

ELECTRICAL

12 V Starting and Charging - Canyon, Colorado

SPECIFICATIONS

FASTENER SPECIFICATIONS

Application	Specification	
	Metric	English
Battery Hold Down Retainer Rod Fastener	22 N.m	16 lb ft
Battery Negative Cable Clamp to Negative Battery Post	4.7 N.m	42 lb in
Battery Negative Cable Ground Terminal to Battery Fuse Block Stud	13 N.m	115 lb in
Battery Negative Cable Ground Terminal to Chassis Frame	22 N.m	16 lb ft
Battery Negative Cable Ground Terminal to Engine Block	58 N.m	43 lb ft
Battery Negative Cable Ground Terminal to Wheel Well Bolt	22 N.m	16 lb ft
Battery Positive Cable Clamp to Positive Battery Post	4.7 N.m	42 lb in
Battery Positive Cable Harness Retainer Fastener (LCV)	10 N.m	89 lb in
Battery Positive Cable to Battery Fuse Block	4.7 N.m	42 lb in
Battery Positive Cable to Generator	15 N.m	11 lb ft
Battery Positive Cable to Junction Block Fastener	13 N.m	115 lb in
Battery Positive Cable to Starter (LCV, LFX)	13 N.m	115 lb in
Battery Retaining Bracket Fastener	22 N.m	16 lb ft
Battery Tray Fastener	7.5 N.m	66 lb in
Engine Wiring Harness Fuse Block Bracket Screw	7 N.m	62 lb in
Engine Wiring Harness Junction Block Bolt	9 N.m	80 lb in
Engine Wiring Harness Junction Block Cable Nut	9 N.m	80 lb in
Generator Mounting Bolt (LCV)	22 N.m	16 lb ft
Generator Mounting Bolt (LFX, LWN)	58 N.m	43 lb ft
Generator Mounting Nut (LCV)	22 N.m	16 lb ft
Generator Mounting Stud (LCV)	9 N.m	80 lb in
Starter Mounting Bolt (LCV)	22 N.m	16 lb ft
Starter Mounting Bolt (LFX, LWN)	58 N.m	43 lb ft
Starter Solenoid Cable to Starter (LWN)	12 N.m	106 lb in

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starting

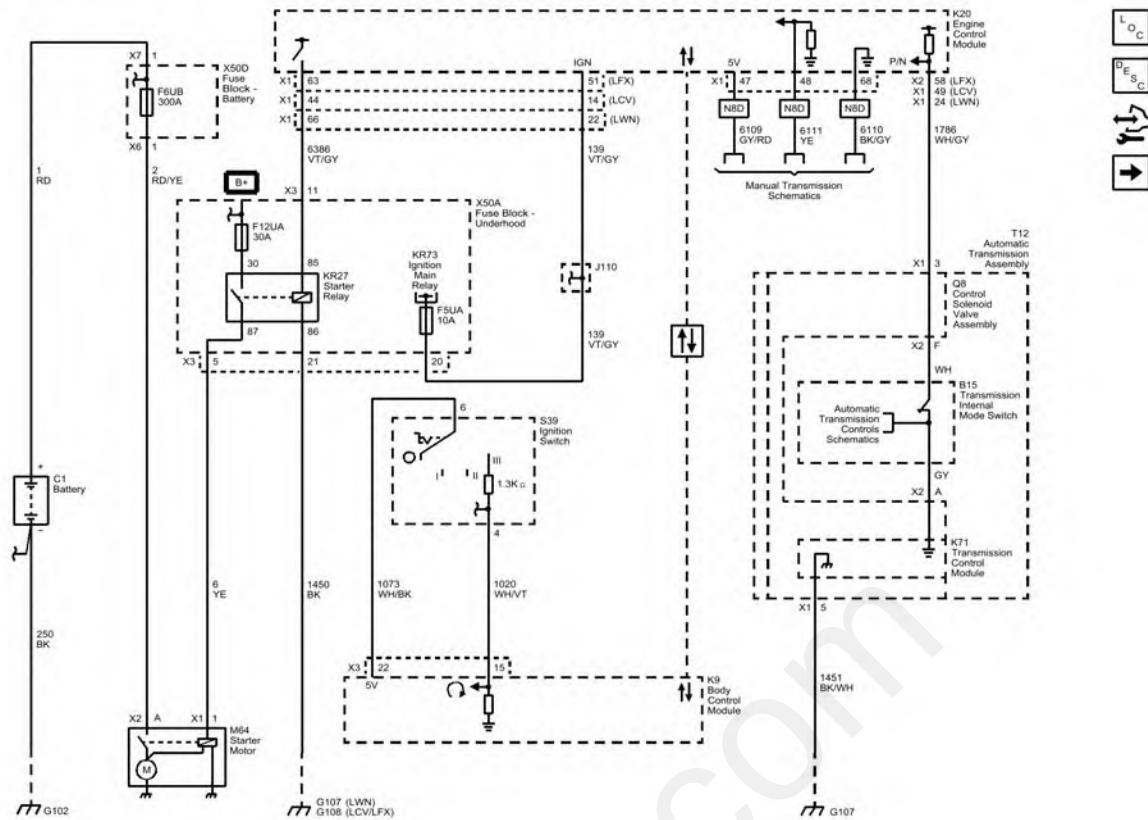


Fig. 1: Starting

Courtesy of GENERAL MOTORS COMPANY

Charging

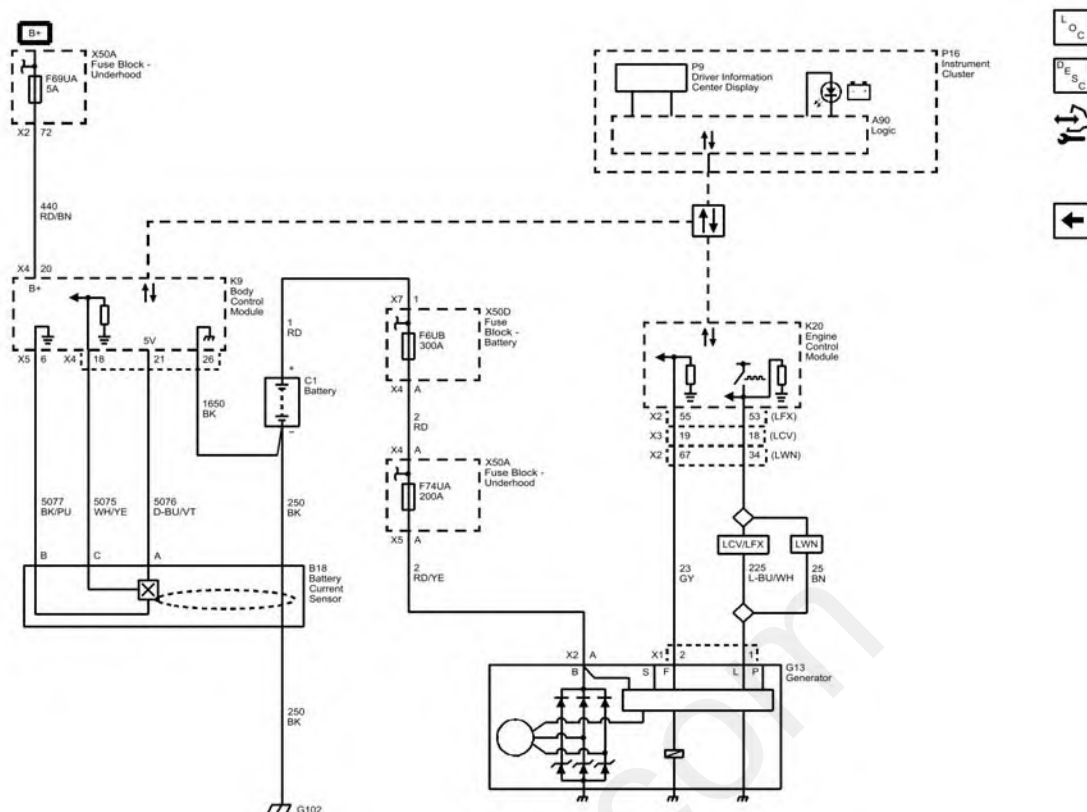


Fig. 2: Charging

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

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

Diagnostic Instructions

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

DTC Descriptors

DTC B1325

Device Power Circuit Voltage

DTC B1327

Device Voltage Circuit

DTC B1328

Device Voltage Circuit

Device Power 2 Circuit

DTC B1390

Control Module Supply Circuit 1

DTC B1395

Control Module Voltage Reference Output 1

DTC B1400

Control Module Supply Circuit 2

DTC B1410

Control Module Supply Circuit 3

DTC B1415

Control Module Voltage Reference Output 3

DTC B1424

Control Module Power Circuit

DTC B1425

Control Module Power Circuit

DTC B1439

Intermittent Device Voltage

DTC B1517

Battery Voltage

DTC C0800

Device Power 1 Circuit Voltage

DTC C0805

Control Module Power 2 Circuit

DTC C0870

Control Module Voltage Reference

DTC C0880

Control Module Voltage Reference

DTC C0895

Voltage

DTC C0899

Device Voltage

DTC C0900

Device Voltage

DTC P0560

System Voltage Low

DTC P0561

System Voltage Performance

DTC P0562

System Voltage Low

DTC P0563

System Voltage High

DTC P0611

Fuel Injector Control Module Performance

DTC P129B

System Voltage Low

DTC P129C

System Voltage High

DTC P15AE

Fuel Injector Control Module System Voltage Low Voltage

DTC P15AF

Fuel Injector Control Module System Voltage High Voltage

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

Circuit/System Description

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

Conditions for Running the DTC

The ignition is ON.

Setting the DTC

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

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

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

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

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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 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**

1. 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

Current Sensor Incorrect Mounting	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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Diagnostic Fault Information

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

Circuit/System Description

The battery current sensor is a 3-wire hall effect current sensor. The body control module (BCM) supplies 5 V and ground to the battery current sensor. The battery current sensor measures the amount of current flowing to or from the battery, and supplies a pulse width modulation (PWM) signal to the BCM. The BCM monitors the battery current signal, and sets DTC B1516 08 if the signal is outside the normal range if 4-96 % duty cycle. The BCM also monitors the current polarity, and sets DTC B1516 66 if reverse polarity is detected.

Conditions for Running the DTC

B1516 08

The BCM is awake.

B1516 66

- The BCM is awake.
- The 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 (RVC) is disabled.

Conditions for Clearing the DTC

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

Diagnostic Aids

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

Reference Information

Schematic Reference

Starting and Charging Schematics

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Description and Operation

Charging System Description and Operation

Electrical Information Reference

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- Connector Repairs
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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**

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 \(LFX\)](#)[Battery Negative Cable Replacement \(LCV\)](#)[Battery Negative Cable Replacement \(LWN\)](#) Battery cable replacement.
- [Control Module References](#) for K9 Body Control Module replacement, programming and setup

DTC B151A: LOW BATTERY CAPACITY DETECTED

Diagnostic Instructions

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

DTC Descriptor

DTC B151A 58

Low Battery Capacity Detected

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

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 Verification

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

DTC B1527: PARASITIC LOAD

Diagnostic Instructions

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

Scan Tool Reference

Control Module References for scan tool information

Verification

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

DTC P0561: SYSTEM VOLTAGE PERFORMANCE

Diagnostic Instructions

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

DTC Descriptors

DTC P0561

System Voltage Performance

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

Circuit/System Description

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

Conditions for Running the DTC

The engine speed is 400 RPM or greater.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

- DTC P0561 is a Type C DTC.

Conditions for Clearing the DTC

DTC P0561 is a Type C DTC.

Diagnostic Aids

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

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

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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. Engine running, accessories OFF
3. Test for 12.6-15.0 V between the battery positive terminal and negative terminal.
 - **If not within 12.6-15.0 V**
Refer to Charging System Test.
 - **If within 12.6-15.0 V**
4. Verify the scan tool BCM Battery Voltage parameter is within a value of 2 V of the battery terminal voltage.
 - **If not within a value of 2 V**
Refer to Circuit/System Testing.
 - **If within a value of 2 V**
5. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
6. Verify the DTC does not set.
 - **If the DTC sets**
Refer to Circuit/System Testing.
 - **If the DTC does not set**
7. All OK.

Circuit/System Testing

NOTE: Use the schematic to identify the following:

- Control modules the vehicle is equipped with

- The control modules ground, B+, and Ignition circuit terminal IDs and connectors

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

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

ions	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Circuit				

Perform the Diagnostic Repair Verification after completing the repair.

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

DTC P0615, P0616, OR P0617: STARTER RELAY CONTROL

Diagnostic Instructions

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

DTC Descriptors

DTC P0615

Starter Relay Control Circuit

DTC P0616

Starter Relay Control Circuit Low Voltage

DTC P0617

Starter Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control	P0615*, P0616**	P0615*, P0616**	P0615*, P0617**	-
Ground	-	P0615*, P0616**	-	-
* LAF, LF1 ** LLT				

Circuit/System Description

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

Conditions for Running the DTC

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

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

P0616, and P0617 are C type DTCs.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

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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 minutes 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 OK**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , verify the fuse is OK and there is voltage at the fuse.
- **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance,
 3. 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 KR27 starter relay.
- **If the test lamp illuminates**
- 5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.
- 6. Verify the test lamp turns ON and OFF when commanding the starter relay ON and OFF with a scan tool.
 - **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 X1 A or X1 1 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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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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 87A.

- **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 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
---------	-----------------	----------------------	------------------	--------------------

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 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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tor Repairs

- Testing for Intermittent Conditions and Poor Connections
- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

- **If the DTC sets**

Refer to Circuit/System Testing.

- **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 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 Correct	• If less than 2 Ω , replace the K20 Engine Control Module	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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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 \(LCV\)](#)[Generator Replacement \(LWN\)](#)
- [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	P0621	-
Signal - F Terminal	P0622	P0622	P0622	P0622

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field windings on and off. The ECM uses the PWM signal input to determine the generator load on the engine. This allows the ECM to adjust the idle speed to compensate for high electrical loads. The ECM monitors the status of the generator field duty cycle signal circuit. When the ignition is ON and the engine is off, the ECM should detect a duty cycle near 0%. When the engine is running, the duty cycle should be between 5-99%.

Conditions for Running the DTC

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

• running at less than 3,000 RPM

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0622 is a type C DTC

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

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

Refer to Circuit/System Testing.

- **If between 5-90%**

3. Verify the scan tool 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.

2. Test for less than 2 Ω in the B+ circuit end to end.

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

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

1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, test or replace the G13 Generator.

- **If the test lamp illuminates**

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

3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.

- **If 5% or greater**

1. Ignition OFF, disconnect the 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**

Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.

2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 95%**
6. Test or replace the G13 Generator.

Repair Instructions

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

- [Generator Replacement \(LFX\)](#)[Generator Replacement \(LCV\)](#)[Generator Replacement \(LWN\)](#)
- [Control Module References](#) for engine control module replacement, programming, and setup

SYMPTOMS - ENGINE ELECTRICAL

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

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

Electrical Drain/Parasitic Load Test

- Charging System Test
- Generator Noise Diagnosis
- Starter Solenoid Does Not Click
- Starter Solenoid Clicks, Engine Does Not Crank
- Engine Cranks Slowly
- Starter Noise Diagnosis

BATTERY INSPECTION/TEST

Diagnostic Instructions

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

Diagnostic Aids

NOTE: For Warranty repairs -

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

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

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

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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

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 - Auxiliary (if equipped) case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
 - **If there is any apparent damage**
Replace the C1 Battery or C1B Battery - Auxiliary.
 - **If there is no damage**
2. Verify that the battery cables are clean and tight. The battery terminal bolts should be torqued as specified in Fastener Specifications.
 - **If the battery cables need to be cleaned or tightened**
Clean as required and tighten as specified.
 - **If the battery cables are clean and tight**
3. Disconnect battery from the vehicle. There is no need to remove the battery from the vehicle.
4. Connect the EL-50313 directly to the battery terminal posts.
5. Select "Charging," "Diagnostic" and "Out of Vehicle" when setting up the test.
6. Select the proper battery type, Flooded, AGM or Stop/Start AGM.

e CCA as shown on the battery label.

8. Verify the test result is not REPLACE BATTERY or BAD CELL-REPLACE

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

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

Replace the C1 Battery or C1B Battery - Auxiliary.

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

9. All OK.

Repair Instructions

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

Battery Replacement

BATTERY CHARGING

Special Tools

EL 50313 Battery Tester

For equivalent regional tools, refer to [Special Tools](#).

Diagnostic Aids

- The charging area should be well ventilated.
- Do not charge a battery that appears to be frozen. Allow the battery to warm to room temperature and test it using the EL 50313 before charging.
- An AGM battery may be damaged if charged to more than 14.5 V.
- A Flooded Cell battery may be damaged if charged to more than 16.5 V.
- Vehicles with dual batteries must be charged individually which will result in two printouts.

Battery State of Charge

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

The maintenance-free batteries state of charge is estimated by reading the voltage of the battery across the battery terminals. Because the voltage is affected by current flow into or out of the battery, the engine must be stopped and all electrical loads turned OFF, including parasitic loads, when checking the voltage. The voltage can also be affected if the battery has just been charged or discharged, so it is important to consider what has happened to the battery in the time just before testing. Use the following procedure to determine the battery's state of charge:

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.

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

Use the state of charge information as follows:

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

Charging Time Required

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

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

Charging Procedure

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

CAUTION: Refer to [Fastener Caution](#) .

g 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 min or longer after turning the ignition off before going to sleep, like the HVAC and body control modules. 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](#)

- 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 generator 6 and later vehicle communication interface module do not "wake up" every 10 min for the first 48 h as the generator 5 and prior. Generator 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 h is normal.
- Some automatic climate control systems can remain in a semi awake state for up to 3 h, 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 remote keyless entry receiver 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 remote keyless entry receiver 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 h 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

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- [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 h 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
 - Headlamps OFF - auto headlamps 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

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 30 mA**

Refer to Circuit/System Testing.

- **If less than 30 mA**

3. All OK.

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 negative cable from the battery.
2. Turn the **EL 38758** switch knob to the OFF position.
3. Install the male end of the **EL 38758** switch to the battery ground terminal.
4. Install the battery negative cable to the female end of the **EL 38758** switch.
5. Turn the **EL 38758** switch knob to the ON position.
6. Road test the vehicle and activate all of the accessories such as the radio and air conditioning.
7. Ignition OFF, connect a 10 A fused jumper wire to the test switch tool terminals.
8. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the jumper wire.
9. Check the fuse in the jumper wire. The fuse should be OK.

- **The circuit fuse is open.**

Refer to Circuit/System Testing.

- **The circuit fuse is good.**

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 30 mA**

Refer to Circuit/System Testing.

- **If less than 30 mA**

14. All OK.

Testing Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
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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 follow 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 diagnostic procedure.

- [Battery Negative Cable Disconnection and Connection](#)
- [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

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

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Description and Operation

Charging System Description and Operation

Electrical Information Reference

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

Circuit/System Verification

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

1. Ignition ON.
2. Verify that no G13 Generator or B18 Battery Current Sensor DTCs are set that would cause a charging system concern.
 - **If DTCs are set**
Refer to Diagnostic Trouble Code (DTC) List - Vehicle .
 - **If no DTCs are set**
3. Verify the scan tool Body Control Module Battery Voltage parameter is 12 V or greater.
 - **If less than 12 V**
Refer to Battery Inspection/Test.
 - **If 12 V or greater**
4. Engine running, all accessories OFF.

The scan tool Body Control Module Battery Voltage parameter continually increases when controlling the Body Control Module Generator Regulator Setpoint from 10% to 80% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each setpoint change.

- **If the battery voltage does not continually increase**

Refer to Circuit/System Testing.

- **If the battery voltage continually increases**

6. All OK.

Circuit/System Testing

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

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2, 2 X2 or A X2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Remove the test lamp, disconnect the battery negative cable, and disconnect the G13 Generator B+ cable.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, test or replace the G13 Generator.
 - **If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
 - **If 5% or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the G13 Generator signal circuit terminal 2 X1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **If less than 5%**
4. Install a 3 A fused jumper wire between the signal circuit terminal 2 X1 and B+, engine running.
5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.
 - **If 95% or less**
 1. Ignition OFF, remove the jumper wire, disconnect the harness connector at the K20 Engine Control Module.
 2. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 Ω in the signal circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit
- If less than 2 Ω , replace the K20 Engine Control Module.
- **If greater than 95%**

6. Test or replace the G13 Generator.

Repair Instructions

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

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

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.

Reference Information

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Connector End View Reference

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[Charging System Description and Operation](#)

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

Scan Tool Reference

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

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 Verification

1. Ignition OFF

12.0 V at the battery terminals.

- **If less than 12.0 V**

Refer to [Battery Inspection/Test](#)

- **If 12.0 V**

3. Verify that there are no A/C lines, heater hoses or other accessory equipment misrouted or rubbing against the generator causing the noise to be transmitted into the passenger compartment.

- **If there is a line rubbing condition**

Reroute or realign the hose or line.

- **If there is no line rubbing condition**

4. Remove the engine drive belt. Verify all the belt driven devices spin freely and do not produce any unusual sounds.

- **If they do not spin freely or they make an unusual sound**

Replace the affected component.

- **If they spin freely and no unusual sound is given**

5. Inspect the generator, its alignment, and its bolt torque.

- **If the generator is misaligned or improperly torque**

Refer to [Generator Replacement \(LFX\)Generator Replacement \(LCV\)Generator Replacement \(LWN\)](#).

- **If the generator is aligned and torqued properly**

6. Ignition ON

7. Engine running idle, verify that the noise concern is not engine related.

- **If the noise concern is engine related**

Proceed to engine mechanical diagnostic information and procedures for the appropriate engine.

- **If the noise concern is not engine related**

8. Ignition OFF

9. Install the engine drive belt.

10. Ignition ON, engine running idle.

11. Verify the generator is not producing unusual noise.

- **If the generator is producing unusual noise**

Replace the generator, refer to [Generator Replacement \(LFX\)Generator Replacement \(LCV\)Generator Replacement \(LWN\)](#).

- **If the generator is not producing unusual noise**

12. All OK.

Repair Instructions

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

STARTER SOLENOID DOES NOT CLICK

Instructions	Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
- Perform the Diagnostic System Check - Vehicle prior to using this diagnostic procedure. - Review Strategy Based Diagnosis for an overview of the diagnostic approach. Diagnostic Procedure Instructions provides an overview of each diagnostic category.					

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	1	1	-	-
Signal	2	1	-	-
Relay Coil Control Terminal 85	-	1	3	-
Starter Control Terminal 87	1	1	3	-
Ground	-	1	-	-
1. Starter solenoid does not click 2. Cranks in any gear 3. Cranks all the time				

Circuit/System Description

When the ignition mode switch is placed in the crank position, a discrete signal is supplied to the body control module (BCM) notifying it that the ignition is in the crank 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 motor.

Reference Information

Schematic Reference

- Starting and Charging Schematics**
- Automatic Transmission Controls Schematics** for the Automatic Transmissions - 6L45/6L50/6L80/6L90
- Manual Transmission Schematics** for the Manual Transmission - Eaton 6-Speed

Connector End View Reference

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

Scan Tool Reference

Circuit/System Verification

Automatic Transmission

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

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)
 - **If no DTCs are set**
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 while attempting to start the vehicle.
 - **If parameter does not display Crank Request**

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

Refer to [Transmission Internal Mode Switch Logic](#)
 - **If the TCM Internal Mode Switch parameter displays 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 engine cranks in park or neutral.
 - **If the KR27 Starter Relay does not click or the engine does not crank**

Refer to Circuit/System Testing.
 - **If the engine cranks**
7. All OK

Manual Transmission

1. Ignition ON.
2. Verify that no ignition, KR27 Starter Relay, clutch pedal position sensor, brake pedal position sensor, engine, or immobilizer 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**

ie scan tool BCM 5 V Ignition Switch (vehicles without push button start) or ECM Power Mode (vehicles with push button start) parameter is Crank Request while attempting to start the vehicle.

- **If parameter does not display Crank Request**

Refer to [Vehicle Will Not Change Power Mode](#)

- **If parameter displays Crank Request**

4. Ignition ON.

5. Verify the scan tool Clutch Pedal Starter Inhibit Switch parameter changes between On and Off while depressing and releasing the clutch pedal.

- **If the Clutch Pedal Starter Inhibit parameter does not change**

Refer to [Clutch Pedal Position Sensor Learn](#)

- **If the clutch pedal starter inhibit parameter does change**

6. Fully depress clutch pedal.

7. Attempt to start the vehicle.

8. 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**

9. Verify the crank relay does click and the engine begins cranking.

- **If the KR27 Starter Relay does not click or the engine does not begin cranking**

Refer to Circuit/System Testing.

- **If the KR27 Starter Relay does click and the engine does begin cranking**

10. 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 the ignition voltage circuits and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance

3. Test for less than 2 Ω in the control circuit end to end.

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , refer to [Power Mode Mismatch](#)

- **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.

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

1. Ignition OFF.

2. Test for infinite resistance between the B+ circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance,

3. Disconnect X1 harness connector at the M64 Starter Motor.

4. Test for infinite resistance between the control circuit terminal 87 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the M64 Starter Motor.

• **If the test lamp illuminates**

5. Ensure the parking brake is applied and the automatic transmission is in PARK or the manual transmission is in neutral. 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.

2. Disconnect the KR27 Starter Relay.

3. Test for 60-180 Ω between terminals 85 and 86.

• **If not within 60-180 Ω**

Replace the relay.

• **If within 60-180 Ω**

4. Test for infinite resistance between the following terminals:

- 30 and 86
- 30 and 87
- 30 and 85
- 85 and 87

• **If not infinite resistance**

Replace the relay.

• **If infinite resistance**

20 A fused jumper wire between relay terminal 85 and B+.

6. Install a jumper wire between relay terminal 86 and ground.

7. Test for less than 2 Ω between terminals 30 and 87.

- **If 2 Ω or greater**

Replace the relay

- **If less than 2 Ω**

8. All OK

Repair Instructions

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

- [Manual Shift Shaft Position Switch Replacement](#)
- [Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#)
- [Starter Replacement \(LFX\)](#) [Starter Replacement \(LCV\)](#) [Starter Replacement \(LWN\)](#)
- [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

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[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

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](#) .

- **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**

the M64 Starter Motor.

Repair Instructions

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

- [Battery Negative Cable Replacement \(LFX\)](#)[Battery Negative Cable Replacement \(LCV\)](#)[Battery Negative Cable Replacement \(LWN\)](#)
- [Battery Positive Cable Replacement \(LCV\)](#)[Battery Positive Cable Replacement \(LFX\)](#)[Battery Positive Cable Replacement \(LWN - Generator\)](#)
- [Starter Replacement \(LFX\)](#)[Starter Replacement \(LCV\)](#)[Starter Replacement \(LWN\)](#)

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

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[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**

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**

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 2.0L (LTG) or 2.5L (LCV) engines or [Drive Belt Replacement](#) for the 3.6L LFX engine.

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 Cable Replacement \(LCV\)](#)[Battery Positive Cable Replacement \(LFX\)](#)[Battery Positive Cable Replacement \(LWN - Generator\)](#)
- [Battery Negative Cable Replacement \(LFX\)](#)[Battery Negative Cable Replacement \(LCV\)](#)[Battery Negative Cable Replacement \(LWN\)](#)
- [Starter Replacement \(LFX\)](#)[Starter Replacement \(LCV\)](#)[Starter Replacement \(LWN\)](#)

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

tors 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

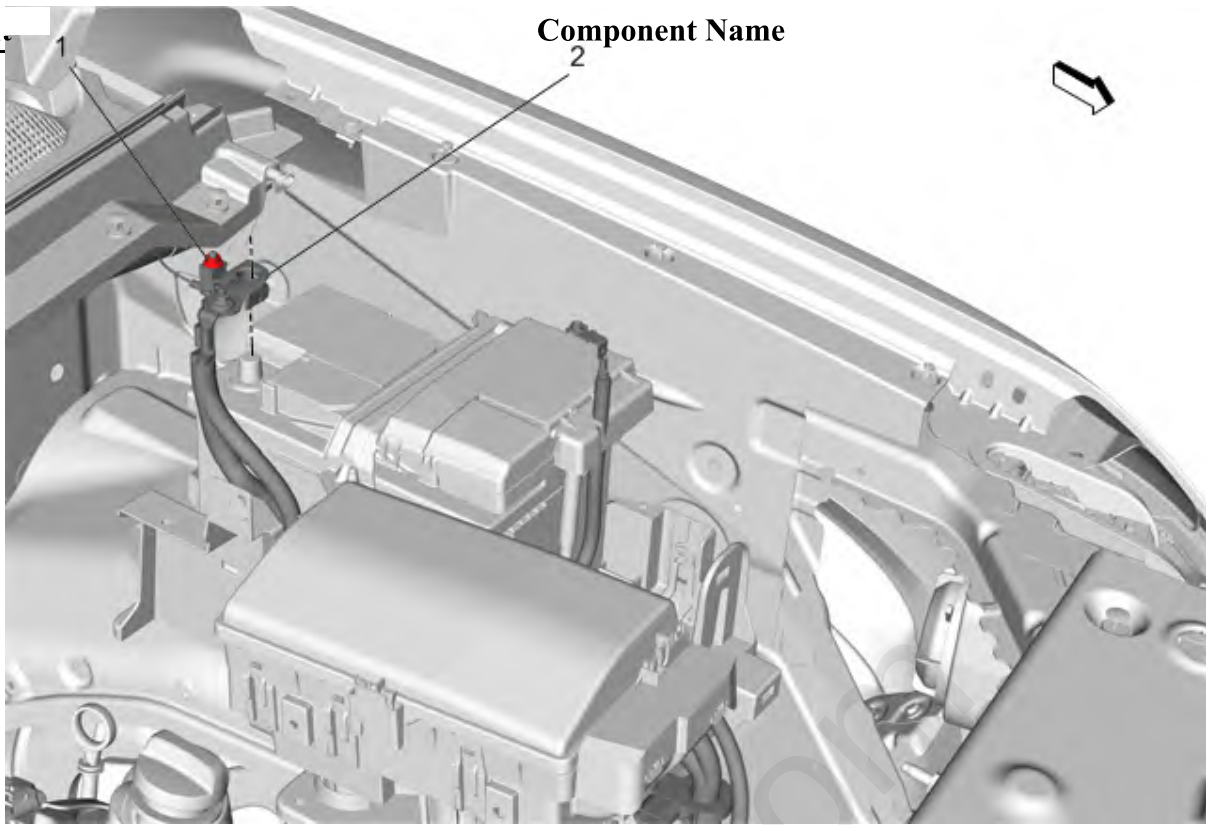


Fig. 3: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

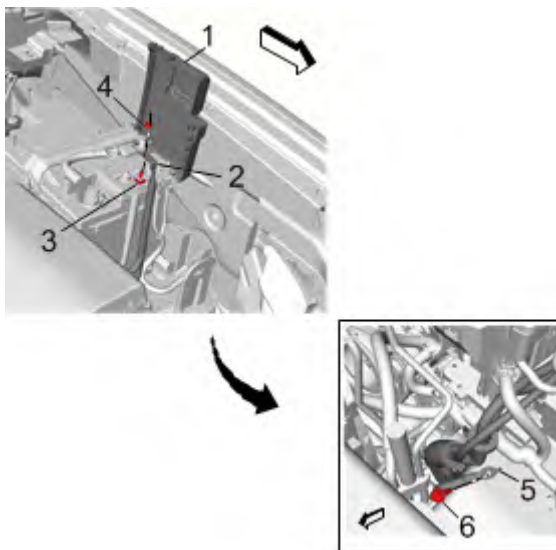
Callout	Component Name

Circuit	Component Name
1	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. CAUTION: Refer to Fastener Caution . Battery Negative Cable Clamp Fastener Tighten 4.7 N.m (42 lb in)
2	Battery Negative Cable Clamp

BATTERY NEGATIVE CABLE REPLACEMENT (LFX)

Removal Procedure

1. Disconnect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .



Battery Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

3. Open the battery fuse block cover (1) and remove the battery negative cable fastener (4).
4. Remove the battery negative cable terminal (2) attached to the battery fuse block stud (3).
5. Remove the battery negative cable ground fastener (6) and remove the battery negative cable terminal (5) from the wheel well.

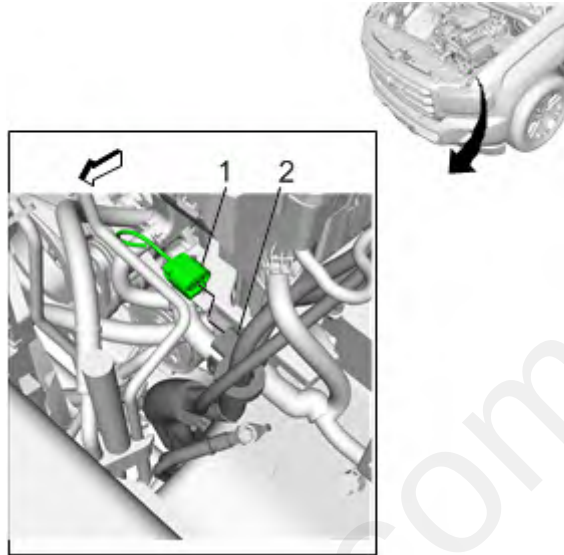


Fig. 5: Body Harness Connector And Battery Current Sensor

Courtesy of GENERAL MOTORS COMPANY

6. Disconnect the body harness connector (1) from the battery current sensor (2).
7. Detach the battery current sensor from the battery tray.
8. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

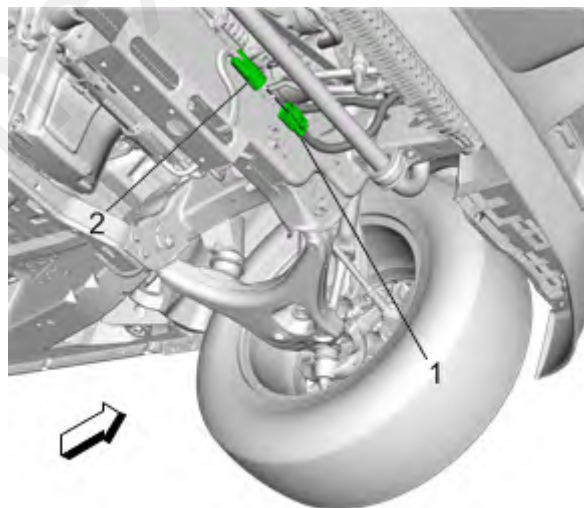


Fig. 6: Electronic Power Steering (EPS) Connector And Battery Negative Cable Connector

Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the electronic power steering (EPS) connector (2), from the battery negative cable connector (1), attached to the front frame crossmember.

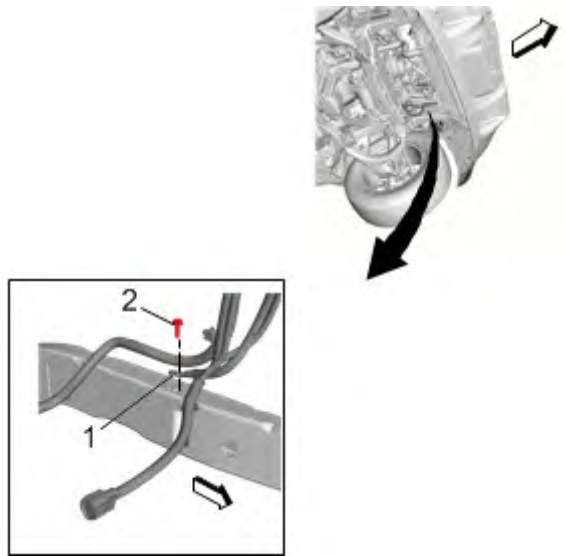


Fig. 7: Battery Negative Cable Frame Ground Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

10. Remove the battery negative cable frame ground fastener (2) and remove the battery negative cable terminal (1), from the chassis frame.
11. Remove the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
12. If equipped with 4WD, remove the electric belt drive rack and pinion steering gear. Refer to [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(4WD\)](#) [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(2WD\)](#) .
13. Remove the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#) .

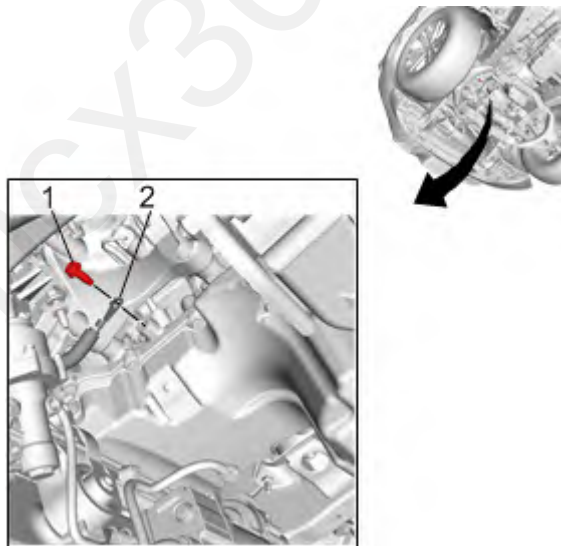


Fig. 8: Battery Negative Cable Engine Block Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

14. Remove the battery negative cable engine block fastener (1) and remove the battery negative cable terminal (2), from the engine block.
15. Lower the vehicle.



Fig. 9: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the routing of the battery negative cable within the engine compartment.

16. Remove the battery negative cable (1) from the engine compartment.

Installation Procedure



Fig. 10: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

1. Position the battery negative cable (1) into the engine compartment.

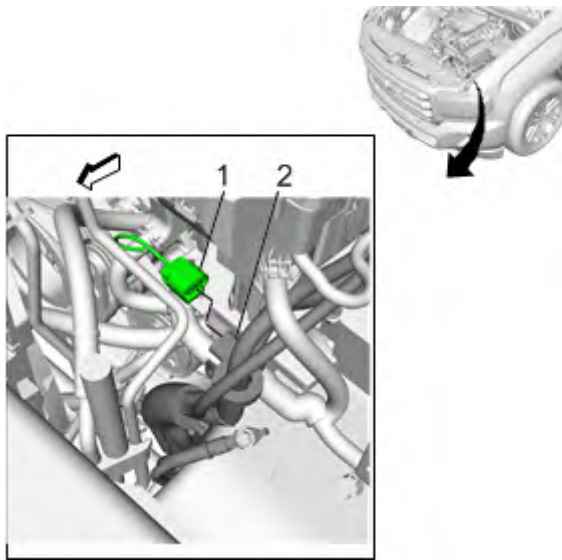


Fig. 11: Body Harness Connector And Battery Current Sensor
 Courtesy of GENERAL MOTORS COMPANY

2. Attach the battery current sensor (2) to the battery tray and connect the body harness connector (1).

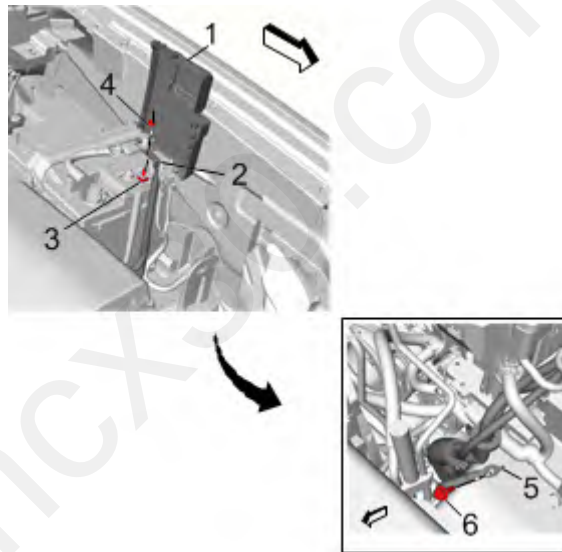


Fig. 12: Battery Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

3. Install the battery negative cable terminal (5) to the wheel well and tighten the fastener (6) to 22 N.m (16 lb ft).
4. Install the battery negative cable terminal (2) to the battery fuse block stud (3) and tighten the fastener (4) to 13 N.m (115 lb in).
5. Close the battery fuse block cover (1).
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

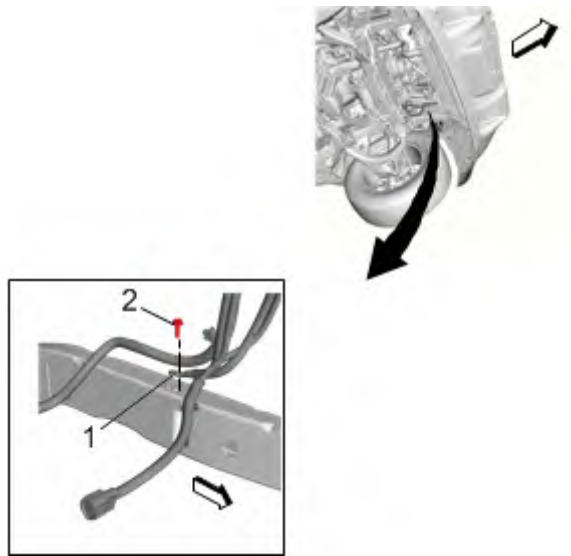


Fig. 13: Battery Negative Cable Frame Ground Fastener And Battery Negative Cable Terminal
 Courtesy of GENERAL MOTORS COMPANY

7. Install the battery negative cable terminal (1), to the chassis frame, and tighten the fastener (2) to 22 N.m (16 lb ft).

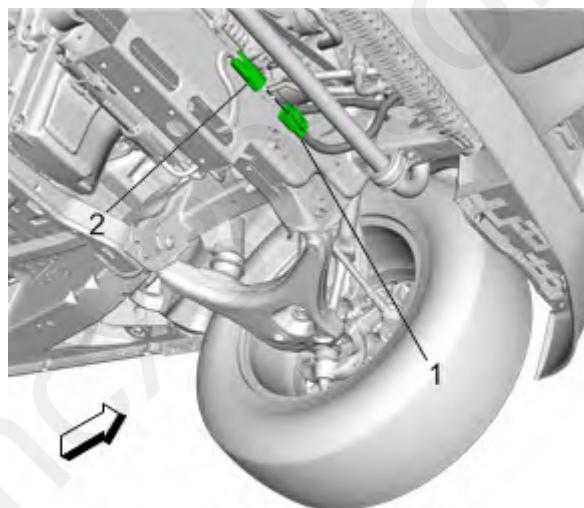


Fig. 14: Electronic Power Steering (EPS) Connector And Battery Negative Cable Connector
 Courtesy of GENERAL MOTORS COMPANY

8. Connect the EPS connector (2) to the battery negative cable connector (1) and attach to the front crossmember.

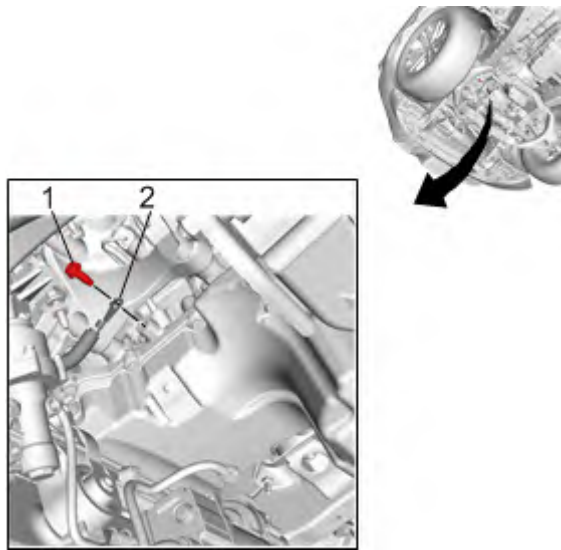


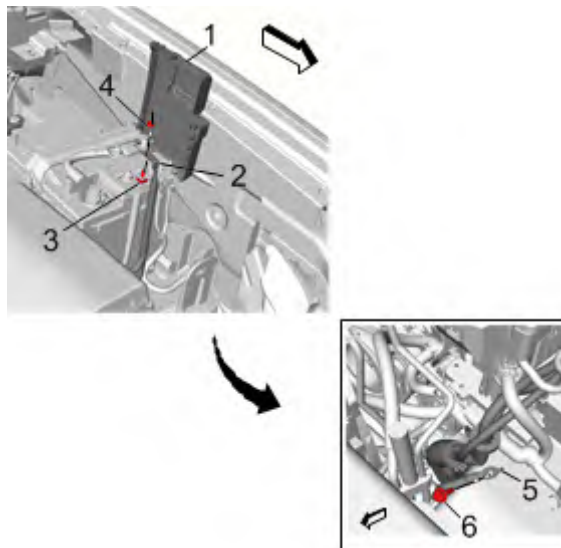
Fig. 15: Battery Negative Cable Engine Block Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

9. Install the battery negative cable terminal (2) to the engine block and tighten the fastener (1) to 58 N.m (43 lb ft).
10. Install the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#) .
11. If equipped with 4WD, install the electric belt drive rack and pinion steering gear. Refer to [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(4WD\)](#) [Electric Belt Drive Rack and Pinion Steering Gear Replacement \(2WD\)](#) .
12. Install the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
13. Lower the vehicle.
14. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
15. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

BATTERY NEGATIVE CABLE REPLACEMENT (LCV)

Removal Procedure

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



Battery Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

3. Open the battery fuse block cover (1) and remove the battery negative cable fastener (4).
4. Remove the battery negative cable terminal (2) attached to the battery fuse block stud (3).
5. Remove the battery negative cable ground fastener (6) and remove the battery negative cable terminal (5) from the wheel well.

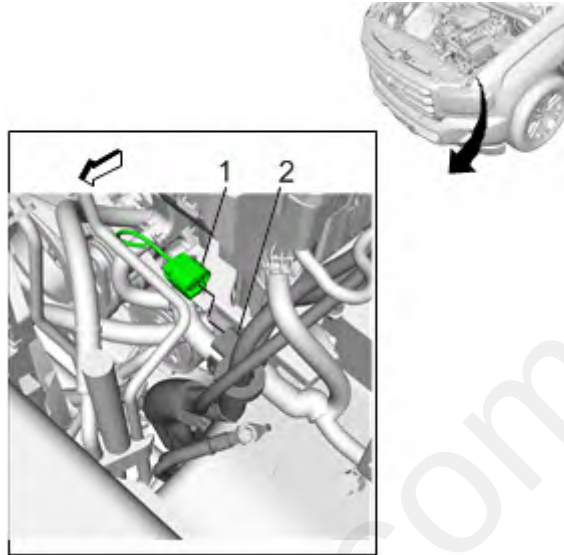


Fig. 17: Body Harness Connector And Battery Current Sensor

Courtesy of GENERAL MOTORS COMPANY

6. Detach the battery current sensor from the battery tray.
7. Disconnect the body harness connector (1) from the battery current sensor (2).
8. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

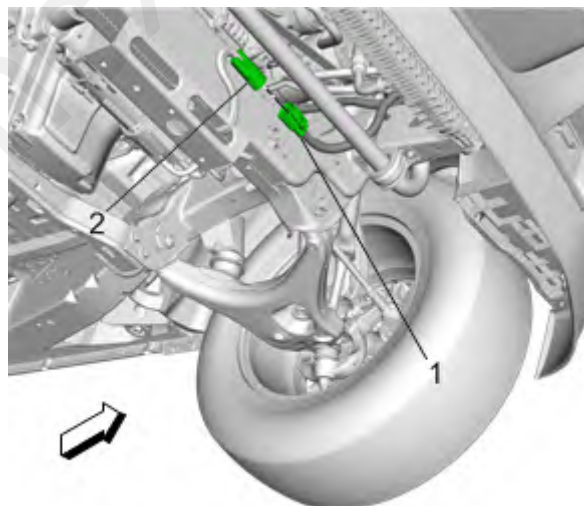


Fig. 18: Electronic Power Steering (EPS) Connector And Battery Negative Cable Connector

Courtesy of GENERAL MOTORS COMPANY

9. Disconnect the electronic power steering (EPS) connector (2), from the battery negative cable connector (1), attached to the front frame crossmember.

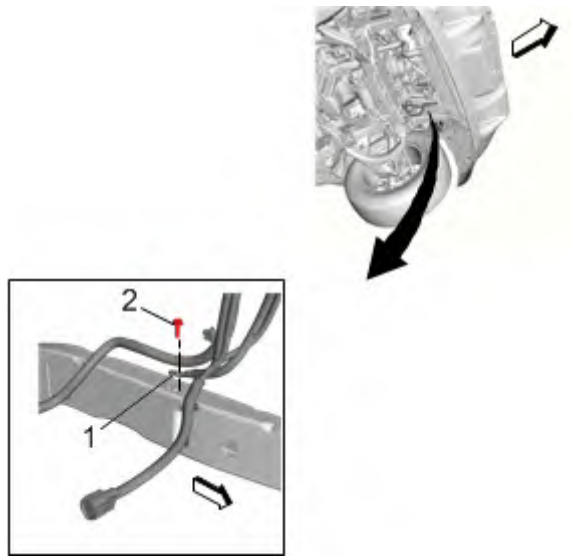


Fig. 19: Battery Negative Cable Frame Ground Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

10. Remove the battery negative cable frame ground fastener (2) and remove the battery negative cable terminal (1), from the chassis frame.
11. Remove the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .

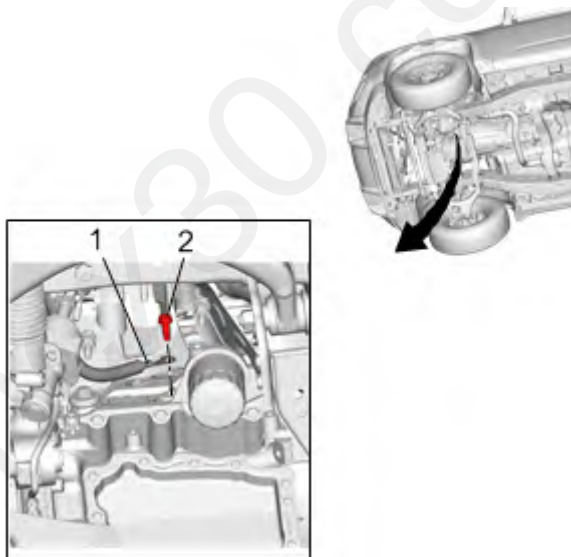


Fig. 20: Battery Negative Cable Engine Block Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

12. Remove the battery negative cable engine block fastener (1) and remove the battery negative cable terminal (2), from the engine block.
13. Lower the vehicle.



Fig. 21: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the routing of the battery negative cable within the engine compartment.

14. Remove the battery negative cable (1) from the engine compartment.

Installation Procedure



Fig. 22: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

1. Position the battery negative cable (1) into the engine compartment.

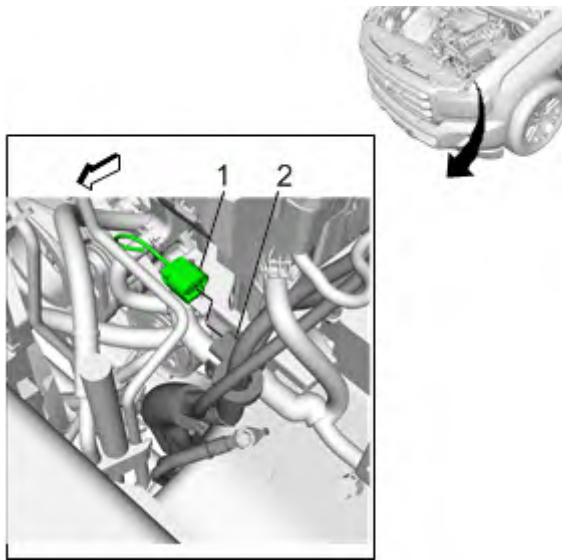


Fig. 23: Body Harness Connector And Battery Current Sensor
 Courtesy of GENERAL MOTORS COMPANY

2. Attach the battery current sensor (2) to the battery tray and connect the body harness connector (1).

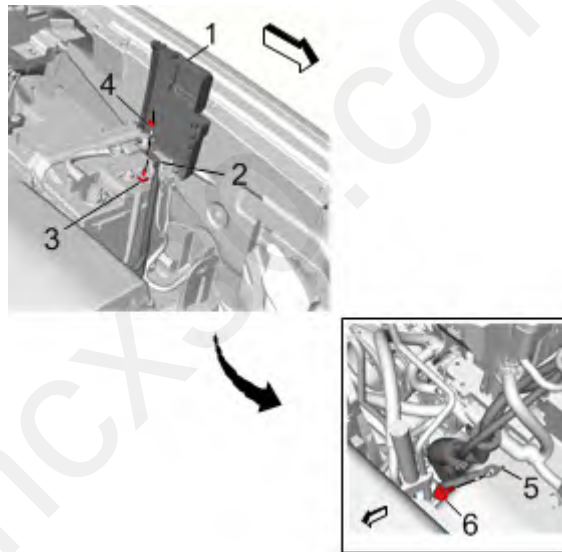


Fig. 24: Battery Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

3. Install the battery negative cable terminal (5) to the wheel well and tighten the fastener (6) to 22 N.m (16 lb ft).
4. Install the battery negative cable terminal (2) to the battery fuse block stud (3) and tighten the fastener (4) to 13 N.m (115 lb in).
5. Close the battery fuse block cover (1).
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

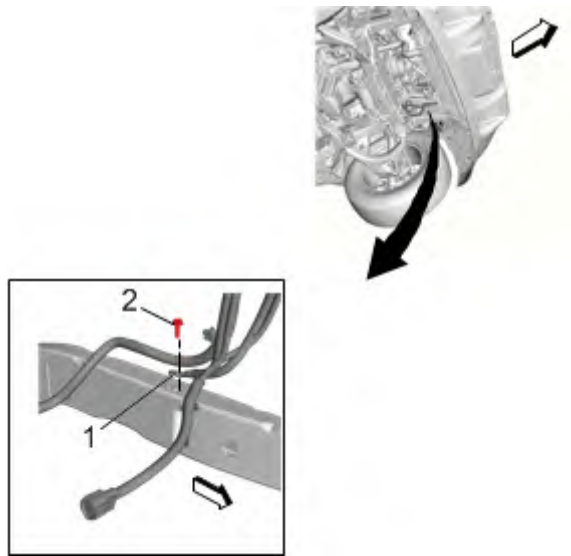


Fig. 25: Battery Negative Cable Frame Ground Fastener And Battery Negative Cable Terminal
 Courtesy of GENERAL MOTORS COMPANY

7. Install the battery negative cable terminal (1), to the chassis frame, and tighten the fastener (2) to 22 N.m (16 lb ft).

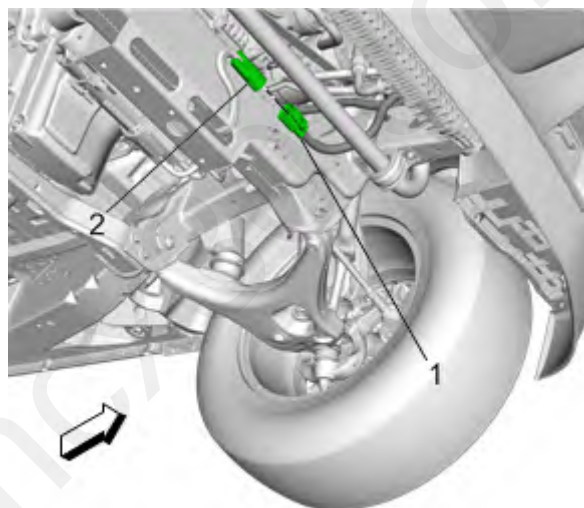


Fig. 26: Electronic Power Steering (EPS) Connector And Battery Negative Cable Connector
 Courtesy of GENERAL MOTORS COMPANY

8. Connect the EPS connector (2) to the battery negative cable connector (1) and attach to the front crossmember.

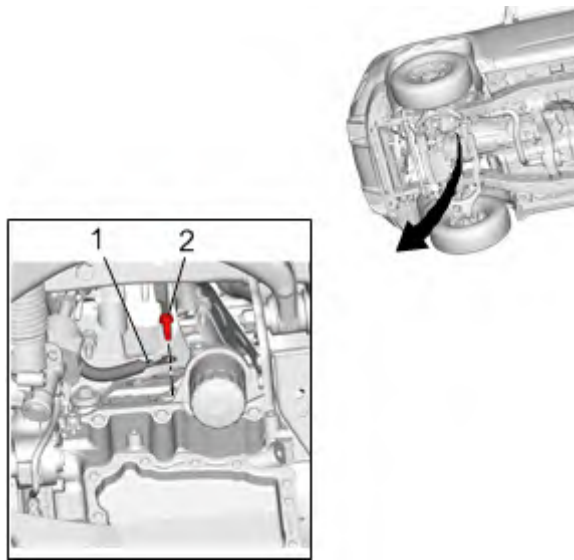


Fig. 27: Battery Negative Cable Engine Block Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

9. Install the battery negative cable terminal (2) to the engine block and tighten the fastener (1) to 58 N.m (43 lb ft).
10. Install the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
11. Lower the vehicle.
12. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

BATTERY NEGATIVE CABLE REPLACEMENT (LWN)

Removal Procedure

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

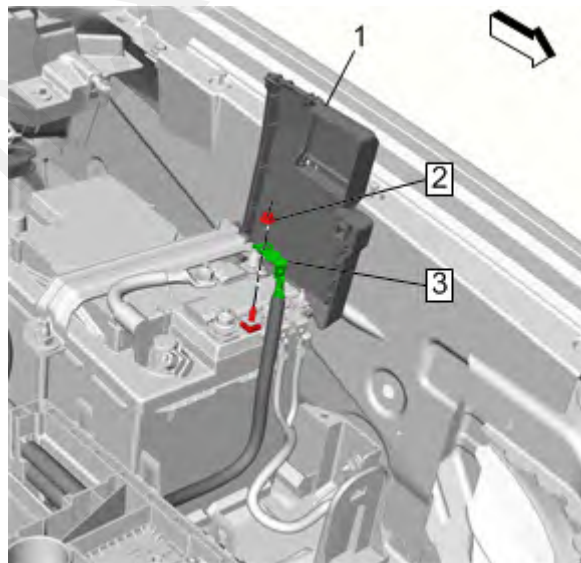


Fig. 28: Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

2. Open the fuse block cover (1).
3. Remove Battery Negative Cable Fastener (2).
4. Remove Battery Negative Cable (3).

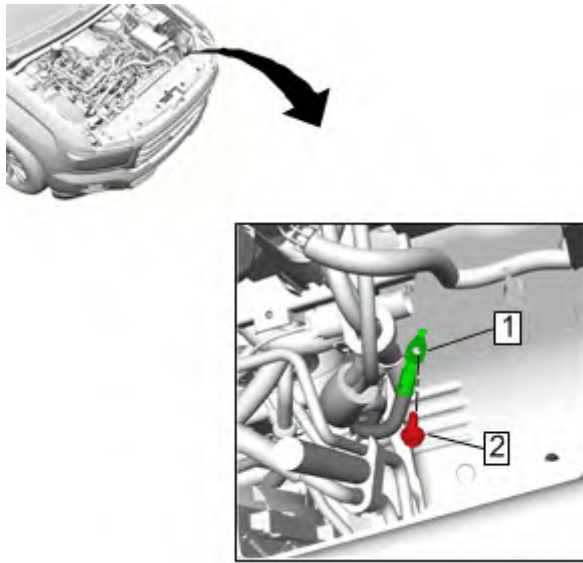


Fig. 29: Battery Negative Cable Ground Fastener
 Courtesy of GENERAL MOTORS COMPANY

5. Remove Battery Negative Cable Ground Fastener (2).
6. Remove Battery Negative Cable (1)

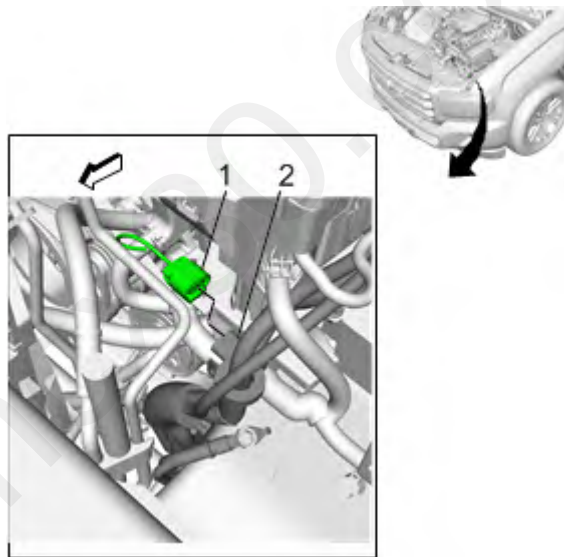


Fig. 30: Body Harness Connector And Battery Current Sensor
 Courtesy of GENERAL MOTORS COMPANY

7. Electrical Connector (1) Disconnect @Battery Current Sensor (2).
8. Detach the battery current sensor from the battery tray.
9. Raise and support the vehicle. **Lifting and Jacking the Vehicle** .
10. Remove Underbody Splash Shield. **Underbody Splash Shield Replacement** Â»Remove

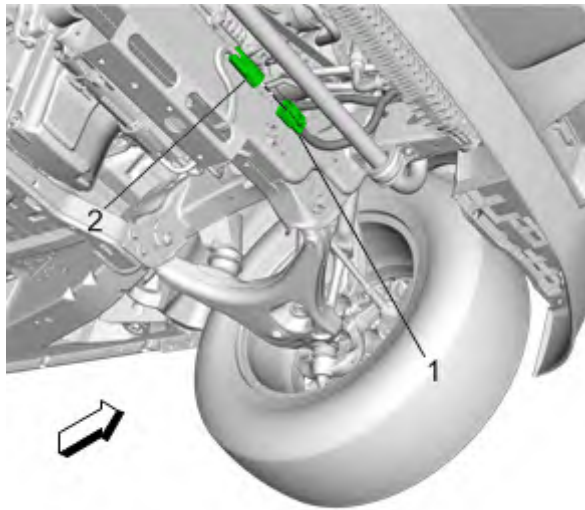


Fig. 31: Electronic Power Steering (EPS) Connector And Battery Negative Cable Connector
Courtesy of GENERAL MOTORS COMPANY

11. Disconnect the electronic power steering (EPS) connector (2), from the battery negative cable connector, attached to the front frame crossmember.



Fig. 32: Battery Negative Cable Frame Ground Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

12. Remove Battery Negative Cable Frame Ground Fastener (2).
13. Remove Battery Negative Cable (1).

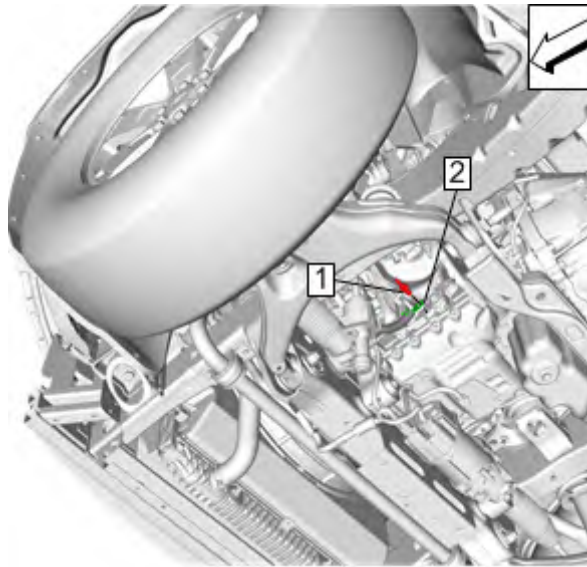


Fig. 33: Engine Ground Cable Stud

Courtesy of GENERAL MOTORS COMPANY

14. Remove Engine Ground Cable Stud (1).
15. Remove Battery Negative Cable (2).
16. Lower the vehicle.



Fig. 34: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the routing of the battery negative cable within the engine compartment.

17. Carefully remove the battery sensor along with the battery negative cable from the vehicle (1)

Installation Procedure



Fig. 35: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

1. Carefully install the battery sensor along with the battery negative cable to the vehicle (1).

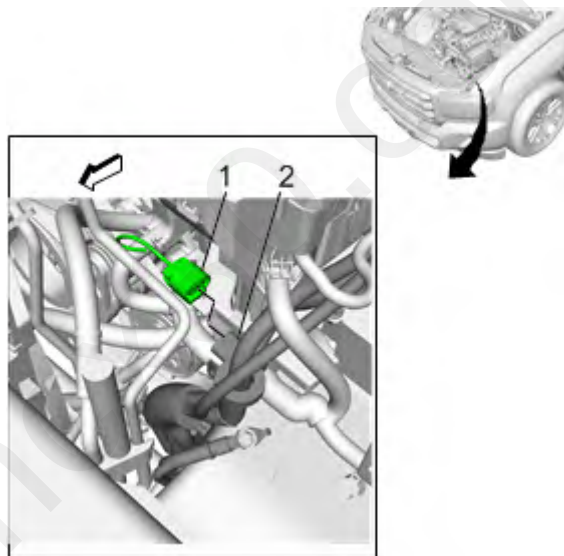


Fig. 36: Body Harness Connector And Battery Current Sensor

Courtesy of GENERAL MOTORS COMPANY

2. Connect Battery Current Sensor Connector (1).

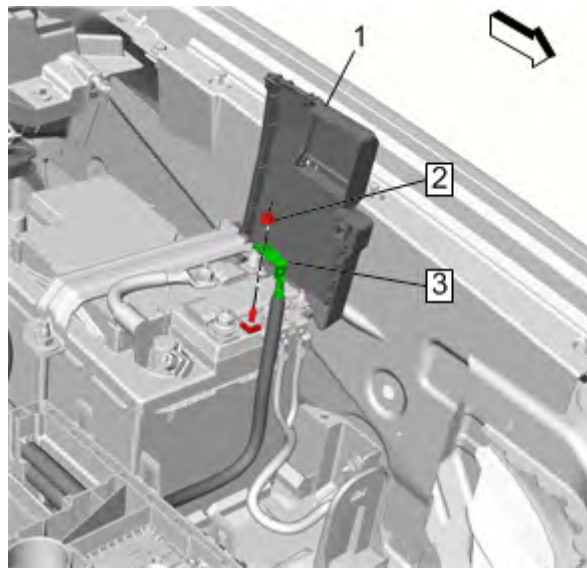


Fig. 37: Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

3. Install Battery Negative Cable (3)

CAUTION: Refer to [Fastener Caution](#)

4. Install Battery Negative Cable Fastener (2) and tighten 13 N.m (115 lb in)
5. Close the battery fuse block cover (1).

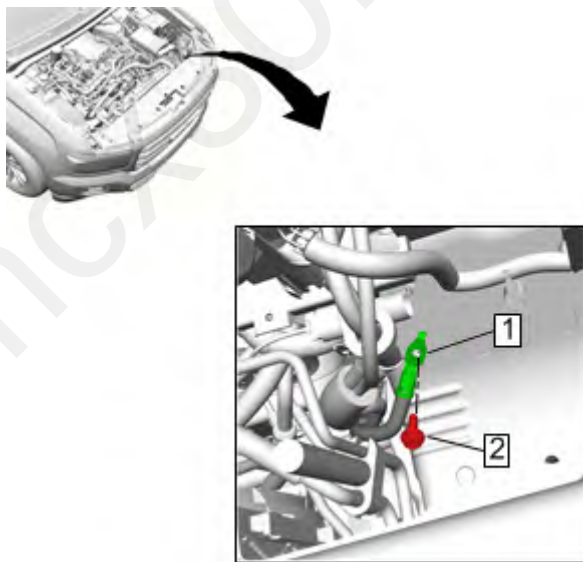


Fig. 38: Battery Negative Cable Ground Fastener

Courtesy of GENERAL MOTORS COMPANY

6. Install Battery Negative Cable (1).
7. Install Battery Negative Cable Ground Fastener (2) and tighten 22 N.m (16 lb ft)
8. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

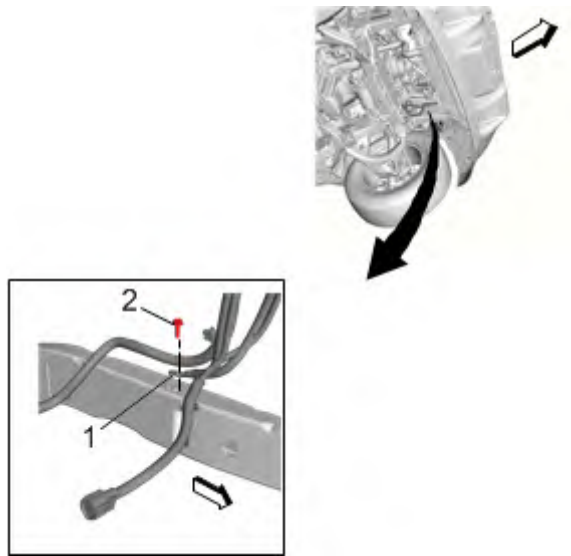


Fig. 39: Battery Negative Cable Frame Ground Fastener And Battery Negative Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

9. Install Battery Negative Cable (1).
10. Install Battery Negative Cable Frame Ground Fastener (2) and tighten 22 N.m (16 lb ft)

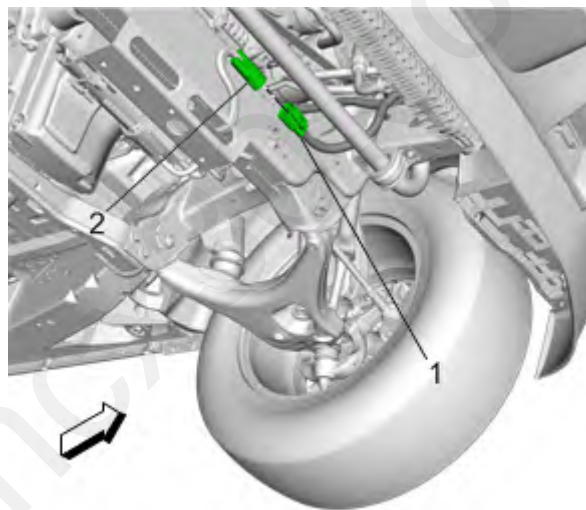


Fig. 40: Electronic Power Steering (EPS) Connector And Battery Negative Cable Connector
Courtesy of GENERAL MOTORS COMPANY

11. Connect the EPS connector (2) to the battery negative cable connector (1) and attach to the front crossmember.

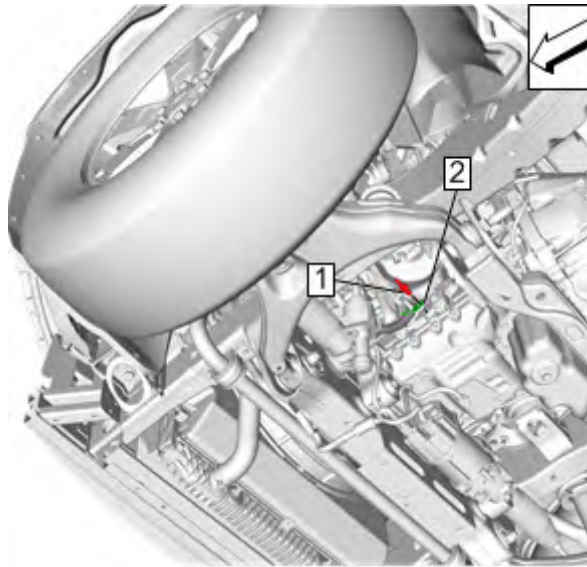


Fig. 41: Engine Ground Cable Stud

Courtesy of GENERAL MOTORS COMPANY

12. Battery Negative Cable (2).
13. Engine Ground Cable Stud (1) and tighten 58 N.m (43 lb ft)
14. Install Underbody Splash Shield. [Underbody Splash Shield Replacement](#)
15. Lower the vehicle.
16. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)

BATTERY POSITIVE CABLE REPLACEMENT (LCV)

Removal Procedure

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

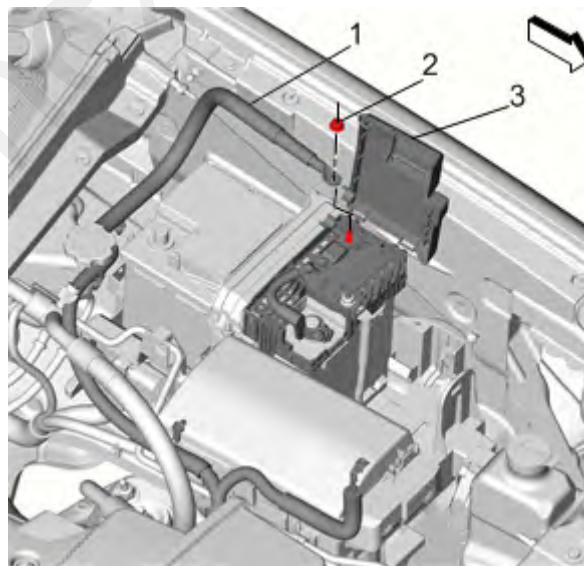


Fig. 42: Fuse Block Cover And Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

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

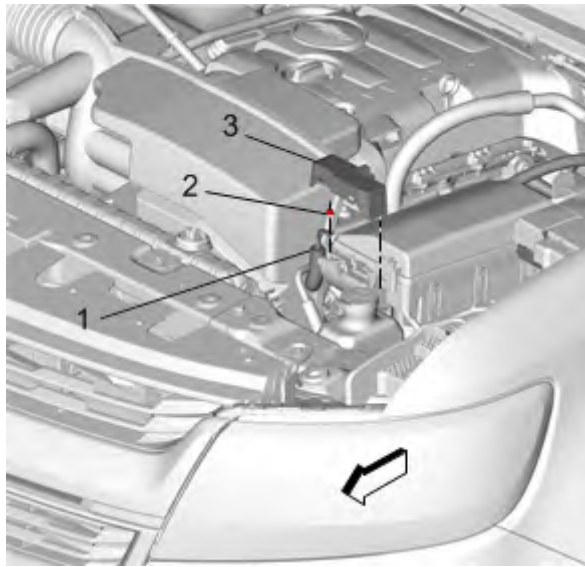


Fig. 43: Junction Block Cover And Battery Positive Cable Fastener
 Courtesy of GENERAL MOTORS COMPANY

4. Remove the junction block cover (3) and remove the battery positive cable fastener (2).
5. Remove the battery positive cable (1) from the junction block stud.
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
7. Remove the steering gear skid shield. Refer to [Steering Gear Skid Shield Replacement](#) .

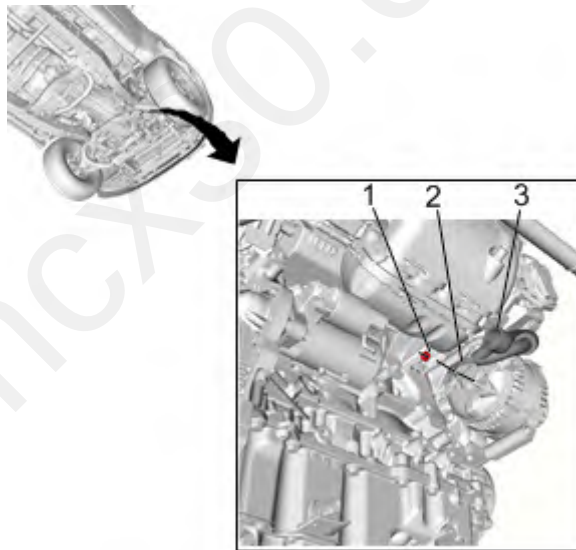


Fig. 44: Protective Boot And Battery Positive Cable Fastener
 Courtesy of GENERAL MOTORS COMPANY

8. Slide the protective boot (3) away from the generator stud and remove the battery positive cable fastener (1).
9. Remove the battery positive cable (2) from the generator stud.

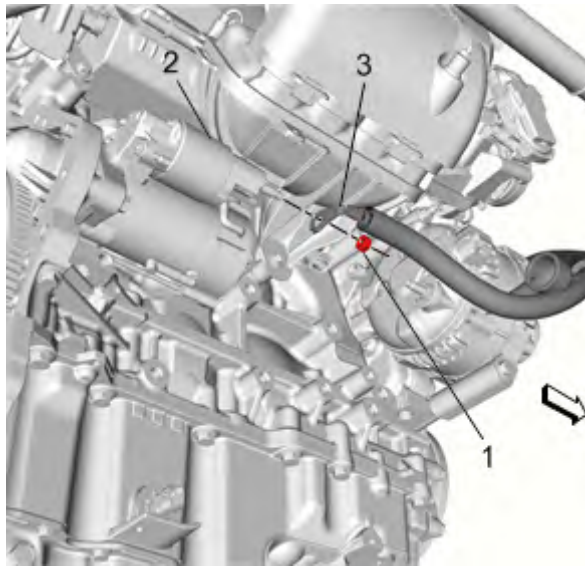


Fig. 45: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

10. Remove the battery positive cable fastener (1) and remove the battery positive cable (3) from the starter solenoid (2).
11. Lower the vehicle.

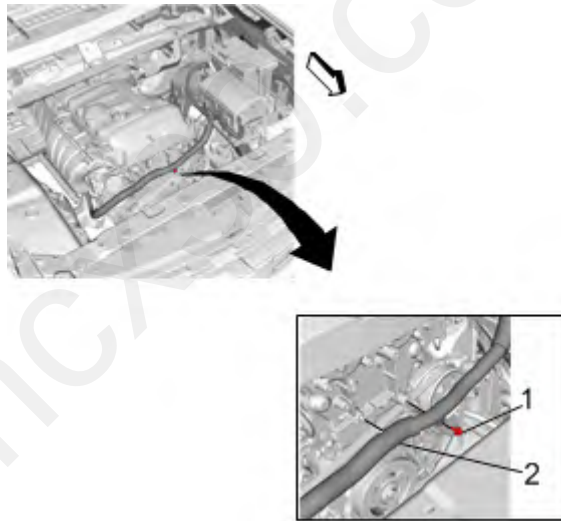


Fig. 46: Battery Positive Cable Retainer Fastener And Battery Positive Cable

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the routing of the battery positive cable within the engine compartment.

12. Remove the battery positive cable retainer fastener (1) and remove the battery positive cable (2) from the engine compartment.

Installation Procedure

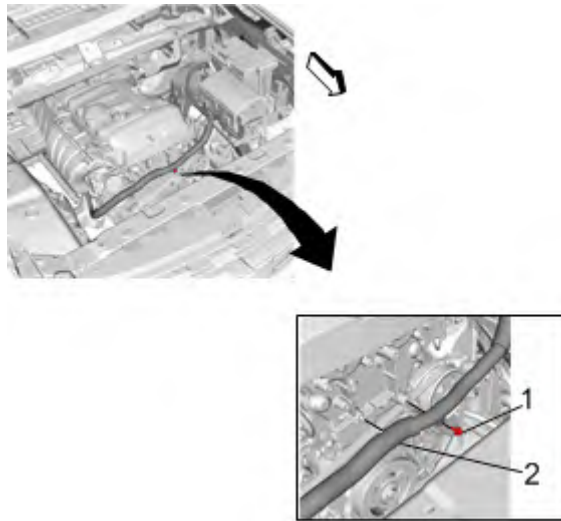


Fig. 47: Battery Positive Cable Retainer Fastener And Battery Positive Cable
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

1. Install the battery positive cable retainer (2) to the front engine block and tighten the fastener (1) to 10 N.m (89 lb in).

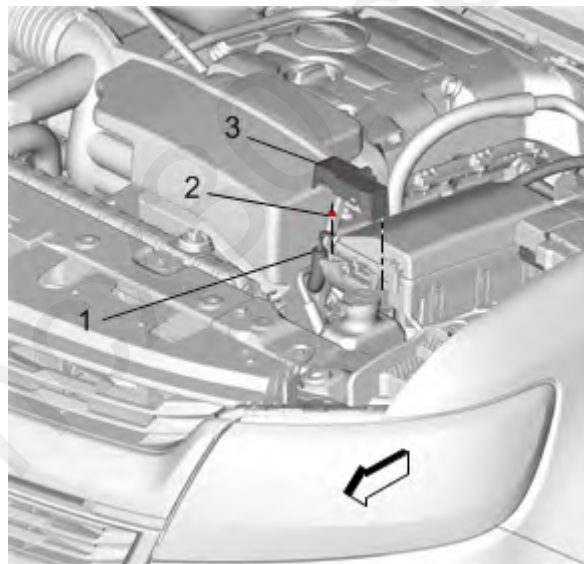


Fig. 48: Junction Block Cover And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Install the battery positive cable (1) to the junction block stud and tighten the fastener (2) to 13 N.m (115 lb in).
3. Install the junction block cover (3).

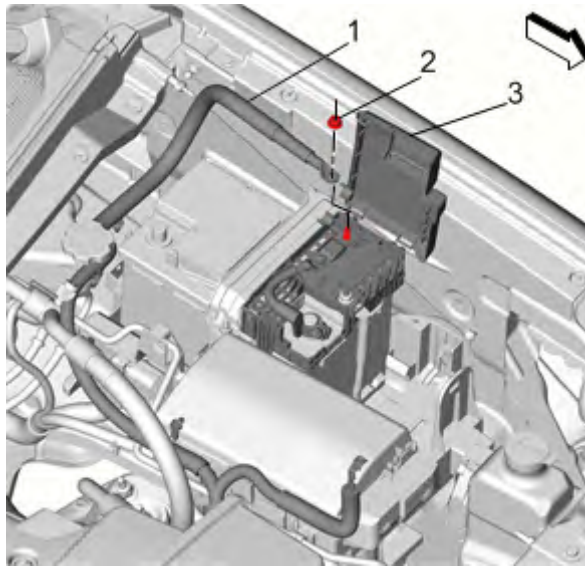


Fig. 49: Fuse Block Cover And Battery Positive Cable Fastener
 Courtesy of GENERAL MOTORS COMPANY

4. Route the battery positive cable (1) to the fuse block stud and tighten the fastener (2) to 15 N.m (11 lb ft).
5. Close the fuse block cover (3).
6. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

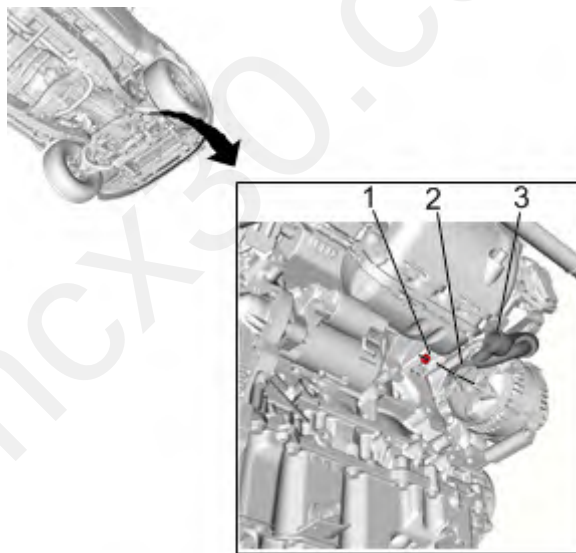


Fig. 50: Protective Boot And Battery Positive Cable Fastener
 Courtesy of GENERAL MOTORS COMPANY

7. Install the battery positive cable (2) to the generator stud and tighten the fastener (1) to 15 N.m (11 lb ft).
8. Slide the protective boot (3) onto the generator stud.

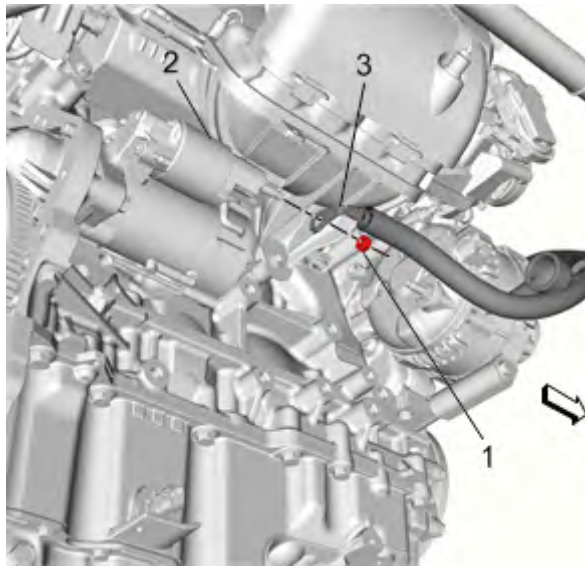


Fig. 51: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

9. Install the battery positive cable (3) to the starter solenoid (2) and tighten the fastener (1) to 13 N.m (115 lb in).
10. Install the steering gear skid shield. Refer to [Steering Gear Skid Shield Replacement](#).
11. Lower the vehicle.
12. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

BATTERY POSITIVE CABLE REPLACEMENT (LFX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).

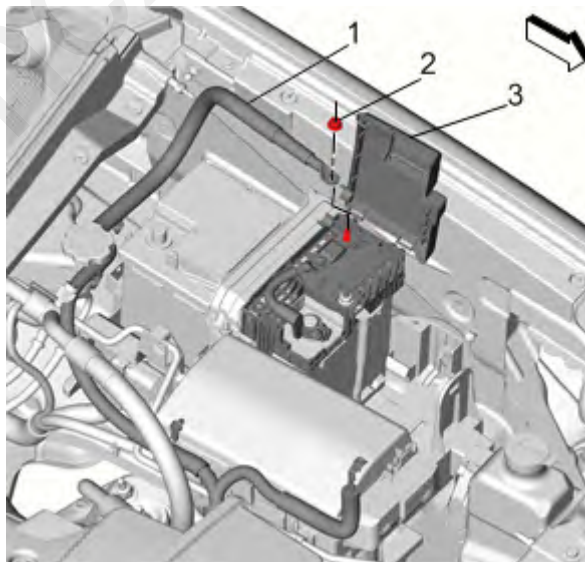


Fig. 52: Fuse Block Cover And Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

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

: the battery positive cable (1) from the fuse block.

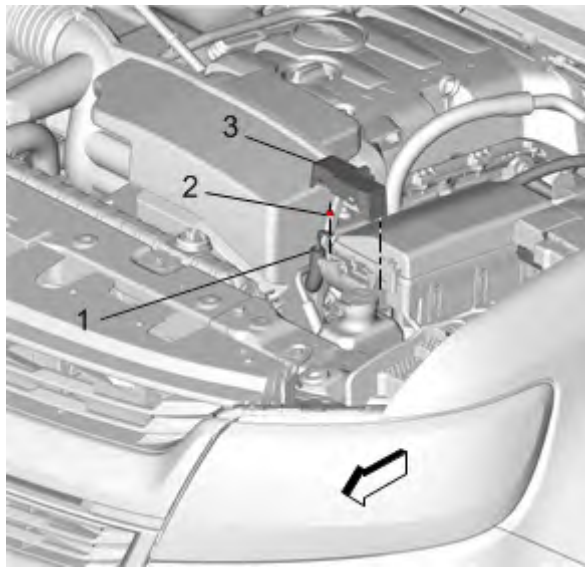


Fig. 53: Junction Block Cover And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Remove the junction block cover (3) and remove the battery positive cable fastener (2).
6. Remove the battery positive cable (1) from the junction block stud.

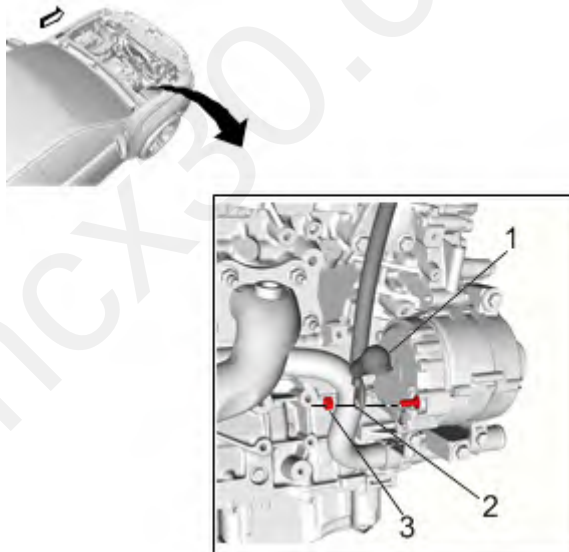


Fig. 54: Protective Boot And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Slide the protective boot (1) away from the generator stud and remove the battery positive cable fastener (3).
8. Remove the battery positive cable (2) from the generator stud.
9. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
10. Remove the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#) .

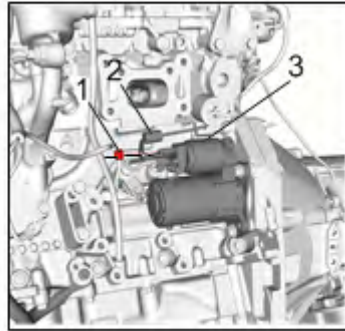
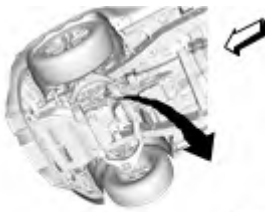


Fig. 55: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

11. Remove the battery positive cable fastener (1) and remove the battery positive cable (2) from the starter solenoid (3).
12. Lower the vehicle.

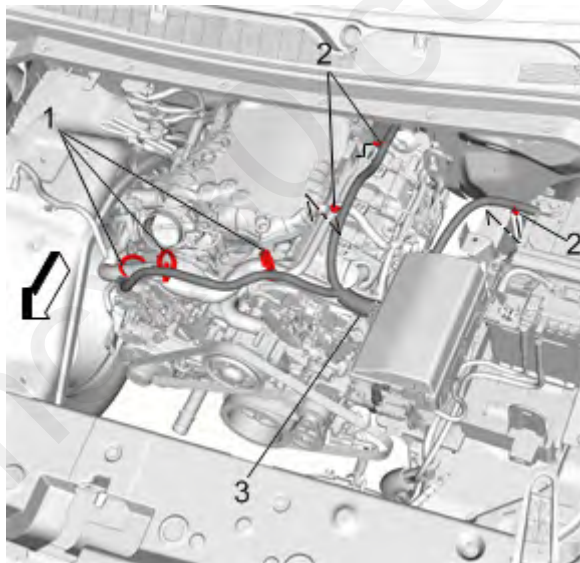


Fig. 56: Retaining Clips

Courtesy of GENERAL MOTORS COMPANY

13. Disconnect the retaining clips (1), securing the battery positive cable, to the engine harness.

NOTE: Note the routing of the battery positive cable within the engine compartment.

14. Disconnect the battery positive cable mounting retainers (2) and remove the battery positive cable (3) from the engine compartment.

Installation Procedure

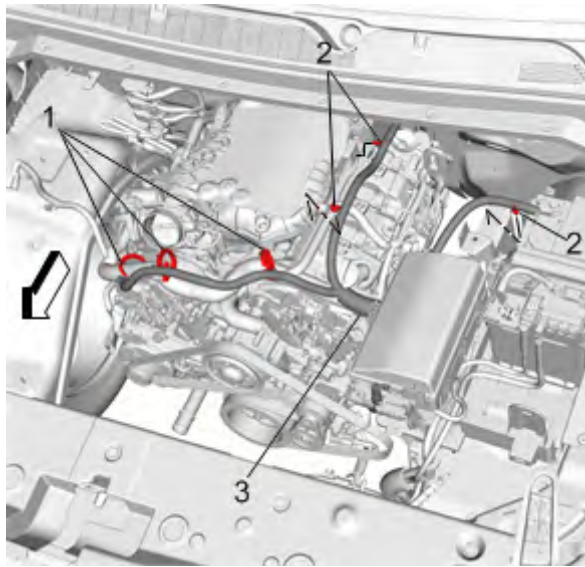


Fig. 57: Retaining Clips

Courtesy of GENERAL MOTORS COMPANY

1. Install the battery positive cable retainers (2) to the battery tray and intake manifold insulator.
2. Secure the battery positive cable (3) to the engine harness with the retainer clips (1).

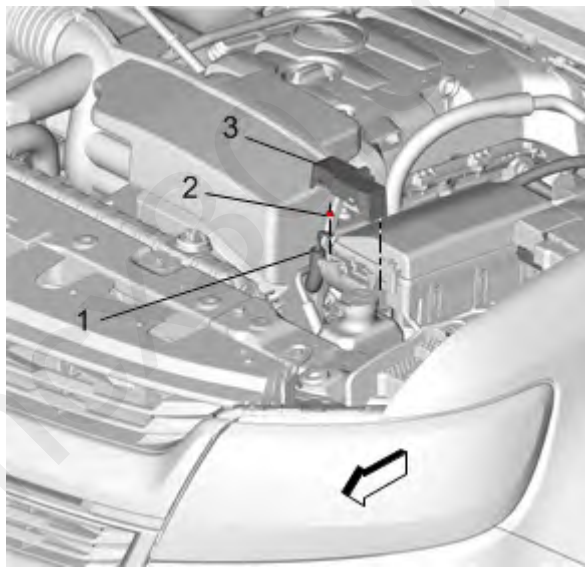


Fig. 58: Junction Block Cover And Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

3. Install the battery positive cable (1) to the junction block stud and tighten the fastener (2) to 13 N.m (115 lb in).
4. Install the junction block cover (3).

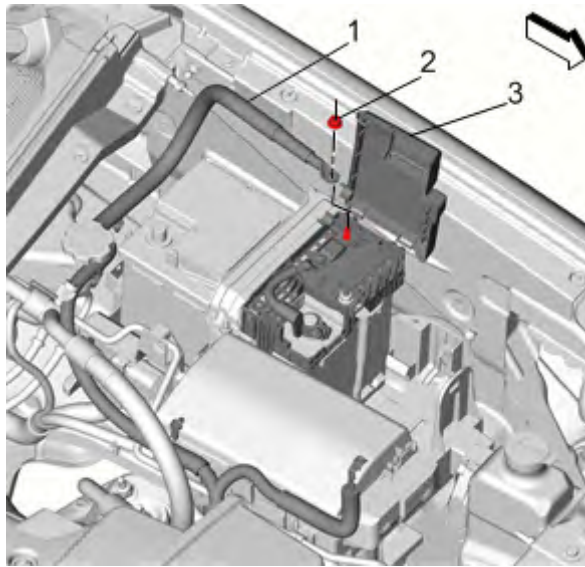


Fig. 59: Fuse Block Cover And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Route the battery positive cable (1) to the fuse block stud and tighten the fastener (2) to 4.7 N.m (42 lb in).

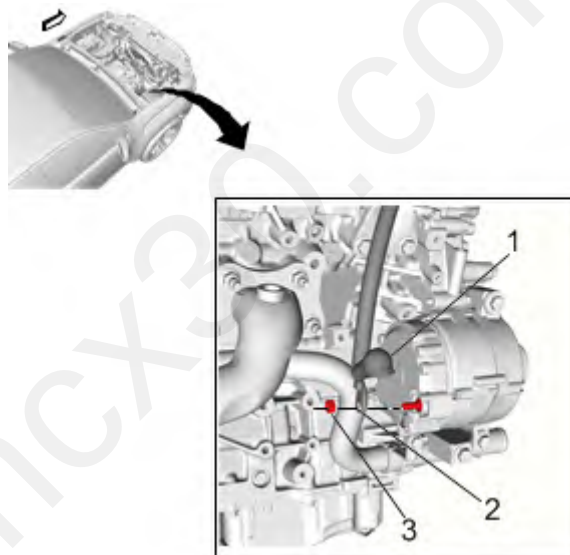


Fig. 60: Protective Boot And Battery Positive Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Install the battery positive cable (2) to the generator stud and tighten the fastener (3) to 15 N.m (11 lb ft).
7. Slide the protective boot (1) onto the generator stud.
8. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

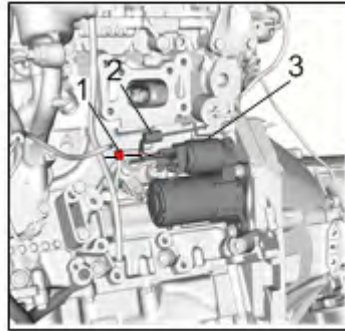
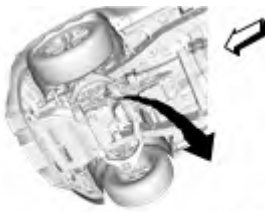


Fig. 61: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

9. Install the battery positive cable (2) to the starter solenoid (3) and tighten the fastener (1) to 13 N.m (115 lb in).
10. Install the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#).
11. Lower the vehicle.
12. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#).
13. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

BATTERY POSITIVE CABLE REPLACEMENT (LWN - GENERATOR)

Removal Procedure

1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)
2. Remove Charge Air Cooler Outlet Duct. [Charge Air Cooler Outlet Duct Replacement](#)

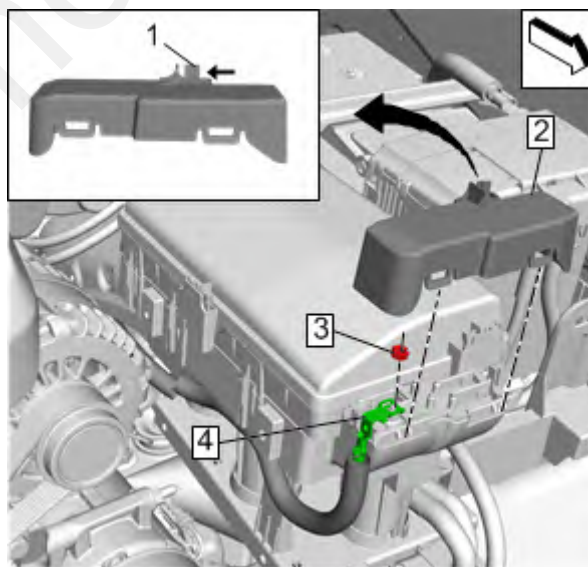


Fig. 62: Engine Wiring Harness Junction Block Cover Release Tab

Courtesy of GENERAL MOTORS COMPANY

3. Slide the engine wiring harness junction block cover release tab (1), in the direction shown.

: Engine Wiring Harness Junction Block Cover (2)

5. Remove Battery Positive Cable Nut (3)

6. Remove Battery Positive Cable (4)

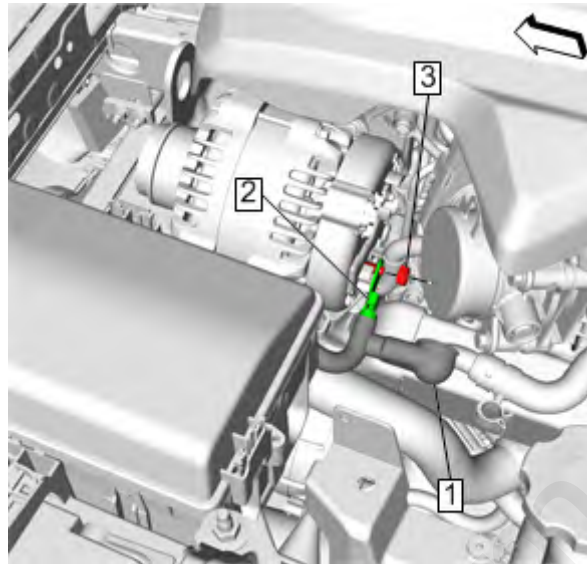


Fig. 63: Positive Battery Cable And Nut

Courtesy of GENERAL MOTORS COMPANY

7. Remove the positive battery cable protective cap from the generator terminal.(1)

8. Remove Battery Positive Cable Nut (3)

9. Remove Battery Positive Cable (2)

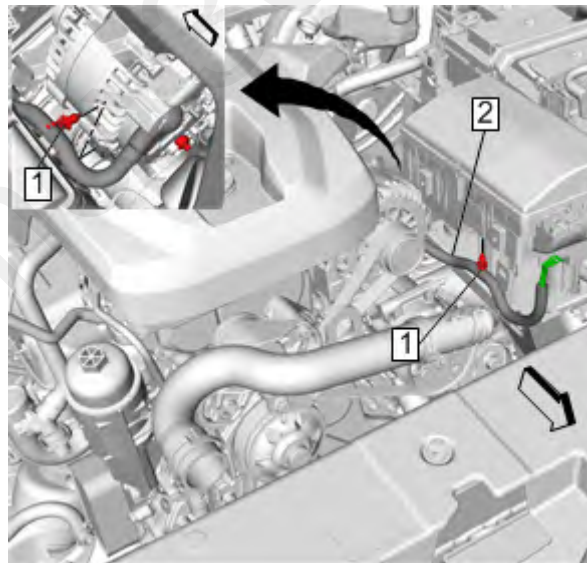


Fig. 64: Battery Positive Cable Retainer

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the routing of the battery positive cable within the engine compartment.

10. Disconnect Battery Positive Cable Retainer (1).

11. Remove the battery positive cable from the vehicle (2).

Installation Procedure

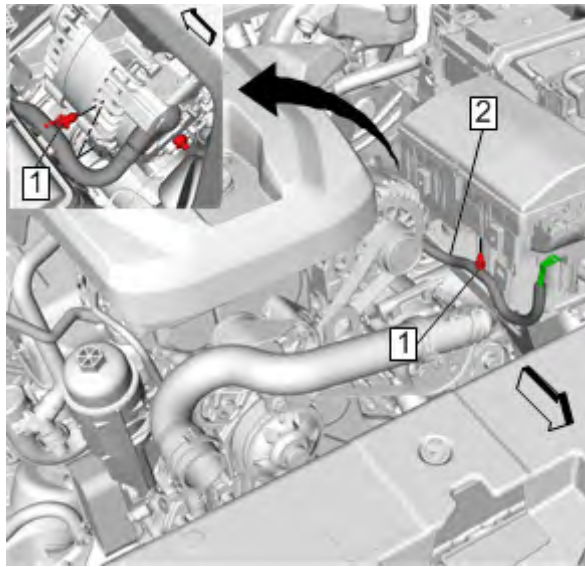


Fig. 65: Battery Positive Cable Retainer

Courtesy of GENERAL MOTORS COMPANY

1. Connect Battery Positive Cable Retainer (1).

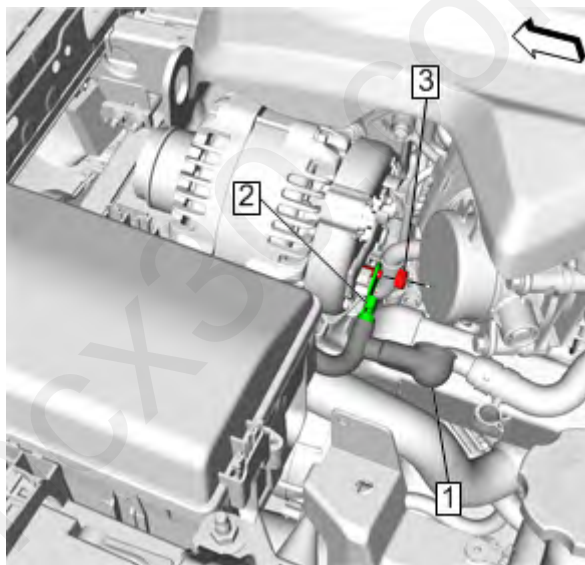


Fig. 66: Positive Battery Cable And Nut

Courtesy of GENERAL MOTORS COMPANY

2. Install Battery Positive Cable (2)

CAUTION: Refer to **Fastener Caution**

3. Install Battery Positive Cable Nut (3) and tighten 15 N.m (11 lb ft)
4. Install the positive battery cable protective cap to the generator terminal (1).

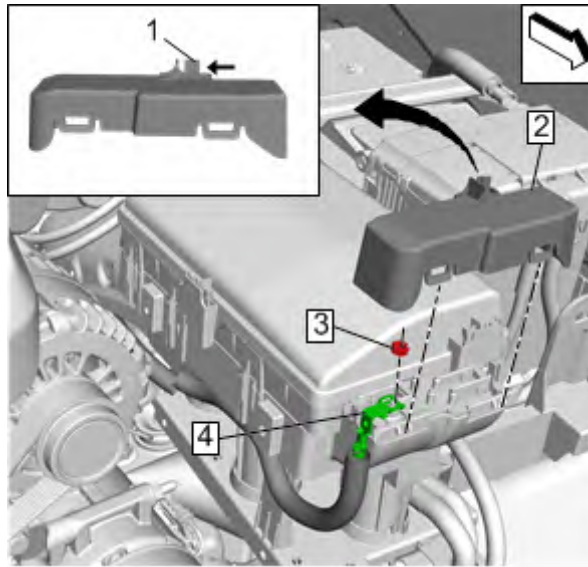


Fig. 67: Engine Wiring Harness Junction Block Cover Release Tab
 Courtesy of GENERAL MOTORS COMPANY

5. Install Battery Positive Cable (4)
6. Install Battery Positive Cable Nut (3) Install and tighten 13 N.m (115 lb in)
7. Install Engine Wiring Harness Junction Block Cover (2).
8. Install [Charge Air Cooler Outlet Duct Replacement](#) .
9. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)

ENGINE WIRING HARNESS FUSE BLOCK COVER REPLACEMENT

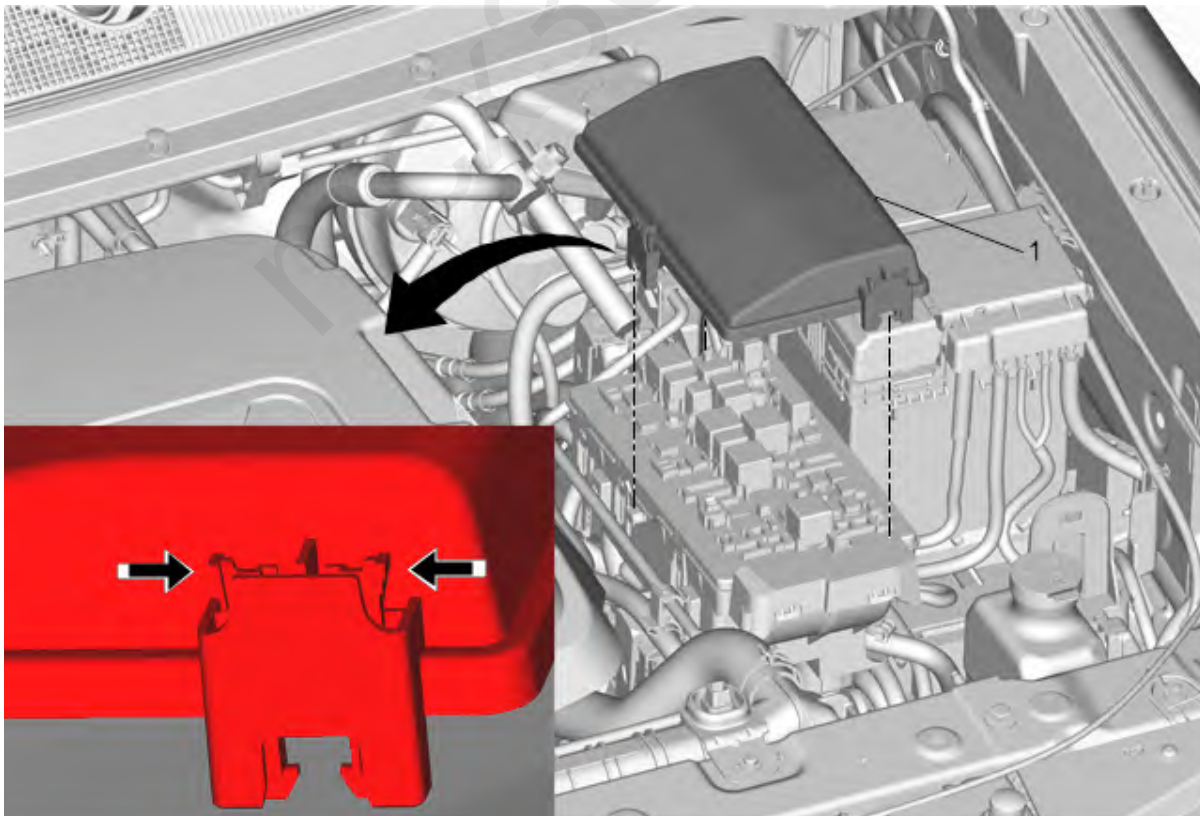


Fig. 68: Engine Wiring Harness Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	Engine Wiring Harness Fuse Block Cover Procedure Squeeze the 3 tabs arrows to release cover.

ENGINE WIRING HARNESS FUSE BLOCK BRACKET REPLACEMENT

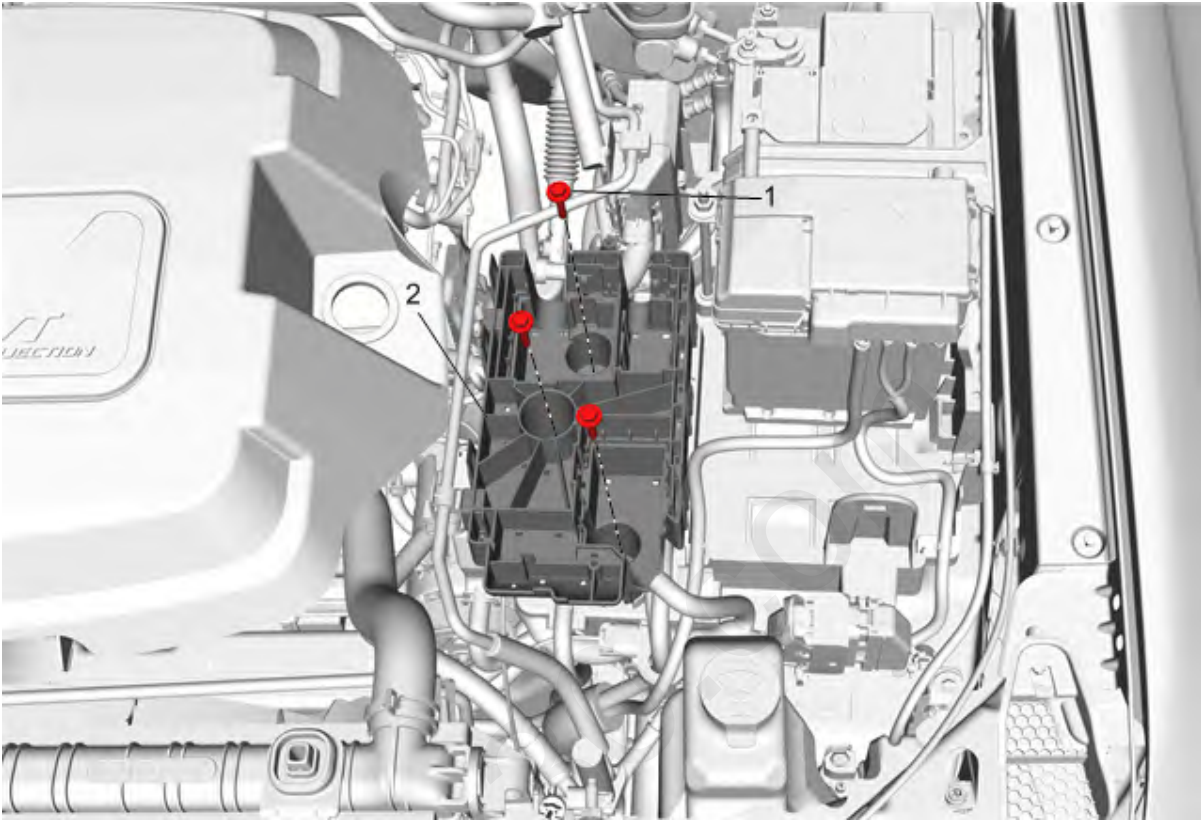


Fig. 69: Engine Wiring Harness Fuse Block Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Remove the engine wiring harness junction block. Refer to Engine Wiring Harness Junction Block Replacement .	
1	Engine Wiring Harness Fuse Block Bracket Screws (Qty: 3) CAUTION: Refer to Fastener Caution . Tighten 7 N.m (62 lb in)
2	Engine Wiring Harness Fuse Block Bracket Procedure Disconnect and unclip all necessary electrical components from the battery tray.

ENGINE WIRING HARNESS JUNCTION BLOCK REPLACEMENT

Removal Procedure

- ect 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 engine wiring harness block cover. Refer to [Engine Wiring Harness Fuse Block Cover Replacement](#)

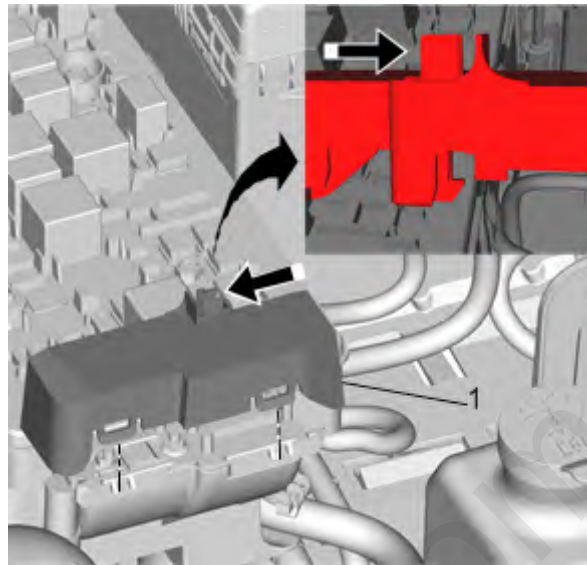


Fig. 70: Lifting 2 Tab On Cover Upward
Courtesy of GENERAL MOTORS COMPANY

4. Push the upper latch to the right (arrow, insert is opposite) and lift the 2 tab on the cover (1) upward and remove cover.

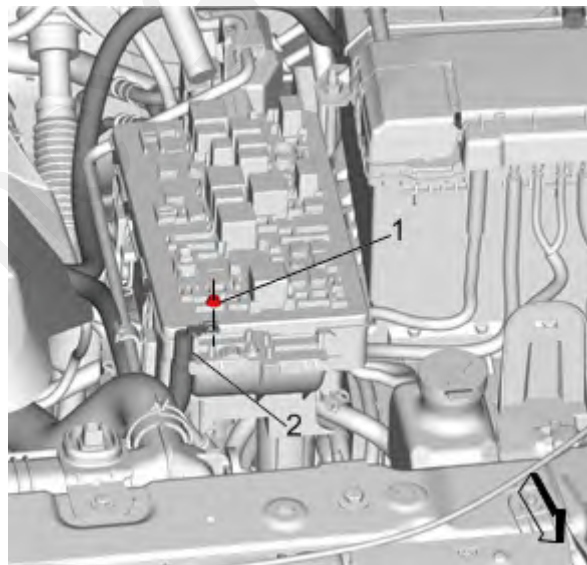


Fig. 71: Starter Generator Cable Nut
Courtesy of GENERAL MOTORS COMPANY

5. Remove the starter generator cable nut (1) and remove the starter generator cable (2) from the block.

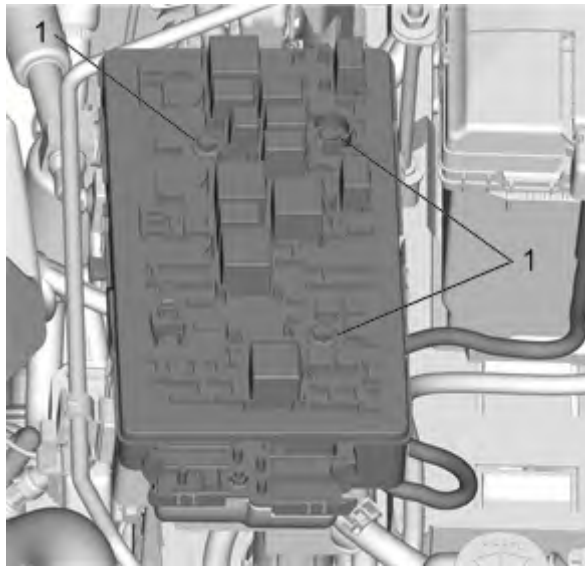


Fig. 72: Fuse Block Bolts

Courtesy of GENERAL MOTORS COMPANY

6. Loosen the fuse block bolts (1), the bolts may not be removable from fuse block.

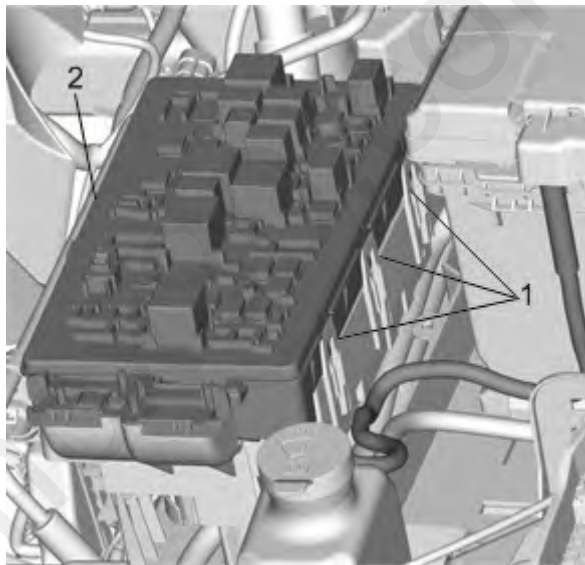


Fig. 73: Retainer Tabs And Fuse Block

Courtesy of GENERAL MOTORS COMPANY

7. Release the 6 retainer tabs (1) from the fuse block (2).

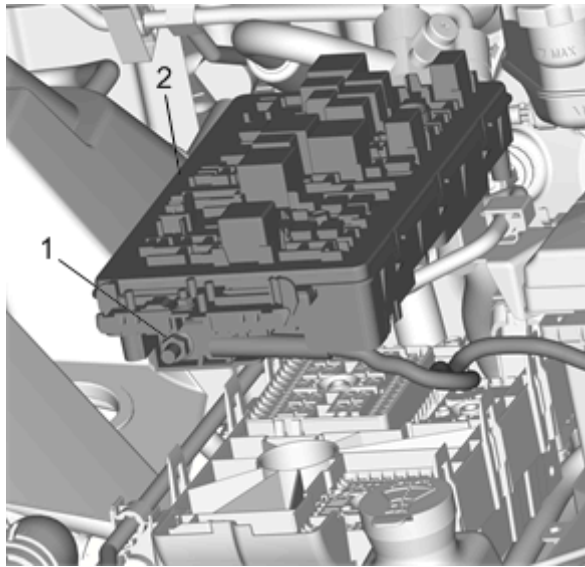


Fig. 74: Fuse Block

Courtesy of GENERAL MOTORS COMPANY

8. Pull the fuse block (2) up with a light shaking motion, far enough to expose the cable nut (1) and cable from the battery. Remove the nut (1) and set aside the cable. Remove the engine wiring harness junction block.

Installation Procedure

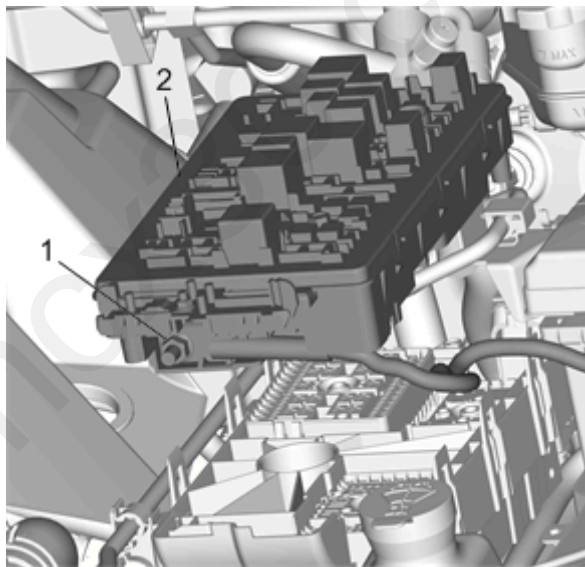


Fig. 75: Fuse Block

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

1. Position the fuse block housing (2) to the vehicle. Install the cable and cable nut (1) to the fuse block (2). Tighten cable nut to 9 N.m (80 lb in).

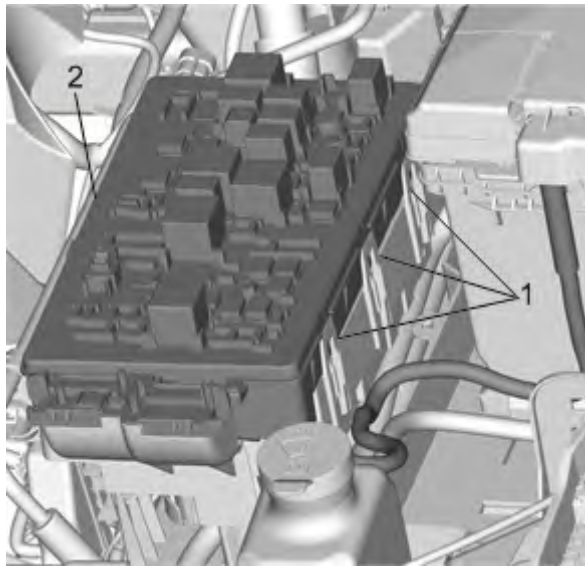


Fig. 76: Retainer Tabs And Fuse Block

Courtesy of GENERAL MOTORS COMPANY

2. Install the fuse block (2) to the bracket and secure the 6 retainer tabs (1).

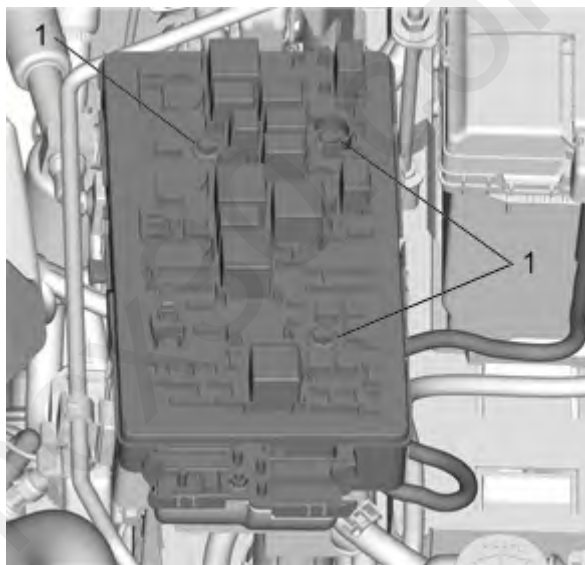


Fig. 77: Fuse Block Bolts

Courtesy of GENERAL MOTORS COMPANY

3. Install the fuse block bolts (1). Tighten bolts to 9 N.m (80 lb in)

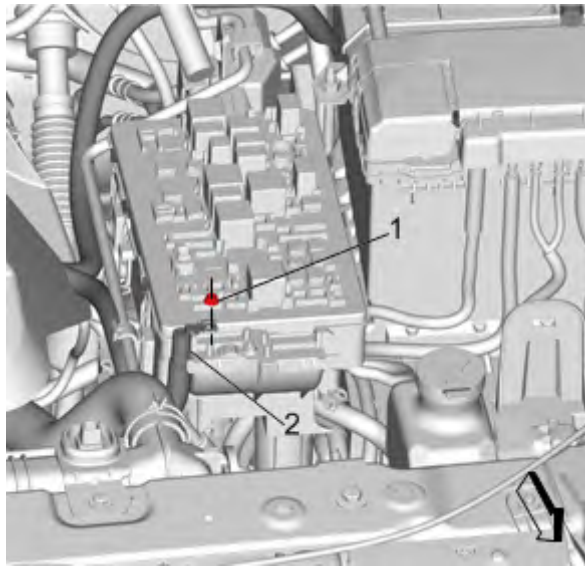


Fig. 78: Starter Generator Cable Nut
 Courtesy of GENERAL MOTORS COMPANY

4. Install the starter generator cable (2), install the starter generator cable nut (1). Tighten cable nut to 9 N.m (80 lb in)

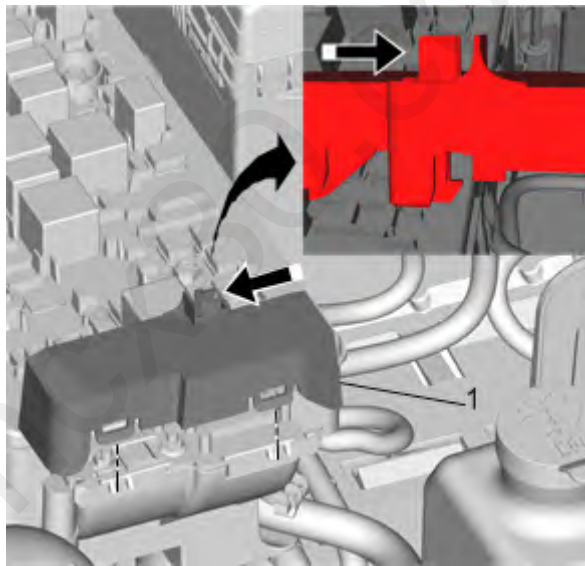


Fig. 79: Lifting 2 Tab On Cover Upward
 Courtesy of GENERAL MOTORS COMPANY

5. Push the upper latch to the right (arrow) and install the cover (1) to the block, insuring the 2 tab on the cover are secure.
6. Install the engine wiring harness block cover. Refer to [Engine Wiring Harness Fuse Block Cover Replacement](#)
7. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
8. Install the front compartment front sight shield. Refer to [Front Compartment Front Sight Shield Replacement](#).

STARTER SOLENOID CABLE REPLACEMENT (LWN)

Removal Procedure

ect the negative battery cable. **Battery Negative Cable Disconnection and Connection**

2. Raise and support the vehicle. **Lifting and Jacking the Vehicle**

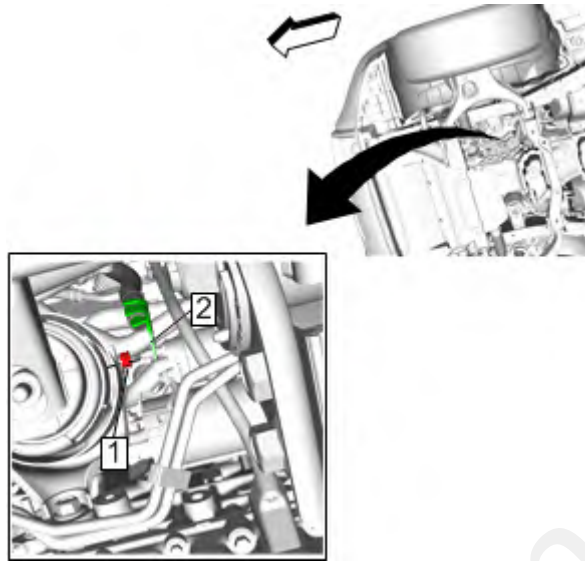


Fig. 80: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

3. Remove Starter Solenoid Cable Nut (1)
4. Remove Starter Solenoid Cable (2)
5. Lower the vehicle.

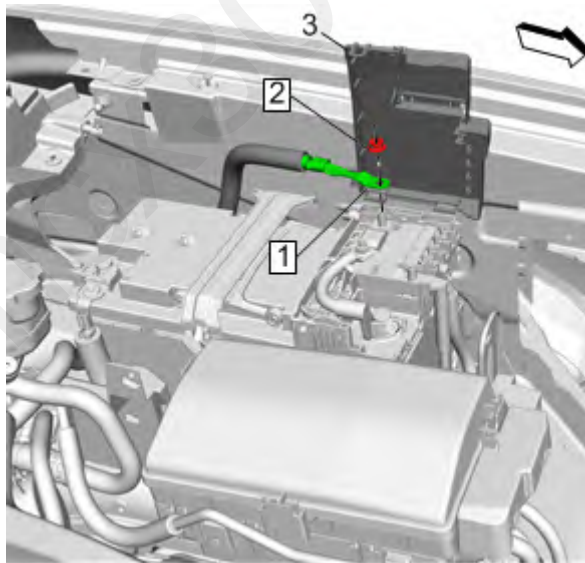


Fig. 81: Battery Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

6. Open the battery fuse block cover (3).
7. Remove Starter Solenoid Cable Nut (2).
8. Remove Starter Solenoid Cable (1).

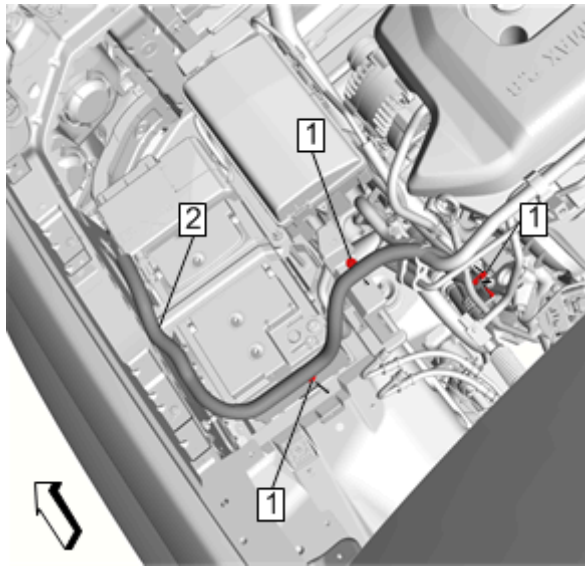


Fig. 82: Starter Solenoid Cable Retainer

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the routing of the starter cable within the engine compartment.

9. Disconnect Starter Solenoid Cable Retainer (1)
10. Remove Starter Solenoid Cable (2)

Installation Procedure

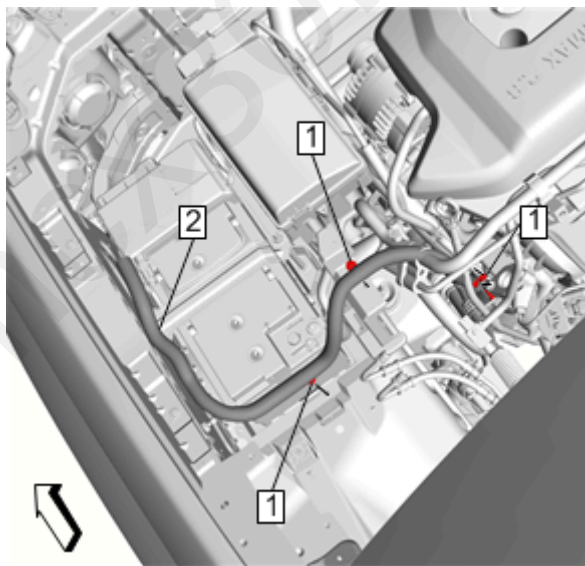


Fig. 83: Starter Solenoid Cable Retainer

Courtesy of GENERAL MOTORS COMPANY

1. Connect Starter Solenoid Cable Retainer (1).

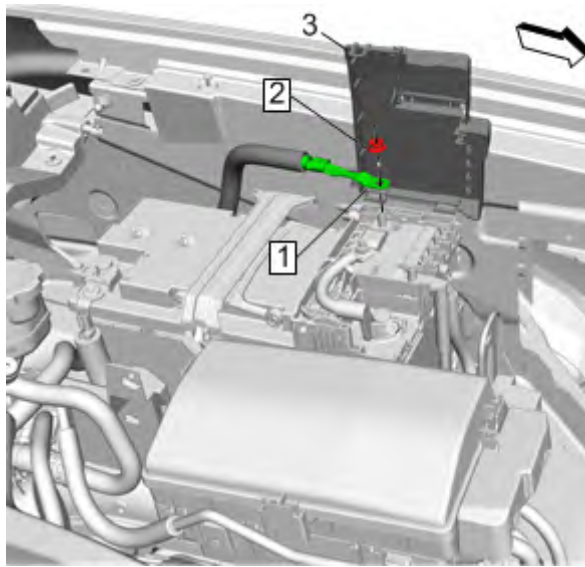


Fig. 84: Battery Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

2. Install Starter Solenoid Cable (1)

CAUTION: Refer to [Fastener Caution](#)

3. Install Starter Solenoid Cable Nut (2) and tighten 15 N.m (11 lb ft)
4. Close the battery fuse block cover (3).
5. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

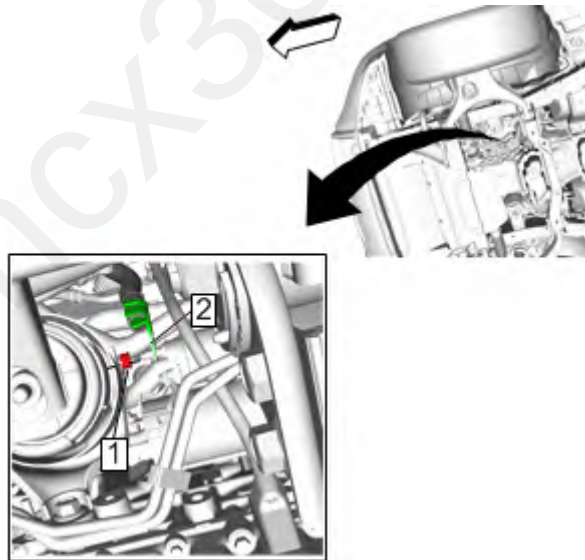


Fig. 85: Starter Solenoid Cable Nut And Cable

Courtesy of GENERAL MOTORS COMPANY

6. Install Starter Solenoid Cable (2)
7. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)
8. Lower the vehicle.
9. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)

BATTERY REPLACEMENT

dure

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

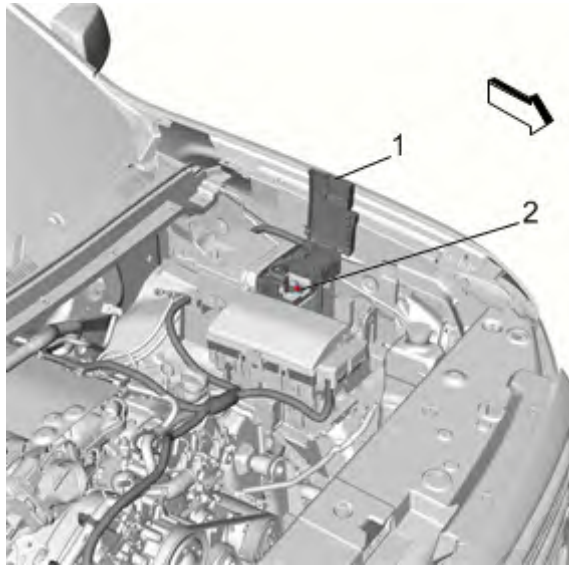


Fig. 86: Battery Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

2. Open the battery fuse block cover (1) and loosen the battery positive cable clamp fastener (2).

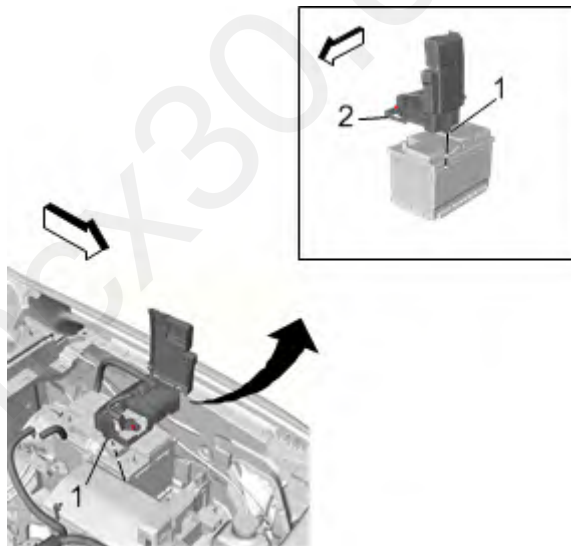


Fig. 87: Battery Fuse Block Retaining Tabs

Courtesy of GENERAL MOTORS COMPANY

3. Release the battery fuse block retaining tabs (1) and set aside the battery fuse block (2).

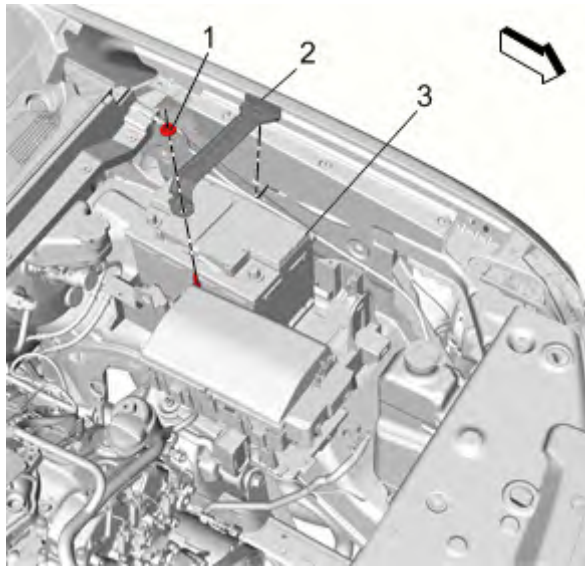


Fig. 88: Battery Retainer Fastener And Battery Retainer Brace
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery retainer fastener (1) and remove the battery retainer brace (2) from the battery (3).

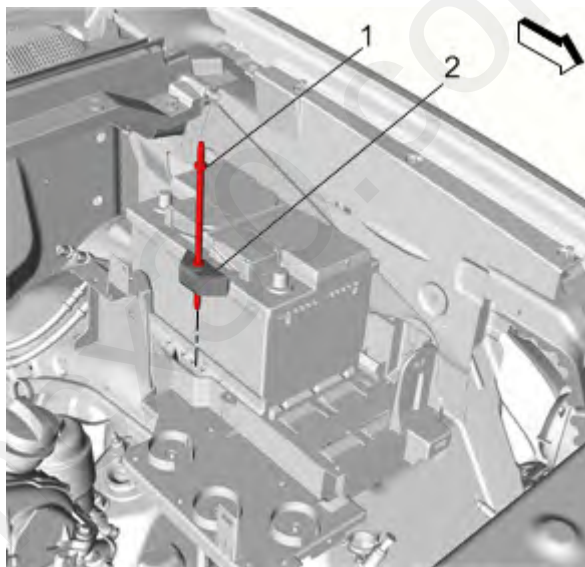


Fig. 89: Battery Hold Down Retainer Rod And Battery Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Remove the battery hold down retainer rod (1) and the battery retainer (2).

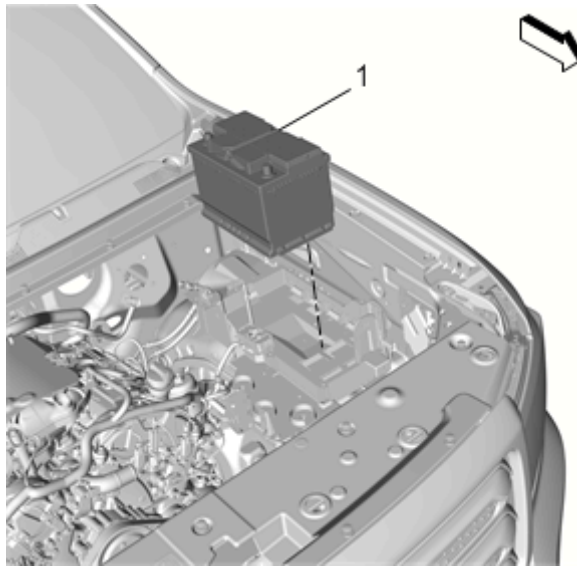


Fig. 90: Battery

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

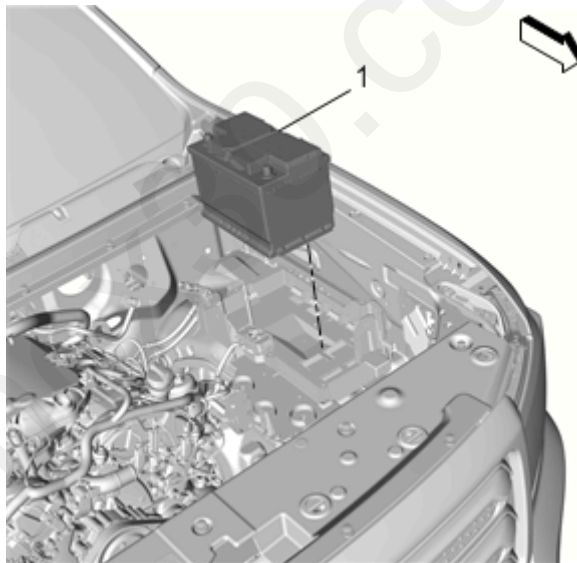


Fig. 91: Battery

Courtesy of GENERAL MOTORS COMPANY

1. Position the battery (1) onto the battery tray.

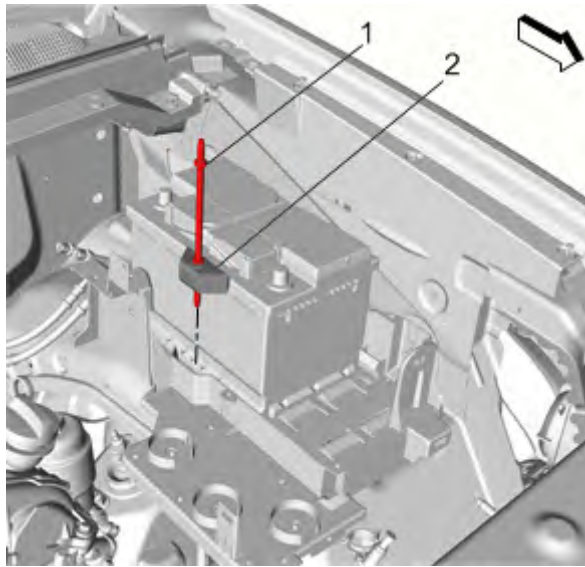


Fig. 92: Battery Hold Down Retainer Rod And Battery Retainer
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

2. Install the battery retainer (2) into position on the battery and tighten the rod fastener (1) to 22 N.m (16 lb ft).

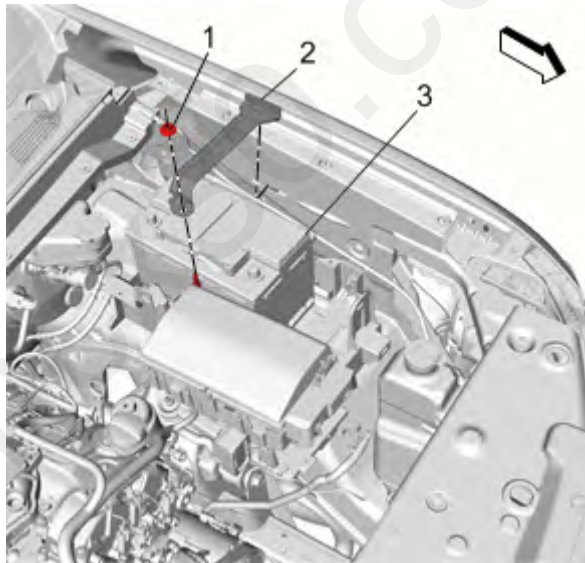


Fig. 93: Battery Retainer Fastener And Battery Retainer Brace
Courtesy of GENERAL MOTORS COMPANY

3. Attach the battery retainer brace (2), onto the battery hold down rod, and tighten the fastener (1) to 22 N.m (16 lb ft).

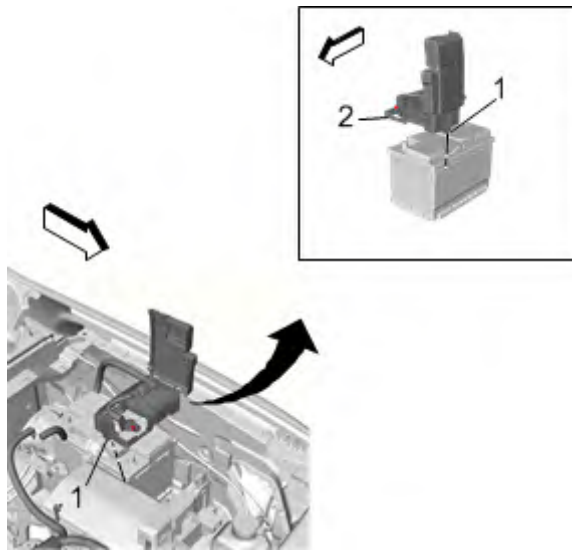


Fig. 94: Battery Fuse Block Retaining Tabs
 Courtesy of GENERAL MOTORS COMPANY

4. Install the battery fuse block (2), to the battery, with the retaining tabs (1).

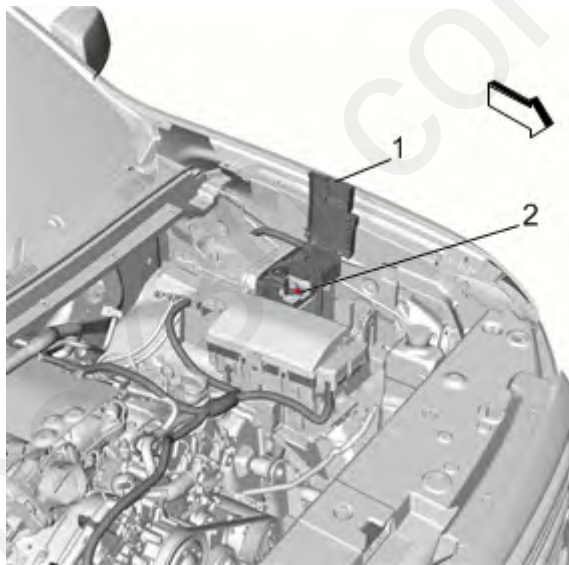


Fig. 95: Battery Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

5. Install the battery positive cable clamp to the battery post and tighten the fastener (2) to 4.7 N.m (42 lb in).
6. Close the battery fuse block cover (1).
7. Connect the battery negative cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

BATTERY TRAY REPLACEMENT

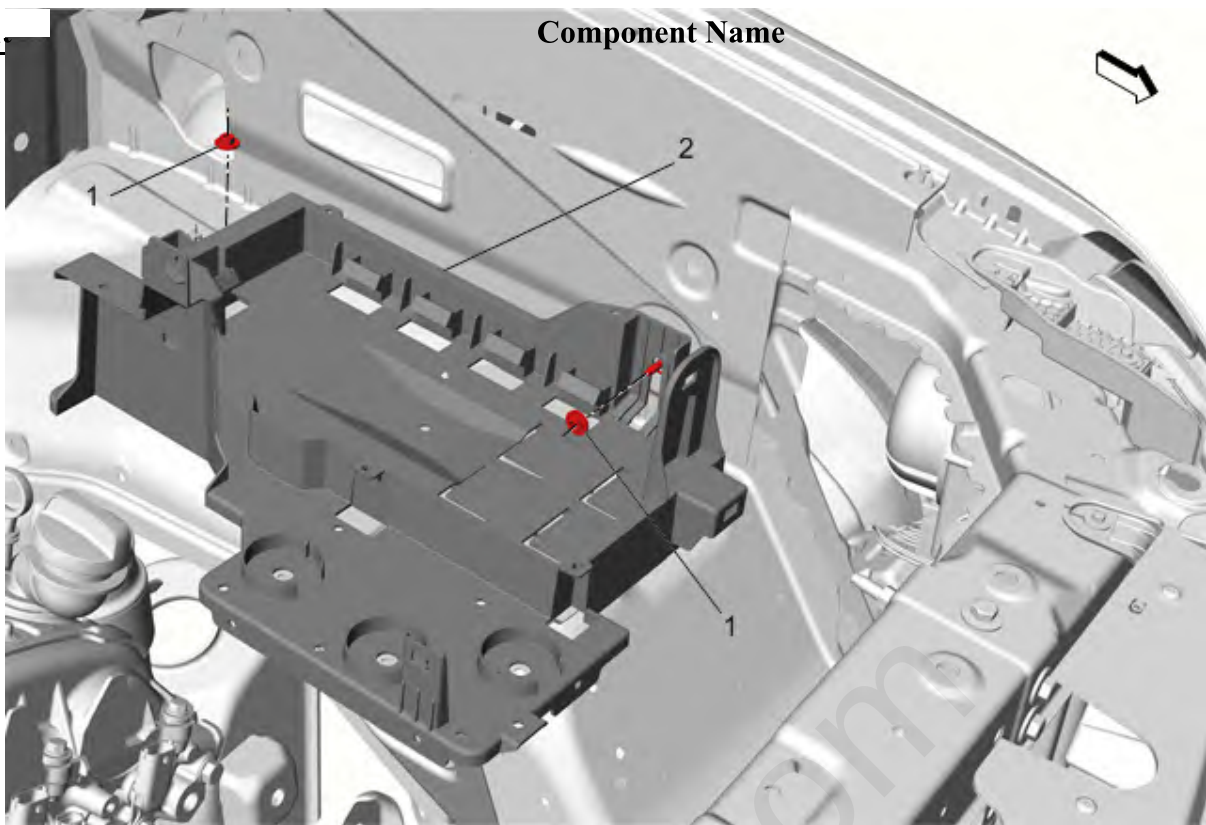


Fig. 96: Battery Tray

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Battery Replacement Engine Wiring Harness Fuse Block Bracket Replacement	
1	Battery Tray Fastener (Qty: 2) CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Battery Tray Procedure Disconnect and unclip all necessary electrical components from the battery tray.

STARTER REPLACEMENT (LFX)

Removal Procedure

- Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
- Remove the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#) .

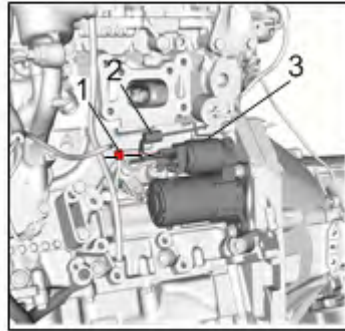
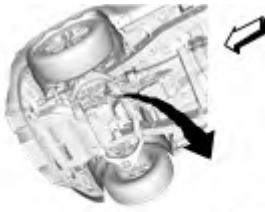


Fig. 97: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

3. Remove the battery positive cable fastener (1) and remove the battery positive cable (2) from the starter solenoid (3).

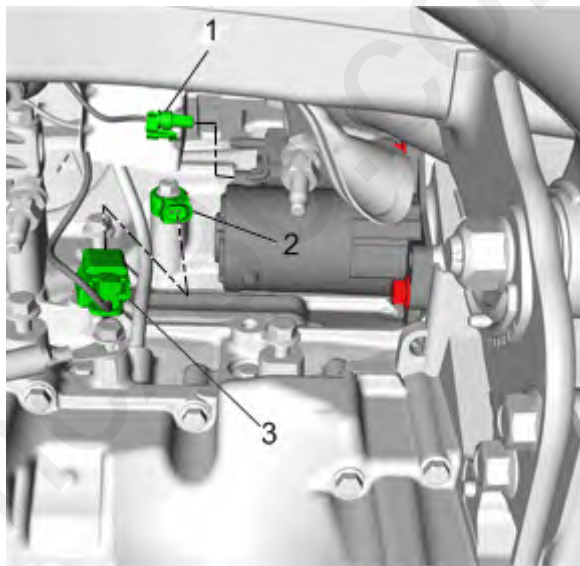


Fig. 98: Engine Harness Connector

Courtesy of GENERAL MOTORS COMPANY

4. Disconnect the engine harness connector (1) and the connector (3) to the knock sensor (2).

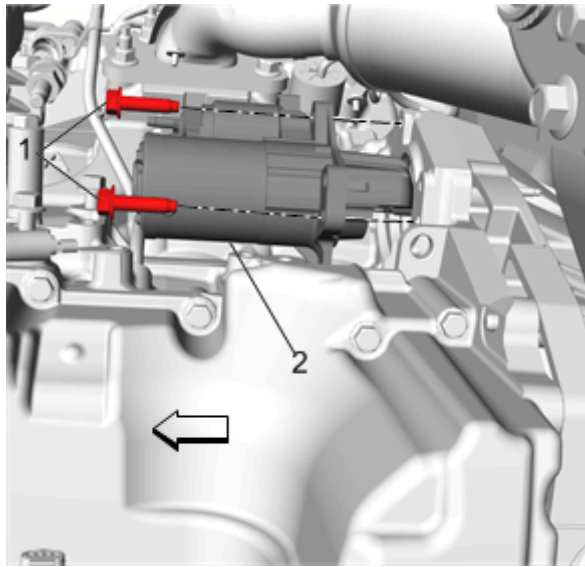


Fig. 99: Starter Mounting Bolts And Starter
Courtesy of GENERAL MOTORS COMPANY

5. Remove the starter mounting bolts (1) and remove the starter (2) from the engine block.

Installation Procedure

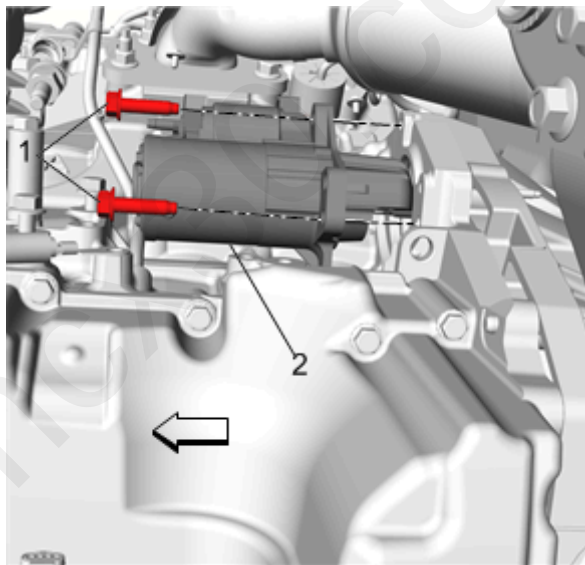


Fig. 100: Starter Mounting Bolts And Starter
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

1. Install the starter (2) into position on the flywheel and tighten the bolts (2) to 58 N.m (43 lb ft).

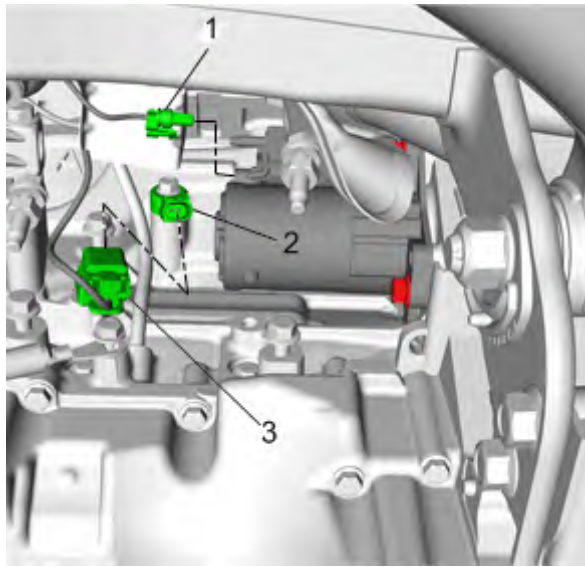


Fig. 101: Engine Harness Connector

Courtesy of GENERAL MOTORS COMPANY

2. Connect the knock sensor connector (3) to the knock sensor (2) and the engine harness connector (1) to the starter solenoid.

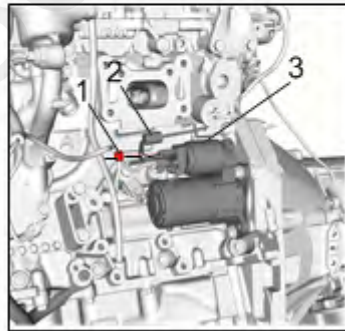
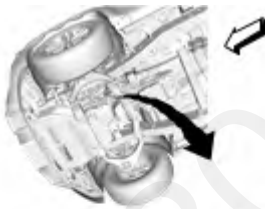


Fig. 102: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

3. Install the battery positive cable (2) to the starter solenoid (3) and tighten the fastener (1) to 13 N.m (115 lb in).
4. Install the left engine mount bracket. Refer to [Engine Mount Bracket Replacement - Left Side](#).
5. Lower the vehicle.
6. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

STARTER REPLACEMENT (LCV)

Removal Procedure

1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#).
2. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

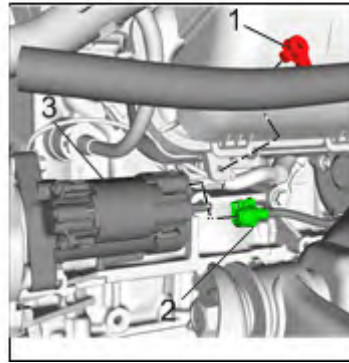


Fig. 103: Engine Harness Retainer

Courtesy of GENERAL MOTORS COMPANY

3. Disconnect Electrical Connector (2) @Starter Solenoid (3)

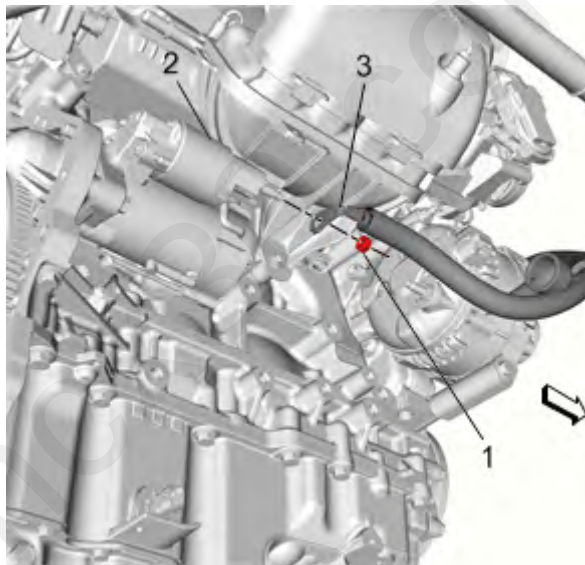


Fig. 104: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

4. Remove Battery Positive Cable Fastener (1) @Starter Solenoid (2)
5. Remove Battery Positive Cable (3)

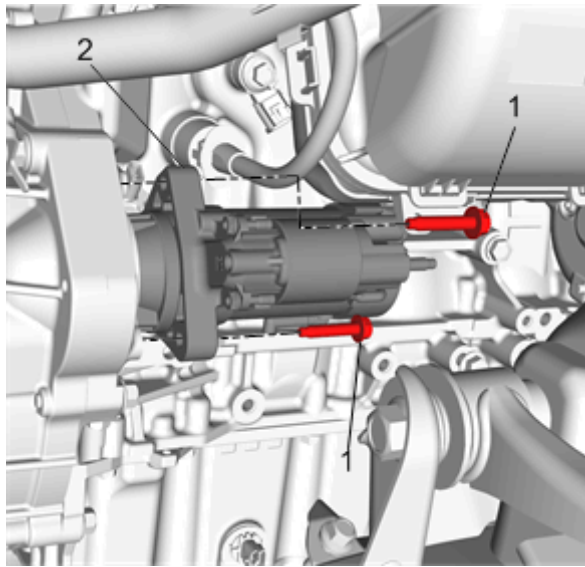


Fig. 105: Starter Mounting Bolts

Courtesy of GENERAL MOTORS COMPANY

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

Installation Procedure

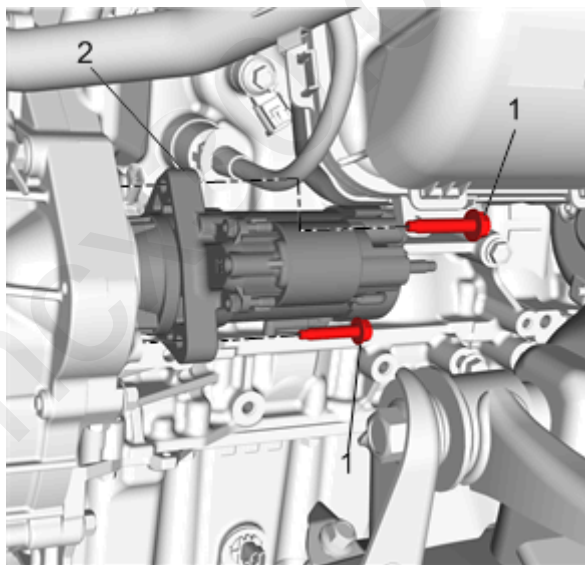


Fig. 106: Starter Mounting Bolts

Courtesy of GENERAL MOTORS COMPANY

1. Install Starter (2)

CAUTION: Refer to **Fastener Caution** .

2. Install Starter Mounting Bolt (1) and tighten 22 N.m (16 lb ft)

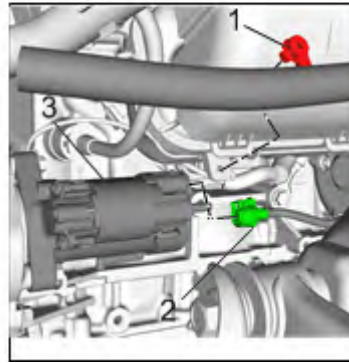


Fig. 107: Engine Harness Retainer

Courtesy of GENERAL MOTORS COMPANY

3. Connect Electrical Connector (2) @Starter Solenoid (3)

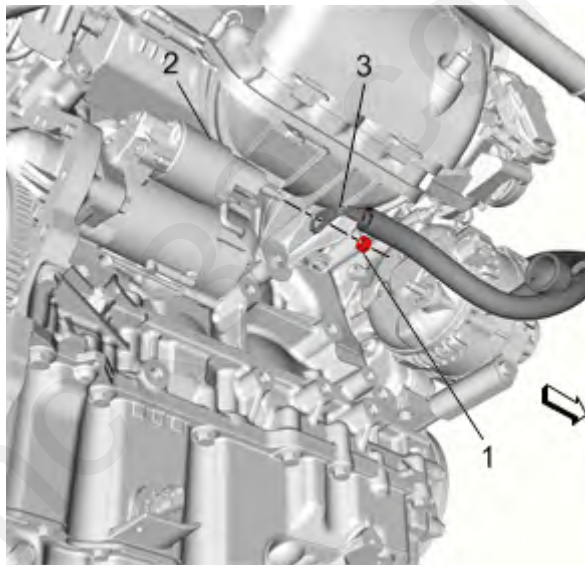


Fig. 108: Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

4. Install Battery Positive Cable (3)
5. Install Battery Positive Cable Fastener (1) @Starter Solenoid (2) and tighten 13 N.m (115 lb in)
6. Lower the vehicle.
7. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

STARTER REPLACEMENT (LWN)

Removal Procedure

1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)
2. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)
3. Remove Front Wheelhouse Liner. [Front Wheelhouse Liner Replacement](#)

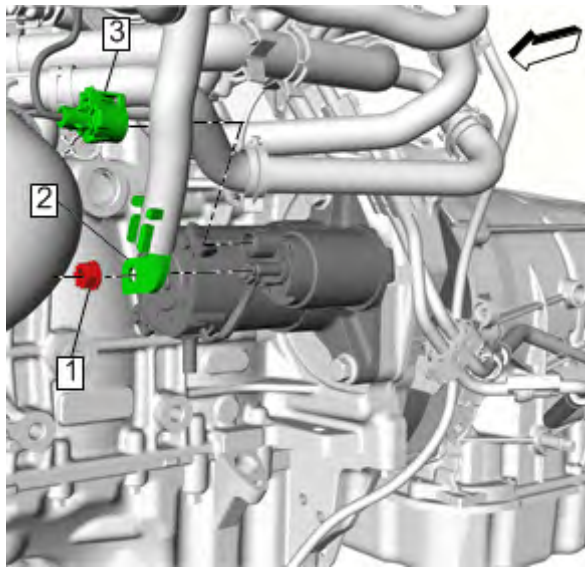


Fig. 109: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove Starter Solenoid Cable Nut (1).
6. Remove Remove Starter Solenoid Cable (2).
7. Disconnect the electrical connector (3).

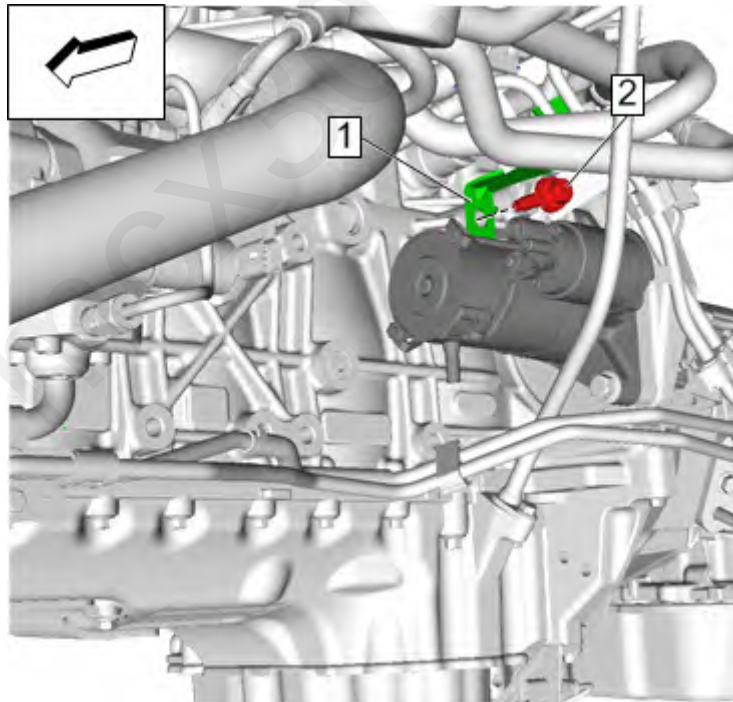


Fig. 110: Fuel Pump Fuel Feed Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Remove Fuel Pump Fuel Feed Pipe Bracket Bolt (2)
9. Reposition away Fuel Pump Fuel Feed Pipe Bracket (1)

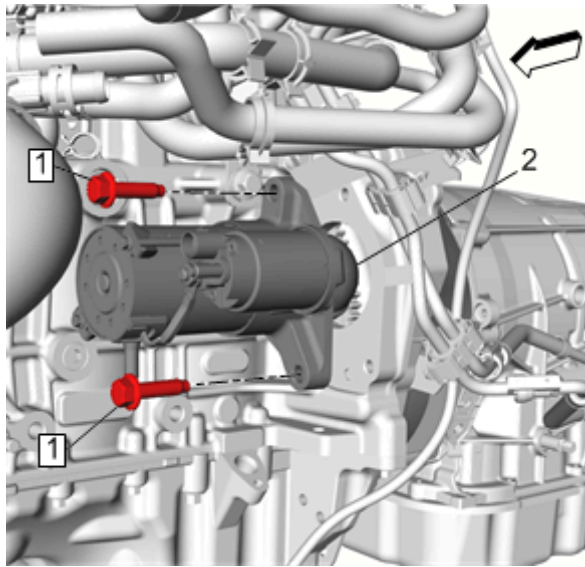


Fig. 111: Starter Mounting Bolt

Courtesy of GENERAL MOTORS COMPANY

NOTE: The heater hoses will need to be carefully pushed upwards to allow the starter room to be moved.

10. Remove Starter Mounting Bolt (1)

NOTE: Remove the starter through the wheelhouse

11. Remove Starter (2)

Installation Procedure

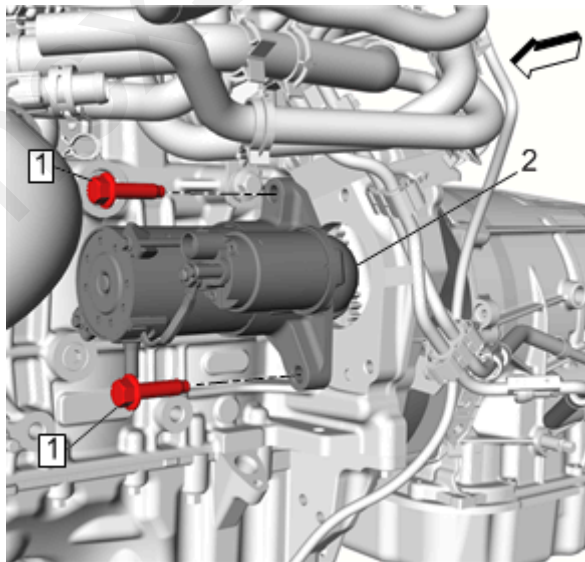


Fig. 112: Starter Mounting Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Install Starter (2)

CAUTION: Refer to [Fastener Caution](#)

tarter Mounting Bolt (1) and tighten 58 N.m (43 lb ft)

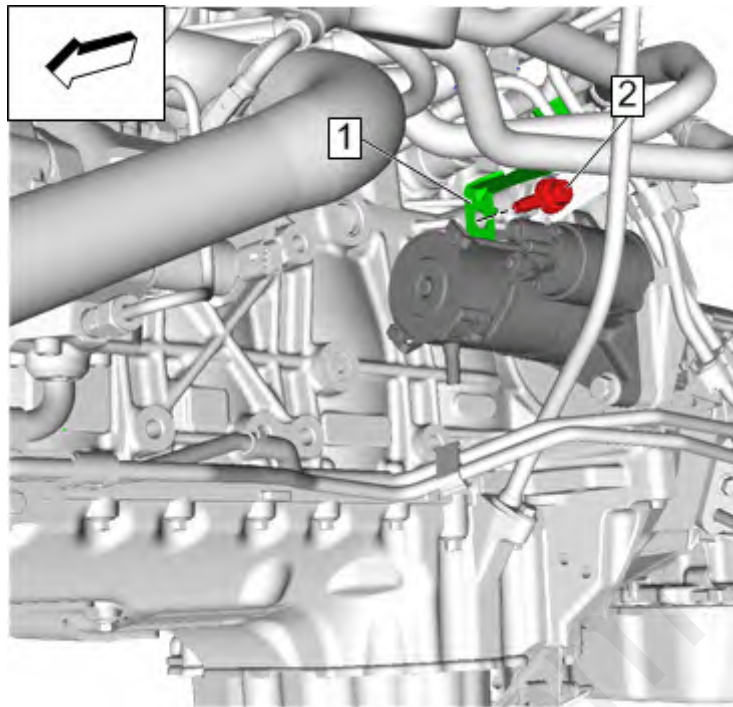


Fig. 113: Fuel Pump Fuel Feed Pipe Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Install Fuel Pump Fuel Feed Pipe Bracket (1)
4. Install Fuel Pump Fuel Feed Pipe Bracket Bolt (2) and tighten 22 N.m (16 lb ft)

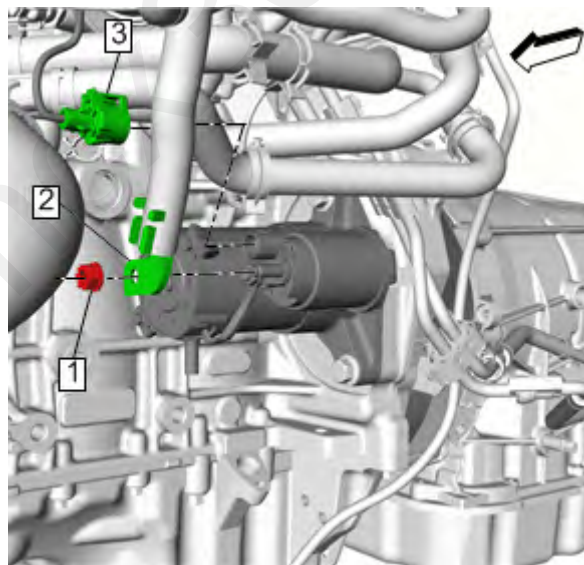


Fig. 114: Starter Solenoid Cable Nut And Cable
Courtesy of GENERAL MOTORS COMPANY

5. Install Starter Solenoid Cable (2)
6. Install Starter Solenoid Cable Nut (1) and tighten 12 N.m (106 lb in)
7. Connect the electrical connector (3).
8. Install Oil Level Indicator Tube. [Oil Level Indicator Tube Replacement](#)
9. Install Front Wheelhouse Liner. [Front Wheelhouse Liner Replacement](#)

he vehicle.

11. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)

GENERATOR BRACKET REPLACEMENT (LWN)

Removal Procedure

1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection](#)
2. Remove Generator. [Generator Replacement \(LWN\)](#)

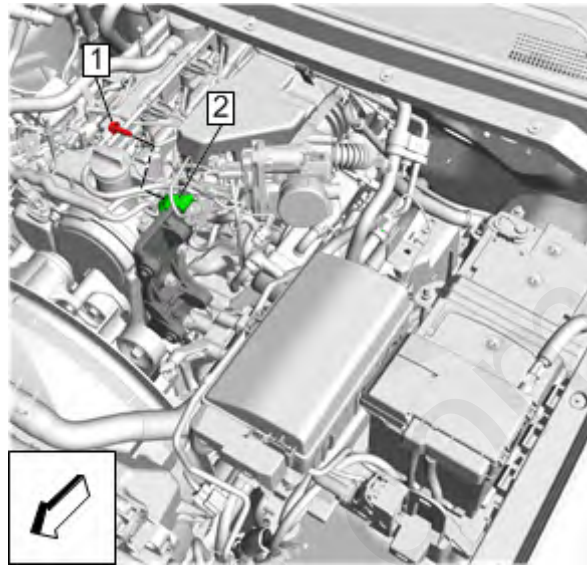


Fig. 115: Retainer Fastener

Courtesy of GENERAL MOTORS COMPANY

3. Remove Retainer Fastener (1)
4. Reposition away Retainer (2)

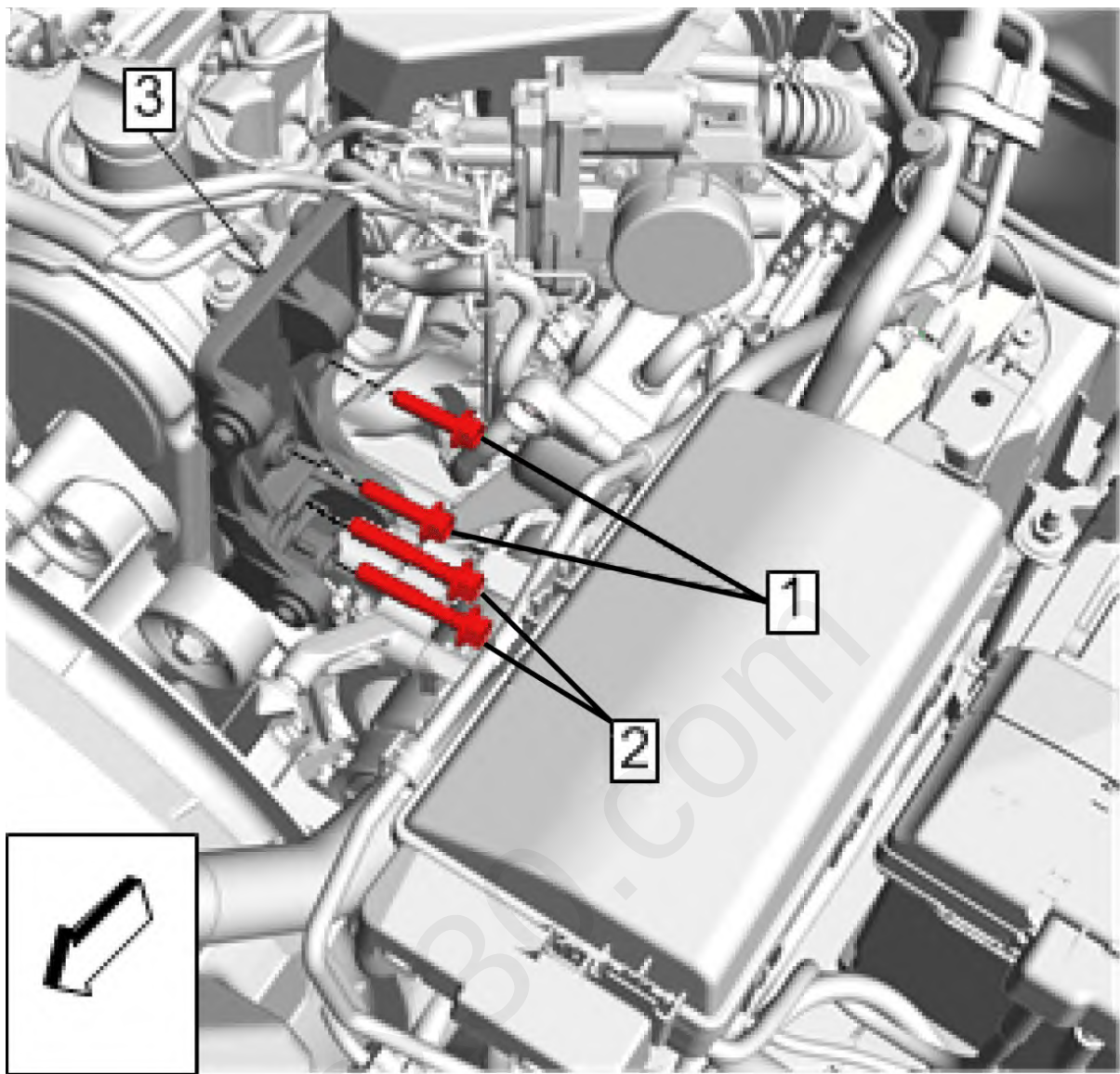


Fig. 116: Generator Bracket Bolt

Courtesy of GENERAL MOTORS COMPANY

5. Remove Generator Bracket Bolt (1)
6. Remove Generator Bracket Bolt (2).
7. Remove Generator Bracket (3).

Installation Procedure

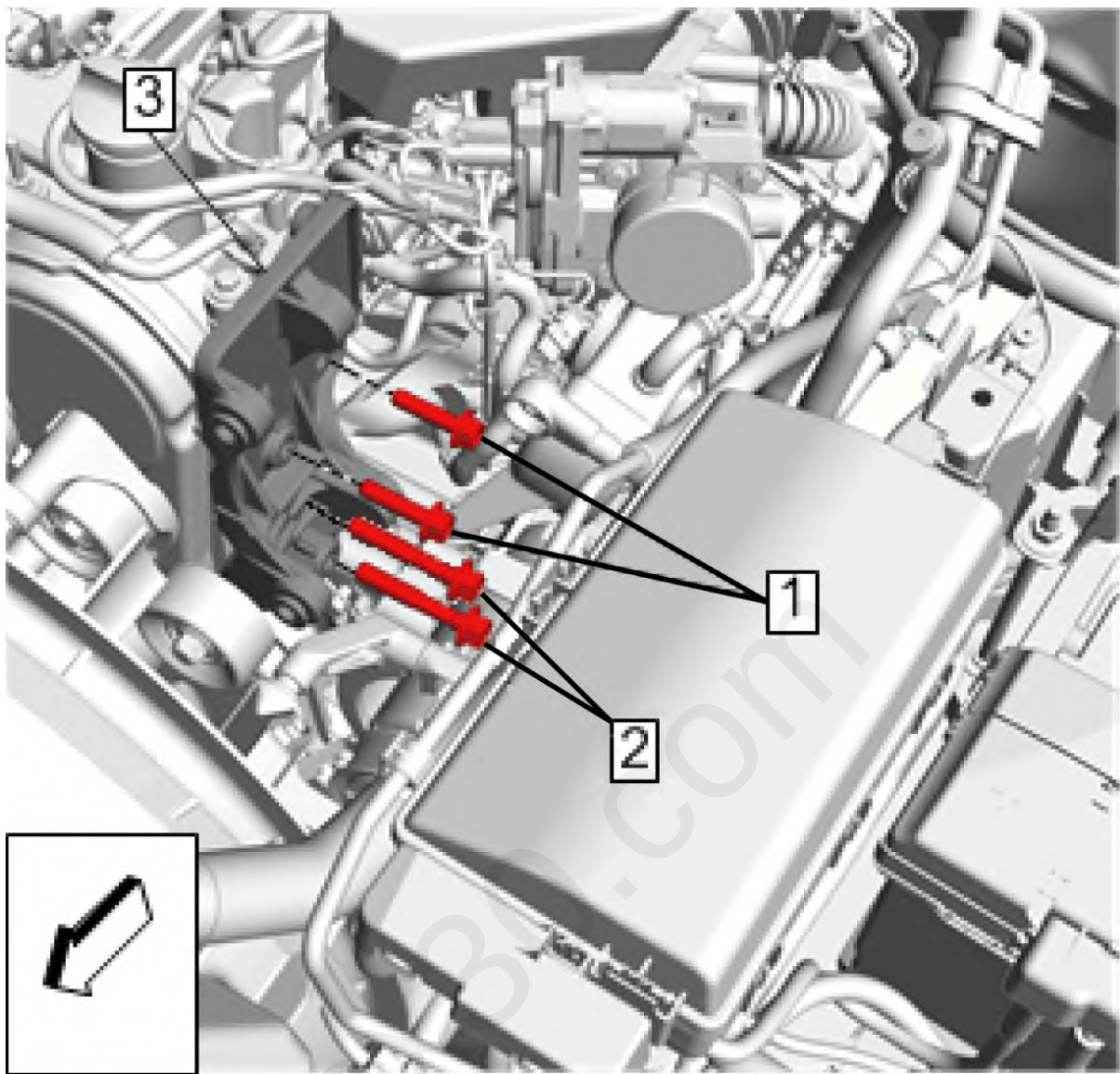


Fig. 117: Generator Bracket Bolt

Courtesy of GENERAL MOTORS COMPANY

1. Install Generator Bracket (3).

CAUTION: Refer to [Fastener Caution](#)

2. Install Generator Bracket Bolt (1) and tighten 45 N.m (33 lb ft)
3. Install Generator Bracket Bolt (2) and tighten 45 N.m (33 lb ft)

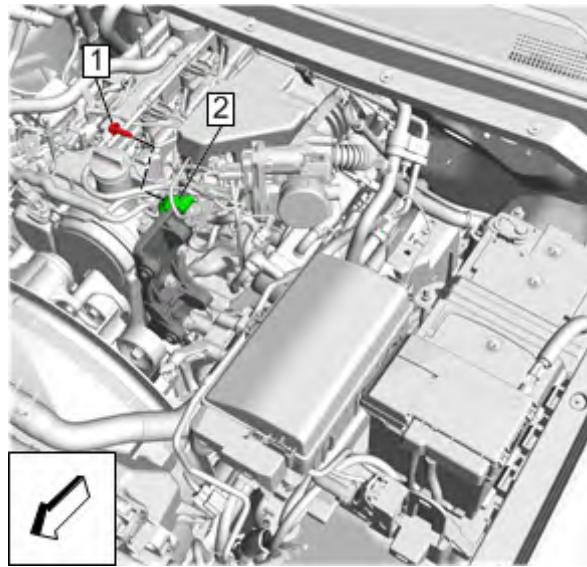


Fig. 118: Retainer Fastener

Courtesy of GENERAL MOTORS COMPANY

4. Install Retainer (2).
5. Install Retainer Fastener (1) and tighten 22 N.m (16 lb ft)
6. Install Generator. **Generator Replacement (LWN)**
7. Connect the negative battery cable. **Battery Negative Cable Disconnection and Connection**

GENERATOR REPLACEMENT (LFX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**.
2. Remove the air cleaner outlet duct. Refer to **Air Cleaner Outlet Duct Replacement**.

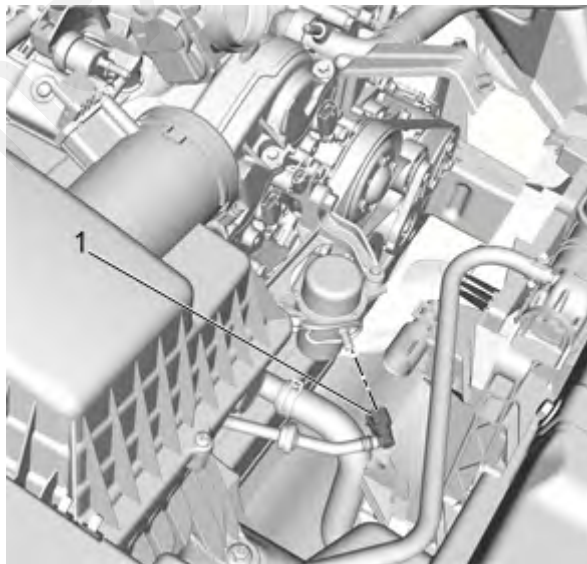


Fig. 119: Power Brake Booster Vacuum Hose Quick Connect

Courtesy of GENERAL MOTORS COMPANY

3. Release the power brake booster vacuum hose quick connect (1) from the power brake booster pump.

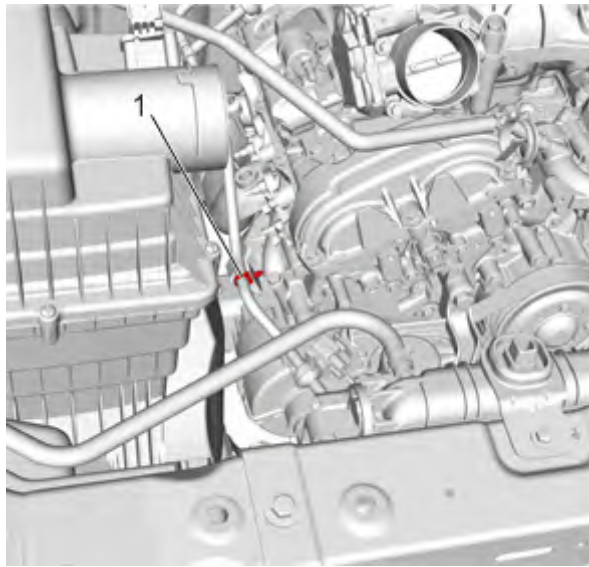


Fig. 120: Power Brake Booster Vacuum Hose And Front Retaining Clip
 Courtesy of GENERAL MOTORS COMPANY

4. Release the power brake booster vacuum hose from the front retaining clip (1).
5. Reposition the power brake booster vacuum hose away from the generator.

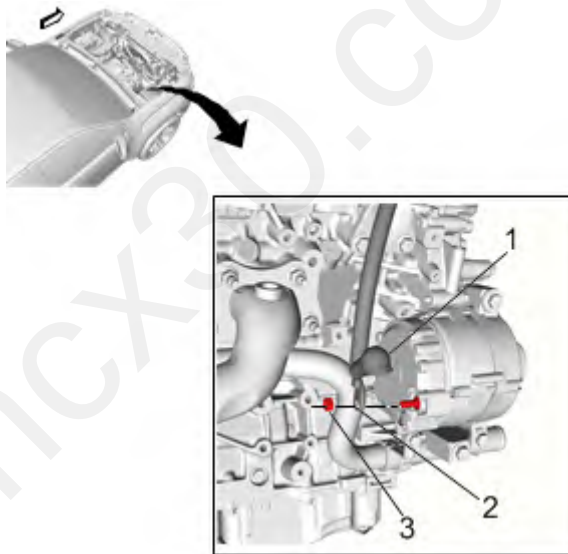


Fig. 121: Protective Boot And Battery Positive Cable Fastener
 Courtesy of GENERAL MOTORS COMPANY

6. Slide the protective boot (1) away from the generator stud and remove the battery positive cable fastener (3).
7. Remove the battery positive cable (2) from the generator stud.

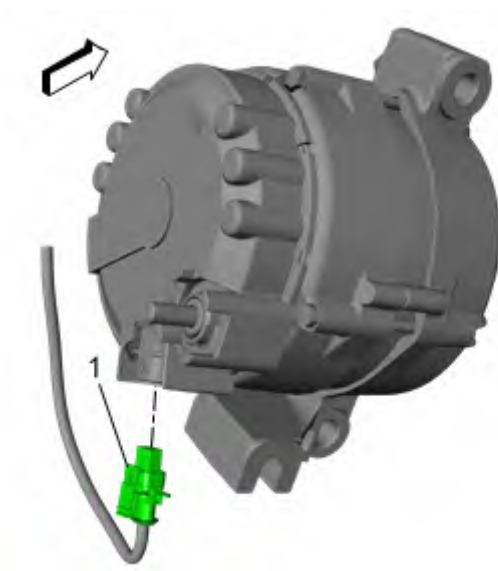


Fig. 122: Engine Harness Connector

Courtesy of GENERAL MOTORS COMPANY

8. Disconnect the engine harness connector (1) from the generator.

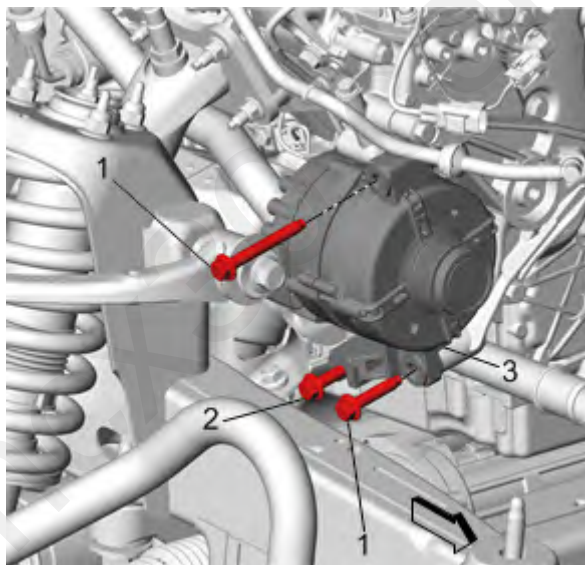


Fig. 123: Generator Mounting Bolt

Courtesy of GENERAL MOTORS COMPANY

9. Loosen the generator mounting bolt (2) but do not remove.
10. Remove the remaining generator mounting bolts (1) from the generator (3).

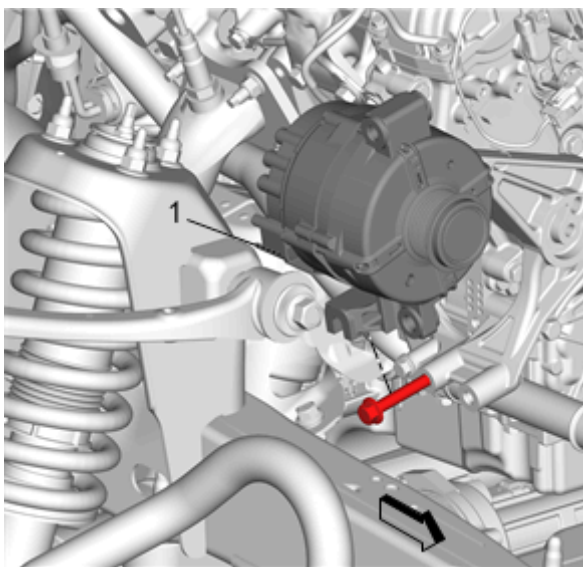


Fig. 124: Generator And Engine Compartment
Courtesy of GENERAL MOTORS COMPANY

11. Remove the generator (2) from the engine compartment.

Installation Procedure

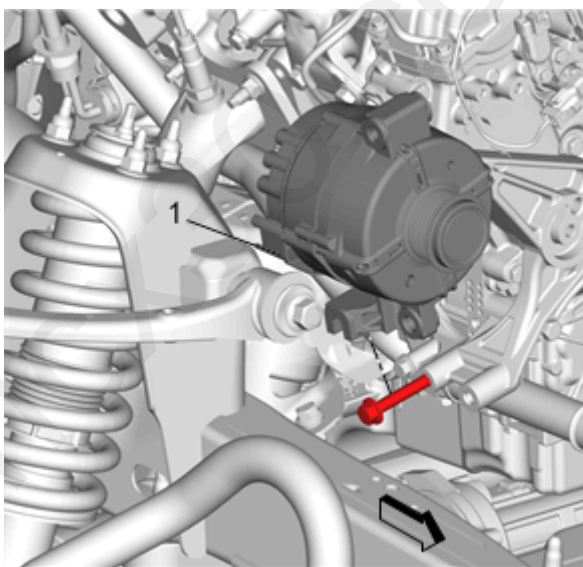


Fig. 125: Generator And Engine Compartment
Courtesy of GENERAL MOTORS COMPANY

1. Position the generator (2) onto the generator mounting bolt (1) and hand tighten.

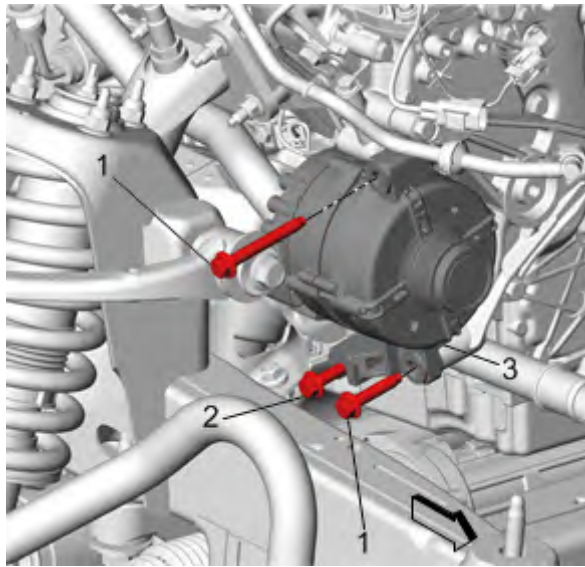


Fig. 126: Generator Mounting Bolt

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to [Fastener Caution](#) .

2. Install the generator mounting bolts (1) and tighten to 58 N.m (43 lb ft).
3. Tighten the generator mounting bolt (2) to 58 N.m (43 lb ft).

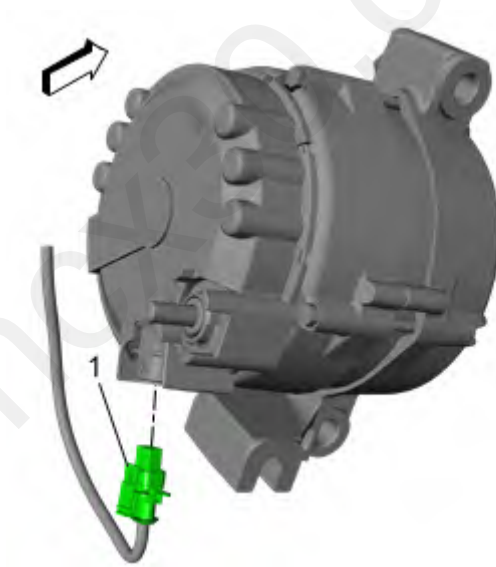


Fig. 127: Engine Harness Connector

Courtesy of GENERAL MOTORS COMPANY

4. Connect the engine harness connector (1) to the generator.

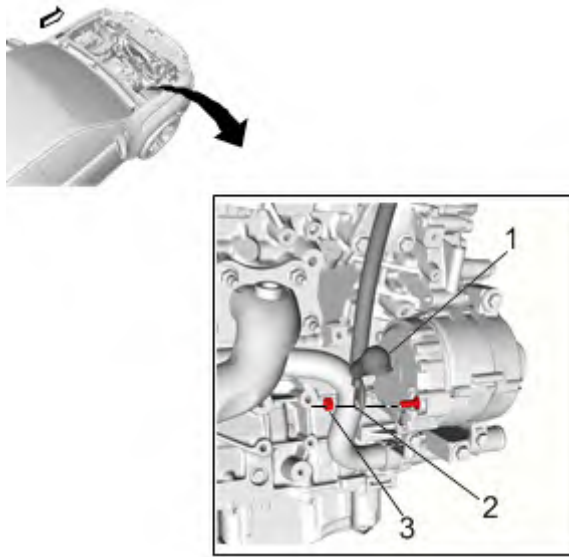


Fig. 128: Protective Boot And Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

5. Install the battery positive cable (2) to the generator stud and tighten the fastener (3) to 15 N.m (11 lb ft).
6. Slide the protective boot (1) onto the generator stud.

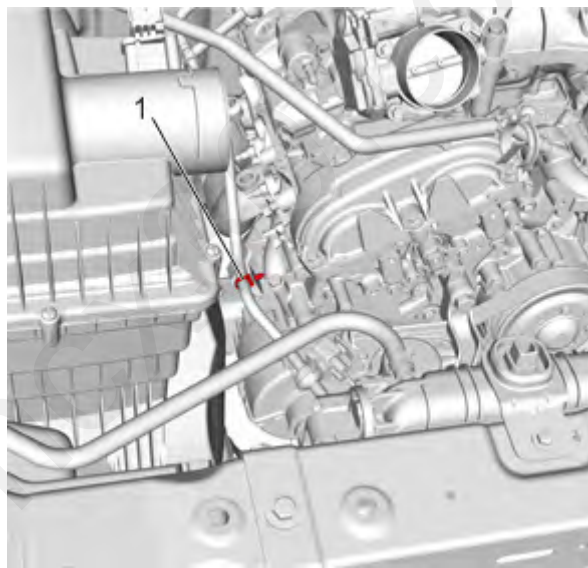


Fig. 129: Power Brake Booster Vacuum Hose And Front Retaining Clip

Courtesy of GENERAL MOTORS COMPANY

7. Install the power brake booster vacuum hose to the front retaining clip (1).

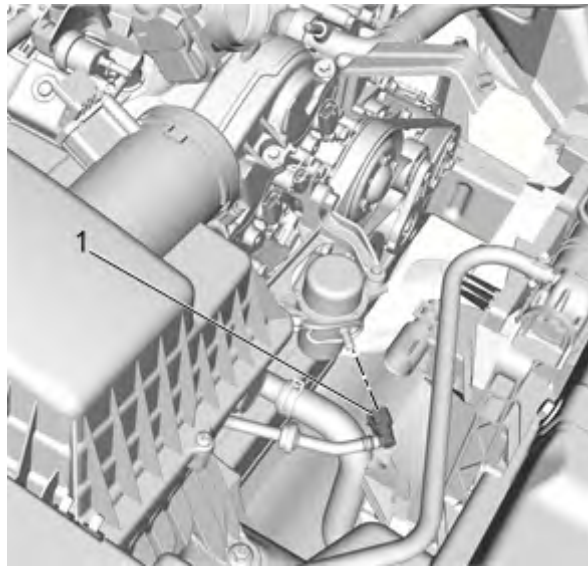


Fig. 130: Power Brake Booster Vacuum Hose Quick Connect
Courtesy of GENERAL MOTORS COMPANY

8. Install the power brake booster vacuum hose quick connect (1) to the power brake booster pump.
9. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
10. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

GENERATOR REPLACEMENT (LCV)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).
2. Remove the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
3. Remove the drive belt. Refer to [Drive Belt Replacement](#) .
4. Remove the radiator inlet hose - LCV radiator to inlet pipe. Refer to [Radiator Inlet Hose Replacement \(LCV Radiator to Inlet Pipe\)](#) [Radiator Inlet Hose Replacement \(LCV Inlet Pipe to Water Outlet\)](#)
5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .
6. Reposition the engine front splash shield. Refer to [Engine Front Splash Shield Replacement](#) .
7. Unclip and reposition the electrical harnesses as necessary.
8. Remove the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#) .
9. Remove the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
10. Remove the steering gear skid shield. Refer to [Steering Gear Skid Shield Replacement](#) .

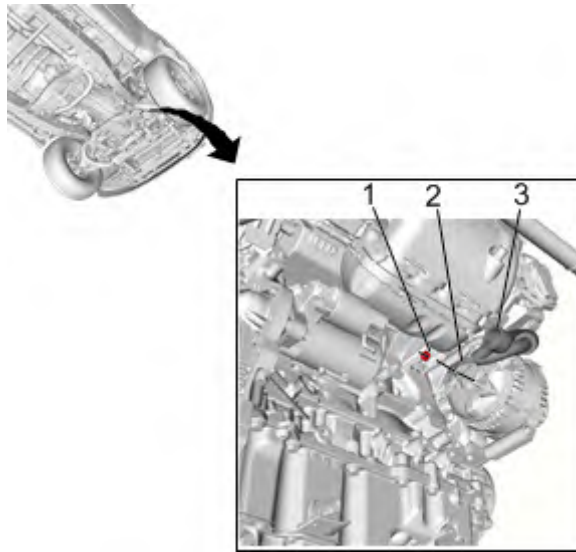


Fig. 131: Protective Boot And Battery Positive Cable Fastener
 Courtesy of GENERAL MOTORS COMPANY

11. Slide the protective boot (3) away from the generator stud and remove the battery positive cable fastener (1).
12. Remove the battery positive cable (2) from the generator stud.
13. Lower the vehicle.

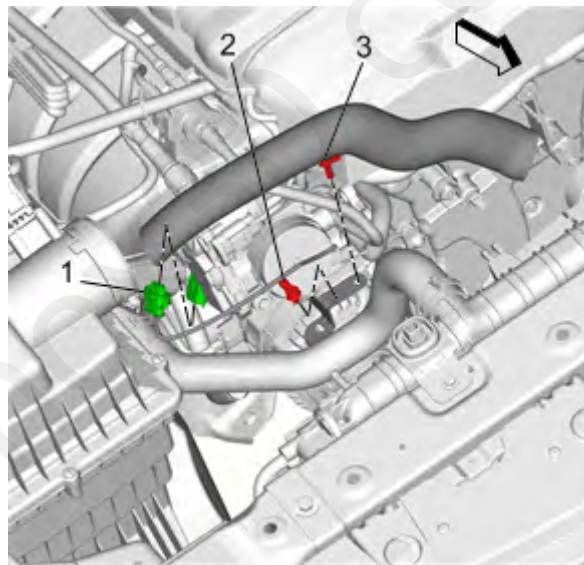


Fig. 132: Throttle Body Connector
 Courtesy of GENERAL MOTORS COMPANY

14. Disconnect the throttle body connector (1) and release the throttle body harness retainer (2) from the engine harness bracket above the generator.
15. Release the engine harness retainer (3) from the engine harness bracket and reposition harness.

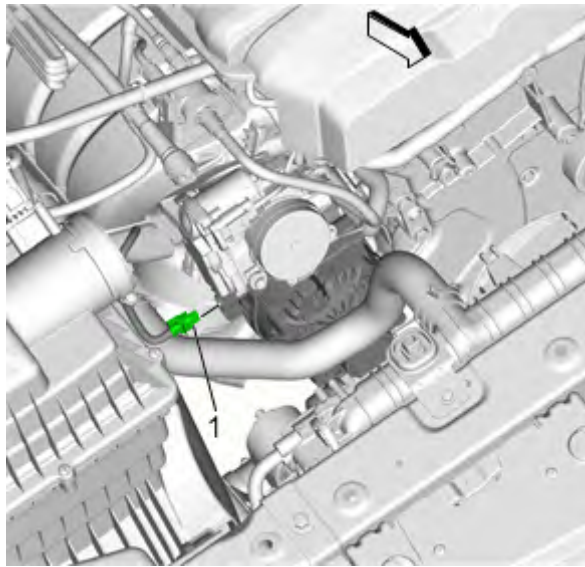


Fig. 133: Engine Harness Connector

Courtesy of GENERAL MOTORS COMPANY

16. Disconnect the engine harness connector (1) from the generator.

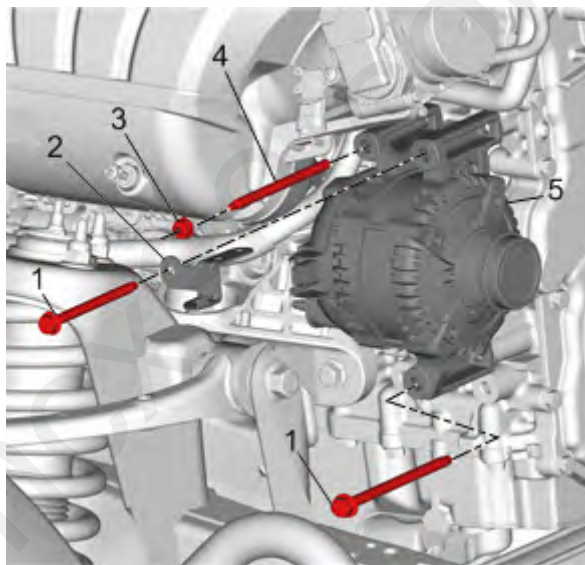


Fig. 134: Generator Mounting Bolts And Generator

Courtesy of GENERAL MOTORS COMPANY

17. Remove the generator mounting bolts (1) and the engine harness bracket (2).
18. Remove the generator mounting nut (3) and stud (4), if necessary.
19. Remove the generator (5) from the engine compartment.

Installation Procedure

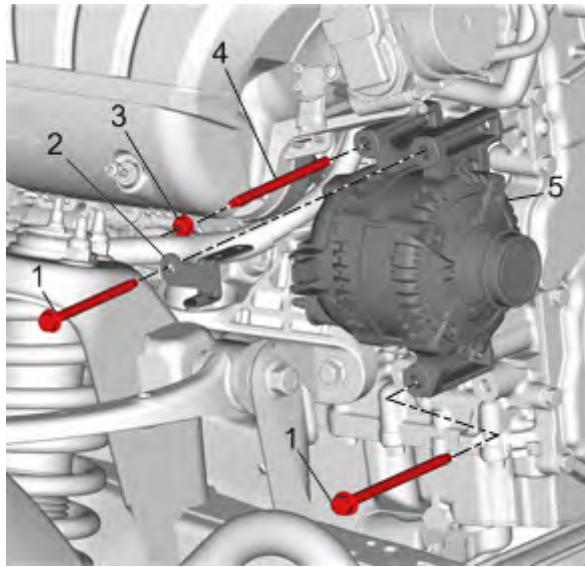


Fig. 135: Generator Mounting Bolts And Generator
 Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to **Fastener Caution** .

1. Install the generator (5) into position and tighten the stud (4) to 9 N.m (80 lb in).
2. Install the harness bracket (2) and the generator mounting bolts (1). Tighten to 22 N.m (16 lb ft).
3. Install the generator mounting nut (3) and tighten to 22 N.m (16 lb ft).

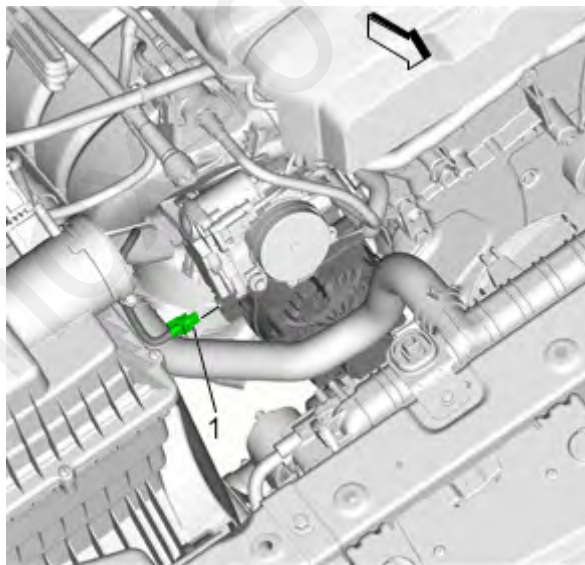


Fig. 136: Engine Harness Connector
 Courtesy of GENERAL MOTORS COMPANY

4. Connect the engine harness connector (1) to the generator.

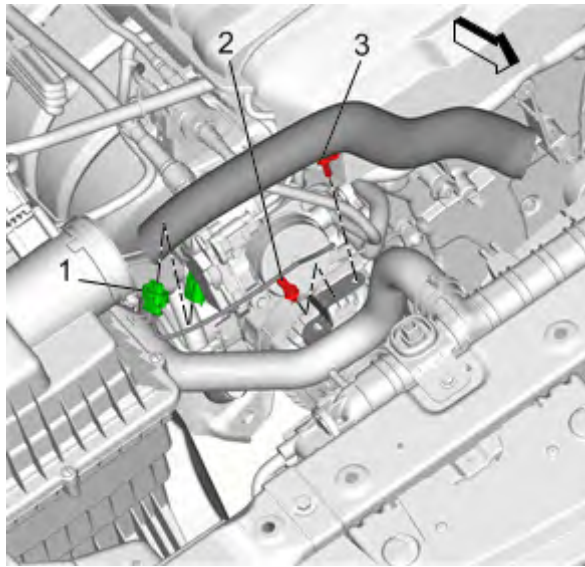


Fig. 137: Throttle Body Connector

Courtesy of GENERAL MOTORS COMPANY

5. Connect the throttle body connector (1) and attach the throttle body harness retainer (2) to the engine harness bracket.
6. Attach the engine harness retainer (3) to the engine harness bracket.
7. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#) .

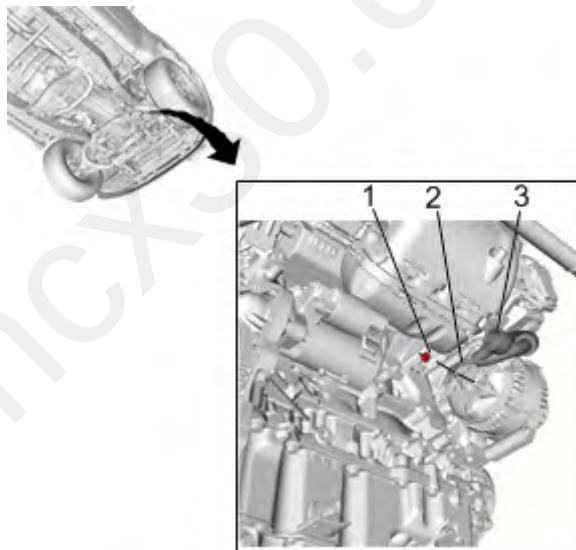


Fig. 138: Protective Boot And Battery Positive Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

8. Install the battery positive cable (2) to the generator stud and tighten the nut (1) to 15 N.m (11 lb ft).
9. Slide the protective boot (3) onto the generator stud.
10. Install the underbody splash shield. Refer to [Underbody Splash Shield Replacement](#) .
11. Install the steering gear skid shield. Refer to [Steering Gear Skid Shield Replacement](#) .
12. Position the engine front splash shield. Refer to [Engine Front Splash Shield Replacement](#) .
13. Install the right front wheelhouse liner. Refer to [Front Wheelhouse Liner Replacement](#) .
14. Lower the vehicle.
15. Install the drive belt. Refer to [Drive Belt Replacement](#) .

- ie radiator inlet hose - LCV radiator to inlet pipe. Refer to [Radiator Inlet Hose Replacement \(LCV Radiator to Inlet Pipe\)](#) [Radiator Inlet Hose Replacement \(LCV Inlet Pipe to Water Outlet\)](#)
17. Install the air cleaner outlet duct. Refer to [Air Cleaner Outlet Duct Replacement](#) .
18. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#).

GENERATOR REPLACEMENT (LWN)

Removal Procedure

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

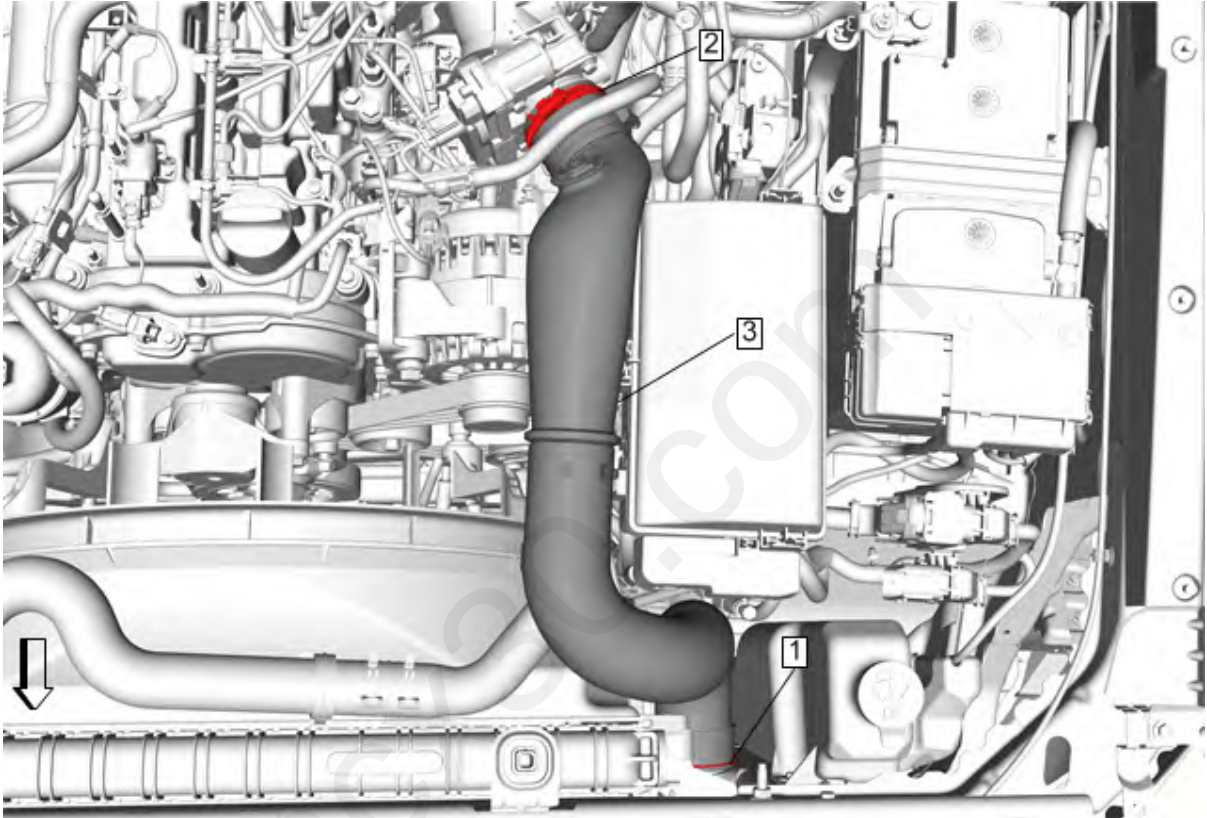


Fig. 139: Charge Air Cooler Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

2. Remove Charge Air Cooler Outlet Duct (3). [Charge Air Cooler Outlet Duct Replacement](#)

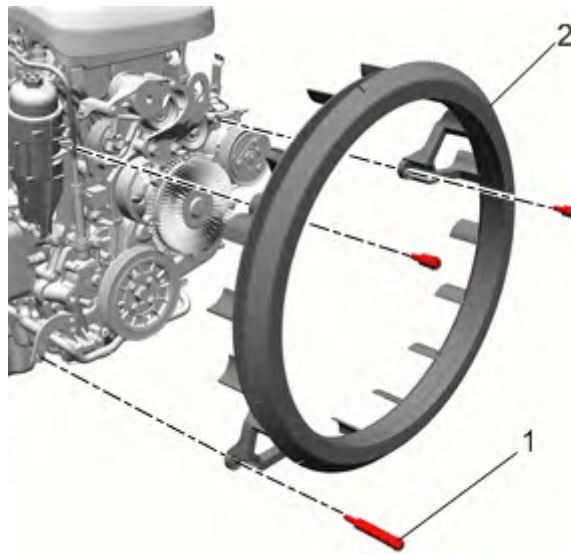


Fig. 140: Engine Coolant Fan Rear Shroud Upper Bolts
 Courtesy of GENERAL MOTORS COMPANY

3. Remove the engine coolant fan rear shroud upper bolts (1). **Engine Coolant Fan Rear Shroud Replacement (LWN)**

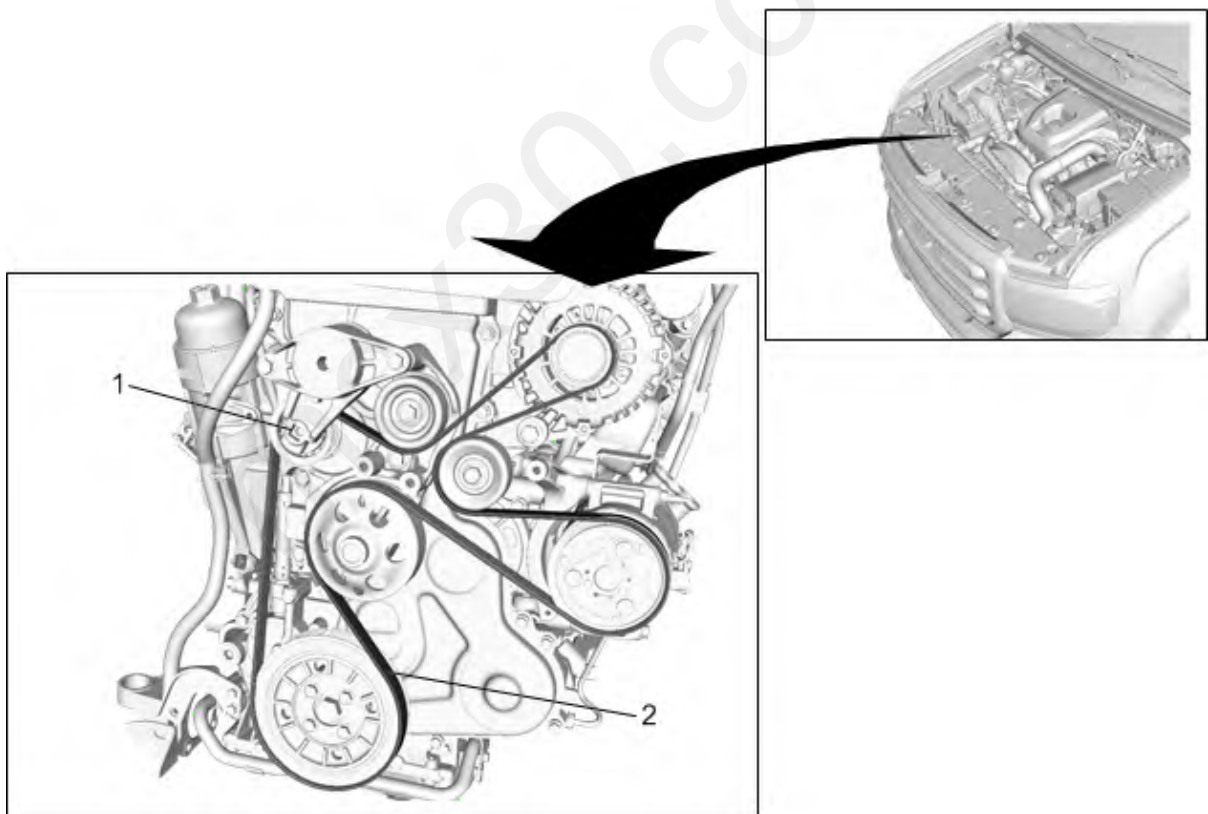


Fig. 141: Drive Belt
 Courtesy of GENERAL MOTORS COMPANY

4. Remove Drive Belt (2). **Drive Belt Replacement**

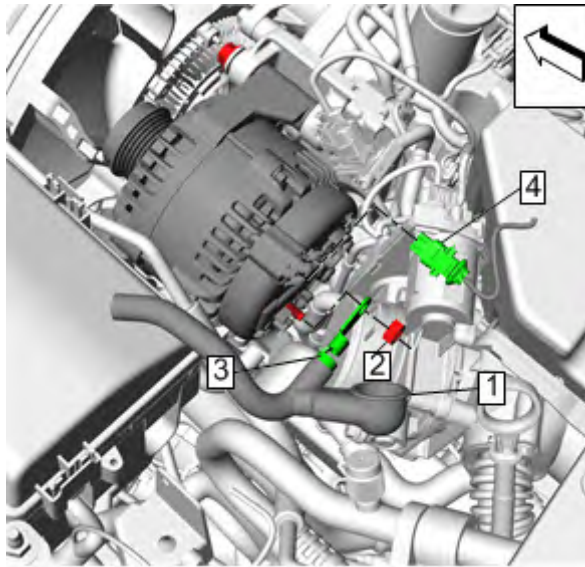


Fig. 142: Generator Terminal Protective Boot
Courtesy of GENERAL MOTORS COMPANY

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

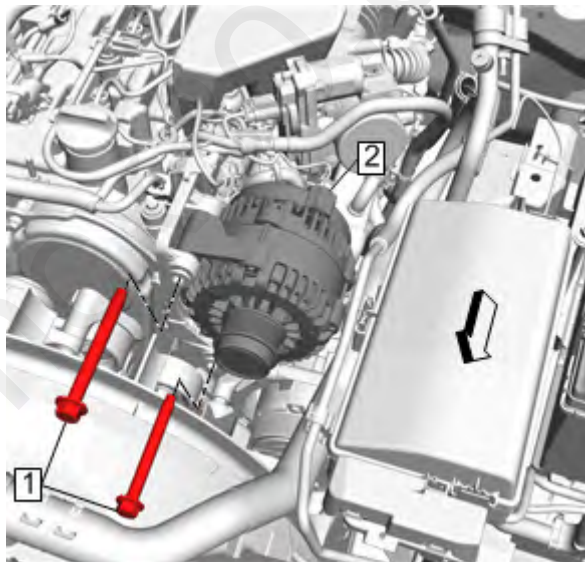


Fig. 143: Generator And Generator Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Remove Generator Bolt (1)
10. Remove the generator (2)

Installation Procedure

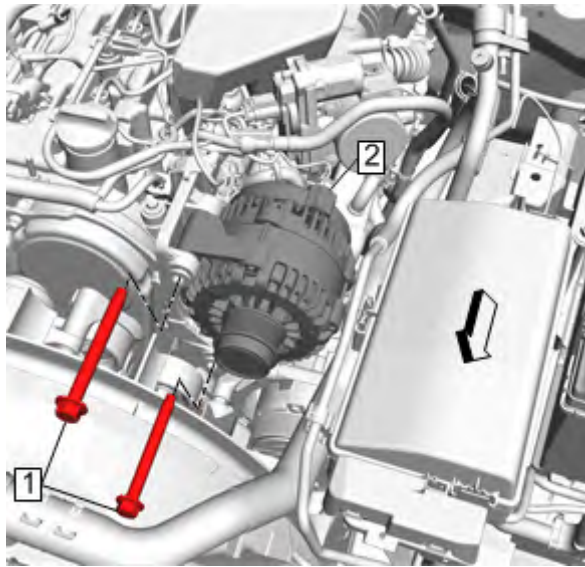


Fig. 144: Generator And Generator Bolt
 Courtesy of GENERAL MOTORS COMPANY

1. Install the generator (2)

CAUTION: Refer to [Fastener Caution](#)

2. Install Generator Bolt (1) and tighten 58 N.m (43 lb ft)

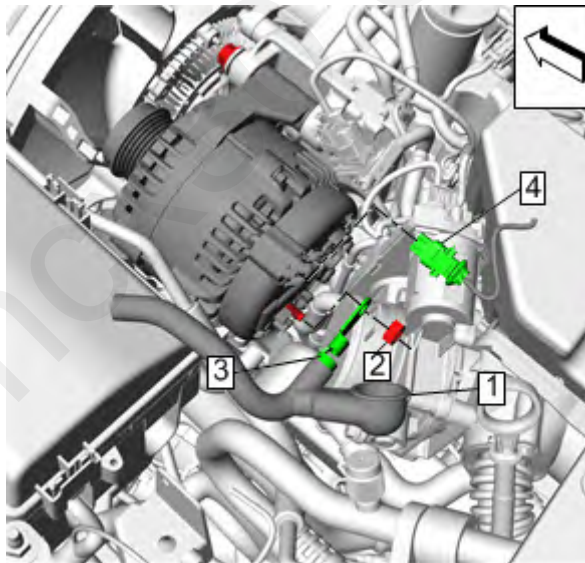


Fig. 145: Generator Terminal Protective Boot
 Courtesy of GENERAL MOTORS COMPANY

3. Connect the electrical connector (4)
4. Install Battery Positive Cable (3).
5. Install Generator Nut (2) and tighten 15 N.m (11 lb ft)
6. Install Generator Terminal Protective Boot (1).

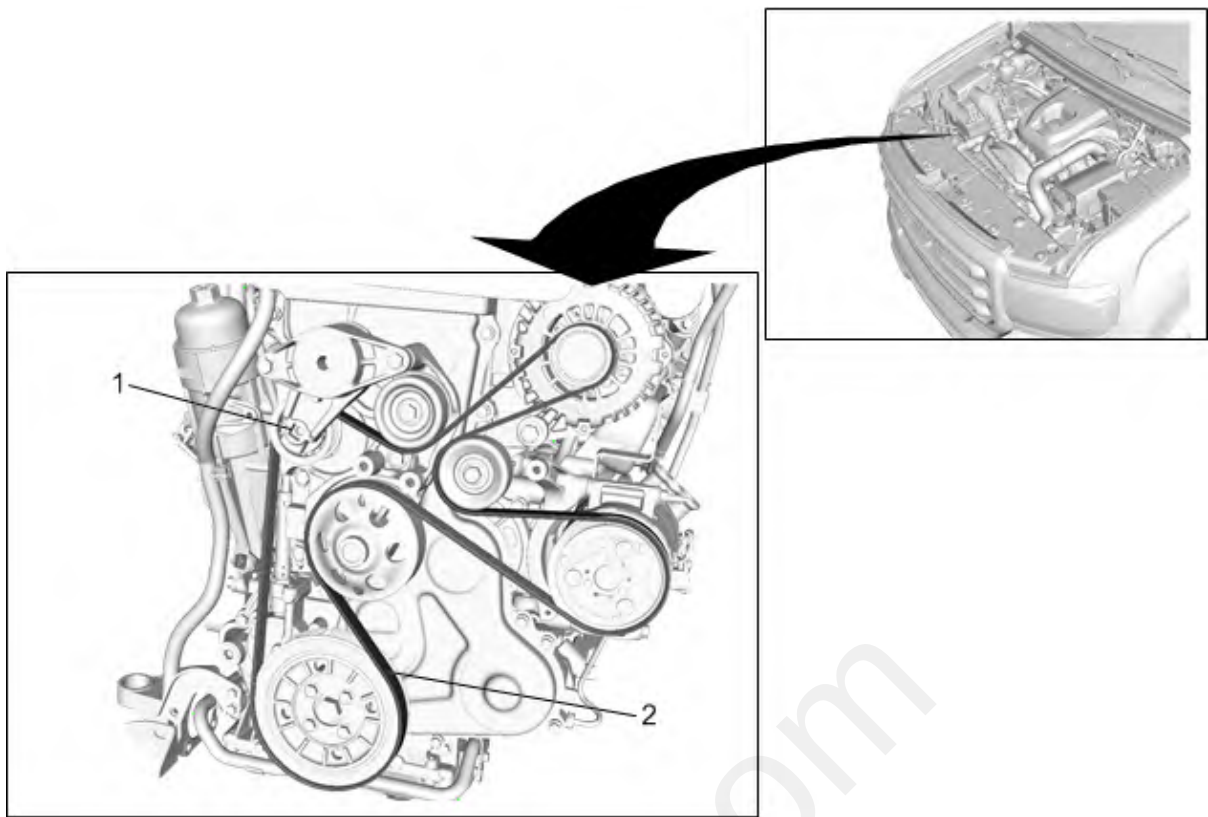


Fig. 146: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

7. Install Drive Belt (2). [Drive Belt Replacement](#)

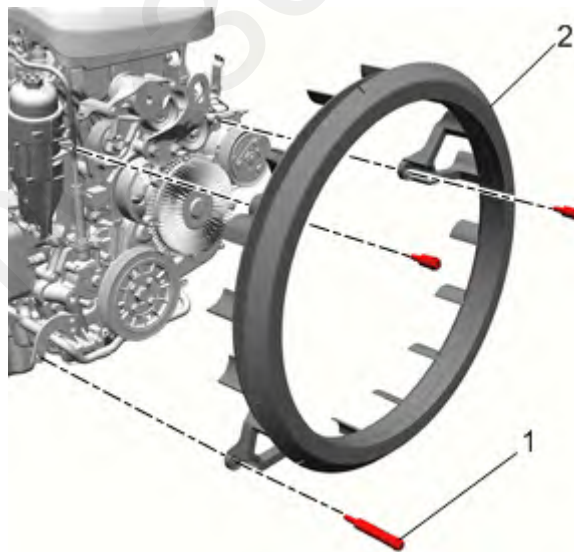


Fig. 147: Engine Coolant Fan Rear Shroud Upper Bolts

Courtesy of GENERAL MOTORS COMPANY

8. Install the engine coolant fan rear shroud upper bolts (1). [Engine Coolant Fan Rear Shroud Replacement \(LWN\)](#)

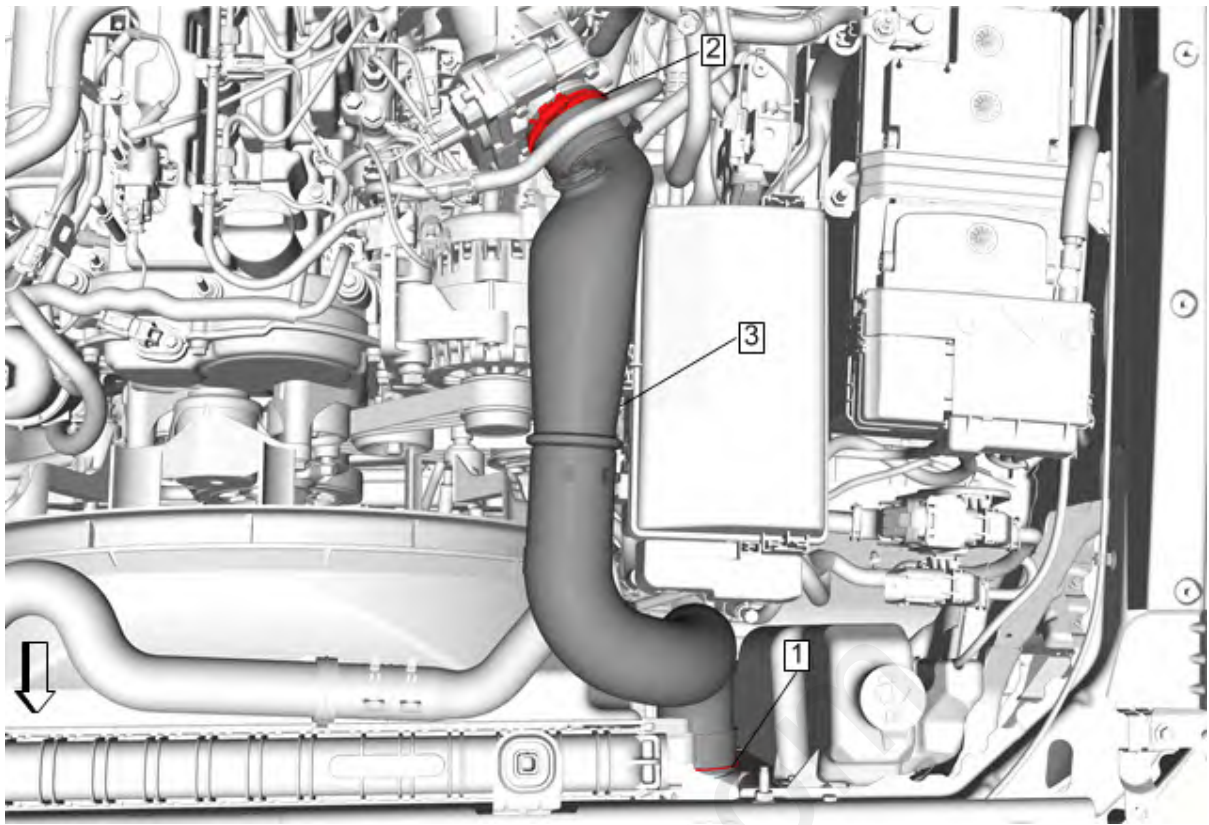


Fig. 148: Charge Air Cooler Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

9. Install Charge Air Cooler Outlet Duct (3). [Charge Air Cooler Outlet Duct Replacement](#)
10. 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.

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 -18°C (0°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

manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

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

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

The state-of-charge can be used as a diagnostic tool to tell the customer or the dealer the condition of the battery. Throughout ignition-on, the algorithm continuously estimates state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and temperature.

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

In addition, the electrical power management function is designed to perform regulated voltage control to improve battery state-of-charge, battery life, and fuel economy. This is accomplished by using knowledge of the battery state-of-charge and temperature to set the charging voltage to an optimum battery voltage level for recharging without detriment to battery life.

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

Charging System Components

Generator

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

Body Control Module (BCM)

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

Battery Current Sensor

The battery current sensor is a serviceable component that is connected to 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

)-100 percent. Normal duty cycle is between 5-95 percent. Between 0-5 percent and 95-100 percent are for diagnostic purposes.

Engine Control Module (ECM)

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

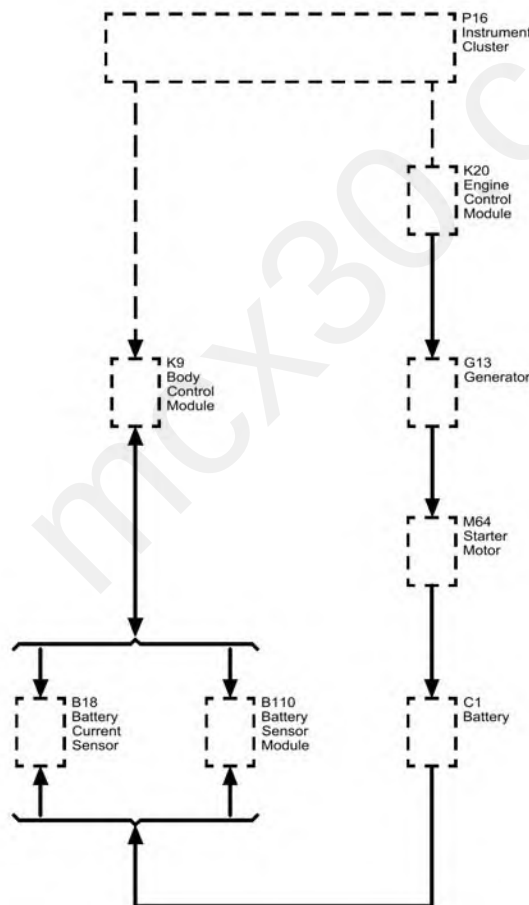


Fig. 149: Charging System Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Component Name	Commanded Duty Cycle	Generator Output Voltage
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	

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

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

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

Battery Sulfation Mode

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

Charge Mode

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 0°C (32°F).
- Battery State of Charge is less than 80 percent.
- Vehicle speed is greater than 145 km/h (90 mph)
- Current sensor fault exists.
- System voltage was determined to be below 12.56 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 0°C (32°F) but less than or equal to 80°C (176°F), the calculated battery current is less than 15 amperes and greater than -8 amperes, and the battery 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

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.

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:

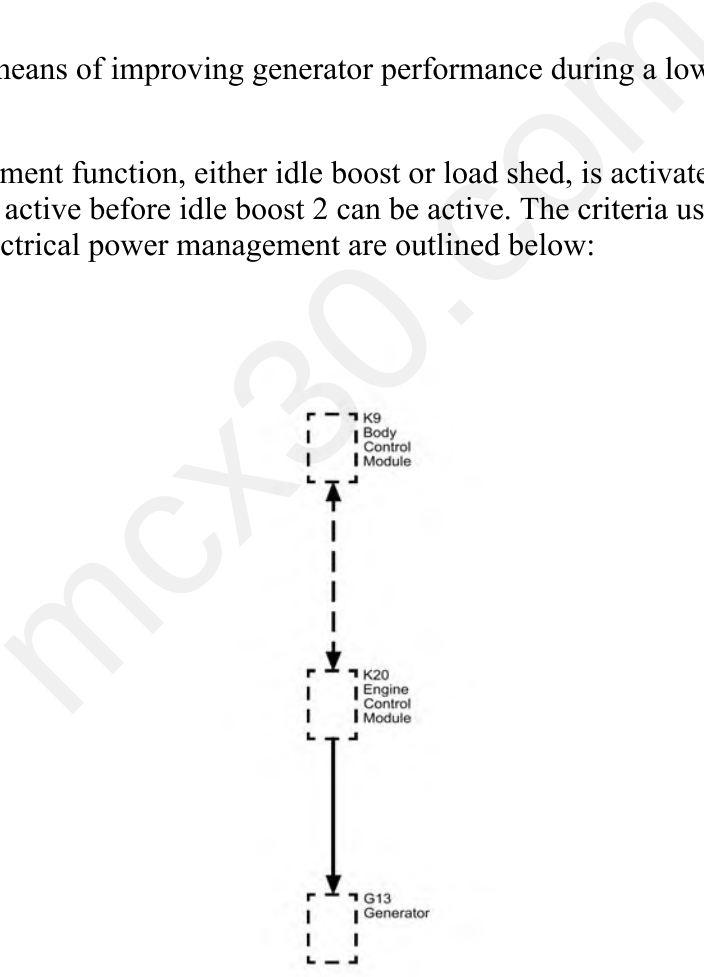


Fig. 150: Electrical Power Management Block Diagram
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
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Current Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
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 -15°C (5°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 Ah	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 11 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -10°C (14°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

Function	Battery Temperature Calculation	Battery Voltage Calculation	Battery Voltage Calculation	App-Hour Calculation	Action Taken
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

Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
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.

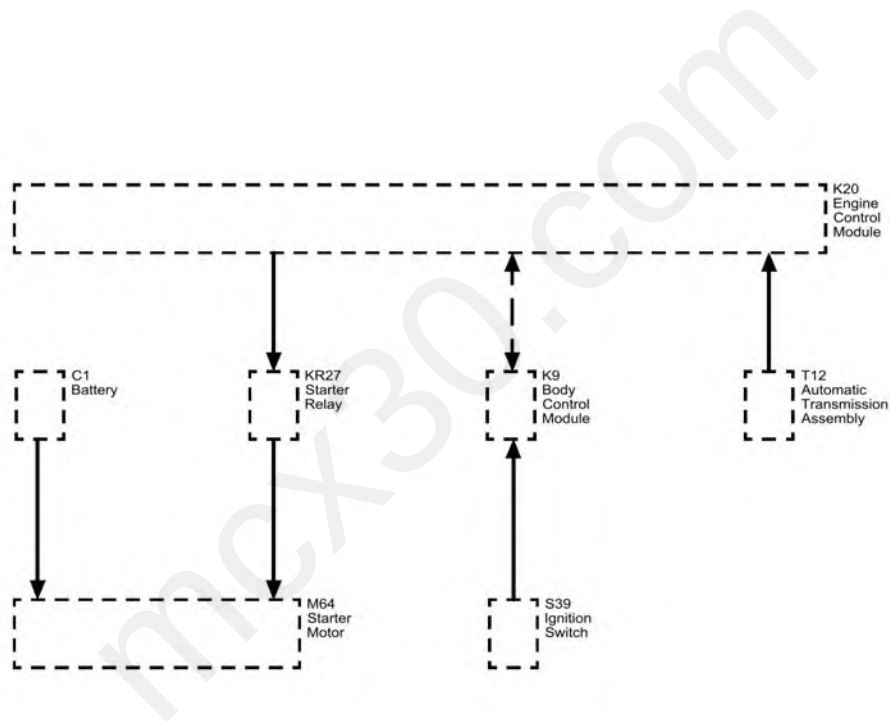
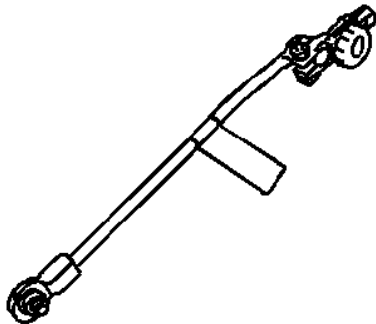
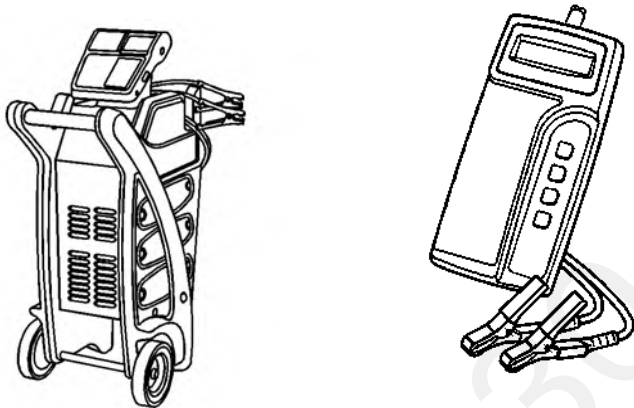


Fig. 151: Starting System Block Diagram
 Courtesy of GENERAL MOTORS COMPANY

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

SPECIAL TOOLS

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