11. Test for infinite resistance between the control circuit terminal 2 at the K125 Dual Battery Control Module and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
12. 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**
13. Disconnect the X3 harness connector at the K20 Engine Control Module and disconnect the F11UA fuse.
14. Test for infinite resistance between the control circuit terminal 1 at the K125 Dual Battery Control Module and B+.
 - **If less than infinite resistance**

Repair the short to voltage on the circuit.
 - **If infinite resistance**
15. Test for infinite resistance between the control circuit terminal 1 at the K125 Dual Battery Control Module and ground.
 - **If less than infinite resistance**

Repair the short to ground on the circuit.
 - **If infinite resistance**
16. 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**
17. Test or replace the K125 Dual Battery Control Module.

Repair Instructions

Perform the **[Diagnostic Repair Verification](#)** after completing the repair.

- **[Battery Negative Cable Disconnection and Connection](#)**
- **[Control Module References](#)** for control module replacement, programming, and setup

STOP/START DISABLE, INHIBIT, AND RESTART REASONS

NOTE: **Not all parameters may be available in all vehicles**

The following Autostop Disable parameters are only valid when Engine is Running. It indicated why are we currently inhibiting autostop at that moment in time.

Autostop Disable					
Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Transmission Range	Engine Running	Transmission not in Drive	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to transmission diagnostics.
Autostop Disable Reason - Passenger Compartment Heater On	Engine Running	Passenger Compartment Heater ON	No	Turn off passenger compartment heater.	As Required
Autostop Disable Reason - Driver Exited Vehicle	Engine Running	Seat belt un buckled and driver's door opened.	No	Make sure driver's seatbelt is secured and driver's door latch is closed..	As Required
Autostop Disable Reason - 12V Start Counter Exceeded	Engine Running	Backup Start Performed indicates that an autostop was prevented due to the expiration of backup start counter. If the motor generator cannot autostart the ICE, a calibratable number of attempts to start the engine with the 12V starter will be performed.	No	Determine cause of the previous no start condition.	As required
Autostop Disable Reason - Vehicle Inclination	Engine Running	Vehicle Grade indicates that an autostop was prevented (or an autostart was commanded) due to the current grade level of the vehicle.	No	Verify vehicle is not on level ground.	If not OK: Verify Multi-Axis Accelerator Sensor.
Autostop Disable Reason - Remote Vehicle Start Request	Engine Running	Remote Start indicates the internal combustion engine has been requested to run through a remote start command.	No	Verify remote start operation.	If OK: Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Acceleration Request	Engine Running	Driveability indicates an autostart was command based on torque conditions requested from the driver (generally a tip-in on the throttle). When this condition is detected, autostops are disallowed.	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Transmission In Reverse	Engine Running	Transmission in reverse gear.	No	Ensure transmission is in drive. Stop/start will not function in any other mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Reduced Engine Power Active	Engine Running	Reduced Power indicates that AutoStops are disallowed when a situation has been detected that causes the vehicle to operate with reduced power.	No	Check ECM DTC's.	As required.
Autostop Disable Reason - HYBRID/EV Battery Pack Temperature	Engine Running	HV Battery Pack Temperature indicates Disallow AutoStops/Command AutoStart when battery temperature is high.	No	Ensure parameter in scan tool is not indicating high. Check DTC's..	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Transmission Range	Engine Running	Transmission Range indicates that an autostop was prevented (or an autostart was commanded) due to the selected transmission range.	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Ignition Switch Start	Engine Running	Key Forced AutoStart Request: The driver can request an autostart in park or neutral by cranking the key. Autostops are not allowed again until out of park/neutral.	No	As required.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - TCM Request	Engine Running	TCM Override indicates that AutoStops are disallowed based on transmission PRNDL position.	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Optimization	Engine Running	System Optimization indicates Command AutoStart based on overall system conditions (engine speed & torque optimization). When this condition is detected, AutoStops are disallowed.	No	Ensure vehicle is over 3MPH/5KMH before autostop is enabled.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Voltage Low	Engine Running	12V battery state of function low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Engine Coolant Temperature Out Of Range	Engine Running	Engine Coolant Temperature indicates that an autostop was prevented (or an autostart was commanded) due to engine coolant temperature out of range (high or low).	No	Ensure coolant temperature isn't too high or low.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Catalyst Test In Progress	Engine Running	Catalyst indicates a requested inhibit for Catalyst monitor from gas or Diesel.	No	Ensure catalyst parameter isn't out of range	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - HO2S Test In Progress	Engine Running	Oxygen Sensor indicates a requested inhibit for Oxygen Sensor Monitor.	No	Ensure oxygen sensor parameter isn't out of range	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Misfire Test In Progress	Engine Running	Misfire Monitor indicates a requested inhibit for Misfire Monitor.	No	Ensure no misfire detected in scan tool.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Catalyst not at Operating Temperature	Engine Running	Catalyst not at Operating Temperature	No	Ensure Catalyst is within operating temperature	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Intake Manifold Temperature Too High	Engine Running	Engine Manifold Temperature indicates an inhibit due to high Manifold Temp.	No	Ensure Manifold Temperature isn't high	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Speed Test in Progress	Engine Running	Engine Speed Diagnostics indicates a requested inhibit due to Engine Speed diagnostics.	No	As required	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - MAF sensor Test In Progress	Engine Running	Mass Air Flow Diagnostics indicates a requested inhibit due to MAF diagnostics.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - MAP Sensor Test In Progress	Engine Running	Manifold Absolute Pressure Diagnostics indicates a requested inhibit due to MAP diagnostics.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Oil Temperature Too High	Engine Running	Engine Oil Temp indicates an inhibit due to high Engine Oil Temp.	No	Check Oil temperature is not too high.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Stop/Start Test in Progress	Engine Running	Starting System indicates an inhibit due to Engine Start Stop functions.	No	Ensure control functions are done before proper function of stop/start	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Coolant Temperature Test In Progress	Engine Running	Engine Coolant Temperature indicates a requested inhibit due to low or high Engine Coolant Temperature.	No	Ensure control function is done before expecting stop/start to function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - EVAP System Test In Progress	Engine Running	Evap System indicates a requested inhibit for Evap System Monitor	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Injector Test In Progress	Engine Running	Fuel Injector Diagnostics indicates a requested inhibit due to Fuel Injector diagnostics.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Pressure Test In Progress	Engine Running	Fuel Pressure indicates a requested inhibit for Fuel Pressure Pump monitor.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel System Test In Progress	Engine Running	Fuel Systems indicates a requested inhibit for Fuel Systems monitor.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Parking Maneuver Detected	Engine Running	Parking maneuver detection indicates a requested inhibit due to parking maneuver active.	No	Check functionality after parking	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - High Engine Rotating Torque	Engine Running	Engine Friction indicates a requested inhibit due to cold engine, friction high.	No	Wait for vehicle to reach proper temperature	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - BARO Pressure Too Low	Engine Running	Ambient Air Pressure indicates a requested inhibit due to low Barometric Pressure	No	Ensure barometric temperature isn't too low in scan tool	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Temperature Too High	Engine Running	Boil Off Diagnostics indicates a requested inhibit due to Fuel Boil Off diagnostics.	No	Ensure fuel temperature isn't too high	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Malfunction	Engine Running	Starting System indicates that a condition in the starting system has been detected that would prevent a re-start of the vehicle and thus, autostops, have been disabled.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Turbocharger Temperature Too High	Engine Running	Turbo Temp indicates an inhibit due to high Turbo Temp.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If OK: Refer to Hood Ajar Malfunction. If not OK: close hood.
Autostop Disable Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Run/Crank Not Active	Engine Running	Vehicle must be in Run Mode	No	Verify ECM Run/Crank signal	If OK: Inform Customer - Normal Disable Condition If not OK: refer to Power Mode Mismatch.
Autostop Disable Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	None
Autostop Disable Reason - Auxiliary Transmission Fluid Pump/Accumulator Not Available	Engine Running	Transmission aux pump or accumulator not available	No	Check for transmission DTCs, refer to automatic transmission service information	As Required
Autostop Disable Reason - Engine Coolant Temperature Out of Range	Engine Running	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to Engine Heating and Cooling diagnostics.
Autostop Disable Reason - Invalid Data Received	Engine Running	ECM has received invalid data	No	Check ECM DTC's	As Required
Autostop Disable Reason - Vehicle Speed Too High	Engine Running	Vehicle speed detected	No	Ensure vehicle is at a complete stop	If OK: Inform Customer - Normal Disable Condition If not OK: refer to SI

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Transmission Fluid Temperature Out of Range	Engine Running	Transmission temperature too hot or cold	No	Verify transmission temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostop Disable Reason - Brake Pedal Released	Engine Running	Brake pedal not pressed (enough)	No	Ensure brake pedal is pressed sufficiently to active autostop	If OK: Inform Customer - Normal Disable Condition If not OK: Verify brake pedal switch operation and calibration.
Autostop Disable Reason - Brake Booster Weak Vacuum	Engine Running	Weak brake booster vacuum	No	Ensure brake booster vacuum is within normal operating values	Check DTCs. Refer to brake booster diagnostics.
Autostop Disable Reason - Accelerator Pedal Pressed	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition If not OK: Ensure pedal sensor operation and calibration.
Autostop Disable Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Low-Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery State of Health Low	Engine Running	12V battery has low state of health	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery State of Charge Low	Engine Running	12V battery state of charge is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Intake Manifold Weak Vacuum	Engine Running	Low manifold vacuum	No	Verify manifold vacuum	Check DTCs, refer to SI
Autostop Disable Reason - Engine Speed High	Engine Running	High idle condition	No	Correct cause of high idle	Check DTCs, refer to SI
Autostop Disable Reason - Wheel Slip Detected	Engine Running	Slippery road conditions	No	Ensure good road conditions	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Vehicle Speed Threshold Not Reached	Engine Running	Vehicle must reach a minimum speed	No	Operate at sufficient speeds	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Maximum Vehicle Stop Time Exceeded	Engine Running	Engine was shut off for maximum allowable off time	No	Operate at sufficient speeds to reactivate	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Starter System Malfunction	Engine Running	Starter System Inoperable	No	Check ECM DTCs, refer to SI	As Required
Autostop Disable Reason - System Malfunction	Engine Running	Starter System Inoperable	No	Check for Vehicle DTCs	As Required
Autostop Disable Reason - Stop/Start Select Switch	Engine Running	Switch not enabled	No	Turn switch on.	If OK: Inform Customer - Normal Disable Condition If Not OK: refer to Stop/Start System Malfunction
Autostop Disable Reason - Idle Boost Mode Active	Engine Running	Idle boost requested	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Generator Load High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Clutch Pedal Applied	Engine Running	Clutch pedal (manual trans) not released	No	Ensure clutch pedal is released	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to clutch switch diagnostic and verify calibration.
Autostop Disable Reason - Low-Voltage Battery Temperature Out of Range	Engine Running	Battery temperature too cold or hot	No	Ensure battery is kept within normal operating range	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Low-Voltage Battery State of Function Low	Engine Running	12V battery state of function low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

The following Autostart Inhibit parameters show why the engine is off or was turned off. There are a couple different things this can mean. Forced Off (Mostly Hybrid), Propulsion System Shutdown (Stall), Cannot Start Engine (Hybrid).

Autostart Inhibit

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Inhibit Reason - Hood Ajar	Engine off	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Inhibit Reason - ECM Request	Engine off	ECM tasks are currently running that will not allow an autostart	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Run/Crank Not Active	Engine off	Vehicle must be in Run Mode	No	Verify ECM Run/Crank signal	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - System Malfunction	Engine off	Vehicle System Issue	No	Check for Vehicle DTCs	As Required
Autostart Inhibit Reason - Autostart Not Commanded	Engine off	Vehicle is in a normal autostop mode	Yes	None	Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Crank Aborted	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Control Function Active	Engine off	Scantool control function active	No	Release control function in scantool	As Required
Autostart Inhibit Reason - ECM Malfunction	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Autostart/Autostop Malfunction	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Driver Exited Vehicle	Engine off	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Engine Coolant Temperature Out of Range	Engine off	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Remote Vehicle Start Disabled	Engine off	Remote Vehicle Start Disabled	No	As Required	As Required
Autostart Inhibit Reason - Calibration Override	Engine off	Calibration forced to shut off by calibration	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Compression Test	Engine off	Engine was forced to shut off following the completion of a compression test	No	As Required	As Required
Autostart Inhibit Reason - TCM Request	Engine off	TCM can force the engine off depending on transmission conditions.	No	As Required	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Engine Stop Required	Engine off	Detection of a situation that might otherwise cause a stall of the vehicle.	No	As Required	As Required

The following Autostart Reasons parameters are only valid when Engine is Running. It indicates why we started the engine the last time it was autostarted.

Autostart Reasons

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - TCM Demand	Engine Running	TCM has requested an autostart	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - Reduced Engine Power Active	Engine Running	ECM has requested Reduced Engine Power	No	Check ECM DTCs.	As required.
Autostart Reason - Maximum Autostop Time Exceeded	Engine Running	Maximum autostop time is limited.	No	Maximum autostop time is typically 2 minutes.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Transmission Fluid Temperature Out of Range	Engine Running	Transmission temperature too hot or cold	No	Verify transmission temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - System Malfunction	Engine Running	Vehicle System Issue	No	Check for Vehicle DTCs	As required.
Autostart Reason - Transmission in Reverse	Engine Running	Transmission was placed in reverse.	No	Ensure transmission is in drive.	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - Invalid Data Received	Engine Running	ECM has received invalid data	No	Check ECM DTCs.	As required.
Autostart Reason - Vehicle Speed Too High	Engine Running	Vehicle speed detected	No	Ensure vehicle is at a complete stop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Optimization	Engine Running	ECM has determined that the engine needs to be started.	No	Check DTCs.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Voltage Low	Engine Running	12V battery state of charge is low.	No	Charge and test battery, operate vehicle for longer drives, check generator operation	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Acceleration Request	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostart Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	As Required
Autostart Reason - Auxiliary Transmission Fluid Pump/Accumulator Not Available	Engine Running	Transmission aux pump or accumulator not available	No	Check for transmission DTCs, refer to automatic transmission service information	As Required
Autostart Reason - Engine Coolant Temperature Out of Range	Engine Running	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Transmission Range	Engine Running	Transmission not in Drive	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostart Reason - Brake Pedal Released	Engine Running	Brake pedal not pressed (enough)	No	Ensure brake pedal is pressed sufficiently to active autostop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Brake Booster Weak Vacuum	Engine Running	Weak brake booster vacuum	No	Ensure brake booster vacuum is within normal operating values	Check DTCs. Refer to brake booster diagnostics.
Autostart Reason - Accelerator Pedal Pressed	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostart Reason - Driver Exited Vehicle	Engine Running	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason -Passenger Compartment Heater On	Engine Running	Passenger Compartment Heater On	No	Check Vehicle DTCs	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Stop/Start select Switch	Engine Running	Stop/Start select Switch off	No	Not in all vehicles.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Driver Exited Vehicle	Engine Running	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Charge Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostart Reason - Inclination	Engine Running	Vehicle Grade indicates that an autostop was prevented (or an autostart was commanded) due to the current grade level of the vehicle.	No	As Required	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Function Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation.	As Required
Autostart Reason - Remote Vehicle Start Request	Engine Running	Remote start requested	No	As Required.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Ignition Switch Start	Engine Running	Switch Start Request	No	The driver can request an autostart in park or neutral by cranking the key. Autostops are not allowed again until out of park/neutral.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Health Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

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+ (relay terminal 30)	1	1	-	-
Relay Coil Control (relay terminal 85)	P0615	P0615	2	-
Starter Control (relay terminal 87)	1	1	2	-
Ground (relay terminal 86)	-	P0615	-	-
1. Starter Solenoid Does Not Click 2. Cranks All The Time				

Circuit/System Description

When the ignition mode switch is placed in the START position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the START position. The BCM then sends a serial data message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch is fully depressed or the automatic 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.

Reference Information

Schematic Reference

- [Starting and Charging Schematics](#)
- [Automatic Transmission Controls Schematics](#)

Connector End View Reference

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- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

[Control Module References](#) for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no ignition, starter relay, brake pedal position sensor, immobilizer, engine, or automatic 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**
3. 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 when the ignition switch is in the crank position.
 - **If Crank Request not displayed**

Refer to [Vehicle Will Not Change Power Mode](#) .
 - **If parameter displays Crank Request**
4. Verify the scan tool TCM Internal Mode Switch parameter displays Park with the transmission range selector in park.
 - **If the TCM Internal Mode Switch parameter does not indicate Park**

Refer to [Transmission Internal Mode Switch Logic](#) , for the Automatic Transmission - 6T40 (MHH) or 6T45 (MH7) or [Transmission Internal Mode Switch Logic](#) for the Automatic Transmission - 6T70 (M7W).
 - **If the TCM Internal Mode Switch parameter indicates Park**
5. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.
 - **If the counter increments**

Replace the B26 Crankshaft Position Sensor.
 - **If the counter does not increment**
6. Verify the KR27 Starter Relay clicks and the engine begins cranking with the ignition in the Crank position.
 - **If the KR27 Starter Relay does not click**

Refer to Circuit/System Testing.
 - **If the KR27 Starter Relay clicks**
7. All OK.

Circuit/System Testing

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 each ignition circuit terminal 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 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.
 - **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, test or replace the M64 Starter Motor.
 - **If the test lamp illuminates**
5. Ensure the parking brake is applied and the T12 Transmission is in P. 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.

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
 - **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.

- **Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Removal** for the Automatic Transmission - 6T40 (MHH) or 6T45 (MH7)
- **Manual Shift Detent Lever with Shaft Position Switch Assembly and Park Pawl Actuator Installation** for the Automatic Transmission - 6T70 (M7W).
- **Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)**
- **Crankshaft Position Sensor Replacement** for the 2.5L engine
- **Crankshaft Position Sensor Replacement** for the 3.6L engine
- **Control Module References** for ECM replacement, programming, and setup.

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

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- [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 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](#) , for the 2.0 L or 2.5 L engines or **Drive Belt Replacement** for the 3.6 L 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 2.0 L or 2.5 L engines or **Engine Will Not Crank - Crankshaft Will Not Rotate** for the 3.6 L 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 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 M64 Starter Motor B+ terminal A X2 with the ignition in the CRANK 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 CRANK position.
 - **If 0.5 V or greater**

Replace the negative battery cable.
 - **less than 0.5 V**
 - 9. Replace the M64 Starter Motor.

Repair Instructions

Perform the [Diagnostic Repair Verification](#) after completing the repair.

- [Battery Positive and Negative Cable Replacement \(LFX\)](#)**Battery Positive and Negative Cable Replacement (LCV)**
- [Battery Negative Cable Replacement \(without KL9\)](#)**Battery Negative Cable Replacement (with KL9)**
- [Starter Replacement \(LFX\)](#)**Starter Replacement (LCV)**

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

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- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

Scan Tool Reference

[Control Module References](#) for scan tool information

Circuit/System Testing

1. Ignition OFF, measure and record the battery voltage at the C1 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**
3. Verify that a test lamp illuminates between the M64 starter motor B+ terminal 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 and the circuit fuse is open**
4. Test for less than 0.5 V between the positive battery cable and terminal 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](#) , for the 2.5 L engine or [Drive Belt Replacement](#) for the 3.6 L.
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 Positive and Negative Cable Replacement \(LFX\)](#)[Battery Positive and Negative Cable Replacement \(LCV\)](#)
- [Starter Replacement \(LFX\)](#)[Starter Replacement \(LCV\)](#)

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 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

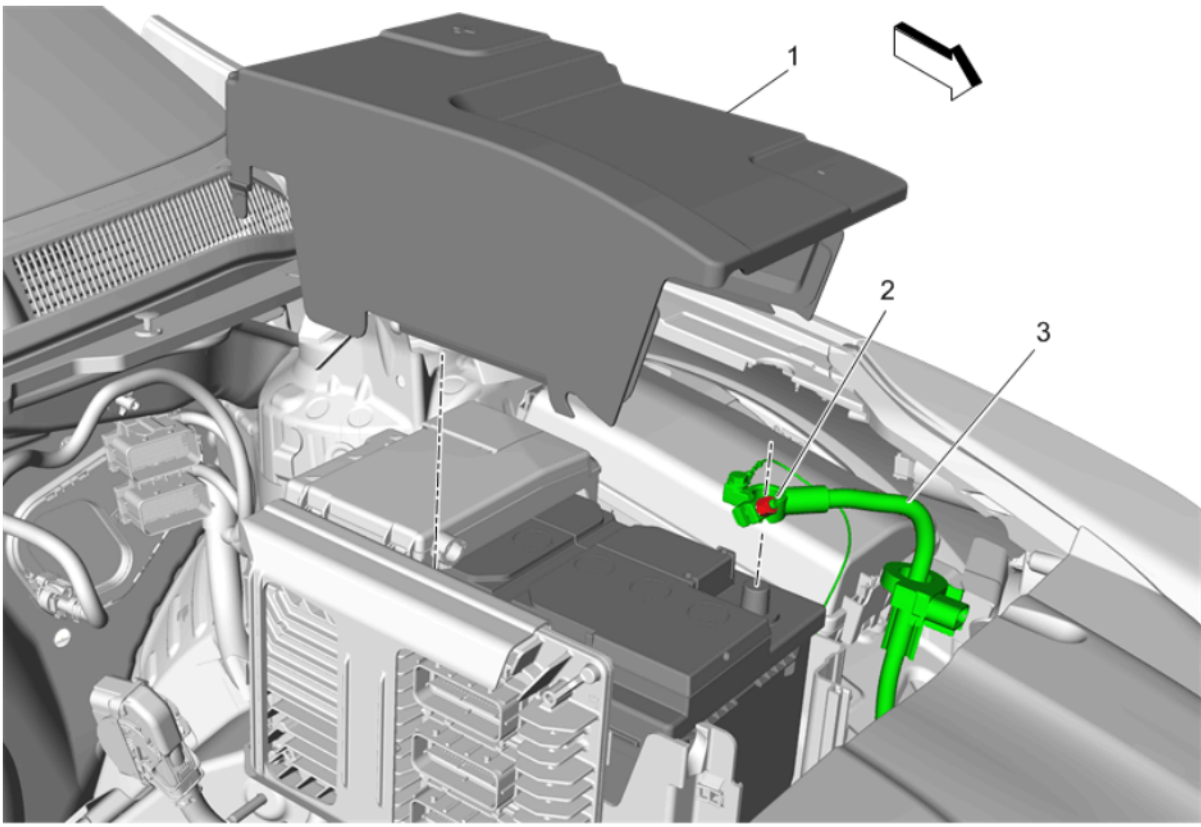


Fig. 5: View Of Battery Negative Cable & Cover
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures 1. Turn the ignition OFF and remove the ignition key. 2. Record all of the radio station presets. 3. Record the remaining engine oil life.	
1	Battery Cover
2	Battery Negative Post Clamp Nut
	WARNING: Refer to Battery Disconnect Warning .
	CAUTION: Refer to Fastener Caution .
3	Tighten 6 N.m (53 lb in)
	Battery Negative Cable

BATTERY SENSOR REPLACEMENT (KL9)

Removal Procedure

- 1. Ensure that all lamps and accessories are turned off.
- 2. Turn the ignition OFF and remove the ignition key.

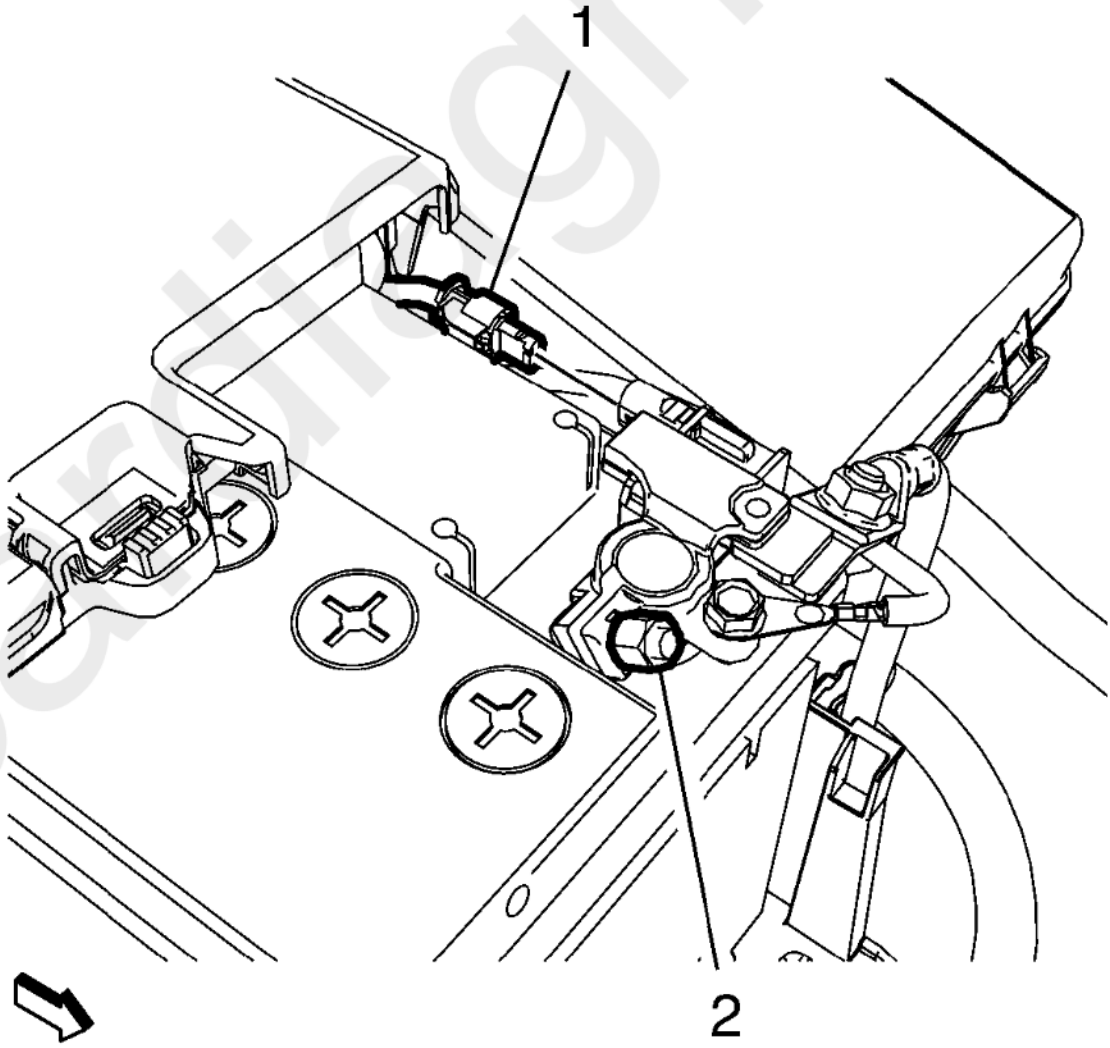


Fig. 6: Wiring Harness Connector And Battery Negative Pole Nut
Courtesy of GENERAL MOTORS COMPANY

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

- 3. Loosen the battery negative pole nut (2).
- 4. Disconnect the wiring harness connector (1) from the battery sensor.

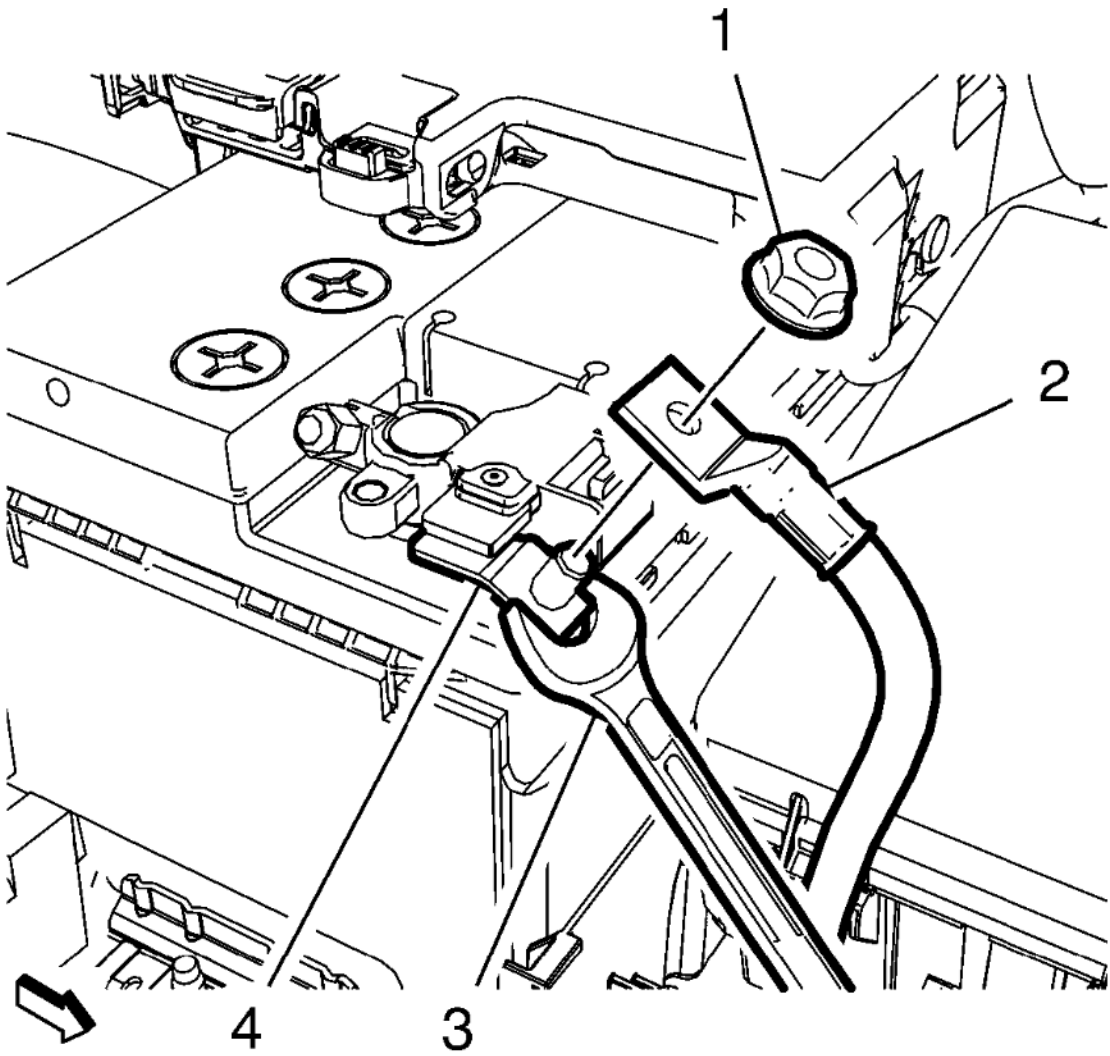


Fig. 7: Battery Sensor, Battery Negative Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

- 5. Install a suitable open-end spanner (3) to counterhold the battery sensor (4) as shown in the graphic.
- 6. Remove the battery negative cable nut (1).
- 7. Remove the battery negative cable (2).

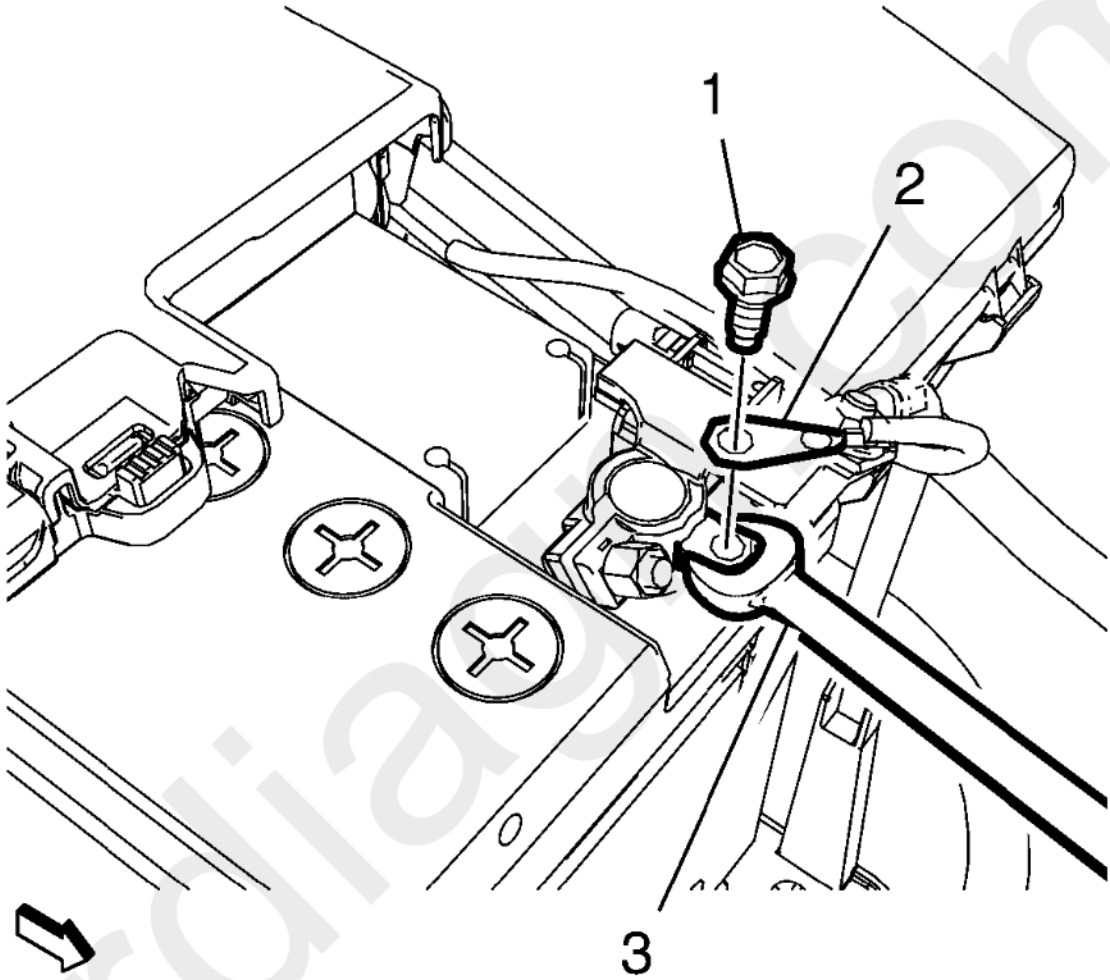


Fig. 8: Wiring Harness Ground Cable And Bolt
Courtesy of GENERAL MOTORS COMPANY

- 8. Install a suitable open-end spanner (3) to counterhold the battery sensor as shown in the graphic.
- 9. Remove the wiring harness ground cable bolt (1) and the wiring harness ground cable (2).

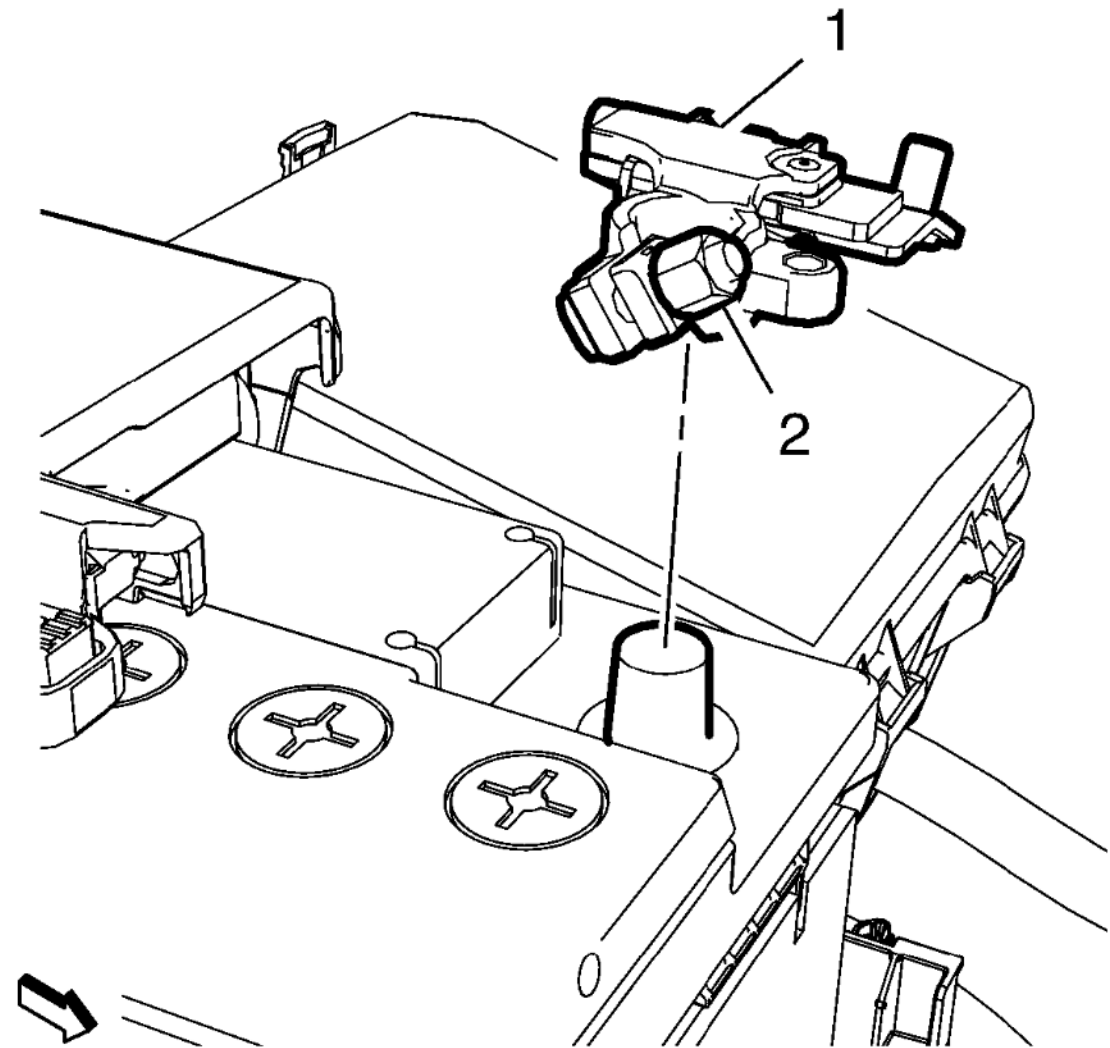


Fig. 9: Battery Sensor
Courtesy of GENERAL MOTORS COMPANY

- 10. Remove the battery sensor (1).

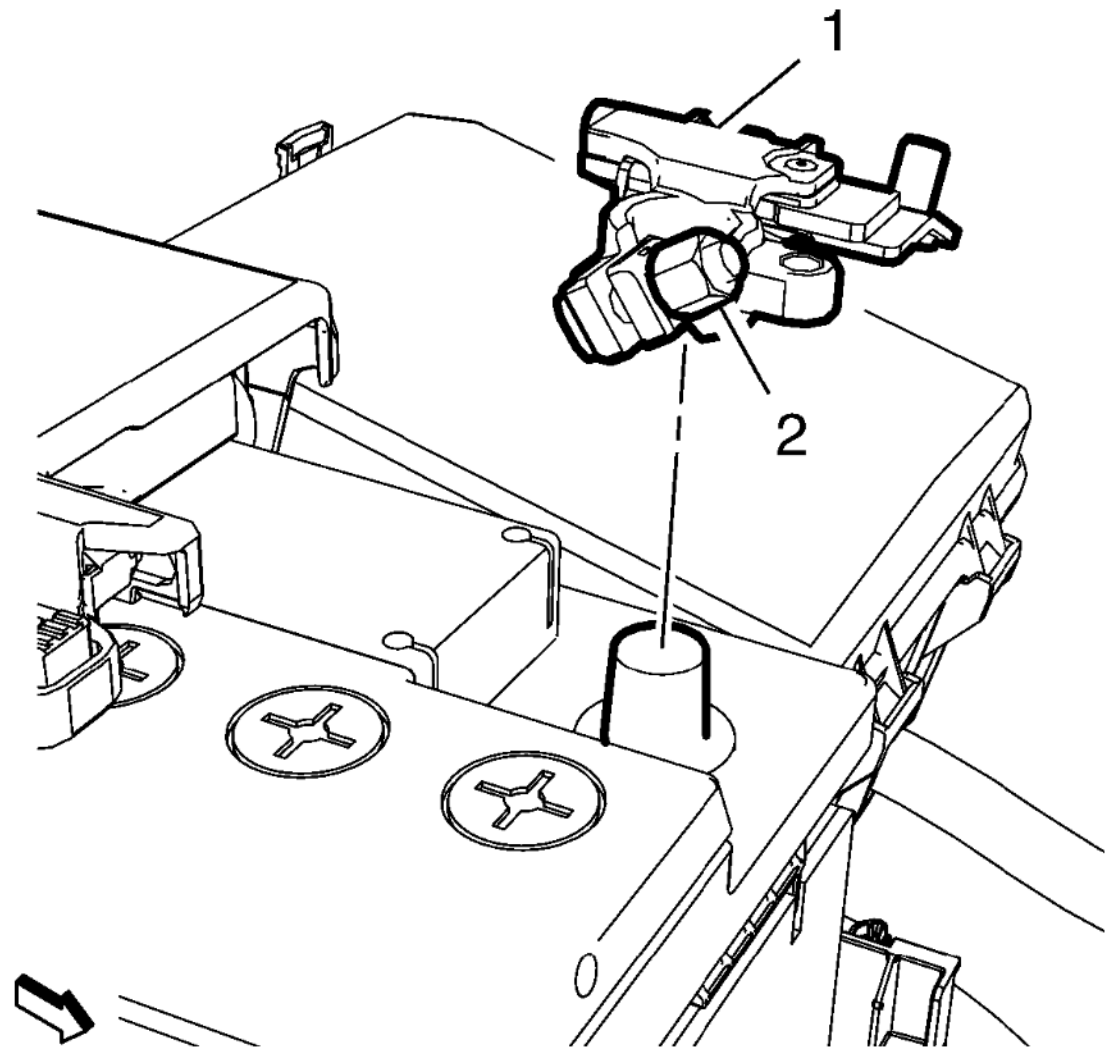


Fig. 10: Battery Sensor
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not tighten the battery sensor pole nut (2).

- 1. Loosely install the battery sensor (1) carefully.

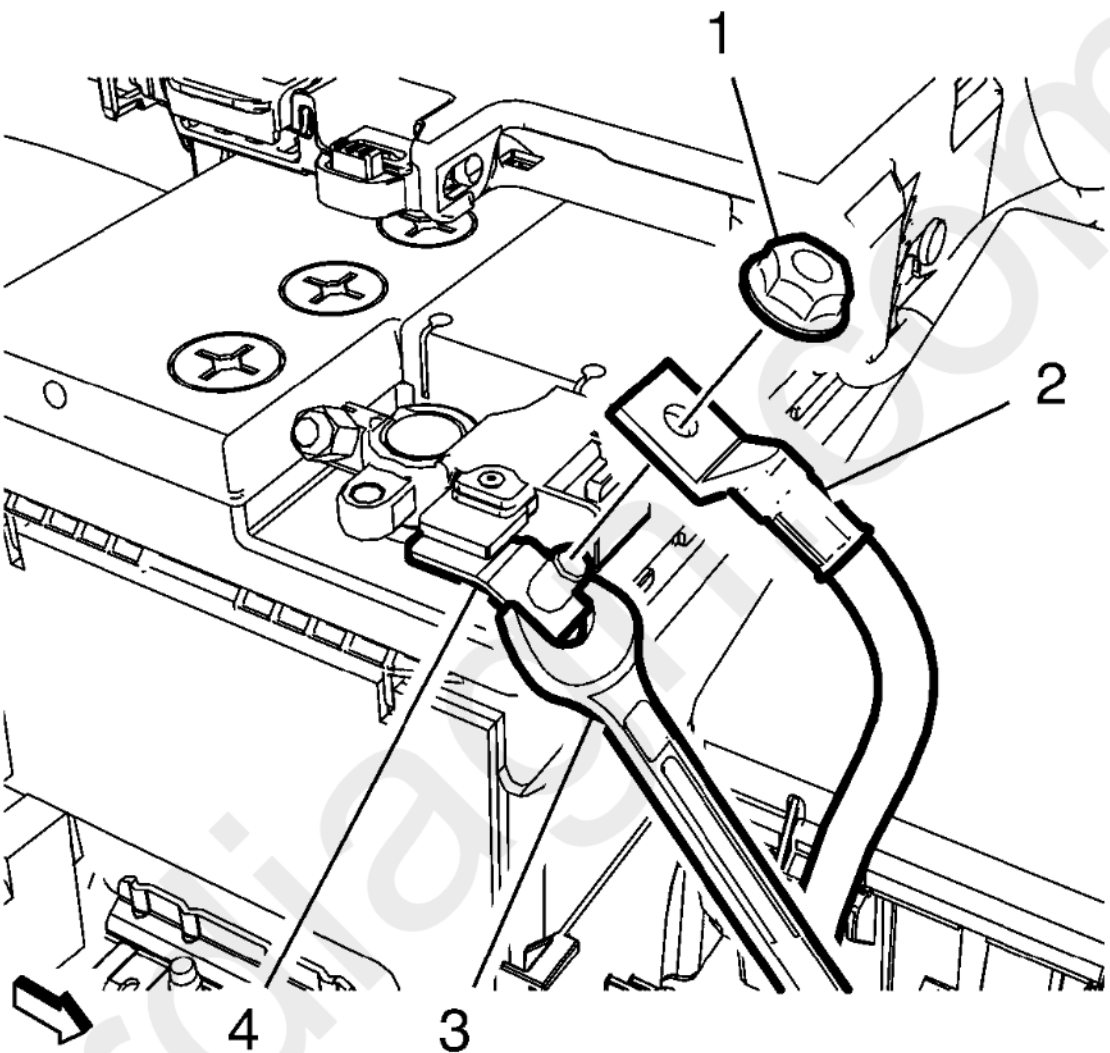


Fig. 11: Battery Sensor, Battery Negative Cable And Nut
Courtesy of GENERAL MOTORS COMPANY

- 2. Install the battery negative cable (2).
- 3. Install a open-end spanner (3) to counterhold the battery sensor (4) as shown in the graphic.

CAUTION: Refer to **Fastener Caution** .

- 4. Install the battery negative cable nut (1) and tighten to 11 N.m (97 lb in).

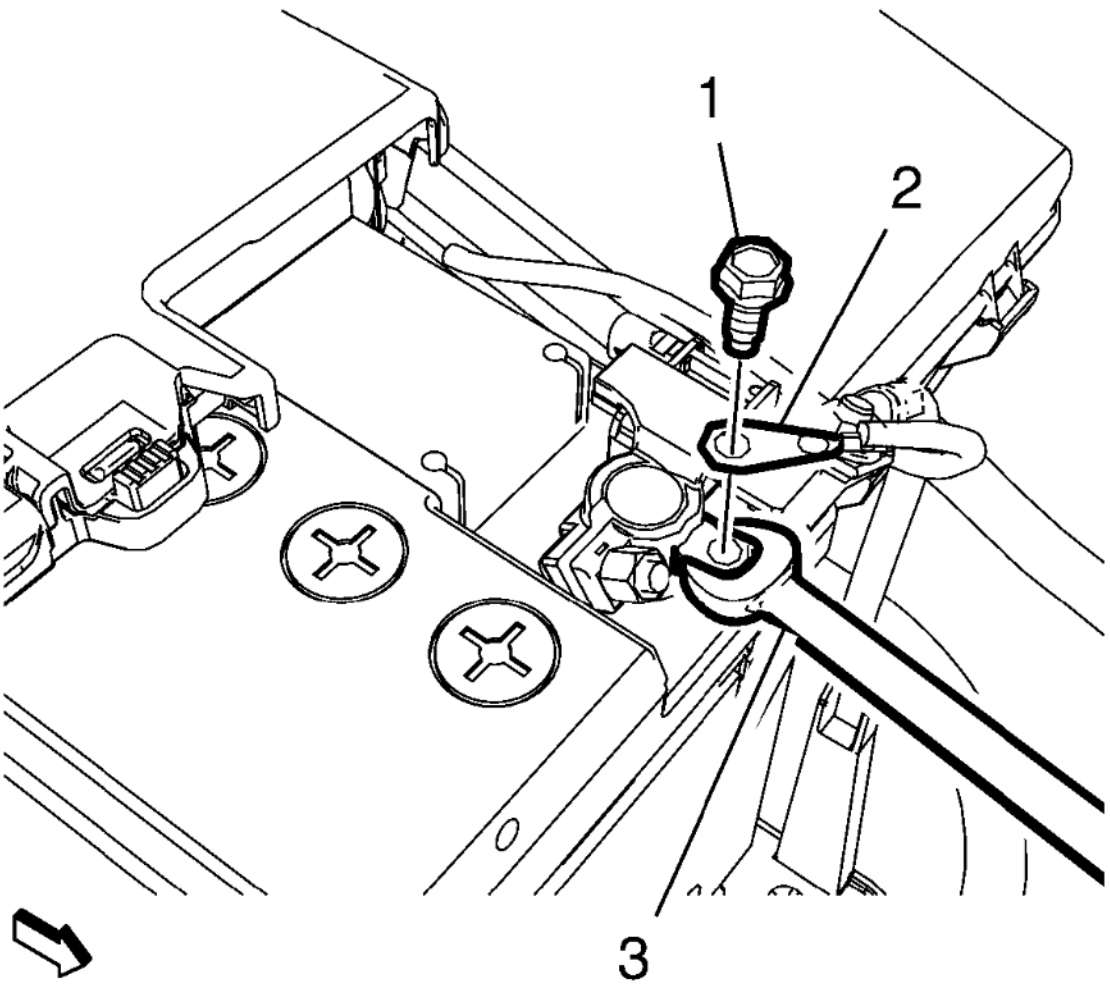


Fig. 12: Wiring Harness Ground Cable And Bolt
Courtesy of GENERAL MOTORS COMPANY

- 5. Install a suitable open-end spanner (3) to counterhold the battery sensor as shown in the graphic.
- 6. Install the wiring harness ground cable (2) and the wiring harness ground cable bolt (1) and tighten to 5 N.m (44 lb in).

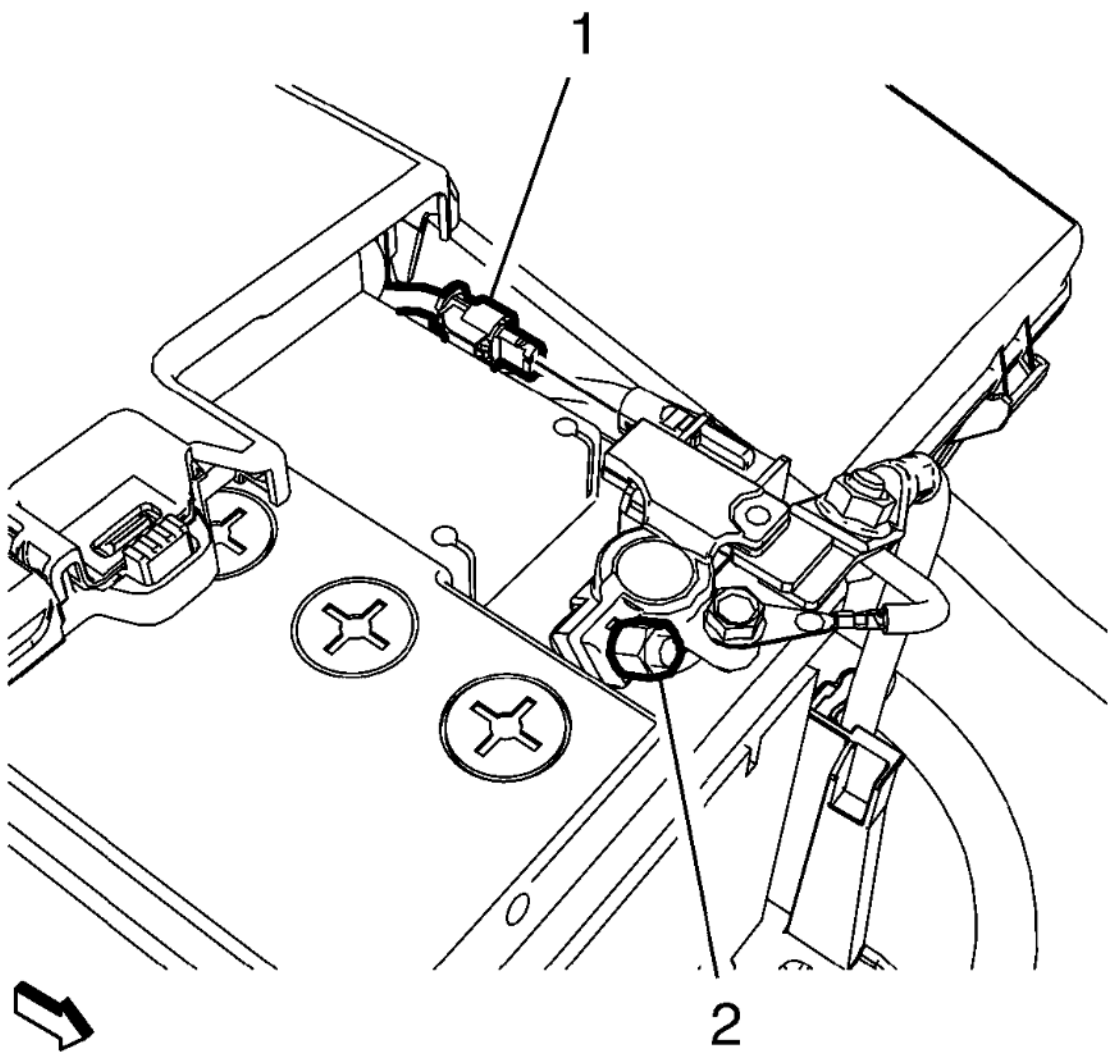


Fig. 13: Wiring Harness Connector And Battery Negative Pole Nut
Courtesy of GENERAL MOTORS COMPANY

- 7. Connect the wiring harness connector (1) to the battery sensor.
- 8. Tighten the battery negative pole nut to 4.5 N.m (40 lb in)
- 9. Perform the battery sensor module learn procedure. Refer to **Battery Sensor Module Learn**.

BATTERY SENSOR MODULE LEARN

Calibration Criteria

NOTE: This procedure is only for vehicles equipped with a Battery Sensor Module. Attempting to run this procedure without a Battery Sensor Module may cause unwanted results. If this occurs, the BCM will need to be reset with an ignition cycle.

The battery sensor module is attached directly to the negative battery terminal and is used to determine the battery condition by calculating the battery state of charge, state of function, and state of health. The battery condition is used to help determine if the 12 volt stop/start system will allow a stop/start event to occur when the vehicle has come to a stop.

To determine the battery condition, the battery sensor module must be calibrated. In normal operation, all current entering or exiting the battery flows through the battery sensor module and is monitored. Any action which charges or discharges the battery that is not monitored by the battery sensor module will require the calibration procedure be performed. Such instances are:

- The battery was replaced by a battery with the same part number
- The battery was replaced by a battery with a different part number or different specifications
- The battery was recharged while outside the vehicle
- The battery was discharged while outside the vehicle
- The battery was improperly charged:

To properly charge the battery, the negative lead of the charger must be connected to chassis ground, NOT directly to the negative battery post. Connecting to chassis ground allows current to flow through the battery sensor module during charging and be measured. Connecting directly to the negative battery post charges the battery, but the current is not measured by the battery sensor module.

If any of these conditions have occurred, the battery sensor module must be calibrated to maintain proper 12 volt start/stop operation.

Calibration Procedure

NOTE: To complete the battery sensor module calibration, there must be no parasitic electrical drains on the battery. A parasitic electrical drain greater than 100 mA will result in an inability to complete the calibration. All parasitic electrical drains must be corrected before the battery sensor module calibration can be completed. Refer to **Battery Electrical Drain/Parasitic Load Test**.

1. Ignition ON, engine OFF.
2. Install a scan tool.
3. Clear all DTCs before proceeding.
4. Navigate to the Configuration/Reset Functions menu of the BCM.
5. Select the Battery Sensor Module procedure and follow the directions displayed on the screen.

BATTERY CURRENT SENSOR REPLACEMENT

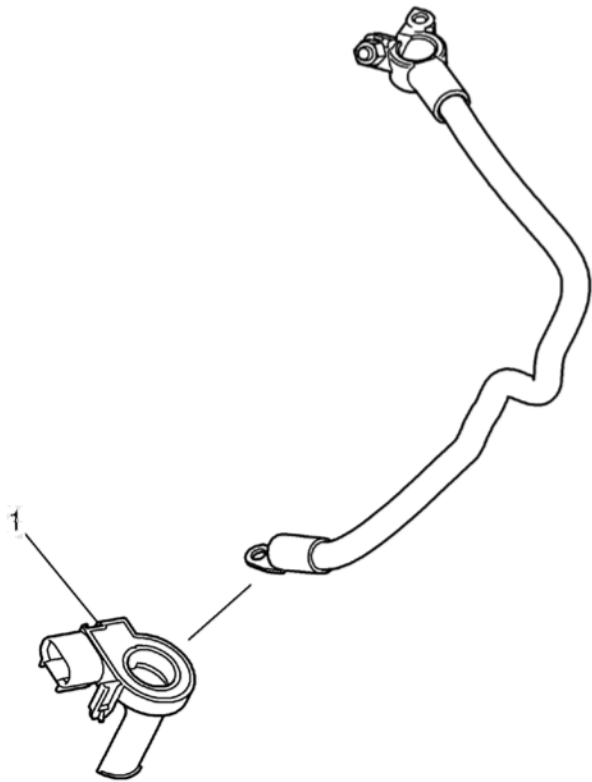


Fig. 14: Battery Current Sensor
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the battery negative cable fastener from the frame strut.	
1	Battery Current Sensor
	Procedure 1. Detach the electrical connector. 2. Ensure that the location measurement of the battery current sensor is recorded for reference during installation. 3. Cut and remove the tape securing the sensor to the negative battery cable. 4. Remove the sensor from the cable.

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT (LFX)

Removal Procedure

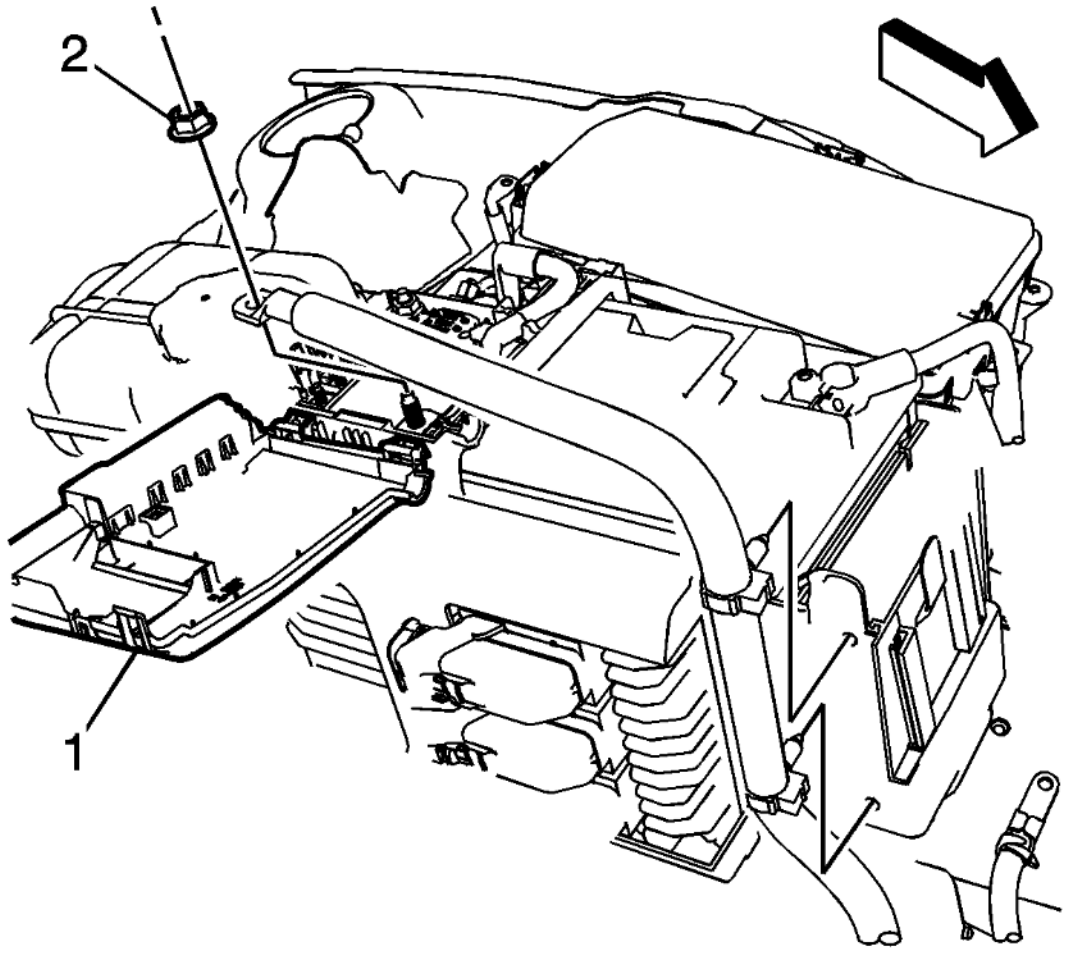


Fig. 15: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

- 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
- 2. Open the battery fuse block cover (1).
- 3. Remove the battery positive fastener (2) from battery fuse block and detach the retainers from the battery tray.

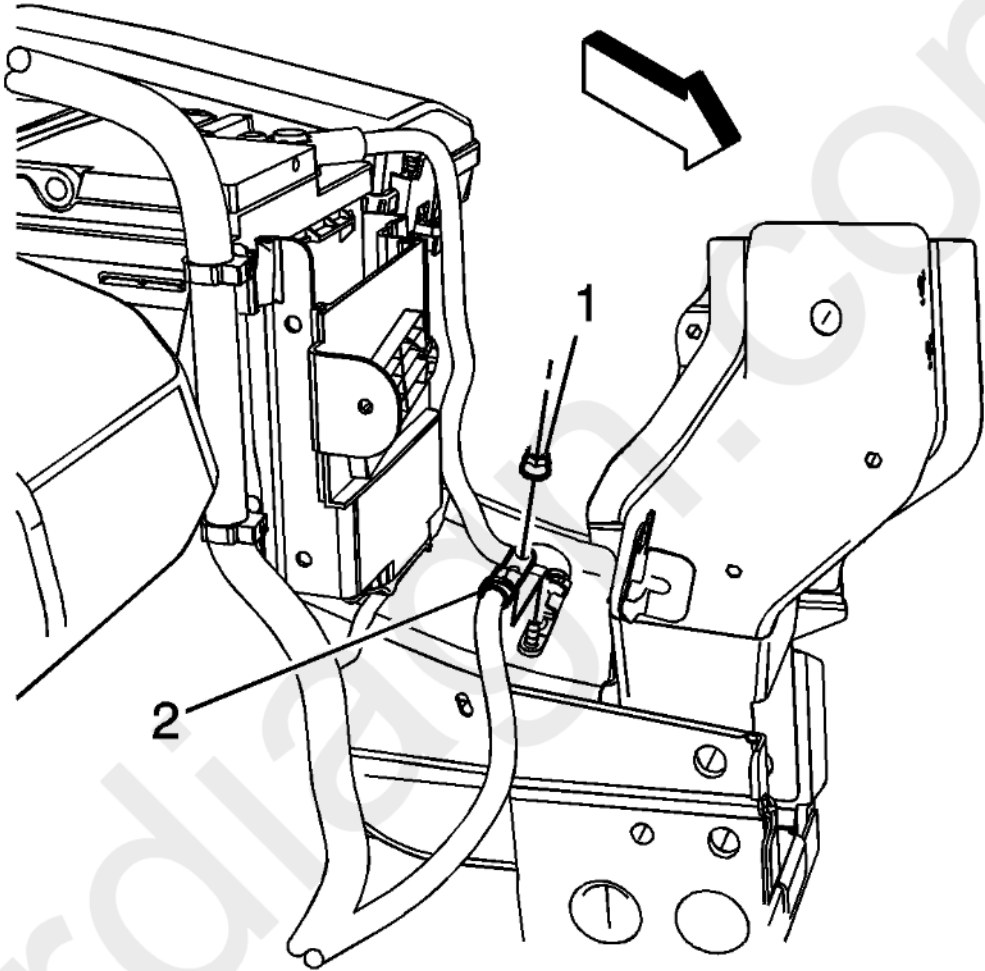


Fig. 16: Battery Negative Nut & Terminal
Courtesy of GENERAL MOTORS COMPANY

- 4. Remove the battery negative fastener (1) and terminal (2) from the left front frame rail.

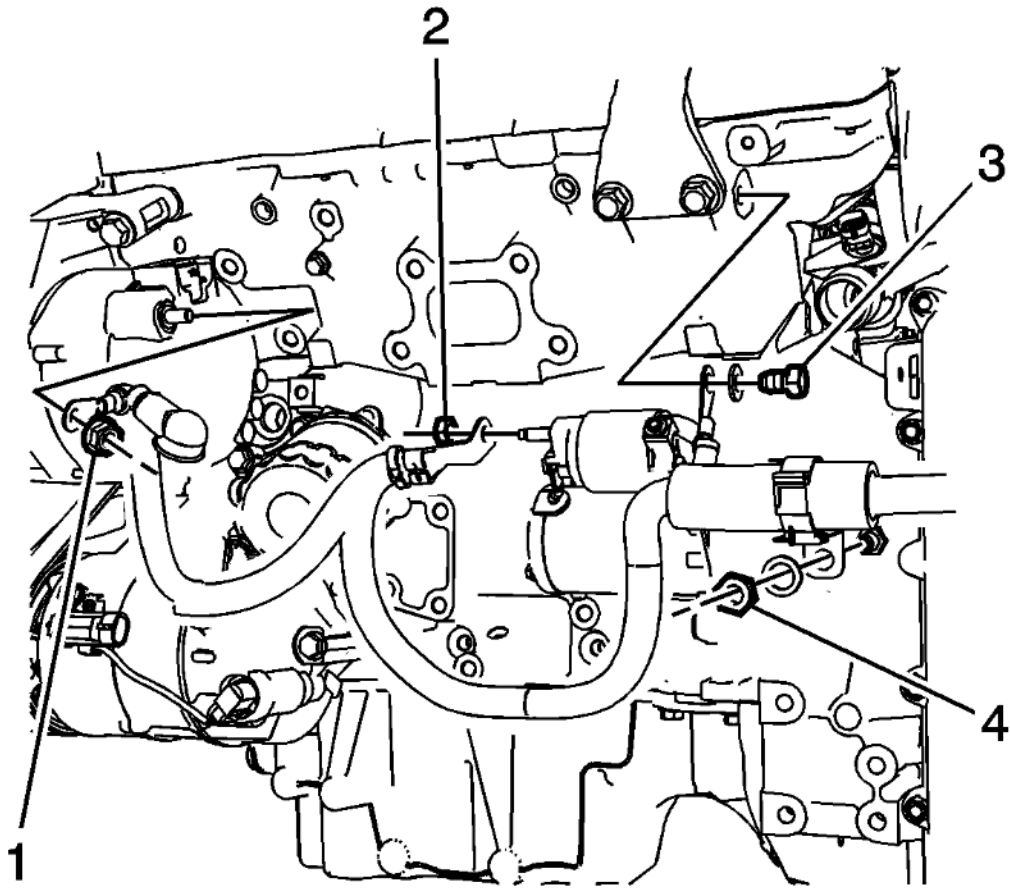


Fig. 17: Battery Cable Nuts
Courtesy of GENERAL MOTORS COMPANY

- 5. Remove the fastener (1) from underneath the protective boot behind the generator.
- 6. Remove the battery positive cable terminal from the generator.
- 7. Remove the starter shield fastener and shield.
- 8. Remove the starter solenoid fastener (2) and battery positive cable terminal from the starter solenoid.
- 9. Remove the negative battery cable fastener (3) and terminal from the back of the left cylinder head.

NOTE: Observe how the battery positive and negative cable was routed within the engine compartment.

10. Remove the battery positive and negative cable retainer fastener (4).

Installation Procedure

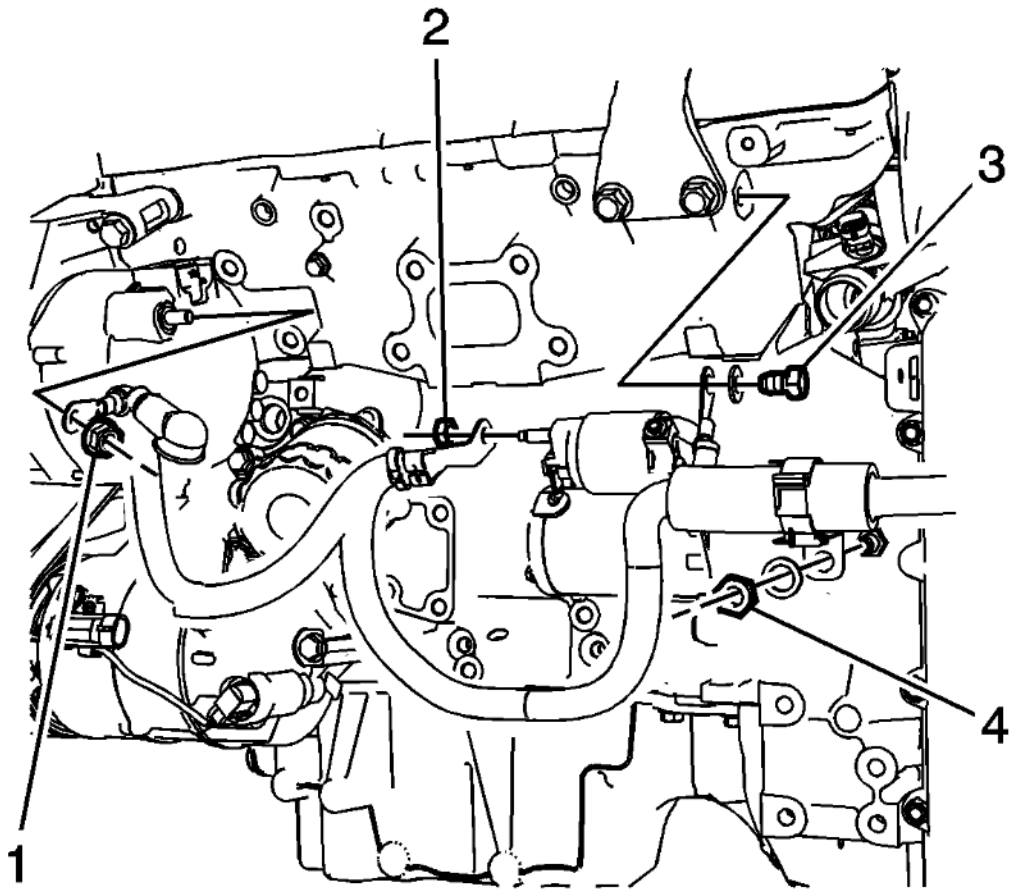


Fig. 18: Battery Cable Nuts
Courtesy of GENERAL MOTORS COMPANY

1. Install the retainers that hold the battery cable harness to the battery tray.

CAUTION: Refer to Fastener Caution .

- 2. Install the battery cable harness retainer to the engine block and tighten the fastener (4) to 25 N.m (18 lb ft).
- 3. Install the negative battery cable terminal and fastener (3) to the left rear cylinder head. Tighten to 25 N.m (18 lb ft).
- 4. Install the battery positive cable terminal and fastener (2) to the starter solenoid. Tighten to 9 N.m (80 lb in).
- 5. Install the starter heat shield and tighten to 5 N.m (44 lb in).
- 6. Install the battery positive cable terminal and fastener (1) to the back of the generator. Tighten to 15 N.m (11 lb ft).

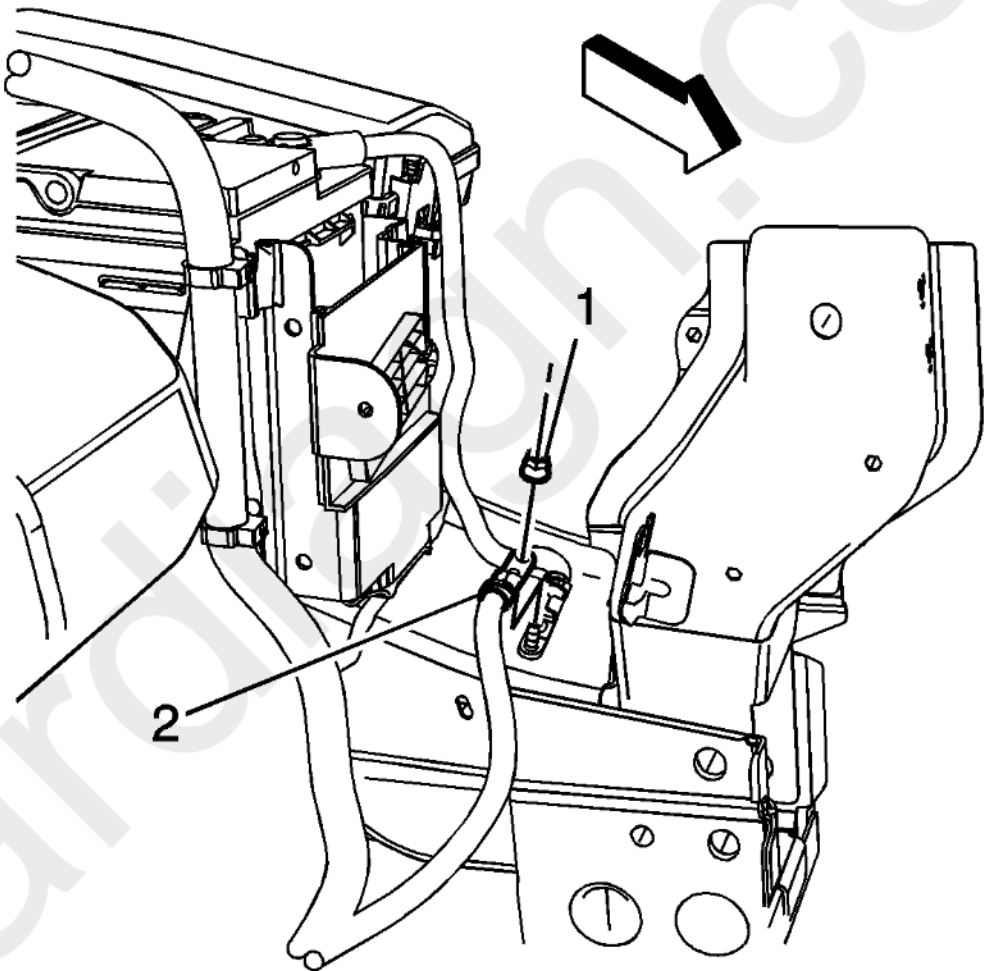


Fig. 19: Battery Negative Nut & Terminal
Courtesy of GENERAL MOTORS COMPANY

7. Install the battery negative cable terminal (2) and fastener (1) to the left front frame rail. Tighten to 9 N.m (80 lb in).

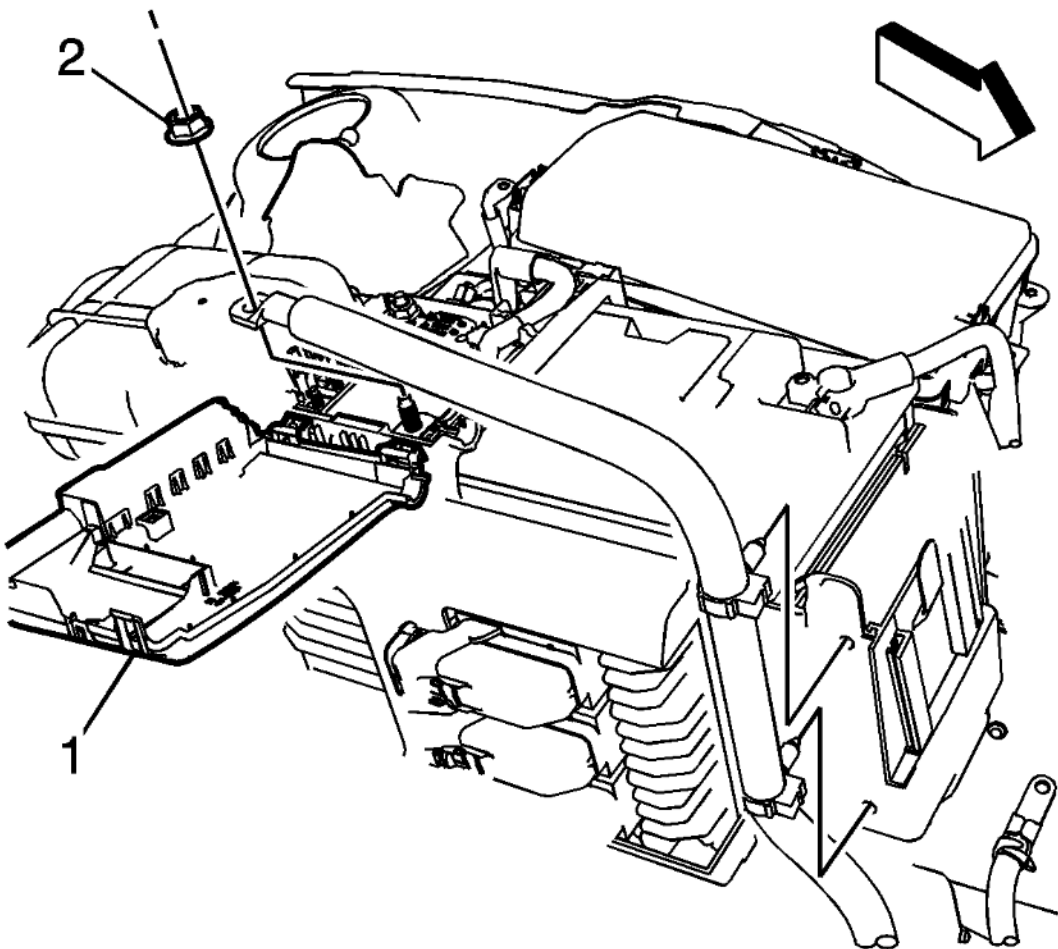


Fig. 20: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

- 8. Install the positive battery cable terminal and fastener (2) to the battery fuse block. Tighten to 12 N.m (106 lb in).
- 9. Close battery fuse block cover (1) and install battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT (LCV)

Removal Procedure

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

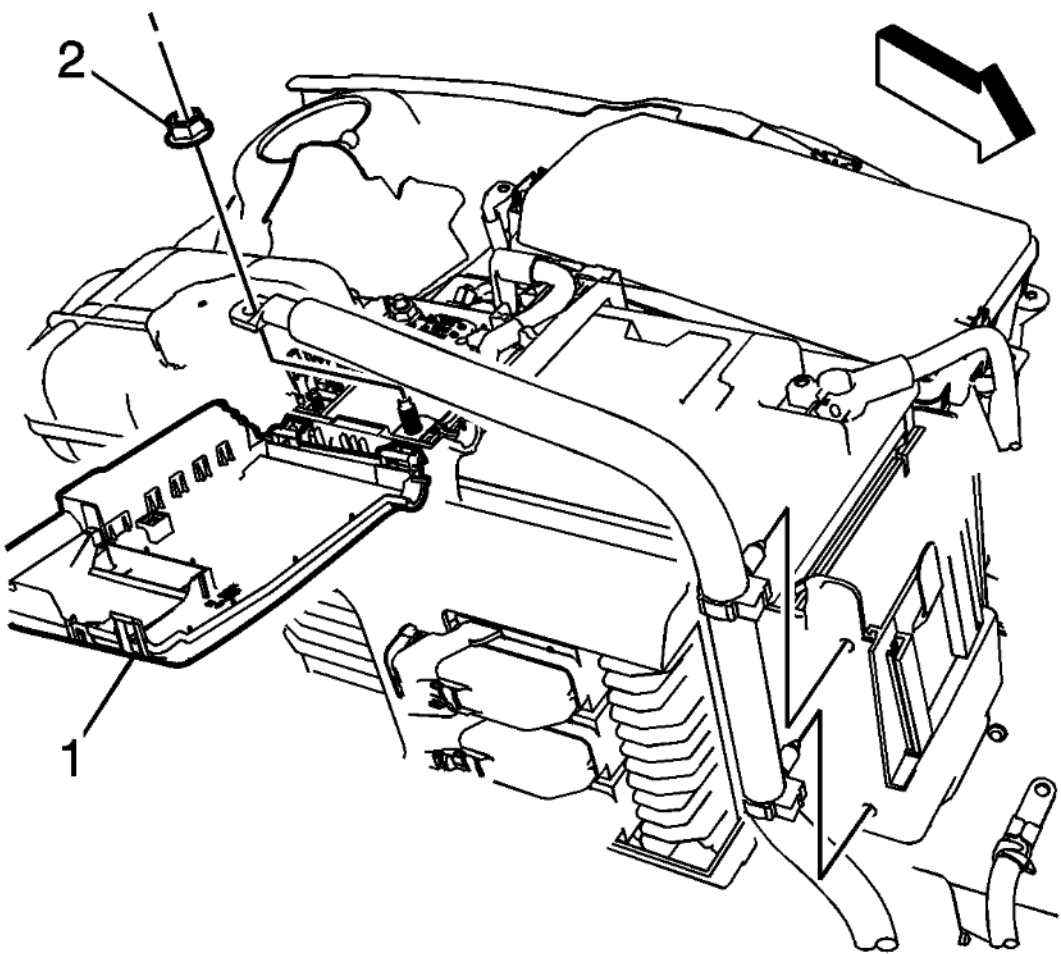


Fig. 21: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

- 2. Open the battery fuse block cover (1).
- 3. Remove the battery positive fastener (2) from battery fuse block and detach the battery positive cable retainers from the battery tray.
- 4. Remove the battery tray. **Battery Tray Replacement**

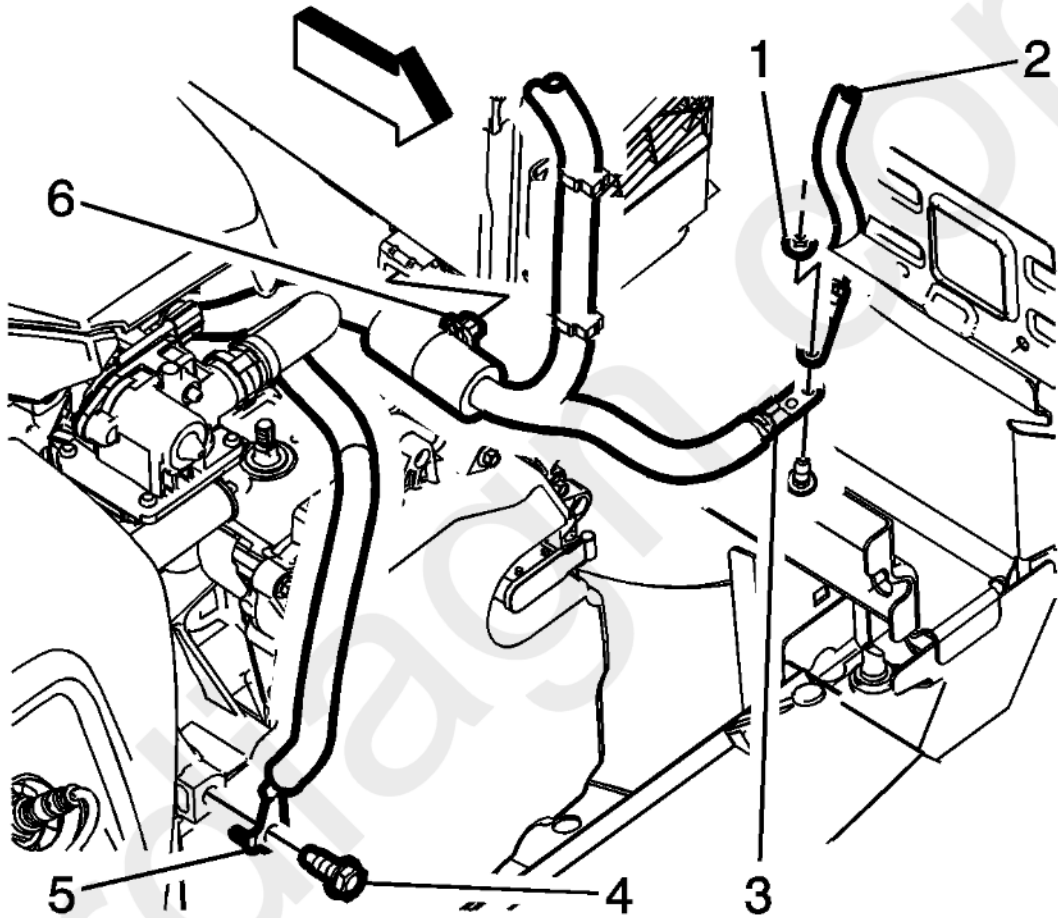


Fig. 22: Battery Negative Fastener
Courtesy of GENERAL MOTORS COMPANY

- 5. Remove the battery negative fastener (1) and the battery negative cable (2), from the left front frame rail.
- 6. Remove the battery positive and negative cable (3) from the left front frame rail.
- 7. Remove the battery negative cable ground fastener (4) and remove the battery negative cable (5).
- 8. Detach the battery positive and negative cable retainer (6), from the battery tray.

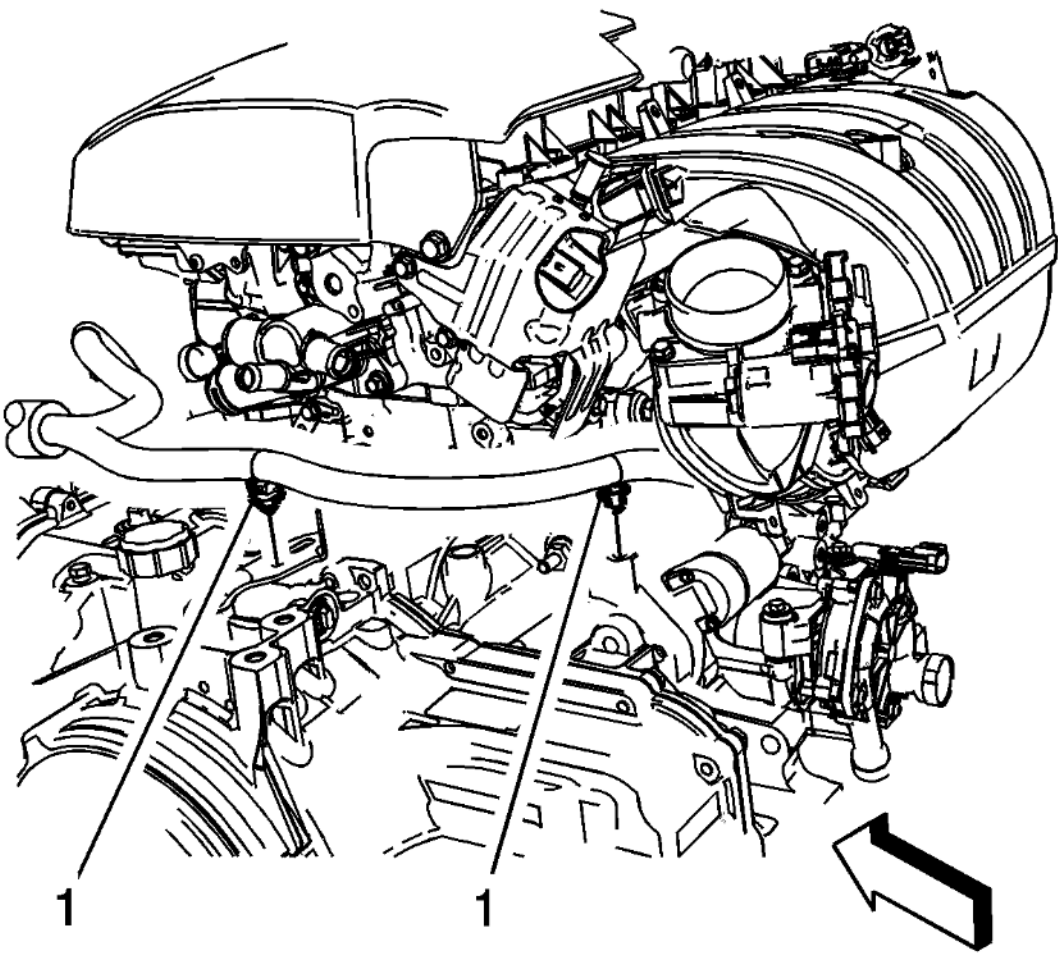


Fig. 23: Battery Positive And Negative Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

- 9. Detach the battery positive and negative cable retainers (1) at the transmission shift cable bracket.
- 10. Raise and support the vehicle. Refer to **Lifting and Jacking the Vehicle**.

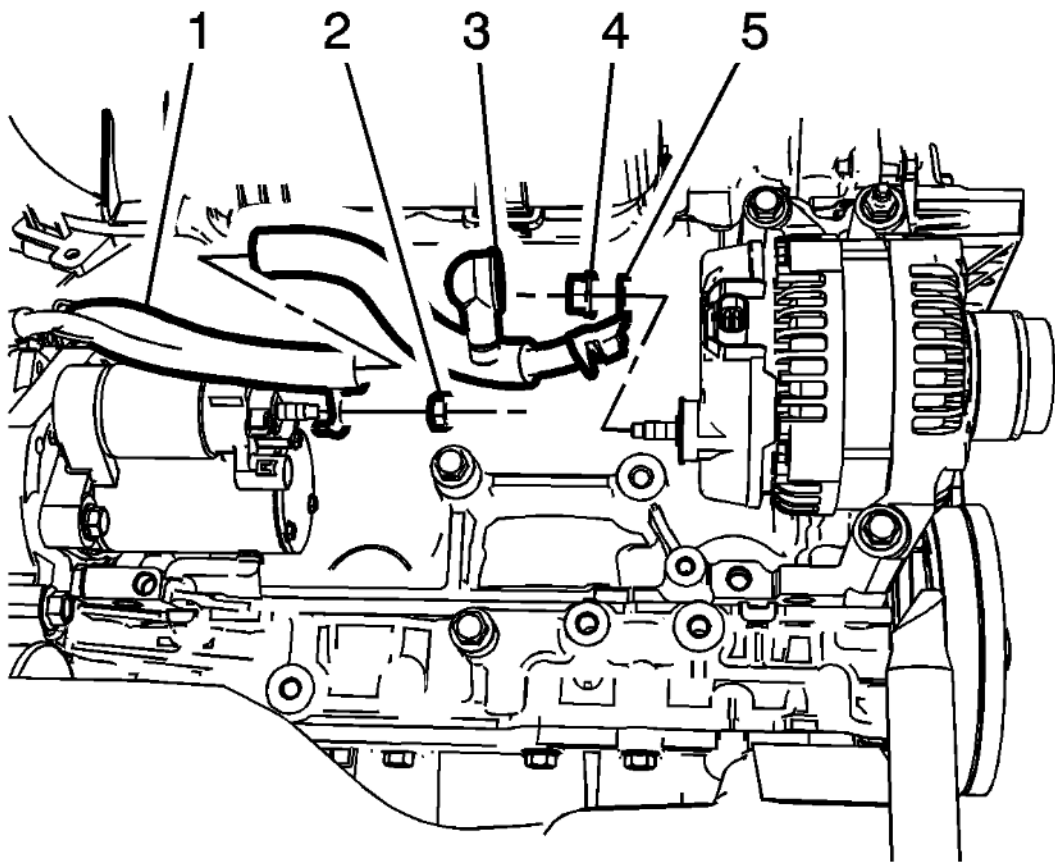


Fig. 24: Starter Solenoid Fastener
Courtesy of GENERAL MOTORS COMPANY

- 11. Remove the starter solenoid fastener (2) and remove the battery positive cable (1) from the starter solenoid.
- 12. Remove the protective boot (3) and the generator battery positive cable fastener (4).
- 13. Remove the battery positive cable (5) from the generator.
- 14. Lower the vehicle.

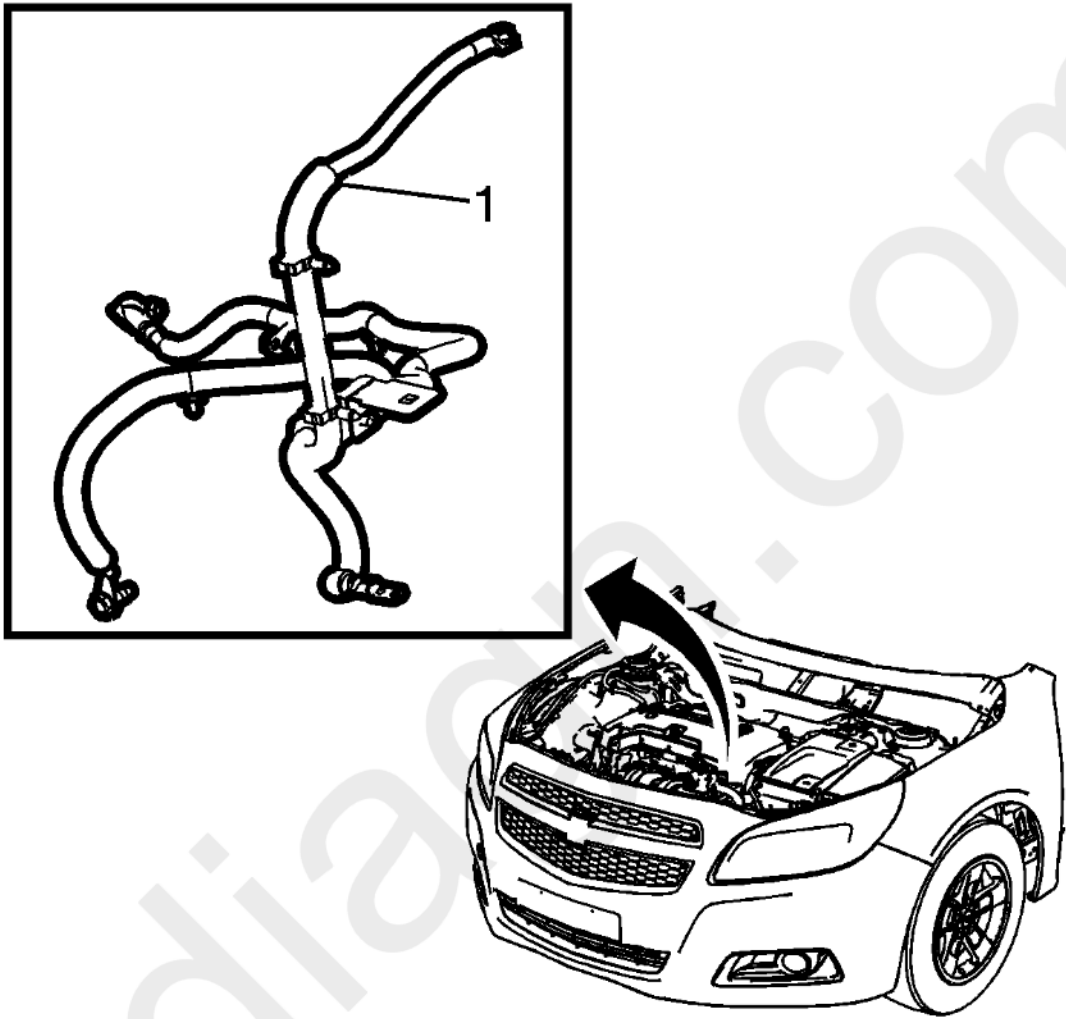


Fig. 25: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: Observe how the battery positive and negative cable was routed within the engine compartment.

- 15. Remove the battery positive and negative cable (1) from the engine compartment.

Installation Procedure

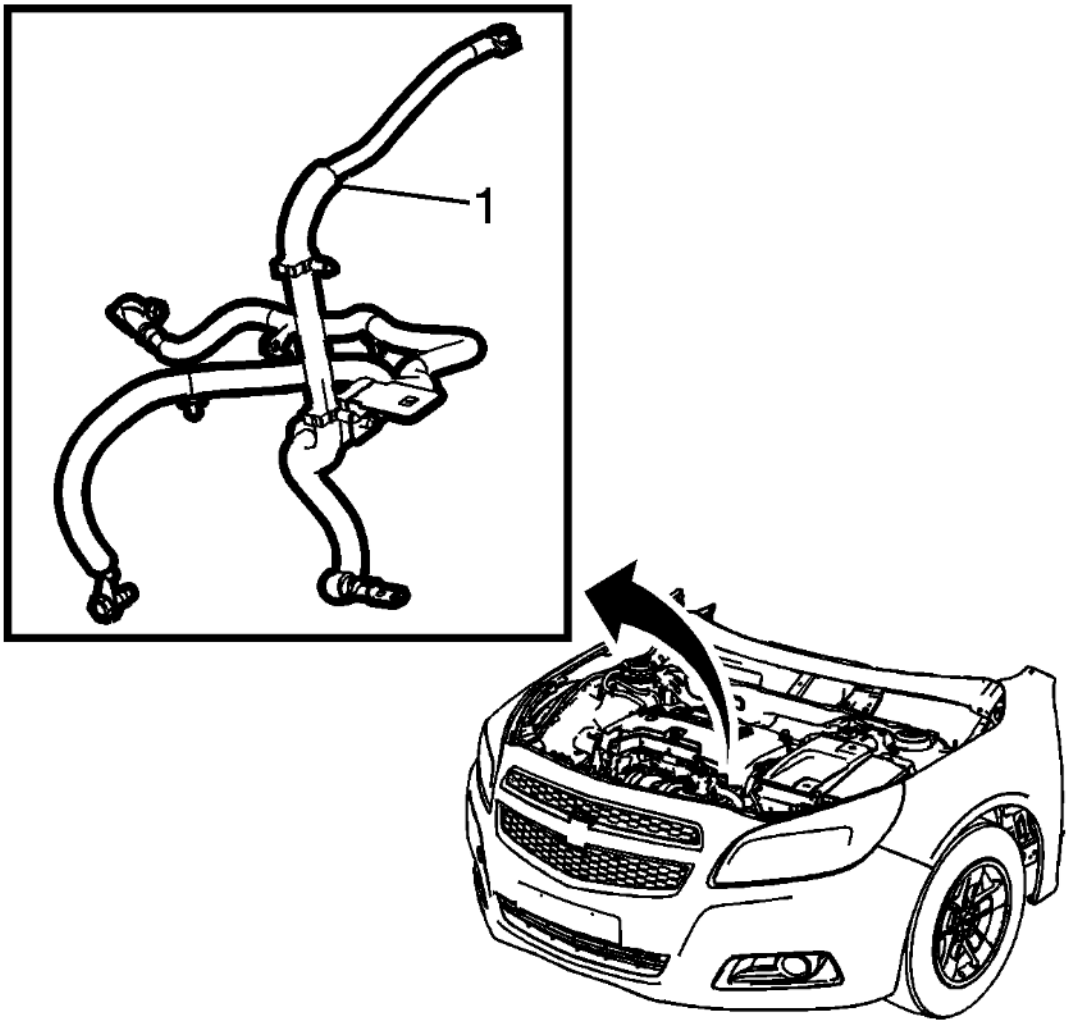


Fig. 26: Battery Positive And Negative Cable
Courtesy of GENERAL MOTORS COMPANY

- 1. Install the positive and negative cable to the engine compartment noting the routing.
- 2. Raise the vehicle.

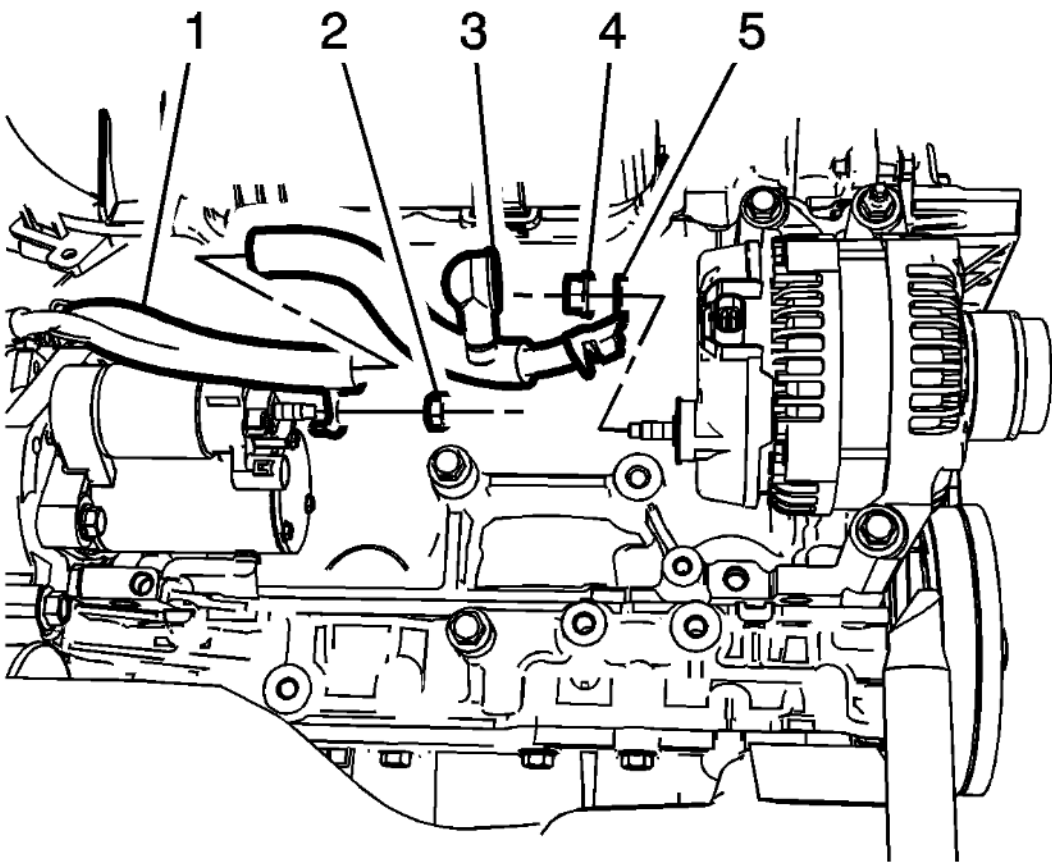


Fig. 27: Starter Solenoid Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

- 3. Install the battery positive cable terminal (5) and fastener (4) to the back of the generator. Tighten to 15 N.m (11 lb ft).
- 4. Install the protective boot (3) to the positive cable stud on the back of the generator.
- 5. Install the battery positive cable (1) to the starter solenoid and tighten the fastener (2) to 10 N.m (89 lb in).
- 6. Lower the vehicle.

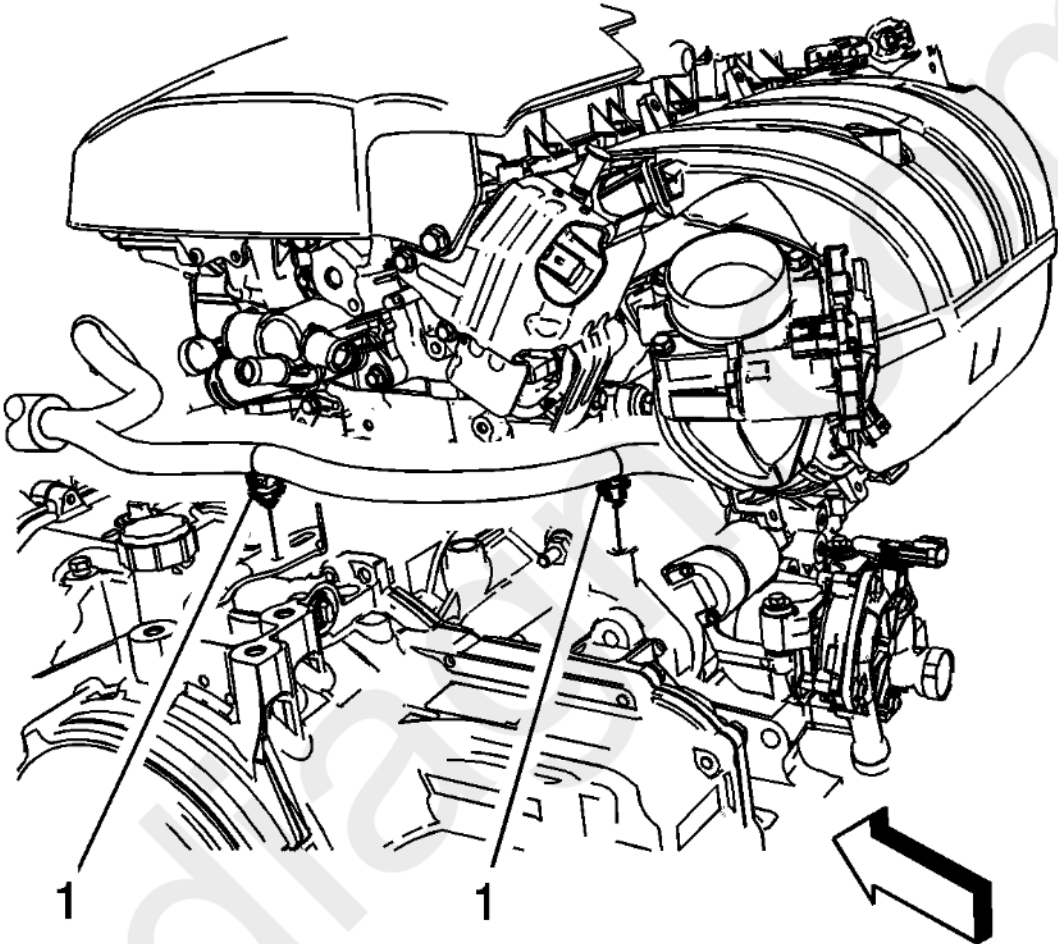


Fig. 28: Battery Positive And Negative Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

- 7. Install the battery positive and negative cable retainers (1), to the transmission shift cable bracket.

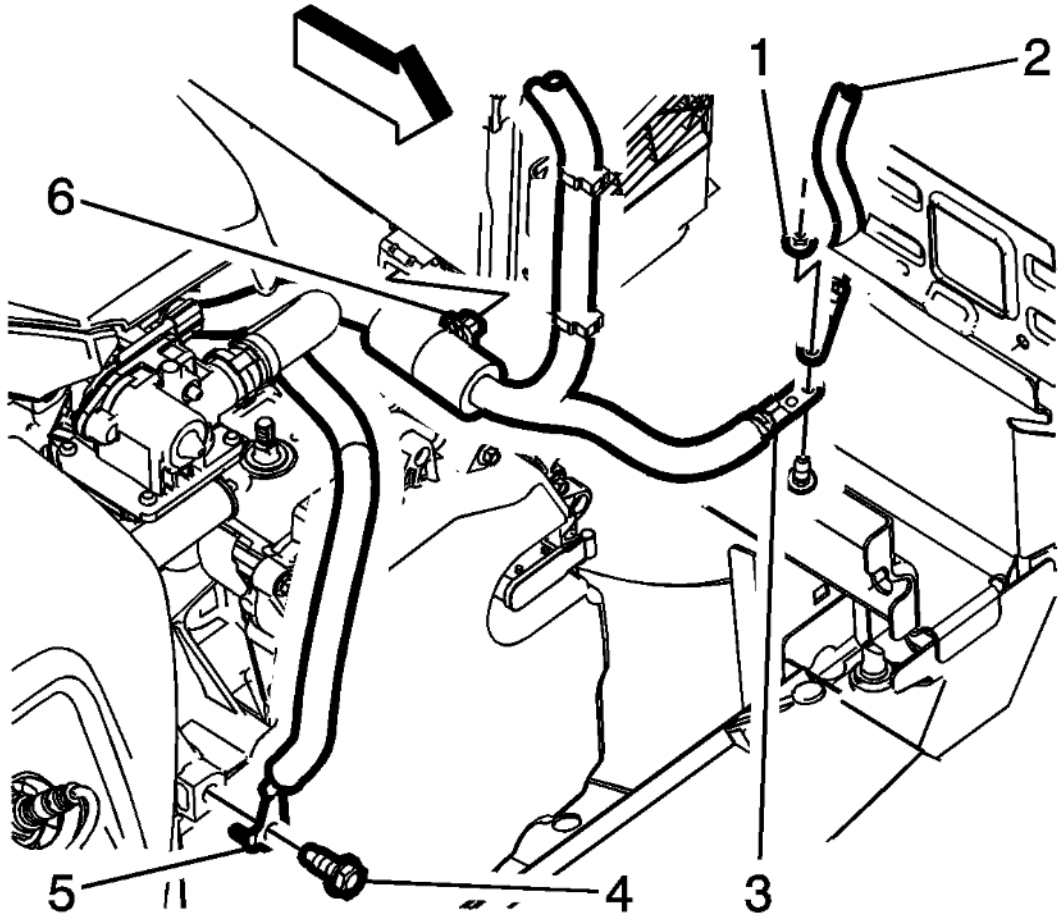


Fig. 29: Battery Negative Fastener
Courtesy of GENERAL MOTORS COMPANY

- 8. Install the battery positive and negative cable retainer (6), to the battery tray bracket
- 9. Install the battery negative cable terminal (5), to the transmission, and tighten the fastener (4) to 25 N.m (18 lb ft).
- 10. Install the battery positive and negative cable ground terminal (3) and the battery negative cable (2) to the frame stud. Tighten the fastener (1) to 12 N.m (106 lb in).
- 11. Install the battery tray. **Battery Tray Replacement**

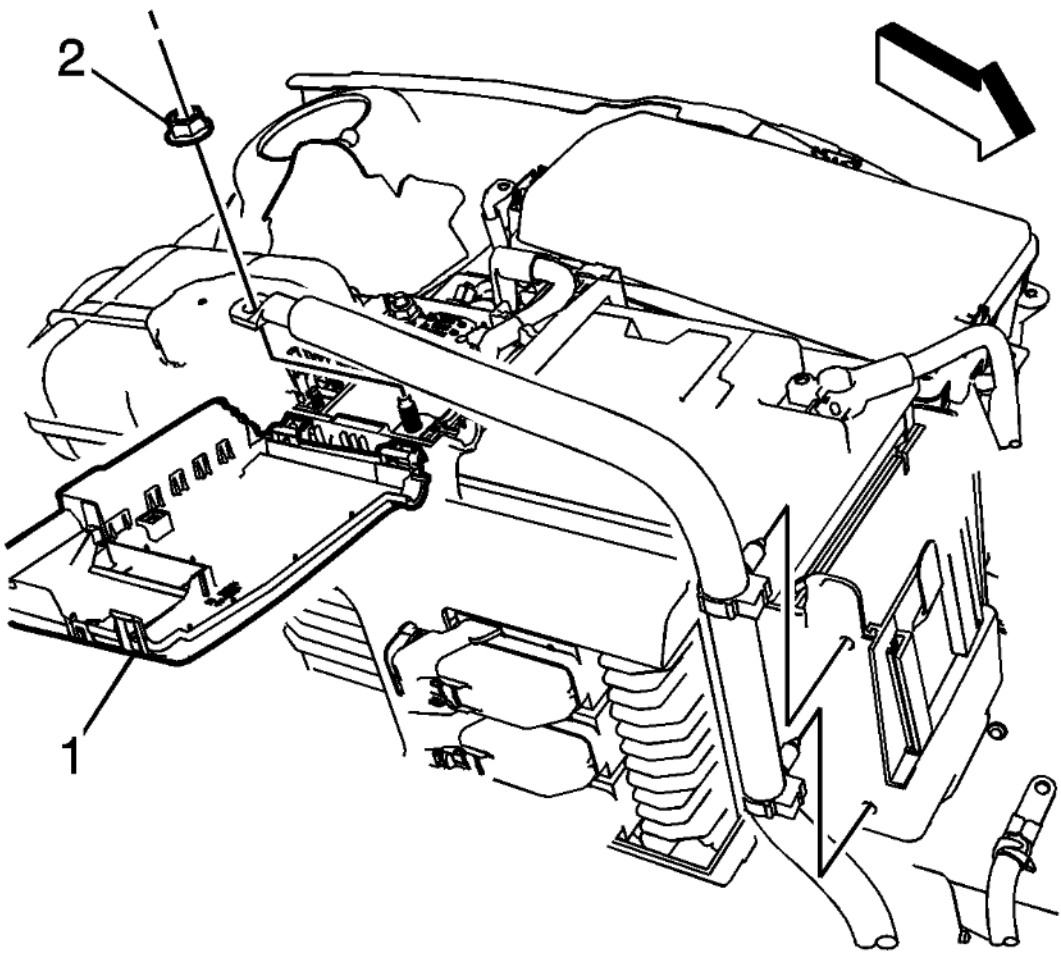


Fig. 30: Positive Battery Cable Terminal, Nut And Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

- 12. Install the battery positive cable terminal and fastener (2), to the battery fuse block. Tighten to 12 N.m (106 lb in).
- 13. Close the battery fuse block cover (1).
- 14. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY NEGATIVE CABLE REPLACEMENT (WITHOUT KL9)

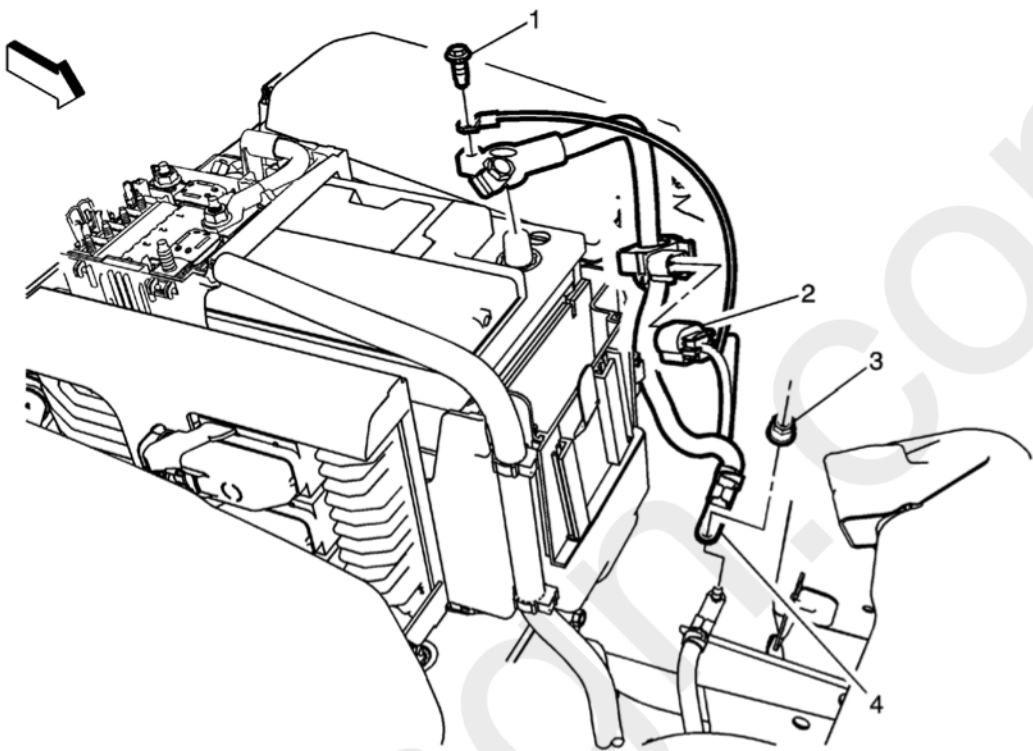


Fig. 31: Battery Negative Cable
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Disconnect the negative battery cable. Refer to Battery Negative Cable Disconnection and Connection .	
1	Body Harness Ground Fastener CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Battery Current Sensor Connector
3	Battery Negative Cable Frame Ground Fastener Tighten 9 N.m (80 lb in)
4	Battery Negative Cable Procedure 1. Mark the location of the battery current sensor on the battery negative cable. 2. Transfer the current sensor to the NEW battery negative cable. 3. Slide the battery current sensor onto the NEW battery negative cable and tape into place.

BATTERY NEGATIVE CABLE REPLACEMENT (WITH KL9)

Removal Procedure

- 1. Ensure that all lamps and accessories are turned off.
- 2. Turn the ignition OFF and remove the ignition key.

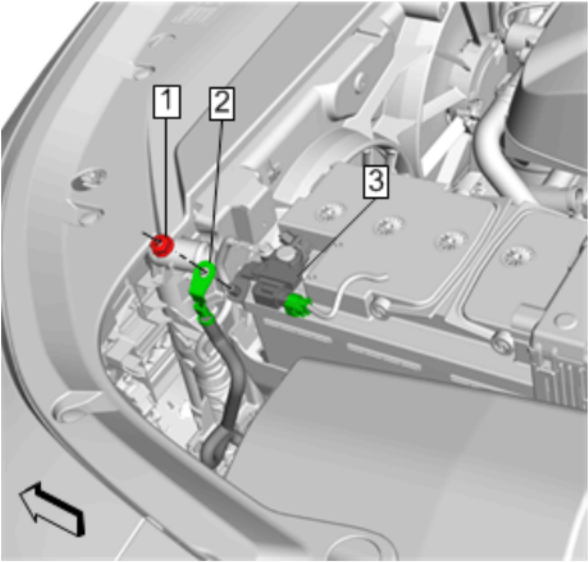


Fig. 32: Battery Sensor, Battery Negative Cable Terminal And Nut
Courtesy of GENERAL MOTORS COMPANY

- 3. Remove the battery negative cable nut (1).
- 4. Remove the battery negative cable terminal (2) from the battery sensor (3).

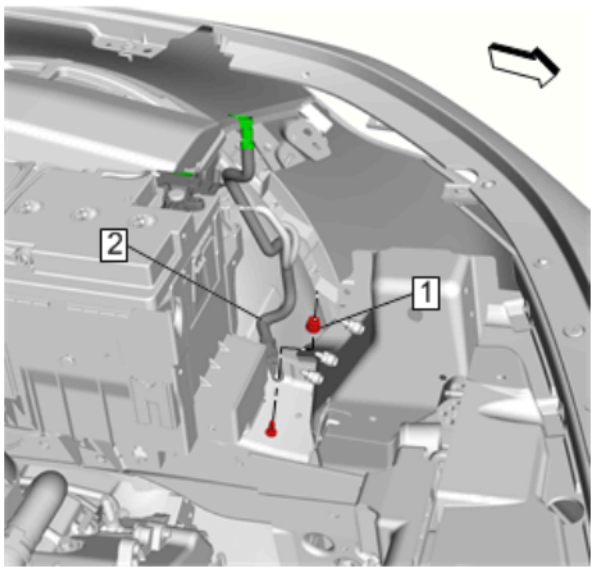


Fig. 33: Battery Negative Cable And Ground Nut
Courtesy of GENERAL MOTORS COMPANY

5. Remove the battery negative cable ground nut (1) and remove the battery negative cable (2) from the vehicle.

Installation Procedure

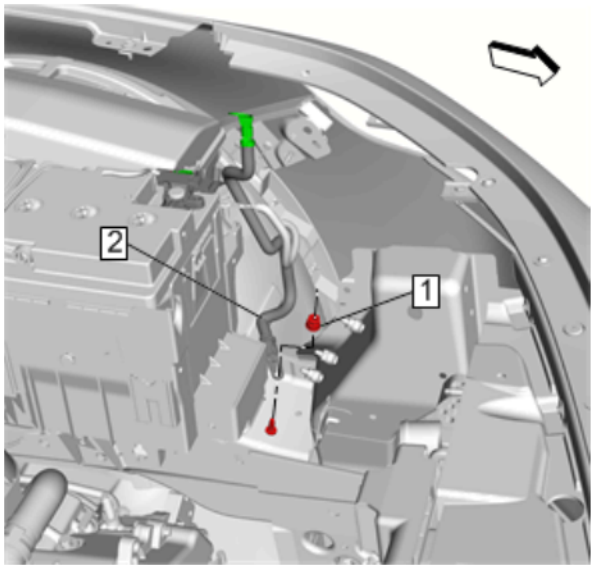


Fig. 34: Battery Negative Cable And Ground Nut
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

1. Install the battery negative cable (2) to the frame ground stud and tighten the nut (1) to 9 N.m (80 lb in).

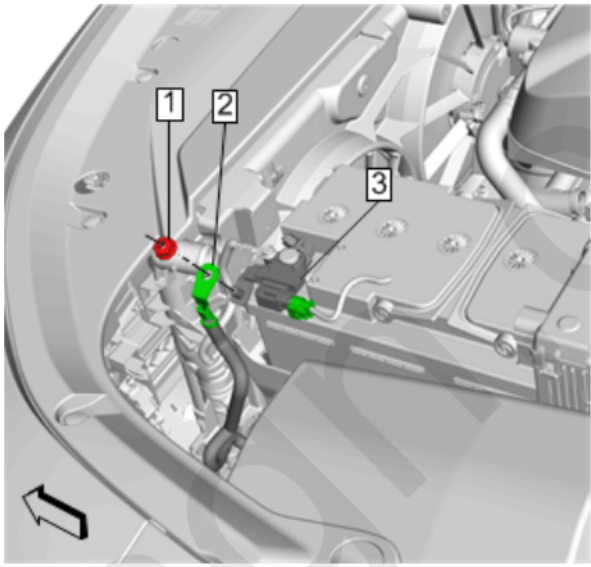


Fig. 35: Battery Sensor, Battery Negative Cable Terminal And Nut
Courtesy of GENERAL MOTORS COMPANY

2. Install the battery negative cable (2) to the battery sensor (3) and tighten the nut (1) to 11 N.m (97 lb in).

AUXILIARY BATTERY NEGATIVE CABLE REPLACEMENT (WITH START/STOP)

Removal Procedure

1. Turn the ignition OFF.
2. Remove the left rear compartment side trim panel. Refer to **Rear Compartment Side Trim Replacement - Left Side** .

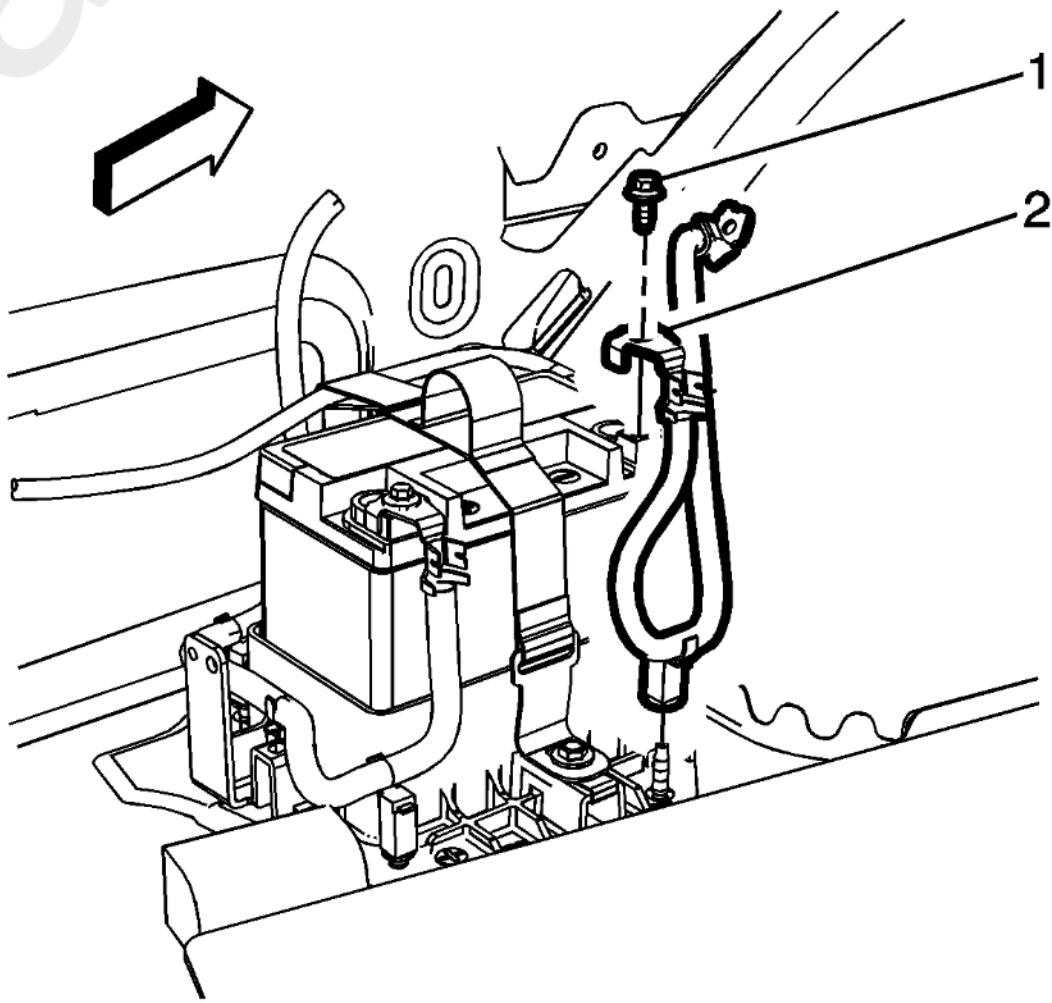


Fig. 36: Auxiliary Battery Negative Cable & Fastener
Courtesy of GENERAL MOTORS COMPANY

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

3. Remove the auxiliary battery negative cable fastener (1) and remove the auxiliary battery negative cable (2).

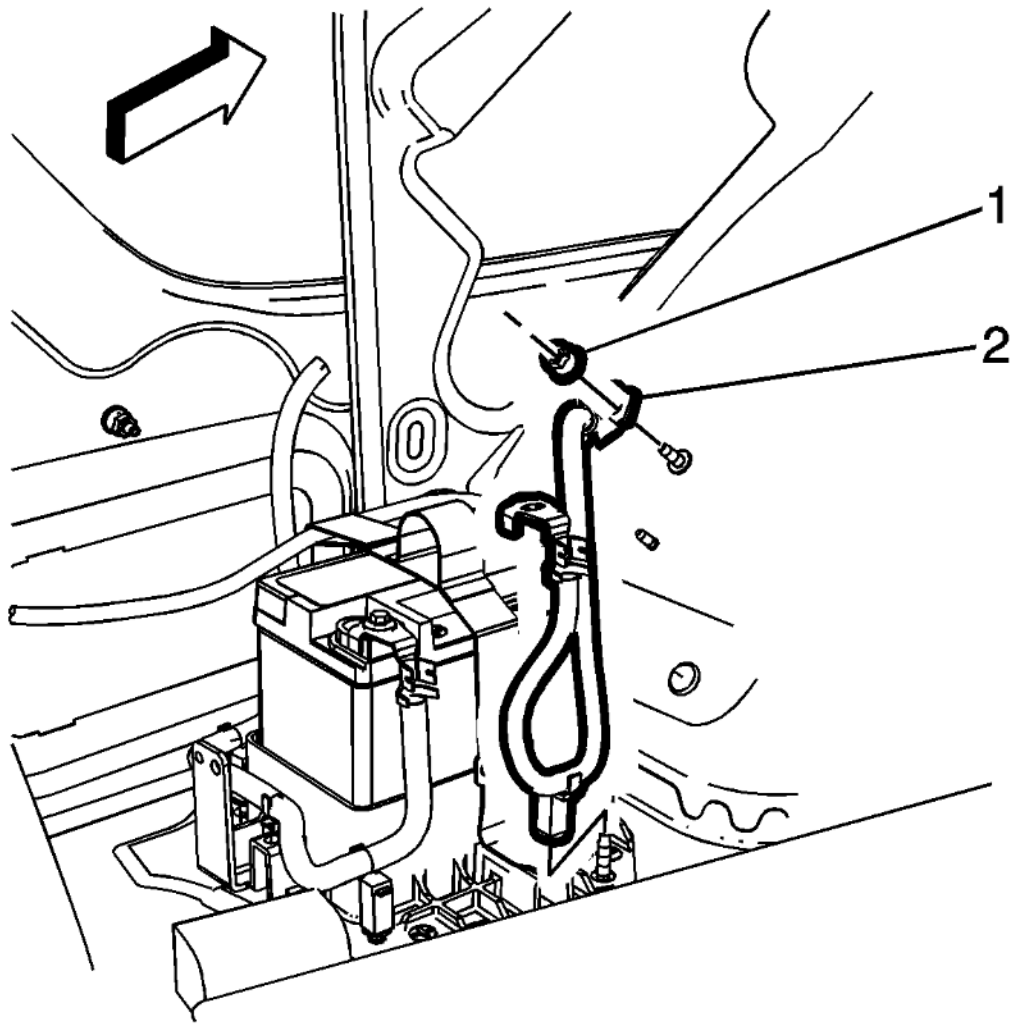


Fig. 37: Auxiliary Battery Negative Cable Terminal & Fastener
Courtesy of GENERAL MOTORS COMPANY

- 4. Remove the fastener (1) that secures the auxiliary negative battery cable terminal (2) to the body stud.
- 5. Detach the auxiliary battery negative cable retainer from the auxiliary battery tray and remove the auxiliary battery negative cable from the rear compartment.

Installation Procedure

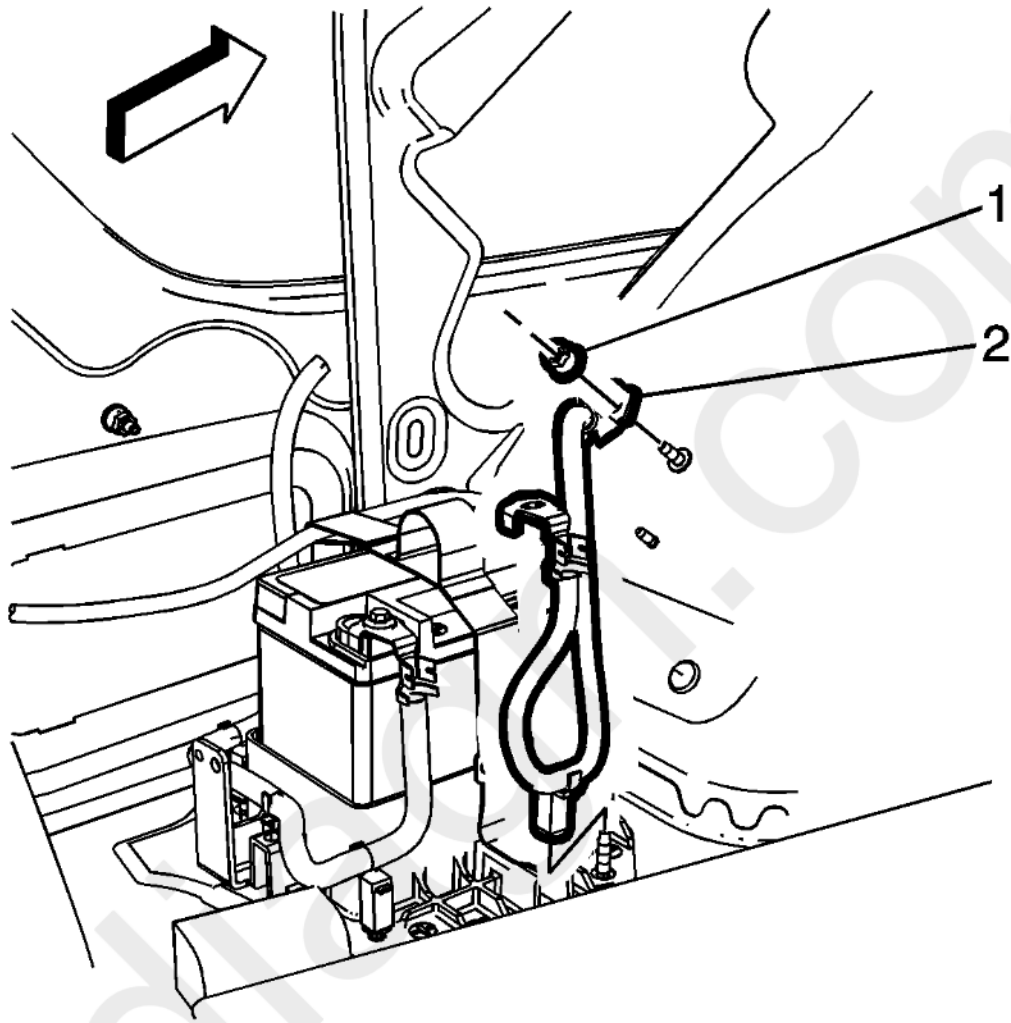


Fig. 38: Auxiliary Battery Negative Cable Terminal & Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

- 1. Install the auxiliary battery negative cable (2) to the body stud and tighten the fastener (1) to 9 N.m (80 lb in).
- 2. Attach the auxiliary battery negative cable retainer to the auxiliary battery tray.

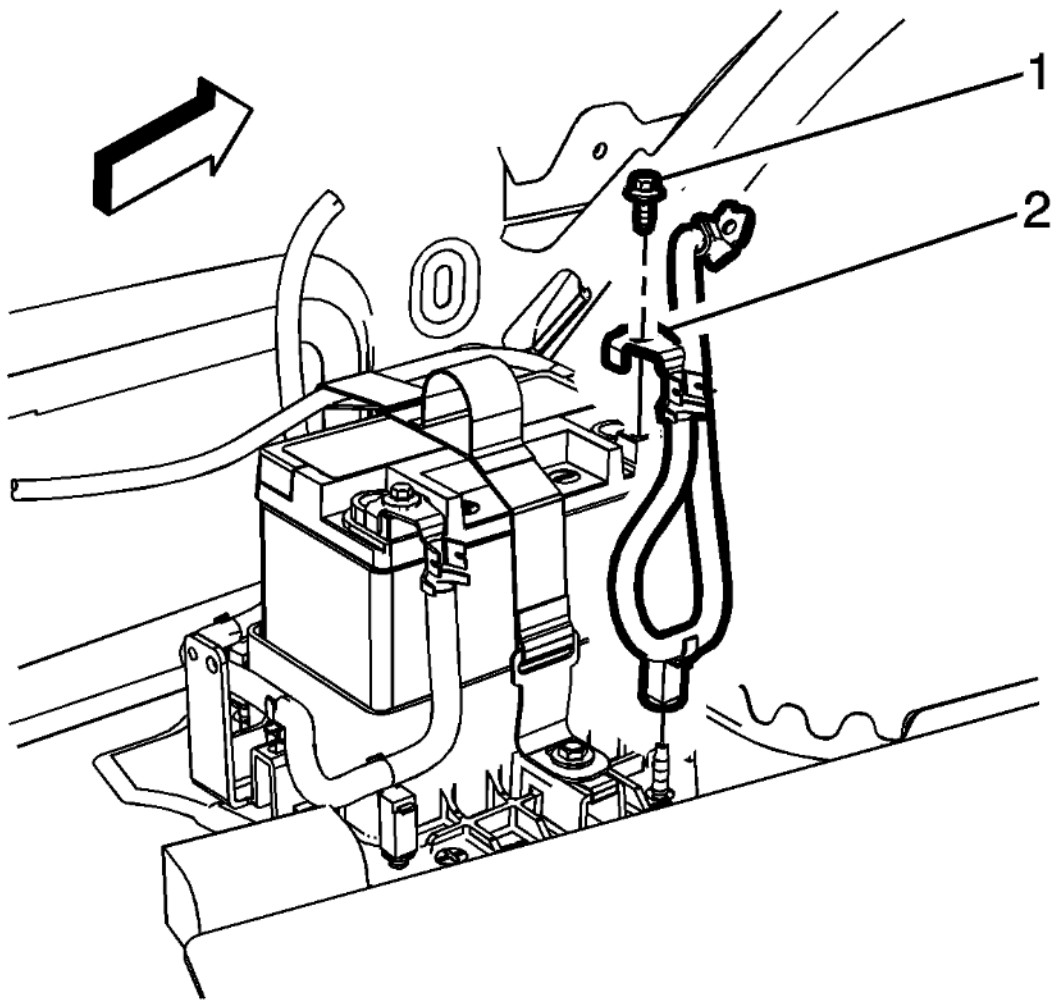


Fig. 39: Auxiliary Battery Negative Cable & Fastener
Courtesy of GENERAL MOTORS COMPANY

- 3. Install the auxiliary battery negative cable (2), to the auxiliary battery negative post, and tighten the fastener (1) to 4.5 N.m (40 lb in).
- 4. Install the left rear compartment side trim panel. Refer to **Rear Compartment Side Trim Replacement - Left Side** .

BATTERY POSITIVE FUSE BLOCK CABLE REPLACEMENT

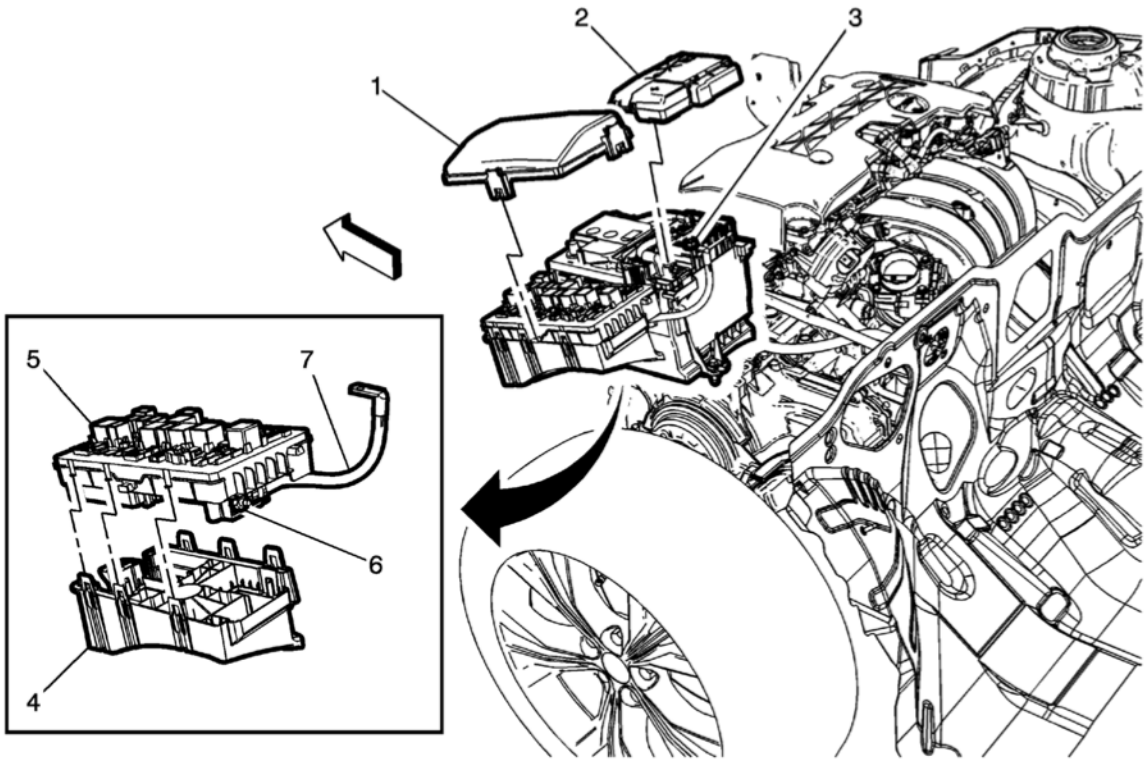


Fig. 40: Battery Positive Fuse Block Cable & Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures	
Disconnect the battery negative cable. Refer to Battery Negative Cable Disconnection and Connection.	
1	Accessory Wiring Junction Block Cover
2	Battery Fuse Block Cover
3	Battery Fuse Block Cable Fastener
	CAUTION: Refer to Fastener Caution .
	Tighten 12 N.m (106 lb in)
4	Accessory Wiring Junction Block Retainer Base
5	Accessory Wiring Junction Block
6	Accessory Wiring Junction Block Fastener
	Tighten 7 N.m (62 lb in)
7	Battery Positive Fuse Block Cable
	Procedure 1. Remove the battery fuse block and the accessory wiring junction block covers. 2. Detach the accessory wiring junction block (5) from the retainer base (4) with the 6 retaining tabs. 3. Remove the fasteners securing the battery positive fuse block cable (7) from the battery fuse block and the accessory wiring junction block.

BATTERY REPLACEMENT

Removal Procedure

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

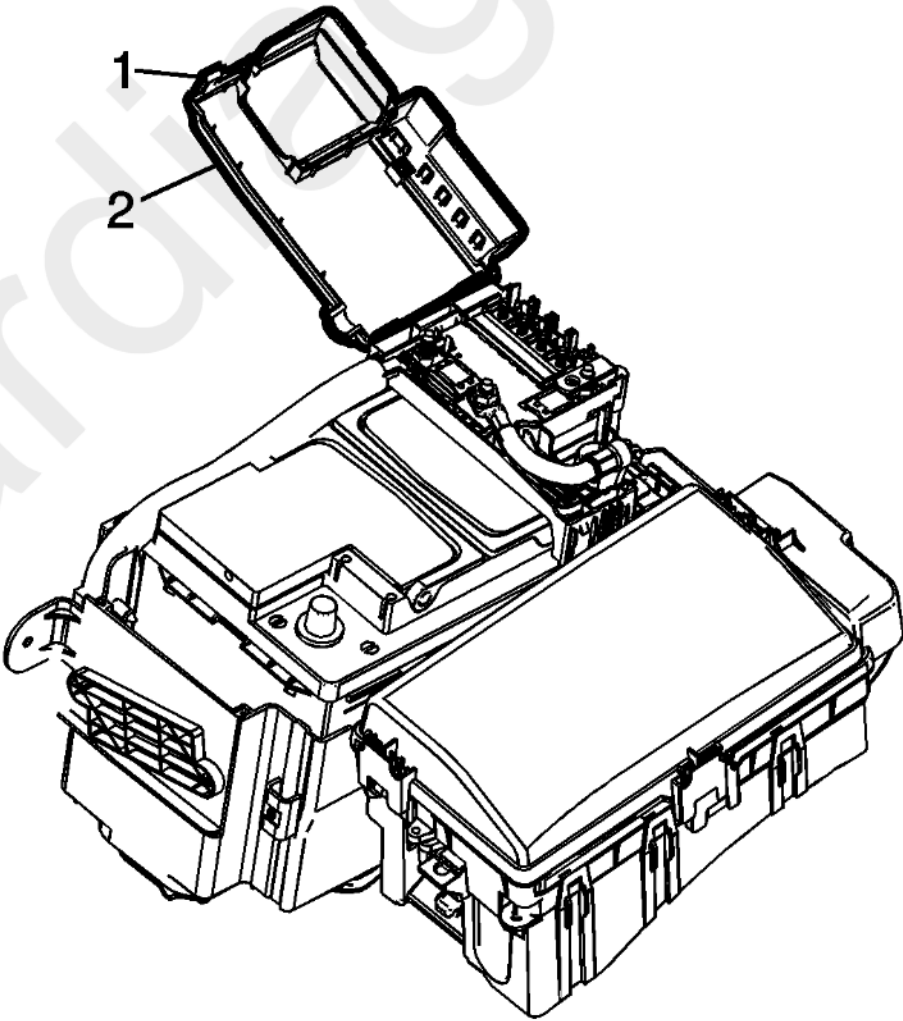


Fig. 41: Battery Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open the battery fuse block cover (2) with the release tab (1).

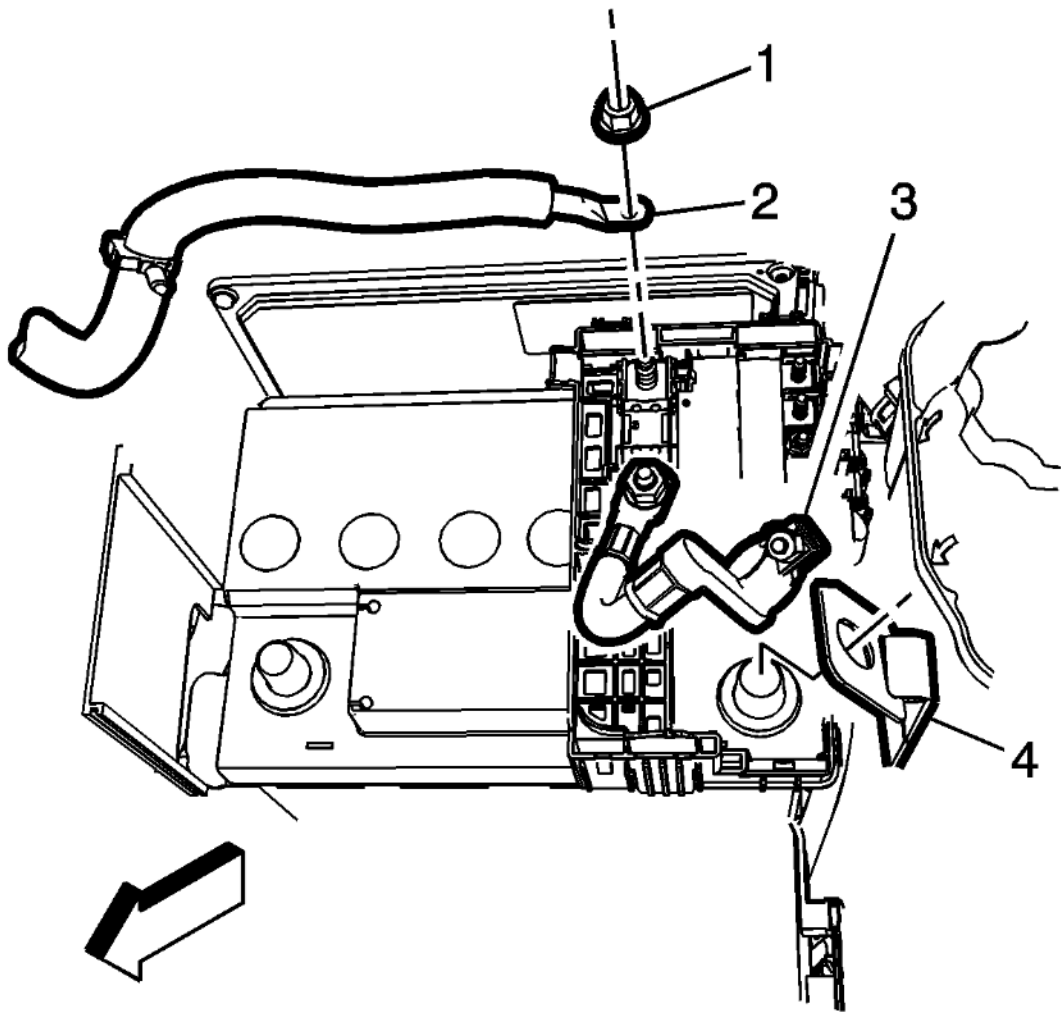


Fig. 42: Battery Hold-Down Strap And Battery Fuse Block Cable Clamp Fastener
Courtesy of GENERAL MOTORS COMPANY

- 3. Release the tabs and open the battery fuse block cover. Remove the battery positive cable fastener and cable, from the battery fuse block.
- 4. Remove the battery fuse block cable clamp fastener (3) and the battery hold-down strap (4).

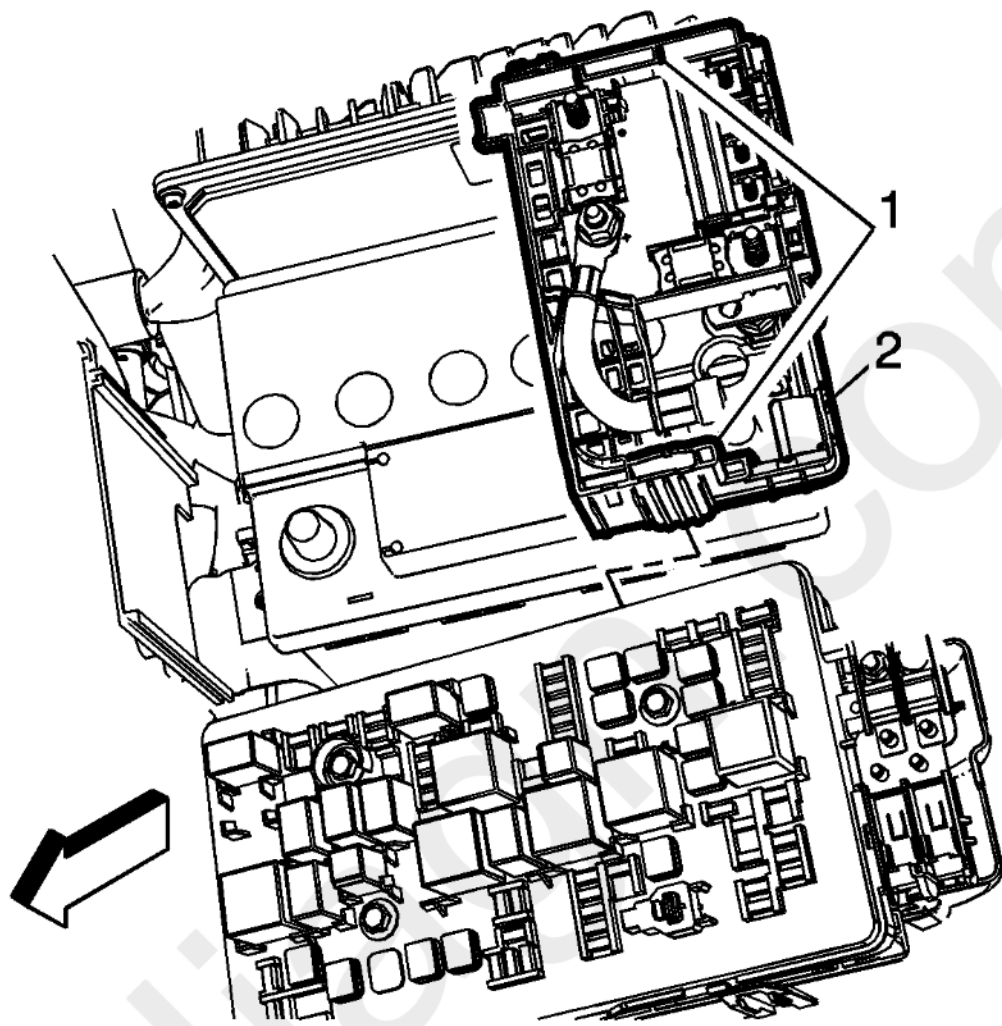


Fig. 43: Battery Fuse Block And Retainers
Courtesy of GENERAL MOTORS COMPANY

- 5. Remove the battery fuse block (2) with the retainers (1) and set aside.

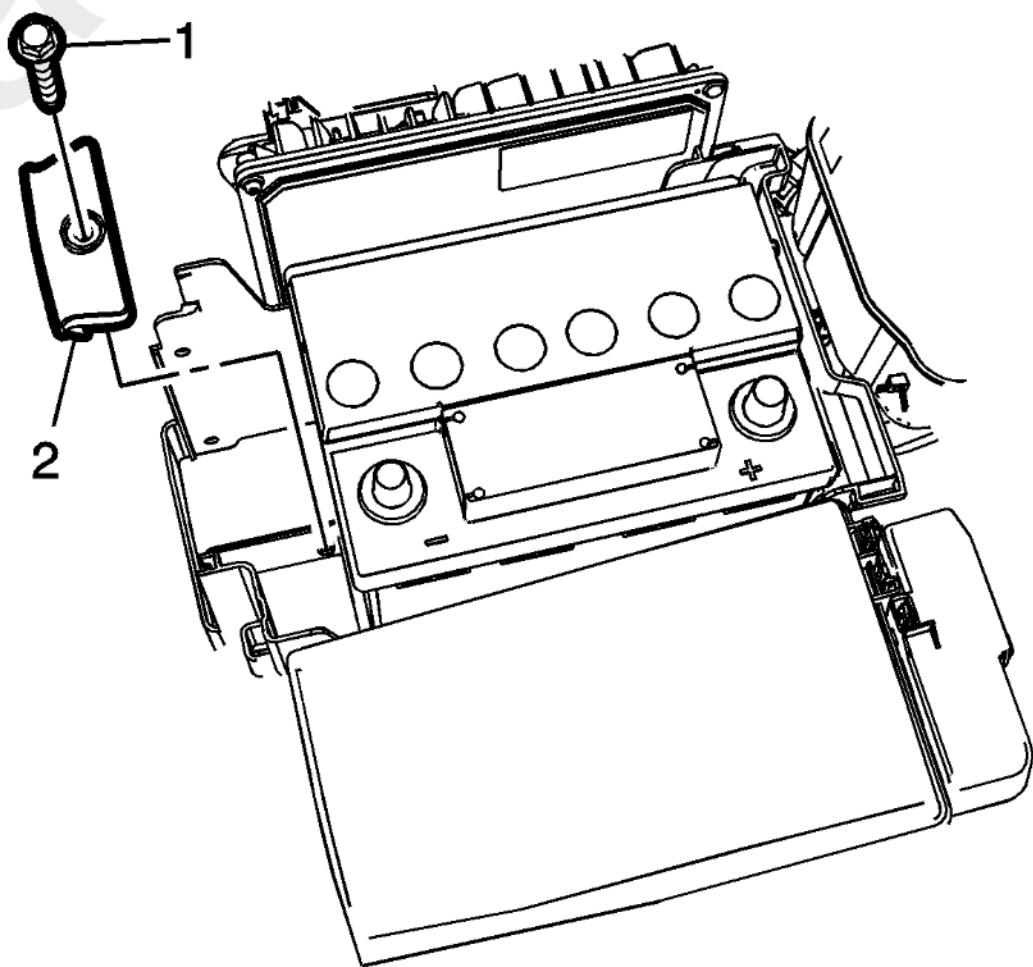


Fig. 44: Battery Retainer And Fastener
Courtesy of GENERAL MOTORS COMPANY

- 6. Remove the battery retainer fastener (1) and the retainer (2).

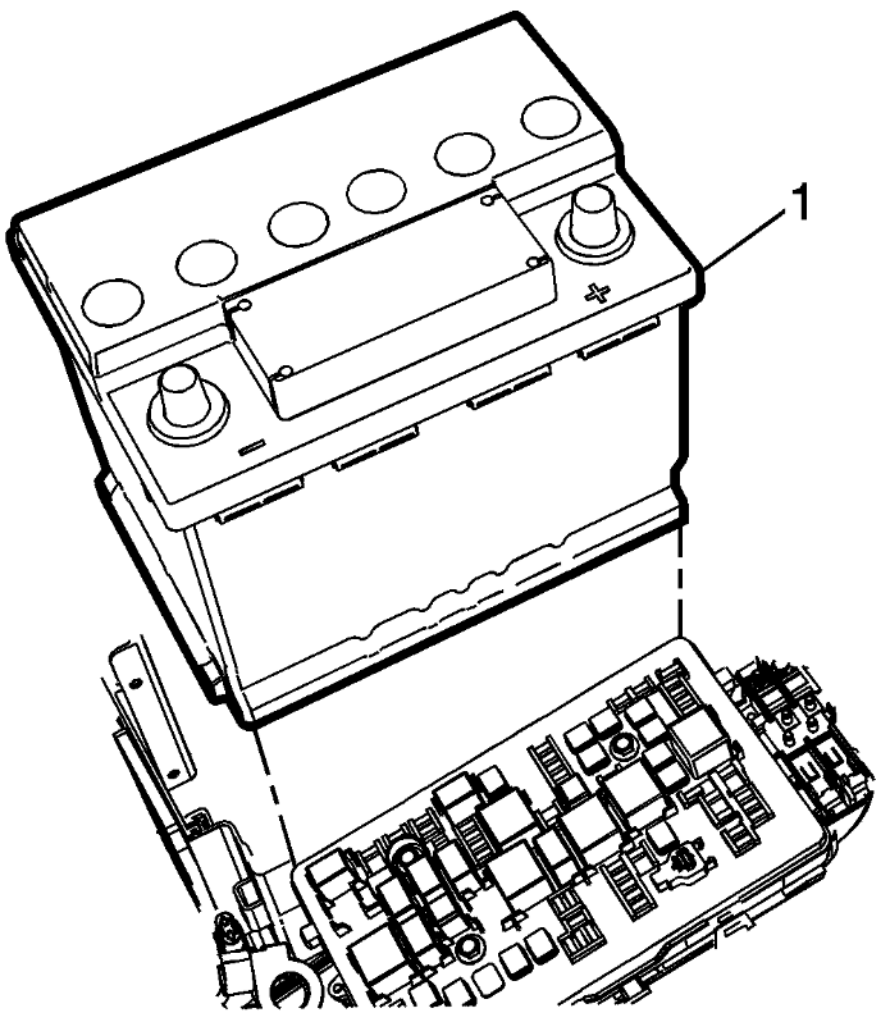


Fig. 45: Battery
Courtesy of GENERAL MOTORS COMPANY

7. Remove the battery (1) from the engine compartment.

Installation Procedure

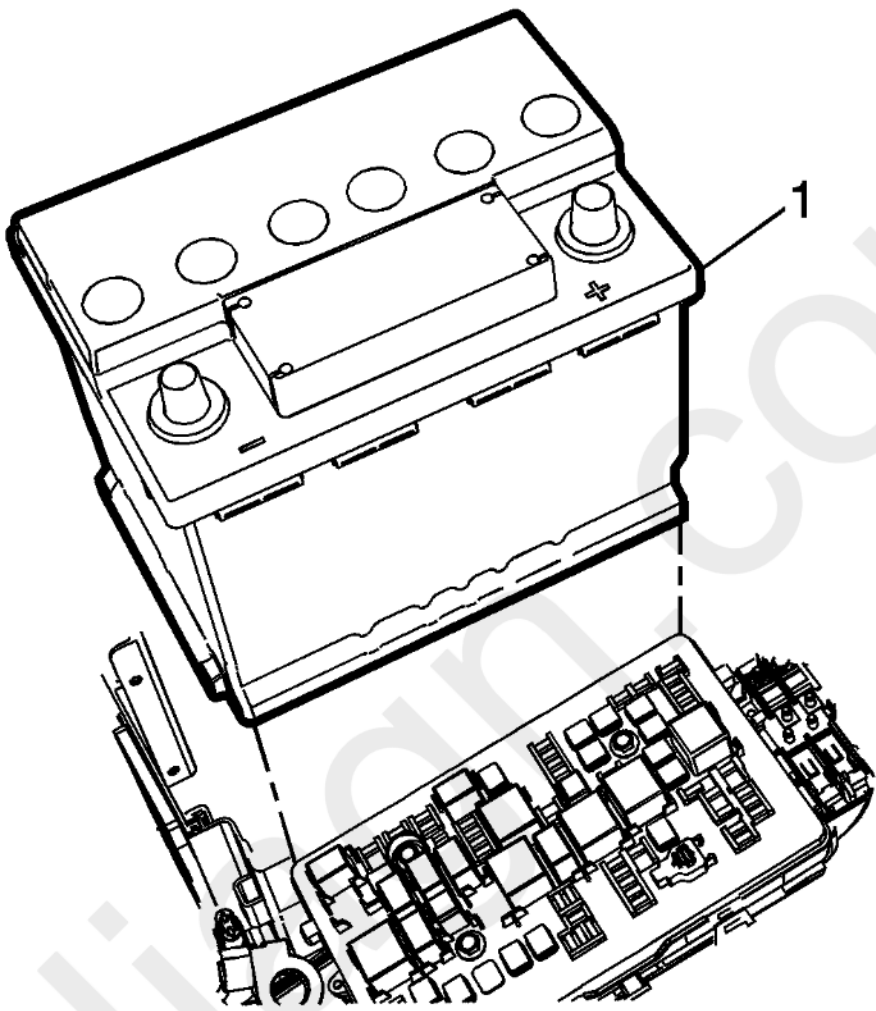


Fig. 46: Battery
Courtesy of GENERAL MOTORS COMPANY

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

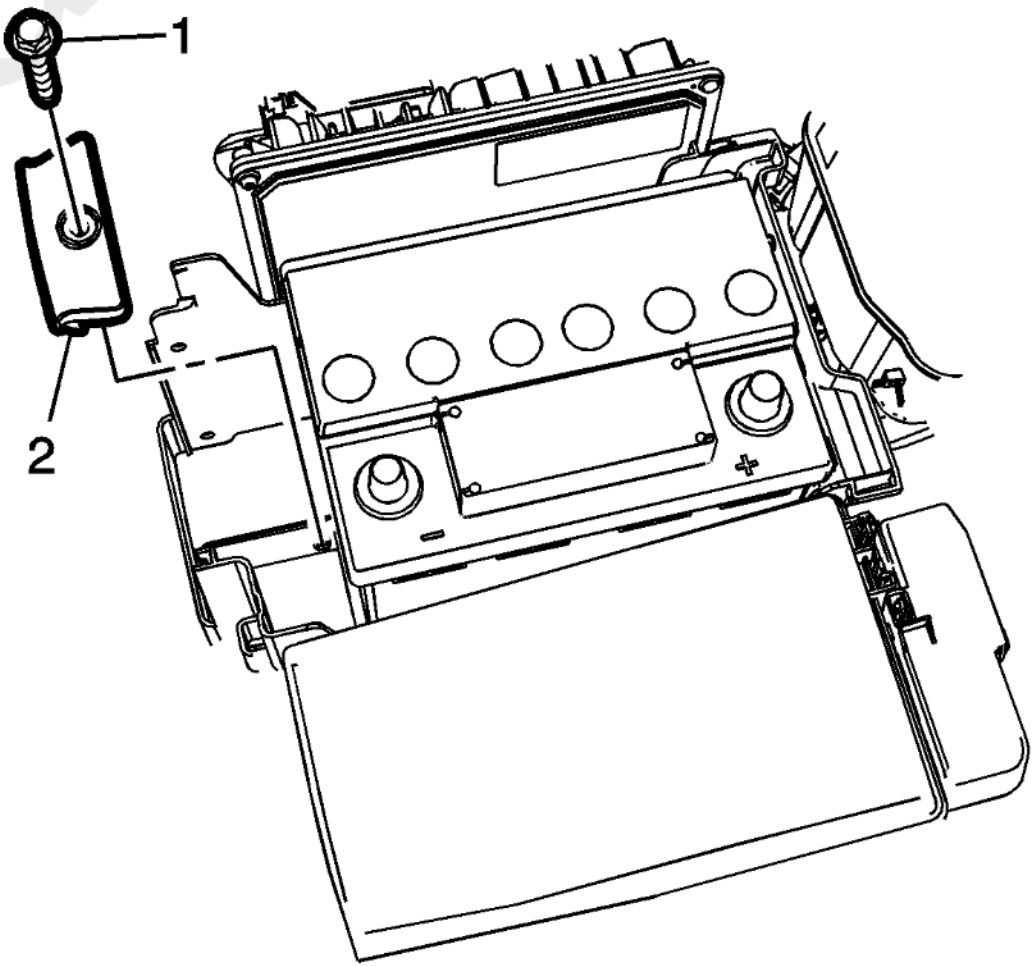


Fig. 47: Battery Retainer And Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

2. Install the battery retainer (2) and tighten the fastener (1) to 10 N.m (88 lb in).

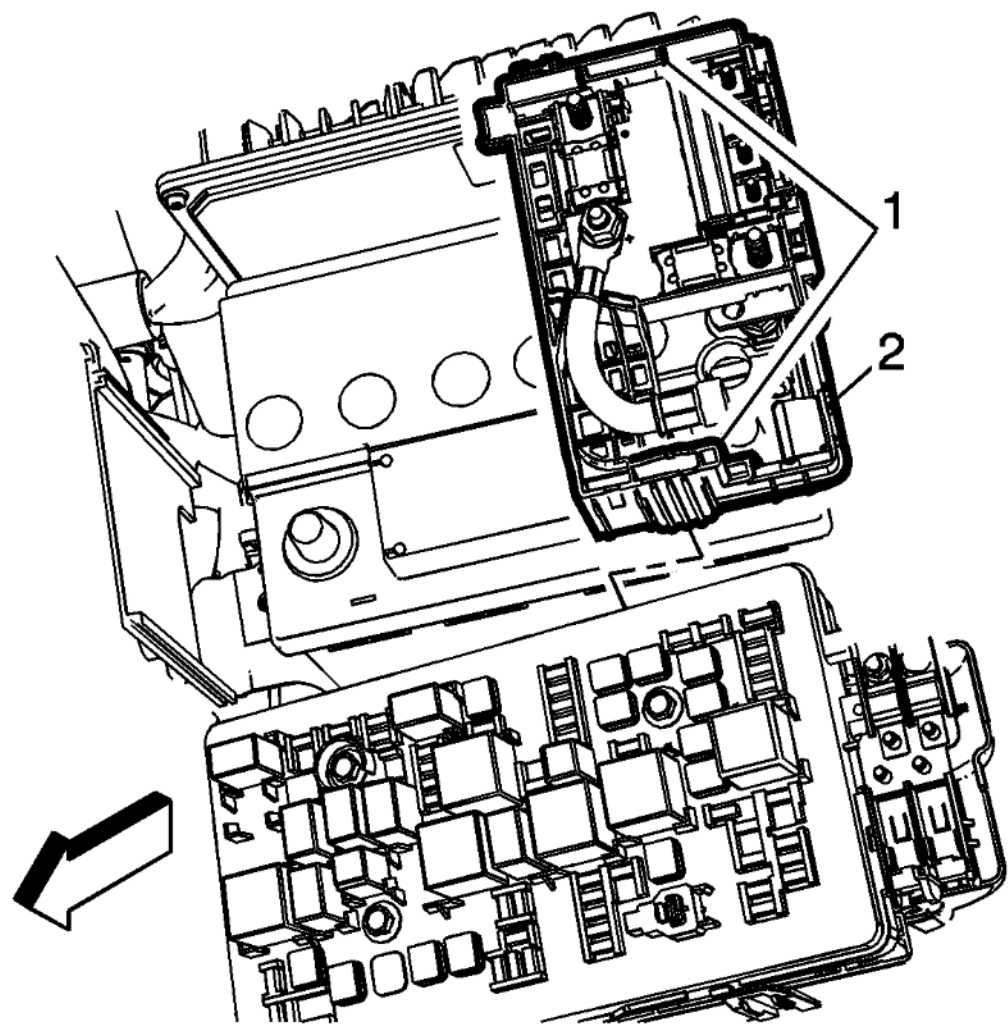


Fig. 48: Battery Fuse Block And Retainers
Courtesy of GENERAL MOTORS COMPANY

3. Install the battery fuse block (2) to the battery with the retainers (1).

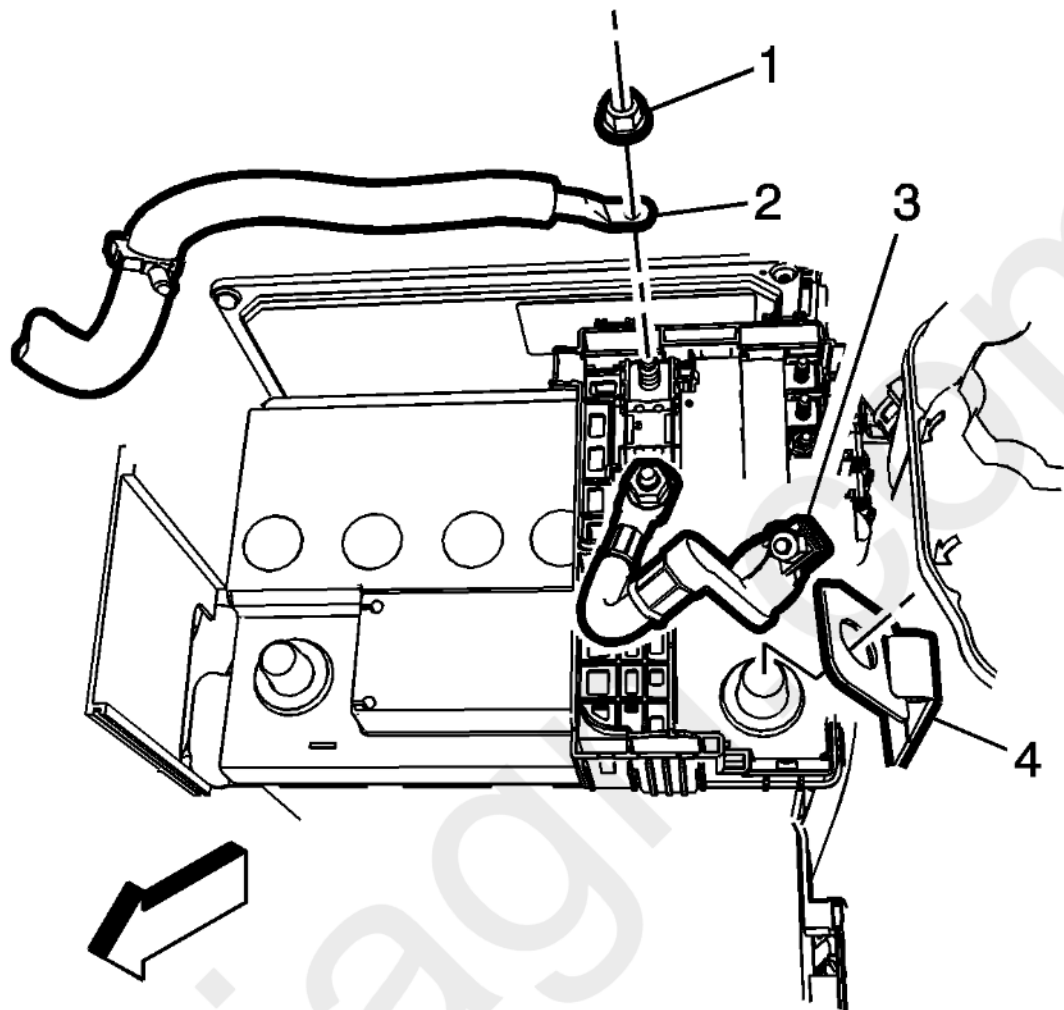


Fig. 49: Battery Hold-Down Strap And Battery Fuse Block Cable Clamp Fastener
Courtesy of GENERAL MOTORS COMPANY

- 4. Install the battery positive cable (2) to the battery fuse block and tighten the fastener (1) to 12 N.m (106 lb in).
- 5. Install the battery hold-down strap (4) to the battery positive post.
- 6. Install the battery positive clamp to the post and tighten the fastener (3) to 4.5 N.m (44 lb in).
- 7. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

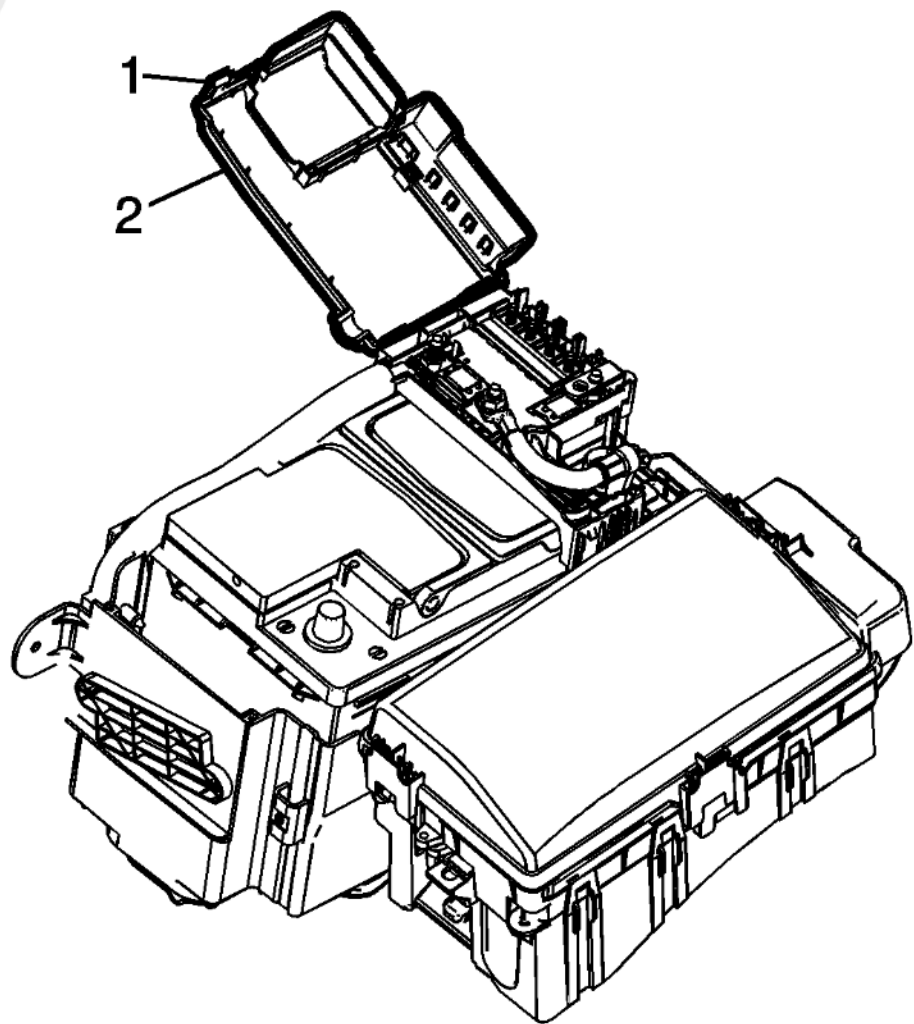


Fig. 50: Battery Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

8. Close the cover (2) on the battery fuse block.

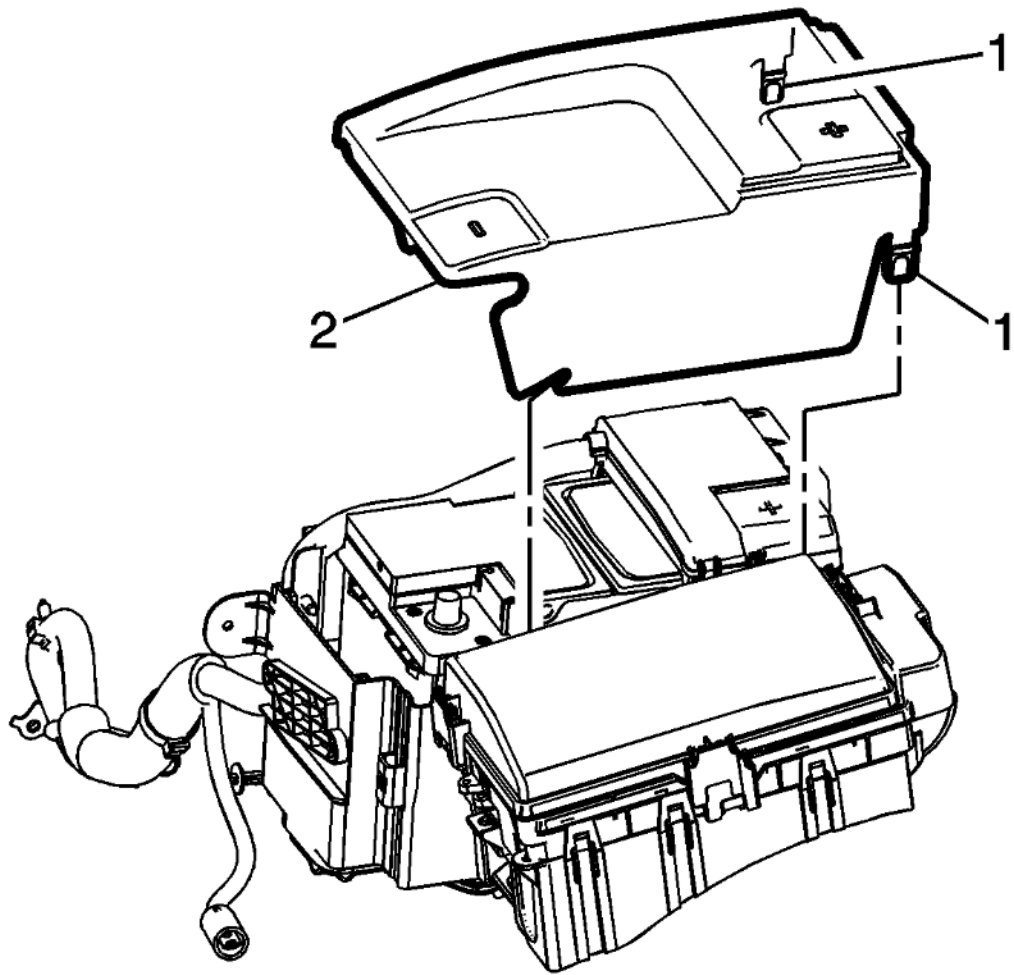


Fig. 51: Battery Cover And Retaining Tabs
Courtesy of GENERAL MOTORS COMPANY

- 9. Install the battery cover (2) with the retaining tabs (1).
- 10. Perform the battery sensor module learn program. Refer to **Battery Sensor Module Learn**

AUXILIARY BATTERY REPLACEMENT (WITH START/STOP)

Removal Procedure

- 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
- 2. Remove the left rear compartment side trim panel. Refer to **Rear Compartment Side Trim Replacement - Left Side**.

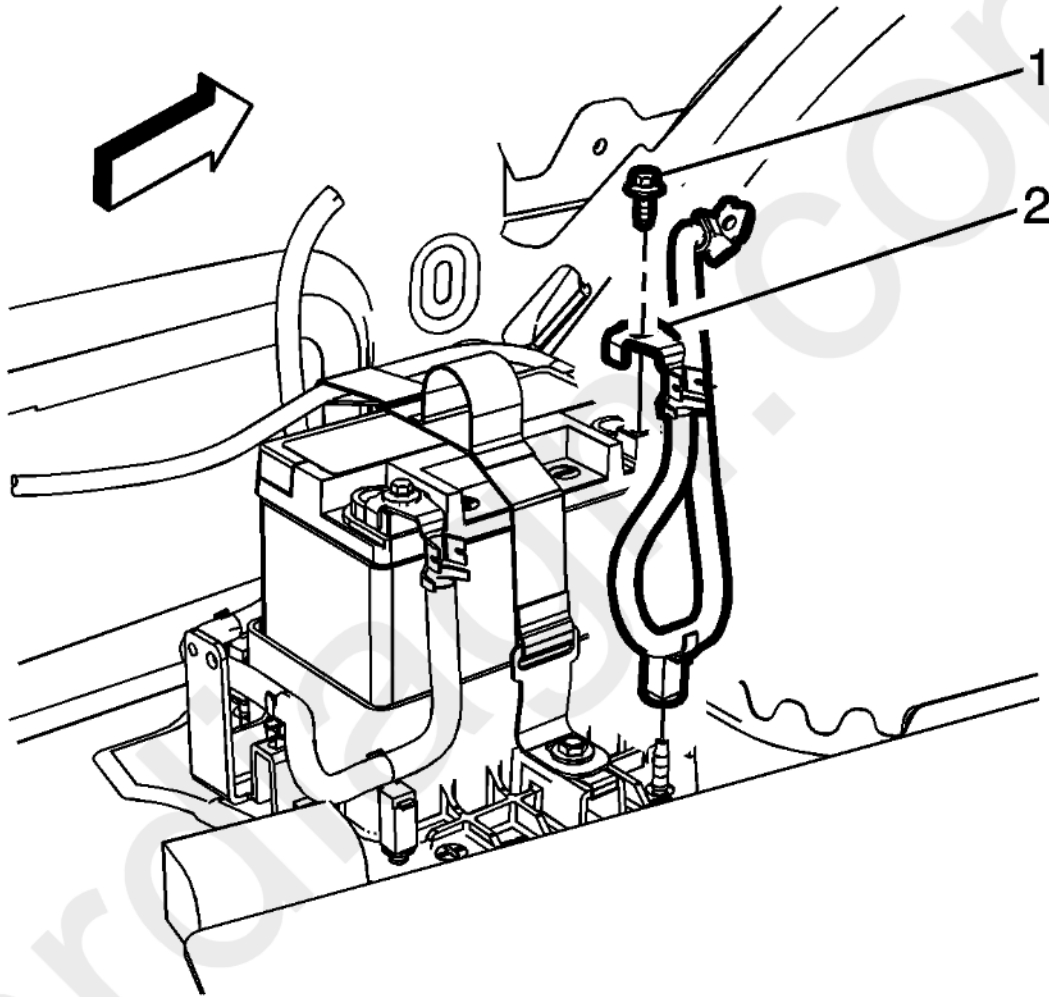


Fig. 52: Auxiliary Battery Negative Cable & Fastener
Courtesy of GENERAL MOTORS COMPANY

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

- 3. Remove the auxiliary battery negative cable fastener (1) and set aside the auxiliary battery negative cable (2).

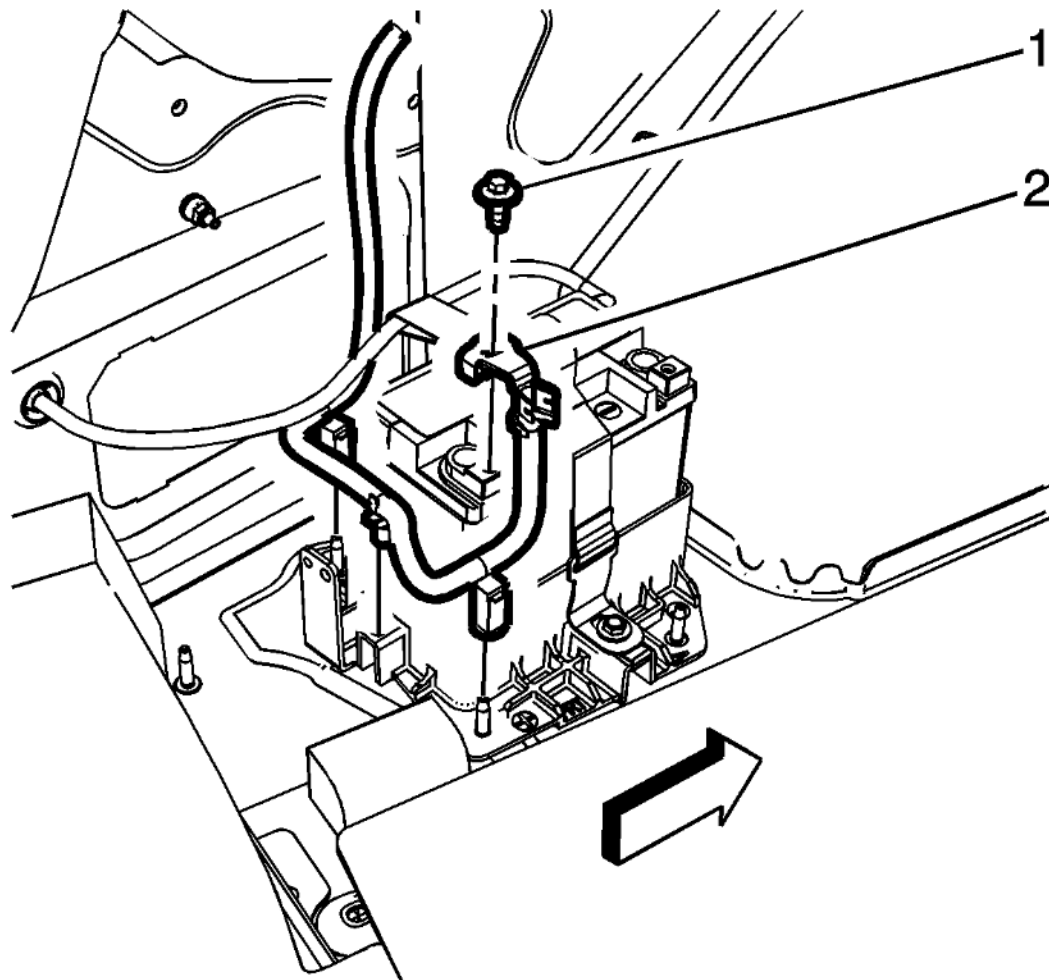


Fig. 53: Auxiliary Battery Positive Cable & Fastener
Courtesy of GENERAL MOTORS COMPANY

- 4. Remove the auxiliary battery positive cable fastener (1) and set aside the auxiliary battery positive cable (2).

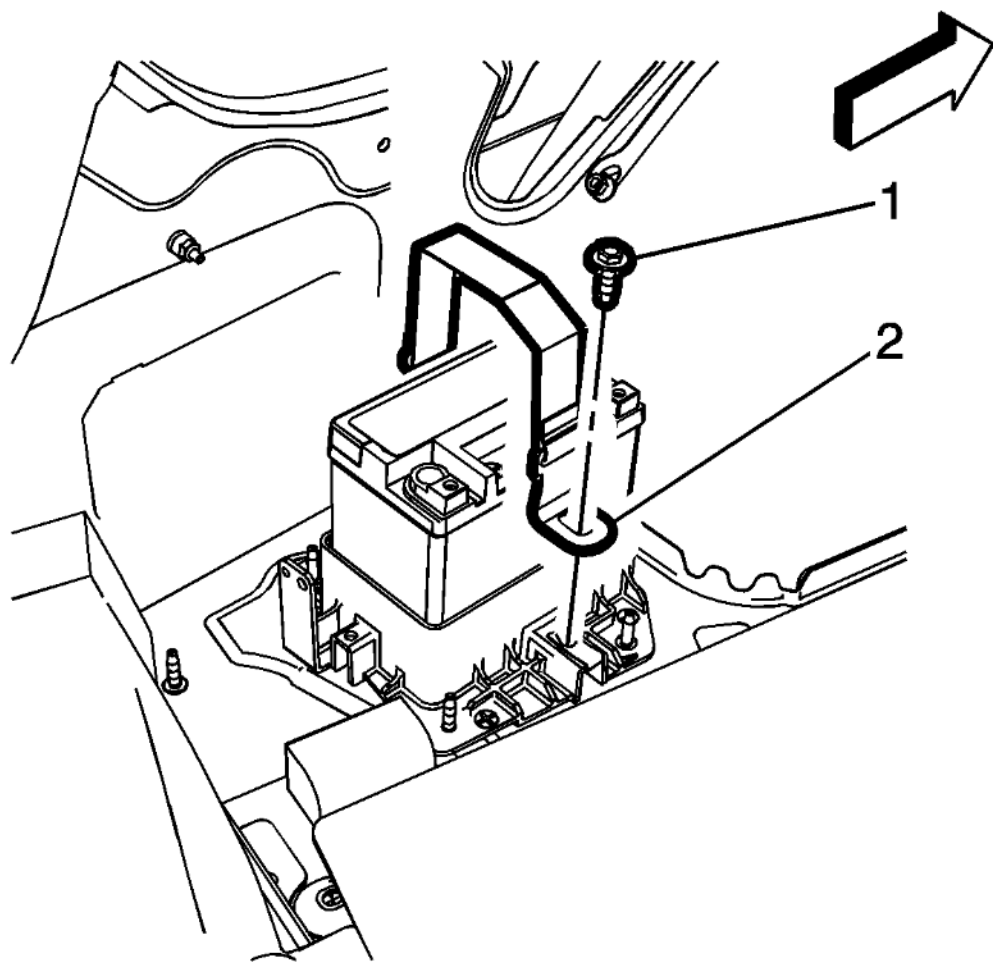


Fig. 54: Auxiliary Battery Hold Down Strap & Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Loosen the auxiliary battery hold down strap fastener (1) and remove the hold down strap (2) from the auxiliary battery.

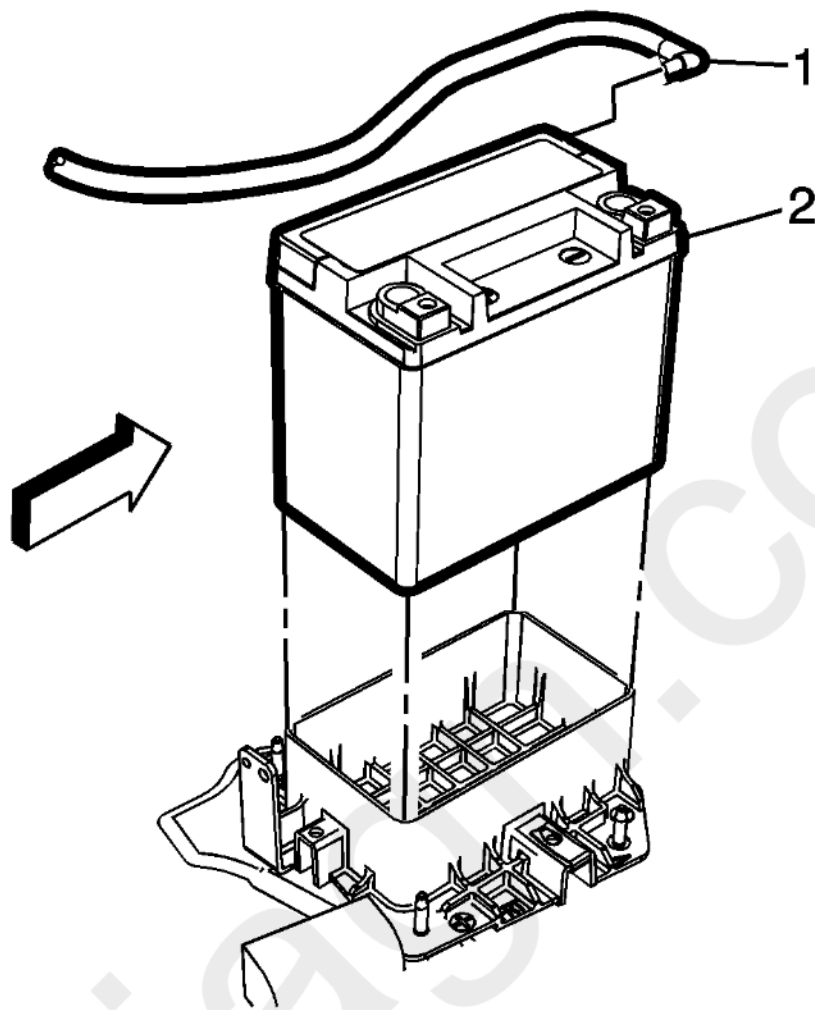


Fig. 55: Auxiliary Battery & Vent Tube
Courtesy of GENERAL MOTORS COMPANY

6. Remove the auxiliary battery vent tube (1) and remove the auxiliary battery (2) from the battery tray.

Installation Procedure

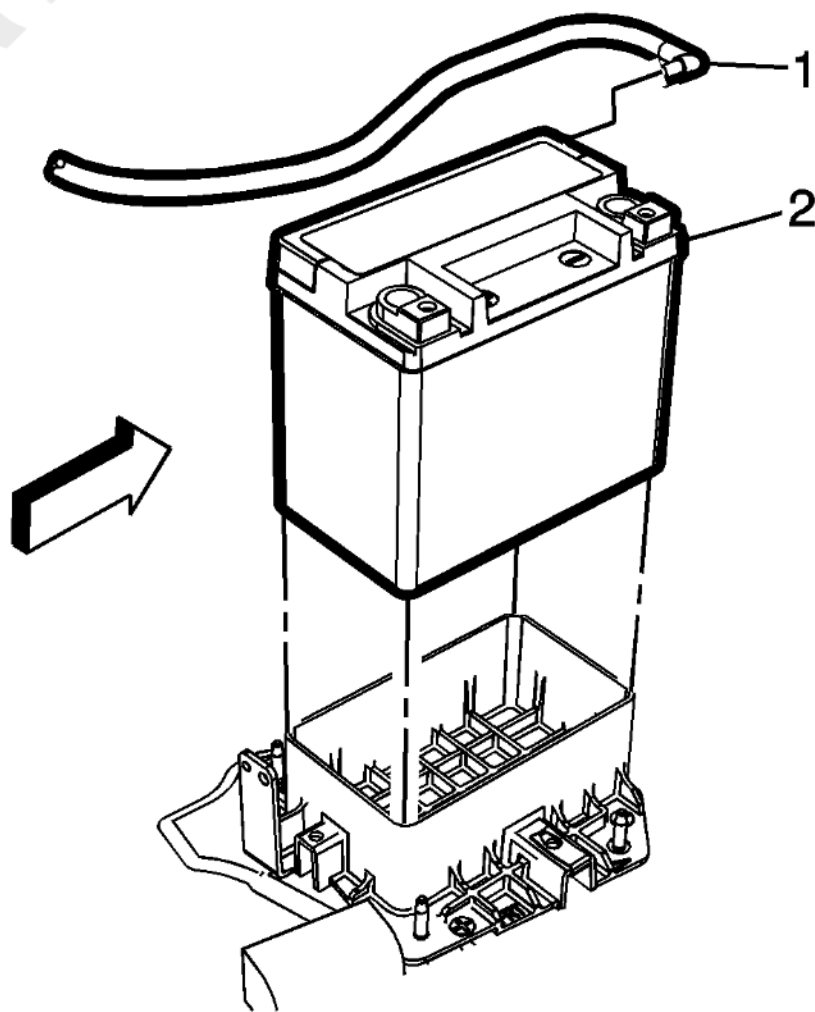


Fig. 56: Auxiliary Battery & Vent Tube
Courtesy of GENERAL MOTORS COMPANY

1. Install the auxiliary battery (2) into the battery tray and connect the auxiliary battery vent tube (1).

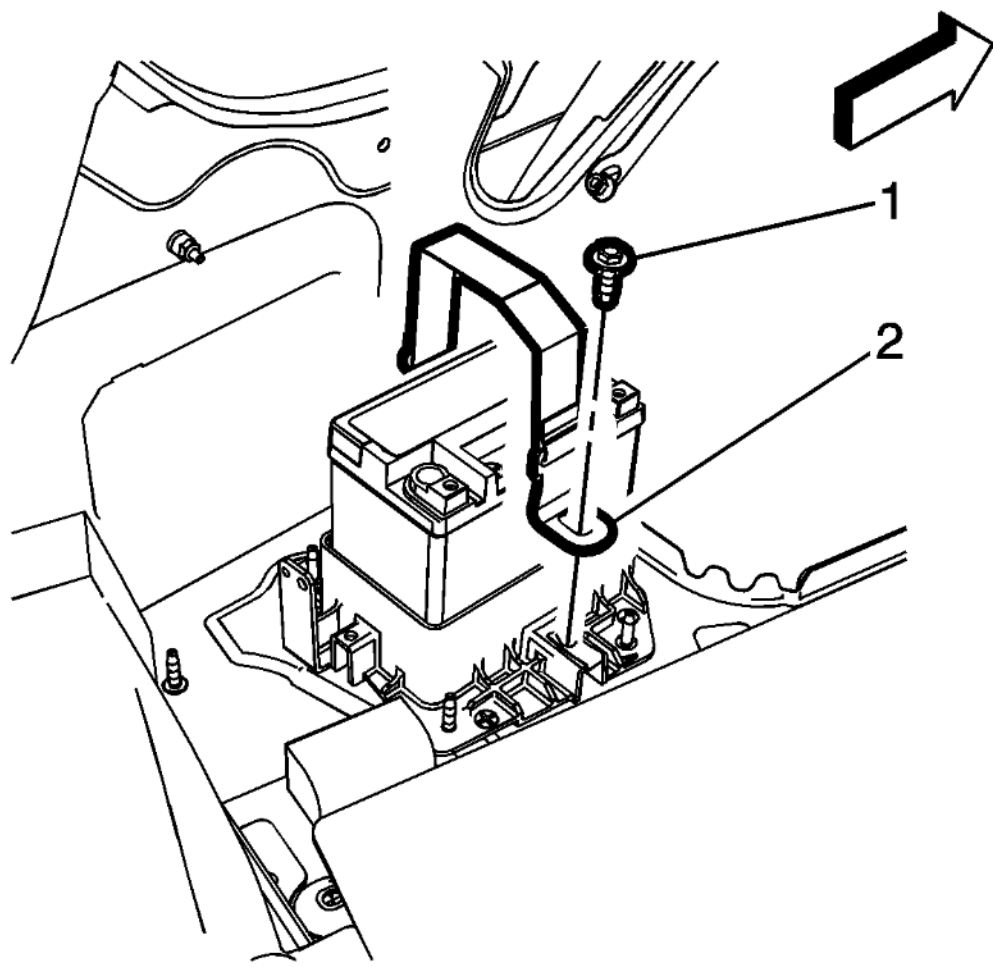


Fig. 57: Auxiliary Battery Hold Down Strap & Fastener
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

2. Install the auxiliary battery hold down strap (2) and tighten the fastener (1) to 8 N.m (71 lb in).

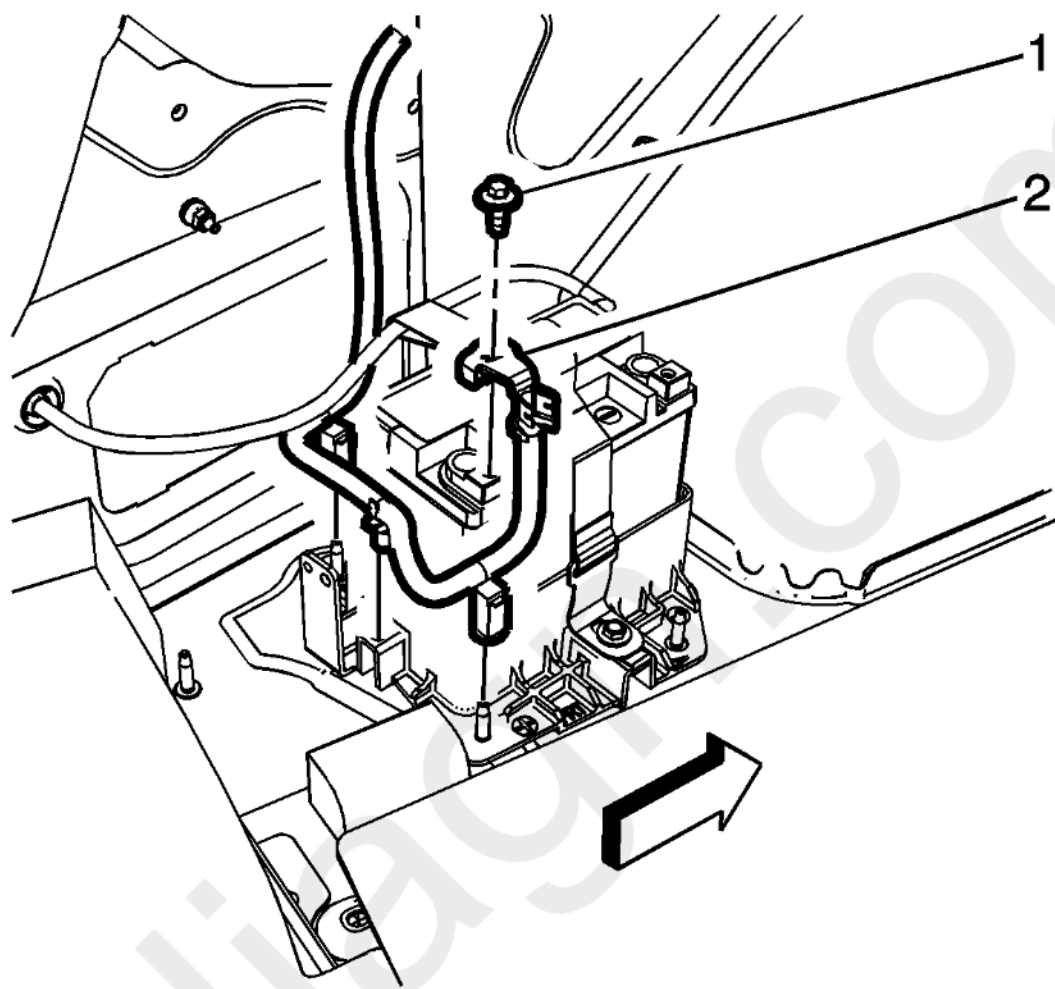


Fig. 58: Auxiliary Battery Positive Cable & Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Install the auxiliary battery positive cable (2) and tighten the fastener (1) to 4.5 N.m (40 lb in).

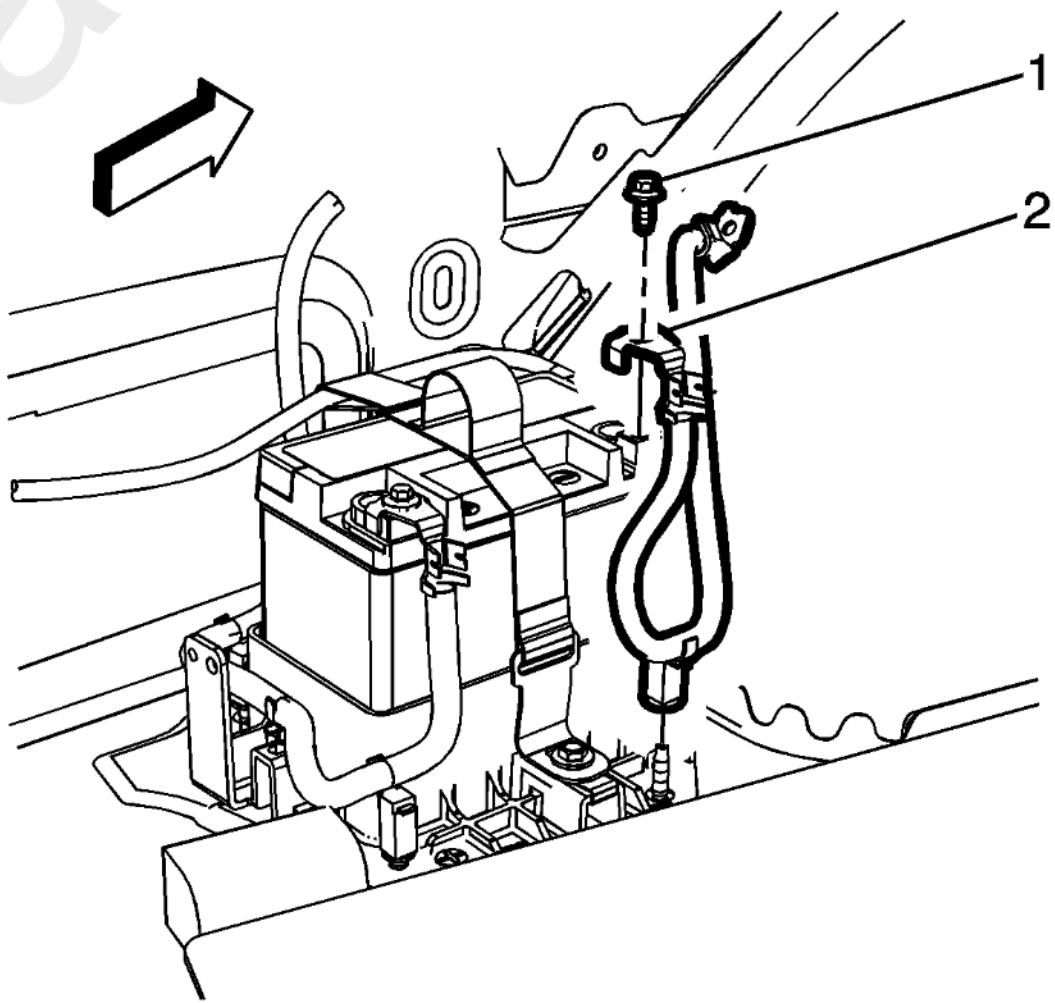


Fig. 59: Auxiliary Battery Negative Cable & Fastener
Courtesy of GENERAL MOTORS COMPANY

4. Install the auxiliary battery negative cable (2) and tighten the fastener (1) to 4.5 N.m (40 lb in).
5. Install the left rear compartment side trim panel. Refer to **Rear Compartment Side Trim Replacement - Left Side** .
6. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

BATTERY TRAY REPLACEMENT

Removal Procedure

1. Remove the battery. **Battery Replacement**
2. Remove the engine control module. **Engine Control Module Replacement (LFX)**
3. Remove the battery current sensor from the battery tray.

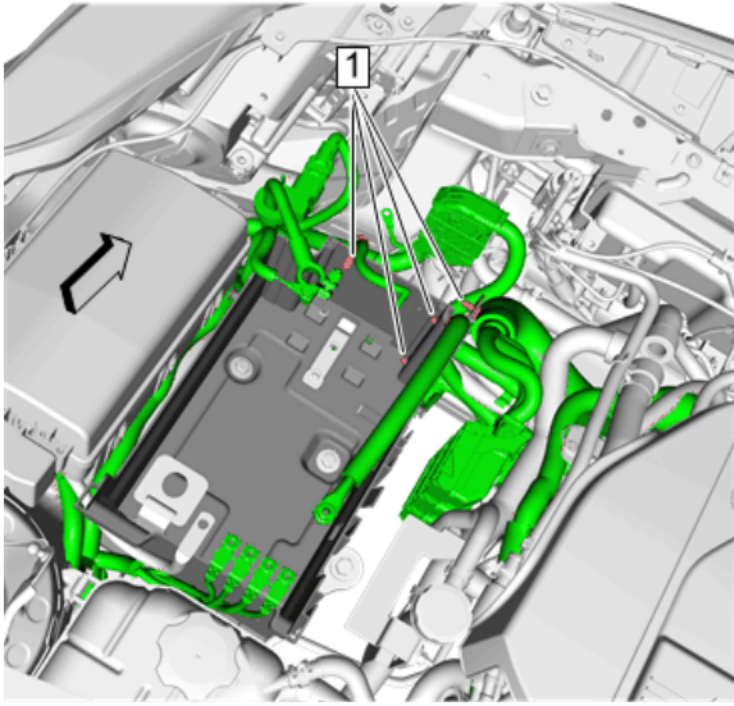


Fig. 60: Retainers
Courtesy of GENERAL MOTORS COMPANY

- 4. Disengage Retainer (4)

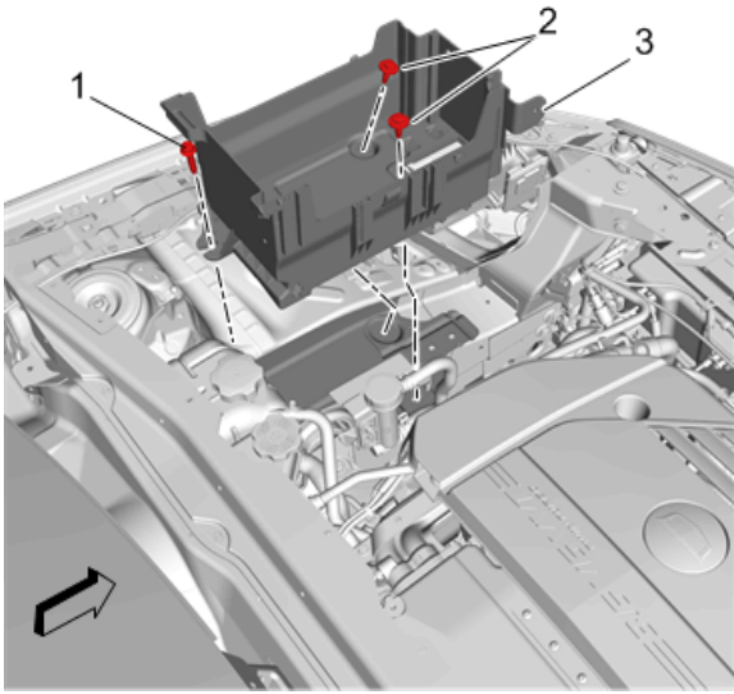


Fig. 61: Battery Tray Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

- 5. Remove Battery Tray Mounting Bolt (1)
- 6. Remove Battery Tray Mounting Bolt (2)
- 7. Remove Battery Tray (3)

Installation Procedure

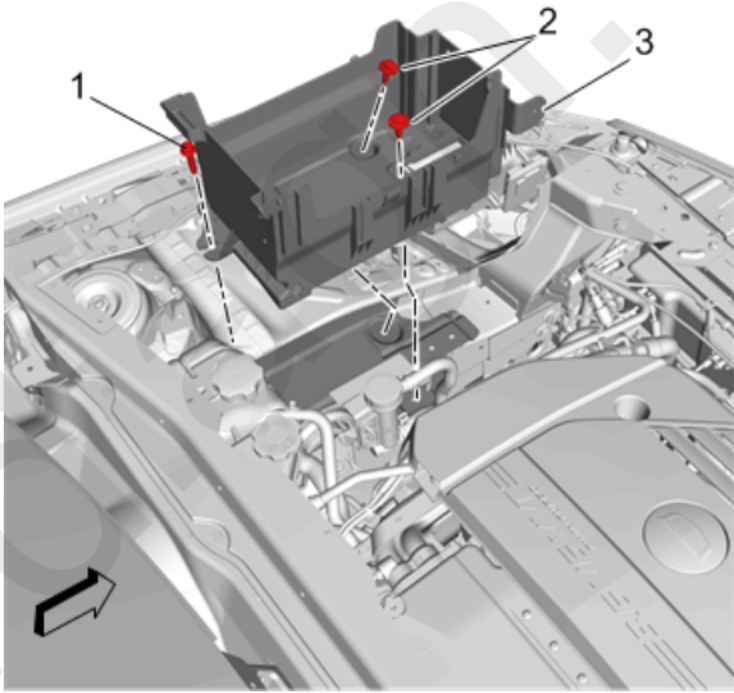


Fig. 62: Battery Tray Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

- 1. Install Battery Tray (3)

CAUTION: Refer to **Fastener Caution**

- 2. Install Battery Tray Mounting Bolt (2) and tighten 15 N.m (11 lb ft)
- 3. Install Battery Tray Mounting Bolt (1) and tighten 15 N.m (11 lb ft)

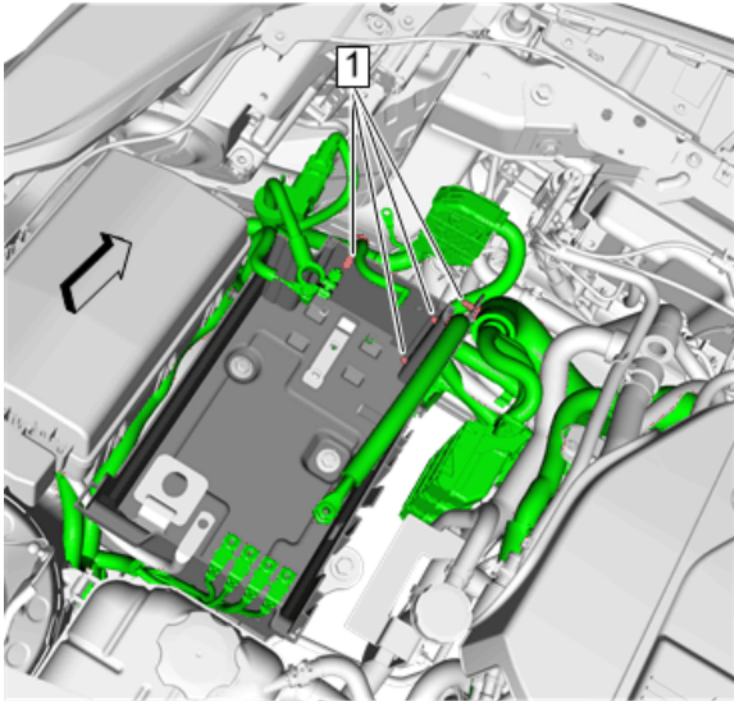


Fig. 63: Retainers
Courtesy of GENERAL MOTORS COMPANY

- 4. Engage Retainer (1)
- 5. Install the engine control module. **Engine Control Module Replacement (LFX)**
- 6. Install the battery. **Battery Replacement**
- 7. Install the battery current sensor to the battery tray.

AUXILIARY BATTERY TRAY REPLACEMENT

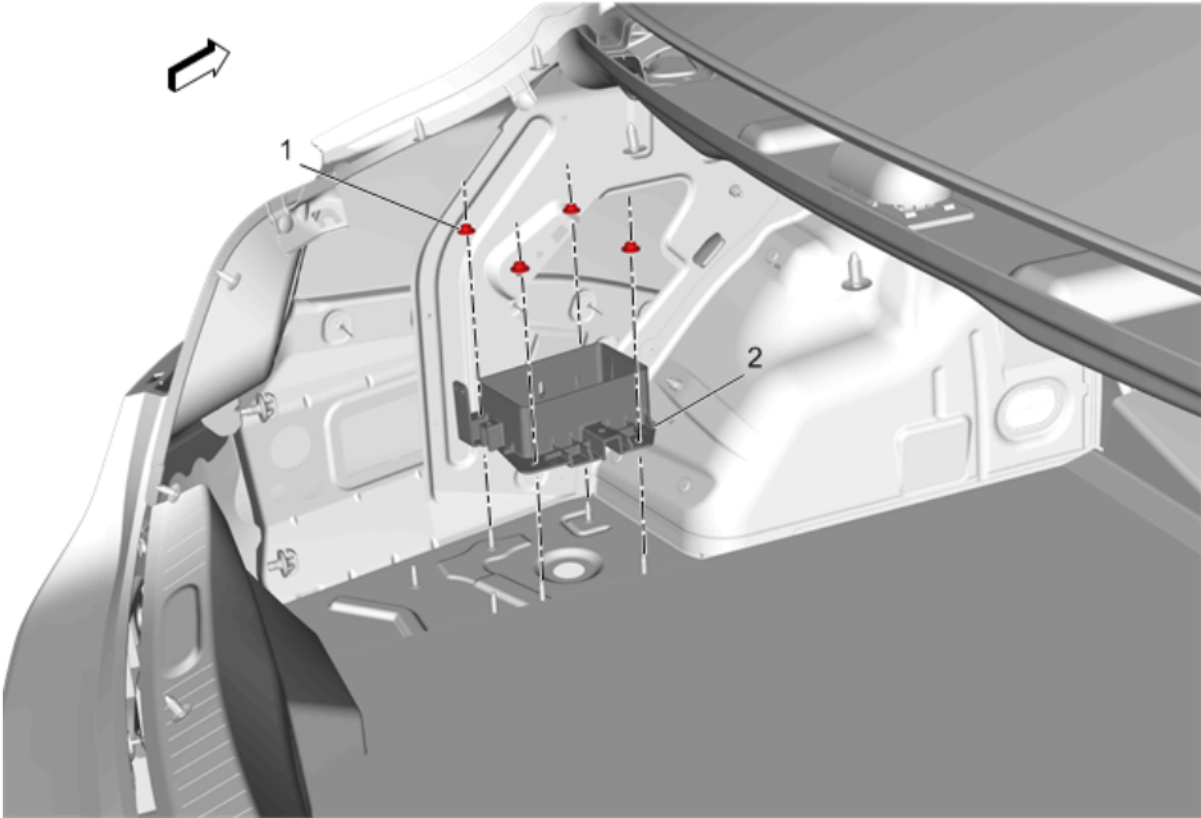


Fig. 64: Auxiliary Battery Tray
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the auxiliary battery. Refer to Auxiliary Battery Replacement (With Start/Stop) .	
1	CAUTION: Refer to Fastener Caution . Auxiliary Battery Tray Fasteners (Qty: 4) Tighten 8 N.m (71 lb in)
2	Auxiliary Battery Tray

STARTER REPLACEMENT (LFX)

Removal Procedure

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

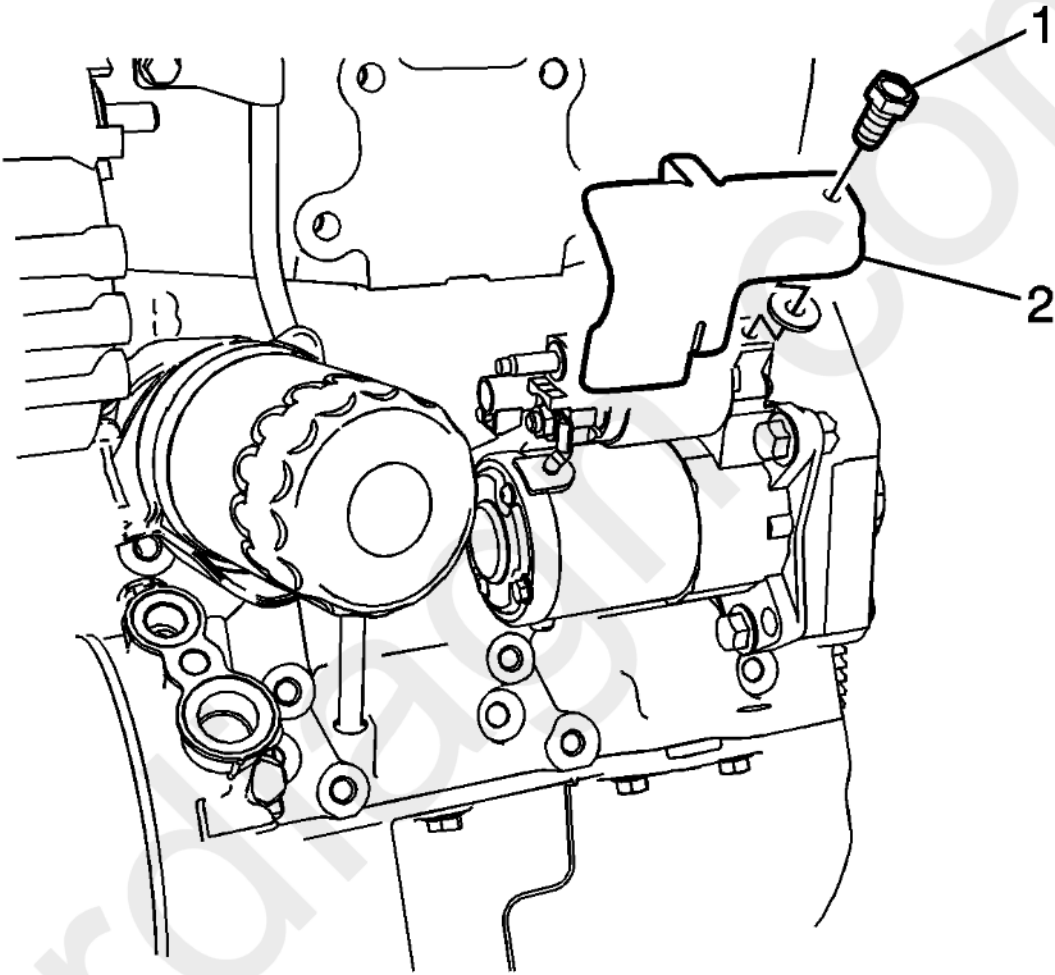


Fig. 65: View Of Starter & Heat Shield
Courtesy of GENERAL MOTORS COMPANY

2. Remove the heat shield fastener (1) and heat shield (2) from the starter.
3. Disconnect the knock sensor connector.

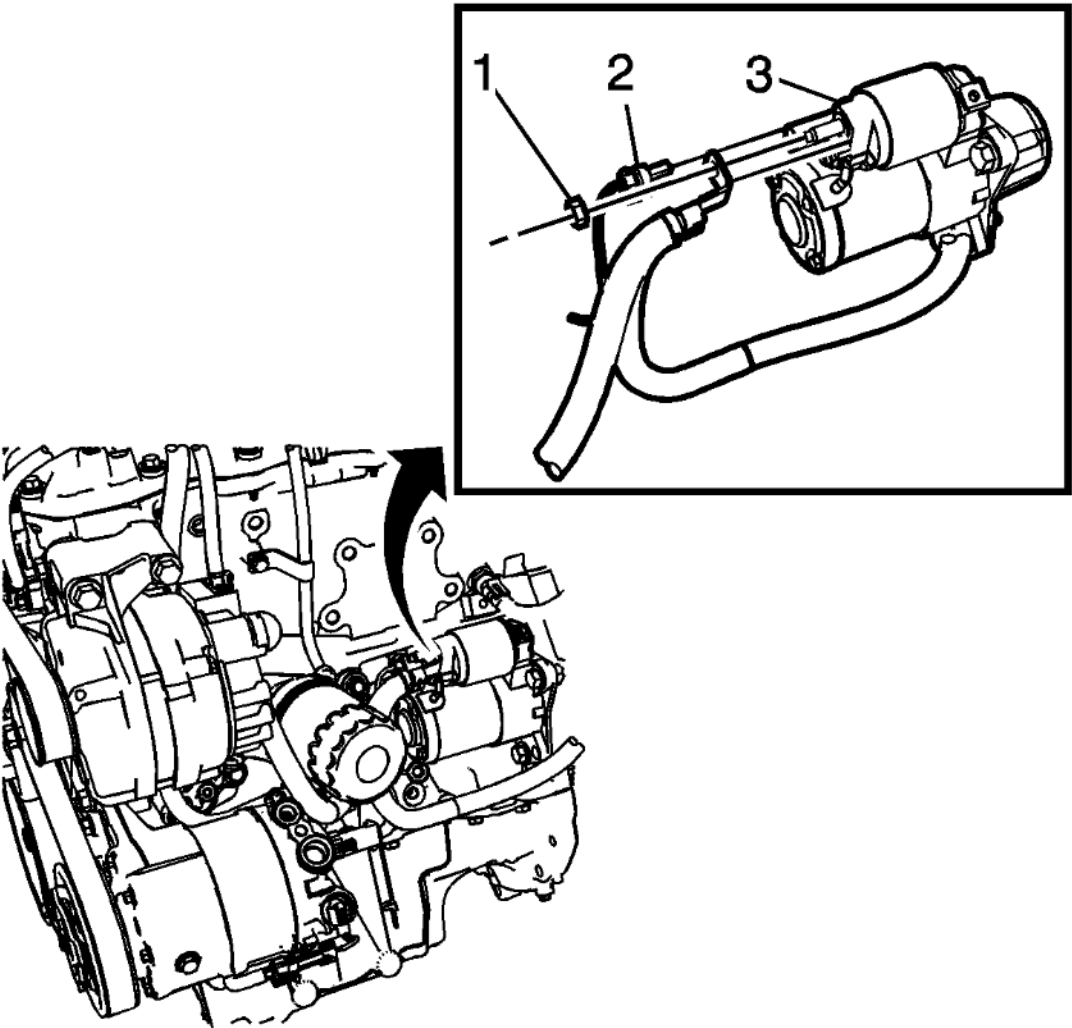


Fig. 66: View Of Starter Solenoid, Engine Harness Connector & Battery Positive Nut
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery positive fastener (1) and the engine harness connector (2), from the starter solenoid (3).

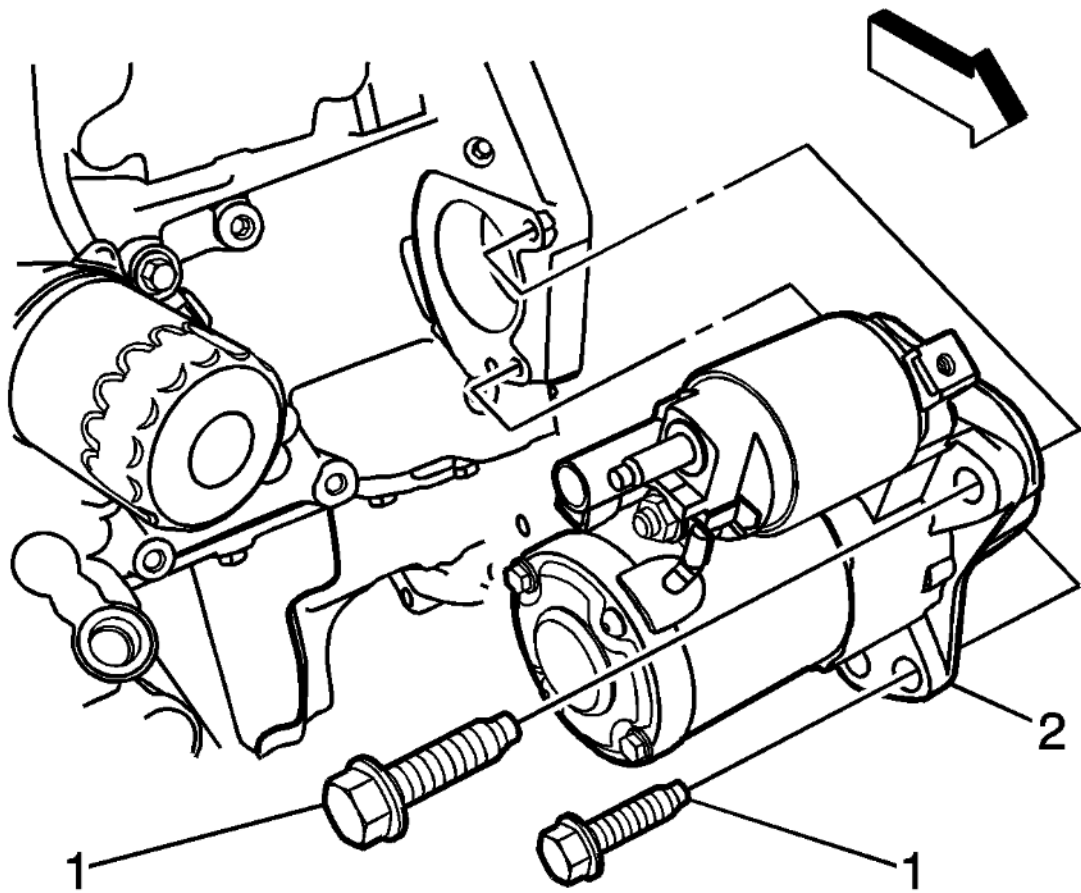


Fig. 67: Starter Motor And Bolts
Courtesy of GENERAL MOTORS COMPANY

- 5. Remove the starter motor fasteners (1).
- 6. Remove the starter motor (2).

Installation Procedure

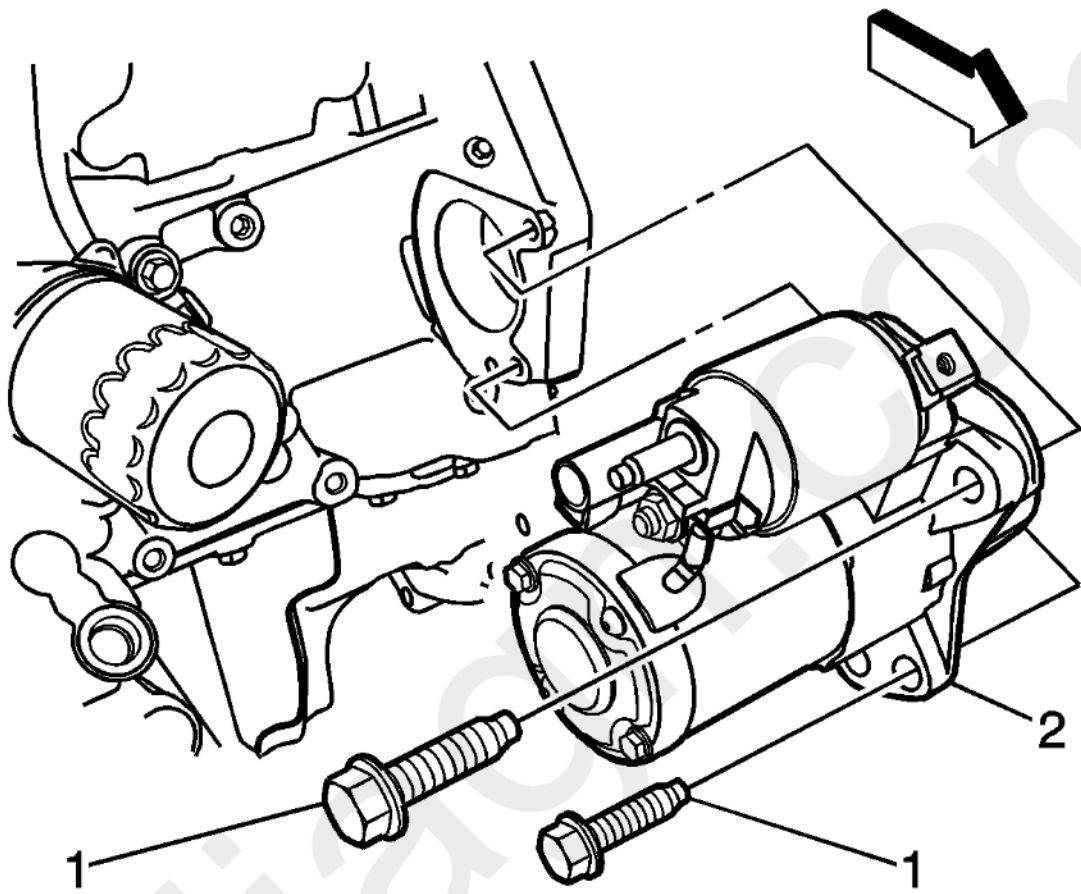


Fig. 68: Starter Motor And Bolts
Courtesy of GENERAL MOTORS COMPANY

- 1. Position the starter motor (2) to the engine block.

CAUTION: Refer to **Fastener Caution** .

- 2. Install the starter motor mounting fasteners (1) and tighten to 58 N.m (43 lb ft).

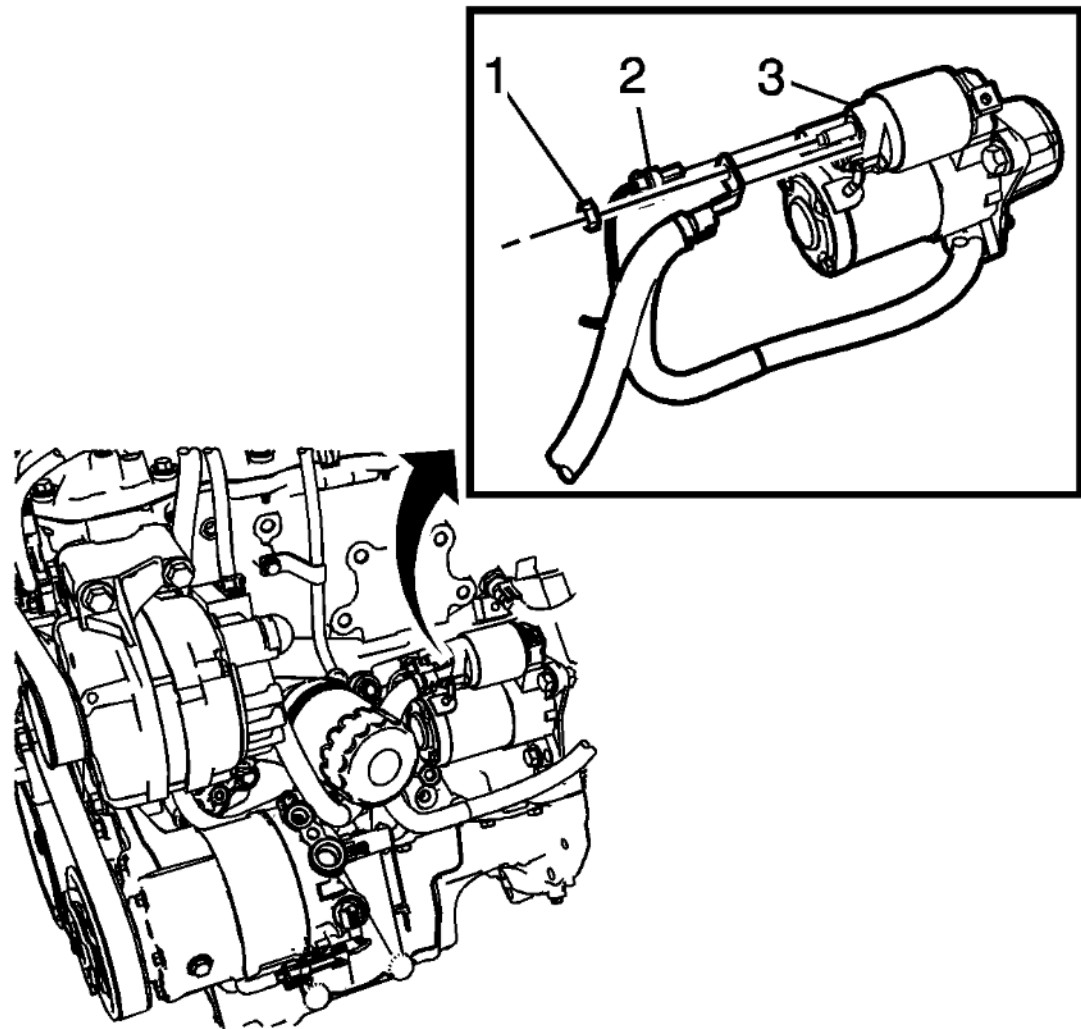


Fig. 69: View Of Starter Solenoid, Engine Harness Connector & Battery Positive Nut
Courtesy of GENERAL MOTORS COMPANY

- 3. Install the battery positive cable and engine harness connector to the starter and tighten the battery positive cable fastener (1) to 9 N.m (80 lb in).
- 4. Install the engine harness connector to the starter solenoid.
- 5. Connect the knock sensor connector.

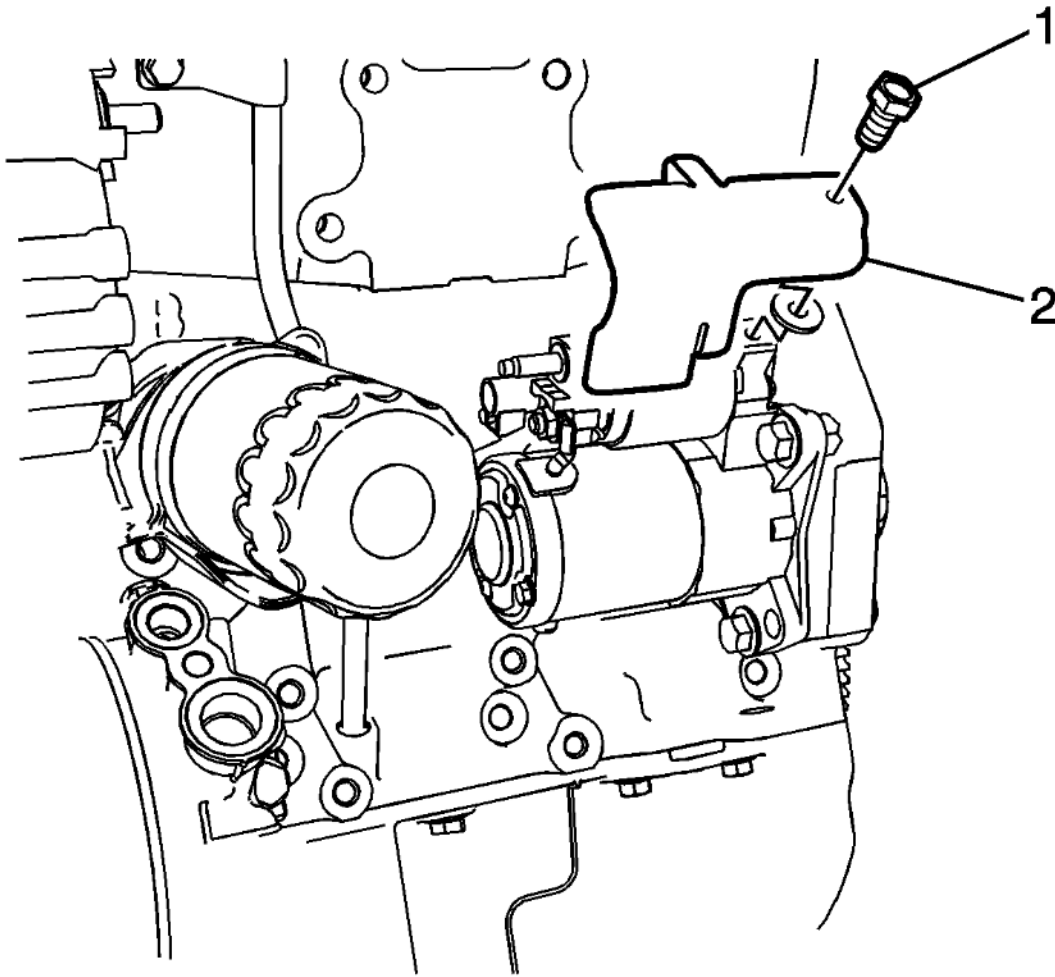


Fig. 70: View Of Starter & Heat Shield
Courtesy of GENERAL MOTORS COMPANY

- 6. Install the starter heat shield (2) and tighten the fastener (1) to 5 N.m (44 lb in).
- 7. Connect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**.

STARTER REPLACEMENT (LCV)

Removal Procedure

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

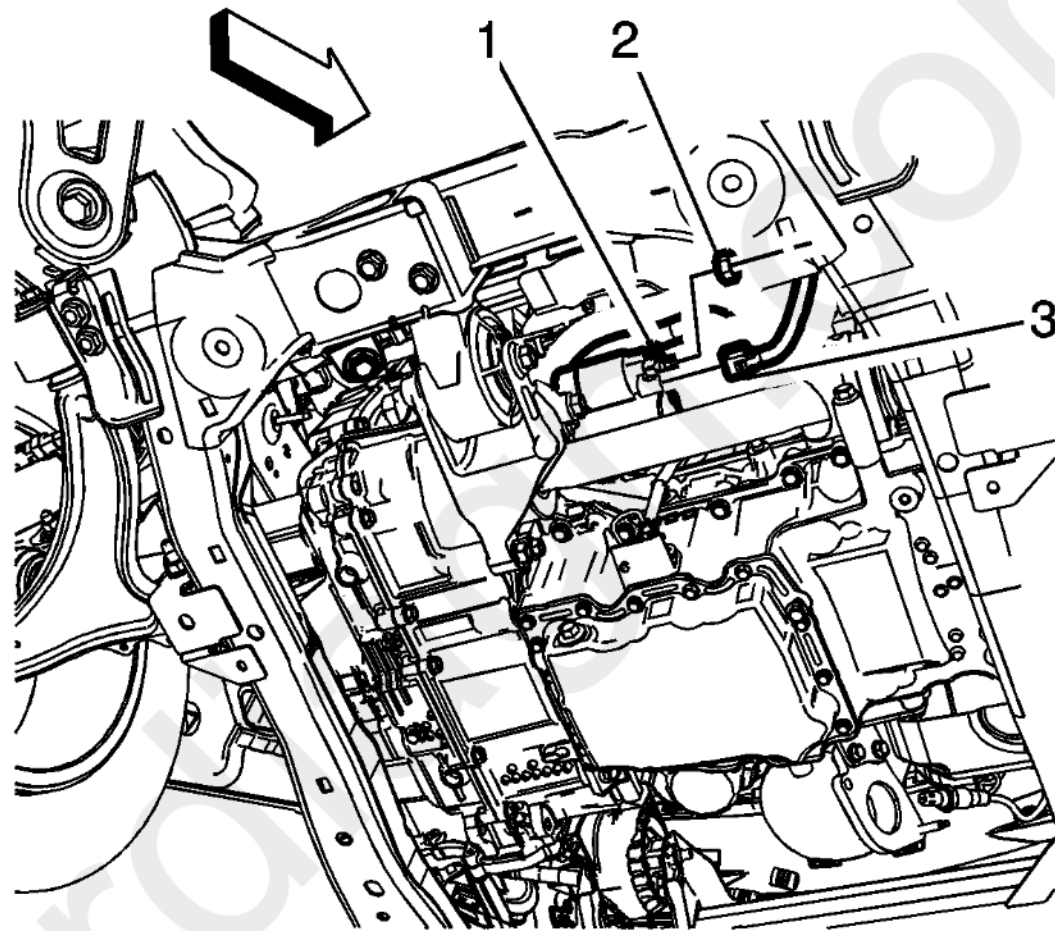


Fig. 71: Battery Positive Cable Terminal And Engine Harness Connector
Courtesy of GENERAL MOTORS COMPANY

- 3. Disconnect Electrical Connector (3)
- 4. Remove Starter Solenoid Cable Nut (2)
- 5. Remove Battery Positive Cable (1)

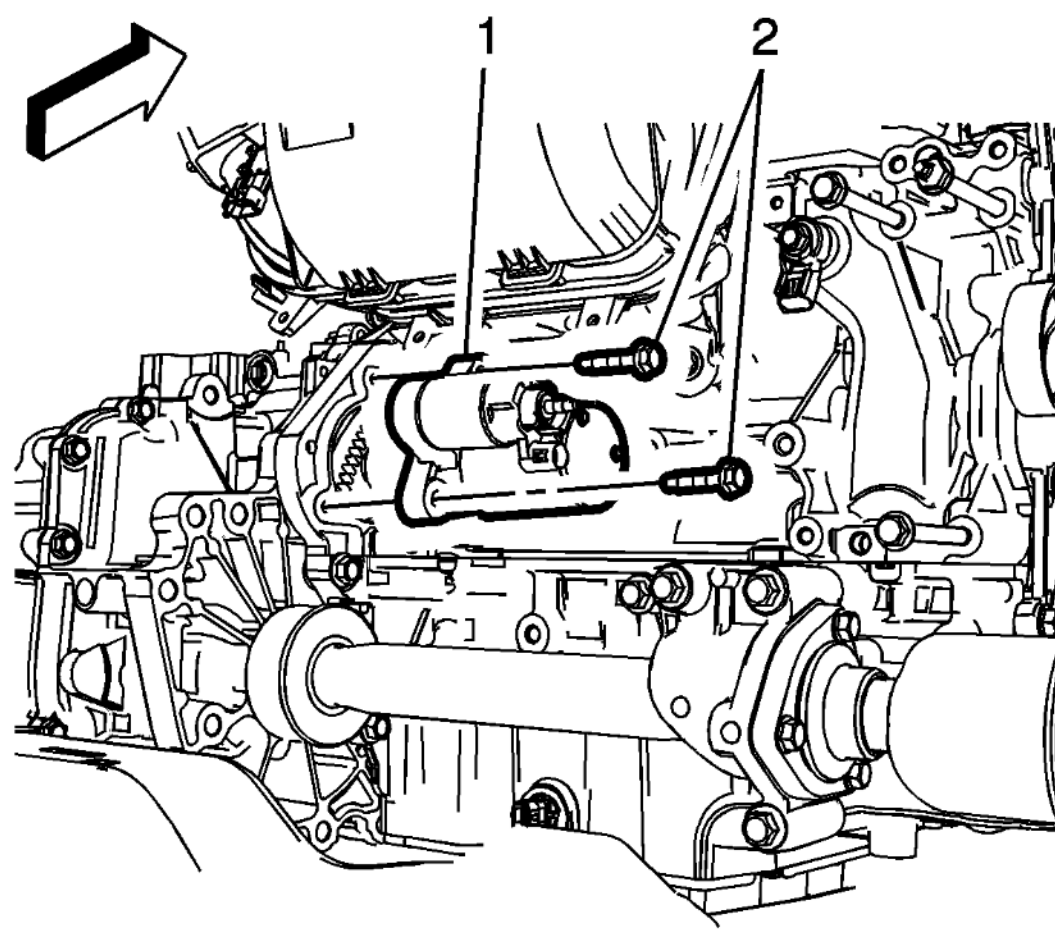


Fig. 72: Starter Mounting Fasteners And Starter
Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

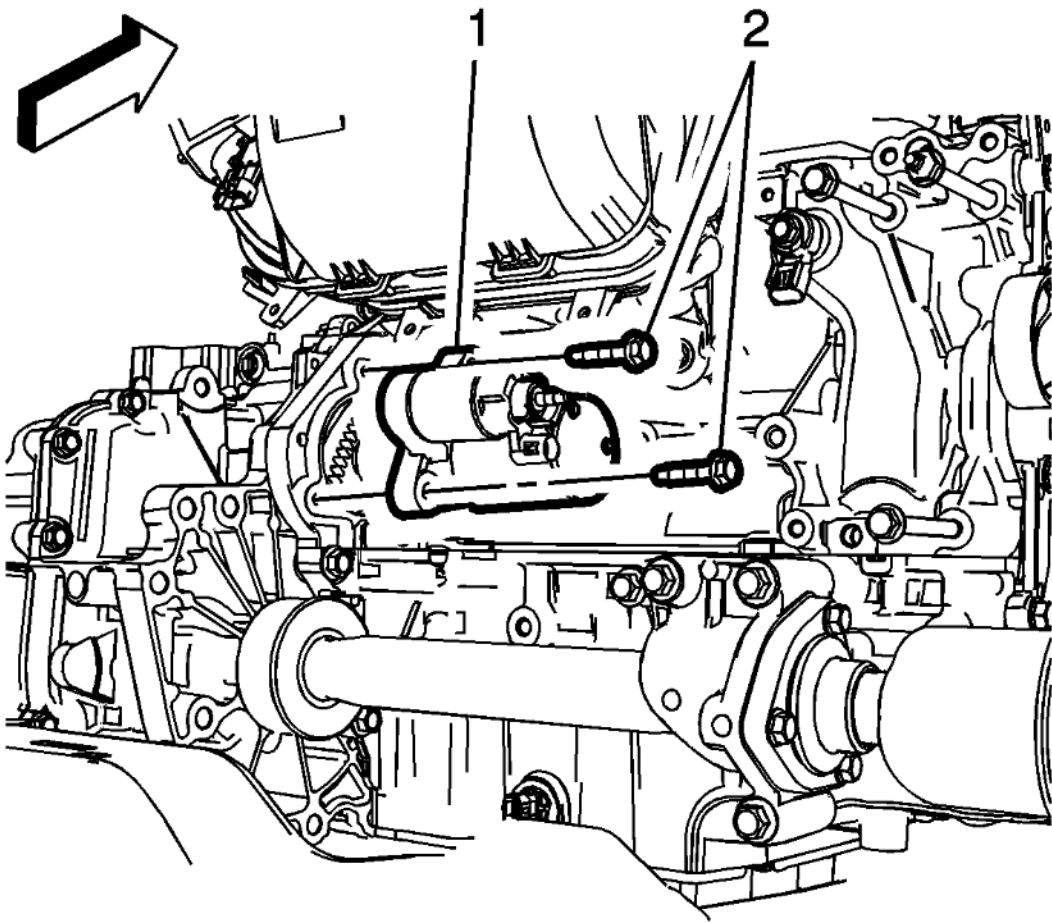


Fig. 73: Starter Mounting Fasteners And Starter
Courtesy of GENERAL MOTORS COMPANY

- 1. Install Starter (1)

CAUTION: Refer to **Fastener Caution**

- 2. Install Starter Mounting Bolt (2) and tighten 22 N.m (16 lb ft)

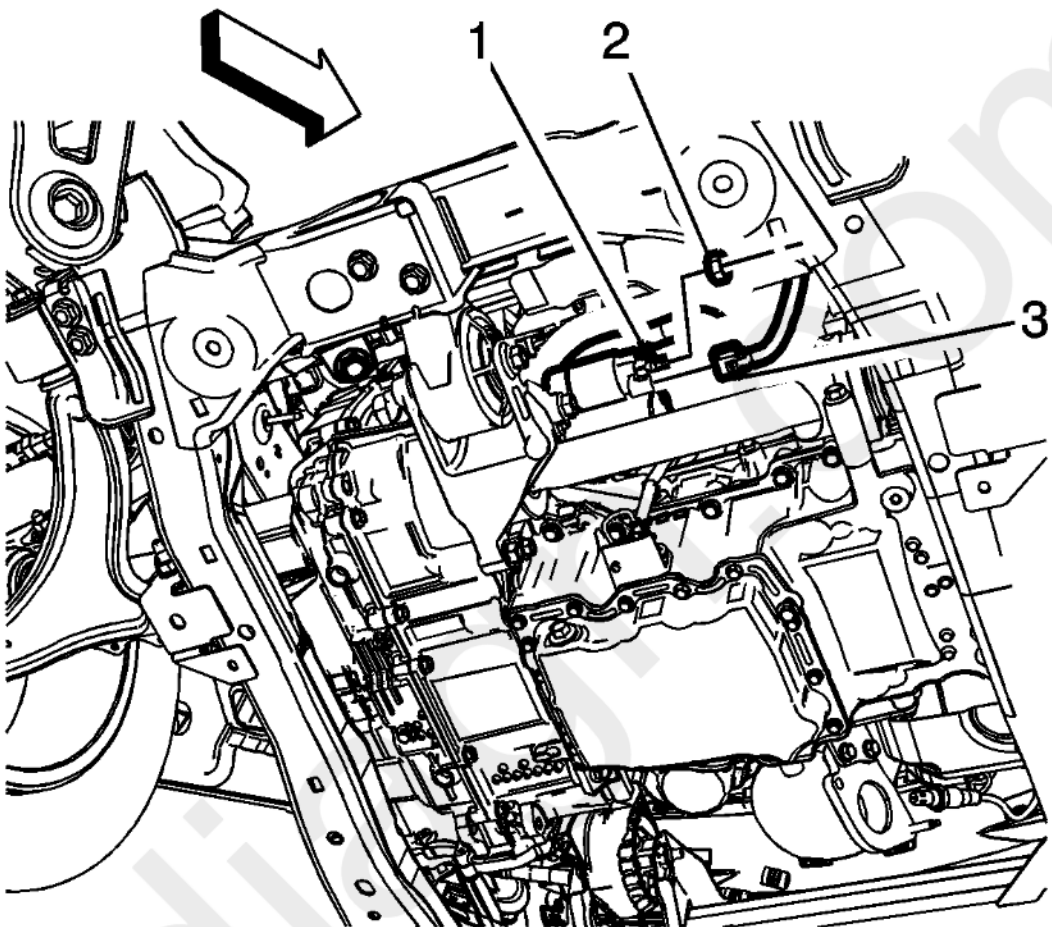


Fig. 74: Battery Positive Cable Terminal And Engine Harness Connector
Courtesy of GENERAL MOTORS COMPANY

- 3. Install Battery Positive Cable (1)
- 4. Install Starter Solenoid Cable Nut (2) and tighten 10 N.m (89 lb in)
- 5. Connect Electrical Connector (3)
- 6. Lower the vehicle.
- 7. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection**

GENERATOR REPLACEMENT (LFX)

Removal Procedure

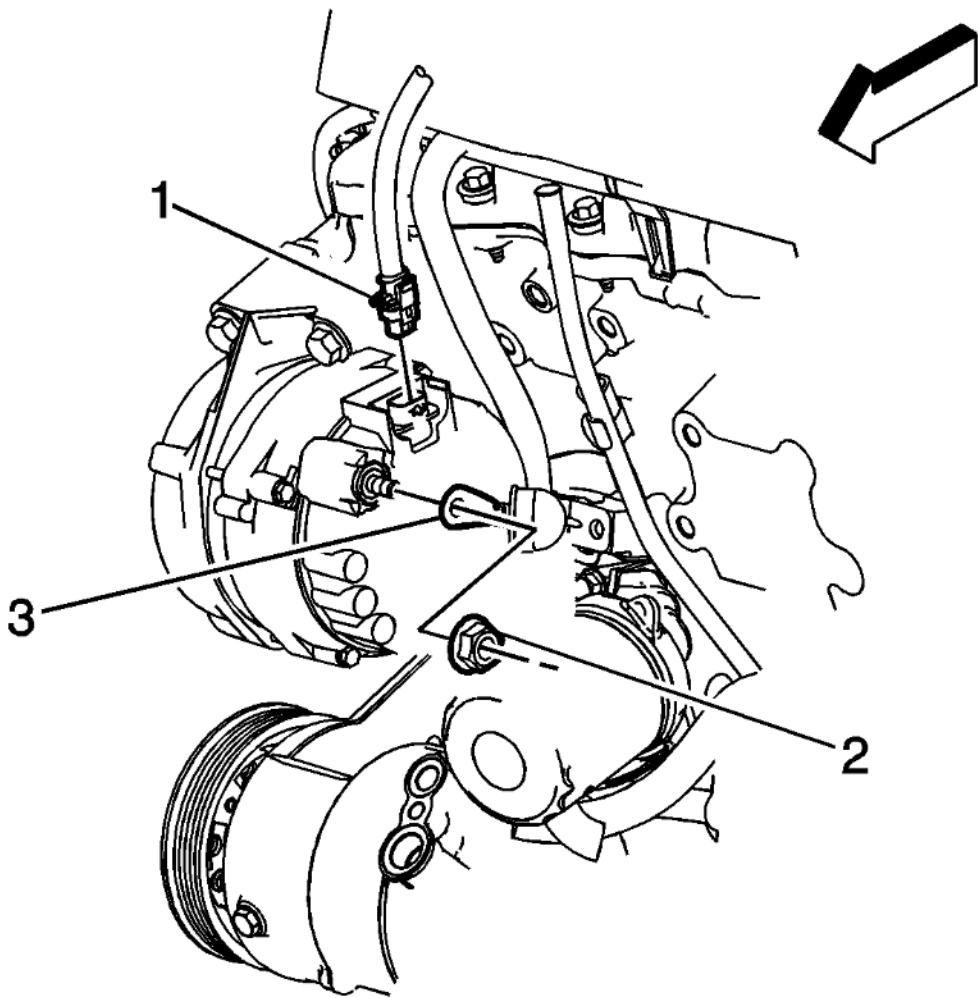


Fig. 75: Identifying Generator, Electrical Harness Connector & Nut
Courtesy of GENERAL MOTORS COMPANY

- 1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
- 2. Remove the front compartment front sight shield. Refer to **Front Compartment Front Sight Shield Replacement**.

- 3. Remove the positive battery cable protective cap at the generator terminal.
- 4. Disconnect the engine harness electrical connector (1) from the generator.
- 5. Remove the positive battery cable fastener (2) at the generator.
- 6. Remove the positive battery cable terminal (3) from the generator.
- 7. Remove the drive belt from the generator and idler pulley. Refer to **Drive Belt Replacement** .

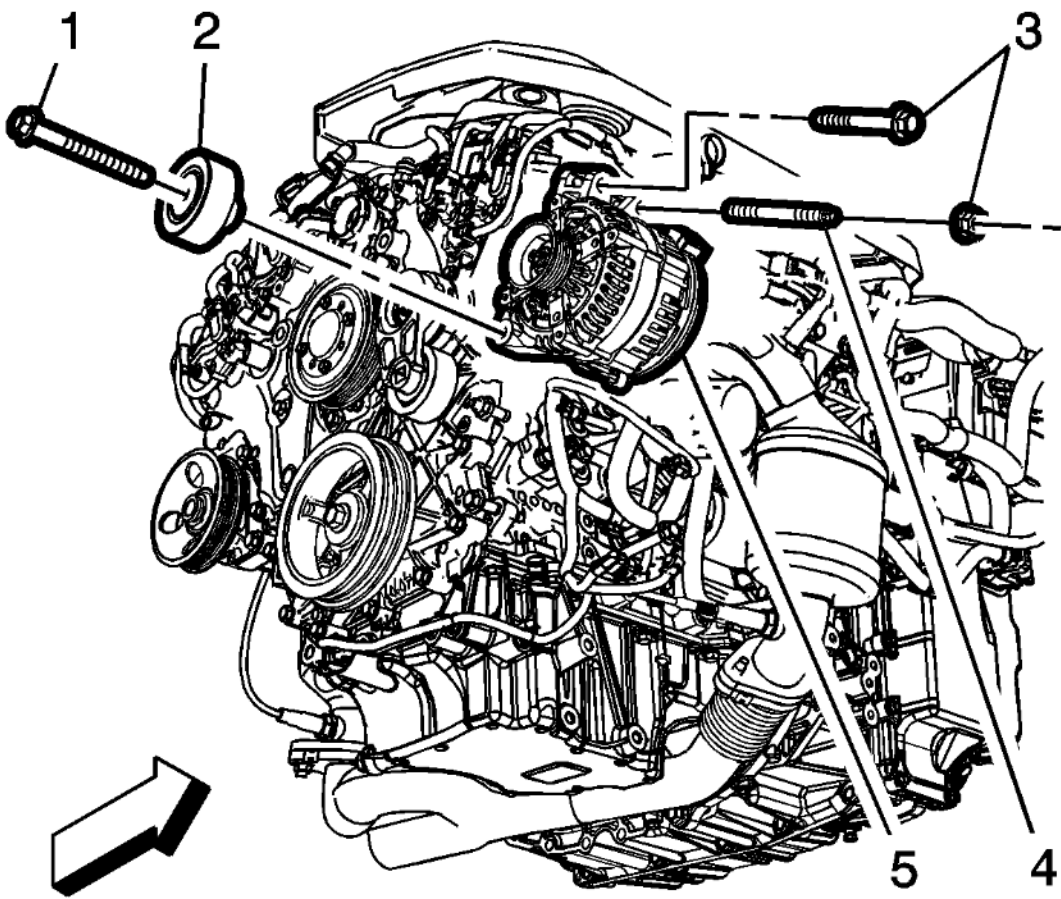


Fig. 76: Generator, Idler Pulley & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

- 8. Remove the idler pulley fastener (1) and idler pulley (2).
- 9. Remove the generator fasteners (3) and the generator mounting stud (4).
- 10. Remove the generator (5).

Installation Procedure

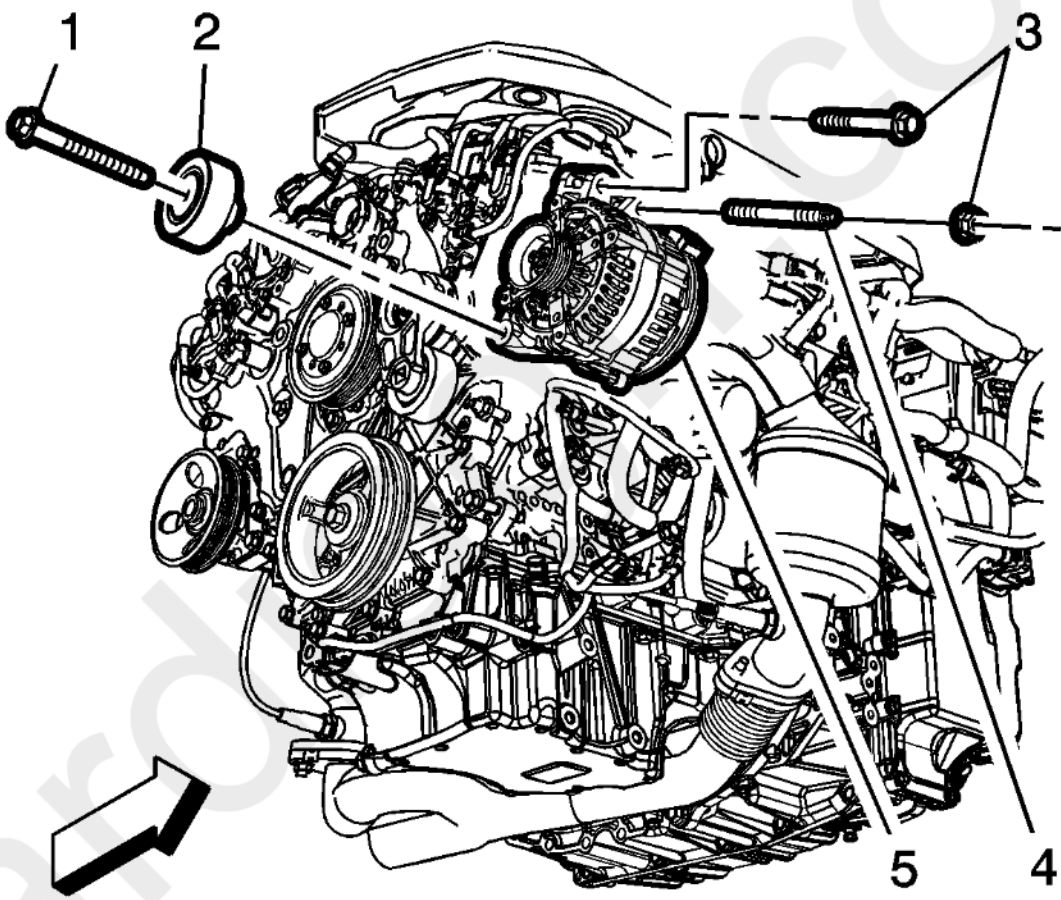


Fig. 77: Generator, Idler Pulley & Mounting Components
Courtesy of GENERAL MOTORS COMPANY

- 1. Position the generator (5) to the engine.

CAUTION: Refer to **Fastener Caution** .

- 2. Install the generator mounting stud (4) to the cylinder head and tighten to 9 N.m (80 lb in).
- 3. Loosely install the generator fasteners (3).
- 4. Loosely install the idler pulley (2) and idler pulley fastener.
- 5. Tighten the idler pulley fastener (1) to 58 N.m (43 lb ft).
- 6. Tighten the generator mounting fasteners (3) to 58 N.m (43 lb ft).

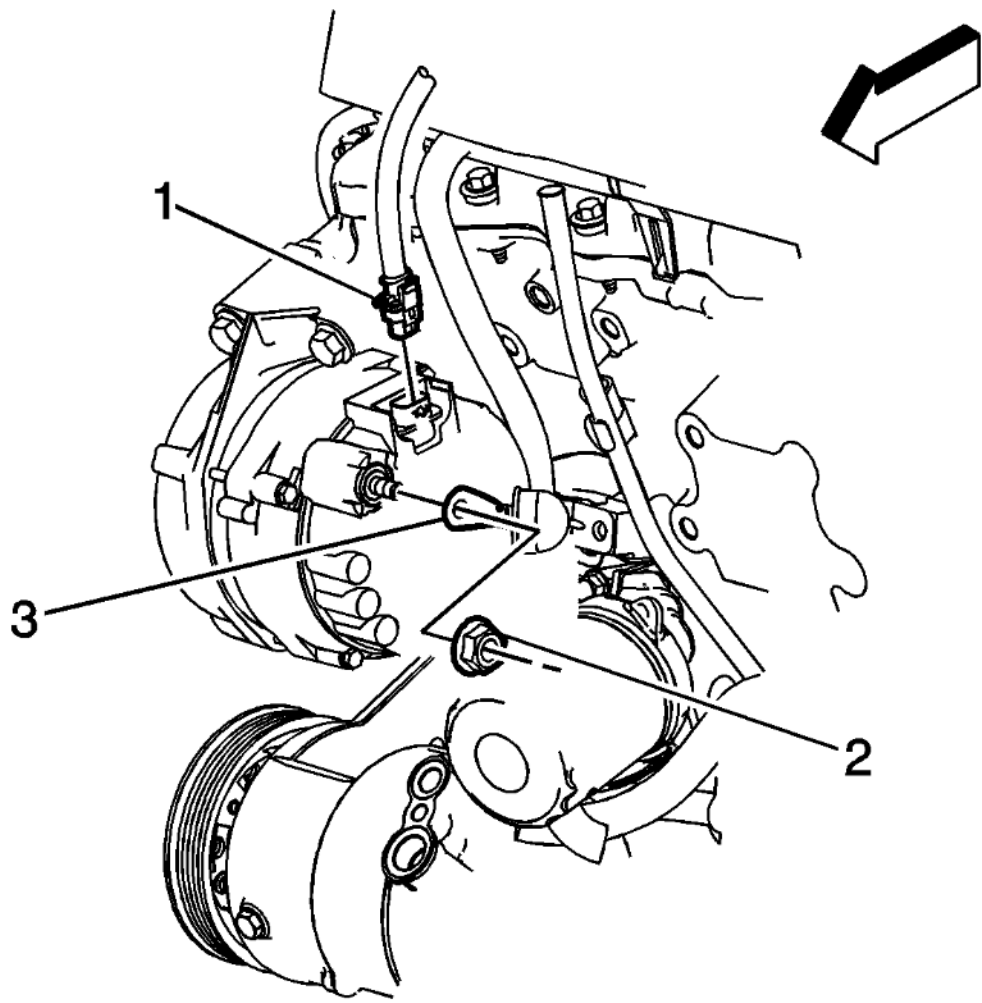


Fig. 78: Identifying Generator, Electrical Harness Connector & Nut
Courtesy of GENERAL MOTORS COMPANY

7. Install the drive belt. Refer to [Drive Belt Replacement](#) .
8. Connect the engine harness electrical connector (1) to the generator.
9. Install the positive battery cable terminal (3) to the generator.
10. Install the positive battery cable fastener (2) to the generator and tighten to 15 N.m (11 lb ft).
11. Install the positive battery cable protective cap to the generator terminal.
12. Install the front compartment front sight shield. Refer to [Front Compartment Front Sight Shield Replacement](#) .
13. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

GENERATOR REPLACEMENT (LCV)

Removal Procedure

1. Disconnect the battery negative cable. [Battery Negative Cable Disconnection and Connection](#)
2. Remove the air cleaner assembly. [Air Cleaner Assembly Replacement](#)
3. Remove the air cleaner outlet duct. [Air Cleaner Outlet Duct Replacement](#)
4. Without removing the splash shield, remove the drive belt, from the generator pulley. [Drive Belt Replacement](#)
5. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

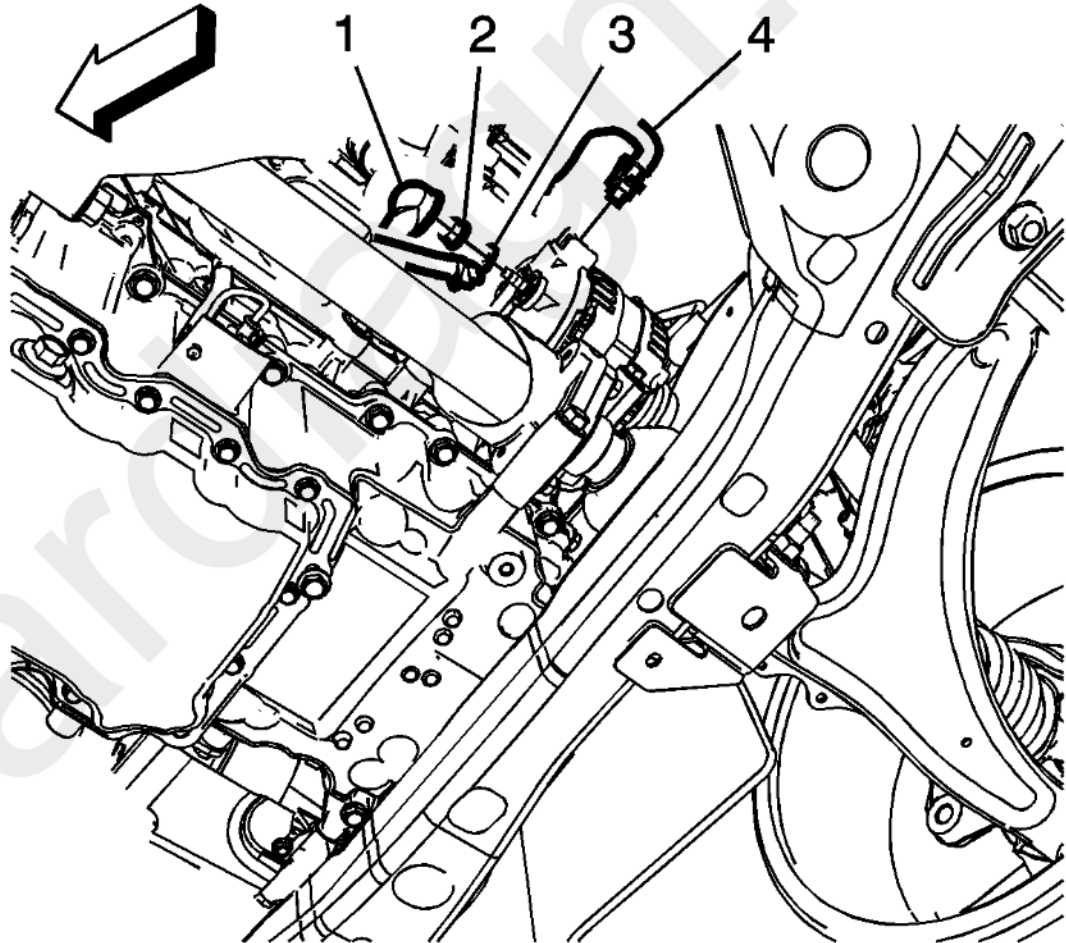


Fig. 79: Protective Boot And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Remove Protective Cap (1)
7. Remove Generator Nut (2)
8. Remove Battery Positive Cable (3)
9. Disconnect the electrical connector.(4)

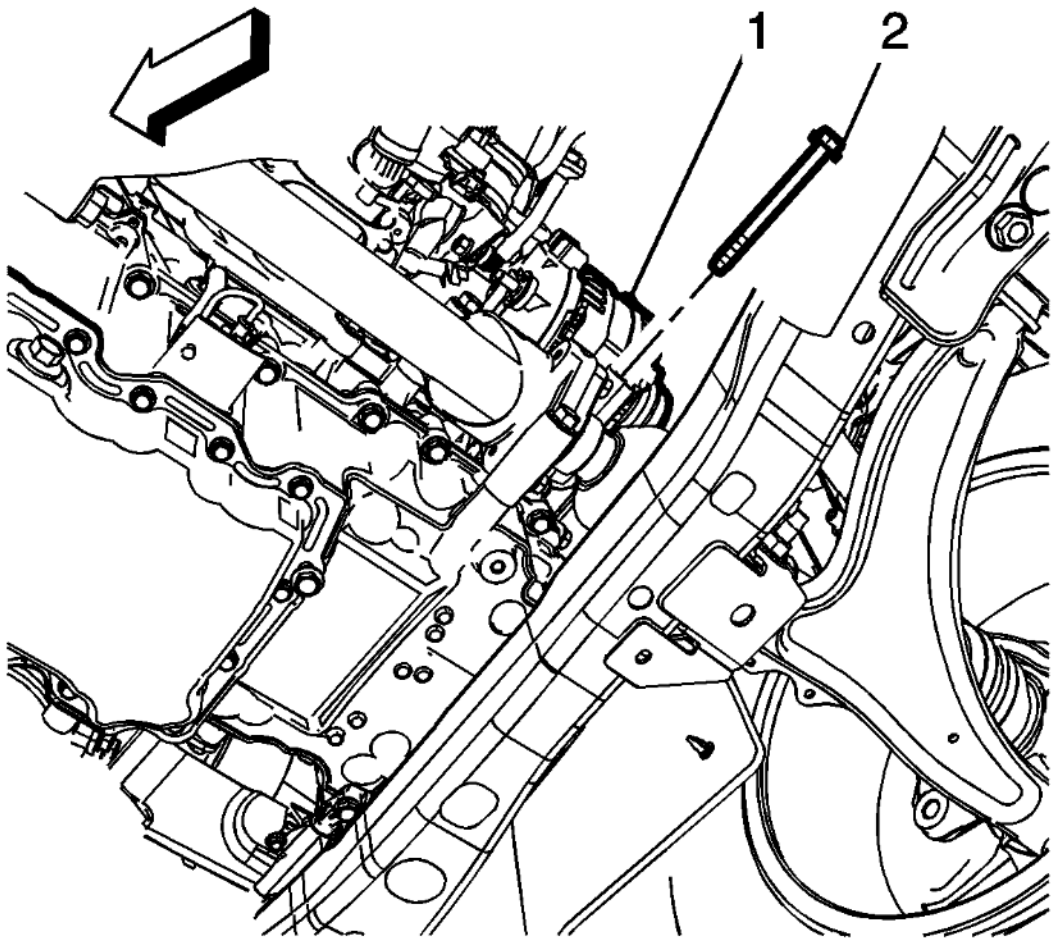


Fig. 80: Lower Generator Mounting Fastener
Courtesy of GENERAL MOTORS COMPANY

10. Remove Generator Bolt (2)

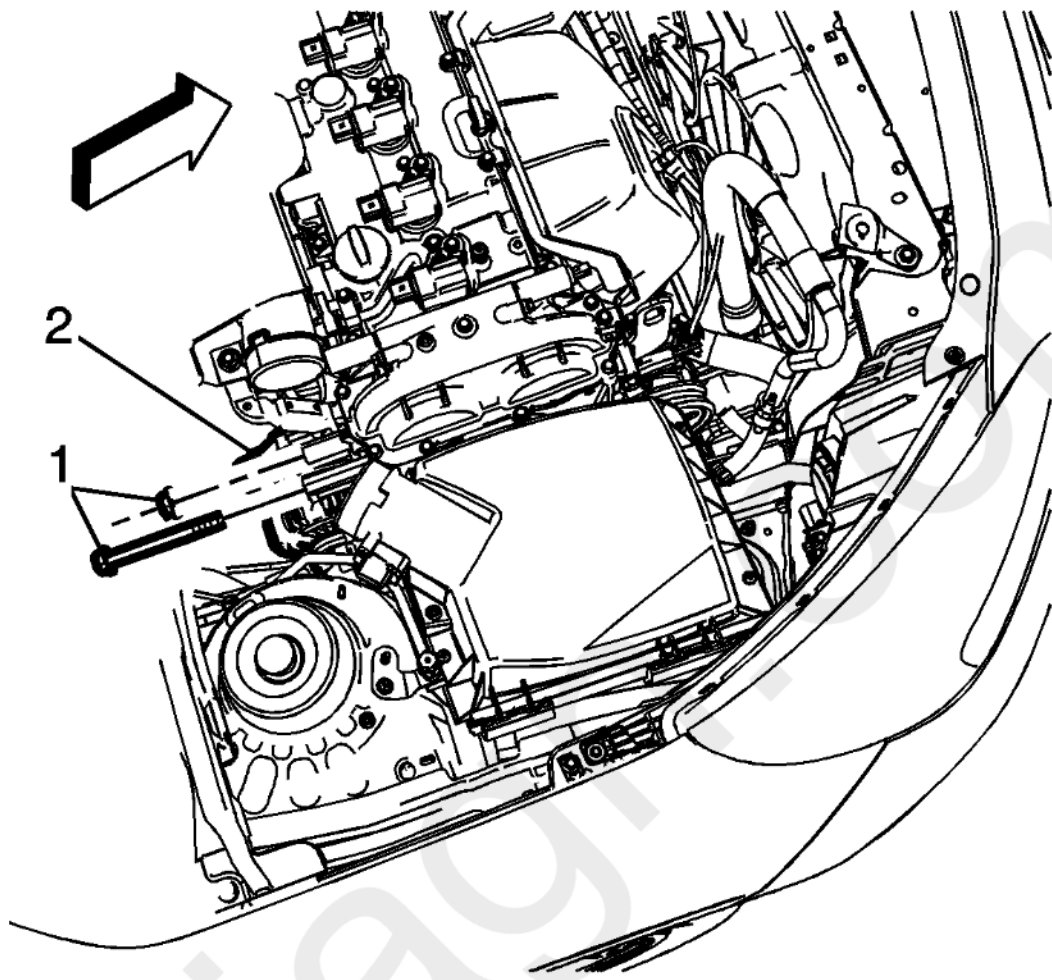


Fig. 81: Upper Generator Mounting Fasteners
Courtesy of GENERAL MOTORS COMPANY

11. Remove Generator Fastener (1)

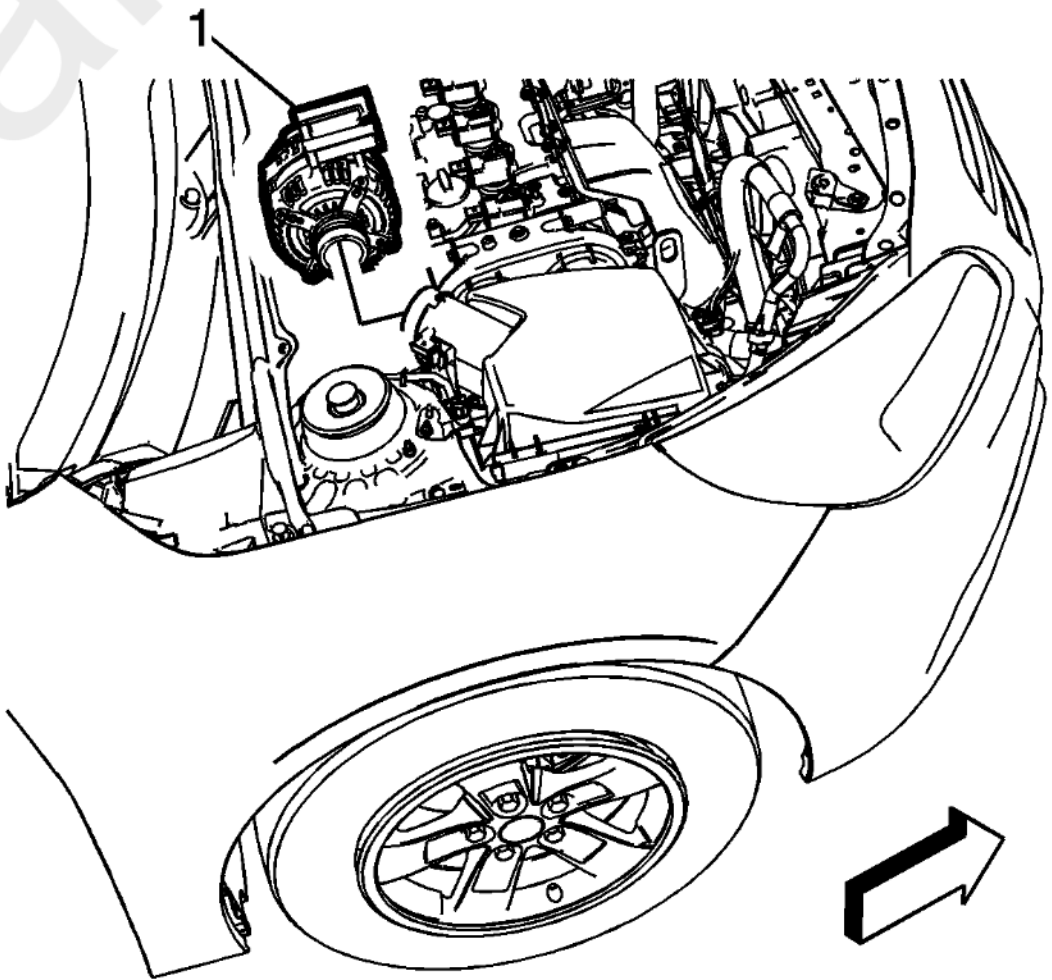


Fig. 82: Generator
Courtesy of GENERAL MOTORS COMPANY

12. Remove the generator.(1)

Installation Procedure

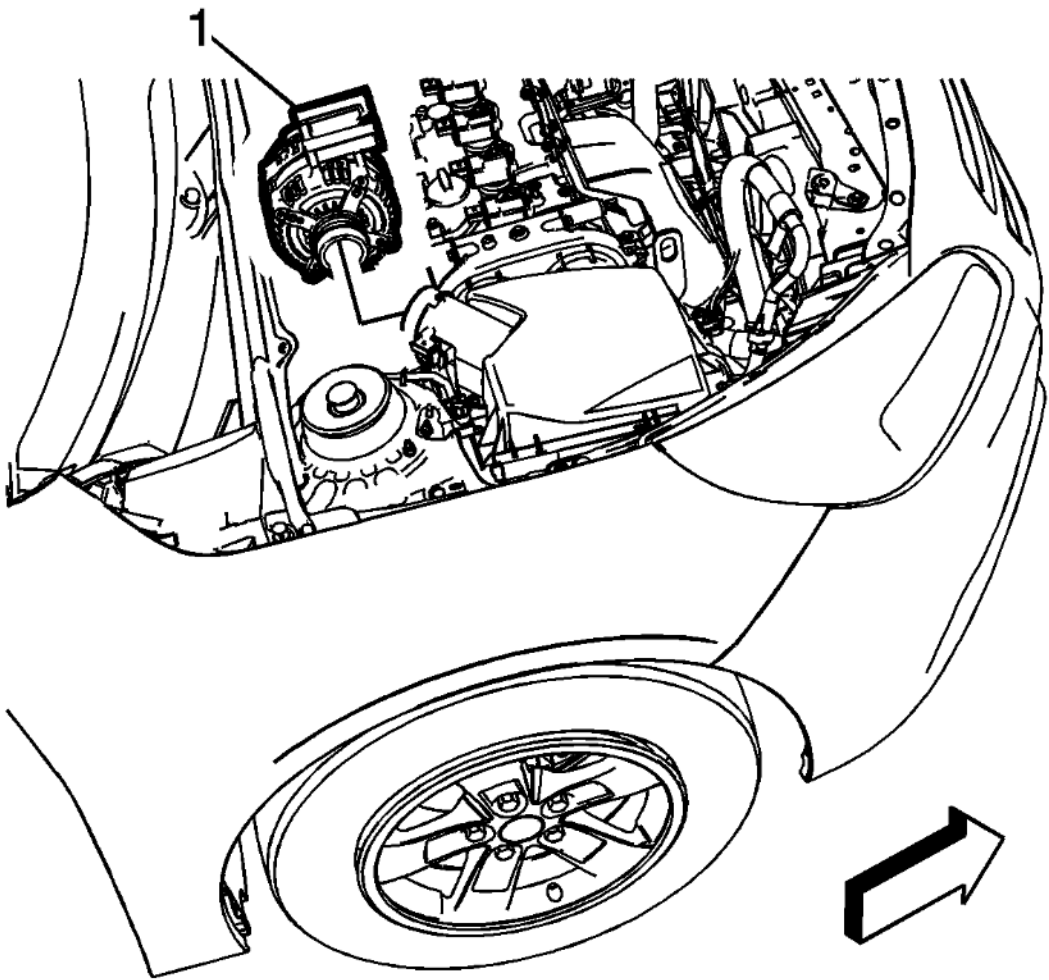


Fig. 83: Generator
Courtesy of GENERAL MOTORS COMPANY

1. Install the generator.(1)

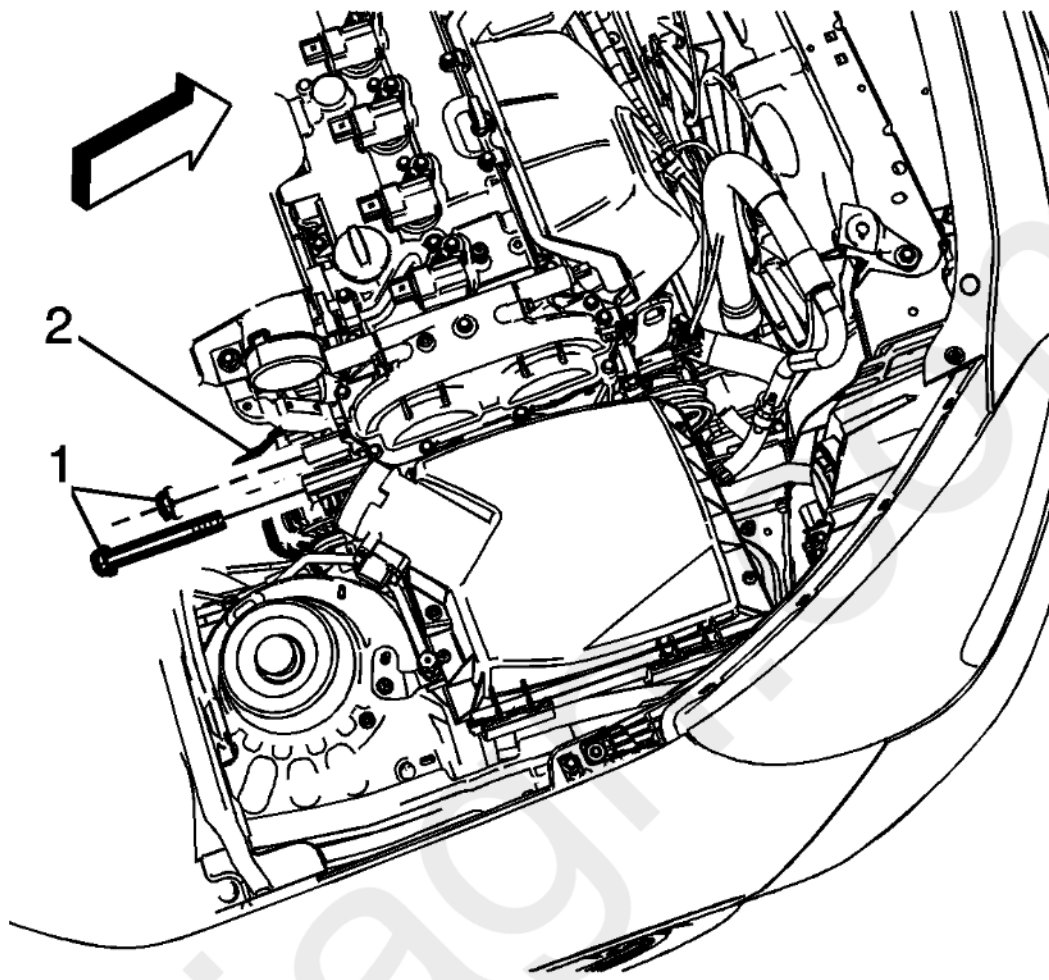


Fig. 84: Upper Generator Mounting Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

2. Install Generator Fastener (1) - and tighten 22 N.m (16 lb ft)

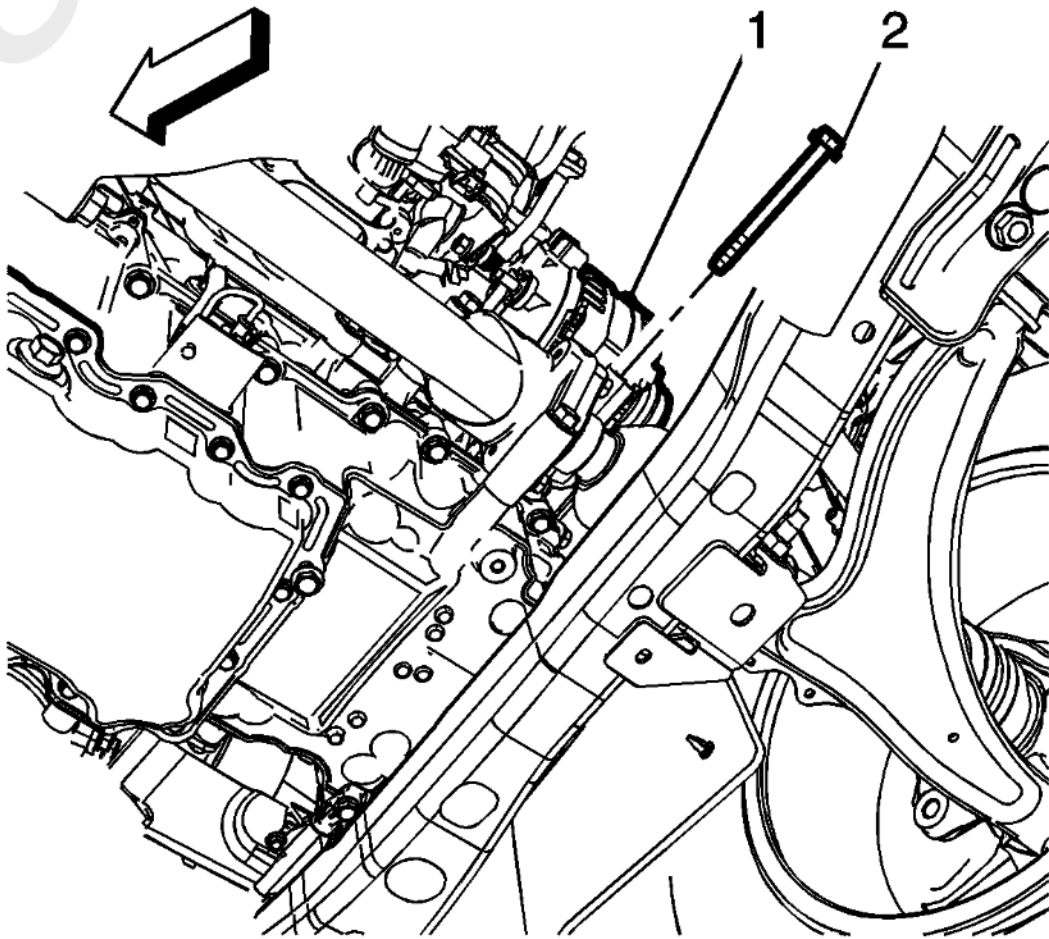


Fig. 85: Lower Generator Mounting Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Install Generator Bolt (2) and tighten 22 N.m (16 lb ft)

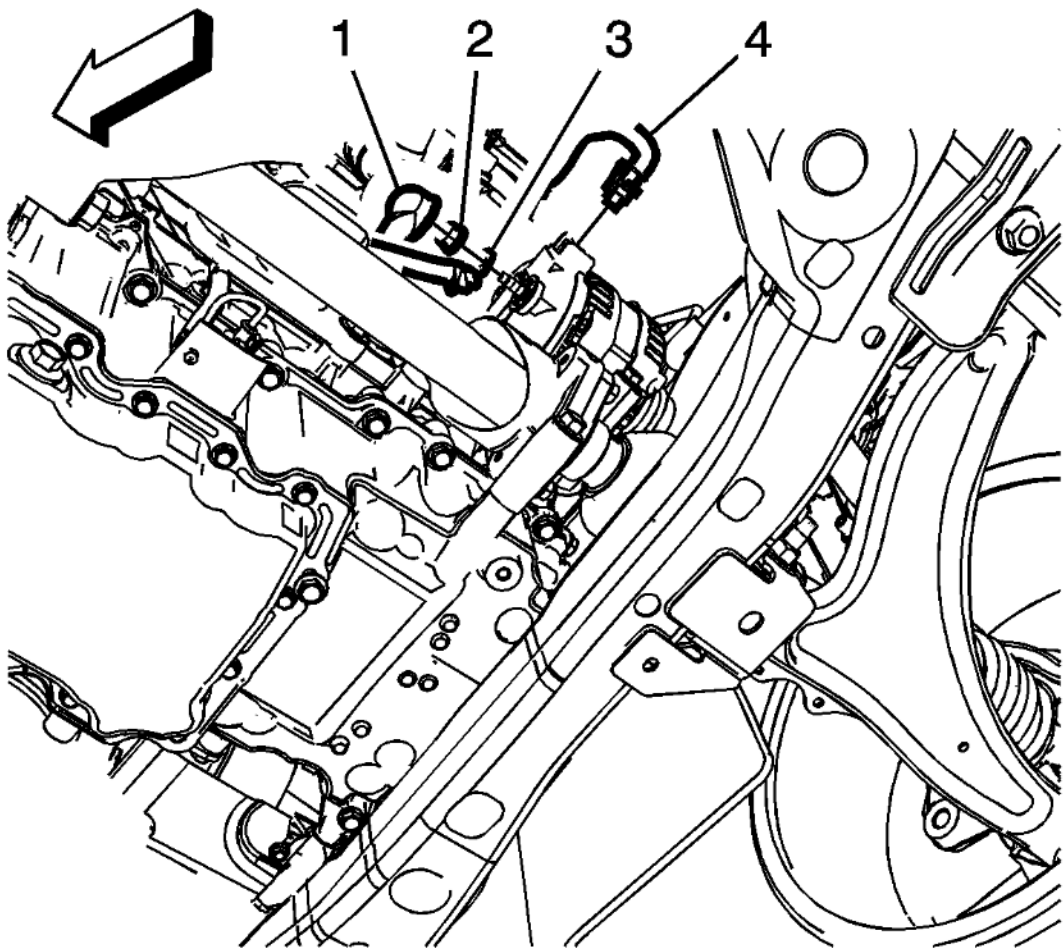


Fig. 86: Protective Boot And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

- 4. Install Battery Positive Cable (3)
- 5. Install Generator Nut (2) and tighten 15 N.m (11 lb ft)
- 6. Connect the electrical connector.(4)
- 7. Install Protective Cap (1)
- 8. Install the drive belt. [Drive Belt Replacement](#)
- 9. Install the air cleaner outlet duct. [Air Cleaner Outlet Duct Replacement](#)
- 10. Install the air cleaner assembly. [Air Cleaner Assembly Replacement](#)
- 11. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)

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

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.

10/13/2019

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 (If applicable)

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

Battery Sensor Module (If applicable)

The BCM monitors the battery sensor module for battery state of current, state of health, and battery charge via the data communication bus. If the battery is determined to be in poor state of health or having a low charge, the BCM will not allow the ECM to Autostop.

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 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.

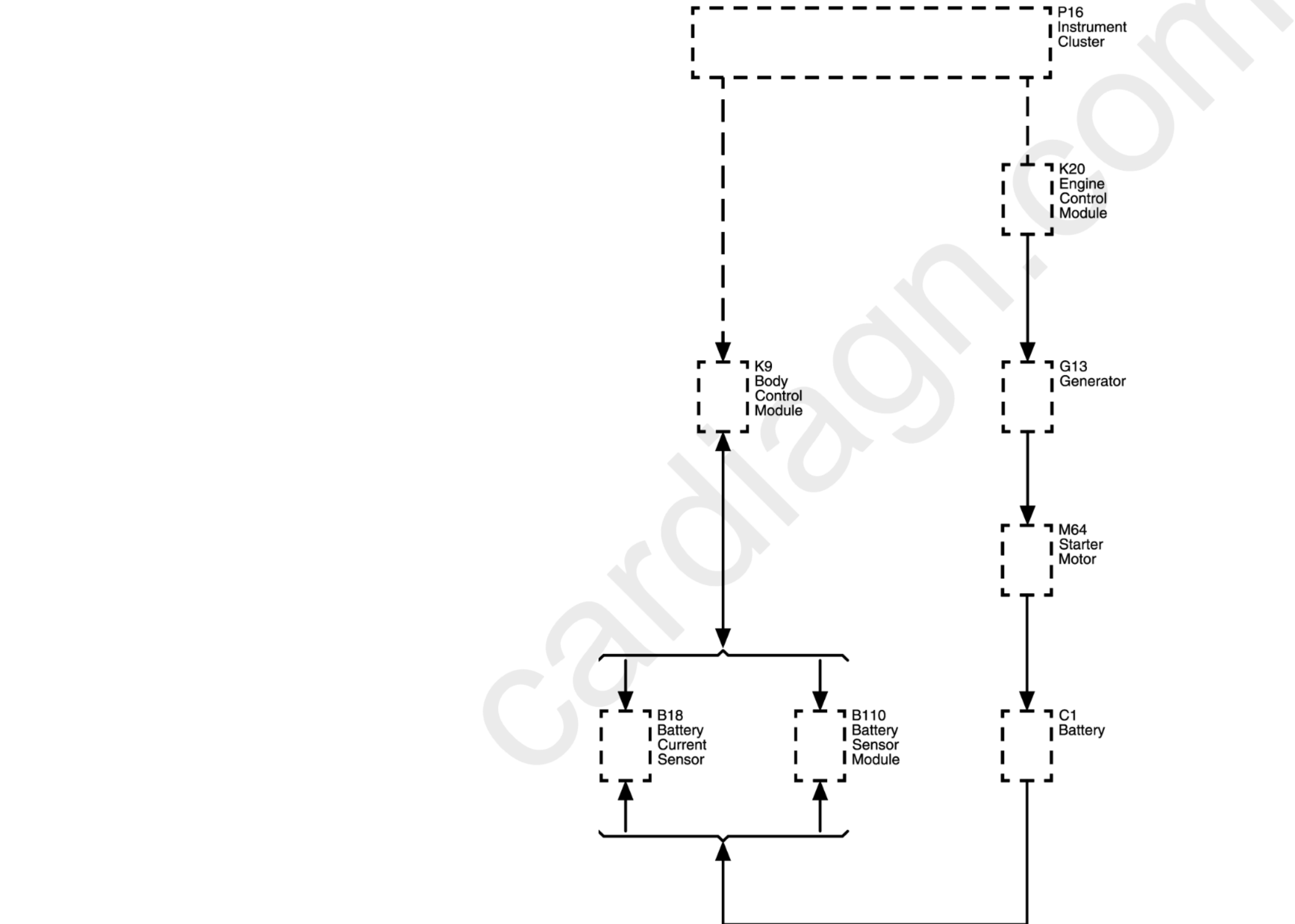


Fig. 87: Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
P16	P16 Instrument Cluster
K20	K20 Engine Control Module
G13	G13 Generator
M64	M64 Starter Motor
C1	C1 Battery
B18	B18 Battery Current Sensor
K9	K9 Body Control Module
B110	B110 Battery Sensor 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
- Head lamp Mode
- 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
----------------------	--------------------------

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.

Head lamp Mode

The BCM will enter Head lamp Mode when ever the head lamps 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.

Tow/Haul Mode (If applicable)

Pressing the Tow/Haul Mode button located on the center stack, the vehicle system voltage is raised and the remote(non-vehicle) battery will be charged. Having the headlights on will raise the system voltage and if the Tow/Haul button is applied it will not serve any purpose. The voltage is regulated between 13.9-14.5 V.

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:

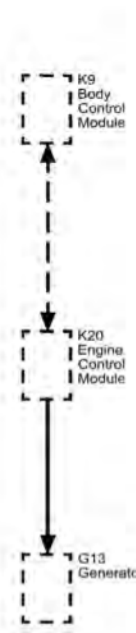


Fig. 88: Electrical Power Management Block Diagram
Courtesy of GENERAL MOTORS COMPANY

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

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
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
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
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.

With KL9

To support the increased number of engine starts, the starter motor is upgraded with a high performance electric motor and a stronger pinion engagement mechanism with reduced noise levels.

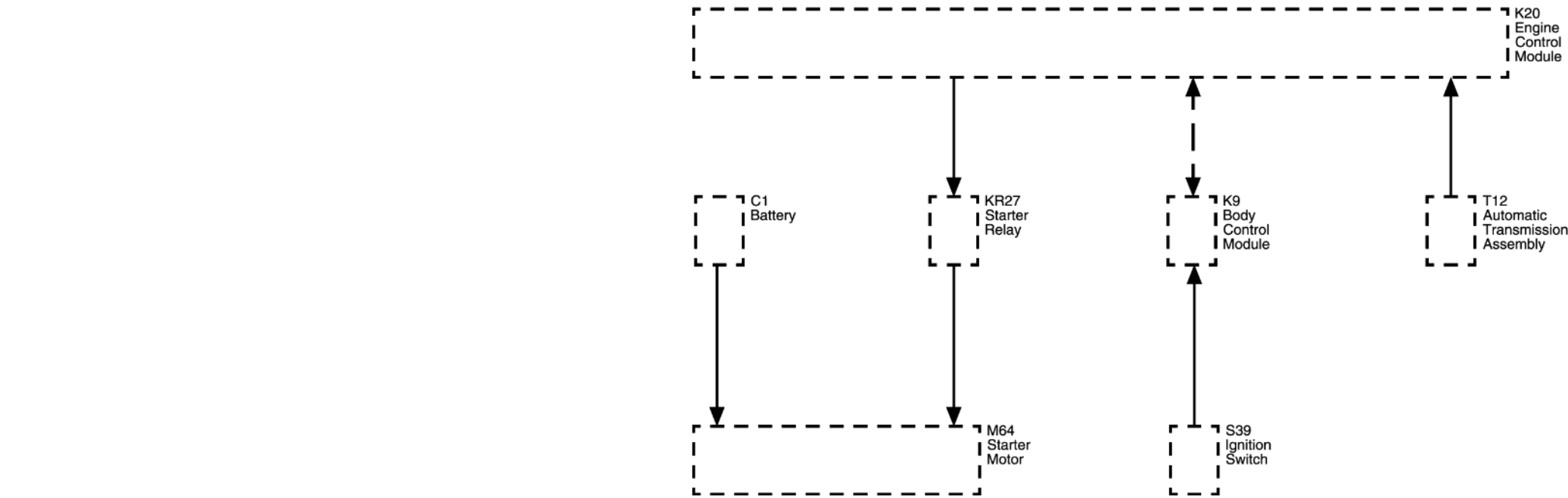


Fig. 89: Starting System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

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

STOP/START SYSTEM DESCRIPTION AND OPERATION

The Stop/Start System is used to improve fuel efficiency in stop/start driving. The vehicle automatically shuts off the engine in appropriate conditions, at a traffic light for example, resulting in zero tail pipe emissions and saving fuel which otherwise is used idling the engine when stationary. The engine restarts when the driver is ready to move away.

When the driver prepares to move away (by releasing the brake pedal and/or depressing the accelerator pedal), the engine will start; it takes approximately 400 ms for the engine to restart from the time the brake pedal transition initiates this activity.

To support the increased number of engine starts, the starter motor is upgraded with a high performance electric motor and a stronger pinion engagement mechanism with reduced noise levels.

There is a battery sensor module connected to the battery which continually monitors the battery charging current, and voltage. This module communicates to the body control module (BCM) via LIN serial data. The engine control module (ECM) receives the voltage and current information from the BCM via high speed serial data and this is used to determine if the battery state of charge (SOC) as calculated in the ECM by the Battery State Estimation (BSE) system, is sufficient to support a Stop/Start condition. The ECM has access to independent sensing systems to verify the information received from the battery sensor module via the BCM is correct. These sensing systems include an analog current sensor wired directly to the ECM and battery voltage sensing via the Run/Crank input to the ECM. This system also utilizes a dual battery configuration which includes the primary 12V battery as well as an auxiliary 12V battery. The auxiliary battery is used to power vehicle loads, except the starter, during stop/start cranking events.

For the engine to shutdown, the vehicle must be below 5 km/h (3 MPH), with the brake pedal depressed to keep the vehicle at rest. To restart, the driver releases the brake pedal and the starter motor engages the engine, and the vehicle is ready to drive away. When the engine has been shut down by the Stop/Start System, the tachometer needle will rest at the Autostop indicator icon (500 RPM point) indicating the engine has been shut down by the Stop/Start System.

When the Stop/Start System has shut down the engine, and the ambient temperature is below 15Â°C (59Â°F), the ECM will activate the Stop/Start auxiliary relay which controls the electric engine coolant cabin heater pump motor to continually circulate the engine coolant through the engine and heater core while the engine is off. This is to ensure the engine and passenger compartment temperature is maintained while off. Once the Stop/Start System has restarted the engine, the ECM will turn off the electric coolant pump motor, thus allowing the engine's internal coolant pump to circulate the engine coolant. The Stop/Start System is automatically activated each time the ignition switch is turned on.

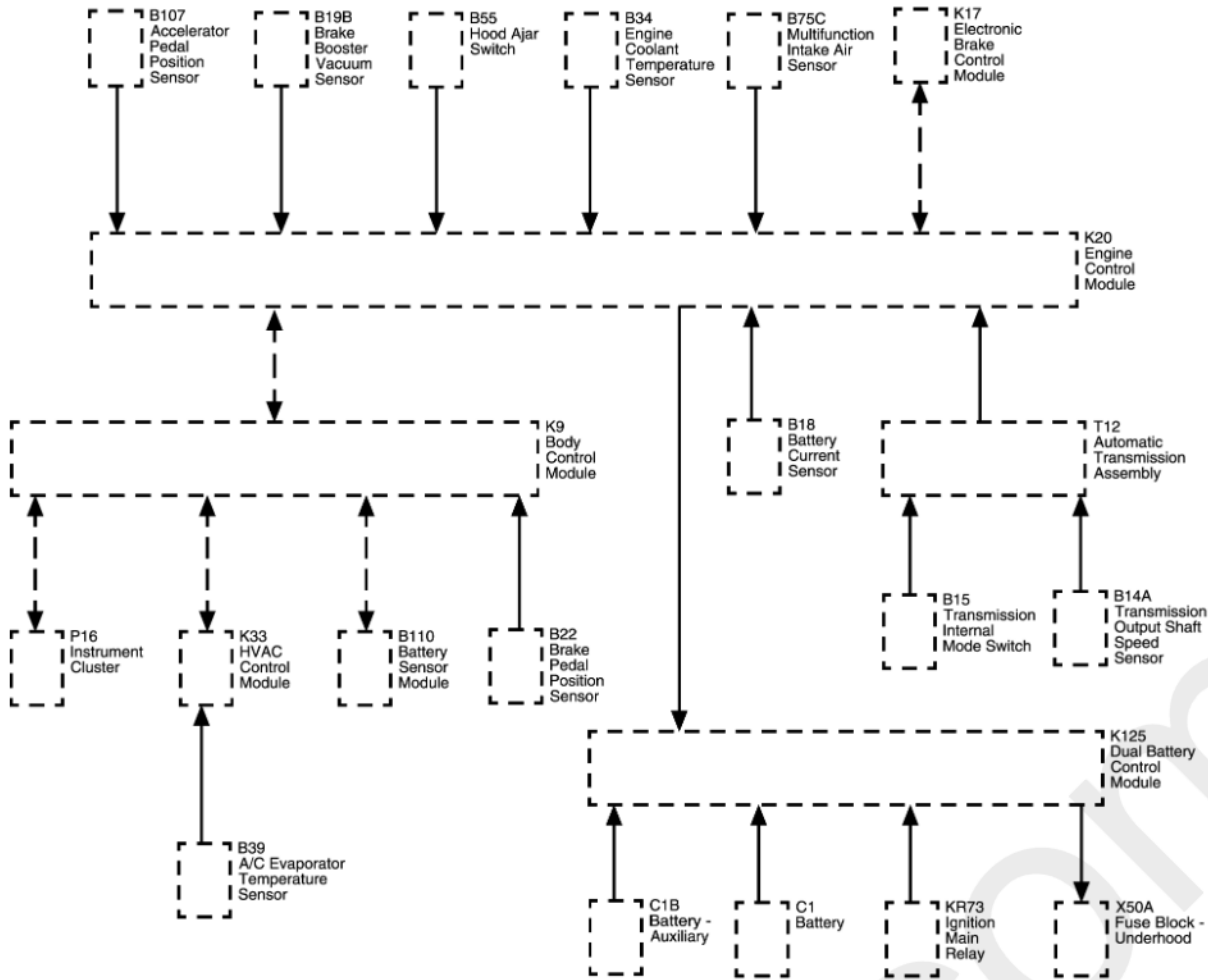


Fig. 90: Start Stop Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
DJ	Serial Data - Local Interconnect Network
B107	B107 Accelerator Pedal Position Sensor
B19B	B19B Brake Booster Vacuum Sensor
B55	B55 Hood Ajar Switch
B34	B34 Engine Coolant Temperature Sensor
B75C	B75C Multifunction Intake Air Sensor
K17	K17 Electronic Brake Control Module
K20	K20 Engine Control Module
B18	B18 Battery Current Sensor
T12	T12 Automatic Transmission Assembly
B15	B15 Transmission Internal Mode Switch
B14A	B14A Transmission Output Shaft Speed Sensor
K9	K9 Body Control Module
P16	P16 Instrument Cluster
K33	K33 HVAC Control Module
B110	B110 Battery Sensor Module
B22	B22 Brake Pedal Position Sensor
B39	B39 A/C Evaporator Temperature Sensor

Autostop Criteria

The ECM will enter an AutoStop condition only if all of the following enabling criteria has been met. The BCM will transmit the state messages to the instrument cluster which will display the Autostop indicator in the tachometer display.

- Initial minimum vehicle speed during drive cycle must be 19 km/h (12 MPH) or greater. Subsequent autostop minimum speed may vary from 2-10 km/h (1-6 MPH), depending on vehicle
- Ambient and engine coolant temperature correlation meets specified values
- Ambient and transmission fluid temperature correlation meets specified values
- Hood switch status is closed
- Brake pedal is depressed beyond a specific value. (Approx. 27%)
- Accelerator pedal is in the learned home position
- Brake booster vacuum is greater than 45 kPa (7 PSI)
- Transmission gear selector is in the Drive position
- Vehicle speed is less than 5 km/h (3 MPH)
- Engine speed is below 1 500 RPM
- Engine coolant temperature is less than 120Â°C (248Â°F)
- No A/C compressor request from HVAC (A/C or Defrost modes)
- Battery voltage greater than 12 V
- Battery state of charge in the ECM is greater than 65% (changes with state of health)

Stop/Start Enable Temperature Criteria

Ambient Temperature	Engine Temperature	Transmission Temperature
-20Â°C (-4Â°F)	70Â°C (158Â°F)	15Â°C (59Â°F)
-5Â°C (-23Â°F)	70Â°C (158Â°F)	15Â°C (59Â°F)
15Â°C (59Â°F)	40Â°C (104Â°F)	15Â°C (59Â°F)
35Â°C (95Â°F)	50Â°C (122Â°F)	35Â°C (95Â°F)
45Â°C (113Â°F)	65Â°C (149Â°F)	45Â°C (113Â°F)

Autostart Criteria

The ECM will perform an Auto Restart if any of the following conditions are true.

Conditions that will enable Autostart:

- 10/13/2019
- Transmission gear selector is moved from the drive position
 - Driver removes pressure from the brake or depresses the accelerator pedal while the vehicle is in the forward Drive gear
 - HVAC function is selected that requires the A/C compressor

System Enabled Conditions that will enable Autostart

- Brake booster vacuum is less than 40 kPa (6 PSI)
- HVAC inside air temperature changes greater than 3Â°C (5Â°F) (with HVAC Automatic)
- A/C compressor request from HVAC (A/C or Defrost modes)
- Battery voltage less than 11 V,
- Battery state of charge is less than 73% (changes with state of health)
- Hood switch status changes to open
- Autostop time exceeded 2 min

If the crank time exceeds 2 s, a manual ignition switch restart will be necessary.

System Components

Engine Control Module (ECM)

The engine control module (ECM) monitors the inputs from the engine coolant temperature (ECT) sensor, vehicle speed sensor (VSS), hood ajar switch, brake booster vacuum sensor, Battery Sensor Module (BSM - Via GMLAN), Analog Battery Current Sensor, the brake pedal position sensor, the accelerator pedal position sensor, and engine speed to determine Autostart and Autostop conditions. The ECM also controls the auxiliary coolant pump motor for cabin heating and the auxiliary transmission fluid pump motor.

Transmission Control Module (TCM)

The transmission control module monitors the inputs from the transmission neutral safety switch to determine the driver selected gear. This information is transmitted to the ECM via serial data to support the Auto Stop Start algorithm.

Engine Coolant Temperature sensor

The ECT sensor is used to determine engine operating temperature.

Intake Air Temperature Sensor

The ECM uses this sensor to monitor ambient air temperature. If too cold, the Autostop will not occur.

Inside Air Temperature Sensor

The HVAC control module monitors the passenger compartment temperature sensor to determine the temperature inside the passenger compartment. The HVAC control module sends this temperature reading to the ECM on the data communication circuit. The ECM uses this temperature values to determine if a restart is requires based on the temperature inside the passenger compartment.

Vehicle Speed Sensor

The vehicle speed sensor is used to determine vehicle speed. If vehicle speed is detected above a calculated value during an Autostop condition, the ECM will start the engine.

Hood Ajar Switch

If the hood switch is in the open position, the vehicle will not Autostop. If the hood is opened during Autostop, the vehicle will automatically restart.

Brake Booster Vacuum Sensor

The ECM monitors vacuum in order to ensure proper power assist for the brake pedal. If the ECM determines vacuum is too low, it will restart the engine.

Brake Pedal Position Sensor & Accelerator Pedal Position Sensor

The ECM monitors both the brake pedal position sensor and the accelerator pedal position sensor to determine the level of activation for each. While the accelerator pedal is in it's at rest position with no pressure applied by the operator, a partially depressed Brake pedal will cause the ECM to prepare the engine for an Autostop event. When the vehicle is in an auto stop event and the status of the brake pedal position sensor changes from meeting the autostop criteria to not meeting this criteria the engine will be restarted provided all of the other conditions to allow an autostart are met. If the Accelerator pedal is moved from its at rest position the vehicle will also enter an auto start event if all other conditions to support an autostart event, except for the brake pedal position, are met.

Transmission Gear Shift Position Switch

The transmission gear shift position switch is used to determine if the transmission is in the proper state to allow an auto stop/start event. The ECM will not allow Autostop until the brake is engaged, the transmission is in the forward gear position and then the vehicle slows to below the minimum speed required to allow and autostop while meeting all of the other minimum criteria to support an autostop event.

Auxiliary Transmission Oil Pump

The ECM will turn on the auxiliary transmission oil pump motor during Autostop to provide the transmission with the proper fluid pressures required to maintain correct transmission functionality required to support Auto Start drive away shifting. Once the engine is running after an auto stop, the ECM will turn off the auxiliary transmission pump motor.

Coolant Pump Motor

The ECM will turn on the auxiliary coolant pump motor during Autostop to help the cabin temperature when required based upon the HVAC system settings. Once the engine is running after an auto stop, the ECM will turn off the coolant pump motor.

Body Control Module (BCM)

The body control module (BCM) monitors the Intelligent Battery Sensor over LIN and transmits the information from these devices to the ECM over high speed GMLAN serial data communications. The BSM provides battery voltage and current to the ECM for use in the Battery State Estimation system. The BCM is also the gateway for the vehicles two primary serial data communication busses and transfers the appropriate messages to and from the instrument cluster and the HVAC system related to stop start functionality.

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to the negative battery cable at the battery. The battery current sensor is a 3-wire hall effect current sensor. The battery current sensor monitors the battery current. It directly inputs to the ECM. 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.

Battery Sensor Module

The BCM monitors the battery sensor module information on battery voltage and current, state of health, state of function and battery state of charge via the LIN data communication bus. Information on the battery current and voltage is transferred through the gateway in the BCM to the ECM for use in the battery state estimation system in the ECM. Other data provided to the BCM by the sensor is used within the BCM to determine the proper control levels of the battery charging system. If the battery is determined to be in a low state of charge (<75%), the ECM will not allow the vehicle to enter an Autostop event.

Instrument Cluster

In order to differentiate between a normal engine shut down (engine speed 0 RPM) and when the engine has been shut down by the Stop/Start System, the tachometer needle will rest at the Autostop indicator icon (500 RPM point) indicating the engine has been shut down by the Stop/Start System. Once the engine is restarted, the tachometer will function normally.

Primary 12V Battery

This battery is the primary energy storage device for vehicle. It powers vehicle at all times except during starting when an auxiliary battery powers all vehicle loads except the starter.

Auxiliary 12V Battery

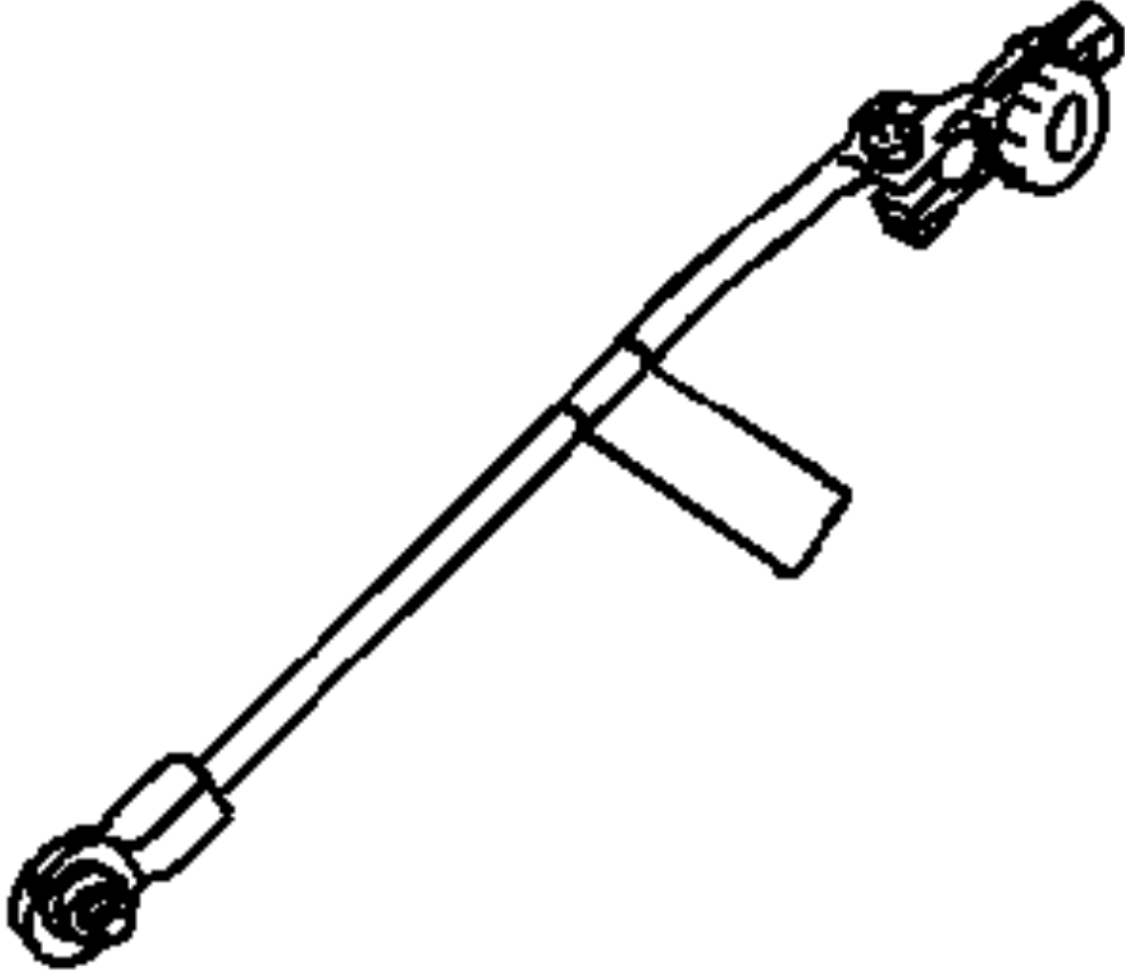
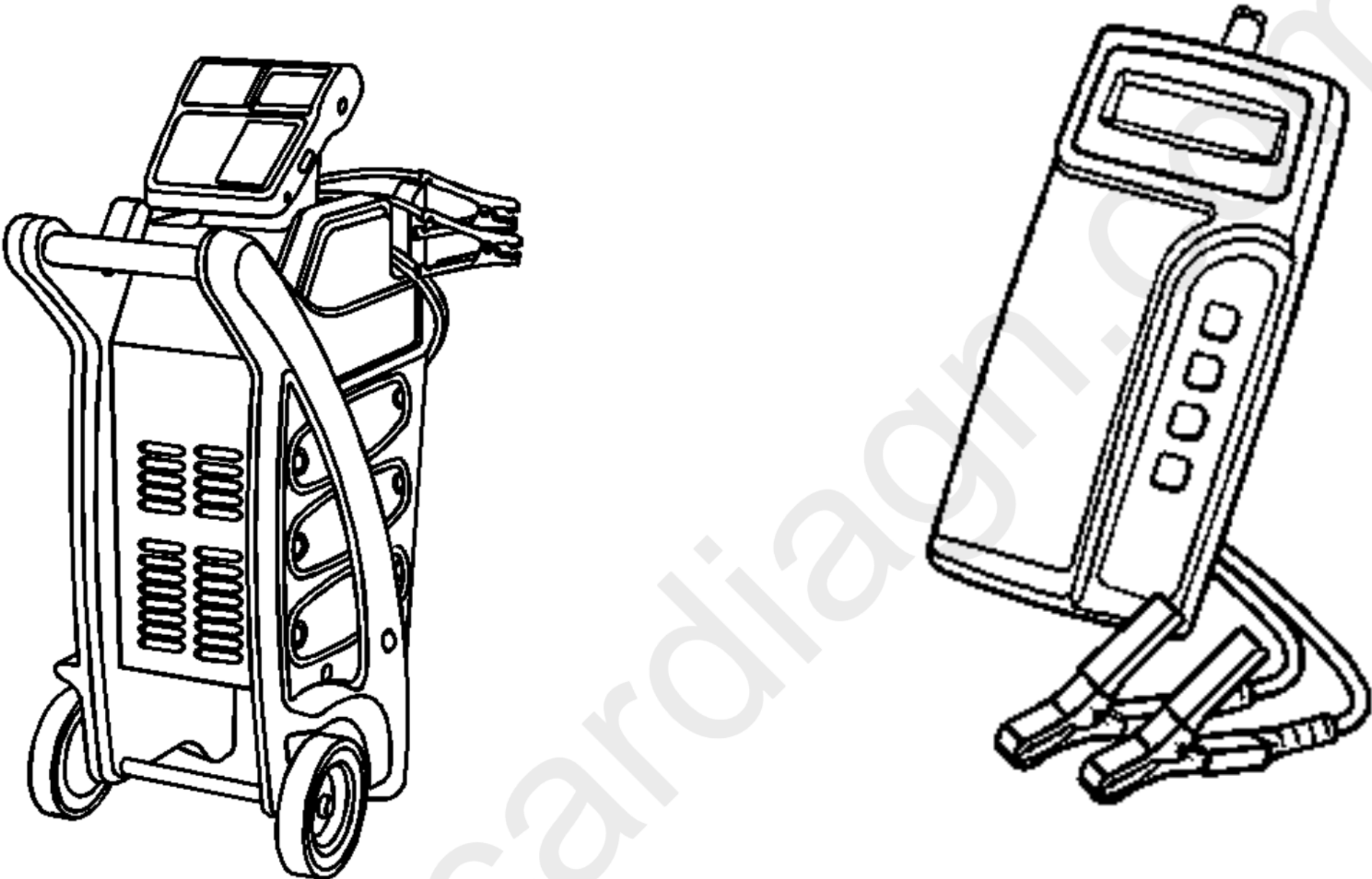
This is an auxiliary energy storage device for vehicle. It powers the vehicle loads, except the starter, during engine cranking (e.g. starter motor engaged).

Dual Battery Control Module (DBCM)

The DBCM is used to isolate 12V primary battery from vehicle loads during cranking events. It switches primary and auxiliary batteries in and out at appropriate times to support vehicle loads and battery charging. It does not utilize vehicle bus communication. The following table defines the utilization of the primary and auxiliary batteries based on specified events.

Vehicle Load Supported by

Event	Primary Battery	Auxiliary Battery
Key off	Yes	No
Key on	Yes	Yes
*Key Crank	No	Yes
Run	Yes	Yes
Auto-stop	Yes	No
*Auto-start	No	Yes
*During a Key Crank or Auto-start event, the primary battery supplies power to the Starter Motor.		

Illustration	Tool Number/Description
	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch
	BC 800 W BC 800 WP EL 50313 EL 42000 EL 50076 J 42000 Battery Tester