

2017 ELECTRICAL

12 V Starting and Charging - CT6

SPECIFICATIONS

FASTENER SPECIFICATIONS

Reusable Threaded Fastener Tightening Specifications

NOTE: <i>All fasteners listed in this table can be reused after removal.</i>	
Application	Specification
	Metric (English)
Auxiliary A/C Evaporator Tube Bracket Fastener	9 N.m (80 lb in)
Battery Cover Bolt	9 N.m (80 lb in)
Battery Hold Down Retainer Bolt	22 N.m (16 lb ft)
Battery Negative Cable Extension Cable @ Engine Block Fastener (LGW)	58 N.m (43 lb ft)
Battery Negative Cable Extension Cable @ Engine Block Fastener (LGX, LTG)	40 N.m (30 lb ft)
Battery Negative Cable Extension Cable @ Frame Junction Block Fastener (LGW, LGX, LTG)	22 N.m (16 lb ft)
Battery Negative Cable Ground Bolt (without HP9)	4 N.m (35 lb in)
Battery Negative Cable Ground Terminal @ Battery Sensor (KL9)	15 N.m (11 lb ft)
Battery Negative Cable Ground Terminal @ Transmission Case Fastener (LCV, LFV)	40 N.m (30 lb ft)
Battery Negative Cable Ground Terminal @ Transmission Case Fastener (LTG)	22 N.m (16 lb ft)
Battery Negative Cable @ Battery Sensor Nut (KL9)	15 N.m (11 lb ft)
Battery Positive Cable @ Battery Distribution Engine Compartment Fuse Block Fastener (with HP9)	22 N.m (16 lb ft)
Battery Positive Cable @ Battery Distribution Engine Compartment Fuse Block Fastener (without HP9)	15 N.m (11 lb ft)
Battery Positive Cable @ Battery Fuse Block Nut	15 N.m (11 lb ft)
Battery Positive Post Clamp Nut	6 N.m (53 lb in)
Battery Post Negative Cable Clamp Nut	4.5 N.m (40 lb in)
Battery Post Positive Cable Clamp Nut	4.5 N.m (40 lb in)
Battery Tray Fastener	22 N.m (16 lb ft)
Body Harness Ground Terminal @ Negative Post Clamp Fastener (without KL9)	9 N.m (80 lb in)
Engine Wiring Fuse Block Bracket Bolt	9 N.m (80 lb in)
Engine Wiring Harness Terminal @ Engine Wiring Harness Junction Block Fastener	15 N.m (11 lb ft)
Generator Battery Jumper Cable Stud @ Battery Distribution Engine Compartment Fuse Block Fastener	15 N.m (11 lb ft)
Generator Battery Jumper Cable @ Engine Wiring Harness Junction Block Fastener (LTG)	15 N.m (11 lb ft)
Generator Battery Jumper Cable @ Generator (LGW, LGX, LTG)	15 N.m (11 lb ft)
Generator Battery Jumper Cable @ Starter Nut (LTG)	12 N.m (106 lb in)
Generator Long Bracket Bolt (LGW)	58 N.m (43 lb ft)

NOTE:

All fasteners listed in this table can be reused after removal.

Application	Specification
	Metric (English)
Generator Mounting Bolt (LGW)	58 N.m (43 lb ft)
Generator Mounting Bolt (LTG, LGX)	22 N.m (16 lb ft)
Generator Mounting Nut (LGW)	58 N.m (43 lb ft)
Generator Mounting Nut (LTG)	22 N.m (16 lb ft)
Generator Mounting Stud (LGW, LTG)	9 N.m (80 lb in)
Generator Nut (Battery Positive Cable - LGW, LGX, LTG)	15 N.m (11 lb ft)
Generator Short Bracket Bolt (LGW)	22 N.m (16 lb ft)
Multifunction Power Supply Converter Bracket Nut	6 N.m (53 lb in)
Spare Wheel Stowage Bracket Bolt	22 N.m (16 lb ft)
Starter Heat Shield Fastener	9 N.m (80 lb in)
Starter Mounting Bolt (LGW, LGX, LTG)	58 N.m (43 lb ft)
Starter Solenoid Cable Harness Retainer Fastener (LGX)	9 N.m (80 lb in)
Starter Solenoid Cable Nut (LGW, LGX, LTG)	12 N.m (106 lb in)
Starter Solenoid Cable @ Battery Distribution Engine Compartment Fuse Block Fastener (LGW, LGX)	15 N.m (11 lb ft)

SCHEMATIC WIRING DIAGRAMS

STARTING AND CHARGING WIRING SCHEMATICS

Starting

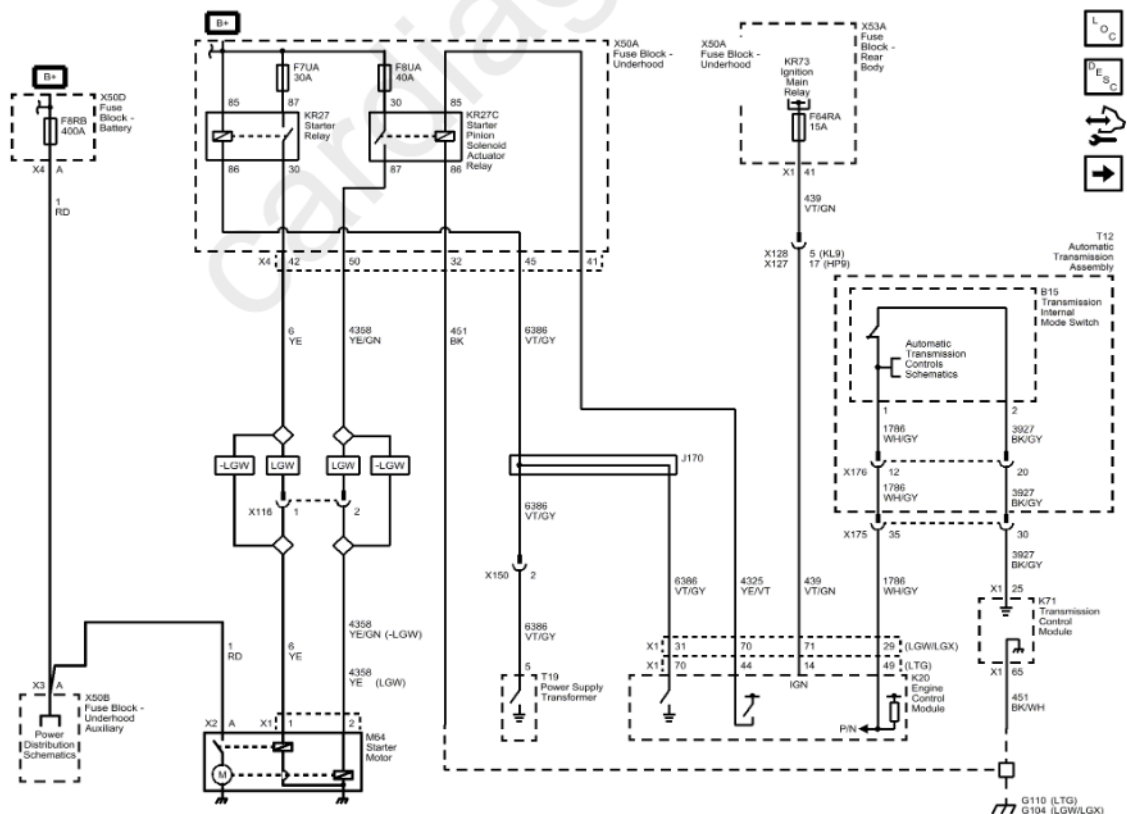


Fig. 1: Starting

Courtesy of GENERAL MOTORS COMPANY

Charging

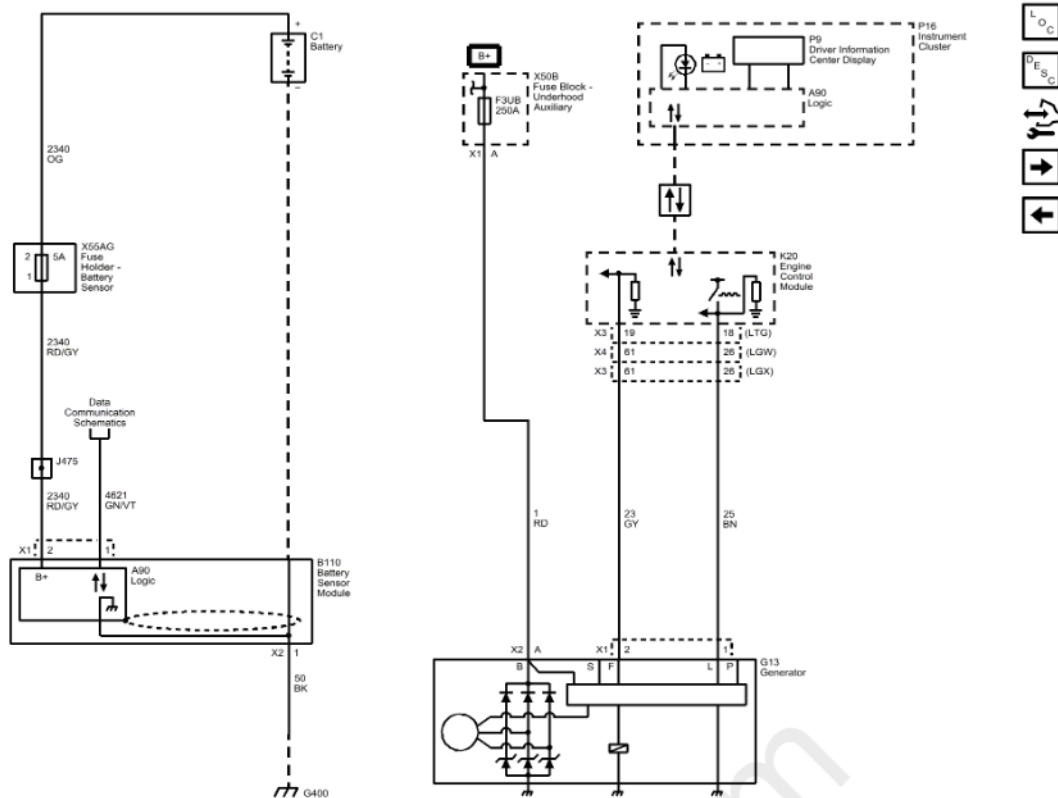


Fig. 2: Charging

Courtesy of GENERAL MOTORS COMPANY

Stop/Start System

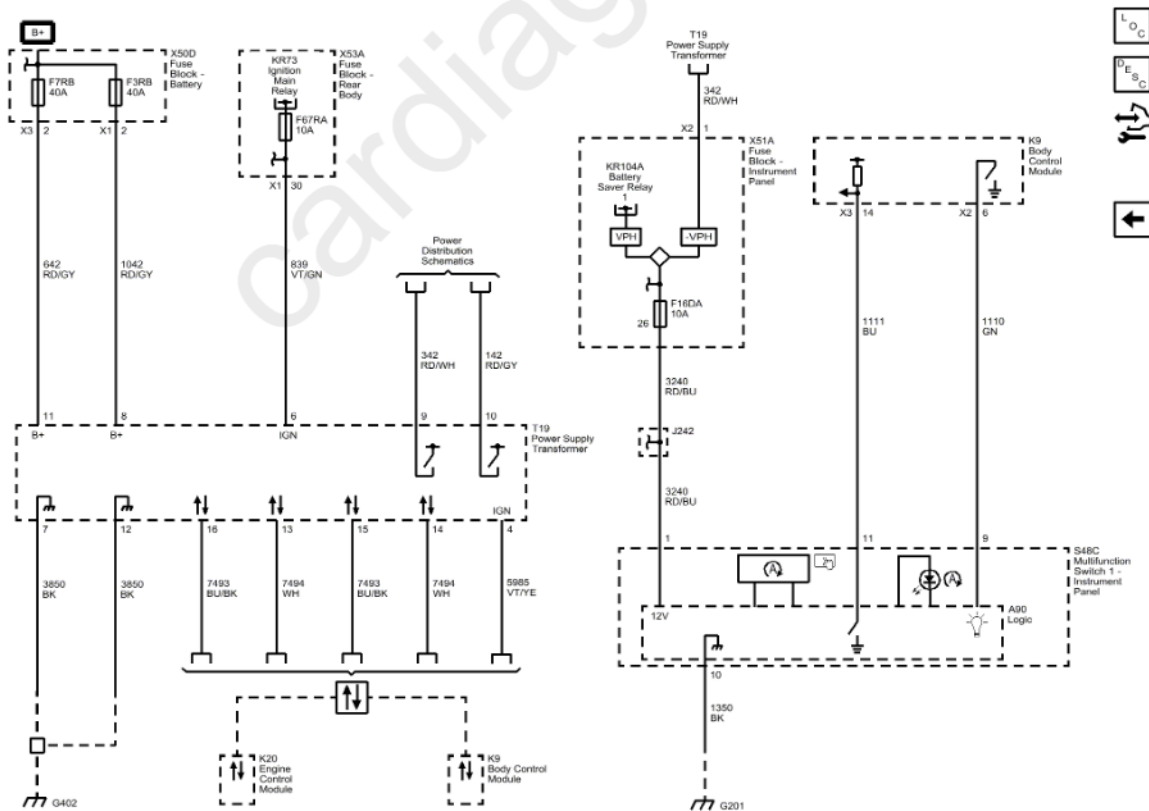


Fig. 3: Stop/Start System

Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC B1325, B1327, B1328, B1330, B1390, B1395, B1400, B1410, B1415, B1424, B1425, B1439, B1517, C0800, C0805, C0870, C0880, C0895, C0899, C0900, P0560-P0563, P0611, P129B, P129C, P15AE, P15AF, P17B0-P17B2, P1E19 OR P1E1A: DEVICE VOLTAGE/CONTROL MODULE/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

DTC B1330

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

Device Voltage

DTC C0899

Device Voltage

DTC C0900

Device Voltage

DTC P0560

System Voltage Low

DTC P0561

System Voltage Performance

DTC P0562

System Voltage Low

DTC P0563

System Voltage High

DTC P0611

Fuel Injector Control Module Performance

DTC P129B

System Voltage Low

DTC P129C

System Voltage High

DTC P15AE

Fuel Injector Control Module System Voltage Low Voltage

DTC P15AF

Fuel Injector Control Module System Voltage High Voltage

DTC P17B0

DTC P17B1

Transmission Range Control Module System Voltage Performance

DTC P17B2

Transmission Range Control Module System Voltage High

DTC P1E19

Auxiliary Transmission Fluid Pump Control Module System Voltage Low Voltage

DTC P1E1A

Auxiliary Transmission Fluid Pump 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.

Conditions for Setting the DTC

The control module or sensor detects a system voltage below or above a threshold.

Action Taken When the DTC Sets

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

Conditions for Clearing the DTC

The system voltage returns to normal operating range.

Diagnostic Aids

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

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

- [Circuit Testing](#)

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

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

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

[Circuit/System Verification](#)

1. Ignition OFF, measure and record the battery voltage at the battery terminals.
2. Verify the battery voltage stabilizes between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.

- **If battery voltage is less than 12.4 V or more than 12.8 V**

Refer to [Battery Inspection/Test](#).

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

3. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
4. Verify the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.

- **If the voltage is not at least 1 V greater than the voltage measured in step 1 or is greater than 15 V.**

Refer to [Charging System Test](#).

- **If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**

5. Verify the appropriate control module battery voltage and ignition voltage parameters are available in the scan tool.

- **If parameters are not available in the scan tool**

Refer to Circuit/System Testing

- **If parameters are available in the scan tool**

6. Verify the appropriate control module scan tool battery voltage and ignition voltage parameters are within 1 V of the battery voltage.

- **If not within 1 V of the battery voltage**

Refer to Circuit/System Testing

- **If within 1 V of the battery voltage**

7. All OK.

[Circuit/System Testing](#)

NOTE: Use the schematic to identify the following:

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

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

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

Repair Instructions

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

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

DTC B151A: BATTERY CAPACITY PERFORMANCE

Diagnostic Instructions

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

DTC Descriptor

DTC B151A 58

Circuit/System Description

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

Conditions for Running the DTC

The vehicle is ON

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

A driver information center message is displayed.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Verify DTC P0621 or P0622 is not set.
 - **If DTC P0621 or P0622 is set**
Refer to **DTC P0621** or **DTC P0622**
 - **If DTC P0621 or P0622 is not set**
2. Perform the **Battery Inspection/Test**.

DTC B1527: PARASITIC LOAD

Diagnostic Instructions

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

- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [Diagnostic Procedure Instructions](#) provides an overview of each diagnostic category.

DTC Descriptor

DTC B1527 00

Parasitic Load

Circuit/System Description

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

Conditions for Running the DTC

The ignition is in Accessory or Run mode.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

There is no battery telltale illuminated or DIC message displayed.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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

Scan Tool Reference

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

Circuit/System Verification

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

DTC P0561: SYSTEM VOLTAGE PERFORMANCE

Diagnostic Instructions

- Perform the [Diagnostic System Check - Vehicle](#) prior to using this diagnostic procedure.

- Review [Strategy Based Diagnosis](#) for an overview of the diagnostic approach.
- [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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- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)

DTC Type Reference

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.

Repair Instructions

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

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

DTC P0615, P0616 OR P0617: STARTER RELAY CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC 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
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Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+ Terminal 87	1	2	-	-
Relay Coil B+ Terminal 85	-	P0615	-	-
Relay Switch Control Terminal 30	2	2	3	-
Relay Coil Control Terminal 86	P0616	P0615	P0617	-
1. Opens fuse, starter inop 2. Starter inop 3. Starter spins all the time.				

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the body control module (BCM). The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is pressed or the transmission is in park/neutral. If it is, the ECM then 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 activated to START.
- The system voltage is between 9.5 18 V.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0615, P0616 and P0617 are C type DTCs.

Conditions for Clearing the DTC

DTC P0615, P0616 and P0617 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Relay Replacement \(Attached to Wire Harness\) Relay Replacement \(Within an Electrical Center\)](#)

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. Verify a test lamp illuminates between the B+ circuit terminal 87 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is good and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance,
 3. Disconnect the X1 harness connector at the M64 Starter Motor.
 4. Test for infinite resistance between the control circuit terminal 1 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**
3. Verify a test lamp illuminates between the B+ circuit terminal 85 and ground.
 - **If the test lamp does not illuminate**
 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 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 , repair the open/high resistance in the positive battery connection.
 - **If the test lamp illuminates**
4. Connect a test lamp between the B+ circuit terminal 85 and the control circuit terminal 86.

NOTE:

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

5. 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 and disconnect the T19 Power Supply Transformer, Ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V

3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the K20 Engine Control Module.
- **If the test lamp is always ON**
 1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module and disconnect the harness connector at the T19 Power Supply Transformer.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module or T19 Power Supply Transformer.
- **If the test lamp turns ON and OFF**
6. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 87 and the control circuit terminal 30.
7. 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 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**
8. Test or replace the KR27 Starter Relay.

Component Testing

Relay Test

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

Replace the relay.
 - **If between 70-150 Ω**
3. Test for infinite resistance between the terminals listed below:
 - (30 or 3) and (86 or 2)
 - (30 or 3) and (87 or 5)
 - (30 or 3) and (85 or 1)
 - (85 or 1) and (87 or 5)
 - (86 or 2) and (87 or 5)
 - **If less than infinite resistance**

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

Replace the relay.

- If less than 5.0 Ω

6. All OK

Repair Instructions

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

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

DTC P0621: GENERATOR L-TERMINAL CIRCUIT

Diagnostic Instructions

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

DTC Descriptor

DTC P0621

Generator L-Terminal Circuit

Diagnostic Fault Information

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

Circuit/System Description

The engine control module (ECM) uses the generator turn on control circuit to control the load of the generator on the engine. A high side driver in the ECM applies a duty cycled voltage to the voltage regulator. The duty cycle controls the voltage regulator to turn the field circuit on and off. The ECM monitors the state of the generator turn on control circuit. The ECM should detect low voltage on the generator turn on control circuit when the ignition is ON and the engine is off or when the charging system malfunctions. With the engine running, the ECM should detect high voltage on the generator turn on control circuit 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 seconds)
- 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 seconds.
- Engine running - The ECM detects a low voltage for 15 seconds on the generator control circuit when the duty cycle voltage is commanded high.
- Engine running - The ECM detects a high voltage for 15 seconds 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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- 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 X2, B X2 or 1 X2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Remove the test lamp, disconnect the battery negative cable and disconnect the G13 Generator B+ cable.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace G13 Generator.

- **If the test lamp illuminates**

2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Test for 1 V or greater between the control circuit terminal 1 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 the 2 Ω , repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the K20 Engine Control Module.

- **If 1V or greater**

4. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module, Ignition ON.
5. Test for less than 1 V between the G13 Generator control circuit terminal 1 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 \(LTG\)](#)[Generator Replacement \(LGW\)](#)[Generator Replacement \(LGX\)](#)
- [Control Module References](#) for 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).
- Engine running at less than 3, 000 RPM.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0622 is a type C DTC.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- **Testing for Intermittent Conditions and Poor Connections**
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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

1. Engine running.
2. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is between 5-90%.

- **If not between 5-90%**

Refer to Circuit/System Testing.

- **If between 5-90%**

3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.

- **If the parameter does not change**

Refer to Circuit/System Testing.

- **If the parameter changes**

4. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.

5. Verify the DTC does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

6. All OK.

Circuit/System Testing

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

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

1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.

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

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

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

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

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

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

- **If the test lamp illuminates**

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

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

- **If 5% or greater**

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

2. Test for less than 1 V between the signal circuit terminal 2 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

- **If less than 5%**

4. Install a 3 A fused jumper wire between the signal circuit terminal 2 and B+, engine running.

5. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is greater than 95%.

- **If 95% or less**

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

2. Test for infinite resistance between the signal circuit and ground.

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

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

Repair Instructions

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

- [Generator Replacement \(LTG\)](#)[Generator Replacement \(LGW\)](#)[Generator Replacement \(LGX\)](#)
- [Control Module References](#) for engine control module replacement, programming and setup.

DTC P100C OR P100D: BATTERY SENSOR MODULE TEMPERATURE ERRATIC

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 P100C

Battery Sensor Module Temperature Erratic

DTC P100D

Battery Sensor Module Internal Temperature Circuit Erratic

Circuit/System Description

The battery sensor module monitors battery module performs internal diagnostics.

Conditions for Running the DTC

- The system voltage is above 11.00 V
- Engine running

Conditions for Setting the DTC

DTC P100C or P100D

The battery sensor module detects an internal fault.

Action Taken When the DTC Sets

- DTC P100C is a type B DTC.
- DTC P100D is a type B DTC.

Conditions for Clearing the DTC

- DTC P100C is a type B DTC.
- DTC P100D is a type B DTC.

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P100C or P100D is not set.
 - **If the DTC is set**
 1. Replace the B110 Battery Sensor Module
 - **If the DTC is not set**
3. All OK

Repair Instructions

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

Battery Sensor Replacement (KL9) for Battery Sensor Module replacement

DTC P155E, P155F OR P156E: DC/DC CONVERTER SIGNAL MESSAGE COUNTER INCORRECT

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 P155E

DC/DC Converter Actuator Voltage Signal Message Counter Incorrect

DTC P155F

DC/DC Converter Performance Signal Message Counter Incorrect

DTC P156E

DC/DC Converter Crank Control Signal Message Counter Incorrect

Circuit/System Description

The power supply transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The power supply transformer communicates to the ECM and the ECM sets faults for any mismatch between alive rolling counts and protection values.

Conditions for Running the DTC

Engine running

Conditions for Setting the DTC

P155E

The ECM detects an error in the communication of the DC/DC converter actuator voltage signal for greater than 10 counts.

P155F

The ECM detects an error in the communication of the DC/DC converter internal health signal for greater than 10 counts.

P156E

The ECM detects an error in the communication of the DC/DC converter crank control terminal signal for greater than 10 counts.

Action Taken When the DTC Sets

- DTC P155E, DTC P155F and DTC P156E are type B DTCs.

Conditions for Clearing the DTC

- DTC P155E, DTC P155F and DTC P156E are type B DTCs.

Reference Information

Schematic Reference

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Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Verify that no other DTCs are set except for DTC P155E, DTC P155F or DTC P156E

- **If any other DTCs are set**

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#)

- **If no other DTCs are set**

3. Replace the T19 Power Supply Transformer.
4. Verify DTC P155E, DTC P155F or DTC P156E does not set while operating the vehicle within the conditions for running the DTC.

- **If any of the DTCs are set**

Replace the K20 Engine Control Module.

- **If none of the DTCs are set**

5. All OK

Repair Instructions

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

- [Multifunction Power Supply Converter Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

DTC P15A2: STOP/START SELECT SWITCH CIRCUIT SIGNAL

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 P15A2

Stop/Start Select Switch Circuit Signal

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal	P15A2	1	P15A2	-
Ground	-	1	P15A2	-
1. Stop/Start switch remains inactive				

Circuit/System Description

The body control module (BCM) signal circuit is pulled to ground when the ECO button is suppressed.

Conditions for Running the DTC

- The ignition is ON.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

The BCM detects either a short to ground or short to voltage in the multifunction switch control signal circuit for more than 60 s.

Action Taken When the DTC Sets

DTC P15A2 00 is a Type C DTC.

Conditions for Clearing the DTC

DTC P15A2 00 is a Type C DTC.

Reference Information

Schematic Reference

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Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON
2. Verify the scan tool Stop/Start Select Switch parameter changes between Active and Inactive when pressing and releasing the ECO switch or S124 Stop/Start Select Switch.
 - **If the parameter does not change**

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

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S48C Multifunction Switch 1 - Instrument Panel.
2. Test for less than 10 Ω between the ground circuit terminal 10 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω at 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, verify with a scan tool the Engine control Module Stop/Start Select Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 11 and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
4. Install a 3 A fused jumper wire between the signal circuit terminal 11 and ground.
 5. Verify the scan tool Stop/Start Select Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the 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
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance on the circuit.
 - If less than 2 Ω , replace the K9 Body Control Module.
 - **If Active**
 6. Test or replace the S48C Multifunction Switch 1 - Instrument Panel.

Repair Instructions

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

- [Parking Assist Alarm Disable Switch Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

DTC P15A3: STOP/START SELECT SWITCH CIRCUIT SIGNAL MESSAGE COUNTER INCORRECT

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 P15A3 00

Stop/Start Select Switch Circuit Signal Message Counter Incorrect

Circuit/System Description

The engine control module (ECM) receives the stop/start switch speed signal via serial data from the body control module (BCM).

Conditions for Running the DTC

- The ignition is ON.
- The DTCs run continuously once the above condition is met.

Conditions for Setting the DTC

The ECM receives an invalid stop/start switch status serial data message from the BCM.

Action Taken When the DTC Sets

DTC P15A3 00 is a Type C DTC.

Conditions for Clearing the DTC

DTC P15A3 00 is a Type C DTC.

Reference Information

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Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition ON
2. Verify no DTCs are set in the K9 Body Control Module.
 - **If any DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**
 - **If no DTCs are set**
3. Verify the scan tool Stop/Start Select Switch parameter changes between Active and Inactive when pressing and releasing the ECO switch.
 - **If the parameter does not change**
Refer to Circuit/System Testing
 - **If the parameter changes**
4. All OK.

Circuit/System Testing

1. Ignition OFF, disconnect the harness connector at the S48C Multifunction Switch 1 - Instrument Panel.
2. Test for less than 10 Ω between the ground circuit terminal 10 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω at 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, verify with a scan tool the Engine Control Module Stop/Start Select Switch parameter is No.
 - **If the parameter is YES**

1. Ignition OFF, disconnect the harness connector X3 at the K9 Body Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground at the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
- **If the parameter is NO**
4. Install a 3 A fused jumper wire between the signal circuit terminal 11 and ground. Verify the ECM scan tool Stop/Start Select Switch parameter is Yes.
 - **If the parameter is NO**
 1. Ignition OFF.
 2. Disconnect the harness connector X3 at the K9 Body Control Module.
 3. Test for less than 1 V the control circuit and ground.
 - If greater than 1 V, repair the short to voltage.
 - If less than 1 V, replace the K9 Body Control Module.
 - **If the parameter is YES**
5. Replace the S48C Multifunction Switch 1 - Instrument Panel.

Repair Instructions

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

- [Parking Assist Alarm Disable Switch Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup

DTC P15FF: BATTERY MONITOR SENSOR SIGNAL MESSAGE COUNTER INCORRECT

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 P15FF

Battery Monitor Sensor Signal Message Counter Incorrect

Circuit/System Description

The battery sensor module monitors battery module performs internal diagnostics. The battery sensor module also communicates to the ECM and the ECM sets faults for any errors in the reported alive rolling counts.

Conditions for Running the DTC

- The system voltage is above 11.00 V
- Engine running

Conditions for Setting the DTC

DTC P15FF

The battery sensor module detects an internal fault or an error in communication of the alive rolling count is detected for greater than 10 counts.

Action Taken When the DTC Sets

- DTC P15FF is a type B DTC.

Conditions for Clearing the DTC

- DTC P15FF is a type B DTC.

Reference Information

Schematic Reference

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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. Verify DTC P15FF is not set.
 - **If the DTC is set**
 1. Replace the B110 Battery Sensor Module
 - **If the DTC is not set**
3. All OK

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Battery Sensor Replacement (KL9) for Battery Sensor Module replacement

DTC P166F: GENERATOR INFORMATION NOT PROGRAMMED ENGINE CONTROL MODULE (ECM)

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 P166F

Generator Information Not Programmed Engine Control Module (ECM)

Circuit/System Description

This DTC sets when the engine control module (ECM) has determined that the generator information is not stored in the ECM memory. The control functions for the generator are integrated in the engine control module (ECM). The generator configuration programming must be done when either of the following procedures are performed:

- The ECM is replaced
- The generator has been replaced

Conditions for Running the DTC

- The control module is ON or awake.
- The DTC runs continuously when the above condition is met.

Conditions for Setting the DTC

The ECM detects the generator configuration is not stored in memory.

Action Taken When the DTC Sets

DTCs P166F is a Type A DTC.

Conditions for Clearing the DTC

DTCs P166F is a Type A DTC.

Reference Information

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.
 1. Configure the K20 Engine Control Module.
 2. Verify the DTC does not set.
 - If the DTC sets, replace the K20 Engine Control Module.
 - If the DTC does not set
 3. All OK.
 - **If DTC P166F is not set**
2. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for ECM replacement, programming and setup.

DTC P058A-P058F, P16D4-P16D6, P16DC-P16DF OR P16E1-P16E3: BATTERY SENSOR MODULE

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 P058A

Battery Sensor Module Performance

DTC P058B

Battery Sensor Module Current Monitoring Performance

DTC P058C

Battery Sensor Module Temperature Monitoring Performance

DTC P058D

Battery Sensor Module Voltage Monitoring Performance

DTC P058E

Battery Sensor Module Temperature Too High

DTC P058F

Battery Sensor Module Temperature Too Low

DTC P16D4

Battery Sensor Module Circuit Low Voltage

DTC P16D5

Battery Sensor Module Circuit High Voltage

DTC P16D6

Battery Sensor Module Current Low

DTC P16DC

Battery Sensor Monitor Timer Performance

DTC P16DD

Battery Sensor Module Current High

DTC P16DE

Battery Sensor Internal Temperature Circuit Low Voltage

DTC P16DF

Battery Sensor Internal Temperature Circuit High Voltage

DTC P16E1

Battery Sensor Module Random Access Memory (RAM)

DTC P16E2

Battery Sensor Module Read Only Memory (ROM)

DTC P16E3

Battery Sensor Module Data Incompatible Diagnostic

Circuit/System Description

The vehicle control module monitors the system voltage, current and internal temperature to verify they are within the normal operating range. It also monitors ROM or RAM memory faults and performs other internal diagnostics.

Conditions for Running the DTC

- The system voltage is above 9.00 V
- The ignition is not OFF

Conditions for Setting the DTC

DTC P058A

The battery sensor module detects an internal fault.

DTC P058B

The battery sensor module detects an internal fault after comparing an induced 50 A current to the battery sensor module calculated current.

DTC P058C

The battery sensor module detects a difference between raw temperature values to be 10.00 Celsius or more for 8 out of 10 samples.

DTC P058D

An absolute difference of 5.00 V or more is detected between the 12 V system reference voltage measured by the ECM and 12 V battery voltage measured by the battery sensor module for 32 out of 40 samples.

DTC P058E

The battery sensor module detects a raw temperature 2 value of 120.00 Celsius or more for 4 out of 5 samples.

DTC P058F

The battery sensor module detects a raw temperature 2 value of -43.00 Celsius or less for 4 out of 5 samples.

DTC P16DC

The battery sensor module does not properly execute wakeups while the vehicle is asleep.

DTC P16DD

The battery sensor module detects a current of greater than 1400 A.

DTC P16DE

The battery sensor module detects an internal temperature of 120.00 Celsius or more for 4 out of 5 samples.

DTC P16DF

The battery sensor module detects an internal temperature of -43.00 Celsius or less for 4 out of 5 samples.

DTC P16D4

The battery sensor module detects a voltage of less than 3 V.

DTC P16D5

The battery sensor module detects a voltage of greater than 26 V.

DTC P16D6

The battery sensor module detects a current of less than -1400 A.

DTC P16E1

The battery sensor module detects a RAM memory fault.

DTC P16E2

The battery sensor module detects a ROM memory fault.

DTC P16E3

The battery sensor module is not using the correct configuration information it receives from the ECM.

Action Taken When the DTC Sets

- The control module stores the DTC information into memory when the diagnostic runs and fails.
- The MIL will not illuminate.
- The control module records the operating conditions at the time the diagnostic fails. The control module stores this information in the Failure Records.
- The driver information center, if equipped, may display a message.
- Stop/Start system may be disabled.

Conditions for Clearing the DTC

- DTC P058A, DTC P058B, DTC P058C, DTC P058D, DTC P058E, DTC P058F, DTC P16DC, DTC P16DD, DTC P16DE, DTC P16DF, DTC P16D4, DTC P16D5, DTC P16D6, DTC P16E1, DTC P16E2 and DTC P16E3 and are Type C DTCs..
- A current DTC Last Test Failed clears when the diagnostic runs and passes
- A history DTC clears after 40 consecutive warm-up cycles, if no failures are reported by this or any other non-emission related diagnostic.
- Clear the DTC with a scan tool.

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.
- A possible cause of this DTC is a discharged battery or a poor/intermittent connection at X1 Battery Sensor Module.

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

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

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

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

[Circuit/System 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. Refer to Circuit/System Testing.

[Circuit/System Testing](#)

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.
2. Test for less than 2 Ω between the Negative Battery post and the B110 Battery Sensor Module clamp
 - **If 2 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 2 Ω**
3. Disconnect the harness connector at the B110 Battery Sensor Module.
4. Verify a test lamp illuminates between B+ circuit terminal 2 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 B110 Battery Sensor Module.
- **If the test lamp illuminates**
5. Replace the B110 Battery Sensor Module.

Repair Instructions

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

[Battery Sensor Replacement \(KL9\)](#) for Battery Sensor Module replacement.

DTC P26E4-P26E6: STARTER DRIVE PINION RELAY CONTROL CIRCUIT

Diagnostic Instructions

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

DTC Descriptors

DTC P26E4

Starter Drive Pinion Relay Control Circuit

DTC P26E5

Starter Drive Pinion Relay Control Circuit Low Voltage

DTC P26E6

Starter Drive Pinion Relay Control Circuit High Voltage

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

- The ignition is activated to START.

- The system voltage is between 9.5-18 V.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P26E4, P26E5 and P26E6 are C type DTCs.

Conditions for Clearing the DTC

DTC P26E4, P26E5 and P26E6 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

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- **Circuit Testing**
- **Connector Repairs**
- **Testing for Intermittent Conditions and Poor Connections**
- **Wiring Repairs**
- **Relay Replacement (Attached to Wire Harness) Relay Replacement (Within an Electrical Center)**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information.

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27C Starter Pinion Solenoid Actuator Relay. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between the ground circuit terminal 86 and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , verify the fuse is good and there is voltage at the fuse.

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

1. Ignition OFF.

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

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

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

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

• **If the test lamp illuminates**

5. Connect a test lamp between the control circuit terminal 85 and the ground circuit terminal 86.

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

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

• **If the test lamp is always OFF**

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

2. Test for infinite resistance between the control circuit and ground.

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

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

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

• **If the test lamp is always ON**

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

2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K20 Engine Control Module.

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

7. Ignition ON, connect a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.

8. Verify the M64 Starter Motor is activated.

• **If the M64 Starter Motor does not activate**

1. Ignition OFF, disconnect the harness connector at the M64 Starter Motor.

2. Test for infinite resistance between the control circuit terminal X1 1 or X1 A and ground.

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

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

- If 2 Ω or greater, repair the open/high resistance in the circuit.
- If less than 2 Ω , replace the M64 Starter Motor.

• **If the M64 Starter Motor activates**

9. Test or replace the KR27C Starter Pinion Solenoid Actuator Relay.

Component Testing

Relay Test

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

- **If less than 70 or greater than 150 Ω**

Replace the relay.

- **If between 70-150 Ω**

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

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

- **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

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

- **If 5.0 Ω or greater**

Replace the relay.

- **If less than 5.0 Ω**

6. All OK

Repair Instructions

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

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

DTC P3051, P3053 OR P3055: DC/DC CONVERTER ACTUATOR 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 Descriptor

DTC P3051

DC/DC Converter Actuator Voltage Sensor Circuit 1 Low Voltage

DTC P3053

DC/DC Converter Actuator Voltage Sensor Circuit 1 High Voltage

DTC P3055

DC/DC Converter Actuator Voltage 1 Performance

Diagnostic Fault Information

Device Voltage Output 1 Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 11	-	P3051, P3055, U260A, B3980, B1325, U0155, U0184, U0198, U0230, U1501*	-	-
B+ Terminal 8	-	P3052, P3056, U18D2, U18D3, U0101, U0422*	-	-
Control Terminal 5	B1445 0B, P3051	B1445 04, P305E*	P3053	P3055
Ignition terminal 4	-	U18A7	-	-
Ignition terminal 6	-	P305C, P305E	-	-
*Other DTCs may set with this fault.				

Circuit/System Description

The power supply transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The power supply transformer communicates to the ECM. When the engine is not cranking, the power supply transformer passes through voltage from the two supply circuits. The ECM receives data about the sensed output voltages provided by the power supply transformer.

Diagnostic Aids

- If P3055 is set, verify ECM and T19 Power Supply Converter grounds are clean and tight.
- Ground circuits for the area of customer concern are clean, tight and in the correct location. Refer to [Ground Distribution Wiring Schematics](#) and [Harness Routing Views](#).
- Verify all devices powered by the T19 Power Supply Transformer are operating properly.
- B+ circuit terminal 11 supplies voltage to output circuit terminal 10, function 12v regulated supply voltage 1
- B+ circuit terminal 8 supplies voltage to output circuit terminal 9, function 12v regulated supply voltage 2

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

P3051

The ECM detects the DC/DC converter actuator voltage 1 is less than 1 V.

P3053

The ECM detects the DC/DC converter actuator voltage 1 is greater than 28 V.

P3055

The ECM detects the difference between the ECM IGN voltage and DC/DC converter output is greater than or equal to 1 V.

Action Taken When the DTC Sets

- DTC P3051, P3053 and P3055 are type B DTCs.

Conditions for Clearing the DTC

- DTC P3051, P3053 and P3055 are type B DTCs.

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- [Wiring Repairs](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

NOTE: Use schematics to determine which devices are powered up on the T19 Power Supply Transformer B+ supply circuit terminal 10 X1.

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. Verify ECM ground is clean and tight.
4. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
5. 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.

6. Ignition ON.

7. Verify that the appropriate devices controlled by the T19 Power Supply Transformer control circuit terminal 10 X1 turn ON when cycling the ignition ON.

- If the devices do not turn ON

Refer to Circuit/System Testing.

- If the devices turn ON

8. Verify DTC P3051, P3053 or P3055 does not set.

- **If the DTC sets**

Refer to Circuit/System Testing.

- **If the DTC does not set**

9. All OK.

Circuit/System Testing

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

1. Ign Off and all vehicle systems OFF, disconnect harness connector at T19 Power Supply Transformer. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 ohms between each circuit ground terminal at the T19 Power Supply Transformer listed below and ground:
 - Terminal 7
 - Terminal 12
3. Disconnect harness connector at the K20 Engine Control Module.
4. Test for less than 5 Ω between each ground circuit terminal and ground.
 - **If 5 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 5 Ω**
5. Verify a test lamp illuminates between each of the B+ circuits at the T19 Power Supply Transformer listed below and ground:
 - Terminal 8
 - Terminal 11
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp, remove appropriate fuses.
 2. Test for infinite resistance between the B+ circuit and ground.
 - less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. 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 , replace the T19 Power Supply Transformer.
 - **If the test lamp illuminates**
6. Ignition ON.
7. Verify a test lamp illuminates between each of the Ign circuits at the T19 Power Supply Transformer listed below and ground:
 - Terminal 4
 - Terminal 6
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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, remove the test lamp.

2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance, replace the T19 Power Supply Transformer.

- **If the test lamp illuminates**

8. Ignition Off. Reconnect T19 Power Supply Transformer.

9. Clear codes and operate vehicle in conditions for an autostop.

10. Verify DTC P3051, P3053 or P3055 does not set.

- **If any of the DTCs are set**

If DTC sets, replace T19 Power Supply Transformer.

- **If none of the DTCs are set**

11. All OK

Repair Instructions

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

- [Multifunction Power Supply Converter Replacement](#) for T19 Power Supply Transformer replacement
- [Control Module References](#) for control module replacement, programming and setup.

DTC P3052, P3054 OR P3056: DC/DC CONVERTER ACTUATOR 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 Descriptor

DTC P3052

DC/DC Converter Actuator Voltage Sensor Circuit 2 Low Voltage

DTC P3054

DC/DC Converter Actuator Voltage Sensor Circuit 2 High Voltage

DTC P3056

DC/DC Converter Actuator Voltage 2 Performance

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ Terminal 11	-	P3051, P3055, U260A, B3980, B1325, U0155, U0184, U0198, U0230, U1501*	-	-
B+ Terminal 8	-	P3052, P3056, U18D2, U18D3, U0101, U0422*	-	-
Control Terminal 5	B1445 0B, P3051	B1445 04, P305E*	P3053	P3055
Ignition terminal 4	-	U18A7	-	-
Ignition terminal 6	-	P305C, P305E	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
*Other DTC's may set with this fault.				

Circuit/System Description

The power supply transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The power supply transformer communicates to the ECM. When the engine is not cranking, the power supply transformer passes through voltage from the two supply circuits. The ECM receives data about the sensed output voltages provided by the power supply transformer.

Diagnostic Aids

- If P3056 is set, verify ECM and T19 Power Supply Converter grounds are clean and tight.
- Verify all devices powered by the T19 Power Supply Transformer are operating properly.
- B+ circuit terminal 11 supplies voltage to output circuit terminal 10, function 12v regulated supply voltage 1
- B+ circuit terminal 8 supplies voltage to output circuit terminal 9, function 12v regulated supply voltage 2

Conditions for Running the DTC

Ignition ON

Conditions for Setting the DTC

P3052

The ECM detects the DC/DC converter actuator voltage 1 is less than 1 V.

P3054

The ECM detects the DC/DC converter actuator voltage 1 is greater than 28 V.

P3056

The ECM detects the difference between the ECM IGN voltage and DC/DC converter output is greater than or equal to 1 V.

Action Taken When the DTC Sets

- DTC P3052, P3054 and P3056 are type B DTCs

Conditions for Clearing the DTC

- DTC P3052, P3054 and P3056 are type B DTCs

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- [Wiring Repairs](#)

DTC Type Reference

[Powertrain Diagnostic Trouble Code \(DTC\) Type Definitions](#)

Scan Tool Reference

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

[Circuit/System Verification](#)

NOTE: Use schematics to determine which devices are powered up on the T19 Power Supply Transformer B+ supply circuit terminal 10 X1.

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. Verify ECM ground is clean and tight.
4. Engine running, headlights ON, measure and record the battery voltage at the battery terminals.
5. 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.
6. Ignition ON.
7. Verify that the appropriate devices controlled by the T19 Power Supply Transformer control circuit terminal 10 X1 turn ON when cycling the ignition ON.
 - If the devices do not turn ON
Refer to Circuit/System Testing.
 - If the devices turn ON
8. Verify DTC P3052, P3054 or P3056 does not set.
 - If the DTC sets
Refer to Circuit/System Testing.
 - If the DTC does not set
9. All OK.

[Circuit/System Testing](#)

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

1. Ign Off and all vehicle systems OFF, disconnect harness connector at T19 Power Supply Transformer. It may take up to 2 min for all vehicle systems to power down.

2. Test for less than 10 ohms between each circuit ground terminal at the T19 Power Supply Transformer listed below and ground:
 - Terminal 7
 - Terminal 12
3. Disconnect harness connector at the K20 Engine Control Module.
4. Test for less than 5 Ω between each ground circuit terminal and ground.
 - **If 5 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 5 Ω**
5. Verify a test lamp illuminates between each of the B+ circuits at the T19 Power Supply Transformer listed below and ground:
 - Terminal 8
 - Terminal 11
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp, remove appropriate fuses.
 2. Test for infinite resistance between the B+ circuit and ground.
 - less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. 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 , replace the T19 Power Supply Transformer.
 - **If the test lamp illuminates**
6. Ignition ON.
7. Verify a test lamp illuminates between each of the Ign circuits at the T19 Power Supply Transformer listed below and ground:
 - Terminal 4
 - Terminal 6
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , 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, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the T19 Power Supply Transformer.
 - **If the test lamp illuminates**
8. Ignition Off. Reconnect T19 Power Supply Transformer.
9. Clear codes and operate vehicle in conditions for an autostop.
10. Verify DTC P3052, P3054 or P3056 does not set.
 - **If any of the DTCs are set**

If DTC sets, replace T19 Power Supply Transformer.
 - **If none of the DTCs are set**
11. All OK

Repair Instructions

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

- [Multifunction Power Supply Converter Replacement](#) for T19 Power Supply Transformer replacement
- [Control Module References](#) for control module replacement, programming and setup.

DTC P305D OR P305E: DC/DC CONVERTER CRANK CONTROL 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 P305D

DC/DC Converter Crank Control Circuit High Voltage

DTC P305E

DC/DC Converter Crank Control Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Starter Relay B+	1	1	-	-
Starter Relay Control	P305E, 2	1	P305D	-
Power Supply Transformer Control	P305E, 2	P305E	P305D	-
1. Starter Solenoid Does Not Click 2. Starter spins all the time				

Circuit/System Description

The power supply transformer is used to boost battery voltage to sensitive loads during engine restart. It provides two voltage outputs that provide the boosted voltage. The power supply transformer communicates to the ECM and sends to the ECM the state of the crank control input.

Conditions for Running the DTC

- Ignition ON

Conditions for Setting the DTC

P305D

The ECM detects the DC/DC converter crank control is high when it should be low.

P305E

The ECM detects the DC/DC converter crank control is low when it should be high.

Action Taken When the DTC Sets

- DTC P305D and DTC P305E are type B DTCs.

Conditions for Clearing the DTC

- DTC P305D and DTC P305E are type B DTCs.

Diagnostic Aids

- These DTC's can be set when programming the Engine Control Module. Please follow the programming and setup instructions if a DTC sets.

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, disconnect the KR27 Starter Relay.
2. Verify a test lamp illuminates between the B+ circuit terminal 85 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. 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 , repair the open/high resistance in the positive battery connection.
 - **If the test lamp illuminates**
3. Ignition OFF, disconnect the harness connector at the T19 Power Supply Transformer, Ignition ON.
4. Connect a test lamp between B+ circuit terminal 85 and the control circuit terminal 86 at the KR27 Starter Relay.

NOTE:

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

5. Verify the test lamp turns ON and OFF when commanding the KR27 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, Ignition ON.
 2. Test for less than 1 V between the control circuit terminal and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1V
 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 infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module
 - **If the test lamp turns ON and OFF**
6. Connect a test lamp between the control circuit terminal 5 at the T19 Power Supply Transformer and B+.

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

7. Verify the test lamp turns ON and OFF when commanding the KR27 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, Ignition ON.
 2. Test for less than 1 V between the control circuit terminal 5 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1V
 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 infinite resistance between the control circuit terminal 5 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K20 Engine Control Module
 - **If the test lamp turns ON and OFF**
8. Replace the T19 Power Supply Transformer

Repair Instructions

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

- [Multifunction Power Supply Converter Replacement](#) for T19 Power Supply Transformer replacement
- [Control Module References](#) for control module replacement, programming and setup.

DTC U3001, U3003, U3006-U3009, U3013, U3014, U3018, U3019 OR U3500-U350B: CONTROL MODULE

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 U3001

Control Module Improper Shutdown

DTC U3003

Battery Voltage

DTC U3006

Control Module Input Power 1

DTC U3007

Control Module Supply Circuit 2

DTC U3008

Control Module Ground 1

DTC U3009

Control Module Ground 2

DTC U3013

Control Module Input Power 3

DTC U3014

Control Module Input Power 4

DTC U3018

Control Module Supply Circuit 1-2 Not Plausible

DTC U3019

Control Module Supply Circuit 3-4 Not Plausible

DTC U3500

Control Module Input Power "A" Circuit Range/Performance

DTC U3501

Control Module Supply Circuit 1 Low Voltage

DTC U3502

Control Module Supply Circuit 1 High Voltage

DTC U3503

Control Module Input Power "A" Circuit Intermittent/Erratic

DTC U3504

Control Module Input Power "B" Circuit Range/Performance

DTC U3505

Control Module Supply Circuit 2 Low Voltage

DTC U3506

Control Module Supply Circuit 2 High Voltage

DTC U3507

Control Module Input Power "B" Circuit Intermittent/Erratic

DTC U3508

Control Module Input Power "C" Circuit Range/Performance

DTC U3509

Control Module Supply Circuit 3 Low Voltage

DTC U350A

Control Module Supply Circuit High Voltage

DTC U350B

Control Module Input Power "C" Circuit Intermittent/Erratic

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.

Conditions for 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

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

NOTE: Use the schematic to identify the following:

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

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

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connectors at the appropriate control module. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
3. If equipped, verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the appropriate control module.
 - **If the test lamp illuminates**
4. Ignition ON.
5. If equipped, verify a test lamp illuminates between each ignition circuit terminal and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , refer to [Power Mode Mismatch \(Without HP9\)](#) and/or [Power Mode Mismatch \(With HP9\)](#).
 - **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.

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

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

PROACTIVE ALERT IDENTIFIER SAC001

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](#) for an overview of the diagnostic approach.

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC001

Predicted Starting and Charging - Battery - Low Cranking Capacity Due to Shorted Cell

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Battery low cranking capacity due to shorted cell detected.

Diagnostic Aids

- This Service Message does not require any diagnosis.
- DO NOT use the **EL-50313** Midtronics GR8 Battery Tester/Charger. Refer to Battery Replacement in SI.
- No other action is required as the Service Message will automatically clear once the battery is replaced and the vehicle is operated over a number of ignition cycles. Other on board DTCs may have set if the vehicle experienced a low voltage condition.

Reference Information

Schematic Reference

Starting and Charging Schematics

Electrical Information Reference

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

Special Tools

Equivalent regional tools [Special Tools](#)

Circuit/System Verification

1. Verify if Service Message is present.

- **If Service message is present.**

Refer to [Battery Replacement](#)

- **If Service Message is not present.**

All Ok.

Repair Instructions

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

- [Battery Replacement](#)

PROACTIVE ALERT IDENTIFIER SAC002

Diagnostic Instructions

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

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC002

Predicted Starting and Charging - Low Cranking Capability Due to High Resistance

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Low Cranking Capability Due to High Resistance

Diagnostic Aids

- No other action is required as the Service Message will automatically clear once the system is replaced. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Reference Information

Schematic Reference

Starting and Charging Schematics

Electrical Information Reference

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

Special Tools

Equivalent regional tools [Special Tools](#)

Circuit/System Testing

1. Verify the battery cable connections are clean and tight.
2. Verify Voltage is between 12.0-15.0 V
 - **If not within the specified range** Refer to [Battery Inspection/Test](#)
 - **If within the specified range**
3. Test for less than the 0.5 V drop between the positive battery cable at the battery and the positive battery cable at the M64 starter motor as the ignition is placed in the CRANK/START position.
 - **If greater than 0.5 V**

Replace the positive battery cable.

- **If less than 0.5 V**

4. Test for less than 0.5 V drop between the negative battery cable and the M64 starter motor case as the ignition switch is placed in the CRANK/START position.

- **If greater than 0.5 V**

Replace the negative battery cable.

- **If less than 0.5 V**

5. Replace the Battery.

Repair Instructions

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

- **Battery Replacement**
- **Battery Negative Cable Replacement (without HP9)**
- **Battery Positive Cable Replacement**

PROACTIVE ALERT IDENTIFIER SAC003

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.
- Review **Diagnostic Procedure Instructions** for an overview of the diagnostic approach.

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC003

Predicted Starting and Charging - Battery - Low Cranking Capability Due to Low State of Charge

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Battery Low Cranking Capability Due to Low State of Charge.

Diagnostic Aids

- Follow the instructions in SI for Battery Inspection/Test and Battery Charging using the **EL-50313** Midtronics GR8 Battery Tester/Charger.
- Perform the Battery Electrical Drain/Parasitic Load Test in order to verify the cause of the low battery, such as aftermarket equipment, Customer driving habits, etc. Refer to SI.
- No other action is required as the Service Message will automatically clear once the battery is charged properly and the vehicle is operated over a number of ignition cycles. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Reference Information

Schematic Reference

Starting and Charging Schematics

Electrical Information Reference

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

- [Wiring Repairs](#)

Special Tools

Equivalent regional tools [Special Tools](#)

Circuit/System Verification

1. Verify the Service Message is present.

- **If Service Message is Present**

Refer to [Battery Inspection/Test](#) and [Battery Charging](#)

Perform [Battery Electrical Drain/Parasitic Load Test](#)

- **If Service Message is not Present.**

2. All Ok.

Repair Instructions

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

PROACTIVE ALERT IDENTIFIER SAC004

Diagnostic Instructions

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

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC004

Predicted Starting and Charging - Low Cranking Capability Due to High Resistance in Starter System

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Low Cranking Capability Due to High Resistance in Starter System.

Diagnostic Aids

- No other action is required as the Service Message will automatically clear once the system is replaced. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Reference Information

Schematic Reference

Starting and Charging Schematics

Electrical Information Reference

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

Equivalent regional tools: [Special Tools](#)

Circuit/System Testing

1. Verify the battery cable connections are clean and tight.
2. Verify Voltage is between 12.0-15.0 V
 - **If not within the specified range** Refer to [Battery Inspection/Test](#)
 - **If within the specified range**
3. Test for less than the 0.5 V drop between the positive battery cable at the battery and the positive battery cable at the M64 starter motor as the ignition is placed in the CRANK/START position.
 - **If greater than 0.5 V**

Replace the positive battery cable.
 - **If less than 0.5 V**
4. Test for less than 0.5 V drop between the negative battery cable and the M64 starter motor case as the ignition switch is placed in the CRANK/START position.
 - **If greater than 0.5 V**

Replace the negative battery cable.
 - **If less than 0.5 V**
5. Replace the Starter.

Repair Instructions

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

- [Starter Replacement \(LTG\)](#)[Starter Replacement \(LGW\)](#)[Starter Replacement \(LGX\)](#)

PROACTIVE ALERT IDENTIFIER SAC005

Diagnostic Instructions

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

Proactive Alert Identifier Descriptor

Proactive Alert Identifier Service Message Identifier SAC005

System Performance - Low Cranking Capability Due to High Resistance in Battery or Short in Starter

Conditions for Running the Proactive Alert Identifier

Service message present.

Conditions for Setting the Proactive Alert Identifier

Low Cranking Capability Due to High Resistance in Battery or Short in Starter.

Diagnostic Aids

- No other action is required as the Service Message will automatically clear once the system is replaced. Other on board DTCs may have set if the vehicle experienced a low voltage condition.
- Use the scan tool to clear ALL DTCs prior to releasing the vehicle to the Customer.

Schematic Reference

Starting and Charging Schematics

Electrical Information Reference

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

Special Tools

Equivalent regional tools: **Special Tools**

Circuit/System Testing

1. Verify the battery cable connections are clean and tight.
2. Verify Voltage is between 12.0-15.0 V
 - **If not within the specified range** Refer to **Battery Inspection/Test**
 - **If within the specified range**
3. Test for less than the 0.5 V drop between the positive battery cable at the battery and the positive battery cable at the M64 starter motor as the ignition is placed in the CRANK/START position.
 - **If greater than 0.5 V**
Replace the positive battery cable.
 - **If less than 0.5 V**
4. Test for less than 0.5 V drop between the negative battery cable and the M64 starter motor case as the ignition switch is placed in the CRANK/START position.
 - **If greater than 0.5 V**
Replace the negative battery cable.
 - **If less than 0.5 V**
5. Replace the Starter.

Repair Instructions

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

- **Starter Replacement (LTG)Starter Replacement (LGW)Starter Replacement (LGX)**

SYMPTOMS - ENGINE ELECTRICAL

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

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

Visual/Physical Inspection

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

Intermittent

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

Symptom List

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

- [Battery Inspection/Test](#)
- [Battery Electrical Drain/Parasitic Load Test](#)
- [Charging System Test](#)
- [Generator Noise Diagnosis](#)
- [Starter Solenoid Does Not Click](#)
- [Starter Solenoid Clicks, Engine Does Not Crank](#)
- [Engine Cranks Slowly](#)
- [Starter Noise Diagnosis](#)

SYMPTOMS - STOP/START SYSTEM

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

1. Perform the [Diagnostic System Check - Vehicle](#) before using the symptom tables in order to verify that all of the following are true:
 - There are no DTCs set.
 - The control modules can communicate via the serial data link.
2. Review the system description and operation in order to familiarize yourself with the system functions. Refer to [Stop/Start System Description and Operation](#).

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the Stop/Start System. Refer to [Checking Aftermarket Accessories](#) .
- Inspect the easily accessible or visible system components, for obvious damage or conditions, which may cause the symptom.

Intermittent

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

Symptom List

Refer to a symptom diagnostic procedure to diagnose the symptom:

[Stop/Start System Malfunction](#)

BATTERY INSPECTION/TEST

Diagnostic Instructions

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

NOTE: For Warranty repairs -

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

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 50313 Battery Tester

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

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 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.

- **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.

7. Enter the CCA as shown on the battery label.

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

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

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

Replace the C1 Battery.

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

Conduct Charging System Test and Battery Electrical Drain/Parasitic Load Test

- **If Battery is Ok and doesn't require Charging**

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.
- If you accidentally blind charged the battery by connecting the battery charger directly at the battery terminals, Autostop/Autostart will be disabled. Disconnect and Reconnect the Battery Sensor Module to enable Autostop/Autostart.

Battery State of Charge

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

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

1. Be sure all electrical loads are turned OFF.
2. Determine whether the battery has been used in a vehicle or charged within the past 12 hours.
 - If the answer is no, the terminal voltage will be stabilized and no action is necessary before reading the voltage. Skip to step 3.
 - If the answer is yes, terminal voltage will not be stabilized and you should wait 12 hours since the last time the battery was used.
3. Estimate the battery temperature by determining the average temperature to which the battery has been exposed for the past 12 hours.
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:

NOTE: The table is accurate to 10% only after the battery has been at rest for 12 hours.

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

Use the state of charge information as follows:

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

Charging Time Required

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

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

Charging Procedure

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

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

When charging side-terminal batteries with the battery cables connected, connect the charger to the positive cable bolt and to a ground located away from the battery. When charging side-terminal batteries with the battery cables disconnected, install the battery side terminal adapters and connect the charger to the adapters.

1. Turn OFF the charger.
2. Ensure that all of the battery terminal connections are clean and tight.
3. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.
4. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery.

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.

NOTE: If you connect the negative cable of the charger directly to the negative terminal of the battery, Autostop/Autostart will be disabled. Disconnect and Reconnect the Battery Sensor Module to enable Autostop/Autostart.

5. Select "Charging," "PDI" and "In Vehicle" when setting up the charger.
6. Select the proper battery type, Flooded, AGM, Spiral AGM or Stop/Start AGM.
7. 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 vehicle's battery are switches, relays and control modules. After the ignition is turned OFF the control modules will begin to go to sleep (shut OFF). All control modules do not go to sleep at the same time, some may take up to 30 minutes or longer after turning the ignition off before going to sleep, 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 Description and Operation](#)
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the compatible criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 minutes. The typical current draw for this is about 1A.
- Digital OnStar[®] Generation 6 and later Vehicle Communication Interface Modules do not "wake up" every 10 minutes for the first 48 hours as the Generation 5 and prior. Generation 6 and later Vehicle Communication Interface Module current draw is very low, less than 40 mA, so the OnStar[®] system is left in that state for up to the first 48 hours. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the Vehicle Communication Interface Module for the first 48 hours is normal.
- Some automatic climate control systems can remain in a semi awake state for up to three hours, actual draw amounts vary by vehicle platform but are typically not greater than 50 mA.
- An extremely low mA current level is consumed by the 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 FOB's 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 more than the customer may desire battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a one hour period to see if the current draw increases and stays above an unacceptable level.
- 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 ampere battery with a 110 minimum. 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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Electrical Information Reference

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

Scan Tool Reference

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

Special Tools

EL 38758 Parasitic Draw Test Switch

Circuit/System Verification

NOTE:

- Most vehicle systems will go to sleep within 30 minimum but it can take up to 2 hours before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 second.
- 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. Malfunction 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 minutes or longer, after all other listed conditions are met

Using an Inductive Pickup Probe

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

Using the EL 38758 Parasitic Draw Test Switch

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection](#).

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.

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

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 may 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 may cause a high current draw

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

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

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

Circuit/System Description

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

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

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

Circuit/System Verification

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

1. Ignition ON.
2. Verify that no G13 Generator or B18 Battery Current Sensor DTCs are set that would cause a charging system concern.
 - **If DTCs are set**
Refer to **Diagnostic Trouble Code (DTC) List - Vehicle**.
 - **If no DTCs are set**
3. Verify the scan tool Body Control Module Battery Voltage parameter is 12 V or greater.
 - **If less than 12 V**
Refer to **Battery Inspection/Test**.
 - **If 12 V or greater**
4. Engine running, all accessories OFF.
5. Verify the scan tool Body Control Module Battery Voltage parameter continually increases when controlling the Body Control Module Generator Regulator Setpoint from 10% to 80% with a scan tool. It may take up to 10 seconds for the battery voltage to stabilize between each setpoint change.
 - **If the battery voltage does not continually increase**
Refer to Circuit/System Testing.
 - **If the battery voltage continually increases**
6. All OK.

Circuit/System Testing

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

Circuit/System Testing

1. Ignition OFF.
2. Test for less than 2 Ω between the G13 Generator housing and battery negative terminal.
 - **If 2 Ω or greater**

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

Repair Instructions

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

[Generator Replacement \(LTG\)](#)[Generator Replacement \(LGW\)](#)[Generator Replacement \(LGX\)](#)

GENERATOR NOISE DIAGNOSIS

Diagnostic Instructions

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

Diagnostic Aids

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

Circuit/System Testing

1. Start the engine. Verify the noise can be heard. Compare the concern to a similar vehicle.
2. Perform a charging system test. Verify that the generator is charging properly.
3. Inspect the generator, generator mounting, wiring harness, heater hoses, A/C lines or other accessory equipment that may be misrouted or be the cause of noise being transmitted into the passenger compartment.
4. Ignition OFF, remove the engine drive belt.
5. Verify the generator, A/C compressor, water pump pulley, power steering pump, idler pulley and tensioner pulley spin freely.
 - **If any of the pulleys do not spin freely**

Replace the affected component.

- **If all belt driven components spin freely**

6. Start the engine. Operate the engine for no longer than 30-40 seconds.

7. Verify that the noise goes away.

- **If the noise is still present**

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

- **If noise is no longer present**

8. Inspect for worn accessory drive components or abnormalities such as severe cracking, bumps or missing areas in the accessory drive belt and/or misalignment of system components

Repair Instructions

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

STOP/START SYSTEM MALFUNCTION

Diagnostic Instructions

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

Circuit/System Description

The 12 volt start/stop system is used to reduced fuel consumption and emissions by automatically turning off the engine when coming to a stop and restarting when moving again. When coming to a stop, assuming no disable conditions exist, the engine will automatically turn. The engine will automatically restart when the driver presses the clutch pedal (manual transmission) or when the driver releases the brake pedal (automatic transmission).

The 12 volt start/stop system can be enabled or disabled by the driver using the Auto Stop Mode Switch. The body control module applies voltage to the switch signal and monitors the voltage. When the Auto Stop Mode Switch is pressed, the signal circuit is pulled to ground and voltage at the body control module is low, indicating the switch has been pressed. The body control module also controls the Auto Stop Mode Switch indicator. When the 12 volt start/stop system is enabled by the driver, the body control module will illuminate the indicator by providing voltage to the indicator control circuit.

To eliminate unwanted infotainment system effects during engine cranking, the 12 volt start/stop system utilizes a power supply transformer that provides a steady B+ to the infotainment system through the battery saver relay. During engine cranking, system voltage may momentarily drop below 10 volts. This momentary drop in voltage may cause the vehicle infotainment to turn off and restart during a start/stop event. The power supply transformer maintains steady B+ to the infotainment system to prevent an infotainment restart during cranking.

Diagnostic Aids

- If the driver does not fully depress the brake pedal, the vehicle may not enter Auto Stop mode.
- Auto Stop may be deactivated if any of the following conditions are present:
 - Ambient and coolant temperature correlation does not match specified values
 - Ambient temperature is less than -10°C (14°F)
 - Battery temperature is less than 0°C (32°F) or greater than 55°C (131°F)
 - HVAC system demand is high
 - HVAC defrost has been selected
 - Battery charge is low
 - The battery was improperly charged or jump started.

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

- Power on Reset is active when the parameters Battery Sensor Module Battery State Information and Battery Sensor Module Reset Occurred - Using Estimated State of Charge read Not Available (Not Learned) and Yes (Estimated). Stop/start is enabled when Power on Reset is active.
- Vehicle has not been allowed to sit for at least 3 hours over 1 week.
- Parasitic current is 100 mA or greater.
- When using a vehicle hoist to verify autostop and autostart operation, ensure the following conditions are also met:
 - Transmission gear selector is in the drive position
 - No DTCs are set
 - Traction control is off

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
2. Test for greater than 12 V between the battery positive terminal and negative terminal.

- **If 12 V or less**

Refer to **Battery Inspection/Test**.

- **If greater than 12 V**

3. Verify no DTCs set.

- **If any DTCs are set**

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

- **If no DTCs are set**

4. Verify the scan tool Stop/Start - Disable Mode parameter changes between Active and Inactive when pressing and releasing the Autostop switch.

- **If the parameter does not change**

Refer to Circuit/System Testing - Autostop Switch Circuit Malfunction

- **If the parameter changes**

5. Verify the Autostop switch indicator turns ON and OFF when commanding the Start/Stop Select Switch Indicator Active and Inactive with a scan tool.

- **If the Autostop switch indicator does not turn ON and OFF**

Refer to Circuit/System Testing - Autostop Switch Indicator Circuit Malfunction

- **If the Autostop switch indicator turns ON and OFF**

6. Verify Battery Sensor Module Battery State Information parameter reads Available (Learned) and Battery Sensor Module Reset Occurred - Using Estimated State of Charge reads No (Measured).

- If parameters read Not Available (Not Learned) and No (Measured).

1. Verify with customer if vehicle may have been jump started or been used to jump start another vehicle or if the battery has been charged recently.

- If Yes, Disconnect and reconnect the negative battery cable.
- If No

2. Connect a DMM to the battery terminals. Verify the battery voltage stays above 8.7 V while starting engine.

- If 8.7 V or below, refer to [Battery Inspection/Test](#)
- If greater than 8.7 V, conduct [Battery Electrical Drain/Parasitic Load Test](#) using an inductive probe.

3. If parasitic current is less than 100 mA, replace Battery Sensor Module.

- If parameters read Available (Learned) and No (Measured) or reads Not Available (Not Learned) and Yes (Estimated)

7. Verify the autostop and autostart functions are functioning properly while operating the vehicle under the conditions for entering a start/stop event. Refer to [Stop/Start System Description and Operation](#).

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

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

- **If the vehicle does not autostop or autostart**

1. Observe the scan tool Autostop Disable Reason, Autostop Inhibit Reason, Autostart Inhibit and Autostart Reason parameters while operating the vehicle under the conditions for entering a start/stop event. Refer to [Stop/Start Disable, Inhibit and Restart Reasons](#). These parameters will identify the specific cause for the autostop or autostart disable.

- **If the vehicle autostops and autostarts**

8. Verify the infotainment system remains active during a start/stop event.

- **If the infotainment system turns off or restarts during a start/stop event.**

Refer to Circuit/System Testing - Stop/Start Capacitor Control Module Malfunction.

- **If the infotainment system remains active during a start/stop event**

9. All OK.

Auto Stop Mode Switch Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the S48C Multifunction Switch - Instrument Panel, ignition ON.
2. Verify the scan tool Stop/Start Select Switch parameter is Inactive.
 - **If not Inactive**
 1. Ignition OFF, disconnect the X3 harness connector at the K9 Body Control Module.
 2. Test for infinite resistance between the signal circuit terminal 14 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K9 Body Control Module.
 - **If Inactive**
3. Install a 3 A fused jumper wire between the signal circuit terminal 11 and ground.
4. Verify the scan tool Stop/Start Select Switch parameter is Active.
 - **If not Active**
 1. Ignition OFF, disconnect the X3 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
 3. Ignition OFF.
 4. Test for less than 2 Ω in the signal circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance on the circuit.
 - If less than 2 Ω , replace the K9 Body Control Module.
 - **If Active**
5. Test or replace the S48C Multifunction Switch - Instrument Panel.

Auto Stop Mode Switch Indicator Circuit Malfunction

1. Ignition OFF, disconnect the harness connector at the S48C Multifunction Switch - Instrument Panel, ignition ON.
2. Connect a test lamp between the control circuit terminal 9 and B+.
3. Verify the test lamp turns ON and OFF when commanding the Start/Stop Select Switch Indicator by applying and unapplying ground to the signal circuit terminal 11.
 - **If the test lamp is always ON**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 Body 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 K9 Body Control Module.
 - **If the test lamp is always OFF**
 1. Ignition OFF, disconnect the X2 harness connector at the K9 Body Control Module, ignition ON.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Test for less than 2 Ω in the control circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance on the circuit.
 - If less than 2 Ω , replace the K9 Body Control Module.
 - **If the test lamp turns ON and OFF**
4. Test or replace the S48C Multifunction Switch - Instrument Panel.

Power Supply Transformer Circuit Malfunction

1. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the T19 Power Supply Transformer. It may take up to 2 min for all vehicle systems to power down.
2. Test for less than 10 Ω between each ground circuit terminal and ground.
 - **If 10 Ω or greater**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the ground circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , repair the open/high resistance in the ground connection.
 - **If less than 10 Ω**
3. Ignition ON.
4. Verify a test lamp illuminates between each B+ circuit terminal and ground.
 - **If the test amp 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, test or replace the T19 Power Supply Transformer.
 - **If the test lamp illuminates**
5. Verify a test lamp illuminates between each ignition circuit 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, Refer to **Power Mode Mismatch (Without HP9)** and/or **Power Mode Mismatch (With HP9)**.
 - **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, test or replace the T19 Power Supply Transformer.
 - **If the test lamp illuminates**
6. Install a test lamp between the control circuit terminal 5 and ground.
7. Verify the test lamp illuminates while cranking the engine.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module and disconnect the KR27 Starter Relay.
 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 illuminates**
8. Test or replace the T19 Power Supply Transformer.

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

- [Multifunction Power Supply Converter Replacement](#) for T19 Power Supply Transformer replacement
- [Parking Assist Alarm Disable Switch Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

STOP/START DISABLE, INHIBIT AND RESTART REASONS

NOTE: Not all parameters may be available in all vehicles

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

Autostop Disable

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

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Remote Vehicle Start Request	Engine Running	Remote Start indicates the internal combustion engine has been requested to run through a remote start command.	No	Verify remote start operation.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Acceleration Request	Engine Running	Driveability indicates an autostart was command based on torque conditions requested from the driver (generally a tip-in on the throttle). When this condition is detected, autostops are disallowed.	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Transmission In Reverse	Engine Running	Transmission in reverse gear.	No	Ensure transmission is in drive. Stop/start will not function in any other mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Reduced Engine Power Active	Engine Running	Reduced Power indicates that AutoStops are disallowed when a situation has been detected that causes the vehicle to operate with reduced power.	No	Check ECM DTC's.	As required.
Autostop Disable Reason - HYBRID/EV Battery Pack Temperature	Engine Running	HV Battery Pack Temperature indicates Disallow AutoStops/Command AutoStart when battery temperature is high.	No	Ensure parameter in scan tool is not indicating high. Check DTC's..	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Transmission Range	Engine Running	Transmission Range indicates that an autostop was prevented (or an autostart was commanded) due to the selected transmission range.	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Ignition Switch Start	Engine Running	Key Forced AutoStart Request: The driver can request an autostart in park or neutral by cranking the key. Autostops are not allowed again until out of park/neutral.	No	As required.	If OK: Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - TCM Request	Engine Running	TCM Override indicates that AutoStops are disallowed based on transmission PRNDL position.	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Optimization	Engine Running	System Optimization indicates Command AutoStart based on overall system conditions (engine speed & torque optimization). When this condition is detected, AutoStops are disallowed.	No	Ensure vehicle is over 3MPH/5KMH before autostop is enabled.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Voltage Low	Engine Running	12V battery state of function low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Engine Coolant Temperature Out Of Range	Engine Running	Engine Coolant Temperature indicates that an autostop was prevented (or an autostart was commanded) due to engine coolant temperature out of range (high or low).	No	Ensure coolant temperature isn't too high or low.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Catalyst Test In Progress	Engine Running	Catalyst indicates a requested inhibit for Catalyst monitor from gas or Diesel.	No	Ensure catalyst parameter isn't out of range	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - HO2S Test In Progress	Engine Running	Oxygen Sensor indicates a requested inhibit for Oxygen Sensor Monitor.	No	Ensure oxygen sensor parameter isn't out of range	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Misfire Test In Progress	Engine Running	Misfire Monitor indicates a requested inhibit for Misfire Monitor.	No	Ensure no misfire detected in scan tool.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Catalyst not at Operating Temperature	Engine Running	Catalyst not at Operating Temperature	No	Ensure Catalyst is within operating temperature	If OK: Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Intake Manifold Temperature Too High	Engine Running	Engine Manifold Temperature indicates an inhibit due to high Manifold Temp.	No	Ensure Manifold Temperature isn't high	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Speed Test in Progress	Engine Running	Engine Speed Diagnostics indicates a requested inhibit due to Engine Speed diagnostics.	No	As required	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - MAF sensor Test In Progress	Engine Running	Mass Air Flow Diagnostics indicates a requested inhibit due to MAF diagnostics.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - MAP Sensor Test In Progress	Engine Running	Manifold Absolute Pressure Diagnostics indicates a requested inhibit due to MAP diagnostics.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Oil Temperature Too High	Engine Running	Engine Oil Temp indicates an inhibit due to high Engine Oil Temp.	No	Check Oil temperature is not too high.	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Stop/Start Test in Progress	Engine Running	Starting System indicates an inhibit due to Engine Start Stop functions.	No	Ensure control functions are done before proper function of stop/start	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Engine Coolant Temperature Test In Progress	Engine Running	Engine Coolant Temperature indicates a requested inhibit due to low or high Engine Coolant Temperature.	No	Ensure control function is done before expecting stop/start to function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - EVAP System Test In Progress	Engine Running	EVAP System indicates a requested inhibit for EVAP System Monitor	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Injector Test In Progress	Engine Running	Fuel Injector Diagnostics indicates a requested inhibit due to Fuel Injector diagnostics.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Fuel Pressure Test In Progress	Engine Running	Fuel Pressure indicates a requested inhibit for Fuel Pressure Pump monitor.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel System Test In Progress	Engine Running	Fuel Systems indicates a requested inhibit for Fuel Systems monitor.	No	Ensure control function is complete before stop/start can function	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Parking Maneuver Detected	Engine Running	Parking maneuver detection indicates a requested inhibit due to parking maneuver active.	No	Check functionality after parking	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - High Engine Rotating Torque	Engine Running	Engine Friction indicates a requested inhibit due to cold engine, friction high.	No	Wait for vehicle to reach proper temperature	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - BARO Pressure Too Low	Engine Running	Ambient Air Pressure indicates a requested inhibit due to low Barometric Pressure	No	Ensure barometric temperature isn't too low in scan tool	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Temperature Too High	Engine Running	Boil Off Diagnostics indicates a requested inhibit due to Fuel Boil Off diagnostics.	No	Ensure fuel temperature isn't too high	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Malfunction	Engine Running	Starting System indicates that a condition in the starting system has been detected that would prevent a re-start of the vehicle and thus, autostops, have been disabled.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Turbocharger Temperature Too High	Engine Running	Turbo Temp indicates an inhibit due to high Turbo Temp.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If OK: Refer to Hood Ajar Malfunction. If not OK: close hood.

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Run/Crank Not Active	Engine Running	Vehicle must be in Run Mode	No	Verify ECM Run/Crank signal	If OK: Inform Customer - Normal Disable Condition If not OK: refer to Power Mode Mismatch.
Autostop Disable Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	None
Autostop Disable Reason - Auxiliary Transmission Fluid Pump/Accumulator Not Available	Engine Running	Transmission aux pump or accumulator not available	No	Check for transmission DTCs, refer to automatic transmission service information	As Required
Autostop Disable Reason - Engine Coolant Temperature Out of Range	Engine Running	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to Engine Heating and Cooling diagnostics.
Autostop Disable Reason - Invalid Data Received	Engine Running	ECM has received invalid data	No	Check ECM DTC's	As Required
Autostop Disable Reason - Vehicle Speed Too High	Engine Running	Vehicle speed detected	No	Ensure vehicle is at a complete stop	If OK: Inform Customer - Normal Disable Condition If not OK: refer to SI

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Transmission Fluid Temperature Out of Range	Engine Running	Transmission temperature too hot or cold	No	Verify transmission temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostop Disable Reason - Brake Pedal Released	Engine Running	Brake pedal not pressed (enough)	No	Ensure brake pedal is pressed sufficiently to active autostop	If OK: Inform Customer - Normal Disable Condition If not OK: Verify brake pedal switch operation and calibration.
Autostop Disable Reason - Brake Booster Weak Vacuum	Engine Running	Weak brake booster vacuum	No	Ensure brake booster vacuum is within normal operating values	Check DTCs. Refer to brake booster diagnostics.
Autostop Disable Reason - Accelerator Pedal Pressed	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition If not OK: Ensure pedal sensor operation and calibration.
Autostop Disable Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Low- Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low- Voltage Battery State of Health Low	Engine Running	12V battery has low state of health	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Low-Voltage Battery State of Charge Low	Engine Running	12V battery state of charge is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Intake Manifold Weak Vacuum	Engine Running	Low manifold vacuum	No	Verify manifold vacuum	Check DTCs, refer to SI
Autostop Disable Reason - Engine Speed High	Engine Running	High idle condition	No	Correct cause of high idle	Check DTCs, refer to SI
Autostop Disable Reason - Wheel Slip Detected	Engine Running	Slippery road conditions	No	Ensure good road conditions	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Vehicle Speed Threshold Not Reached	Engine Running	Vehicle must reach a minimum speed	No	Operate at sufficient speeds	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Maximum Vehicle Stop Time Exceeded	Engine Running	Engine was shut off for maximum allowable off time	No	Operate at sufficient speeds to reactivate	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Starter System Malfunction	Engine Running	Starter System Inoperable	No	Check ECM DTCs, refer to SI	As Required
Autostop Disable Reason - System Malfunction	Engine Running	Starter System Inoperable	No	Check for Vehicle DTCs	As Required
Autostop Disable Reason - Stop/Start Select Switch	Engine Running	Switch not enabled	No	Turn switch on.	If OK: Inform Customer - Normal Disable Condition If Not OK: refer to Stop/Start System Malfunction
Autostop Disable Reason - Idle Boost Mode Active	Engine Running	Idle boost requested	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Generator Load High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Clutch Pedal Applied	Engine Running	Clutch pedal (manual trans) not released	No	Ensure clutch pedal is released	If OK: Inform Customer - Normal Disable Condition If not OK: Refer to clutch switch diagnostic and verify calibration.
Autostop Disable Reason - Low-Voltage Battery Temperature Out of Range	Engine Running	Battery temperature too cold or hot	No	Ensure battery is kept within normal operating range	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Low-Voltage Battery State of Function Low	Engine Running	12V battery state of function low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

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

Autostart Inhibit

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Inhibit Reason - Hood Ajar	Engine off	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Inhibit Reason - ECM Request	Engine off	ECM tasks are currently running that will not allow an autostart	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Run/Crank Not Active	Engine off	Vehicle must be in Run Mode	No	Verify ECM Run/Crank signal	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - System Malfunction	Engine off	Vehicle System Issue	No	Check for Vehicle DTCs	As Required

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Inhibit Reason - Autostart Not Commanded	Engine off	Vehicle is in a normal autostop mode	Yes	None	Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Crank Aborted	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Control Function Active	Engine off	Scantool control function active	No	Release control function in scantool	As Required
Autostart Inhibit Reason - ECM Malfunction	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Autostart/Autostop Malfunction	Engine off	ECM has disabled propulsion system	No	Check ECM DTCs	As Required
Autostart Inhibit Reason - Driver Exited Vehicle	Engine off	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Engine Coolant Temperature Out of Range	Engine off	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Remote Vehicle Start Disabled	Engine off	Remote Vehicle Start Disabled	No	As Required	As Required
Autostart Inhibit Reason - Calibration Override	Engine off	Calibration forced to shut off by calibration	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Inhibit Reason - Compression Test	Engine off	Engine was forced to shut off following the completion of a compression test	No	As Required	As Required
Autostart Inhibit Reason - TCM Request	Engine off	TCM can force the engine off depending on transmission conditions.	No	As Required	If OK: Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Inhibit Reason - Engine Stop Required	Engine off	Detection of a situation that might otherwise cause a stall of the vehicle.	No	As Required	As Required

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

Autostart Reasons

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

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - Vehicle Speed Too High	Engine Running	Vehicle speed detected	No	Ensure vehicle is at a complete stop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Optimization	Engine Running	ECM has determined that the engine needs to be started.	No	Check DTCs.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Voltage Low	Engine Running	12V battery state of charge is low.	No	Charge and test battery, operate vehicle for longer drives, check generator operation	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Acceleration Request	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostart Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	As Required
Autostart Reason - Auxiliary Transmission Fluid Pump/Accumulator Not Available	Engine Running	Transmission aux pump or accumulator not available	No	Check for transmission DTCs, refer to automatic transmission service information	As Required
Autostart Reason - Engine Coolant Temperature Out of Range	Engine Running	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Transmission Range	Engine Running	Transmission not in Drive	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - Brake Pedal Released	Engine Running	Brake pedal not pressed (enough)	No	Ensure brake pedal is pressed sufficiently to active autostop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Brake Booster Weak Vacuum	Engine Running	Weak brake booster vacuum	No	Ensure brake booster vacuum is within normal operating values	Check DTCs. Refer to brake booster diagnostics.
Autostart Reason - Accelerator Pedal Pressed	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostart Reason - Driver Exited Vehicle	Engine Running	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Passenger Compartment Heater On	Engine Running	Passenger Compartment Heater On	No	Check Vehicle DTCs	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Stop/Start select Switch	Engine Running	Stop/Start select Switch off	No	Not in all vehicles.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Driver Exited Vehicle	Engine Running	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Charge Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - Inclination	Engine Running	Vehicle Grade indicates that an autostop was prevented (or an autostart was commanded) due to the current grade level of the vehicle.	No	As Required	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Function Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation.	As Required
Autostart Reason - Remote Vehicle Start Request	Engine Running	Remote start requested	No	As Required.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Ignition Switch Start	Engine Running	Switch Start Request	No	The driver can request an autostart in park or neutral by cranking the key. Autostops are not allowed again until out of park/neutral.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Low Voltage Battery State of Health Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required

STARTER SOLENOID DOES NOT CLICK

Diagnostic Instructions

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

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ (KR27 Starter Relay terminal 87)	1	1	-	-
B+ (KR27 Starter Relay terminal 85)	1	P0615	-	-
Control (KR27 Starter Relay terminal 86)	P0616	P0615	P0617	-
Control (KR27 Starter Relay terminal 30)	1	1	2	-
B+ (KR27C Starter Pinion Solenoid Actuator Relay terminal 30)	3	3	-	-

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Control (KR27C Starter Pinion Solenoid Actuator terminal 87)	3	3	4	-
1. Starter inop. 2. Starter spins all the time 3. Starter pinion inop. 4. Starter pinion spins all the time				

Circuit/System Description

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

- [Circuit Testing](#)
- [Connector Repairs](#)
- [Testing for Intermittent Conditions and Poor Connections](#)
- [Wiring Repairs](#)
- [Relay Replacement \(Attached to Wire Harness\)](#) [Relay Replacement \(Within an Electrical Center\)](#)

Scan Tool Reference

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

Circuit/System Verification

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

Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#) .
 - **If no DTCs are set**
3. Verify the scan tool BCM 5 V Ignition Switch (vehicles without push button start) or ECM Power Mode (vehicles with push button start) parameter is Crank Request 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 with the transmission range selector in park.

- **If the TCM Internal Mode Switch parameter does not indicate Park**

Refer to [Transmission Internal Mode Switch Voltage](#)

- **If the TCM Internal Mode Switch parameter indicates Park**

5. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.

- **If the counter increments**

Replace the B26 Crankshaft Position Sensor.

- **If the counter does not increment**

6. Verify the crank relay clicks and the engine begins cranking with the ignition in the Crank position.

- **If the KR27 Starter Relay does not click**

Refer to Circuit/System Testing.

- **If the KR27 Starter Relay clicks**

7. All OK.

Circuit/System Testing

1. Ignition ON.

2. Verify the scan tool ECM Ignition 1 Signal parameter is greater than 10 V.

- **If 10 V or less**

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

2. Test for infinite resistance between 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 , replace the K20 Engine Control Module.

- **If greater than 10 V**

3. Ignition OFF, disconnect the KR27 Starter Relay, ignition ON.

4. Verify that a test lamp illuminates between the B+ circuit terminal 87 and ground.

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

1. Ignition OFF.

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

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

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

1. Ignition OFF.

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

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

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

4. Test for infinite resistance between the control circuit terminal 30 and ground.

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

- **If the test lamp illuminates**
5. Ensure the parking brake is applied and the T12 transmission is in PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
 6. Verify the M64 Starter Motor is activated.
 - **If the M64 starter motor does not activate**
 1. Disconnect the X1 harness connector at the M64 Starter Motor.
 2. Test for less than 2 Ω in the control circuit end to end.
 - If greater the 2 Ω , repair the open/high resistance in the circuit.
 - If less than 2 Ω , replace the M64 Starter Motor.
 - **If the M64 starter motor activates**
 7. Ignition OFF, disconnect the KR27C Starter Pinion Solenoid Actuator Relay, ignition ON.
 8. Verify that a test lamp illuminates between the B+ circuit terminal 30 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF.
 2. Test for infinite resistance between the B+ circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance,
 3. Disconnect X1 harness connector at the M64 Starter Motor.
 4. Test for infinite resistance between the control circuit terminal 87 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the M64 Starter Motor.
 - **If the test lamp illuminates**
 9. Ensure the parking brake is applied and the T12 transmission is in PARK. Momentarily install a 30 A fused jumper wire between the B+ circuit terminal 30 and the control circuit terminal 87.
 10. Verify the M64 Starter Motor pinion engages.
 - **If the M64 starter motor pinion does not engage**
 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 pinion engages**
 11. Ignition OFF, reconnect the KR27 Starter Relay and KR27C Starter Pinion Solenoid Actuator Relay, ignition CRANK.
 12. Verify the M64 Starter Motor is activated.
 - **If the M64 starter motor does not activate**

Test or replace the KR27 Starter Relay.
 - **If the M64 starter motor activates**
 13. Test or replace the KR27C Starter Pinion Solenoid Actuator Relay.

Component Testing

Relay Test

1. Ignition OFF, disconnect the KR27 Starter Relay.
2. Test for 60-180 Ω between terminals 85 and 86.

- **If less than 60 or greater than 180 Ω**

Replace the relay.

- **If between 60-180 Ω**

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

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

- **If less than infinite resistance**

Replace the relay.

- **If infinite resistance**

4. Install a 20 A fused jumper wire between relay terminal 85 and 12 V. Install a jumper wire between relay terminal 86 and ground.

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

- **If 2 Ω or greater**

Replace the relay.

- **If less than 2 Ω**

6. All OK

Repair Instructions

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

- [Crankshaft Position Sensor Replacement](#)
- [Control Module References](#) for control module replacement, programming and setup.

STARTER SOLENOID CLICKS, ENGINE DOES NOT CRANK

Diagnostic Instructions

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

Reference Information

Schematic Reference

[Starting and Charging Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Description and Operation

[Starting System Description and Operation](#)

Electrical Information Reference

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

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

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 Battery terminals.
2. Verify the measured voltage is between 12.0-15.0 V.

- **If voltage is less than 12.0 V or greater than 15.0 V**

Refer to [Battery Inspection/Test](#).

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

3. Remove the drive belts. Refer to [Drive Belt Replacement \(LGX\)](#), [Drive Belt Replacement \(LGW\)](#) and [Drive Belt Tensioner Replacement \(LGX\)](#), [Drive Belt Tensioner Replacement \(LGW\)](#) for the 3.0L or 3.6L.

4. Verify the crankshaft rotates rotate the crankshaft by hand using the appropriate tools.

- **If the crankshaft does not rotate**

Refer to [Engine Will Not Crank - Crankshaft Will Not Rotate](#) , for the 2.0L engine or [Engine Will Not Crank - Crankshaft Will Not Rotate](#) for the 3.0L or 3.6L engine

- **If the crankshaft rotates**

5. Verify the engine does not crank when attempting to start the vehicle.

- **If the engine cranks**

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

- **If the engine does not crank**

6. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal A X2 and ground.

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

1. Ignition OFF.

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

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

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

1. Ignition OFF.

2. Test for greater than 100 Ω between the B+ circuit and ground.

- If 100 Ω or less, repair the short to ground on the circuit.
- If greater than 100 Ω , replace the M64 Starter Motor.

- **If the test lamp illuminates**

7. Test for less than 0.5 V between the positive battery 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**

8. 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.

- **less than 0.5 V**

9. Replace the M64 Starter Motor.

Repair Instructions

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

- **Battery Negative Cable Replacement (without HP9)**
- **Battery Positive Cable Replacement**
- **Starter Replacement (LTG) Starter Replacement (LGW) Starter Replacement (LGX)**

ENGINE CRANKS SLOWLY

Diagnostic Instructions

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

Reference Information

Schematic Reference

Starting and Charging Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Starting System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

Refer to **Battery Inspection/Test**.
 - **If voltage is between 12.0-15.0 V**
3. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal A X2 and ground.
 - **If the test lamp does not illuminate 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**
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.
 - **less than 0.5 V**
 6. Remove the drive belts. Refer to [Drive Belt Replacement \(LGX\)](#) [Drive Belt Replacement \(LGW\)](#) and [Drive Belt Tensioner Replacement \(LGX\)](#) [Drive Belt Tensioner Replacement \(LGW\)](#) for the 3.0L or 3.6L
 7. Verify the crankshaft rotates rotate the crankshaft by hand using the appropriate tools.
 - **If the crankshaft does not rotate**
Refer to [Engine Will Not Crank - Crankshaft Will Not Rotate](#) , for the 2.0L engine or [Engine Will Not Crank - Crankshaft Will Not Rotate](#) for the 3.0L or 3.6L engine.
 - **If the crankshaft rotates**
 8. 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 generator etc.
 - **If the engine does not crank**
 9. Replace the M64 Starter Motor.

Repair Instructions

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

- [Battery Negative Cable Replacement \(without HP9\)](#)
- [Battery Positive Cable Replacement](#)
- [Starter Replacement \(LTG\)](#)[Starter Replacement \(LGW\)](#)[Starter Replacement \(LGX\)](#)

STARTER NOISE DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

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

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

Removal Procedure

1. Rear Compartment Floor Panel Trim Removal - Rear Compartment Floor Panel Trim Replacement (Without HP9) and/or Rear Compartment Floor Panel Trim Replacement (With HP9)
2. Spare Tire Stowage Retainer (1) Removal



Fig. 4: Spare Tire

Courtesy of GENERAL MOTORS COMPANY

3. Spare Tire (2)» Remove

4. Rear Body Fuse Block Cover (1)» Remove



Fig. 5: Rear Body Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

5. Battery Cover Bolt (2)» Remove

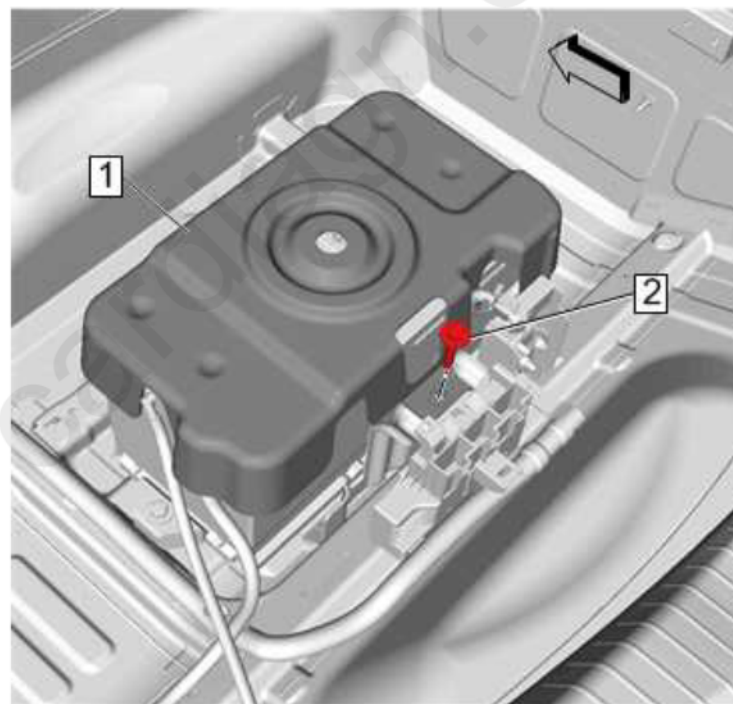


Fig. 6: Battery Cover

Courtesy of GENERAL MOTORS COMPANY

6. Battery Cover (1)» Remove

7. Battery Post Negative Cable Clamp Nut (1)» Loosen

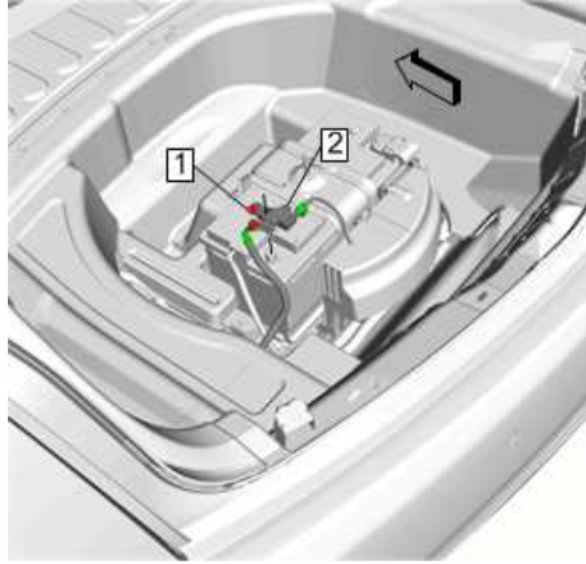


Fig. 7: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to [Battery Disconnect Warning](#)

8. Battery Negative Cable (2)» Remove and position aside

Installation Procedure

1. Battery Negative Cable (2)» Install

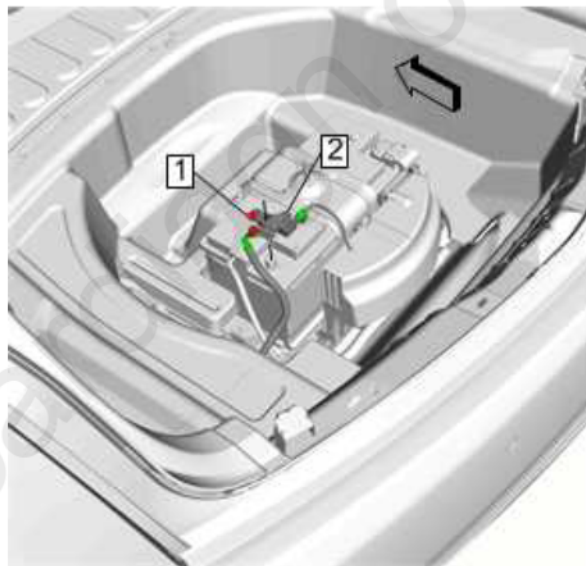


Fig. 8: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

2. Battery Post Negative Cable Clamp Nut (1)» Install and tighten 4.5 N.m (40 lb in)

CAUTION: Refer to [Fastener Caution](#)

3. Spare Tire (2)» Install



Fig. 9: Spare Tire

Courtesy of GENERAL MOTORS COMPANY

4. Spare Tire Stowage Retainer (1)» Hand tighten
5. Battery Cover (1)» Install

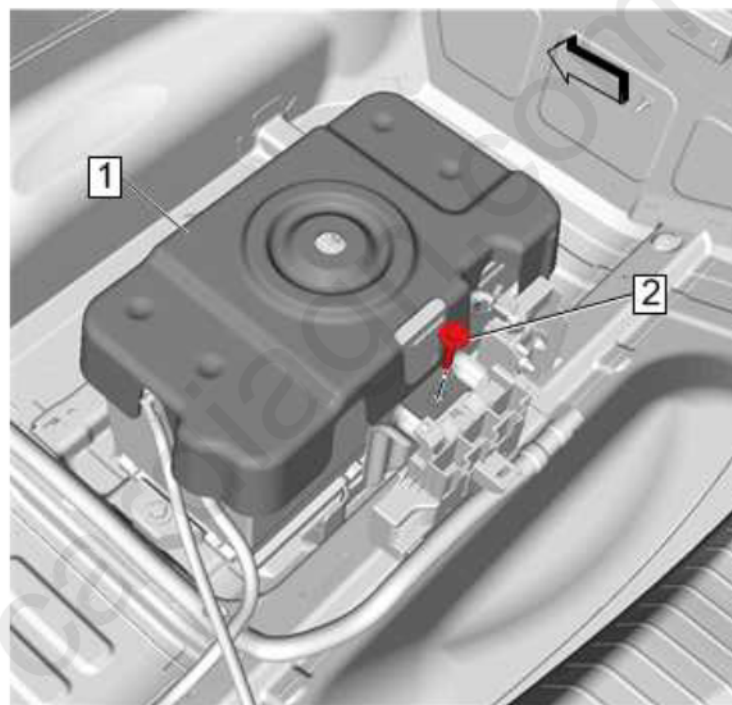


Fig. 10: Battery Cover

Courtesy of GENERAL MOTORS COMPANY

6. Battery Cover Bolt (2)» Install and tighten 9 N.m (80 lb in)
7. Rear Body Fuse Block Cover (1)» Install



Fig. 11: Rear Body Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

8. Rear Compartment Floor Panel Trim» Install - [Rear Compartment Floor Panel Trim Replacement \(Without HP9\)](#) and/or [Rear Compartment Floor Panel Trim Replacement \(With HP9\)](#)

BATTERY SENSOR REPLACEMENT (KL9)

Removal Procedure

1. Rear Compartment Floor Panel Trim» Remove - [Rear Compartment Front Trim Replacement \(Without HP9\)](#)

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.

2. Spare Tire Stowage Retainer (1)» Remove



Fig. 12: Spare Tire

Courtesy of GENERAL MOTORS COMPANY

3. Spare Tire (2) » Remove
4. Use a open ended wrench to hold the battery negative cable terminal stationary (1).

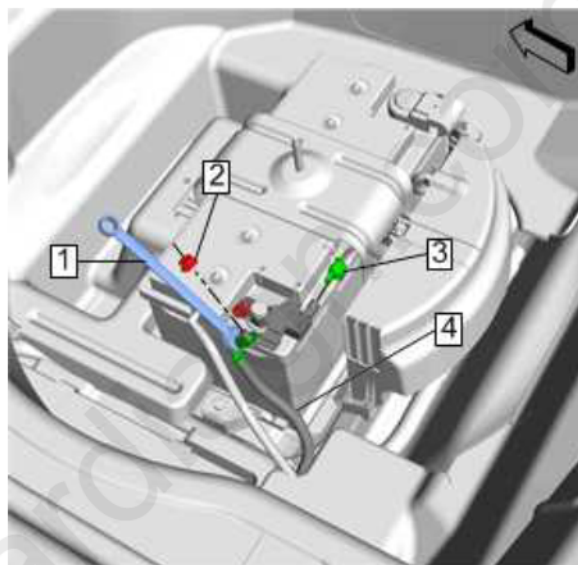


Fig. 13: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

WARNING: Refer to **Battery Disconnect Warning**

5. Battery Negative Cable to Battery Current Sensor Nut (2) » Remove
6. Electrical Connector (3) » Disconnect
7. Battery Negative Cable (4) » Reposition away
8. Battery Post Negative Cable Clamp Nut (1) » Loosen

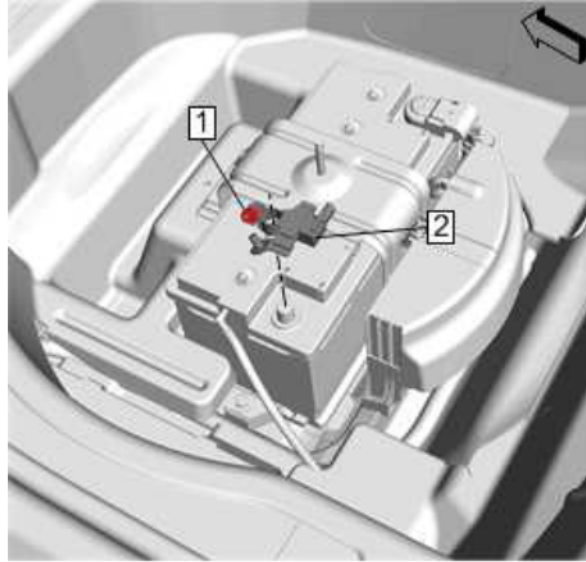


Fig. 14: Battery Post Negative Cable Clamp Nut
Courtesy of GENERAL MOTORS COMPANY

9. Battery Sensor Module (2)» Remove

Installation Procedure

1. Battery Sensor Module (2)» Install

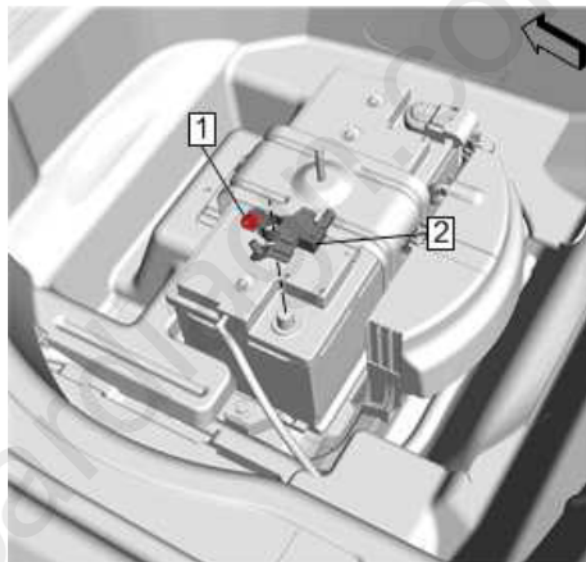


Fig. 15: Battery Post Negative Cable Clamp Nut
Courtesy of GENERAL MOTORS COMPANY

2. Battery Post Negative Cable Clamp Nut (1)» Install and tighten 4.5 N.m (40 lb in)

CAUTION: Refer to **Fastener Caution**

3. Battery Negative Cable (4)» Install

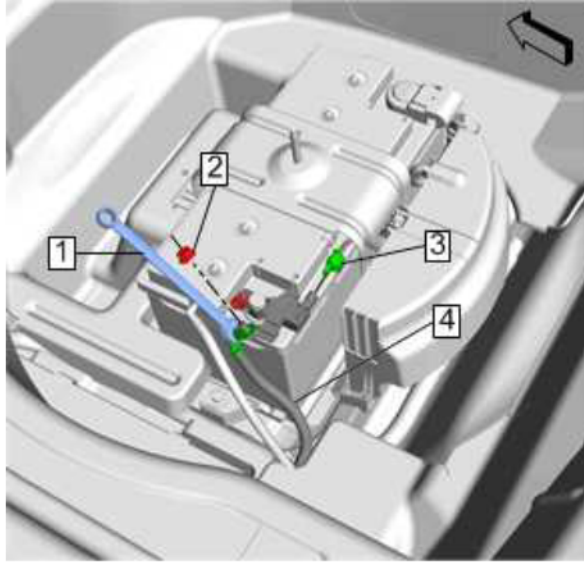


Fig. 16: Battery Negative Cable

Courtesy of GENERAL MOTORS COMPANY

4. Hold the battery negative terminal into position with a open ended wrench. (1)
5. Battery Negative Cable to Battery Current Sensor Nut (2)» Install and tighten 15 N.m (11 lb ft)
6. Electrical Connector (3)» Connect
7. Spare Tire (2)» Install

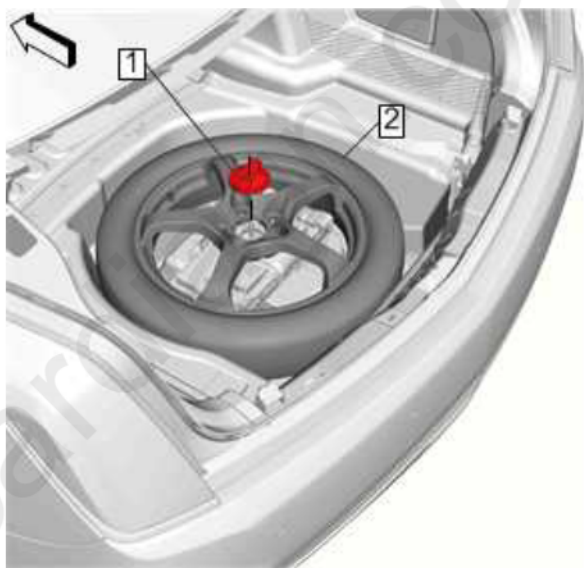


Fig. 17: Spare Tire

Courtesy of GENERAL MOTORS COMPANY

8. Spare Tire Stowage Retainer (1)» Hand tighten
9. Rear Compartment Floor Panel Trim» Install - [Rear Compartment Front Trim Replacement \(Without HP9\)](#)

BATTERY NEGATIVE CABLE REPLACEMENT (WITHOUT HP9)

Removal Procedure

1. Rear Compartment Floor Panel Trim» Remove - [Rear Compartment Floor Panel Trim Replacement \(Without HP9\)](#)

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.

2. Spare Tire Stowage Retainer (1) » Remove

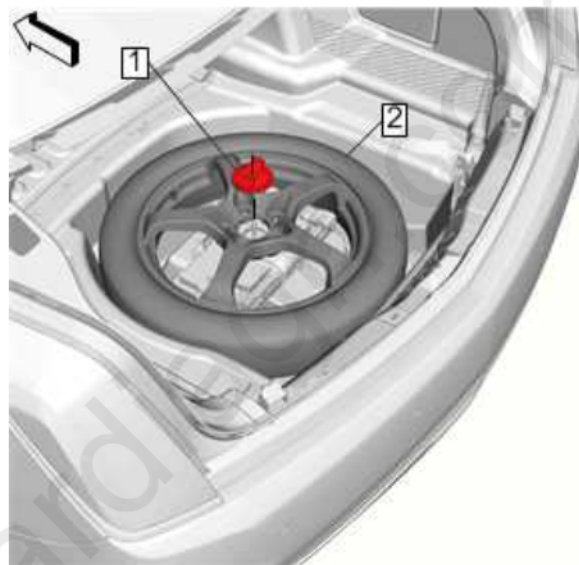


Fig. 18: Spare Tire

Courtesy of GENERAL MOTORS COMPANY

3. Spare Tire (3) » Remove

4. Use a open ended wrench to hold the battery negative cable terminal, so as not to damage the battery sensor, when removing the fastener. (1)

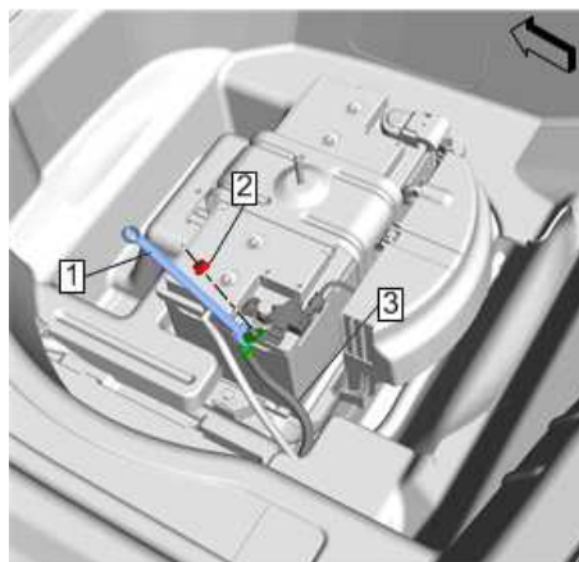


Fig. 19: Battery Negative Cable To Battery Current Sensor Nut
Courtesy of GENERAL MOTORS COMPANY

5. Battery Negative Cable to Battery Current Sensor Nut (2)» Remove
6. Battery Negative Cable (3)» Reposition away
7. Battery Negative Cable Terminal Cover (1)» Remove

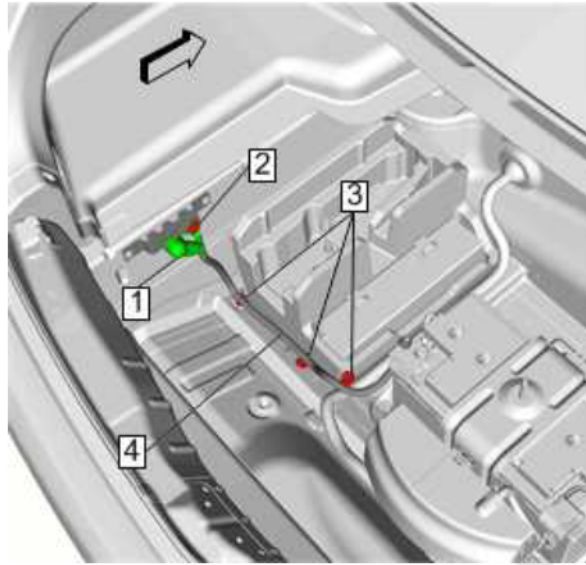


Fig. 20: Battery Negative Cable Terminal Cover
Courtesy of GENERAL MOTORS COMPANY

8. Battery Negative Cable Ground Fastener (2)» Remove
9. Retainer (3)» Disengage [3x]
10. Battery Negative Cable (4)» Remove

Installation Procedure

1. Battery Negative Cable (4)» Install

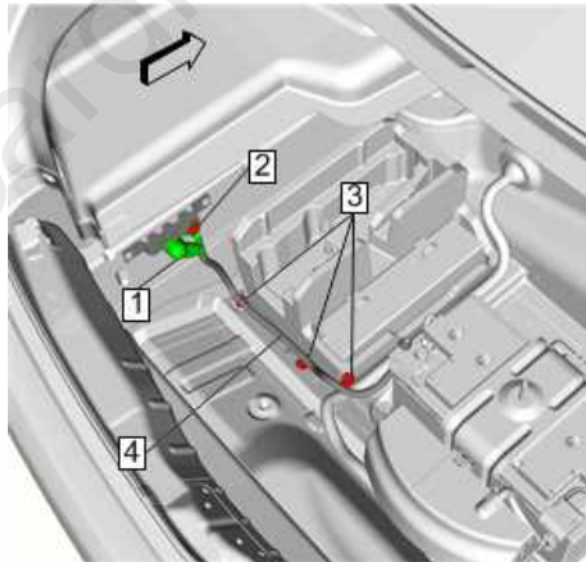


Fig. 21: Battery Negative Cable Terminal Cover
Courtesy of GENERAL MOTORS COMPANY

2. Retainer (3)» Engage [3x]
3. Battery Negative Cable Ground Fastener (2)» Install and tighten 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

4. Battery Negative Cable (3)» Install

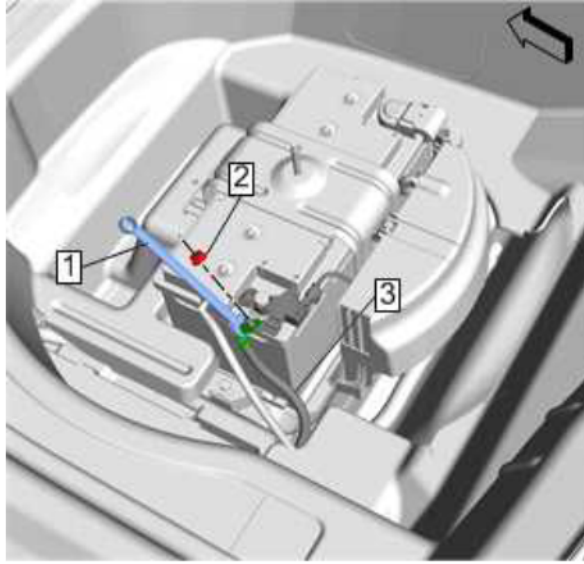


Fig. 22: Battery Negative Cable To Battery Current Sensor Nut
Courtesy of GENERAL MOTORS COMPANY

5. Hold the battery negative terminal into position with the open ended wrench. (1)
6. Battery Negative Cable to Battery Current Sensor Nut (2)» Install and tighten 15 N.m (11 lb ft)
7. Spare Tire (2)» Install

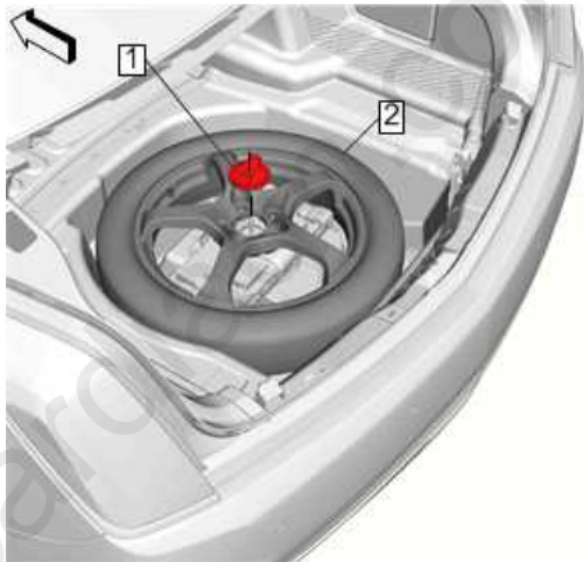


Fig. 23: Spare Tire
Courtesy of GENERAL MOTORS COMPANY

8. Spare Tire Stowage Retainer (1)» Hand tighten
9. Rear Compartment Floor Panel Trim» Install - **Rear Compartment Floor Panel Trim Replacement (Without HP9)**

BATTERY NEGATIVE CABLE EXTENSION CABLE REPLACEMENT (LTG)

Removal Procedure

1. Drivetrain and Front Suspension Cradle Plate (3)» Remove - **Drivetrain and Front Suspension Cradle Plate Replacement**

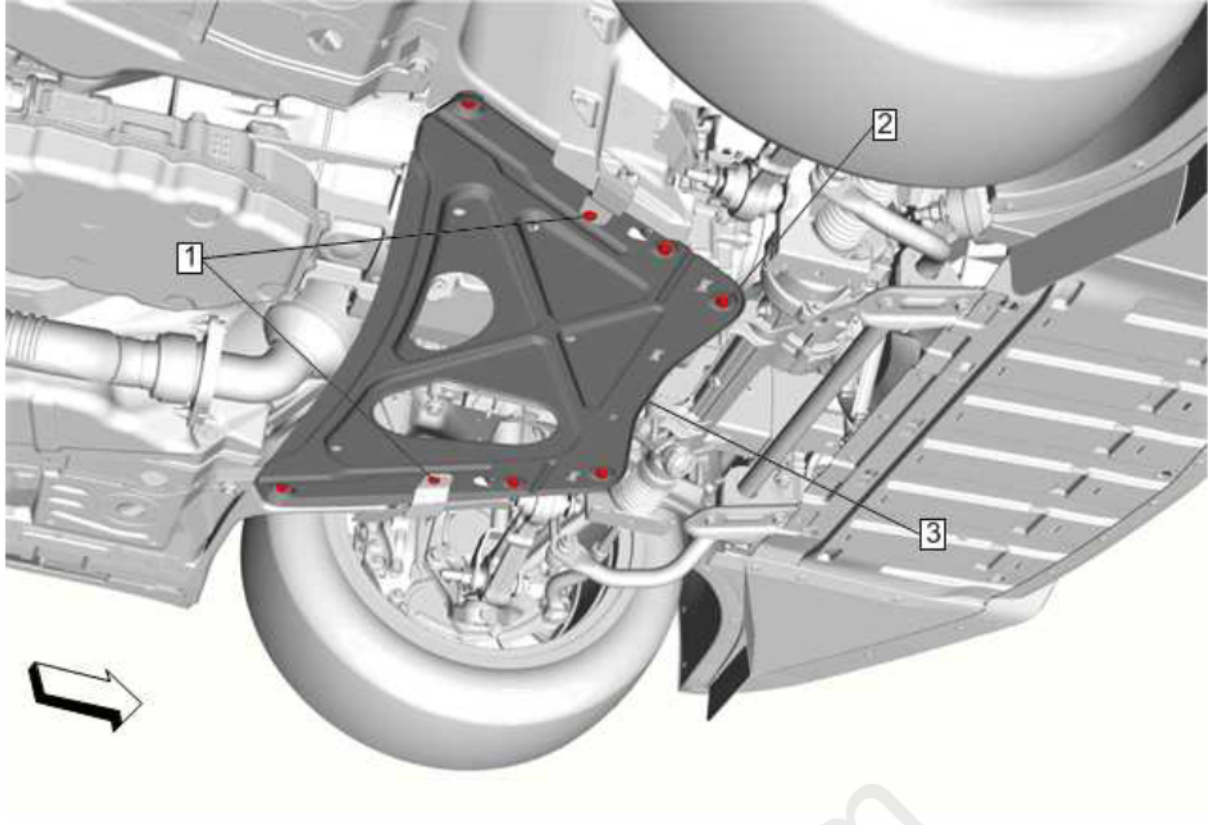


Fig. 24: Drivetrain and Front Suspension Cradle Plate

Courtesy of GENERAL MOTORS COMPANY

2. Front Tire Front Air Deflector (2) » Remove - **Front Tire Front Air Deflector Replacement**

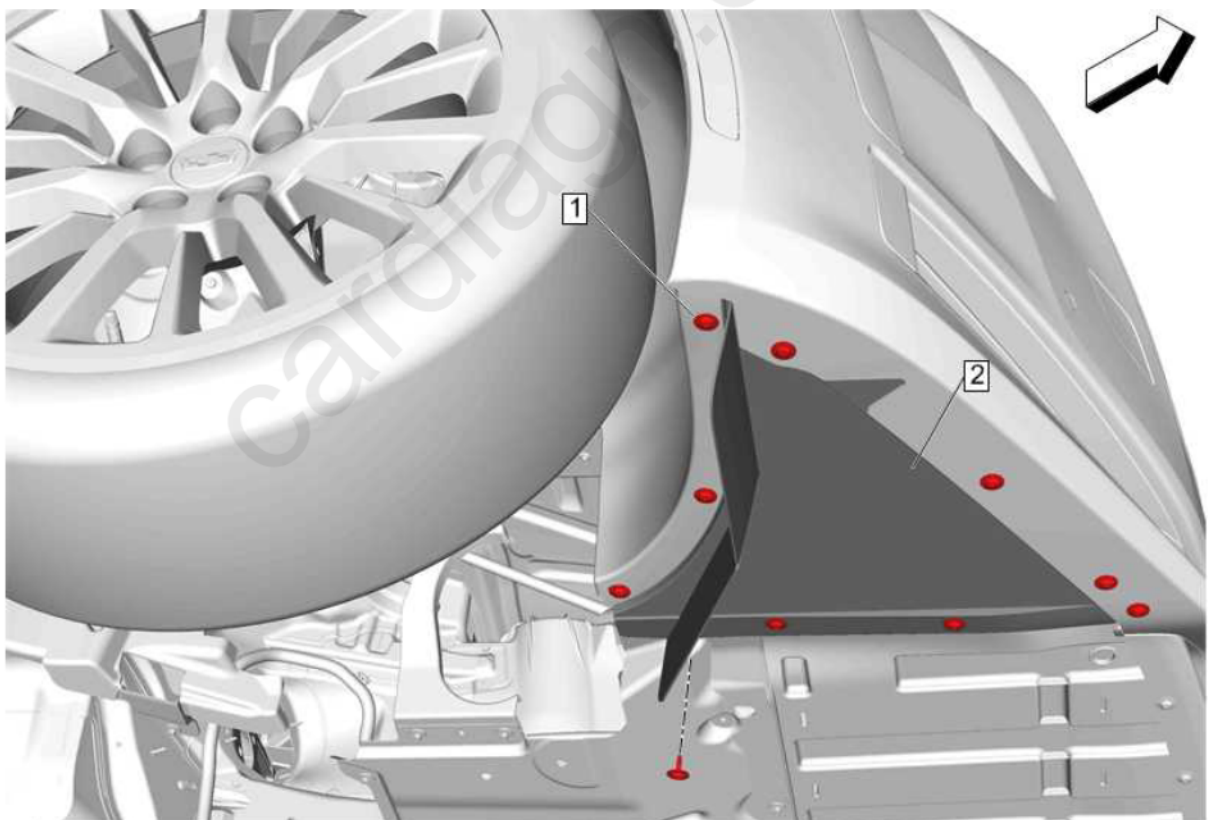


Fig. 25: Front Tire Front Air Deflector

Courtesy of GENERAL MOTORS COMPANY

3. Battery Negative Cable Extension Cable Fastener (1) » Remove

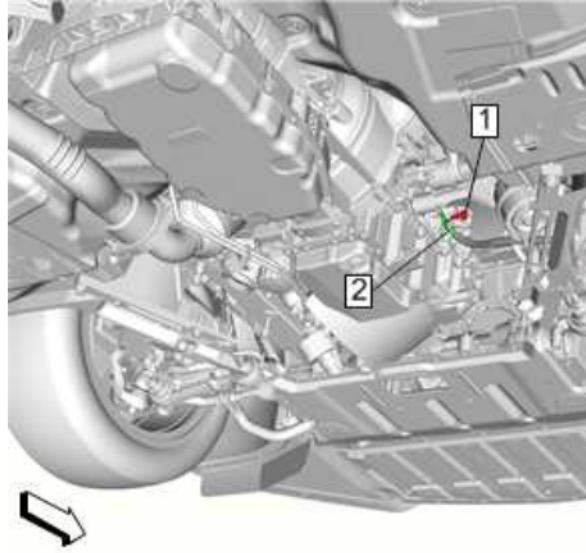


Fig. 26: Battery Negative Cable Extension Cable
Courtesy of GENERAL MOTORS COMPANY

4. Battery Negative Cable Extension Cable (2)» Remove
5. Wiring Harness Retainer (1)» Disengage [2x]

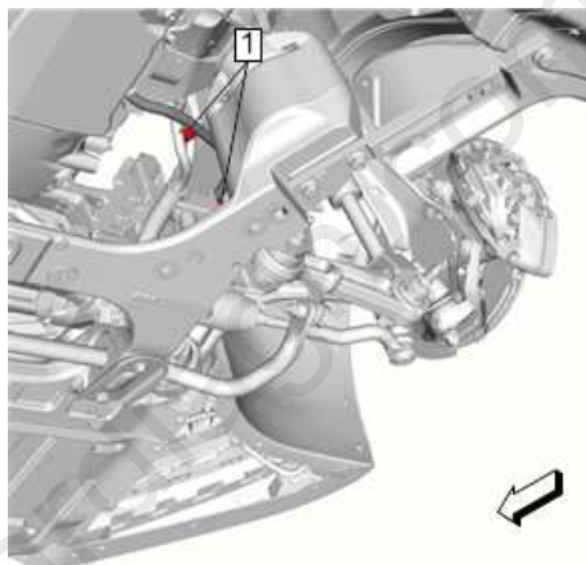


Fig. 27: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Battery Negative Cable Extension Cable Fastener (2)» Remove

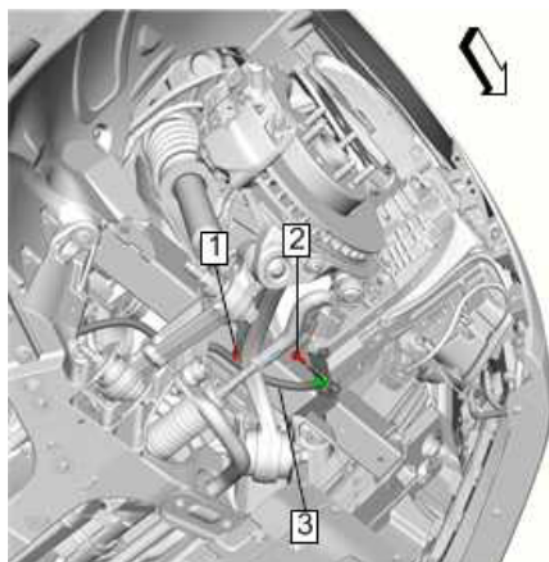


Fig. 28: Battery Negative Cable Extension Cable
Courtesy of GENERAL MOTORS COMPANY

7. Wiring Harness Retainer (1)» Disengage
8. Battery Negative Cable Extension Cable (3)» Remove

Installation Procedure

1. Battery Negative Cable Extension Cable (3)» Install

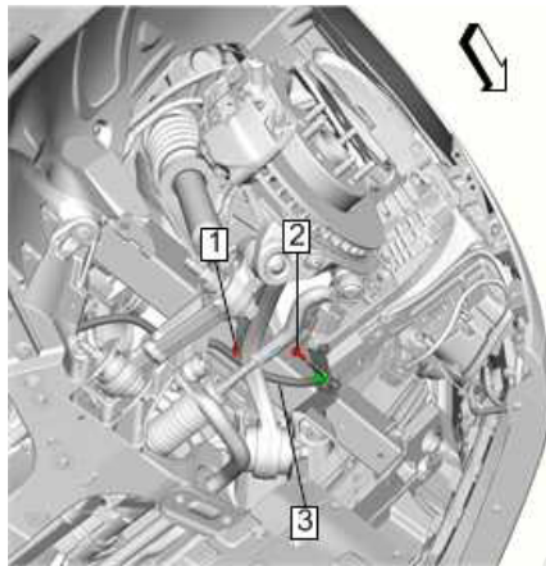


Fig. 29: Battery Negative Cable Extension Cable
Courtesy of GENERAL MOTORS COMPANY

2. Wiring Harness Retainer (1)» Engage
3. Battery Negative Cable Extension Cable Fastener (2)» Install and tighten 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

4. Wiring Harness Retainer (1)» Engage [2x]

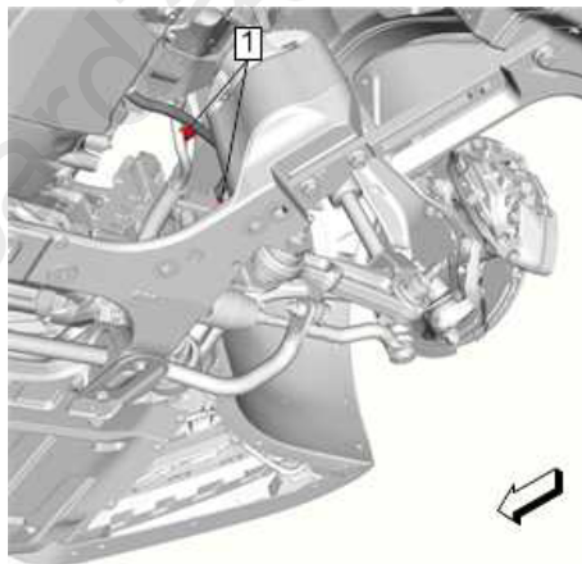


Fig. 30: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Battery Negative Cable Extension Cable (2)» Install

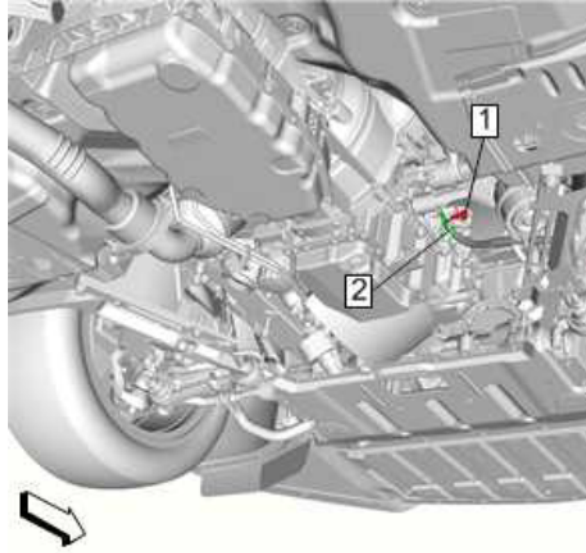


Fig. 31: Battery Negative Cable Extension Cable
 Courtesy of GENERAL MOTORS COMPANY

- 6. Battery Negative Cable Extension Cable Fastener (1)» Install and tighten 40 N.m (30 lb ft)
- 7. Front Tire Front Air Deflector (2)» Install - **Front Tire Front Air Deflector Replacement**

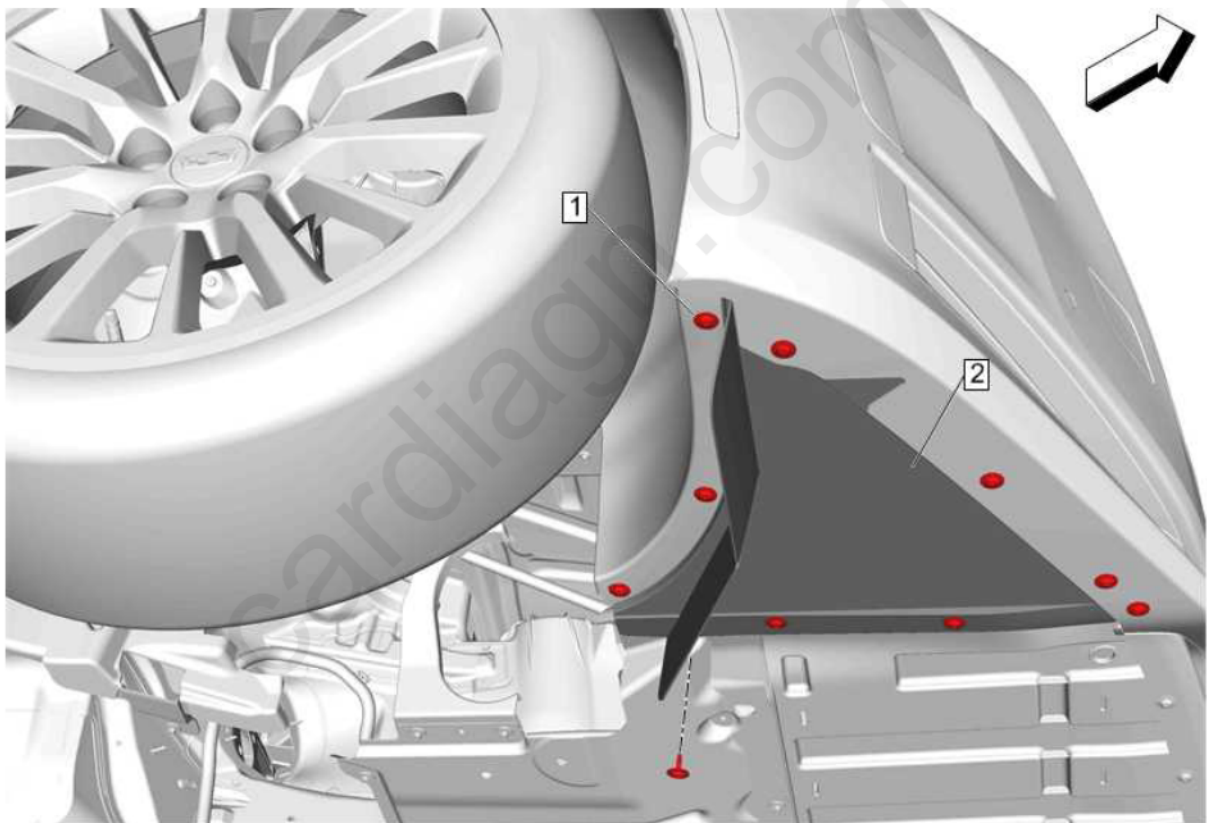


Fig. 32: Front Tire Front Air Deflector
 Courtesy of GENERAL MOTORS COMPANY

- 8. Drivetrain and Front Suspension Cradle Plate (3)» Install - **Drivetrain and Front Suspension Cradle Plate Replacement**

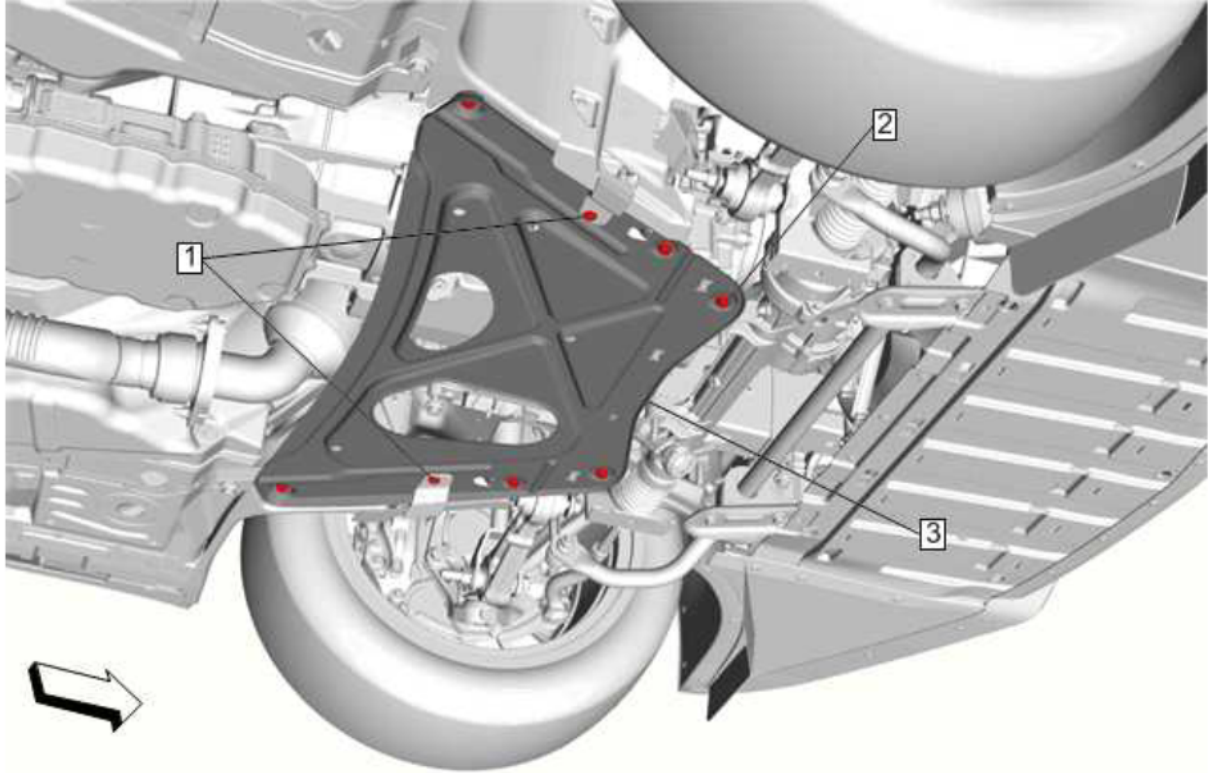


Fig. 33: Drivetrain and Front Suspension Cradle Plate
 Courtesy of GENERAL MOTORS COMPANY

BATTERY NEGATIVE CABLE EXTENSION CABLE REPLACEMENT (LGW)

Removal Procedure

1. Front Tire Front Air Deflector (2) Remove - [Front Tire Front Air Deflector Replacement](#)

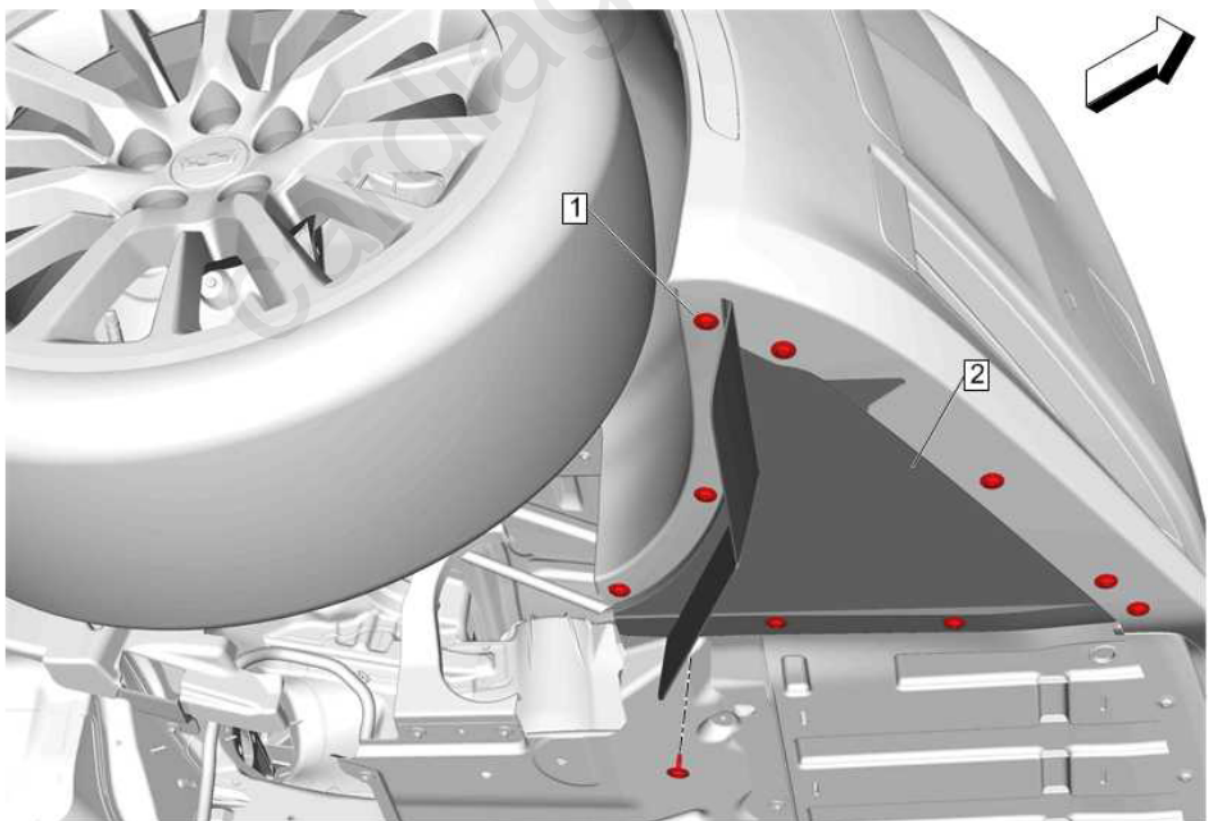


Fig. 34: Front Tire Front Air Deflector
 Courtesy of GENERAL MOTORS COMPANY

2. Battery Negative Cable Extension Cable Fastener (2) Remove

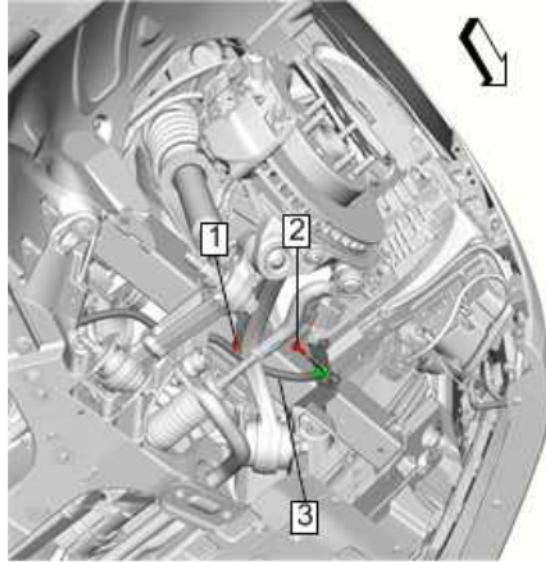


Fig. 35: Battery Negative Cable Extension Cable
 Courtesy of GENERAL MOTORS COMPANY

3. Wiring Harness Retainer (1)» Disengage
4. Battery Negative Cable Extension Cable (3)» Remove
5. Air Cleaner Outlet Rear Duct (1)» Remove - **Air Cleaner Outlet Rear Duct Replacement (LGW)**

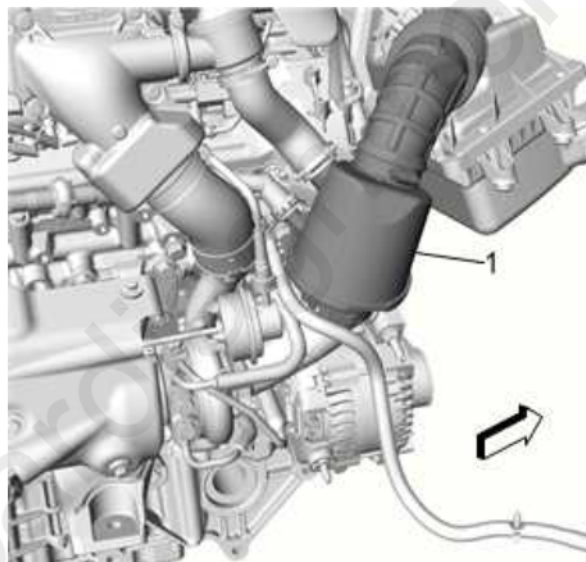


Fig. 36: Air Cleaner Outlet Rear Duct
 Courtesy of GENERAL MOTORS COMPANY

6. Battery Negative Cable Extension Cable Fastener (2)» Remove

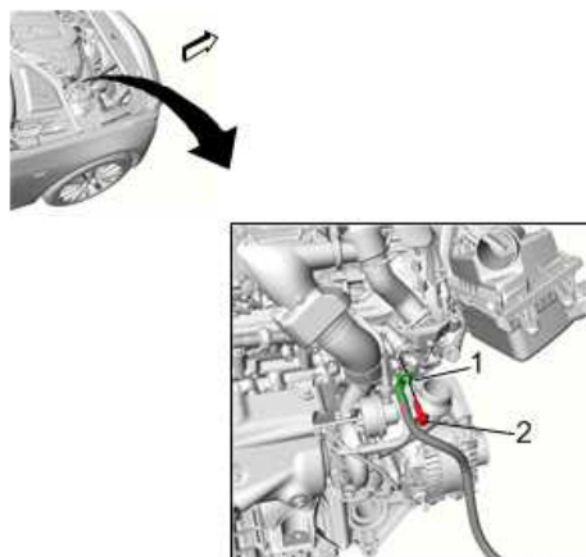


Fig. 37: Battery Negative Cable Extension Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

7. Battery Negative Cable Extension Cable (1)» Remove

Installation Procedure

1. Battery Negative Cable Extension Cable (1)» Install

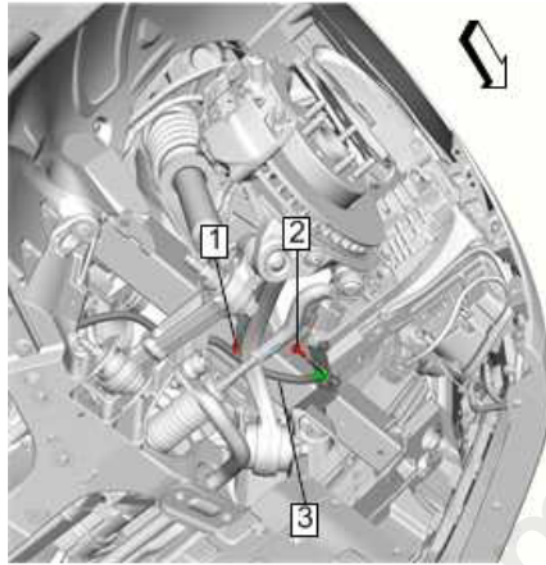


Fig. 38: Battery Negative Cable Extension Cable
Courtesy of GENERAL MOTORS COMPANY

2. Wiring Harness Retainer (1)» Engage
3. Battery Negative Cable Extension Cable Fastener (2)» Install and tighten 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

4. Front Tire Front Air Deflector (2)» Install - **Front Tire Front Air Deflector Replacement**

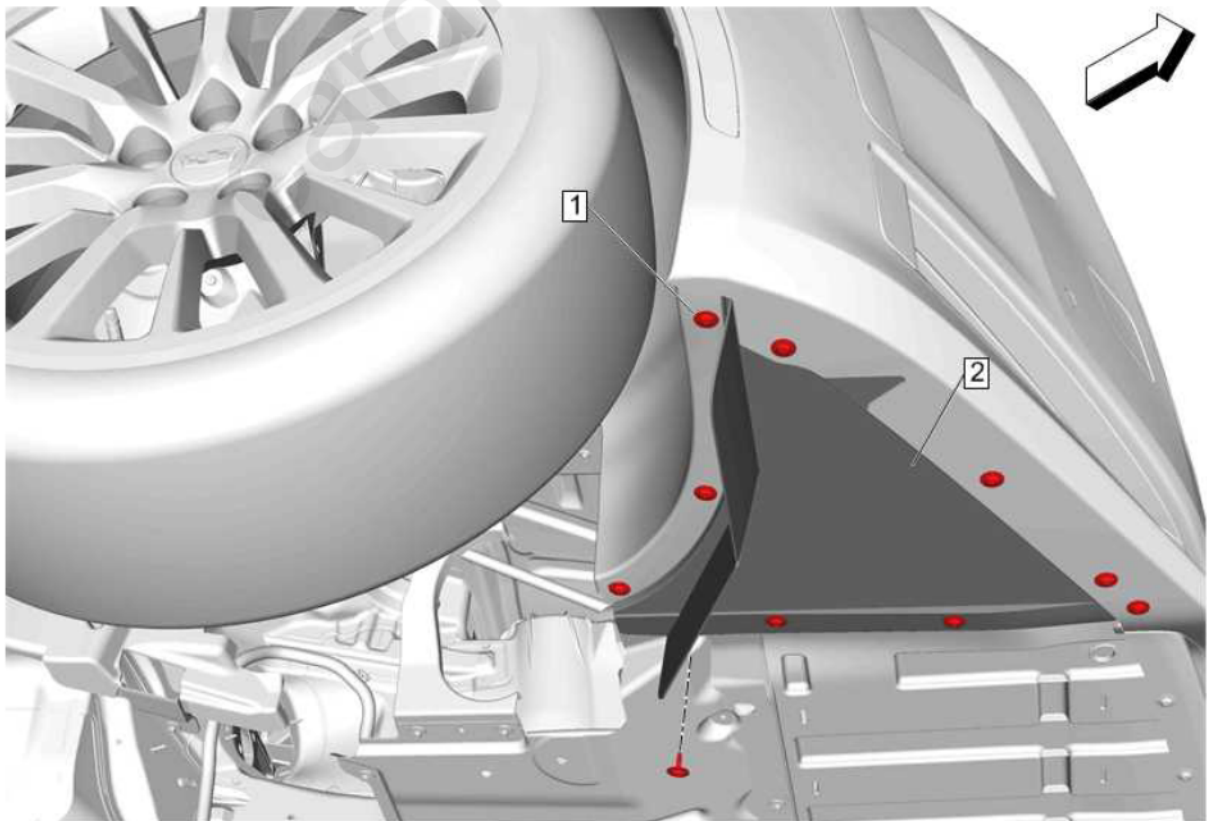


Fig. 39: Front Tire Front Air Deflector
Courtesy of GENERAL MOTORS COMPANY

5. Battery Negative Cable Extension Cable (1)» Install

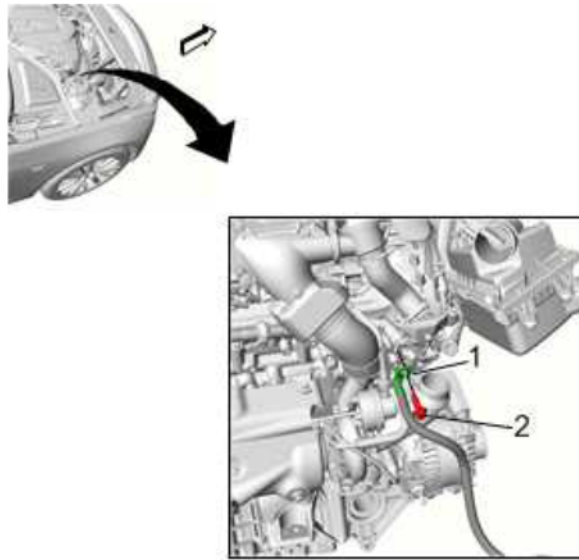


Fig. 40: Battery Negative Cable Extension Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Battery Negative Cable Extension Cable Fastener (2)» Install and tighten 58 N.m (43 lb ft)
7. Air Cleaner Outlet Rear Duct (1)» Install - **Air Cleaner Outlet Rear Duct Replacement (LGW)**

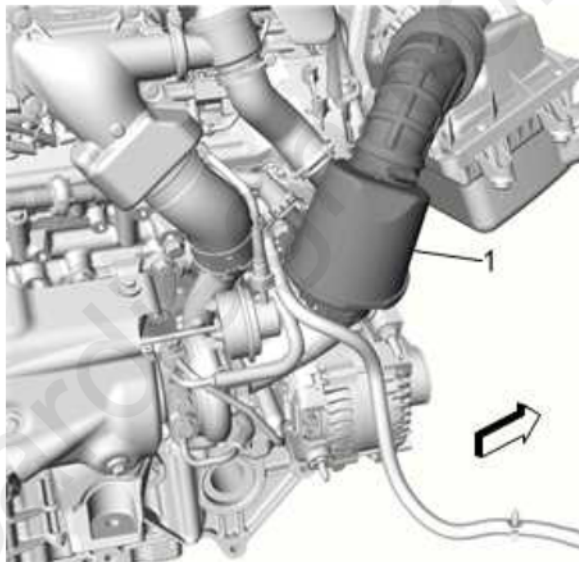


Fig. 41: Air Cleaner Outlet Rear Duct
Courtesy of GENERAL MOTORS COMPANY

BATTERY NEGATIVE CABLE EXTENSION CABLE REPLACEMENT (LGX)

Removal Procedure

1. Front Tire Front Air Deflector (2)» Remove - **Front Tire Front Air Deflector Replacement**

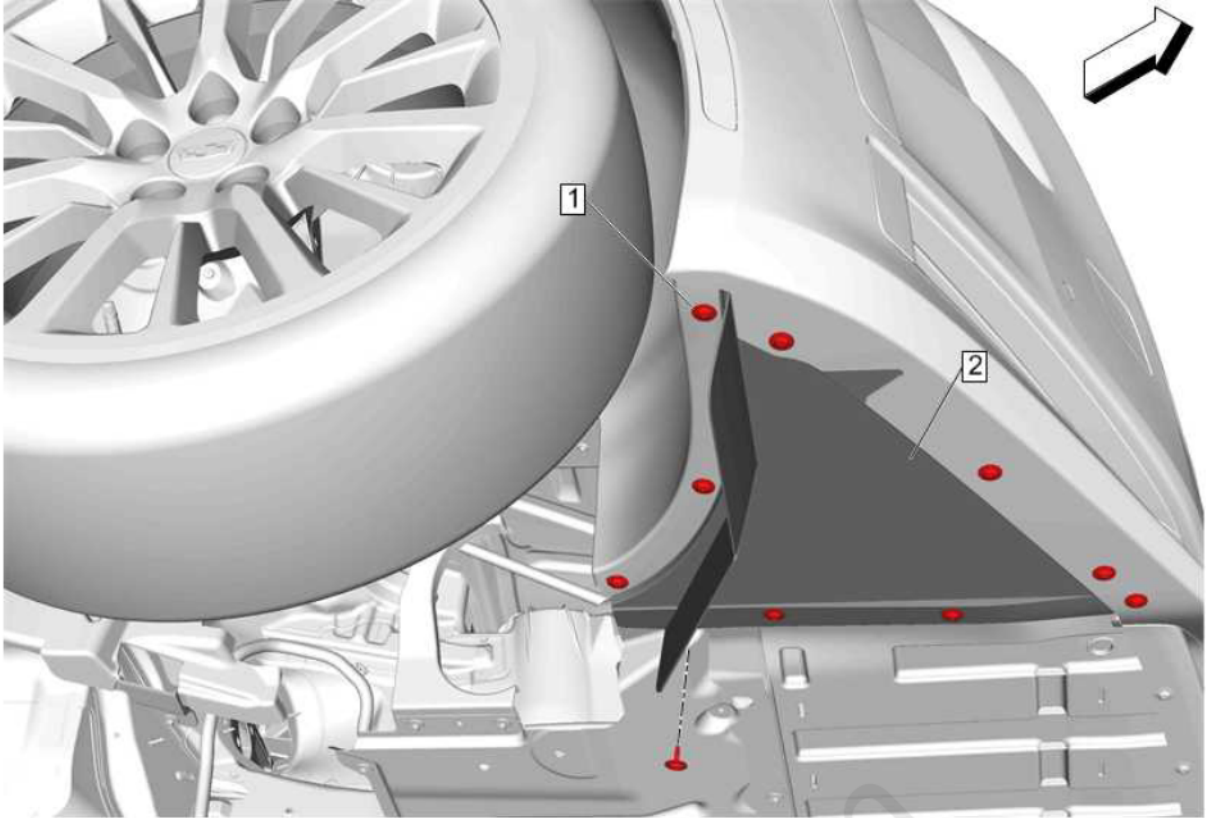


Fig. 42: Front Tire Front Air Deflector

Courtesy of GENERAL MOTORS COMPANY

2. Battery Negative Cable Extension Cable Fastener (2)» Remove

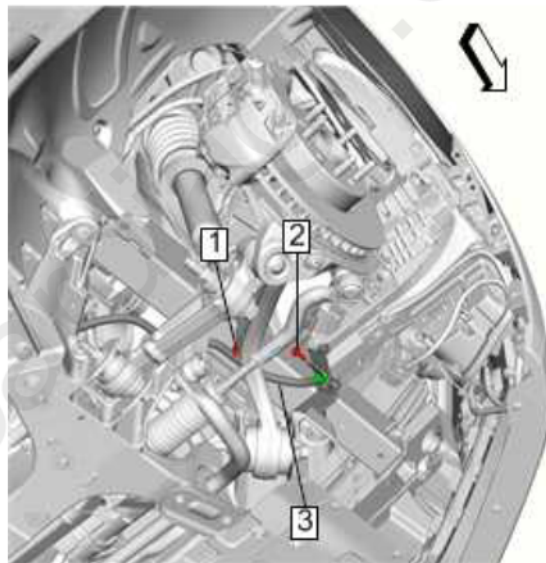


Fig. 43: Battery Negative Cable Extension Cable

Courtesy of GENERAL MOTORS COMPANY

3. Wiring Harness Retainer (1)» Disengage
4. Battery Negative Cable Extension Cable (3)» Remove
5. Generator (2)» Remove - **Generator Replacement (LGX)**

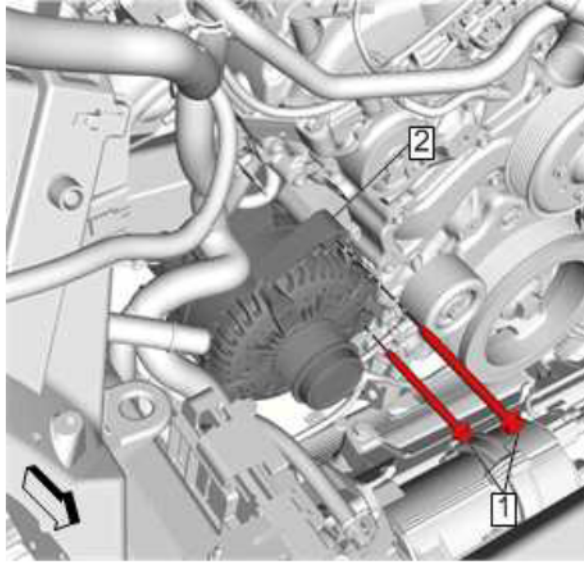


Fig. 44: Generator

Courtesy of GENERAL MOTORS COMPANY

6. Battery Negative Cable Extension Cable Fastener (1)» Remove

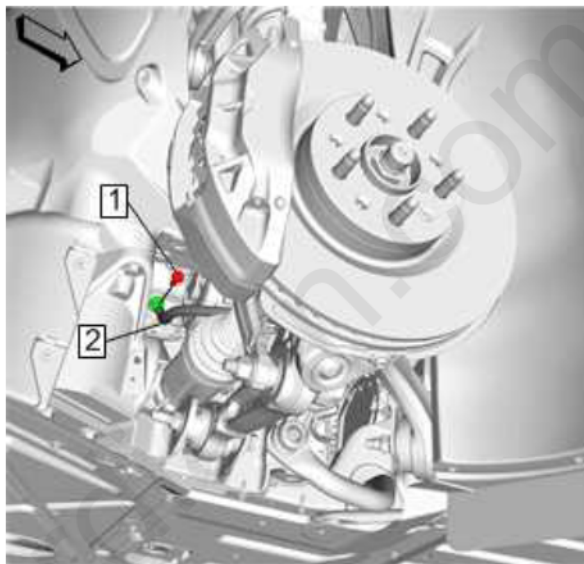


Fig. 45: Battery Negative Cable Extension Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

7. Battery Negative Cable Extension Cable (2)» Remove

Installation Procedure

1. Battery Negative Cable Extension Cable (3)» Install

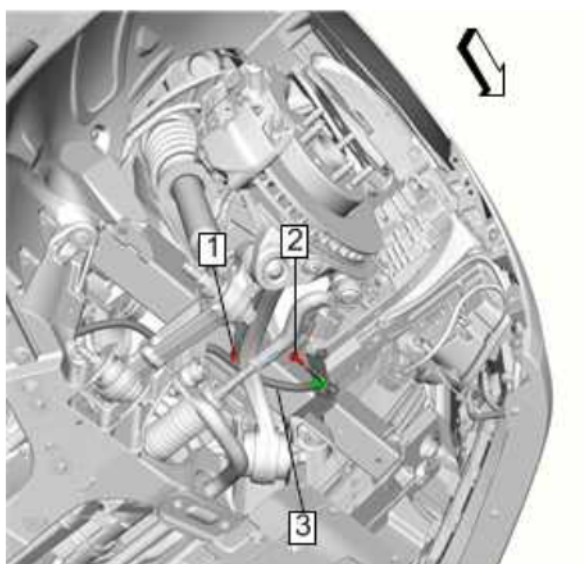


Fig. 46: Battery Negative Cable Extension Cable
Courtesy of GENERAL MOTORS COMPANY

2. Wiring Harness Retainer (1)» Engage
3. Battery Negative Cable Extension Cable Fastener (2)» Install and tighten 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

4. Front Tire Front Air Deflector (2)» Install - **Front Tire Front Air Deflector Replacement**

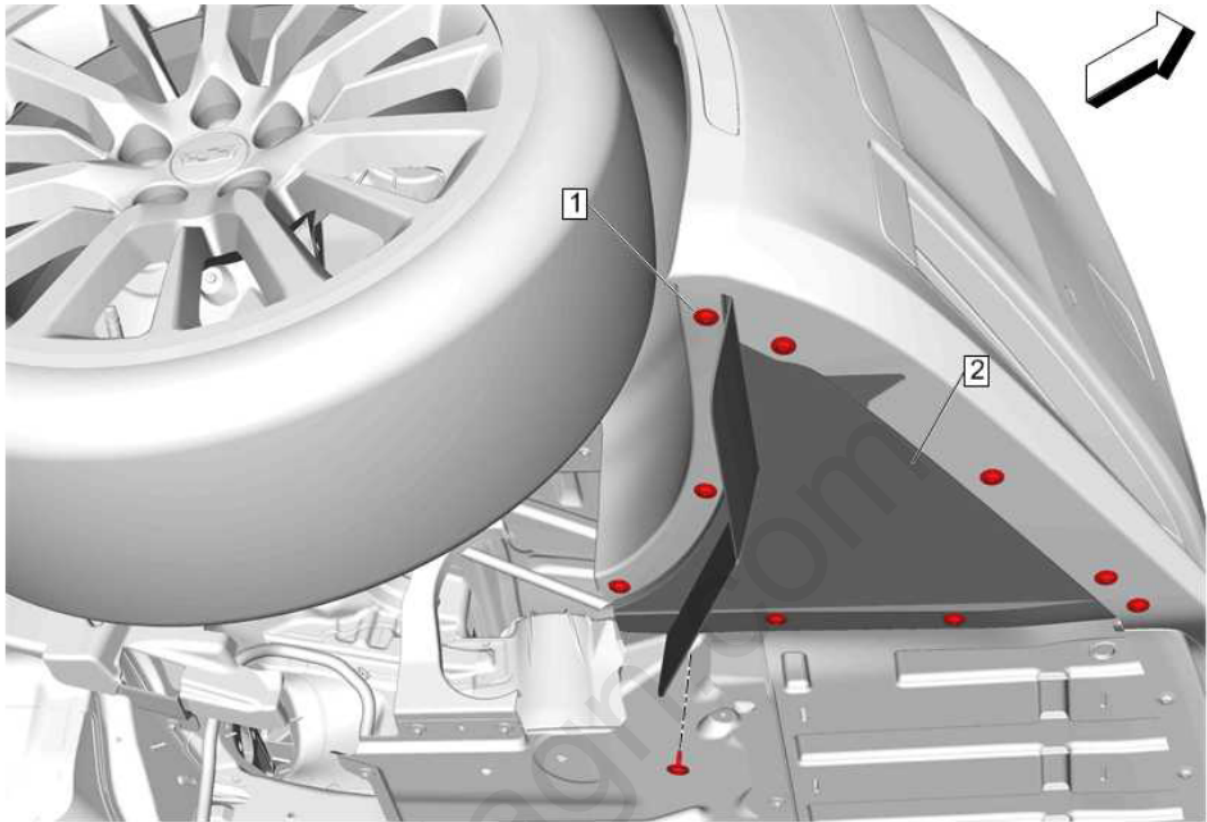


Fig. 47: Front Tire Front Air Deflector
Courtesy of GENERAL MOTORS COMPANY

5. Battery Negative Cable Extension Cable» (2) Install

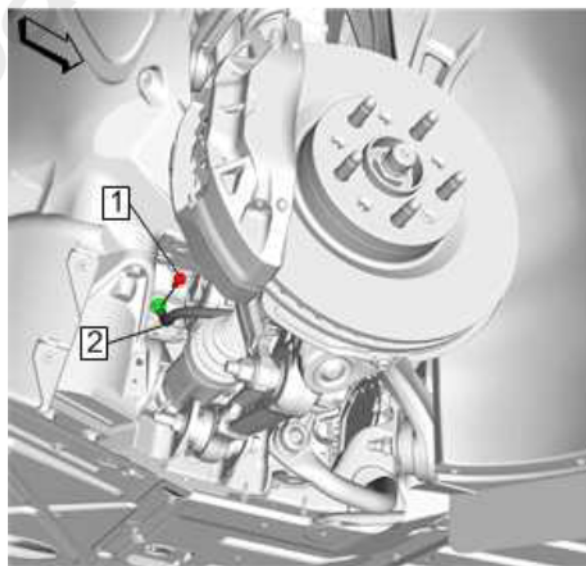


Fig. 48: Battery Negative Cable Extension Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

6. Battery Negative Cable Extension Cable Fastener (1)» Install and tighten 40 N.m (30 lb ft)
7. Generator (2)» Install - **Generator Replacement (LGX)**

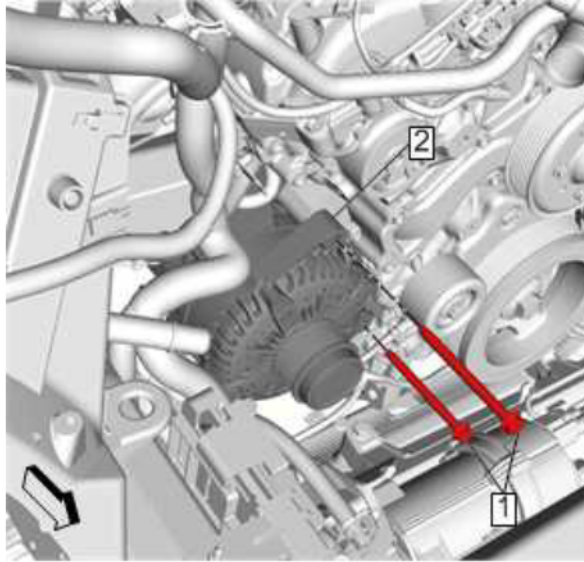


Fig. 49: Generator

Courtesy of GENERAL MOTORS COMPANY

BATTERY POSITIVE CABLE REPLACEMENT

Removal Procedure

1. Rear Compartment Floor Panel Trim» Remove - **Rear Compartment Floor Panel Trim Replacement (Without HP9)** **Rear Compartment Floor Panel Trim Replacement (With HP9)**

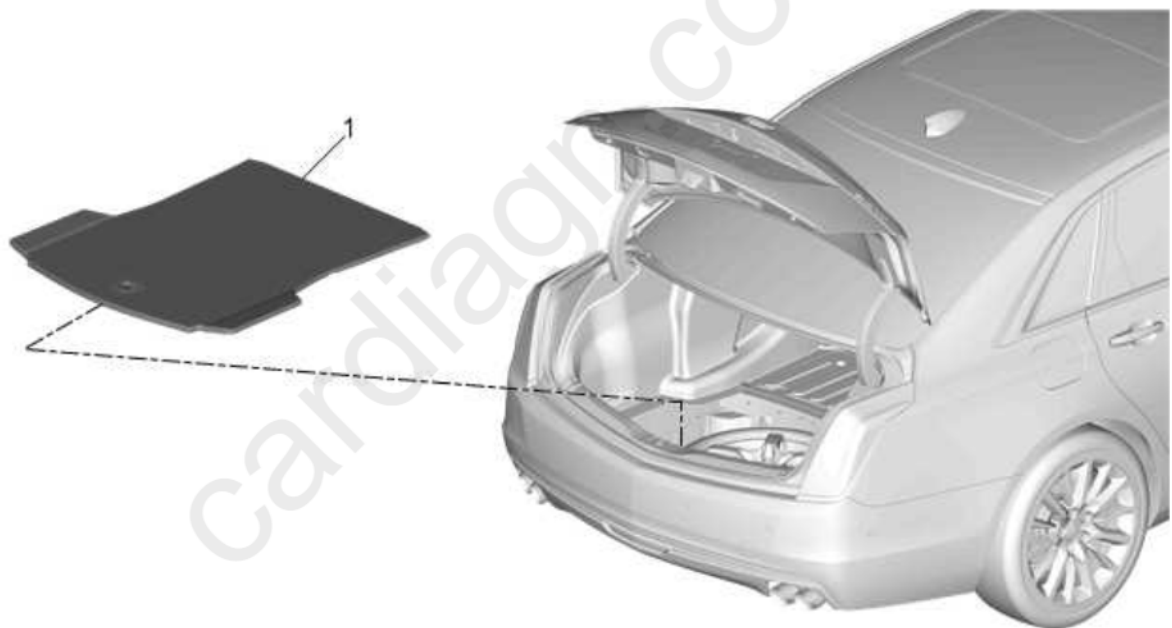


Fig. 50: Rear Compartment Floor Panel Trim

Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**
3. Spare Tire Stowage Retainer (1)» Remove



Fig. 51: Spare Tire

Courtesy of GENERAL MOTORS COMPANY

4. Spare Tire (2) » Remove
5. Battery Distribution Fuse Block Cover Retaining Tab (1) » Disengage

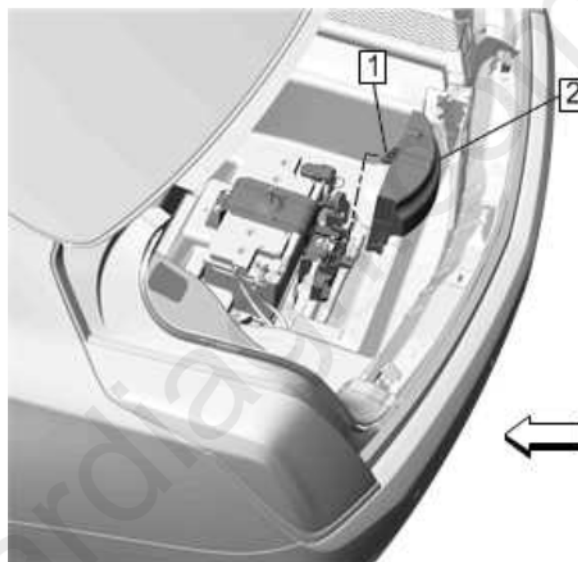


Fig. 52: Battery Distribution Fuse Block Cover Retaining Tab

Courtesy of GENERAL MOTORS COMPANY

6. Battery Distribution Fuse Block Cover (2) » Remove
7. Battery Positive Cable Nut (1) » Remove

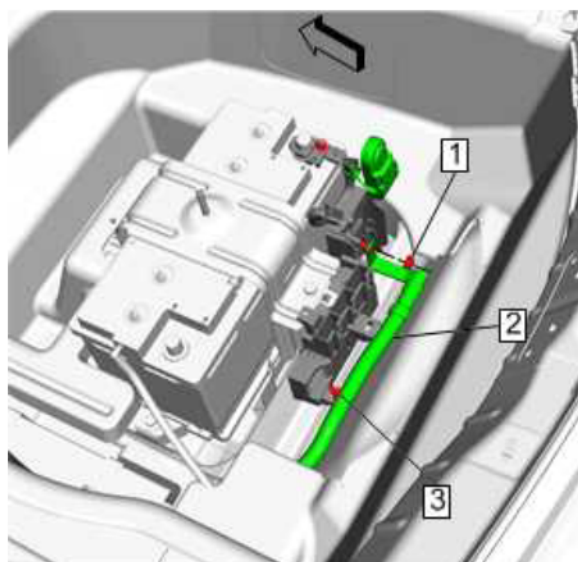


Fig. 53: Battery Positive Cable Nut
Courtesy of GENERAL MOTORS COMPANY

8. Retainer (3)» Disengage
9. Battery Positive Cable (2)» Remove
10. Retainer (1)» Disengage [4x]

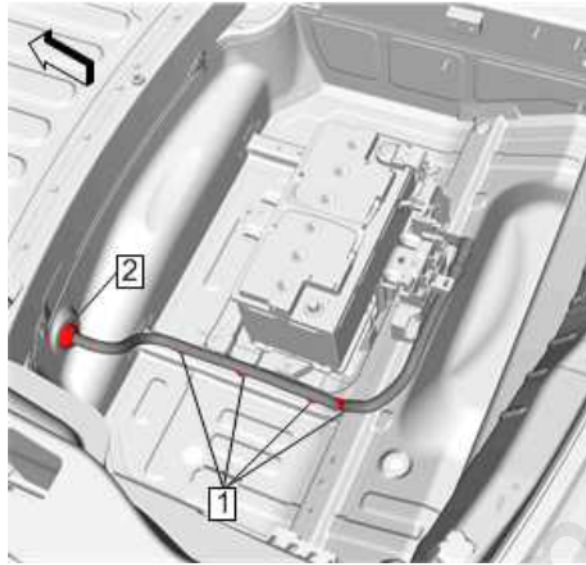


Fig. 54: Retainer And Rubber Grommet
Courtesy of GENERAL MOTORS COMPANY

11. Rubber Grommet (2)» Disengage
12. Feed the battery positive cable through rear compartment opening.
13. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)
14. Fuel Tank (1)» Remove - [Fuel Tank Replacement](#)

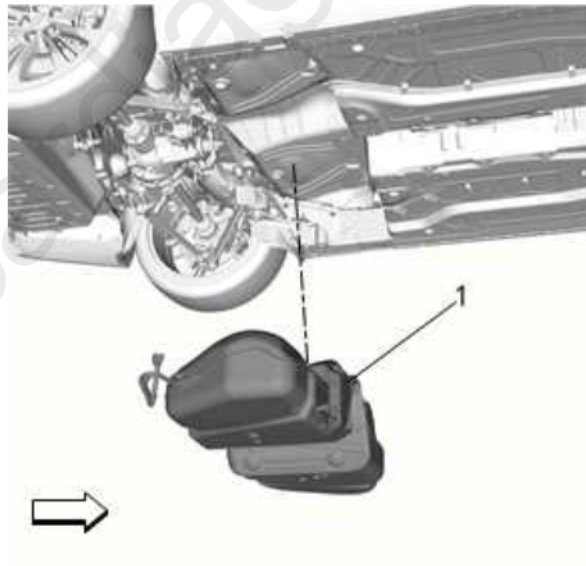


Fig. 55: Fuel Tank
Courtesy of GENERAL MOTORS COMPANY

15. Front Body Exhaust Heat Shield - Left (3)» Remove - [Front Body Exhaust Heat Shield Replacement \(Right Side, LTG\)](#) [Front Body Exhaust Heat Shield Replacement \(Left Side, LTG\)](#) [Front Body Exhaust Heat Shield Replacement \(Right Side, LGW, LGX\)](#) [Front Body Exhaust Heat Shield Replacement \(Left Side, LGW, LGX\)](#)

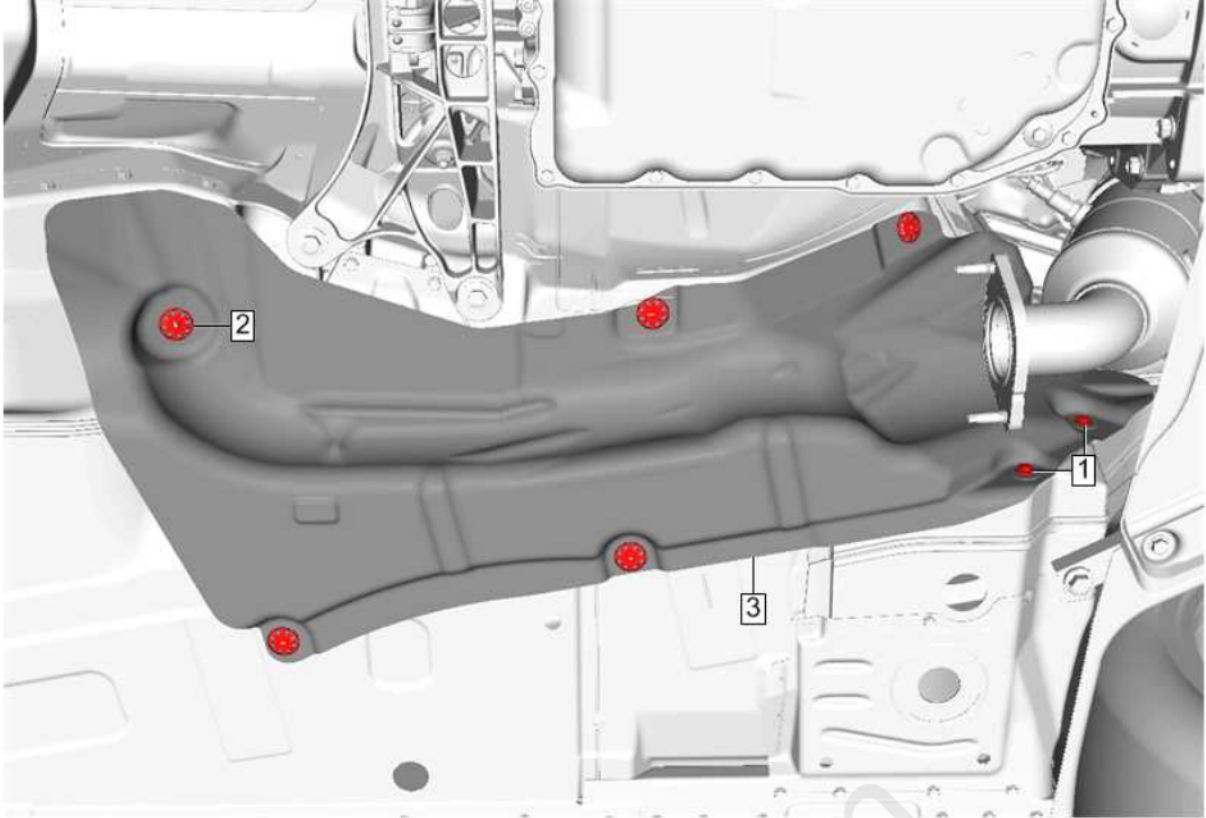


Fig. 56: Front Body Exhaust Heat Shield
Courtesy of GENERAL MOTORS COMPANY

16. Retainer (1)» Disengage [4x]

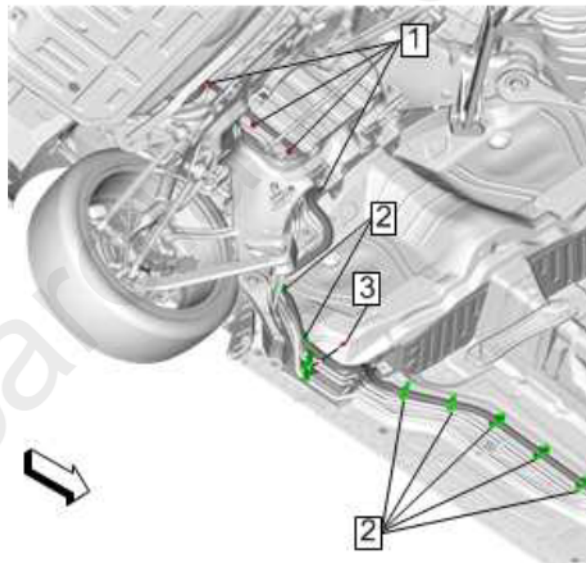


Fig. 57: Retainer
Courtesy of GENERAL MOTORS COMPANY

- 17. Release the clips with a suitable tool. (2)
- 18. Remove the auxiliary A/C evaporator tube bracket fastener. (3)
- 19. Retainer (1)» Disengage [5x]

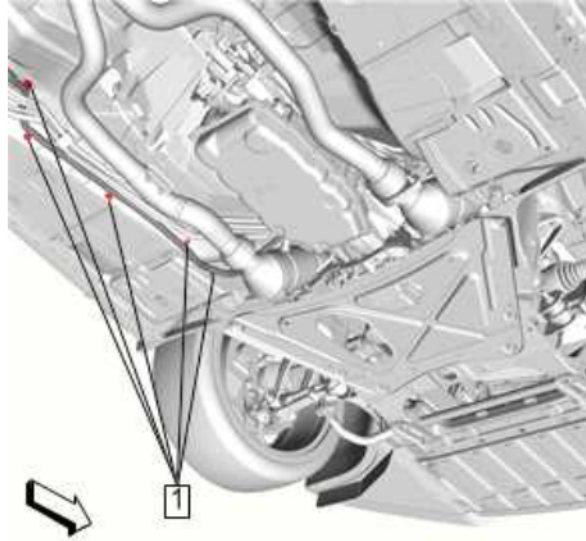


Fig. 58: Retainer

Courtesy of GENERAL MOTORS COMPANY

20. Lower the vehicle.

21. Retainer (1) » Disengage [5x]

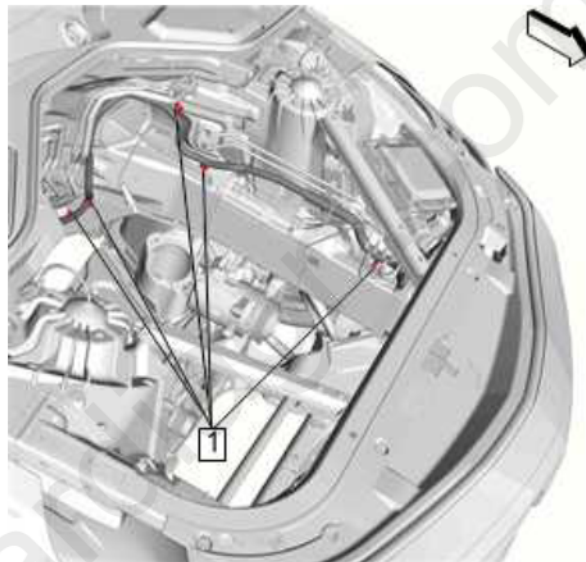


Fig. 59: Retainer

Courtesy of GENERAL MOTORS COMPANY

22. Power Distributor Fuse Block Cover (1) » Remove

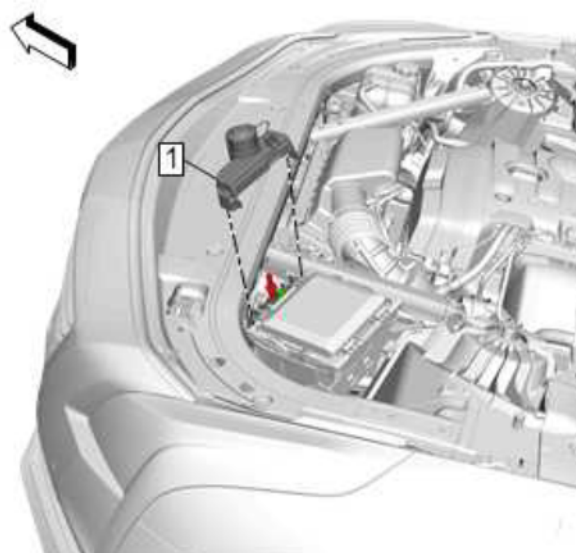


Fig. 60: Power Distributor Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

23. Battery Positive Cable Nut (1)A, A» Remove

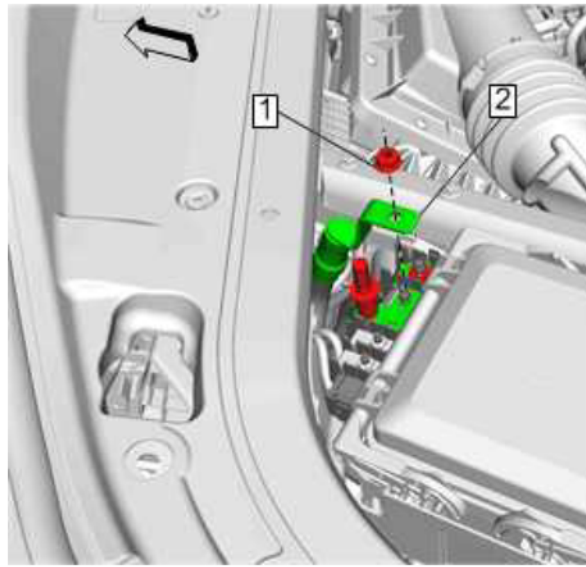


Fig. 61: Battery Positive Cable Nut

Courtesy of GENERAL MOTORS COMPANY

24. Battery Positive Cable (2)A, A» Remove

Installation Procedure

1. Battery Positive Cable (2)A, A» Install

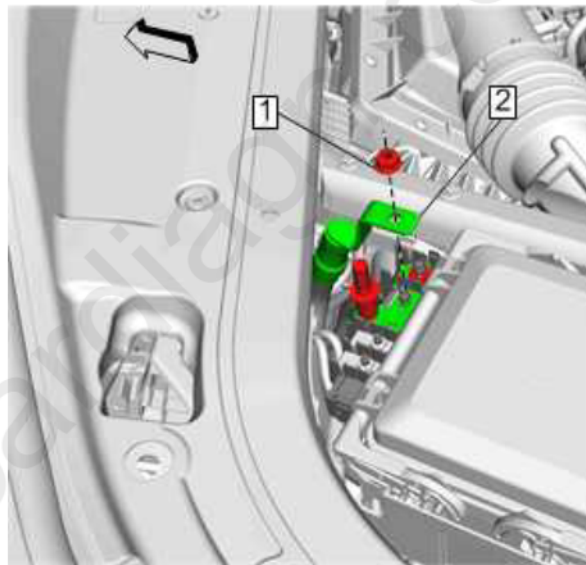


Fig. 62: Battery Positive Cable Nut

Courtesy of GENERAL MOTORS COMPANY

2. Battery Positive Cable Nut (1)A, A» Install and tighten 15 N.m (11 lb ft)

CAUTION: Refer to **Fastener Caution**

3. Power Distributor Fuse Block Cover (1)A, A» Install

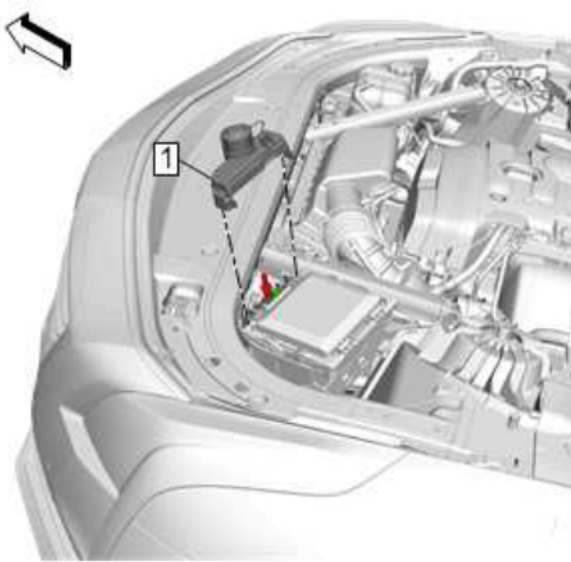


Fig. 63: Power Distributor Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

4. Retainer (1) » Engage [5x]



Fig. 64: Retainer
 Courtesy of GENERAL MOTORS COMPANY

5. Raise and support the vehicle. Refer to [Lifting and Jacking the Vehicle](#)

6. Retainer (1) » Engage [5x]

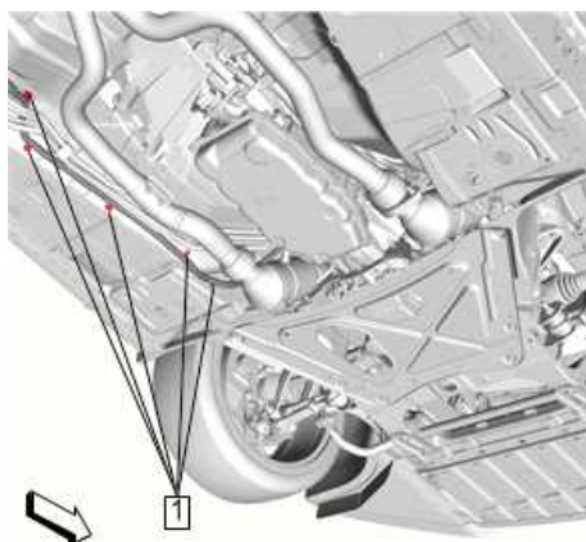


Fig. 65: Retainer
 Courtesy of GENERAL MOTORS COMPANY

7. Retainer (1)» Engage [4x]

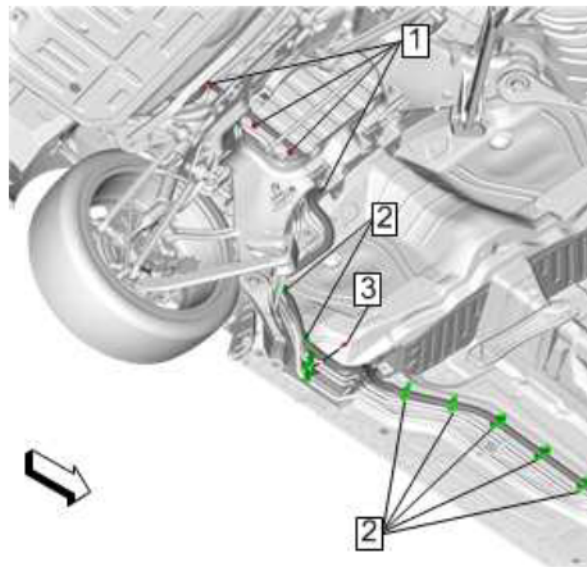


Fig. 66: Retainer

Courtesy of GENERAL MOTORS COMPANY

8. Secure the clips. (2)

9. Install the auxiliary A/C evaporator tube bracket fastener. (3)» Install and tighten 9 N.m (80 lb in)

10. Power Distributor Fuse Block Cover (1)» Install

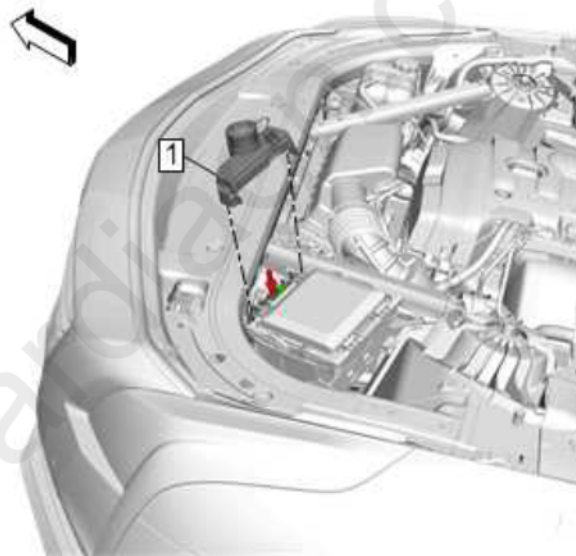


Fig. 67: Power Distributor Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

11. Retainer (1)» Engage [5x]

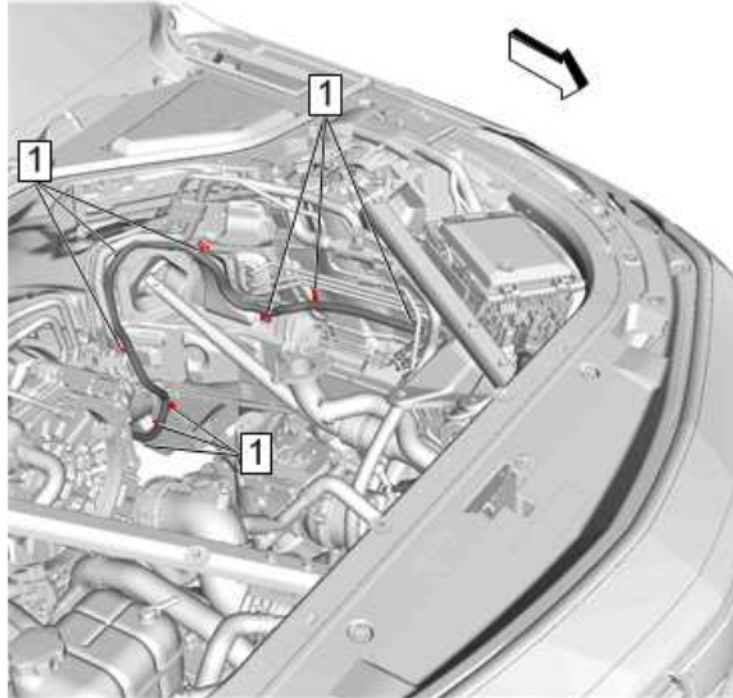


Fig. 68: Retainer

Courtesy of GENERAL MOTORS COMPANY

12. Lower the vehicle.
13. Feed the battery positive cable through rear compartment opening.

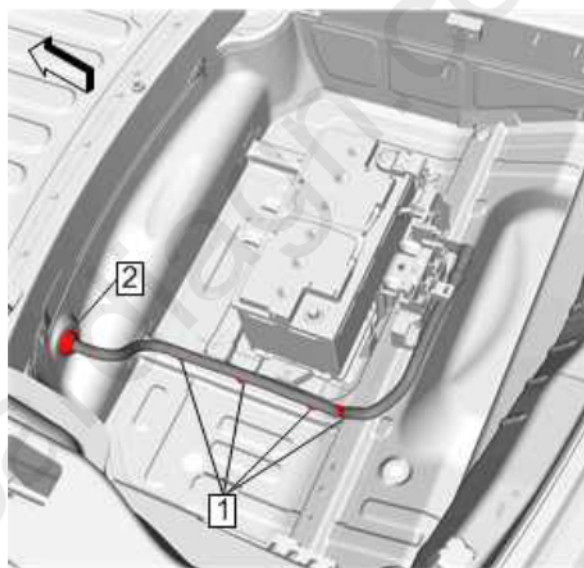


Fig. 69: Retainer And Rubber Grommet

Courtesy of GENERAL MOTORS COMPANY

14. Rubber Grommet (2)» Install
15. Retainer (1)» Engage [4x]
16. Battery Positive Cable (2)» Install

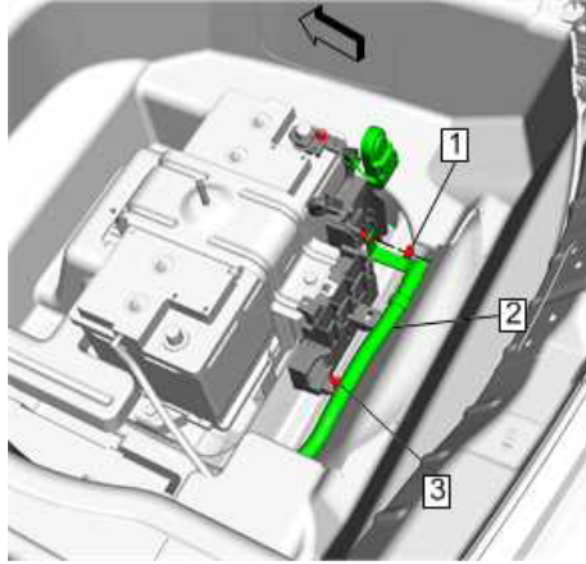


Fig. 70: Battery Positive Cable Nut

Courtesy of GENERAL MOTORS COMPANY

17. Retainer (3) » Engage
18. Battery Positive Cable Nut (1) » Install and tighten 15 N.m (11 lb ft)
19. Battery Distribution Fuse Block Cover (2) » Install

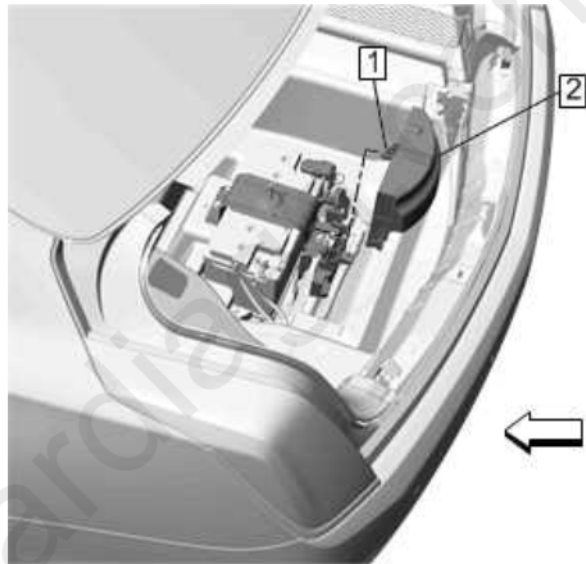


Fig. 71: Battery Distribution Fuse Block Cover Retaining Tab

Courtesy of GENERAL MOTORS COMPANY

20. Battery Distribution Fuse Block Cover Retaining Tab (1) » Engage
21. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**
22. Spare Tire (2) » Install



Fig. 72: Spare Tire

Courtesy of GENERAL MOTORS COMPANY

23. Spare Tire Stowage Retainer (1)» Hand tighten
24. Rear Compartment Floor Panel Trim» Install - **Rear Compartment Floor Panel Trim Replacement (Without HP9)** **Rear Compartment Floor Panel Trim Replacement (With HP9)**

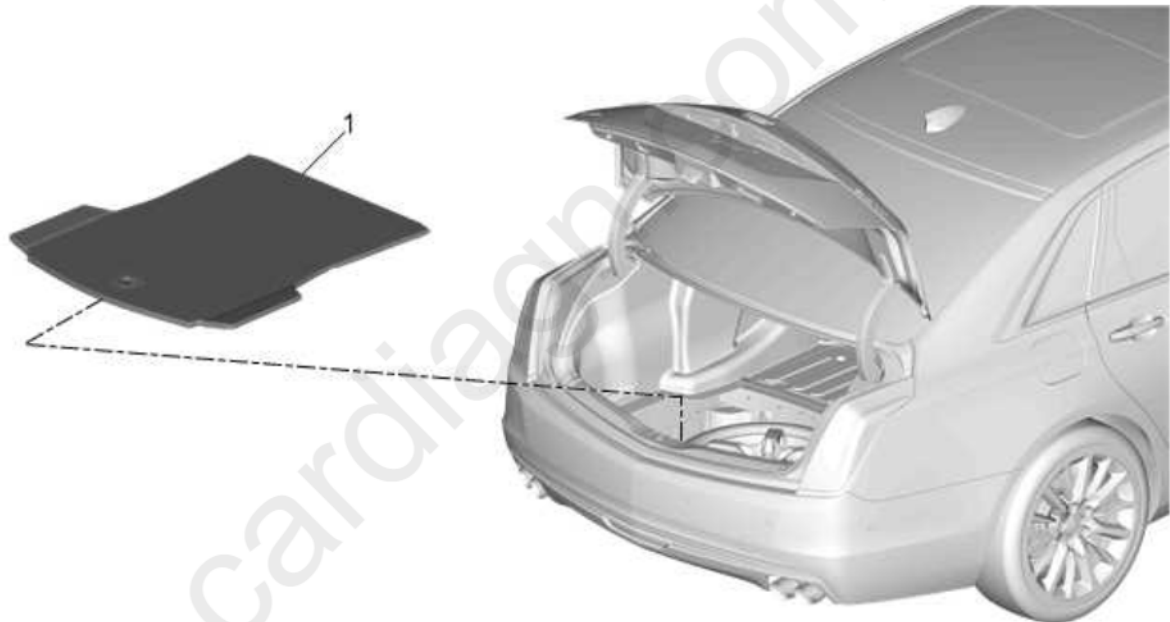


Fig. 73: Rear Compartment Floor Panel Trim

Courtesy of GENERAL MOTORS COMPANY

ENGINE WIRING HARNESS FUSE BLOCK BRACKET REPLACEMENT

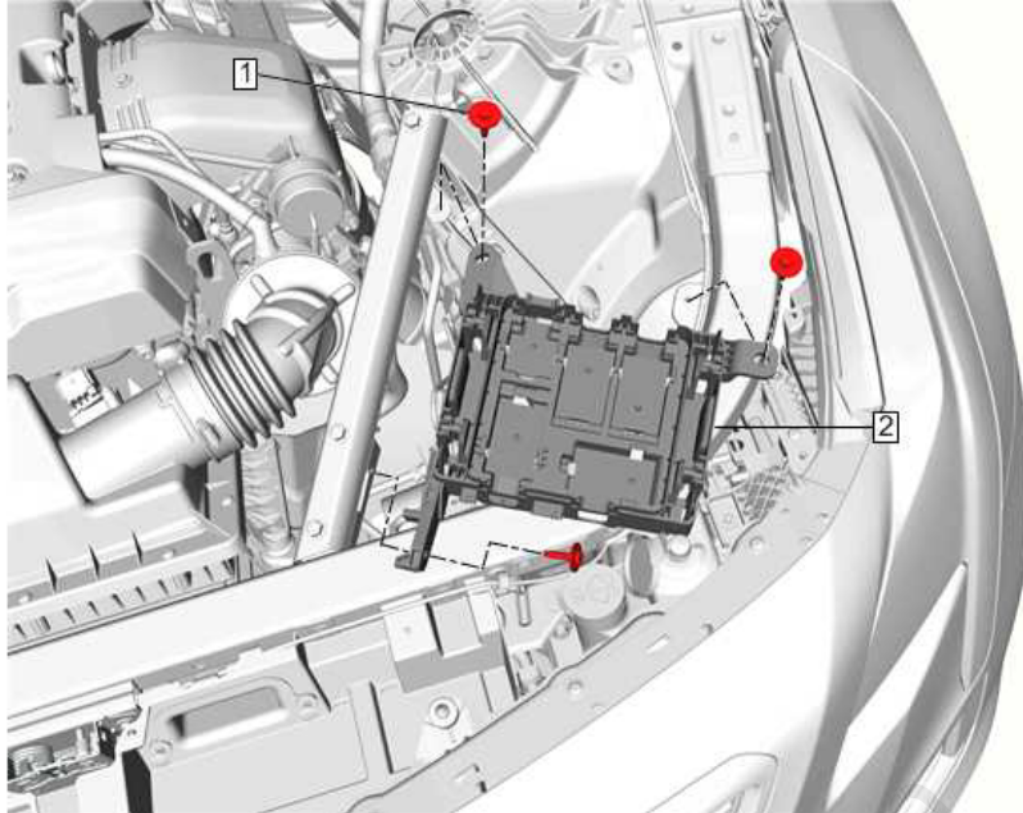


Fig. 74: Engine Wiring Harness Fuse Block Bracket
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures Engine Wiring Harness Junction Block Replacement - Remove wire harness connector ends from engine wiring harness fuse block bracket.	
1	Engine Wiring Harness Fuse Block Bracket Bolt [3x] CAUTION: Refer to Fastener Caution . Tighten 9 N.m (80 lb in)
2	Engine Wiring Harness Fuse Block Bracket

ENGINE WIRING HARNESS JUNCTION BLOCK REPLACEMENT

Removal Procedure

- Disconnect the battery negative cable. Refer to **Battery Negative Cable Disconnection and Connection**
- Generator Battery Jumper Cable Stud (1)» Remove

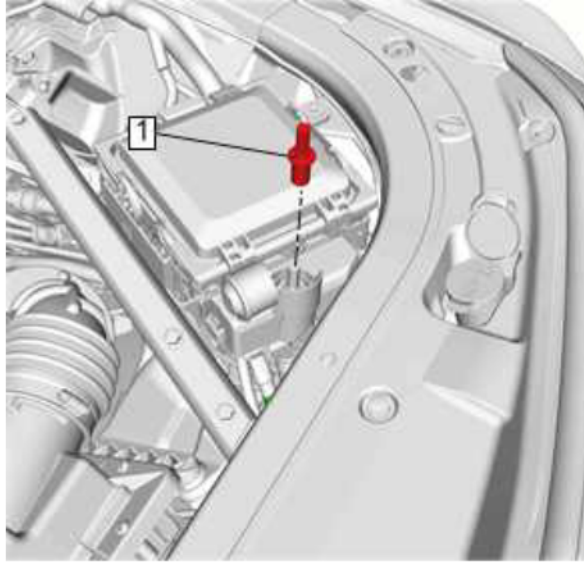


Fig. 75: Generator Battery Jumper Cable Stud
 Courtesy of GENERAL MOTORS COMPANY

3. Power Distributor Fuse Block Cover (1) Æ, Æ» Remove

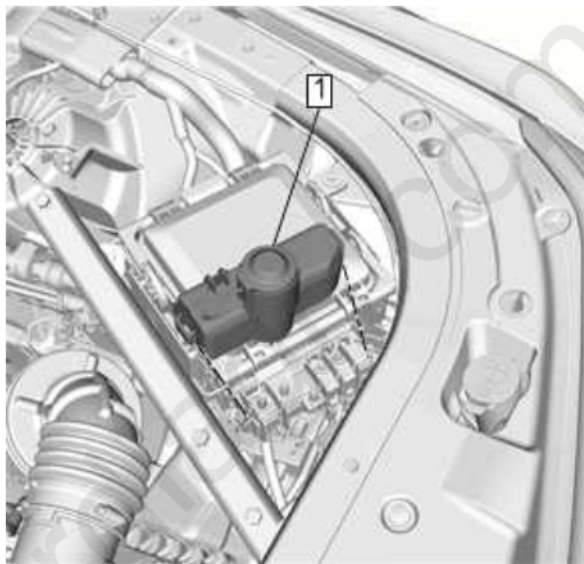


Fig. 76: Power Distributor Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

4. Engine Wiring Harness Junction Block Cover (1) Æ, Æ» Remove

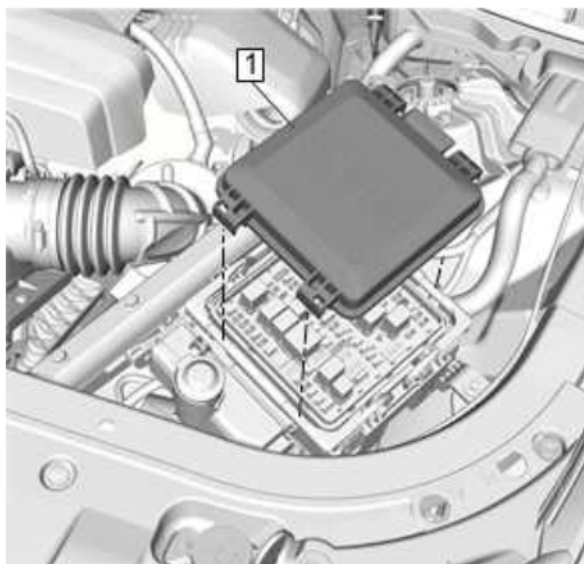


Fig. 77: Engine Wiring Harness Junction Block Cover
 Courtesy of GENERAL MOTORS COMPANY

5. Generator Battery Jumper Cable Nut (1)A, A» Remove

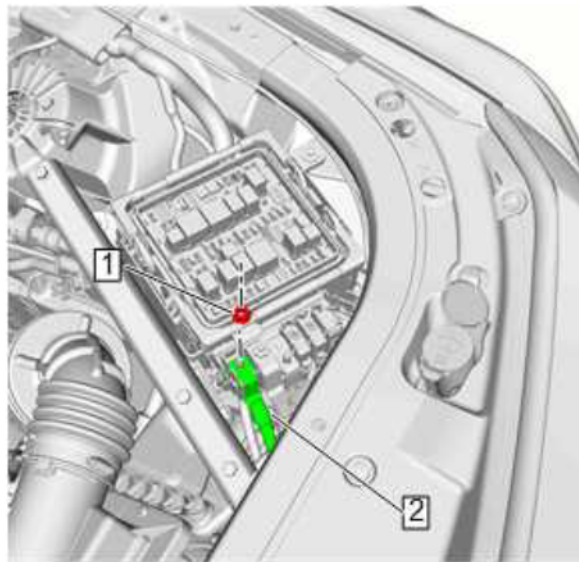


Fig. 78: Generator Battery Jumper Cable Nut
Courtesy of GENERAL MOTORS COMPANY

6. Battery Positive Cable Junction Block Lead Nut (1)A, A» Remove

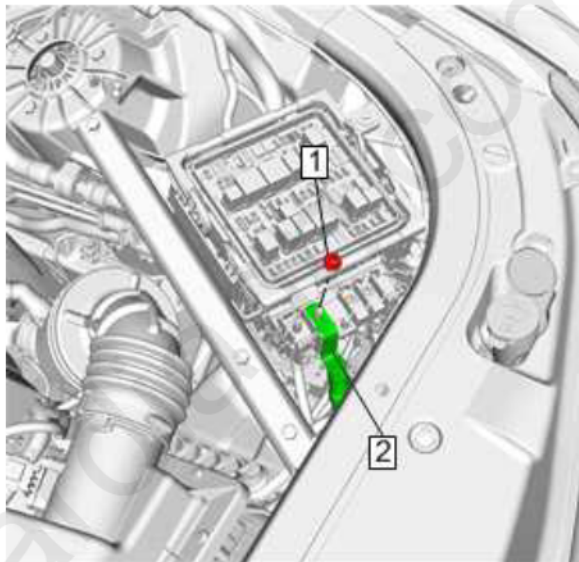
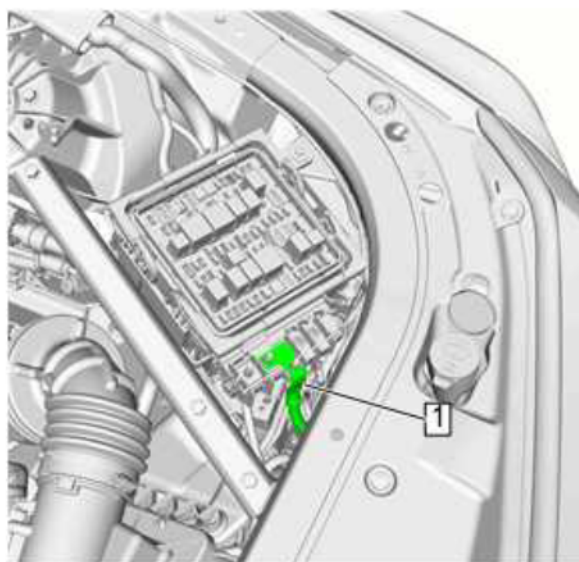


Fig. 79: Positive Cable Junction Block Lead Nut
Courtesy of GENERAL MOTORS COMPANY

7. Battery Positive Cable (2)A, A» Remove

8. Generator Battery Jumper Cable (1)A, A» Remove



9. Engine Wiring Harness Terminal Nut (1)» Remove [2x]

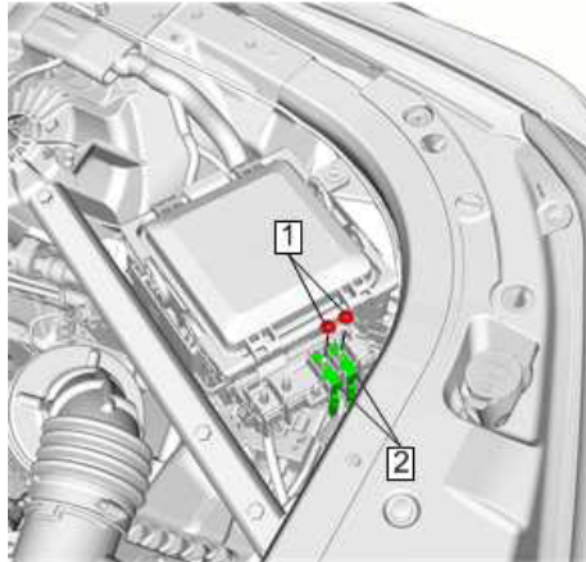


Fig. 81: Engine Wiring Harness Terminal Nut
Courtesy of GENERAL MOTORS COMPANY

10. Engine Wiring Harness Terminal (2)» Remove
11. Release the 4 retainer tabs using a suitable hook-like tool to release the locking levers to allow the locking levers to be rotated to the full up position. Remove Engine Wiring Harness Junction Block (1).

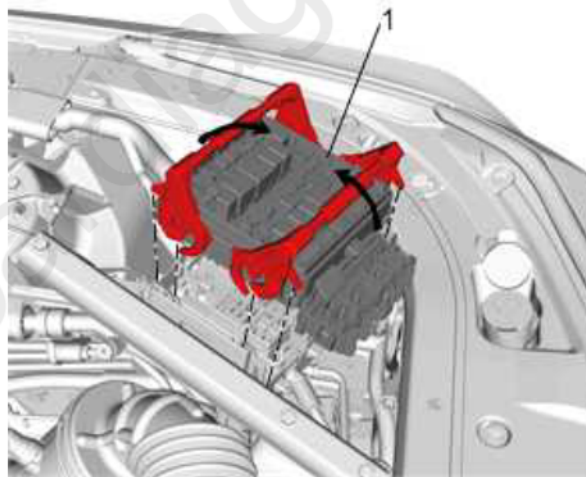


Fig. 82: Engine Wiring Harness Junction Block
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Position the fuse block (1) to the vehicle and push down until the retainer tabs lock into place.

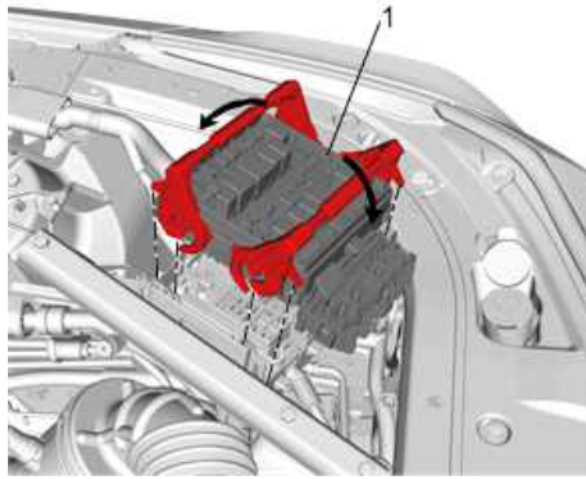


Fig. 83: Fuse Block

Courtesy of GENERAL MOTORS COMPANY

2. Engine Wiring Harness Terminal (2)» Install

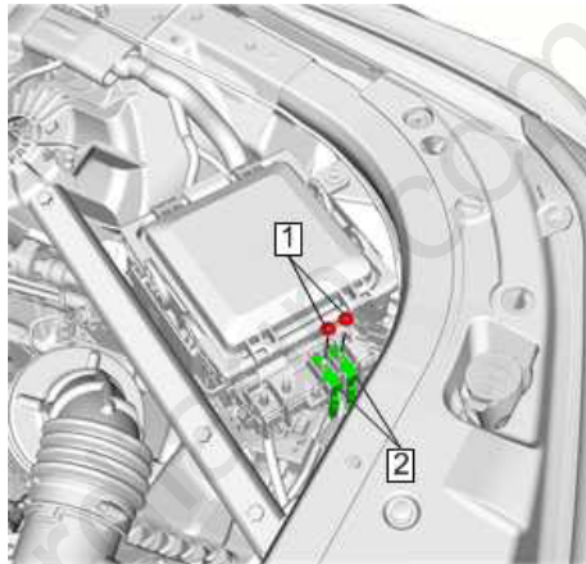


Fig. 84: Engine Wiring Harness Terminal Nut

Courtesy of GENERAL MOTORS COMPANY

3. Engine Wiring Harness Terminal Nut (1)» Install and tighten [2x] 15 N.m (11 lb ft)

CAUTION: Refer to **Fastener Caution** .

4. Generator Battery Jumper Cable (1)» Install

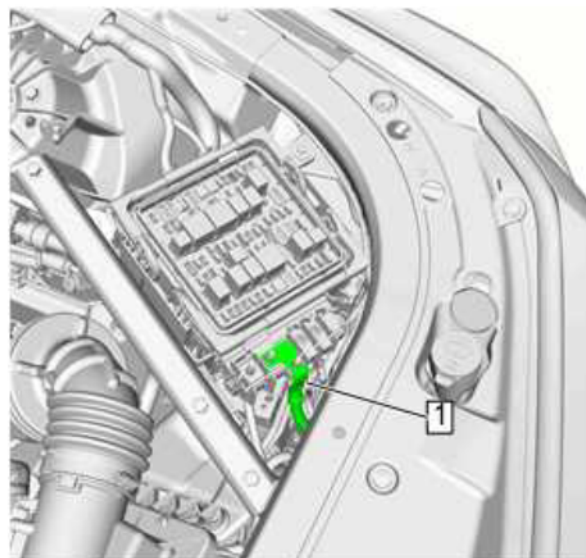


Fig. 85: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

5. Battery Positive Cable (2)» Install

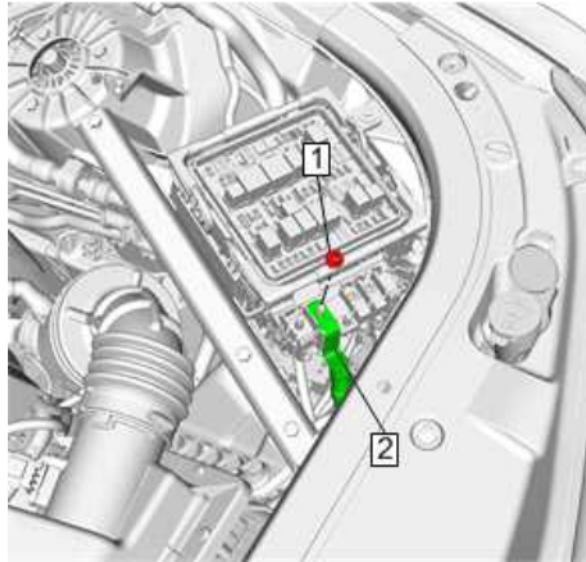


Fig. 86: Positive Cable Junction Block Lead Nut
Courtesy of GENERAL MOTORS COMPANY

6. Battery Positive Cable Junction Block Lead Nut (1)» Install and tighten 22 N.m (16 lb ft)

7. Battery Positive Cable Nut (1)» Install and tighten 15 N.m (11 lb ft)

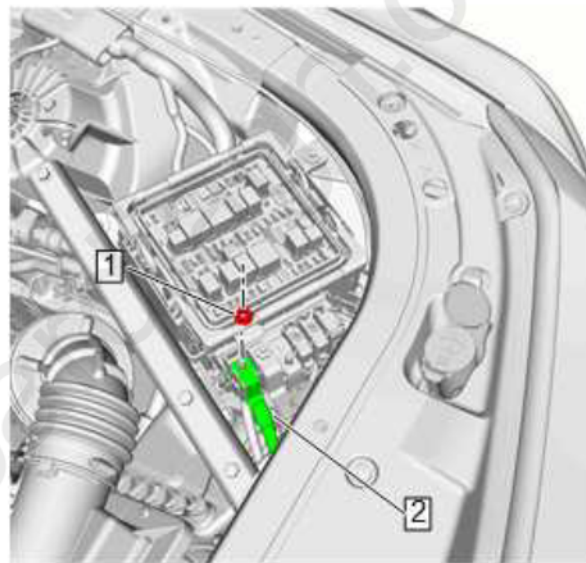


Fig. 87: Generator Battery Jumper Cable Nut
Courtesy of GENERAL MOTORS COMPANY

8. Engine Wiring Harness Junction Block Cover (1)» Install

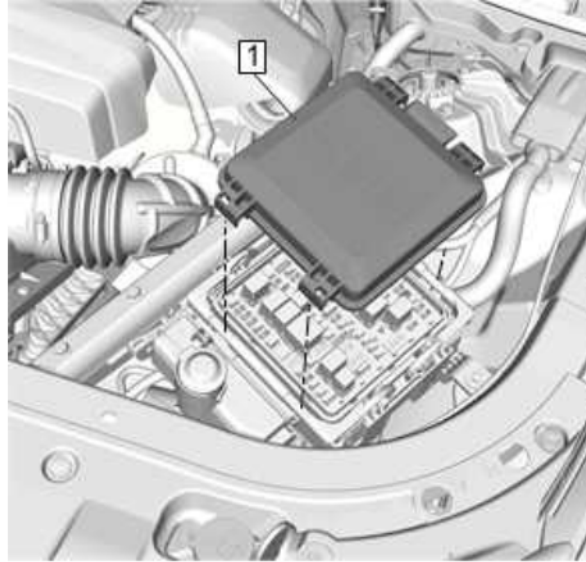


Fig. 88: Engine Wiring Harness Junction Block Cover
 Courtesy of GENERAL MOTORS COMPANY

9. Power Distributor Fuse Block Cover (1)» Install

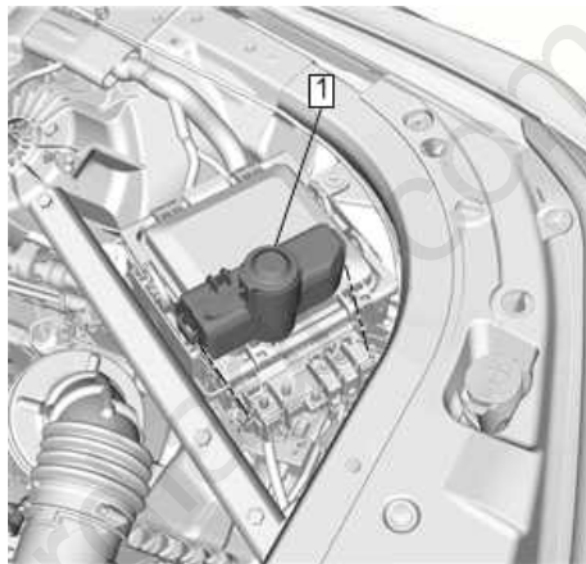


Fig. 89: Power Distributor Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

10. Generator Battery Jumper Cable Stud (1)» Install and tighten 15 N.m (11 lb ft)

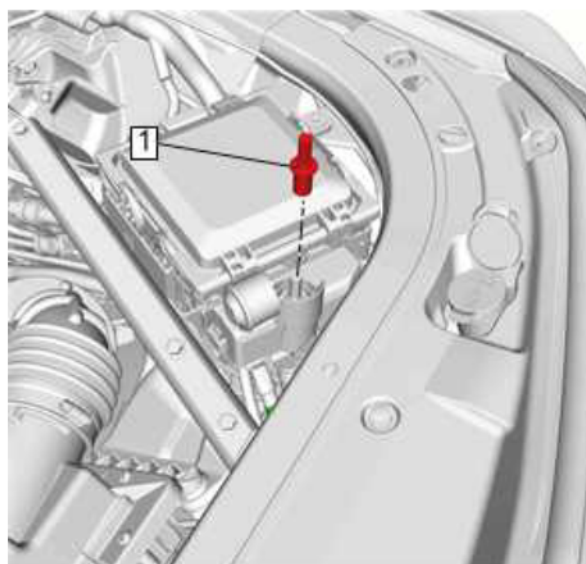


Fig. 90: Generator Battery Jumper Cable Stud
 Courtesy of GENERAL MOTORS COMPANY

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

GENERATOR BATTERY JUMPER CABLE REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Air Cleaner Assembly (1)» Remove - [Air Cleaner Assembly Replacement](#)

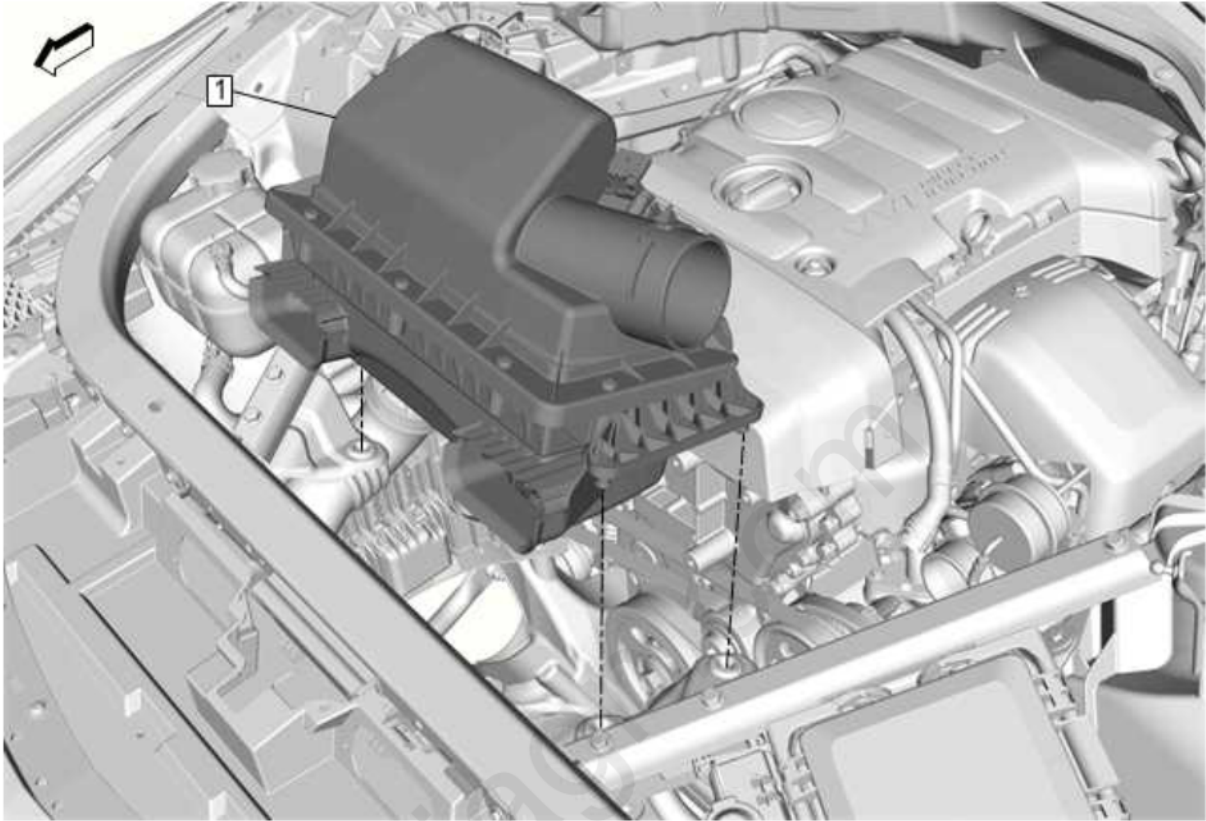


Fig. 91: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

3. Intake Manifold (2)» Remove - [Intake Manifold Replacement \(Except Hybrid\)](#)

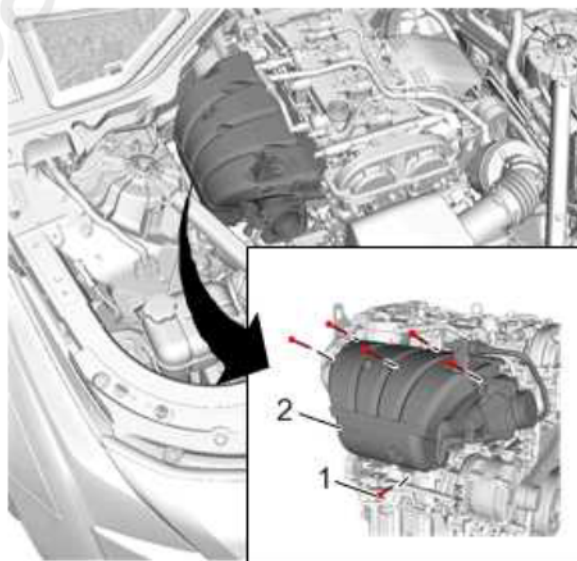


Fig. 92: Intake Manifold

Courtesy of GENERAL MOTORS COMPANY

4. Generator Nut (2)» Remove

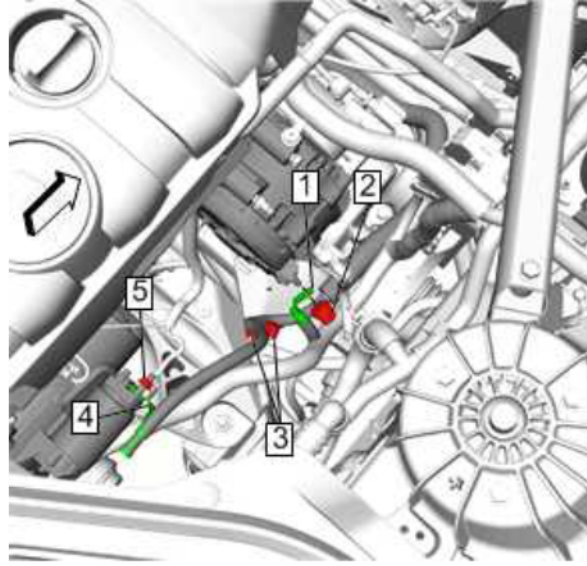


Fig. 93: Generator Nut

Courtesy of GENERAL MOTORS COMPANY

5. Generator Battery Jumper Cable (1)» Remove
6. Wiring Harness Retainer (3)» Disengage [2x]
7. Starter Solenoid Cable Nut (5)» Remove
8. Generator Battery Jumper Cable (4)» Remove
9. Power Distributor Fuse Block Cover (1)» Remove

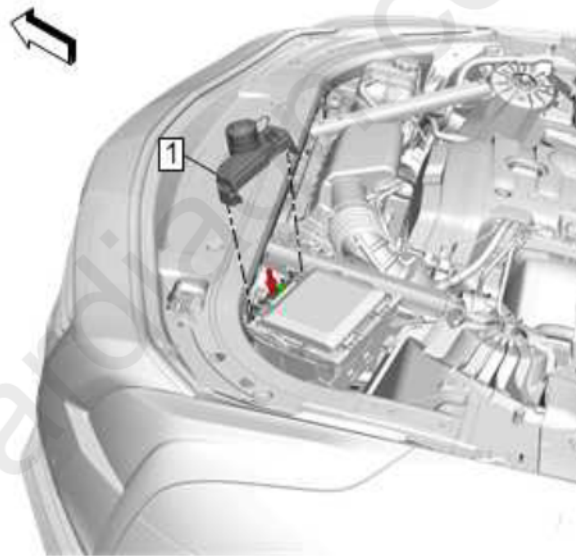


Fig. 94: Power Distributor Fuse Block Cover

Courtesy of GENERAL MOTORS COMPANY

10. Battery Positive Cable Nut (1)» Remove

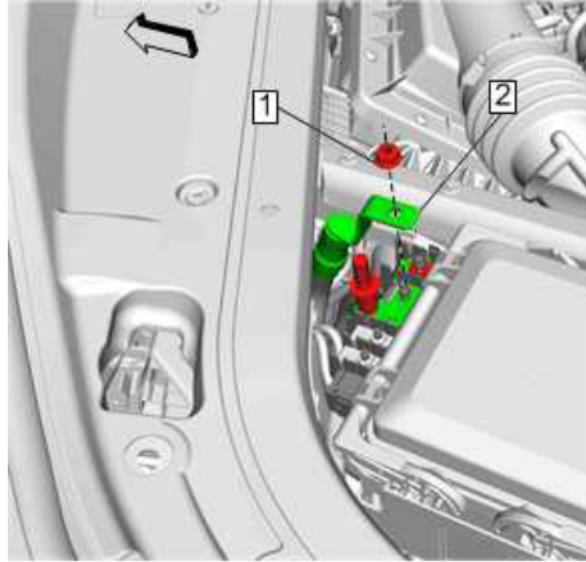


Fig. 95: Battery Positive Cable Nut

Courtesy of GENERAL MOTORS COMPANY

- 11. Battery Positive Cable (2) ã, â» Remove
- 12. Generator Battery Jumper Cable Fastener (1) ã, â» Remove

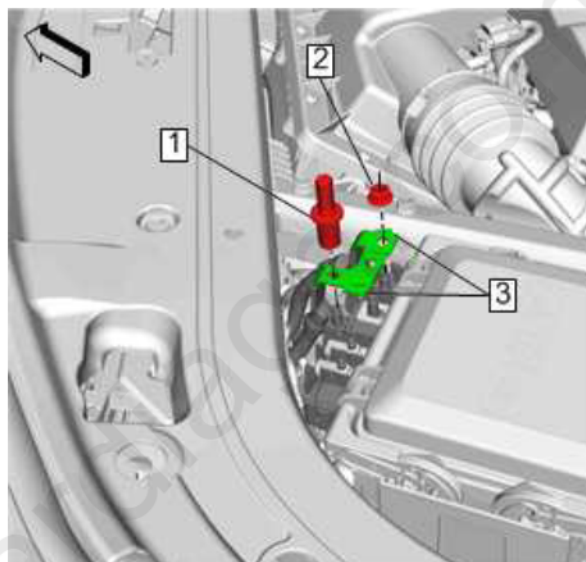
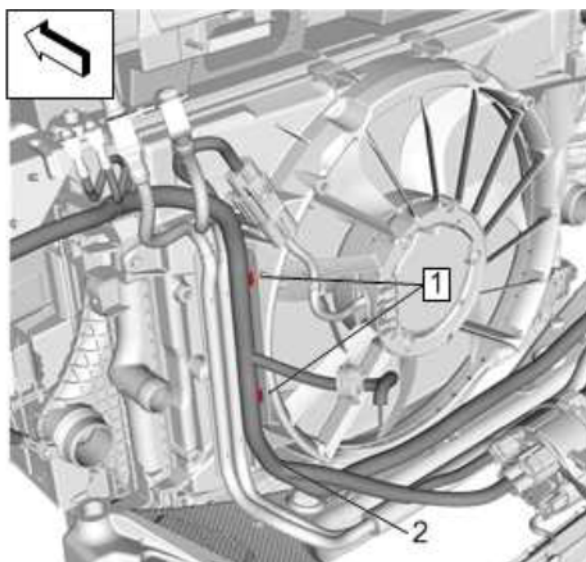


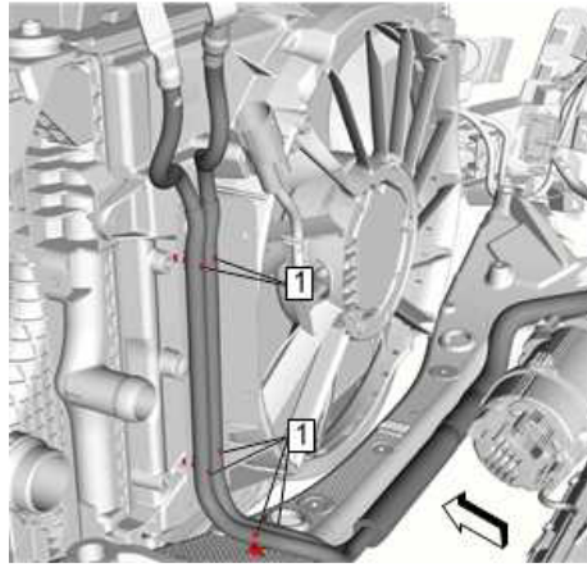
Fig. 96: Generator Battery Jumper Cable Fastener

Courtesy of GENERAL MOTORS COMPANY

- 13. Generator Battery Jumper Cable Fastener (2) ã, â» Remove
- 14. Generator Battery Jumper Cable (3) ã, â» Remove [2x]
- 15. Wiring Harness Retainer (1) ã, â» Disengage [2x]

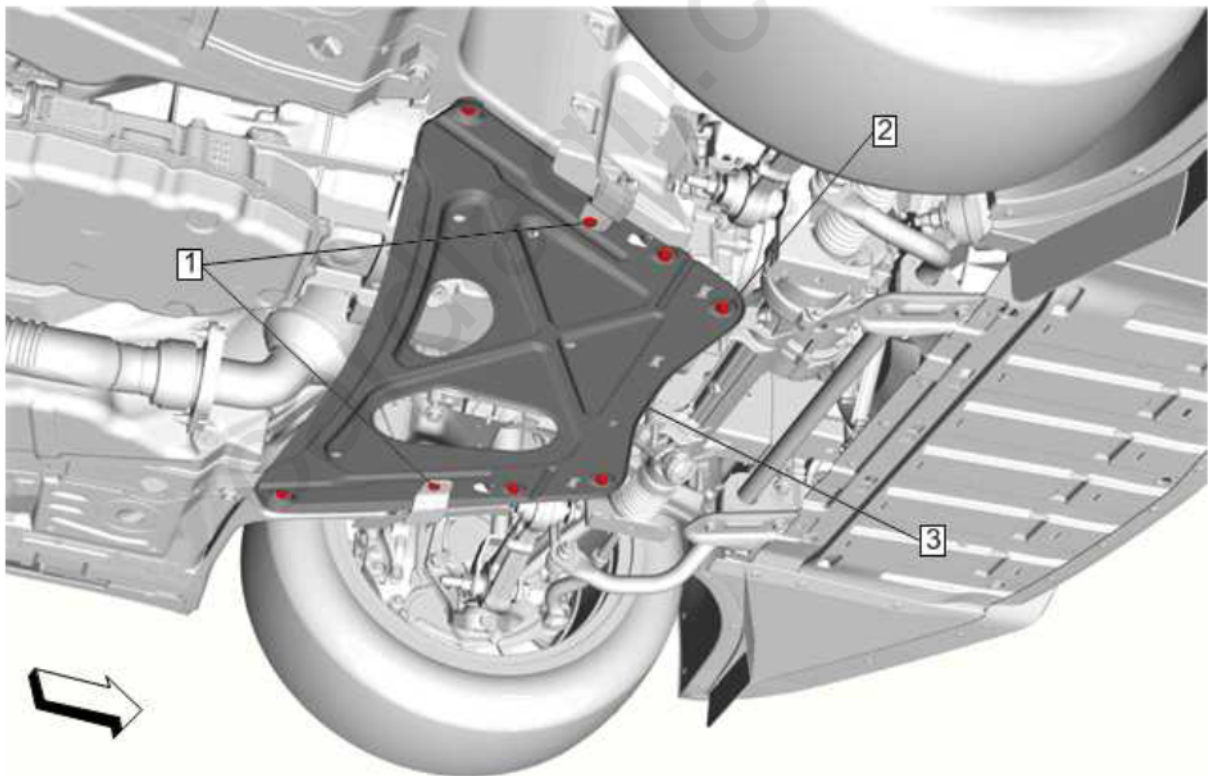


16. Wiring Harness Retainer (1) » Disengage [6x]



[Fig. 98: Wiring Harness Retainer](#)
Courtesy of GENERAL MOTORS COMPANY

17. Drivetrain and Front Suspension Cradle Plate (3) » Remove - [Drivetrain and Front Suspension Cradle Plate Replacement](#)



[Fig. 99: Drivetrain and Front Suspension Cradle Plate](#)
Courtesy of GENERAL MOTORS COMPANY

18. Wiring Harness Retainer (1) @ Drivetrain and Front Suspension Cradle (2) » Disengage [4x]

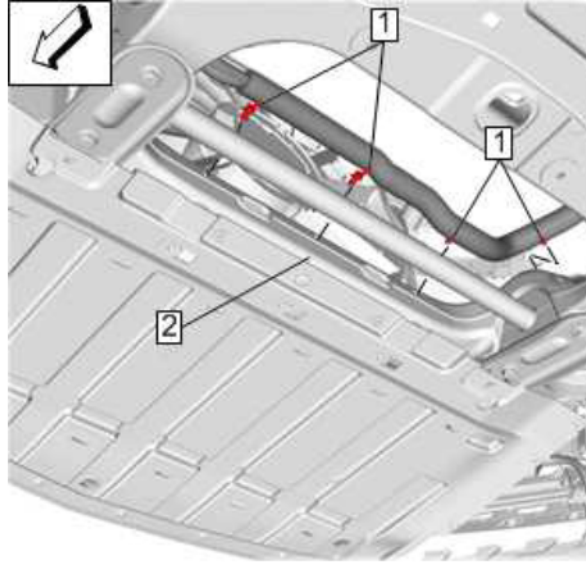


Fig. 100: Drivetrain and Front Suspension Cradle
 Courtesy of GENERAL MOTORS COMPANY

19. Wiring Harness Retainer (1) @ Engine Control Module Bracket (2) » Disengage

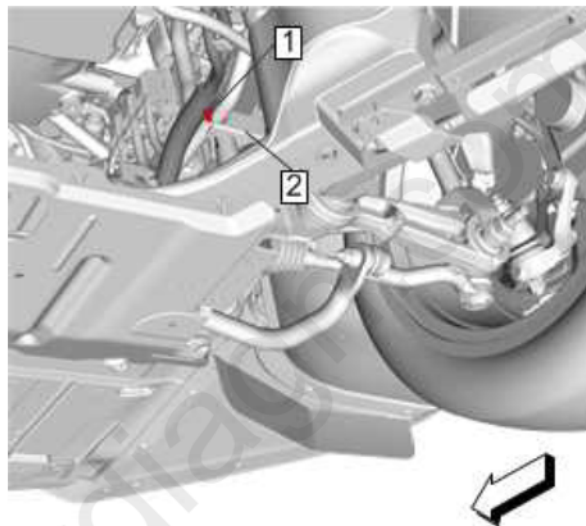


Fig. 101: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

20. Generator Battery Jumper Cable (1) » Remove



Fig. 102: Battery Jumper Cable
 Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the location and routing of the wiring harness to ensure proper reinstallation.

Installation Procedure

1. Generator Battery Jumper Cable (1) » Install



Fig. 103: Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

2. Wiring Harness Retainer (1) @ Engine Control Module Bracket (2) » Engage

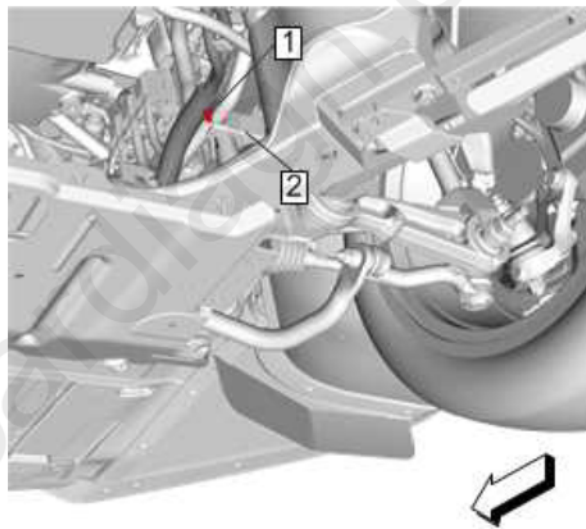


Fig. 104: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

3. Wiring Harness Retainer (1) @ Drivetrain and Front Suspension Cradle (2) » Engage [4x]

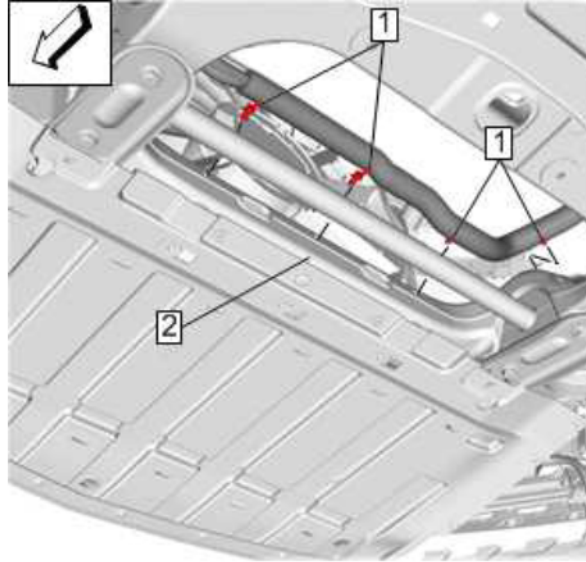


Fig. 105: Drivetrain and Front Suspension Cradle
 Courtesy of GENERAL MOTORS COMPANY

4. Drivetrain and Front Suspension Cradle Plate (3)» Install - **Drivetrain and Front Suspension Cradle Plate Replacement**

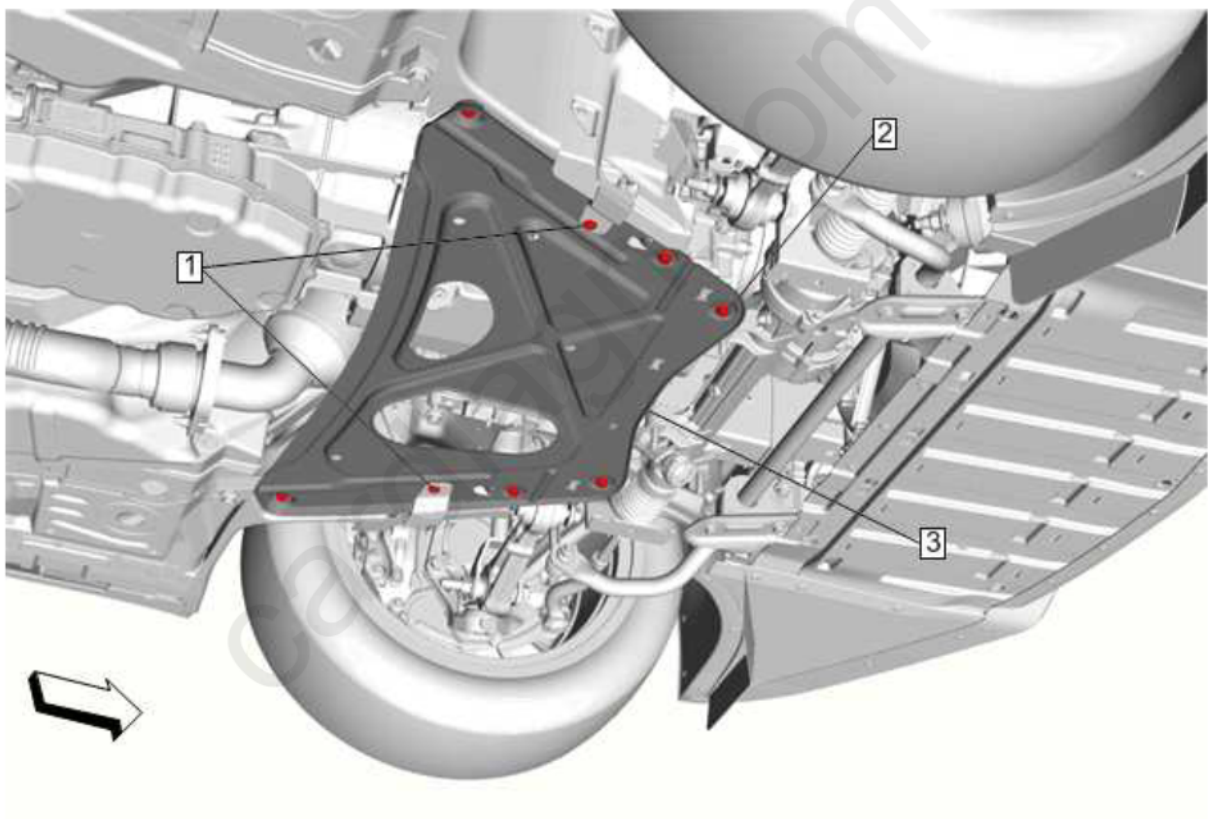


Fig. 106: Drivetrain and Front Suspension Cradle Plate
 Courtesy of GENERAL MOTORS COMPANY

5. Wiring Harness Retainer (1)» Engage [6x]

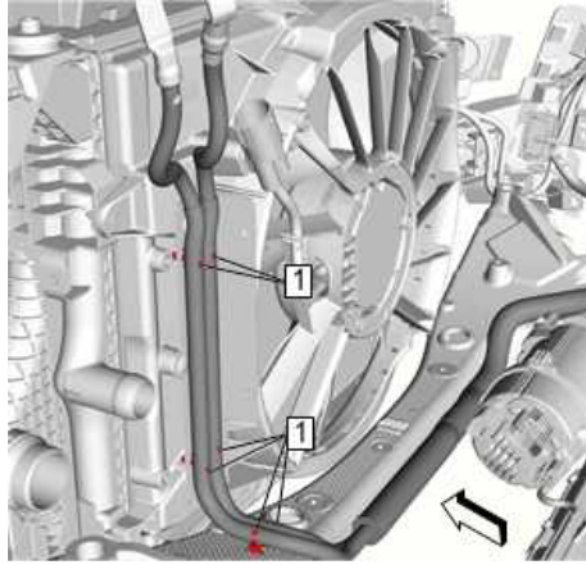


Fig. 107: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

6. Wiring Harness Retainer (1) » Engage [2x]

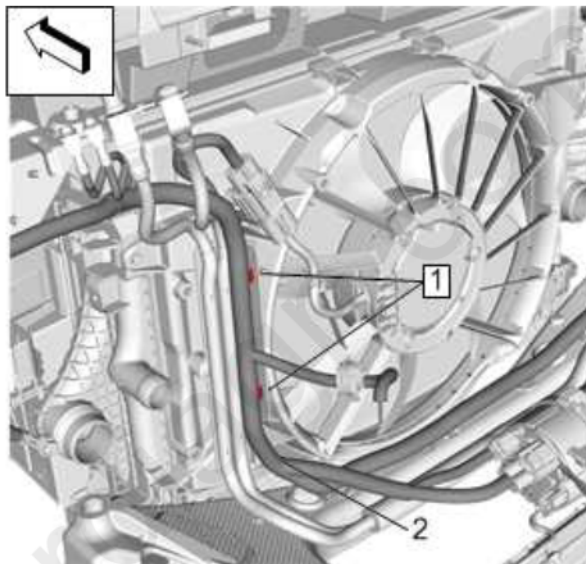


Fig. 108: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

7. Generator Battery Jumper Cable (4) » Install

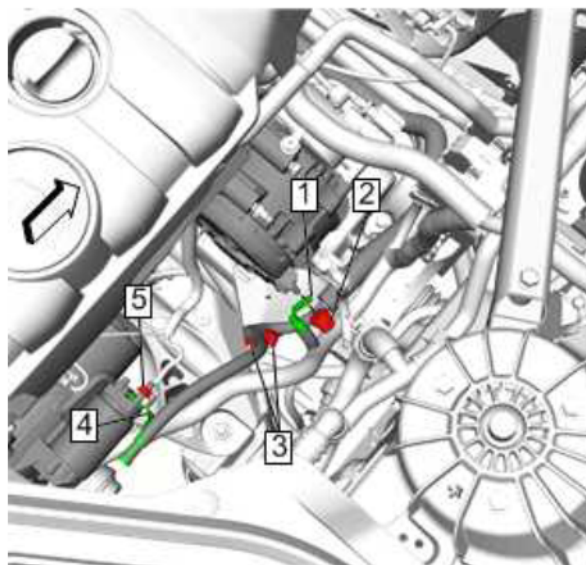


Fig. 109: Generator Nut
 Courtesy of GENERAL MOTORS COMPANY

8. Starter Solenoid Cable Nut (5)» Install and tighten 12 N.m (106 lb in)

CAUTION: Refer to [Fastener Caution](#)

9. Generator Battery Jumper Cable (1)» Install
10. Generator Nut (2)» Install and tighten 15 N.m (11 lb ft)
11. Wiring Harness Retainer (3)» Engage [2x]
12. Generator Battery Jumper Cable (3)» Install [2x]

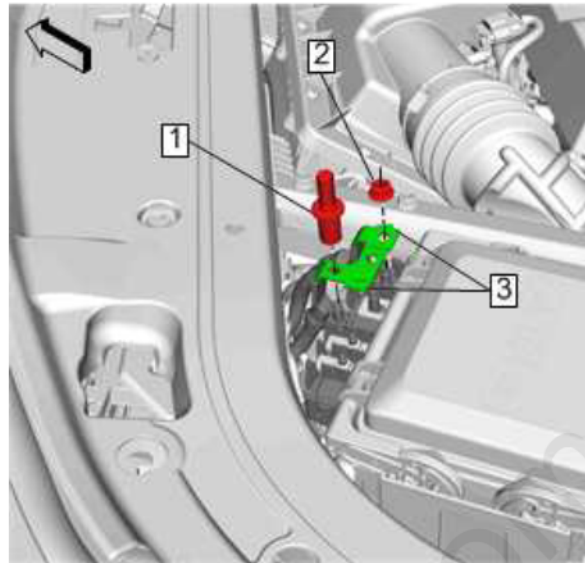


Fig. 110: Generator Battery Jumper Cable Fastener
Courtesy of GENERAL MOTORS COMPANY

13. Generator Battery Jumper Cable Fastener (2)» Install and tighten 15 N.m (11 lb ft)
14. Generator Battery Jumper Cable Fastener (1)» Install and tighten 15 N.m (11 lb ft)
15. Battery Positive Cable (2)» Install

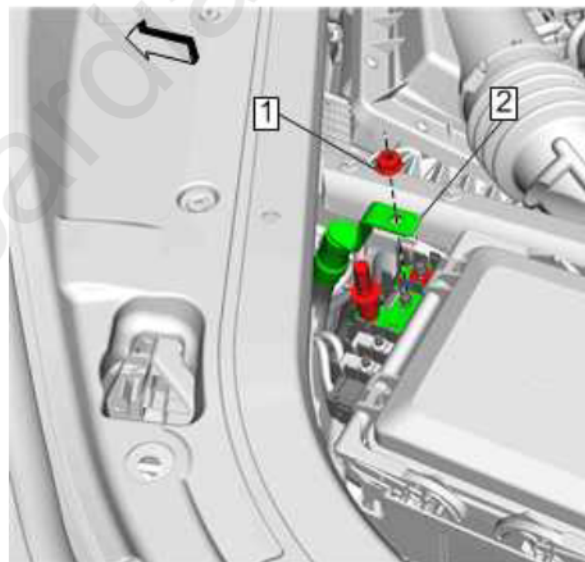


Fig. 111: Battery Positive Cable Nut
Courtesy of GENERAL MOTORS COMPANY

16. Battery Positive Cable Nut (1)» Install and tighten 15 N.m (11 lb ft)
17. Power Distributor Fuse Block Cover (1)» Install

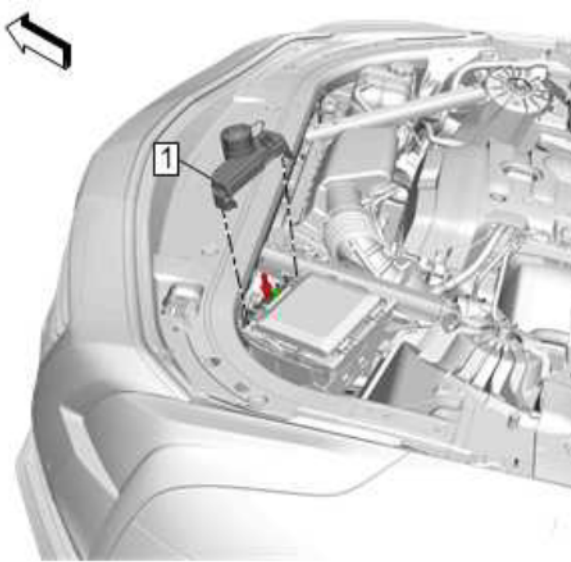


Fig. 112: Power Distributor Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

18. Intake Manifold (2)» Install - [Intake Manifold Replacement \(Except Hybrid\)](#)

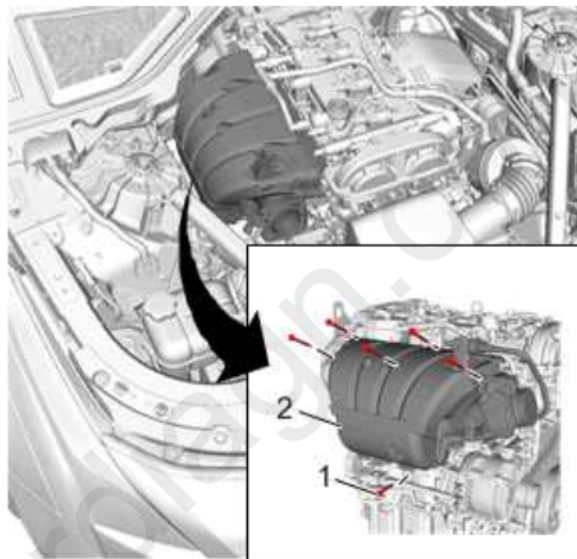


Fig. 113: Intake Manifold
 Courtesy of GENERAL MOTORS COMPANY

19. Air Cleaner Assembly (1)» Install - [Air Cleaner Assembly Replacement](#)

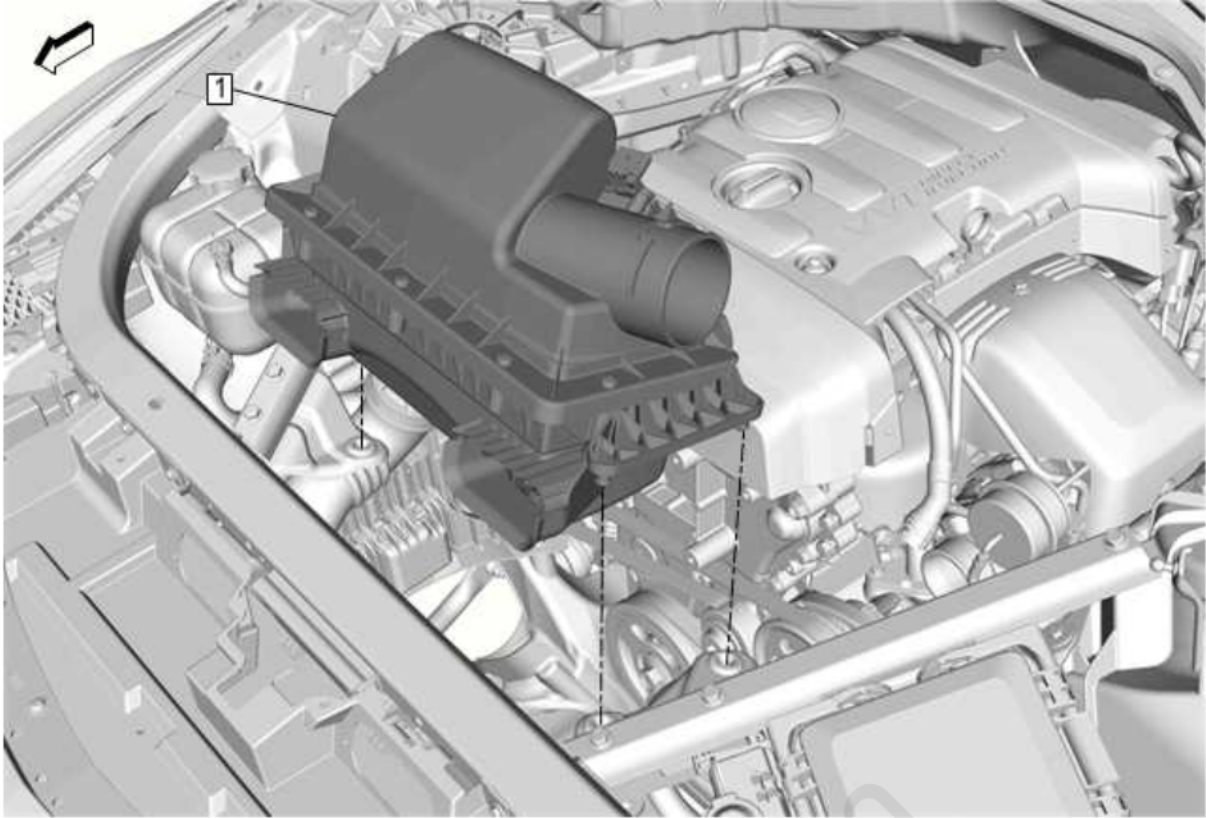


Fig. 114: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

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

GENERATOR BATTERY JUMPER CABLE REPLACEMENT (LGW)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Air Cleaner Assembly (1) » Remove - [Air Cleaner Assembly Replacement \(LGW\)](#)

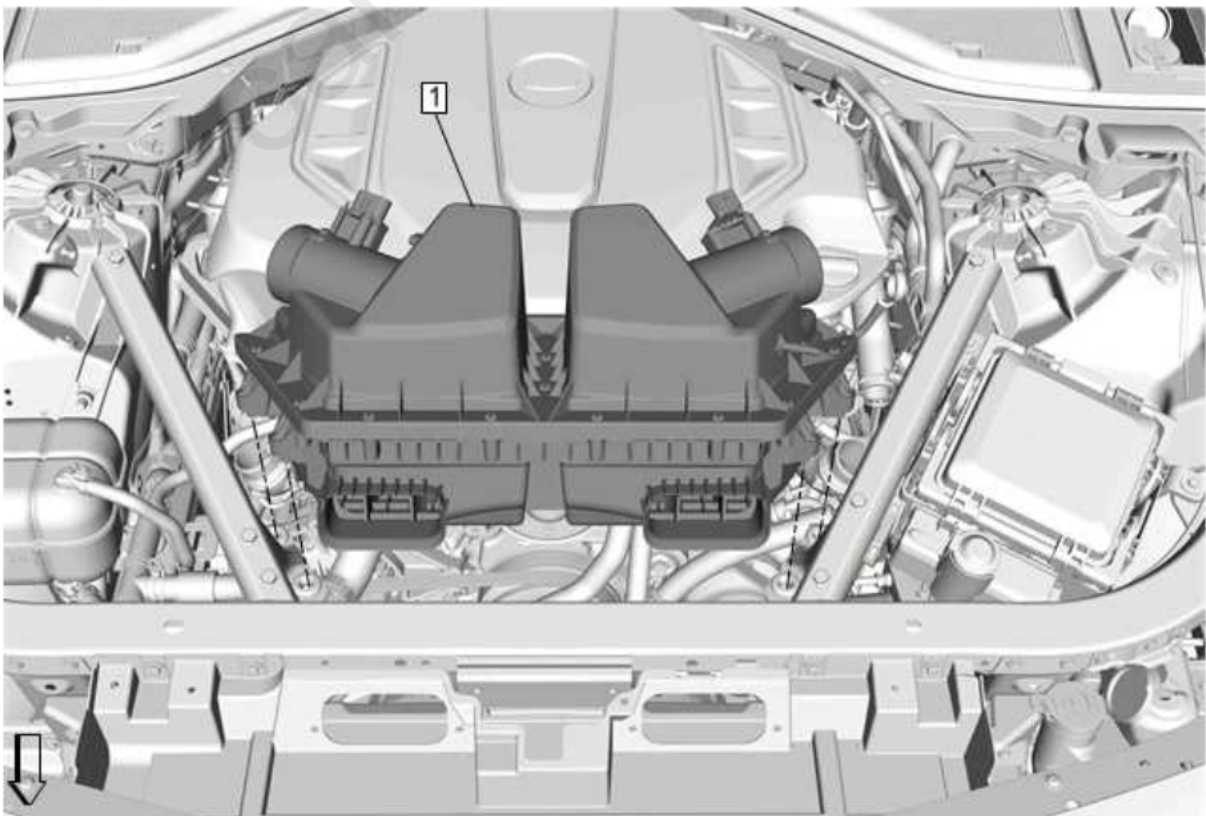


Fig. 115: Air Cleaner Assembly (LGW)
Courtesy of GENERAL MOTORS COMPANY

3. Engine Front Splash Shield (3)» Remove - **Engine Front Splash Shield Replacement - Right Side (Rear)** **Engine Front Splash Shield Replacement - Right Side (Front)**

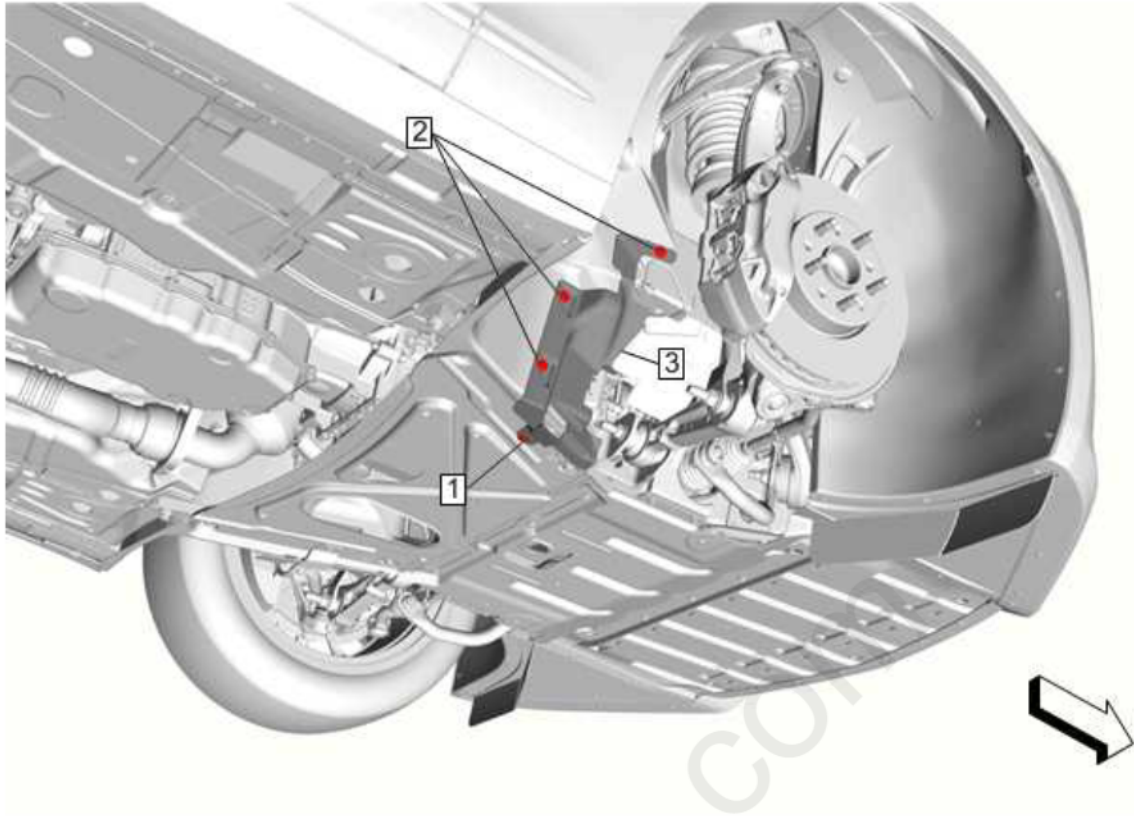


Fig. 116: Front Splash Shield
Courtesy of GENERAL MOTORS COMPANY

4. Power Distributor Fuse Block Cover (1)» Remove

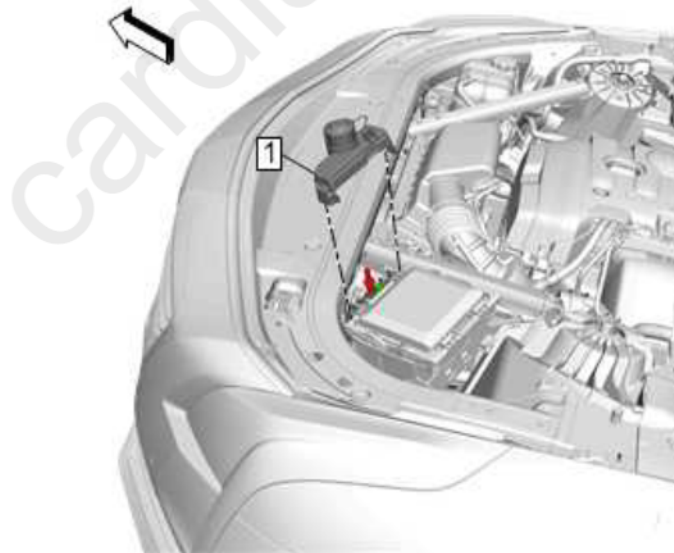


Fig. 117: Power Distributor Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

5. Generator Battery Jumper Cable Fastener (1)» Remove

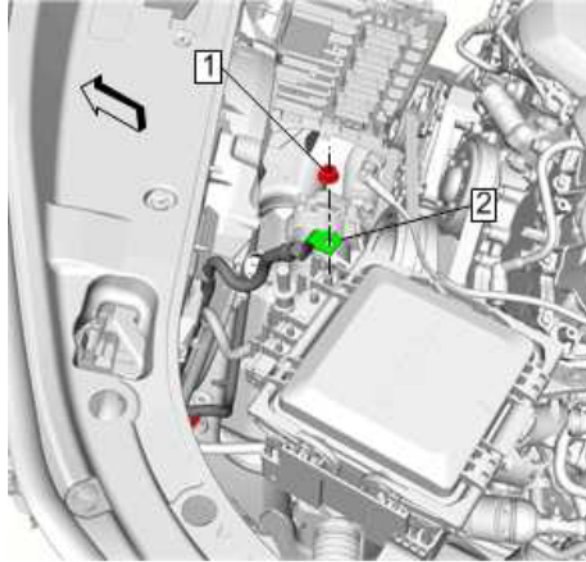


Fig. 118: Generator Battery Jumper Cable
 Courtesy of GENERAL MOTORS COMPANY

6. Generator Battery Jumper Cable (2) » Remove
7. Wiring Harness Retainer (1) » Disengage [2x]

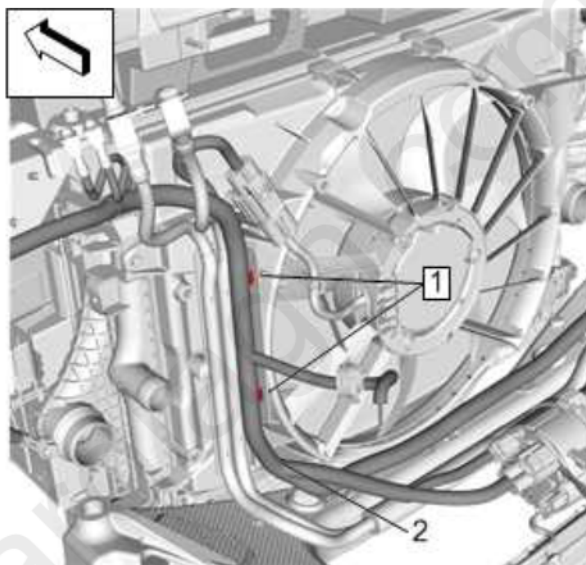


Fig. 119: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

8. Wiring Harness Retainer (1) » Disengage [3x]

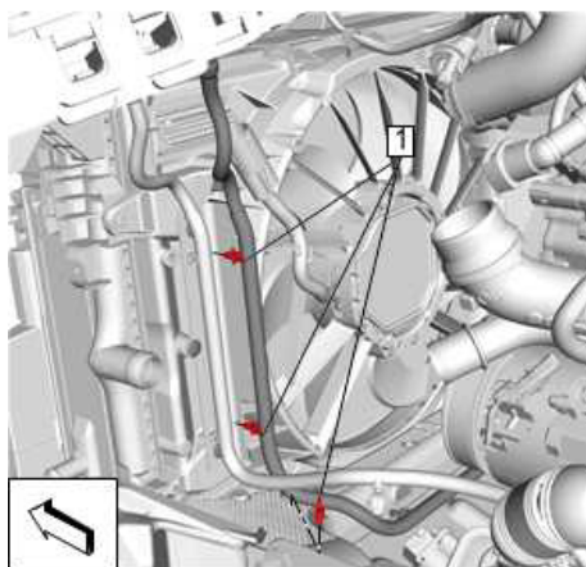


Fig. 120: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

9. Wiring Harness Retainer (1)A,A» Disengage [3x]

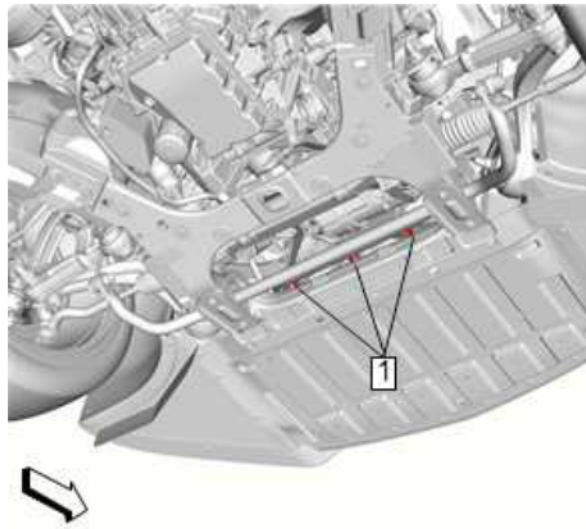


Fig. 121: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

10. Wiring Harness Retainer (1)A,A» Disengage [2x]

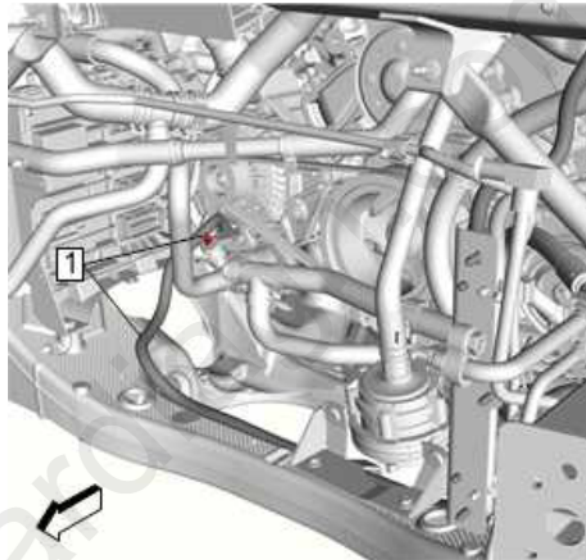


Fig. 122: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

11. Generator Nut (1)A,A» Remove

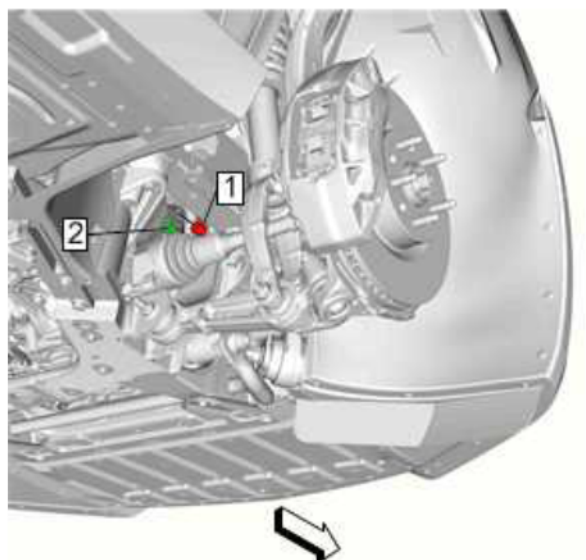


Fig. 123: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

12. Generator Battery Jumper Cable (2)» Remove
13. Generator Battery Jumper Cable (1)» Remove

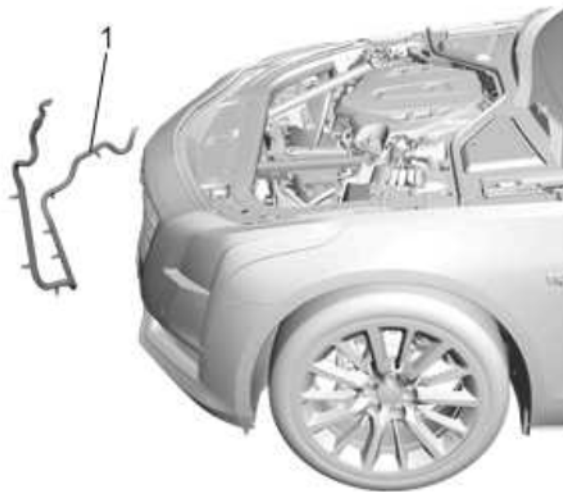


Fig. 124: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Generator Battery Jumper Cable (1)» Install

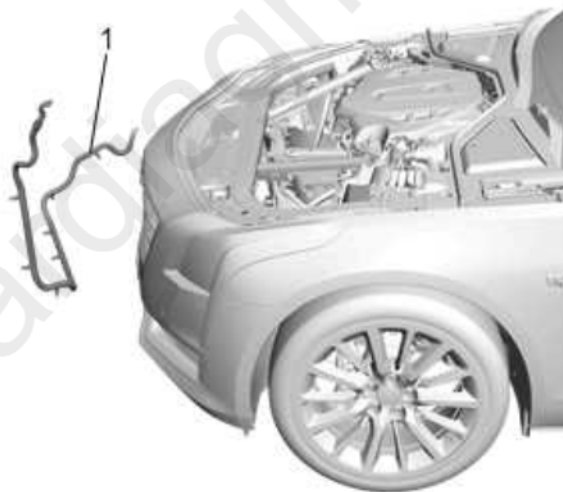


Fig. 125: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the location and routing of the wiring harness to ensure proper reinstallation.

2. Generator Battery Jumper Cable (2)» Install

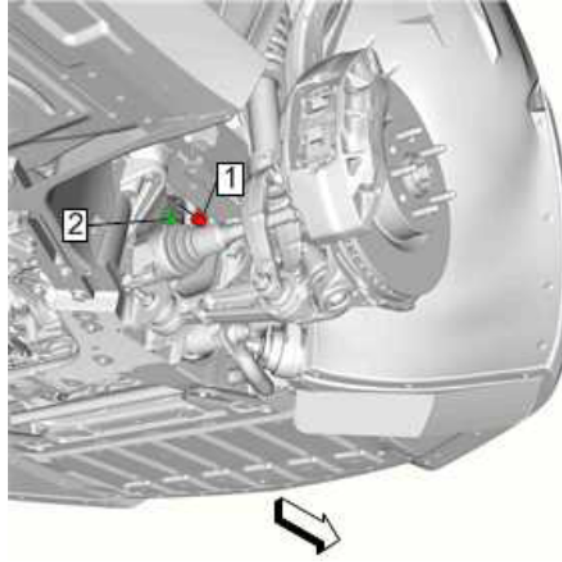


Fig. 126: Generator Battery Jumper Cable
 Courtesy of GENERAL MOTORS COMPANY

3. Generator Nut (1)» Install and tighten 15 N.m (11 lb ft)

CAUTION: Refer to **Fastener Caution**

4. Engine Front Splash Shield (3)» Install - **Engine Front Splash Shield Replacement - Right Side (Rear) Engine Front Splash Shield Replacement - Right Side (Front)**

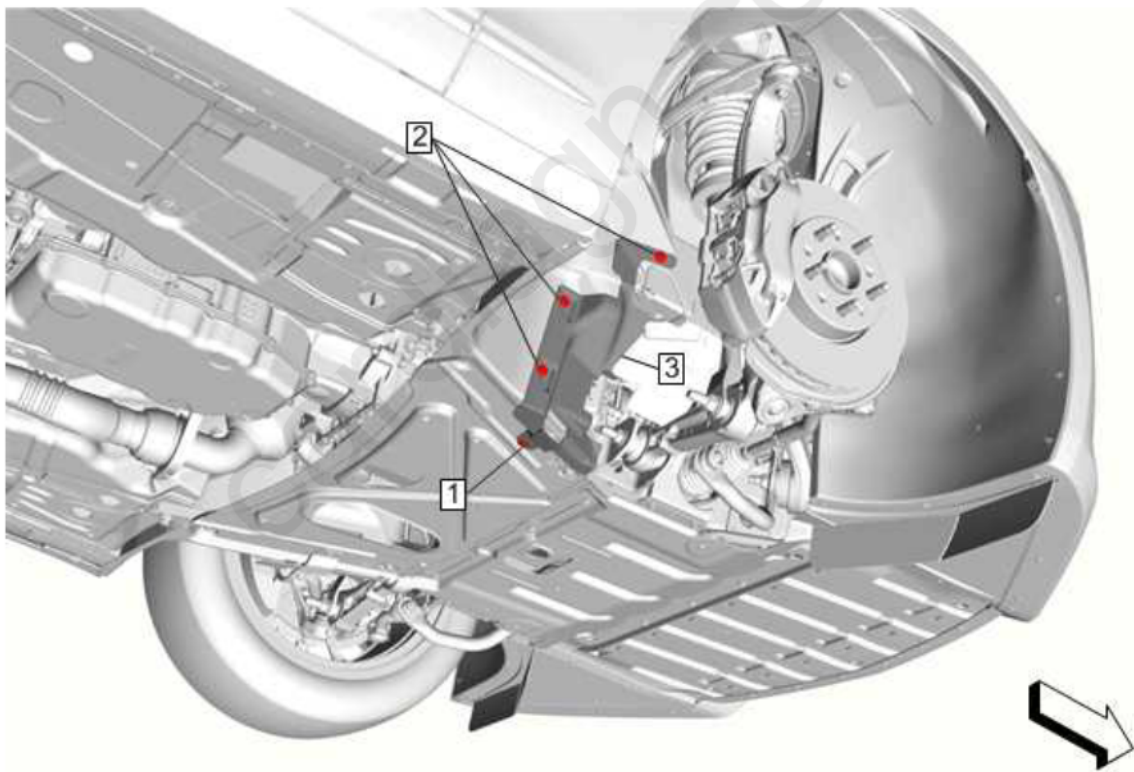


Fig. 127: Front Splash Shield
 Courtesy of GENERAL MOTORS COMPANY

5. Wiring Harness Retainer (1)» Engage [2x]

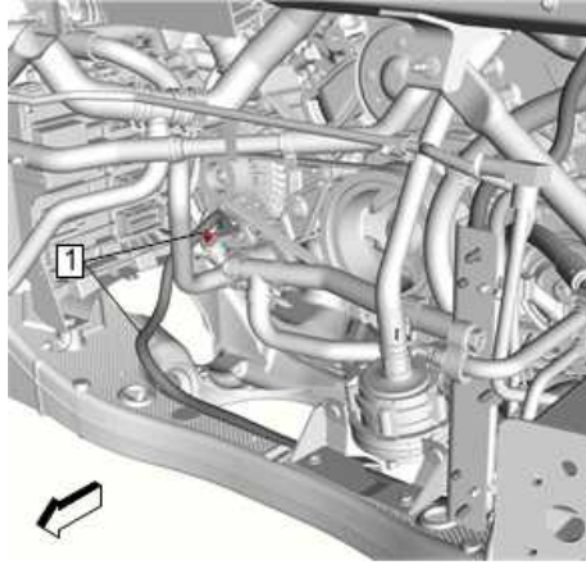


Fig. 128: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

6. Wiring Harness Retainer (1) Engage [3x]

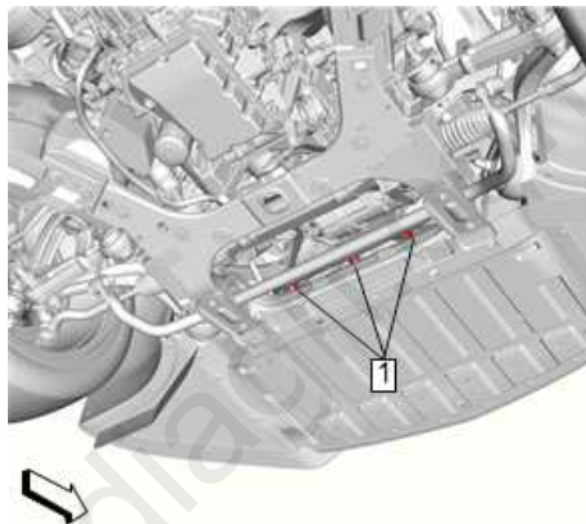


Fig. 129: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

7. Wiring Harness Retainer (1) Engage [3x]

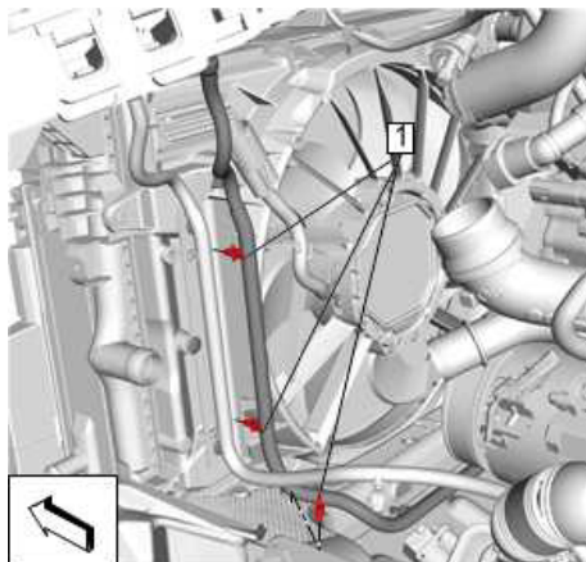


Fig. 130: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

8. Wiring Harness Retainer (1)» Engage [2x]

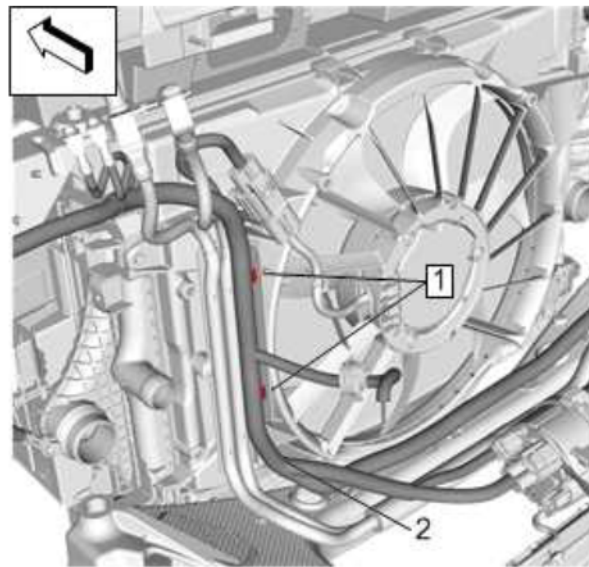


Fig. 131: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

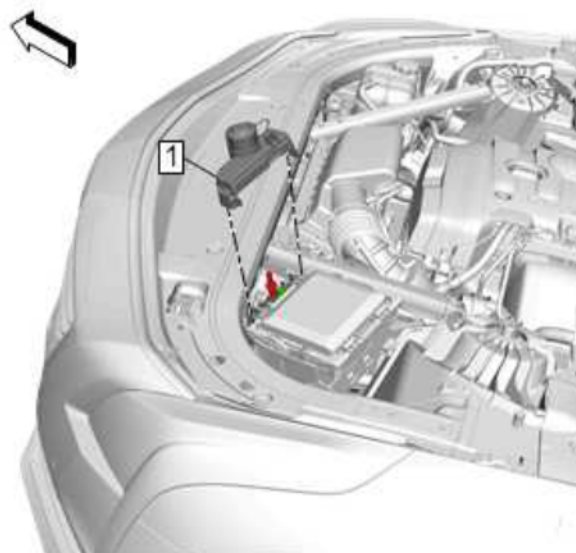
9. Generator Battery Jumper Cable (2)» Install



Fig. 132: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

10. Generator Battery Jumper Cable Fastener (1)» Install and tighten 15 N.m (11 lb ft)

11. Power Distributor Fuse Block Cover (1)» Install



12. Air Cleaner Assembly (1)» Install - **[Air Cleaner Assembly Replacement \(LGW\)](#)**

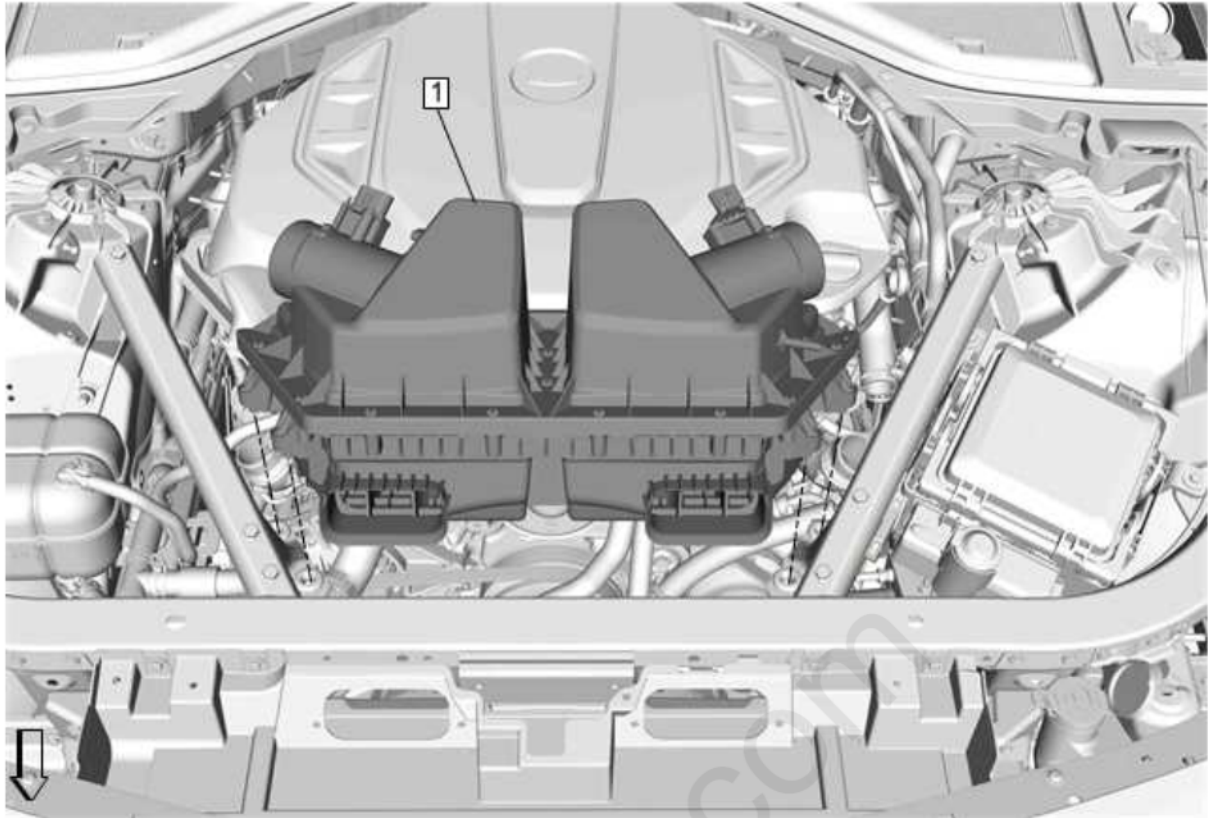


Fig. 134: Air Cleaner Assembly (LGW)
Courtesy of GENERAL MOTORS COMPANY

13. Connect the negative battery cable. Refer to **[Battery Negative Cable Disconnection and Connection](#)**

GENERATOR BATTERY JUMPER CABLE REPLACEMENT (LGX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **[Battery Negative Cable Disconnection and Connection](#)**
2. Air Cleaner Assembly (1)» Remove - **[Air Cleaner Assembly Replacement \(LGX\)](#)**

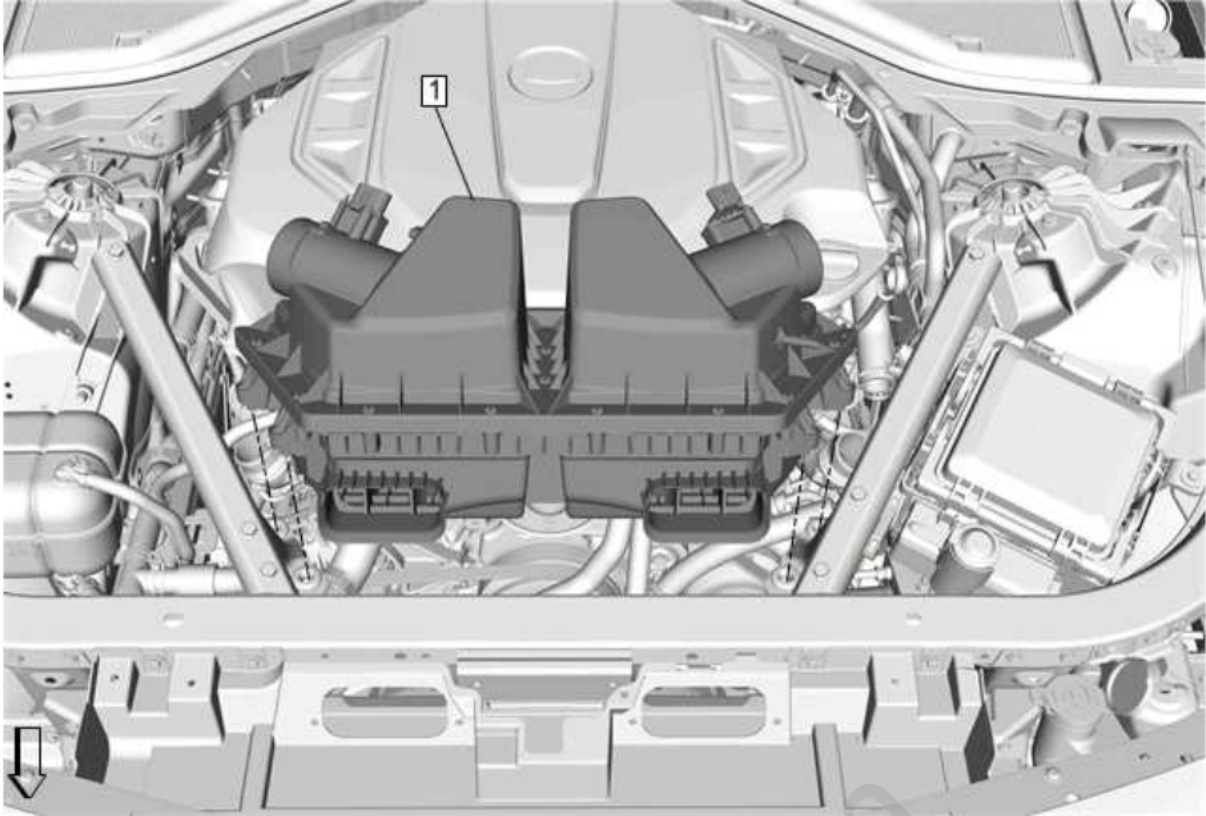


Fig. 135: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

3. Engine Front Splash Shield (3)» Remove - **Engine Front Splash Shield Replacement - Right Side (Rear)** **Engine Front Splash Shield Replacement - Right Side (Front)**

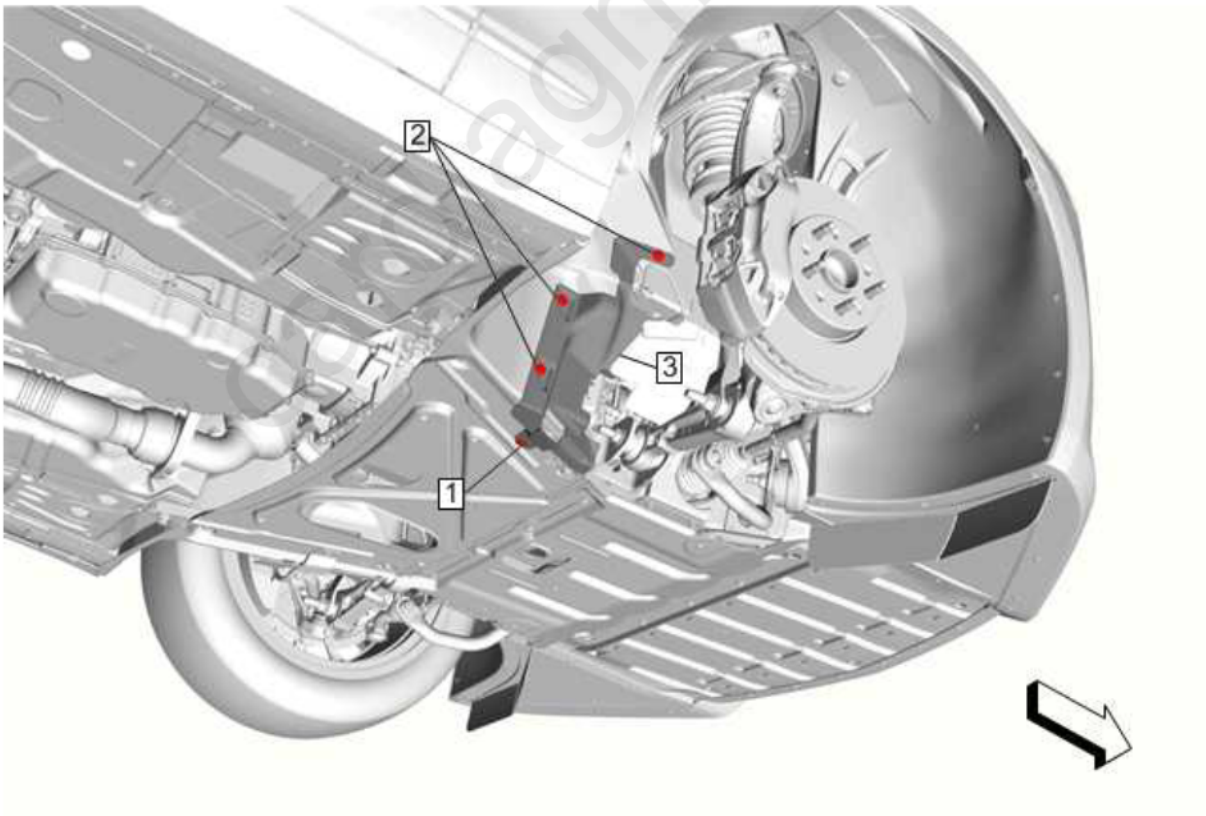


Fig. 136: Front Splash Shield

Courtesy of GENERAL MOTORS COMPANY

4. Power Distributor Fuse Block Cover (1)» Remove

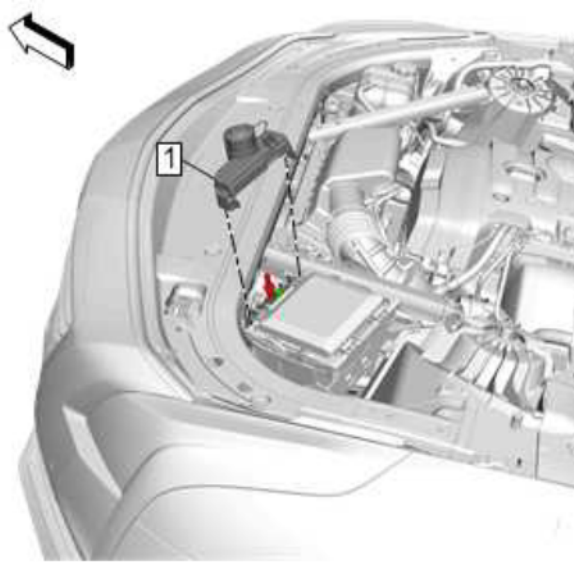


Fig. 137: Power Distributor Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

5. Generator Battery Jumper Cable Fastener (1)» Remove



Fig. 138: Generator Battery Jumper Cable
 Courtesy of GENERAL MOTORS COMPANY

6. Generator Battery Jumper Cable (2)» Remove
7. Wiring Harness Retainer (1)» Disengage [2x]

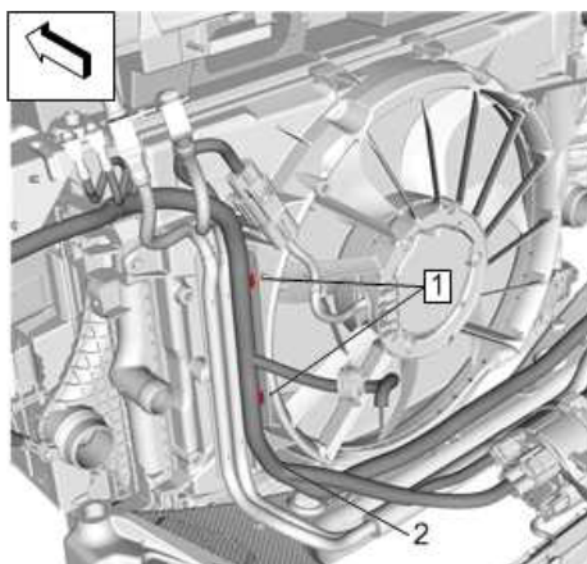


Fig. 139: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

8. Wiring Harness Retainer (1)A, A» Disengage [3x]

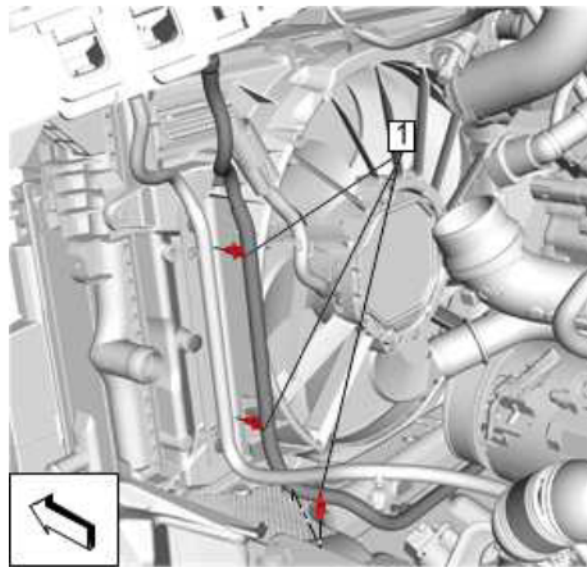


Fig. 140: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

9. Wiring Harness Retainer (1)A, A» Disengage [3x]

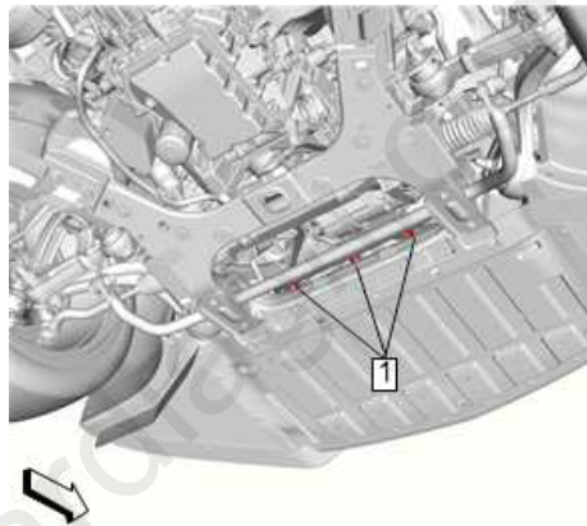
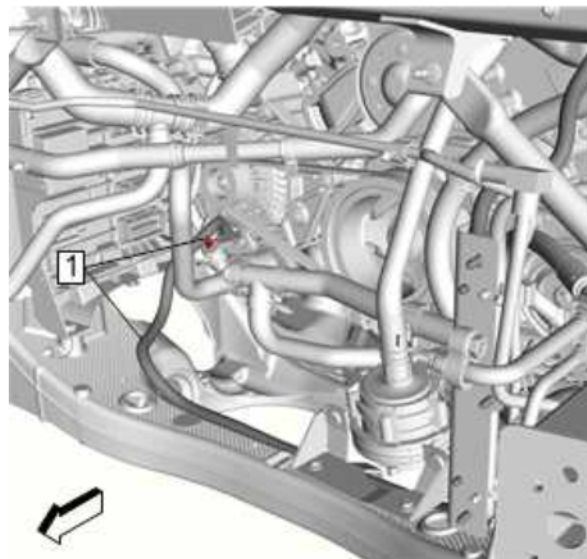


Fig. 141: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

10. Wiring Harness Retainer (1)A, A» Disengage [2x]



11. Generator Nut (1)» Remove

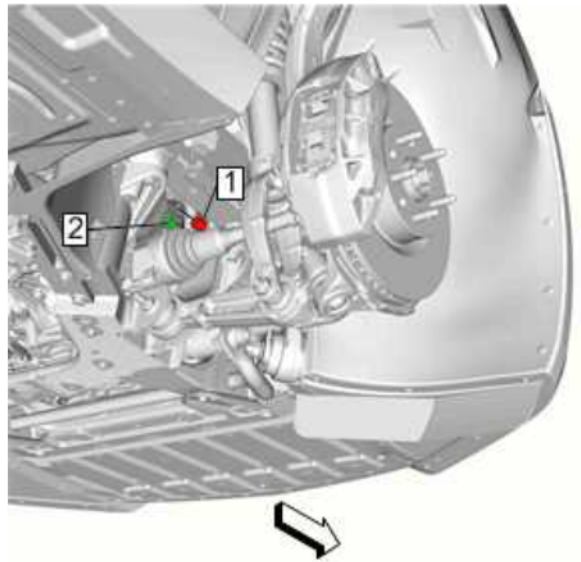


Fig. 143: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

12. Generator Battery Jumper Cable (2)» Remove
13. Generator Battery Jumper Cable (1)» Remove

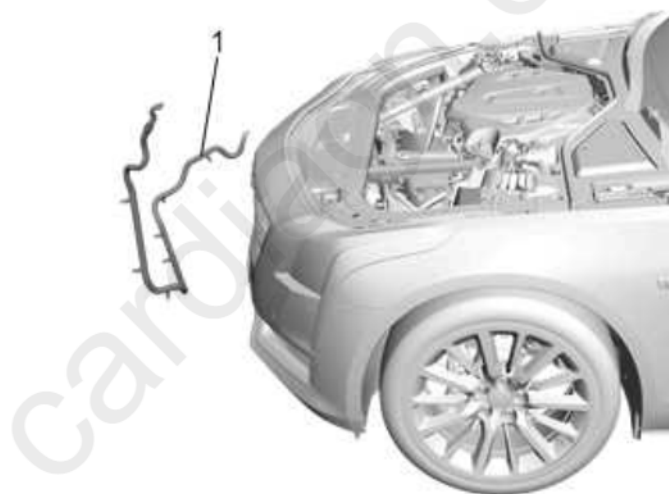


Fig. 144: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. Generator Battery Jumper Cable (1)» Install

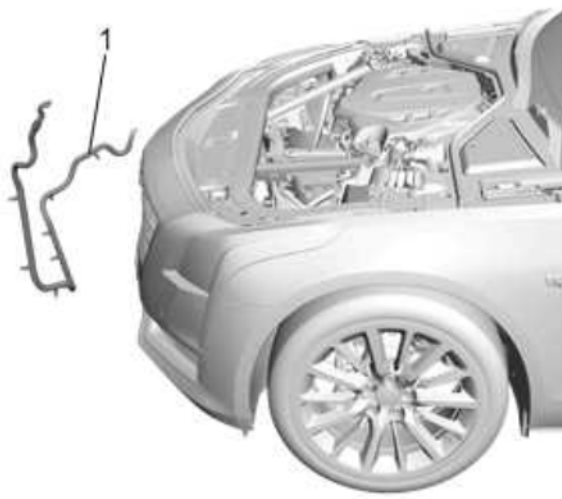


Fig. 145: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the location and routing of the wiring harness to ensure proper reinstallation.

2. Generator Battery Jumper Cable (2)» Install

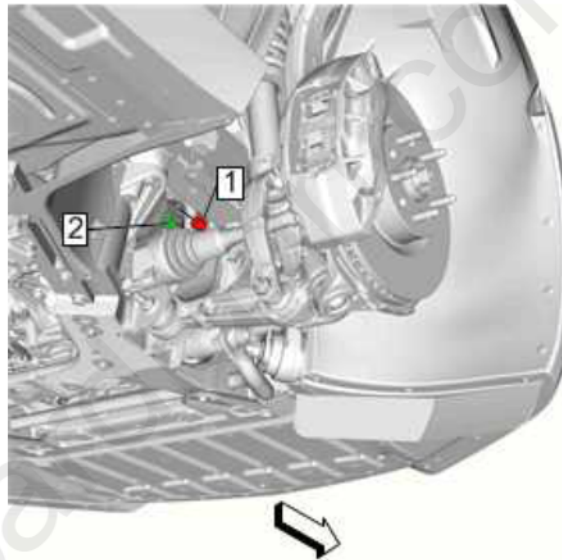


Fig. 146: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

3. Generator Nut (1)» Install and tighten 15 N.m (11 lb ft)

CAUTION: Refer to **Fastener Caution**

4. Engine Front Splash Shield (3)» Install - **Engine Front Splash Shield Replacement - Right Side (Rear)** **Engine Front Splash Shield Replacement - Right Side (Front)**

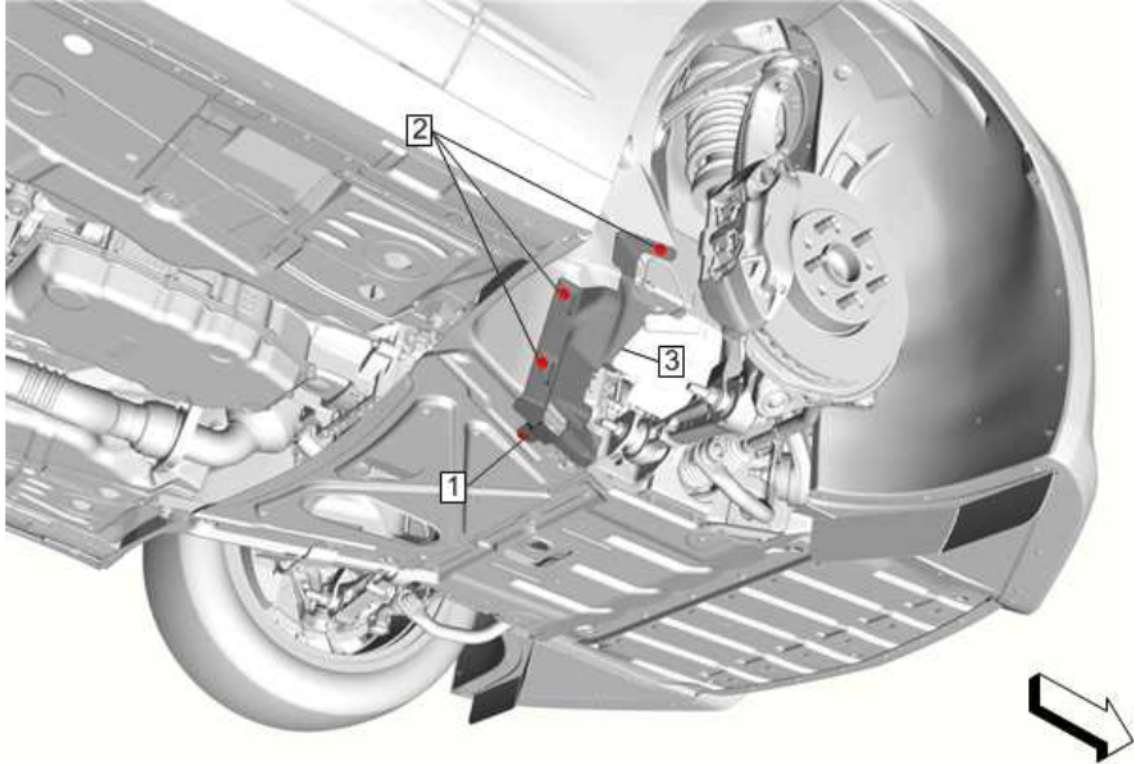


Fig. 147: Front Splash Shield

Courtesy of GENERAL MOTORS COMPANY

5. Wiring Harness Retainer (1) Engage [2x]

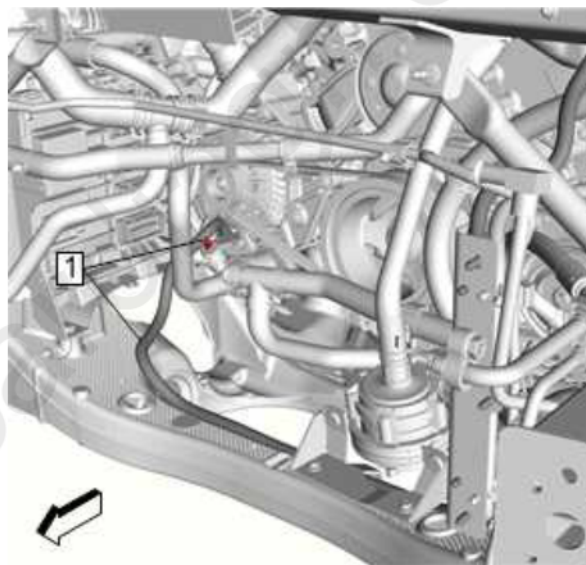


Fig. 148: Wiring Harness Retainer

Courtesy of GENERAL MOTORS COMPANY

6. Wiring Harness Retainer (1) Engage [3x]

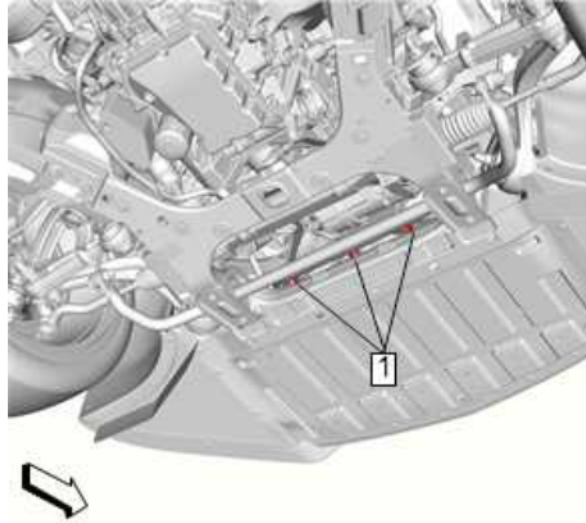


Fig. 149: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Wiring Harness Retainer (1) Engage [3x]

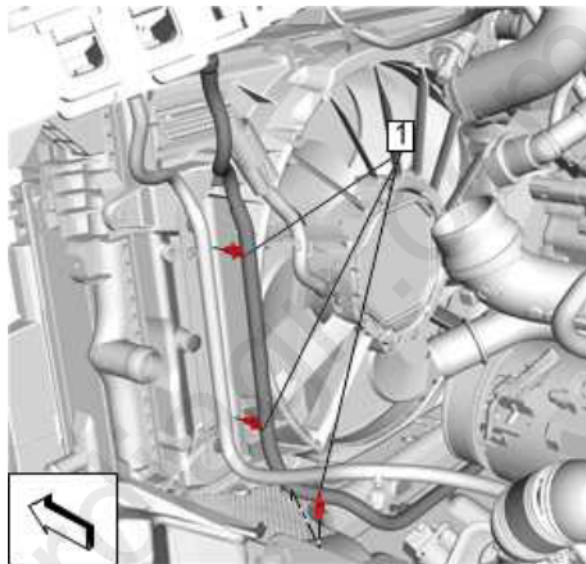


Fig. 150: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Wiring Harness Retainer (1) Engage [2x]

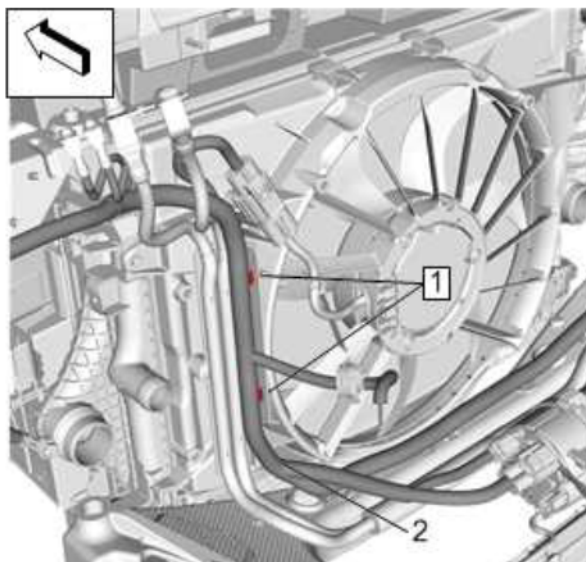


Fig. 151: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

9. Generator Battery Jumper Cable (2)» Install

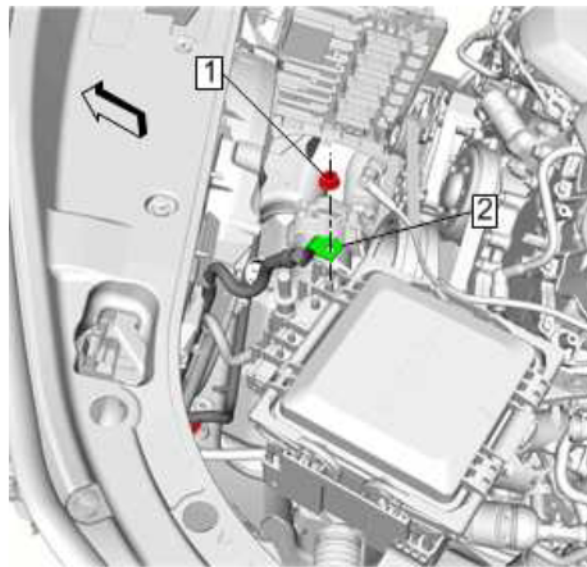


Fig. 152: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

10. Generator Battery Jumper Cable Fastener (1)» Install and tighten 15 N.m (11 lb ft)

11. Power Distributor Fuse Block Cover (1)» Install

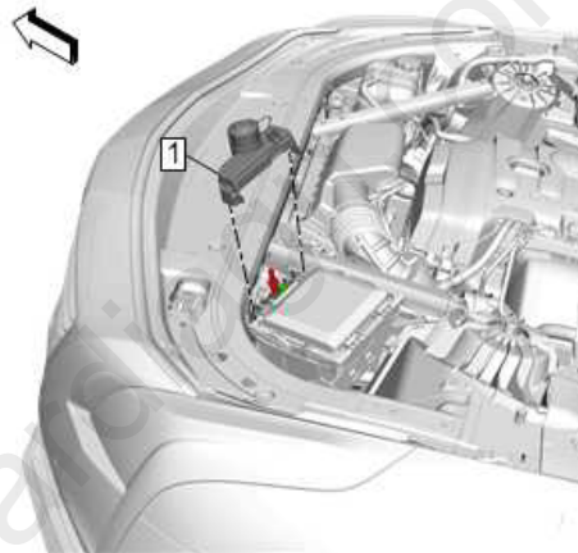


Fig. 153: Power Distributor Fuse Block Cover
Courtesy of GENERAL MOTORS COMPANY

12. Air Cleaner Assembly (1)» Install - [Air Cleaner Assembly Replacement \(LGX\)](#)

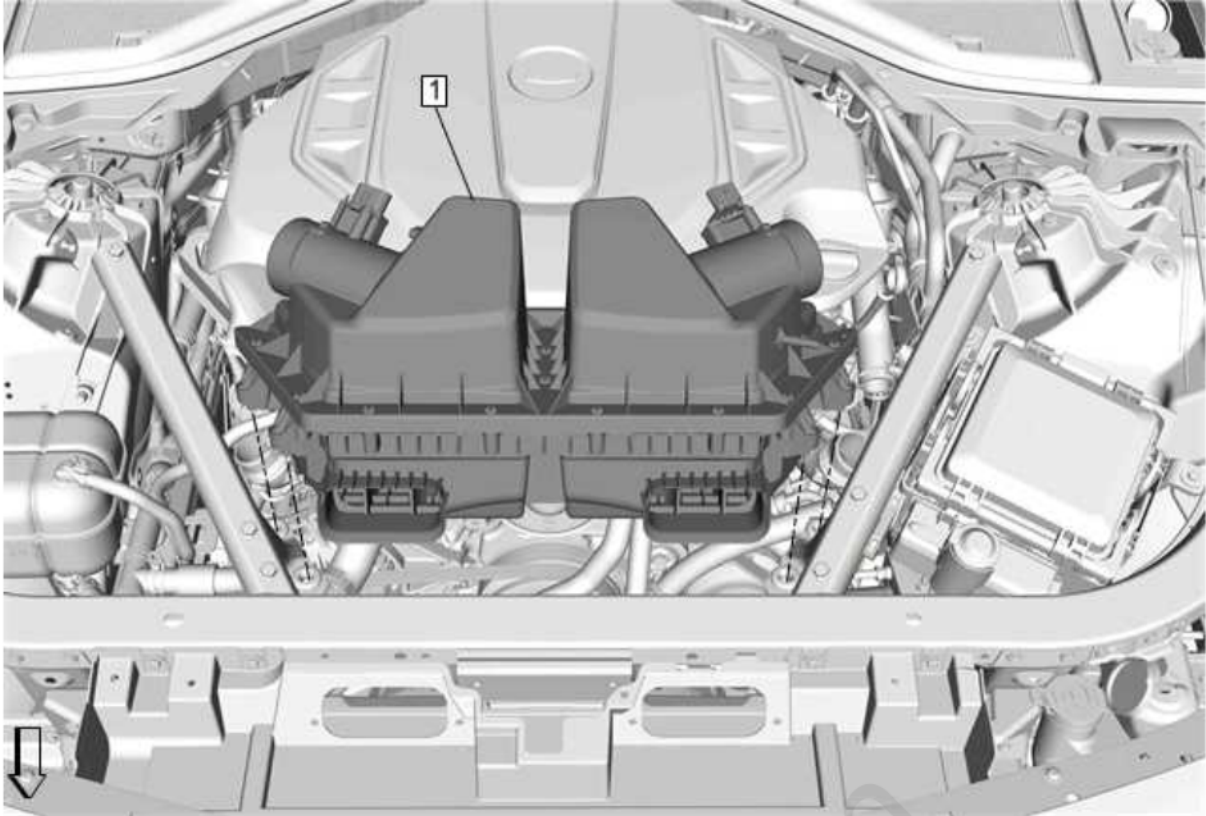


Fig. 154: Air Cleaner Assembly

Courtesy of GENERAL MOTORS COMPANY

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

STARTER SOLENOID CABLE REPLACEMENT (LGX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Air Cleaner Outlet Duct (1) » Remove - [Air Cleaner Outlet Duct Replacement \(LGX\)](#)

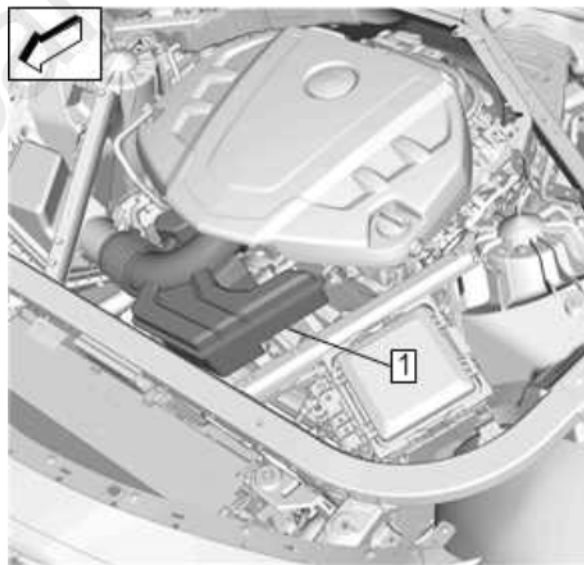


Fig. 155: Air Cleaner Outlet Duct

Courtesy of GENERAL MOTORS COMPANY

3. Drivetrain and Front Suspension Cradle Plate (3) » Remove - [Drivetrain and Front Suspension Cradle Plate Replacement](#)

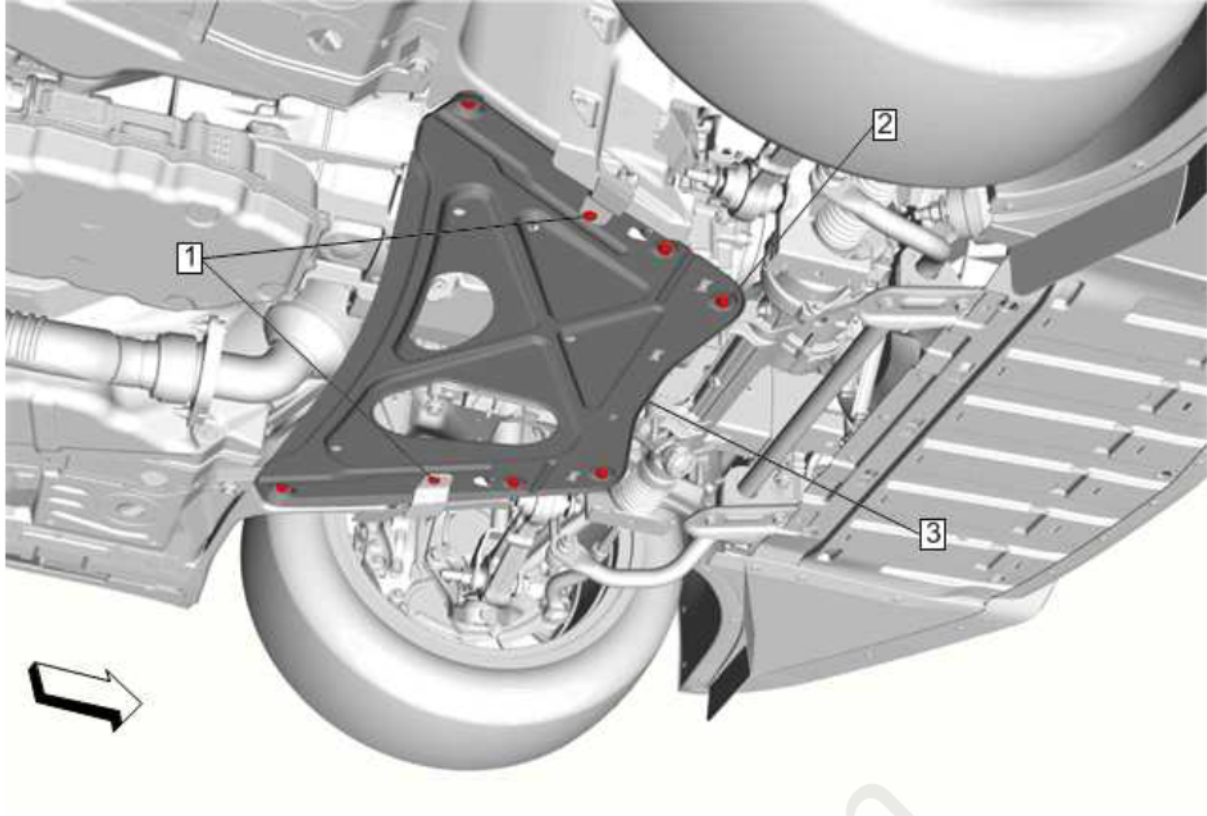


Fig. 156: Drivetrain and Front Suspension Cradle Plate
 Courtesy of GENERAL MOTORS COMPANY

4. Power Distributor Fuse Block Cover (1) » Remove

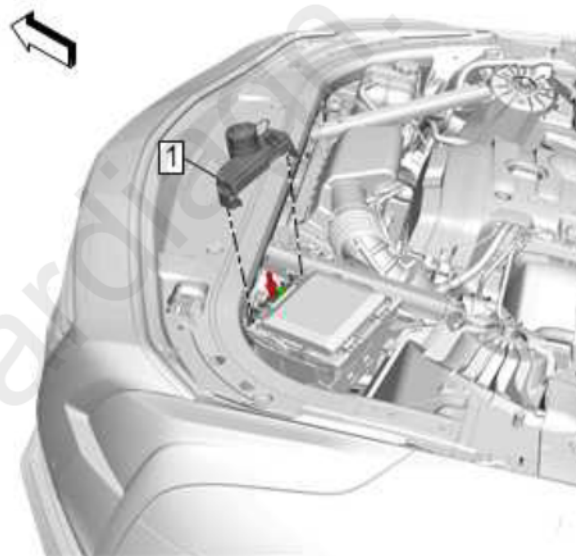


Fig. 157: Power Distributor Fuse Block Cover
 Courtesy of GENERAL MOTORS COMPANY

5. Battery Positive Cable Nut (1) » Remove

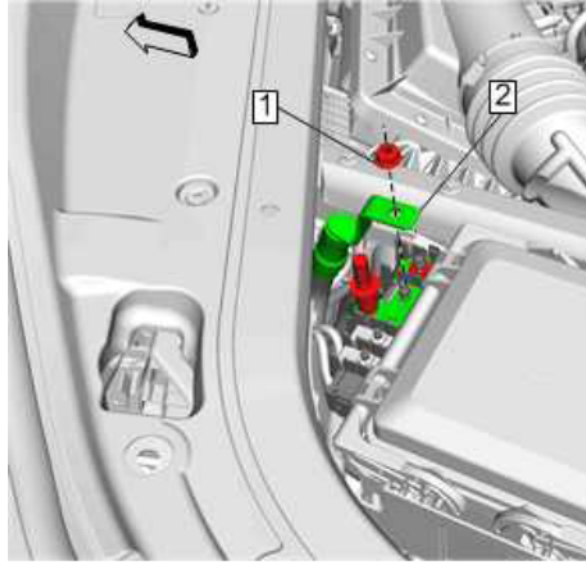


Fig. 158: Battery Positive Cable Nut

Courtesy of GENERAL MOTORS COMPANY

- 6. Battery Positive Cable (2)» Remove
- 7. Starter Solenoid Cable Fastener (1)» Remove



Fig. 159: Starter Solenoid Cable And Fastener

Courtesy of GENERAL MOTORS COMPANY

- 8. Starter Solenoid Cable (2)» Remove
- 9. Wiring Harness Retainer (1)» Disengage [4x]

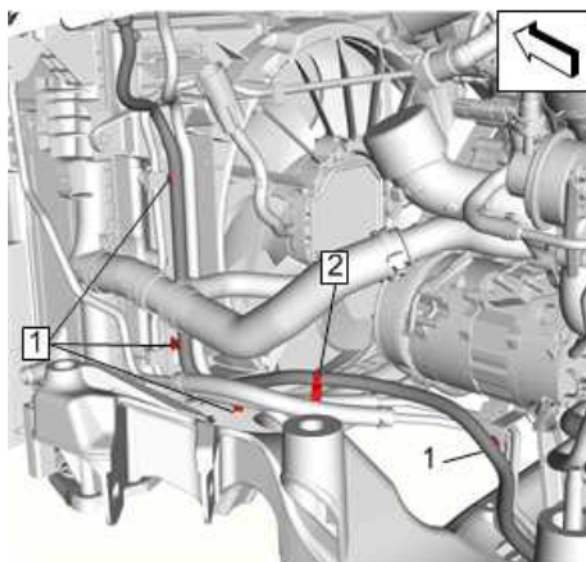


Fig. 160: Wiring Harness Retainer And Clip
Courtesy of GENERAL MOTORS COMPANY

- 10. Wiring Harness Clip (2)» Disengage
- 11. Wiring Harness Retainer (1)» Disengage [2x]

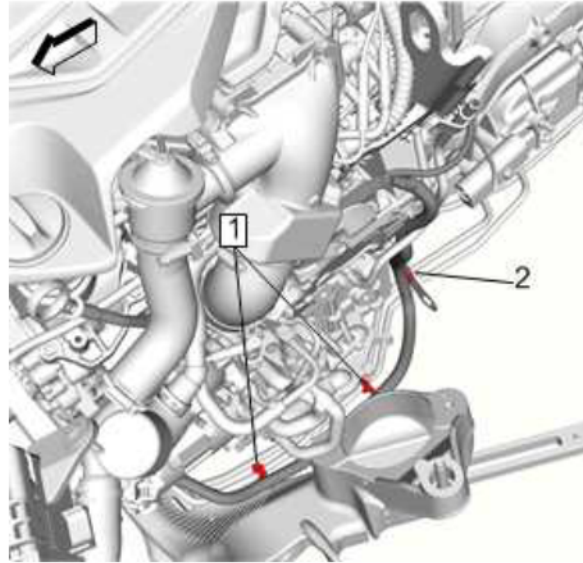


Fig. 161: Wiring Harness Retainer
Courtesy of GENERAL MOTORS COMPANY

- 12. Wiring Harness Retainer (2)» Disengage
- 13. Starter Heat Shield (2)» Remove - **Starter Shield Replacement (LGX)**

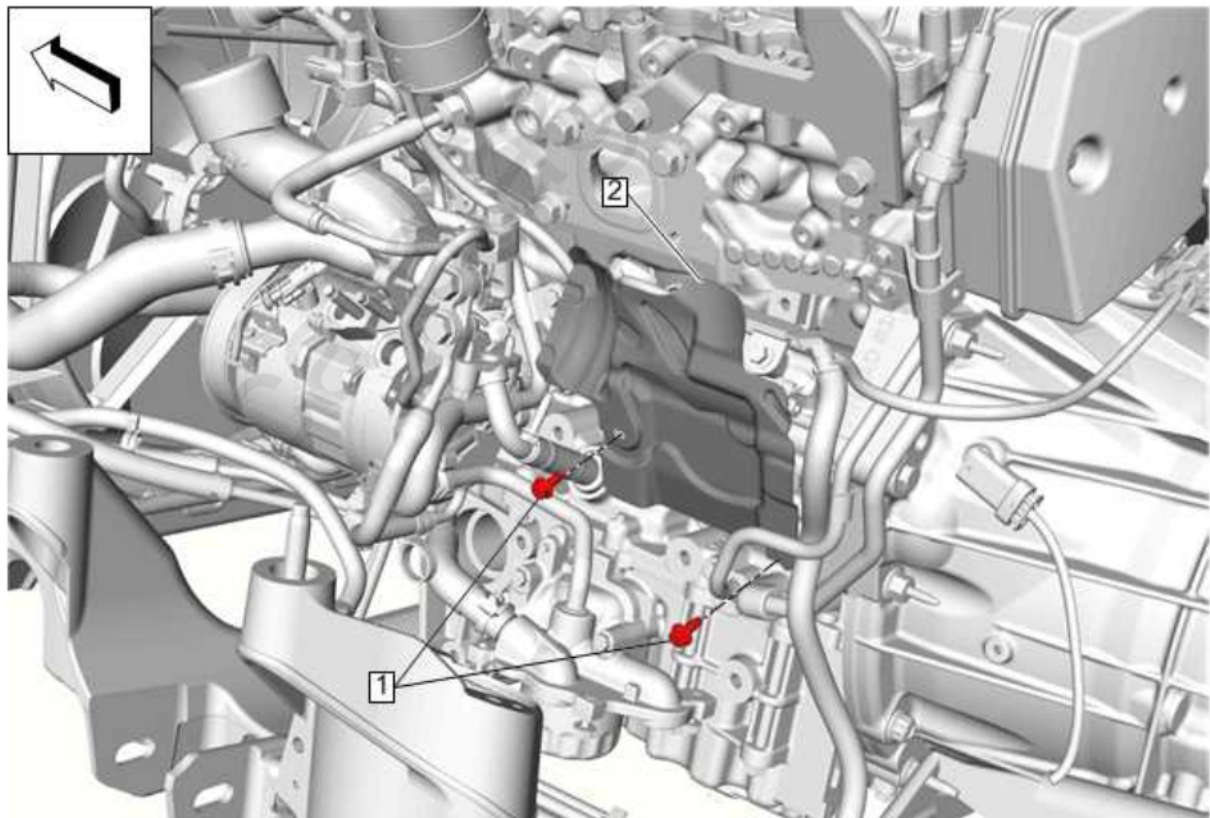


Fig. 162: Starter Heat Shield
Courtesy of GENERAL MOTORS COMPANY

- 14. Starter Solenoid Cable Nut (1)» Remove

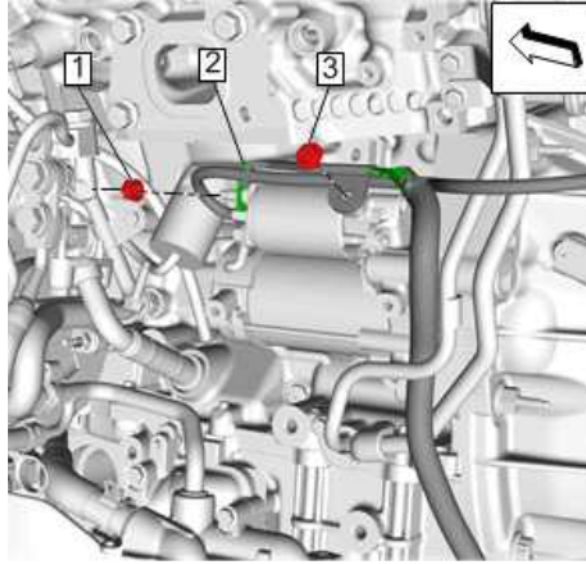


Fig. 163: Starter Solenoid Cable

Courtesy of GENERAL MOTORS COMPANY

15. Harness Retainer Fastener (3) » Remove
16. Starter Solenoid Cable (2) » Remove
17. Starter Solenoid Cable (1) » Remove

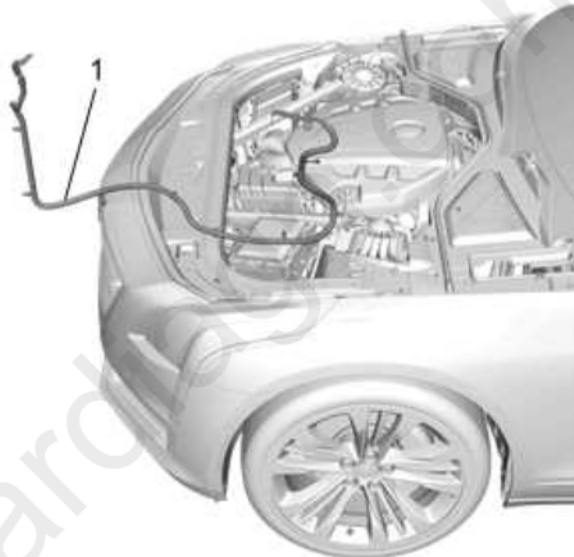


Fig. 164: Starter Solenoid Cable

Courtesy of GENERAL MOTORS COMPANY

NOTE: Note the location and routing of the wiring harness to ensure proper reinstallation.

Installation Procedure

1. Starter Solenoid Cable (1) » Install

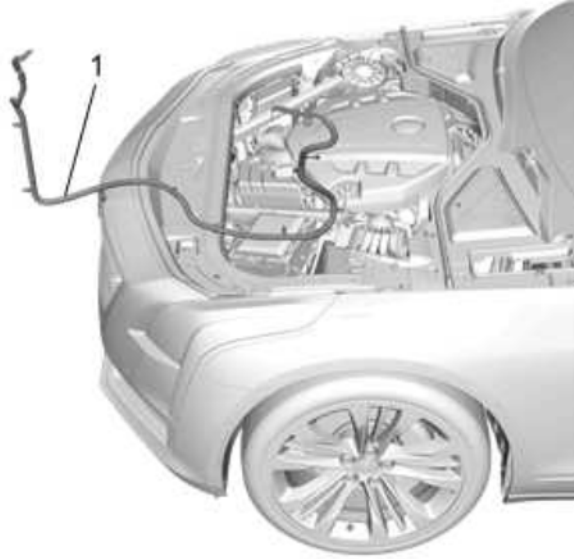


Fig. 165: Starter Solenoid Cable

Courtesy of GENERAL MOTORS COMPANY

2. Starter Solenoid Cable (2)» Install

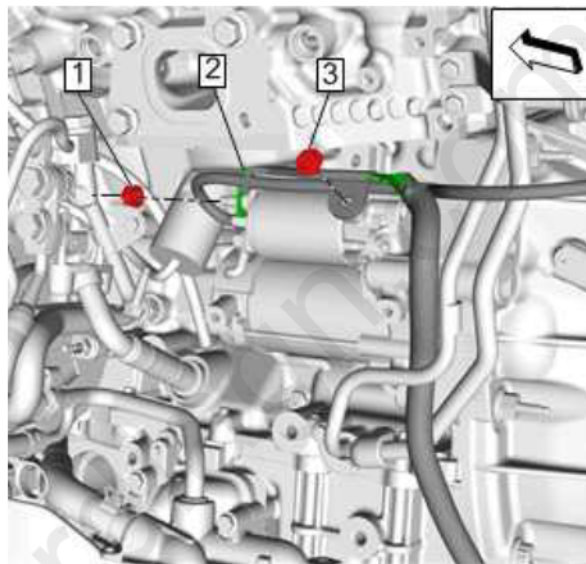


Fig. 166: Starter Solenoid Cable

Courtesy of GENERAL MOTORS COMPANY

3. Starter Solenoid Cable Nut (1)» Install and tighten 12 N.m (106 lb in)

CAUTION: Refer to **Fastener Caution**

4. Harness Retainer Fastener (3)» Install and tighten 9 N.m (80 lb in)
5. Starter Heat Shield (2)» Install - **Starter Shield Replacement (LGX)**

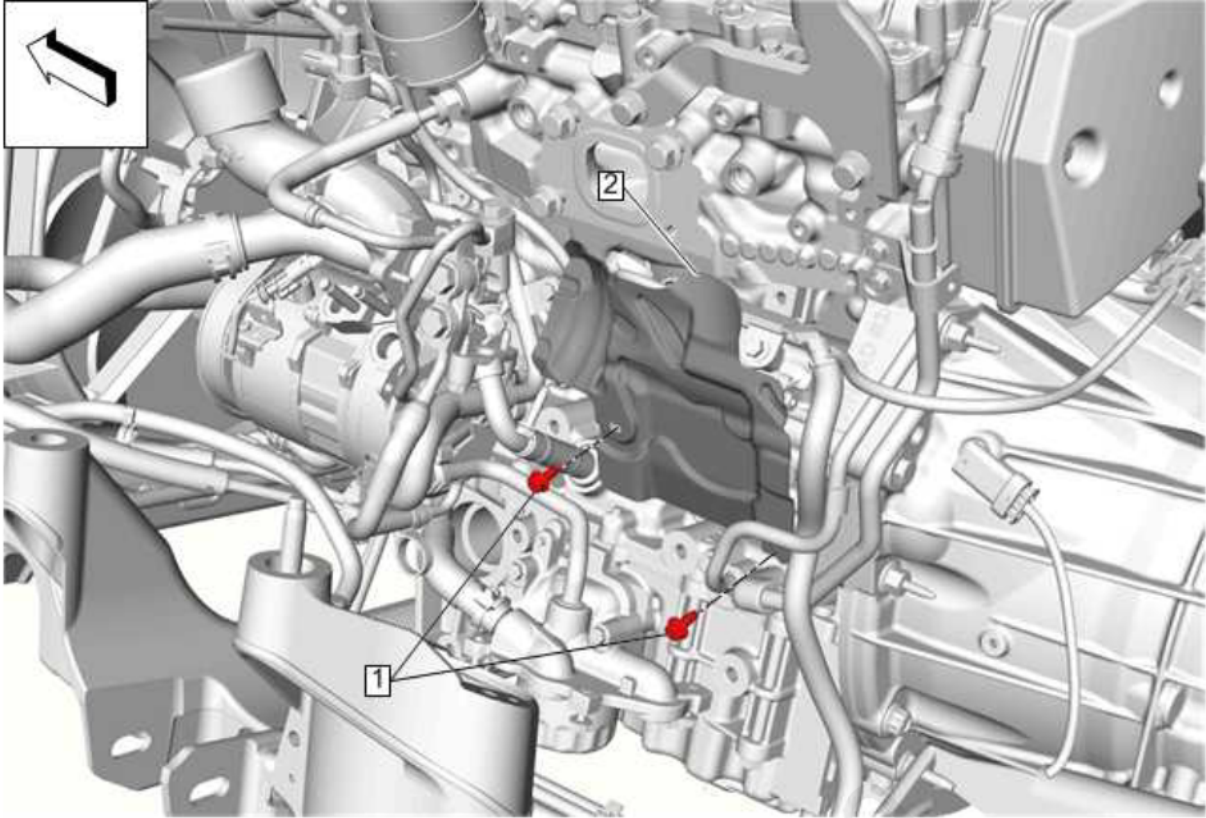


Fig. 167: Starter Heat Shield

Courtesy of GENERAL MOTORS COMPANY

6. Wiring Harness Retainer (1) » Engage [2x]

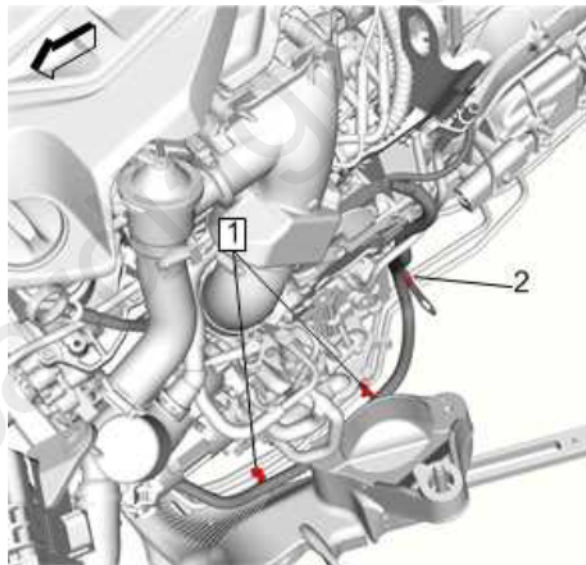


Fig. 168: Wiring Harness Retainer

Courtesy of GENERAL MOTORS COMPANY

7. Wiring Harness Retainer (2) » Engage
8. Wiring Harness Retainer (1) » Engage [4x]

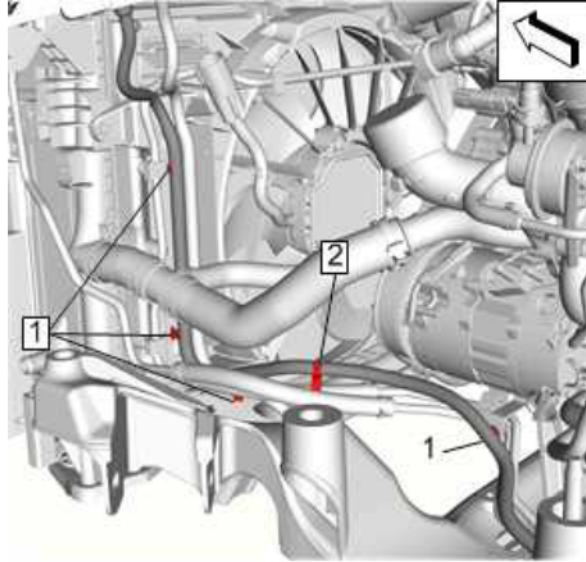


Fig. 169: Wiring Harness Retainer And Clip

Courtesy of GENERAL MOTORS COMPANY

9. Wiring Harness Clip (2)» Engage
10. Drivetrain and Front Suspension Cradle Plate (3)» Install - **Drivetrain and Front Suspension Cradle Plate Replacement**

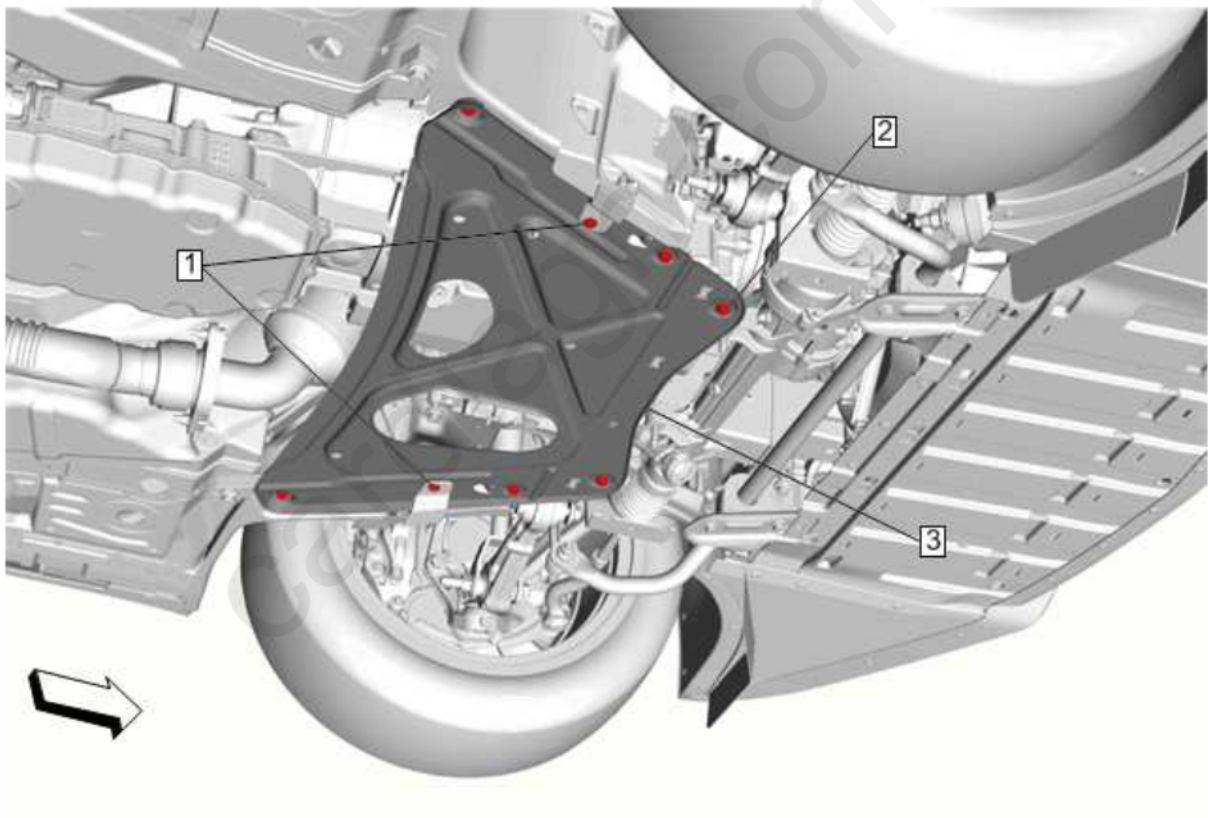


Fig. 170: Drivetrain and Front Suspension Cradle Plate

Courtesy of GENERAL MOTORS COMPANY

11. Starter Solenoid Cable (2)» Install

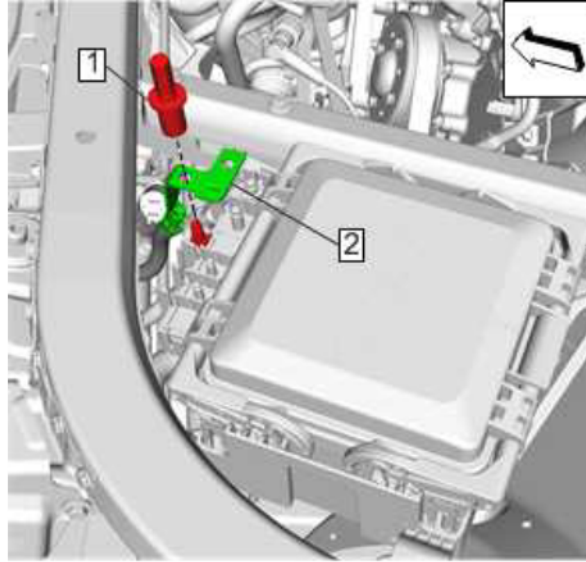


Fig. 171: Starter Solenoid Cable And Fastener
 Courtesy of GENERAL MOTORS COMPANY

12. Starter Solenoid Cable Fastener (1)» Install and tighten 15 N.m (11 lb ft)
13. Battery Positive Cable (2)» Install

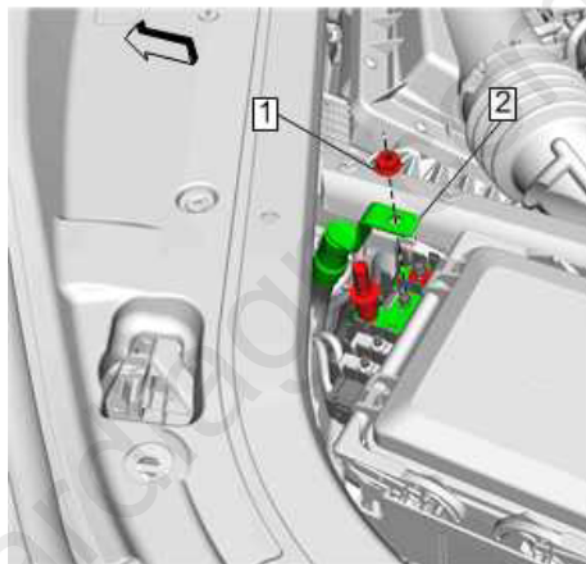
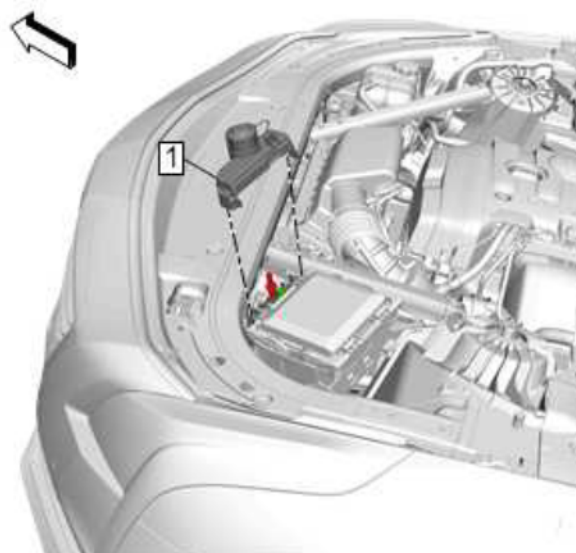


Fig. 172: Battery Positive Cable Nut
 Courtesy of GENERAL MOTORS COMPANY

14. Battery Positive Cable Nut (1)» Install and tighten 15 N.m (11 lb ft)
15. Power Distributor Fuse Block Cover (1)» Install



16. Air Cleaner Outlet Duct (1)» Install - [Air Cleaner Outlet Duct Replacement \(LGX\)](#)

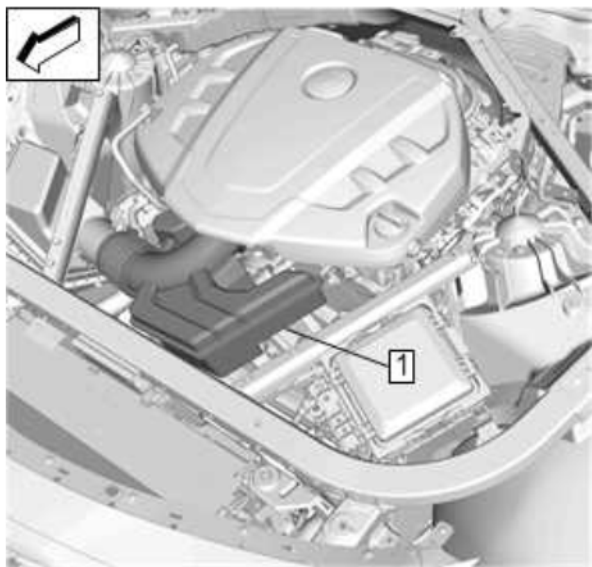


Fig. 174: Air Cleaner Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

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

MULTIFUNCTION POWER SUPPLY CONVERTER REPLACEMENT

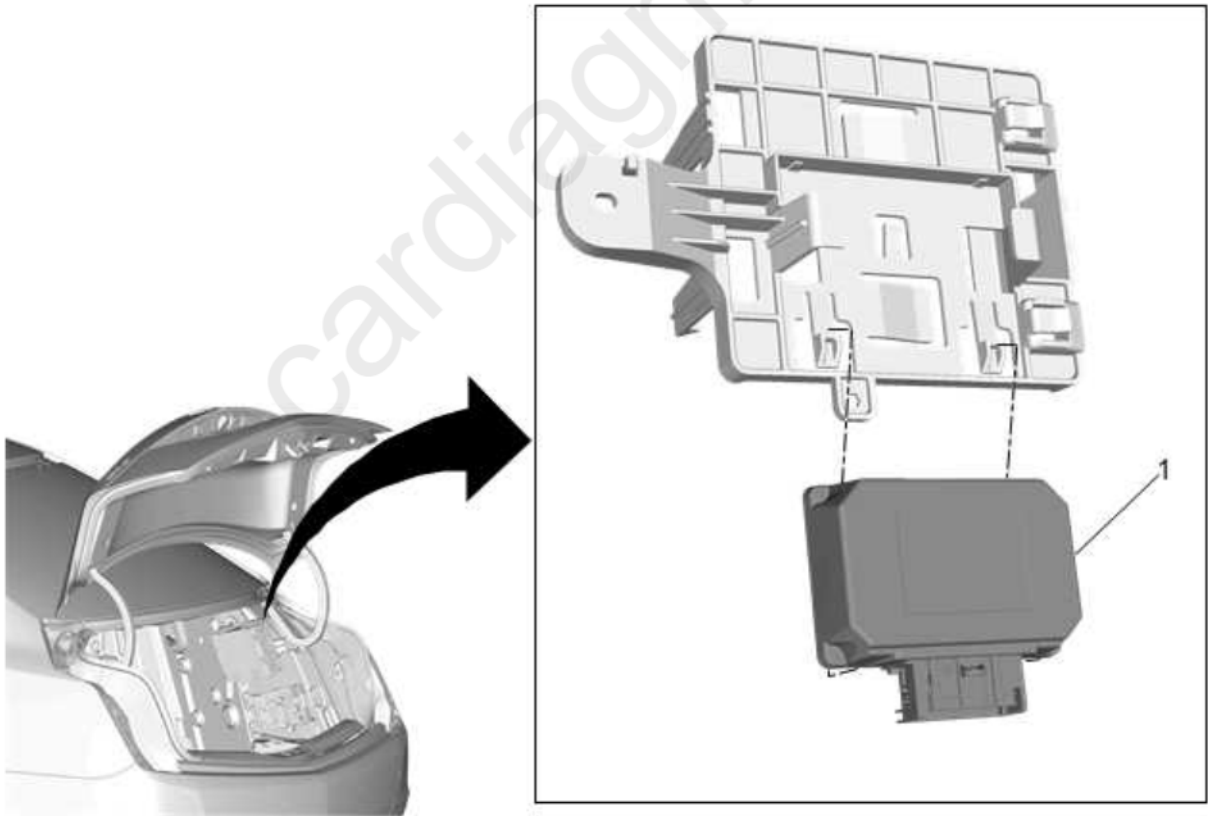


Fig. 175: Multifunction Power Supply Converter
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Radio Bracket Replacement	

Callout	Component Name
1	Multifunction Power Supply Converter Procedure Remove the converter from the bracket by pushing down on the 2 tabs and sliding out of the bracket.

BATTERY REPLACEMENT

Removal Procedure

1. Rear Compartment Floor Panel Trim, & » Remove - [Rear Compartment Front Trim Replacement \(Without HP9\)](#)
2. Spare Tire Stowage Retainer (1), & » Remove



Fig. 176: Spare Tire
Courtesy of GENERAL MOTORS COMPANY

3. Spare Tire (2), & » Remove
4. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
5. Battery Positive Post Cover (2), & » Remove

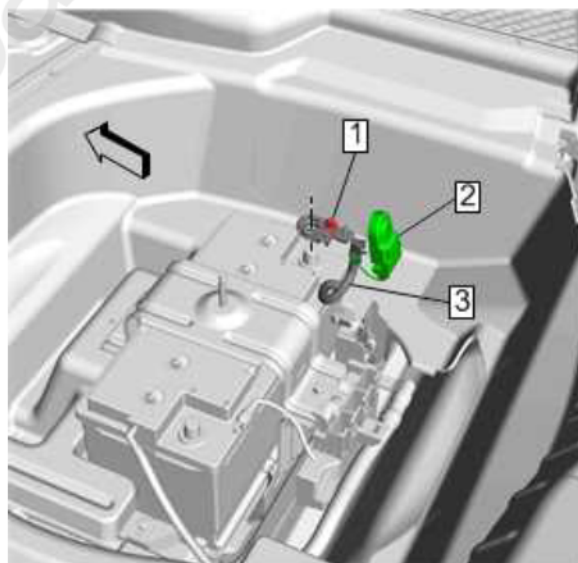


Fig. 177: Positive Post Cover And Clamp Nut
Courtesy of GENERAL MOTORS COMPANY

6. Battery Positive Post Clamp Nut (1), & » Loosen
7. Battery Positive Cable (3), & » Remove
8. Spare Wheel Stowage Bracket Bolt (1), & » Remove [2x]

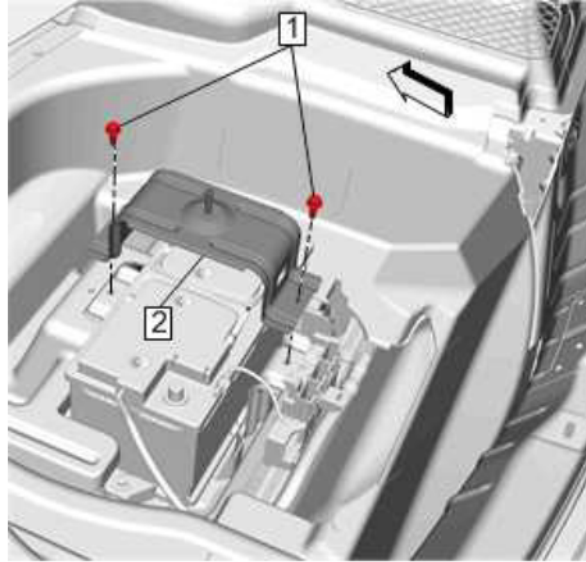


Fig. 178: Spare Wheel Carrier Bracket
Courtesy of GENERAL MOTORS COMPANY

- 9. Spare Wheel Carrier Bracket (2)» Remove
- 10. Battery Vent Tube (2)» Disengage

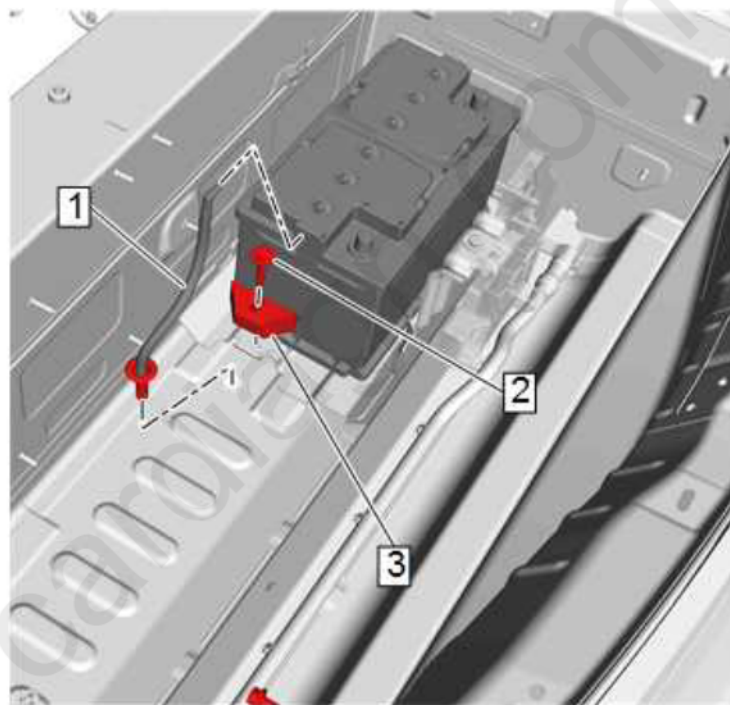


Fig. 179: Battery Vent Tube And Battery Hold Down Bolt
Courtesy of GENERAL MOTORS COMPANY

- 11. Battery Hold Down Bolt (1)» Remove
- 12. Battery Hold Down Retainer (3)» Remove
- 13. Battery (1)» Remove

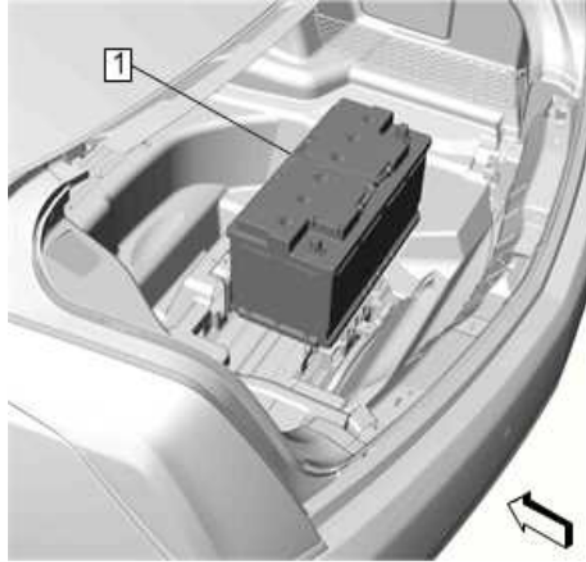


Fig. 180: Battery

Courtesy of GENERAL MOTORS COMPANY

Installation Procedure

1. If you are replacing the battery with a serviced NEW battery, detach the vent plug (1), that comes with the positive post cover.

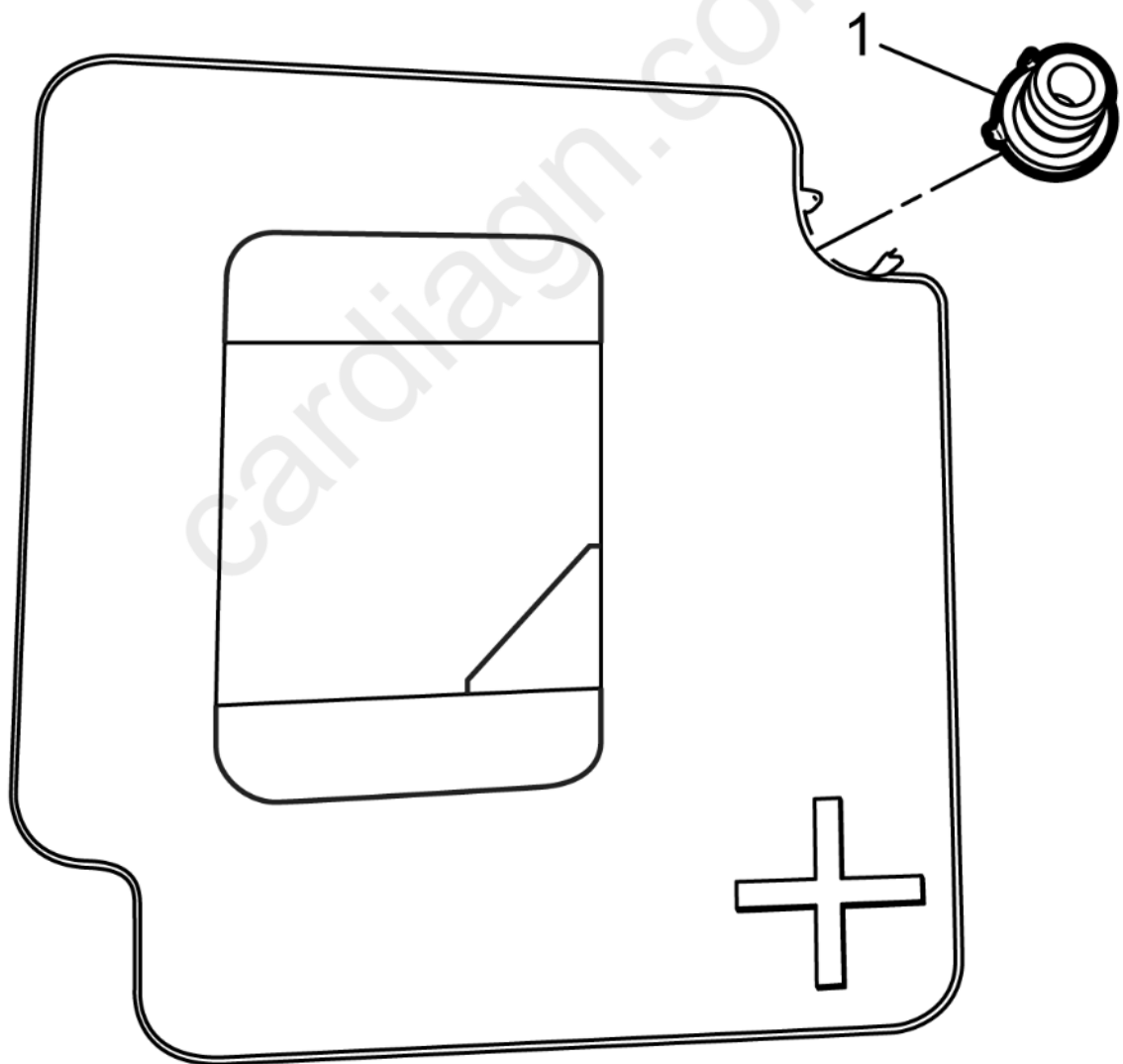


Fig. 181: Vent Plug

Courtesy of GENERAL MOTORS COMPANY

2. Install the vent plug (1), opposite side of the battery vent hose (2).

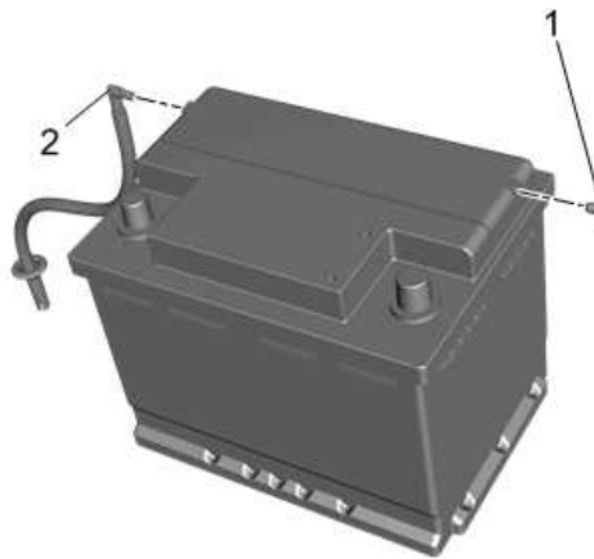


Fig. 182: Vent Plug And Battery Vent Hose
 Courtesy of GENERAL MOTORS COMPANY

3. Battery (1)» Install

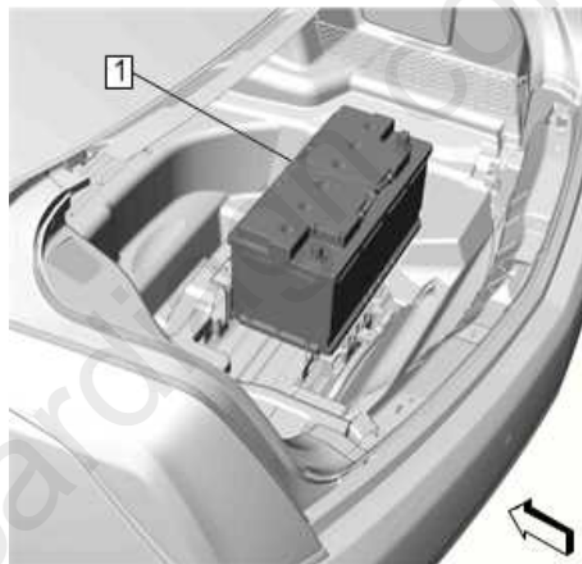


Fig. 183: Battery
 Courtesy of GENERAL MOTORS COMPANY

4. Battery Vent Tube (2)» Engage (2)

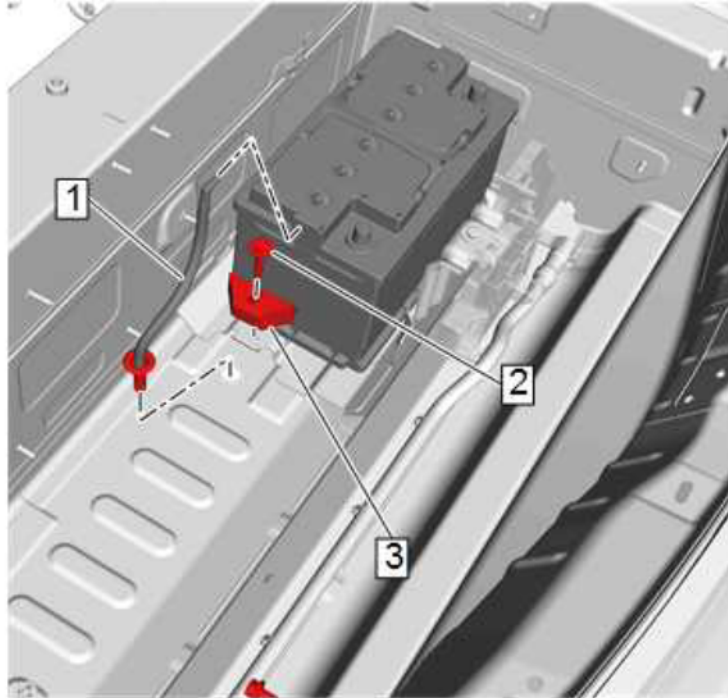


Fig. 184: Battery Vent Tube And Battery Hold Down Bolt
 Courtesy of GENERAL MOTORS COMPANY

5. Battery Hold Down Retainer (3)» Install
6. Battery Hold Down Bolt (1)» Install and tighten 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

7. Spare Wheel Carrier Bracket (2)» Install

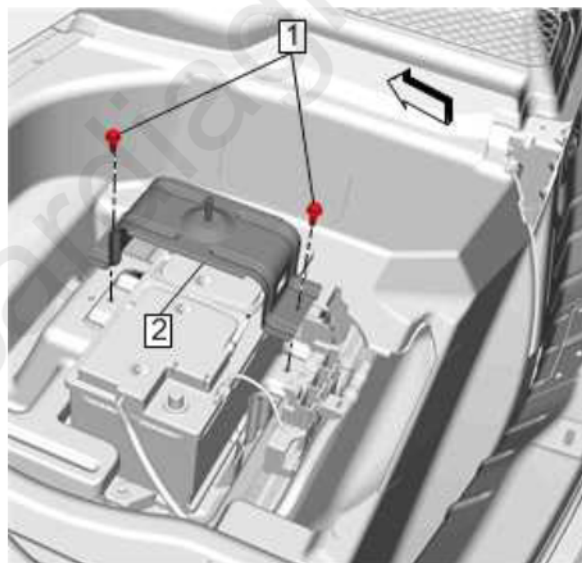


Fig. 185: Spare Wheel Carrier Bracket
 Courtesy of GENERAL MOTORS COMPANY

8. Spare Wheel Stowage Bracket Bolt (1)» Install and tighten [2x] 22 N.m (16 lb ft)
9. Battery Positive Cable (3)» Install

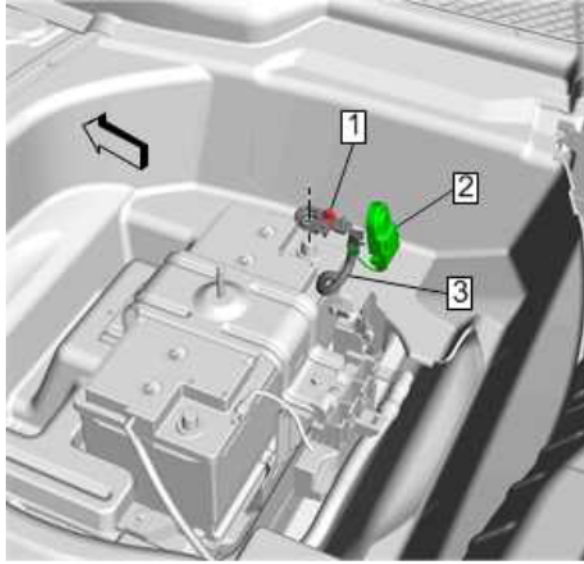


Fig. 186: Positive Post Cover And Clamp Nut
Courtesy of GENERAL MOTORS COMPANY

10. Battery Positive Post Clamp Nut (1)» Tighten 6 N.m (53 lb in)
11. Battery Positive Post Cover (2)» Install
12. Connect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
13. Spare Tire (2)» Install

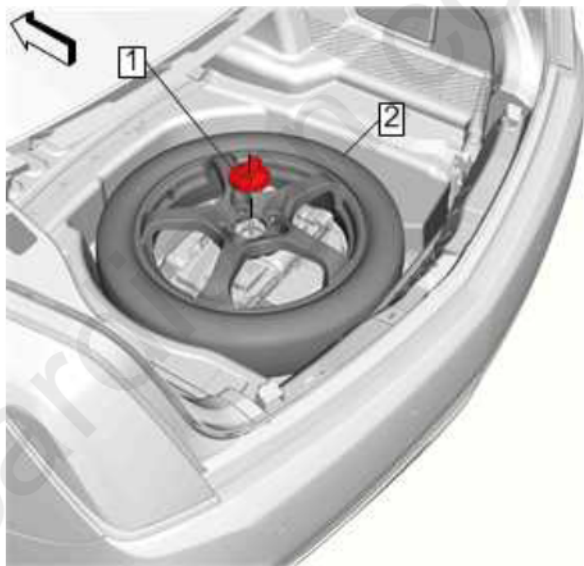


Fig. 187: Spare Tire
Courtesy of GENERAL MOTORS COMPANY

14. Spare Tire Stowage Retainer (1)» Hand tighten
15. Rear Compartment Floor Panel Trim» Install - [Rear Compartment Front Trim Replacement \(Without HP9\)](#)

BATTERY VENT TUBE REPLACEMENT

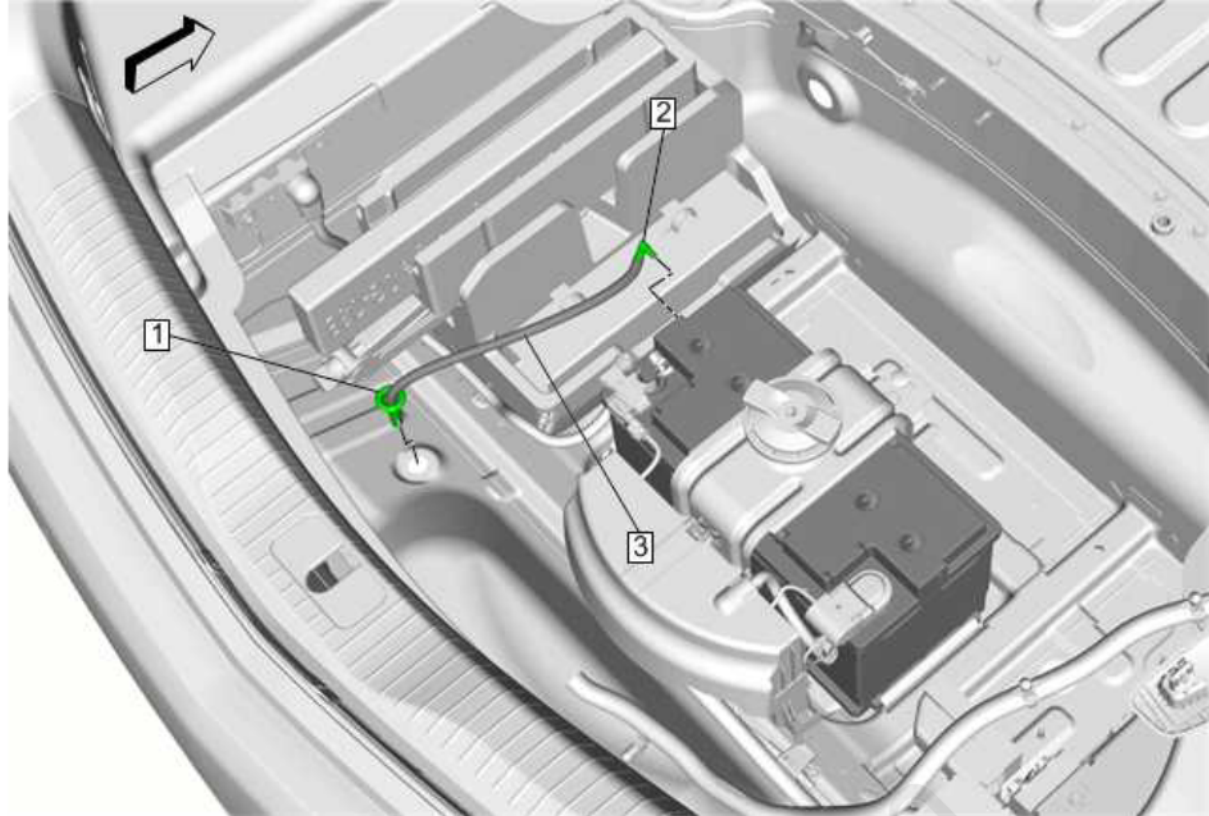


Fig. 188: Battery Vent Tube

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedures <u>Rear Compartment Floor Panel Trim Replacement (Without HP9) Rear Compartment Floor Panel Trim Replacement (With HP9)</u> Å, Å» Remove - Remove the spare tire. <u>Rear Compartment Floor Stowage Compartment Cover Replacement (Without HP9)</u>	
1	Battery Vent Tube Nipple
2	Grommet
3	Battery Vent Tube

STARTER REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**
2. Engine Mount Bracket - Right Side (2) Å, Å» Remove - **Engine Mount Bracket Replacement - Right Side**

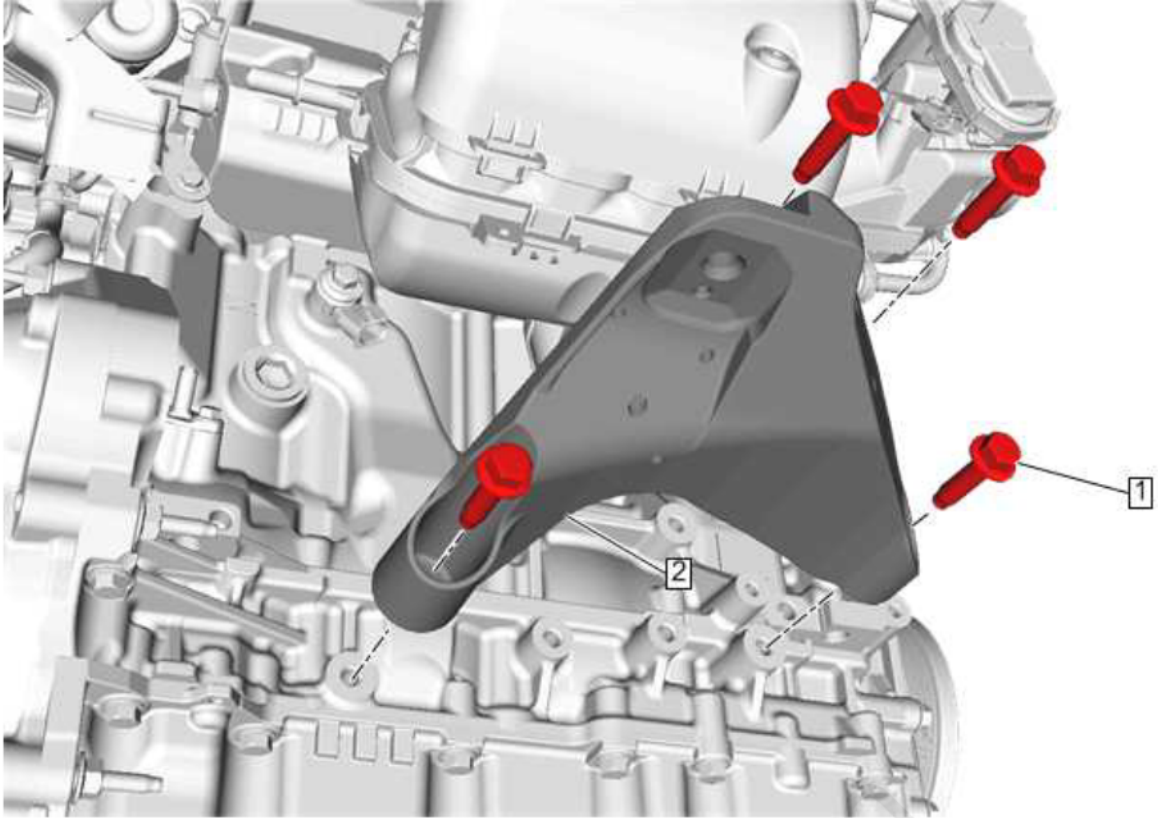


Fig. 189: Engine Mount Bracket - Right Side
 Courtesy of GENERAL MOTORS COMPANY

3. Starter Solenoid Cable Nut (1)» Remove

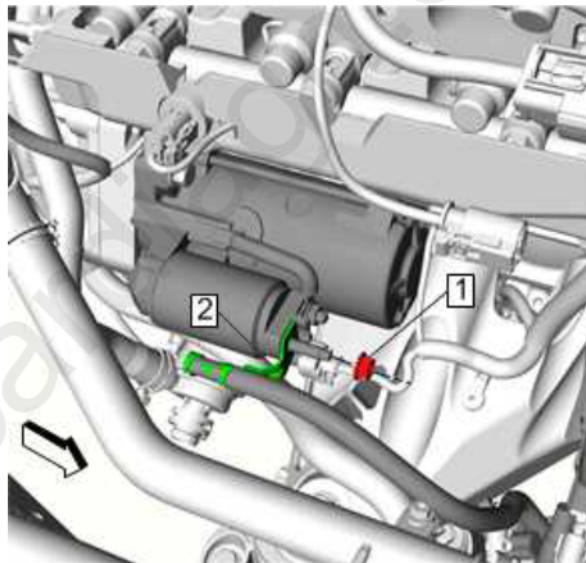


Fig. 190: Starter Solenoid Cable Nut
 Courtesy of GENERAL MOTORS COMPANY

4. Generator Battery Jumper Cable (2)» Remove
5. Starter Solenoid Connector (1)» Disconnect

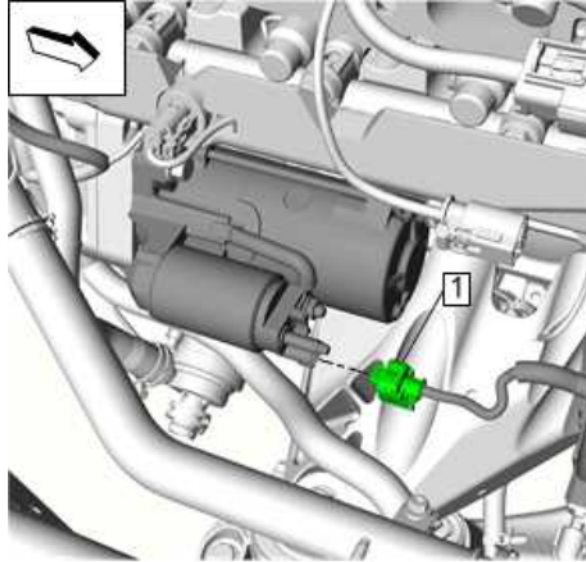


Fig. 191: Starter Solenoid Connector

Courtesy of GENERAL MOTORS COMPANY

6. Starter Mounting Bolt (1)» Remove [2x]

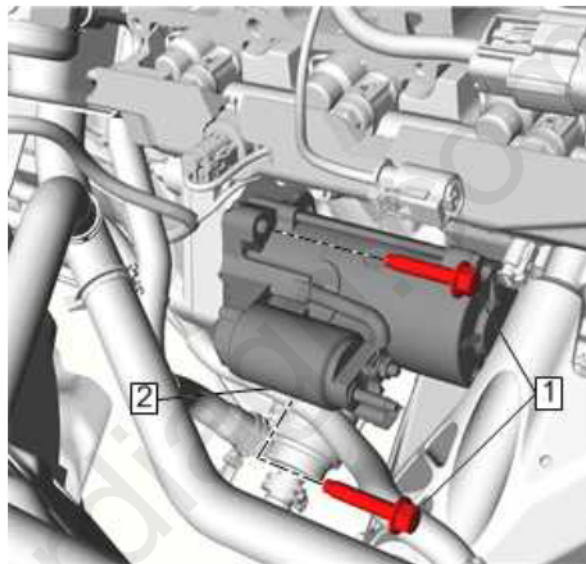


Fig. 192: Starter Mounting Bolt

Courtesy of GENERAL MOTORS COMPANY

7. Starter (2)» Remove

Installation Procedure

1. Starter (2)» Install

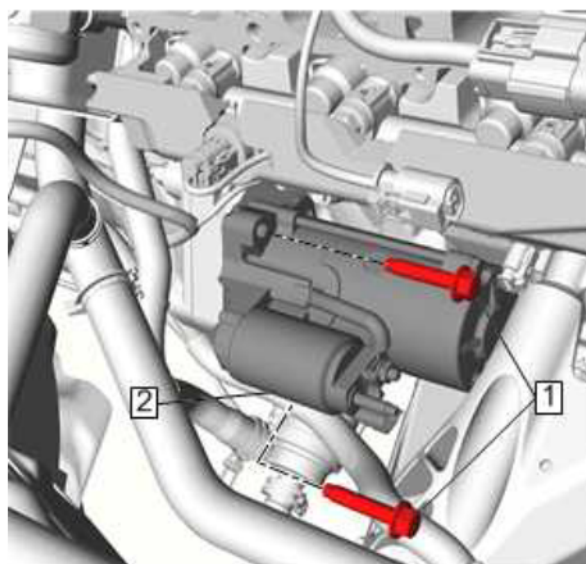


Fig. 193: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Starter Mounting Bolt (1)» Install and tighten [2x] 58 N.m (43 lb ft)

CAUTION: Refer to [Fastener Caution](#)

3. Starter Solenoid Connector (1)» Connect

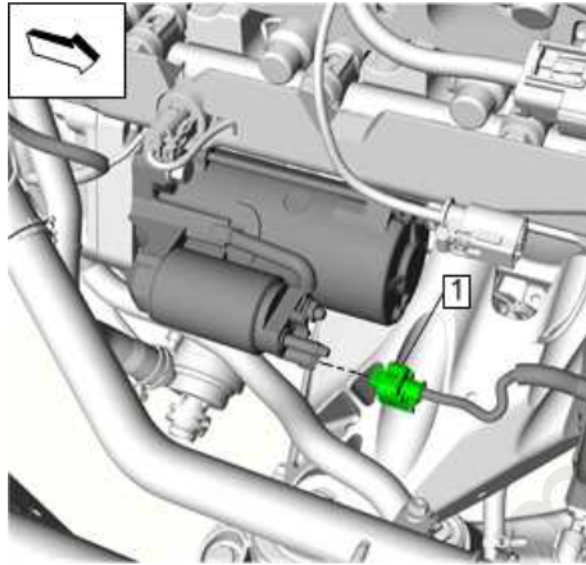


Fig. 194: Starter Solenoid Connector
Courtesy of GENERAL MOTORS COMPANY

4. Generator Battery Jumper Cable (2)» Install

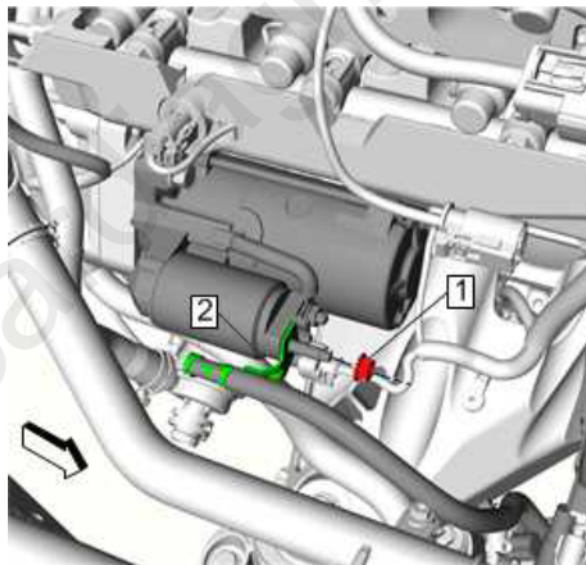


Fig. 195: Starter Solenoid Cable Nut
Courtesy of GENERAL MOTORS COMPANY

5. Starter Solenoid Cable Nut (1)» Install and tighten 12 N.m (106 lb in)
6. Engine Mount Bracket - Right Side (2)» Install - [Engine Mount Bracket Replacement - Right Side](#)

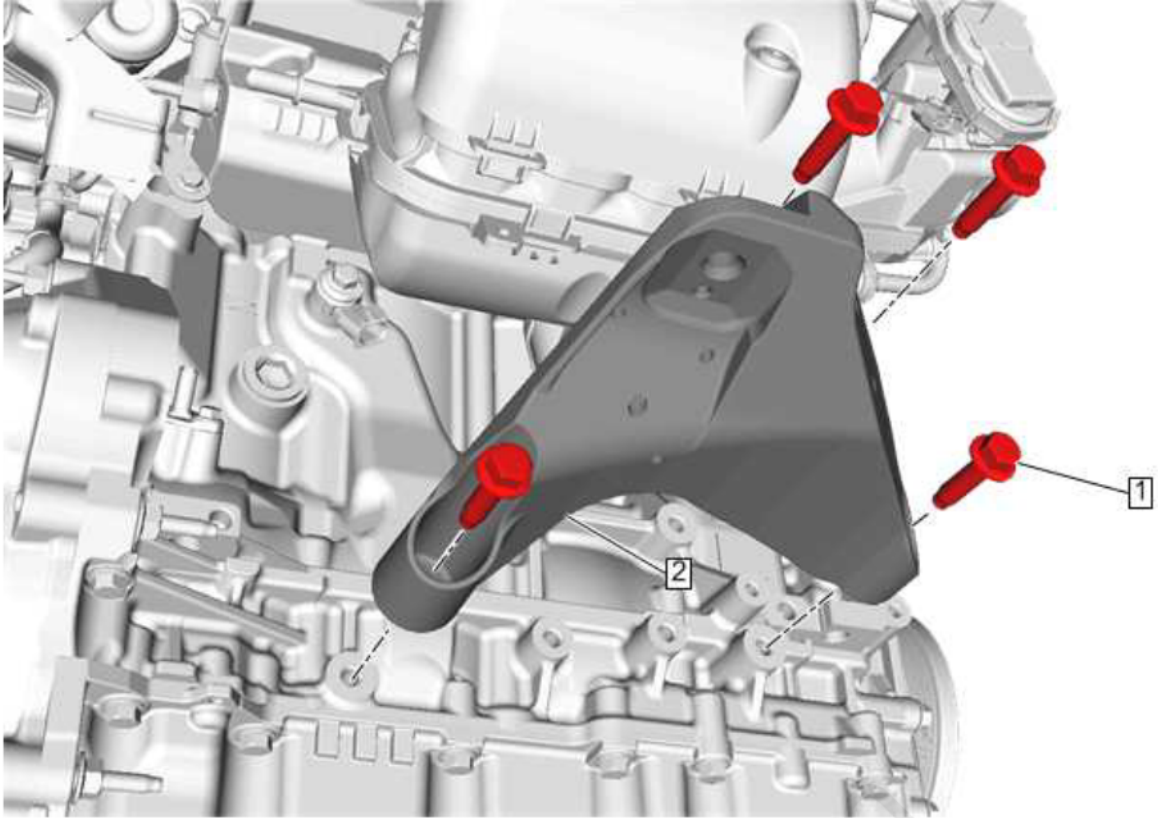


Fig. 196: Engine Mount Bracket - Right Side
 Courtesy of GENERAL MOTORS COMPANY

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

STARTER REPLACEMENT (LGW)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Turbocharger - Left Side (1)» Remove - [Turbocharger Replacement \(Left Side\)](#)

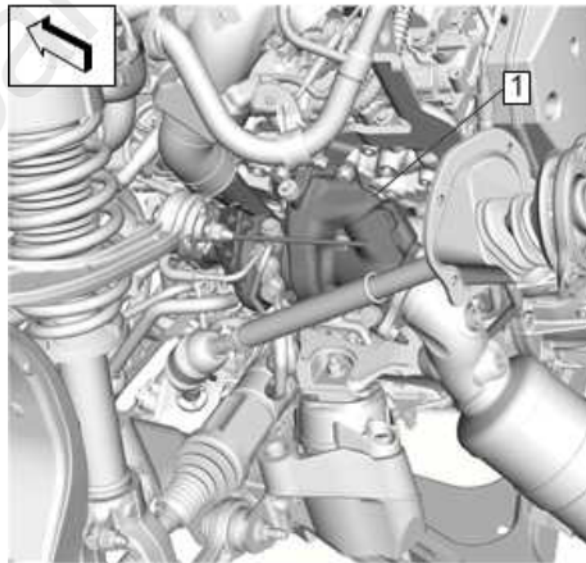


Fig. 197: Turbocharger
 Courtesy of GENERAL MOTORS COMPANY

3. Starter Heat Shield (2)» Remove - [Starter Shield Replacement \(LGW\)](#)

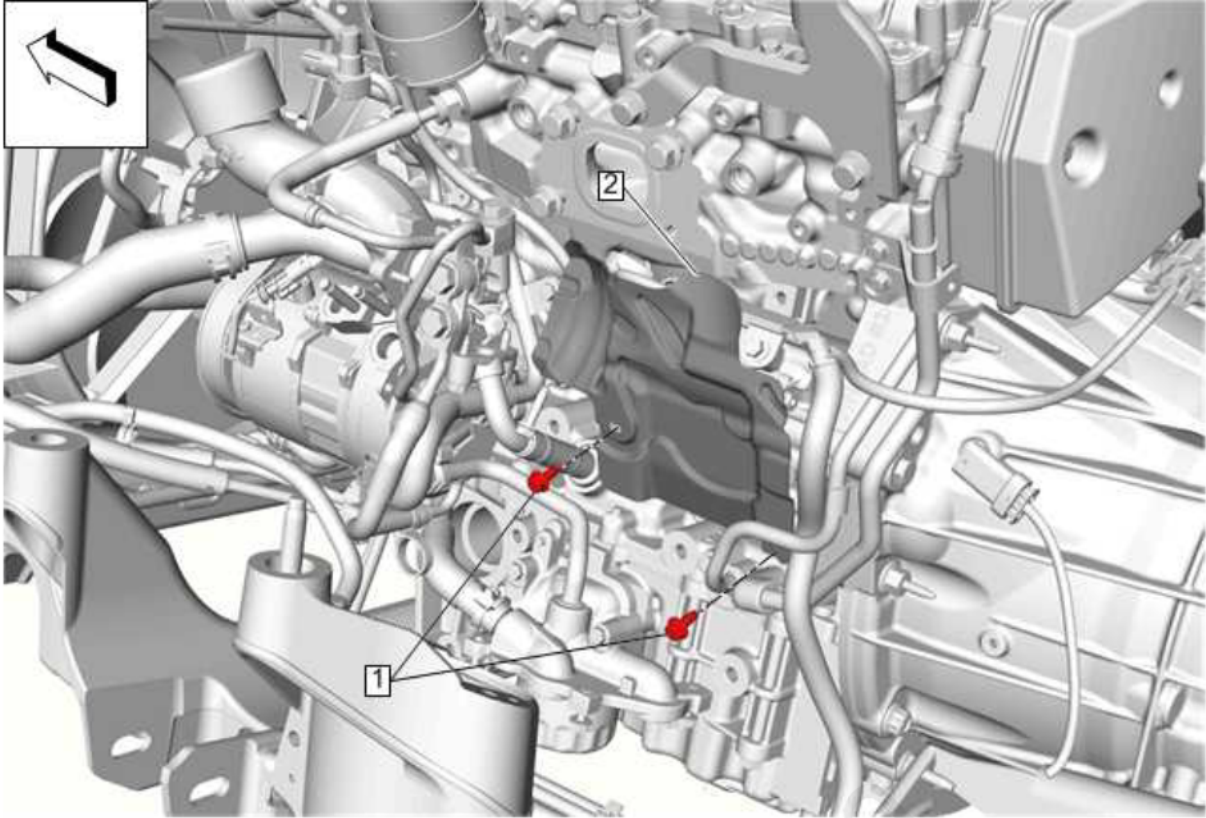


Fig. 198: Starter Heat Shield

Courtesy of GENERAL MOTORS COMPANY

4. Vacuum Pump Pipe (1) » Remove - [Vacuum Pump Pipe Replacement \(To Brake Booster Vacuum Hose\)](#) [Vacuum Pump Pipe Replacement \(To Turbocharger Control Solenoid Valve Vacuum Hose\)](#)

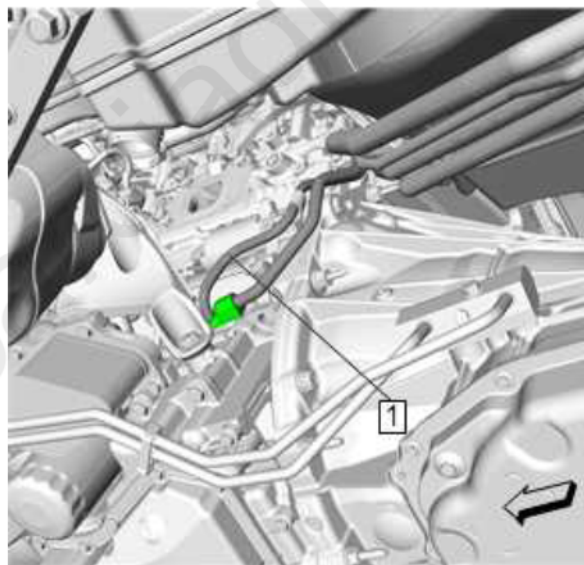


Fig. 199: Vacuum Pump Pipe

Courtesy of GENERAL MOTORS COMPANY

5. Starter Solenoid Cable Nut (1) » Remove

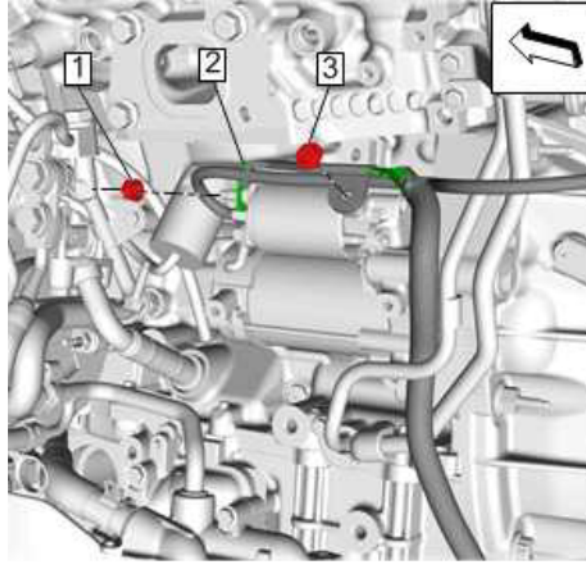


Fig. 200: Starter Solenoid Cable

Courtesy of GENERAL MOTORS COMPANY

6. Harness Retainer Fastener (3)» Remove
7. Starter Solenoid Cable (2)» Remove
8. Starter Solenoid Connector (1)» Disconnect

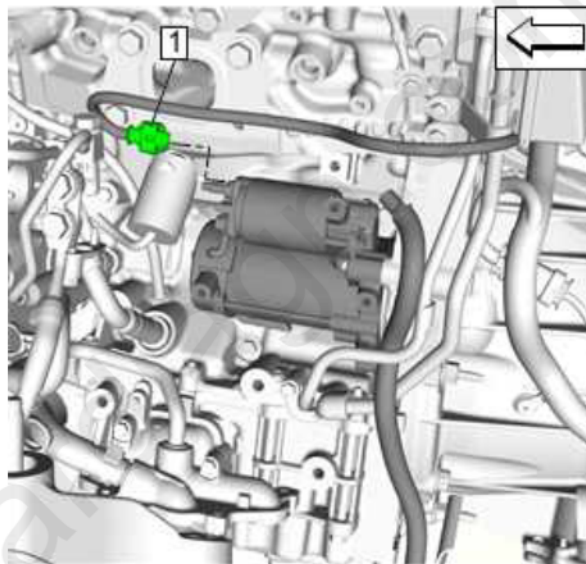


Fig. 201: Starter Solenoid Connector

Courtesy of GENERAL MOTORS COMPANY

9. Starter Mounting Bolt (1)» Remove [2x]

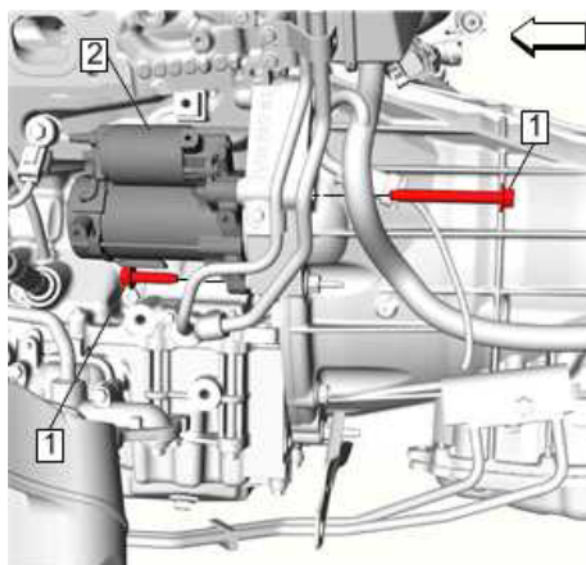


Fig. 202: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

10. Starter (2)» Remove

Installation Procedure

1. Starter (2)» Install

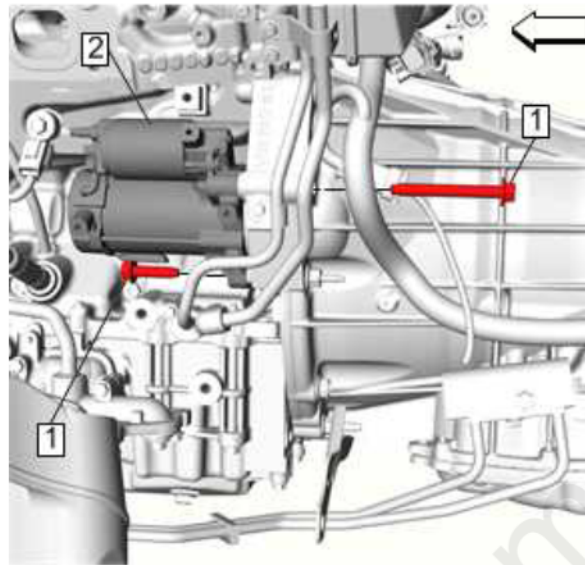


Fig. 203: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Starter Mounting Bolt (1)» Install and tighten [2x] 58 N.m (43 lb ft)

CAUTION: Refer to **Fastener Caution**

3. Starter Solenoid Connector (1)» Connect

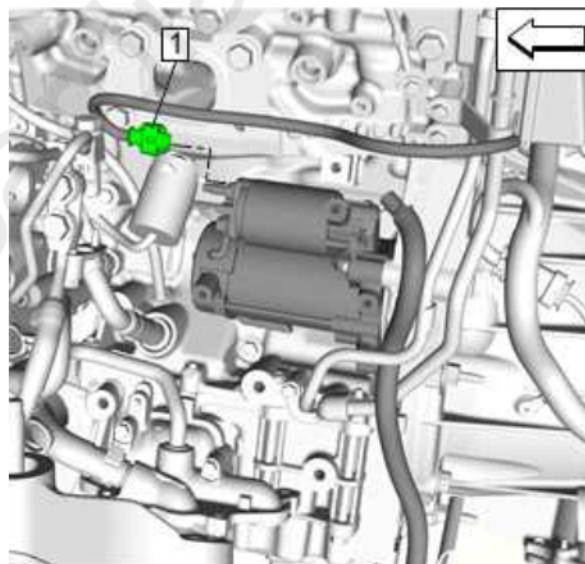


Fig. 204: Starter Solenoid Connector
Courtesy of GENERAL MOTORS COMPANY

4. Starter Solenoid Cable (2)» Install

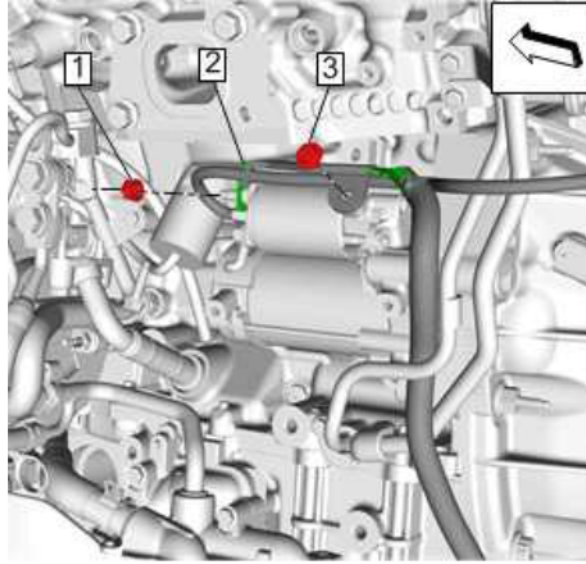


Fig. 205: Starter Solenoid Cable

Courtesy of GENERAL MOTORS COMPANY

5. Harness Retainer Fastener (3)» Install and tighten 9 N.m (80 lb in)
6. Starter Solenoid Cable Nut (1)» Install and tighten 12 N.m (106 lb in)
7. Starter Heat Shield (2)» Install - [**Starter Shield Replacement \(LGW\)**](#)

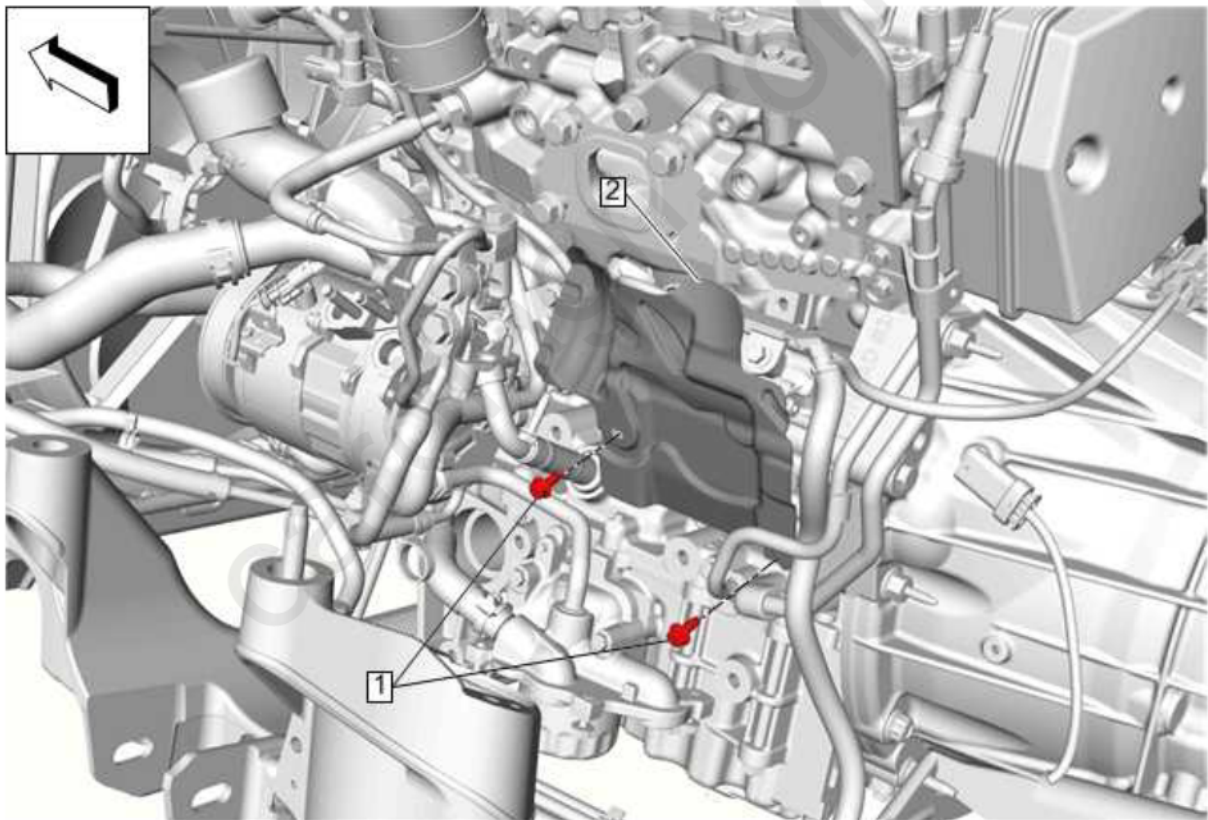


Fig. 206: Starter Heat Shield

Courtesy of GENERAL MOTORS COMPANY

8. Vacuum Pump Pipe (1)» Install - [**Vacuum Pump Pipe Replacement \(To Brake Booster Vacuum Hose\)**](#) [**Vacuum Pump Pipe Replacement \(To Turbocharger Control Solenoid Valve Vacuum Hose\)**](#)

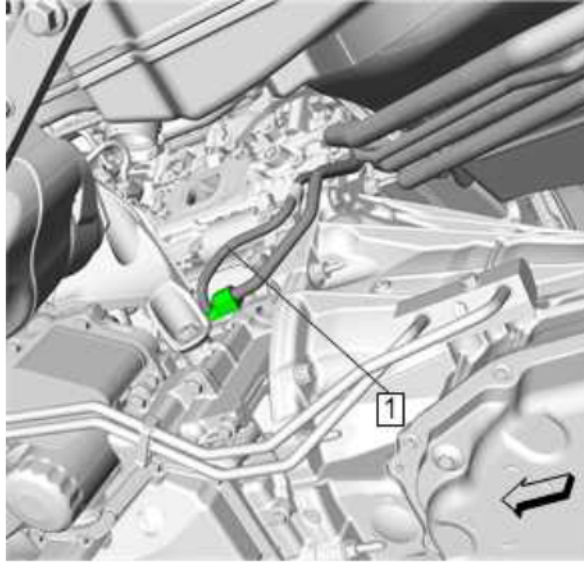


Fig. 207: Vacuum Pump Pipe

Courtesy of GENERAL MOTORS COMPANY

9. Turbocharger - Left Side (1) » Install - [Turbocharger Replacement \(Left Side\)](#)

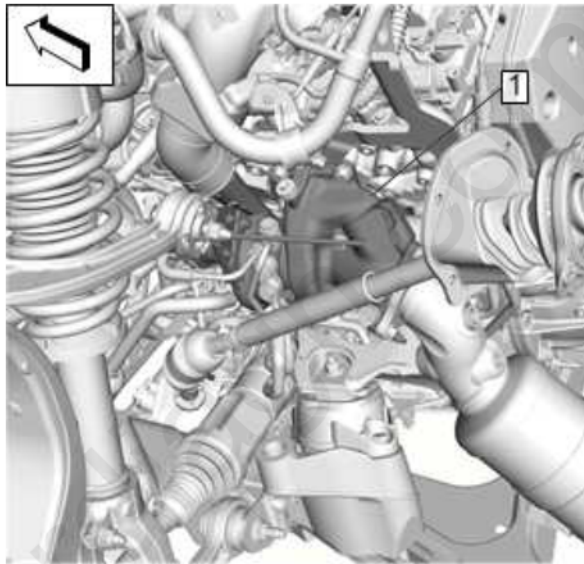


Fig. 208: Turbocharger

Courtesy of GENERAL MOTORS COMPANY

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

STARTER REPLACEMENT (LGX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Starter Heat Shield (2) » Remove - [Starter Shield Replacement \(LGX\)](#)

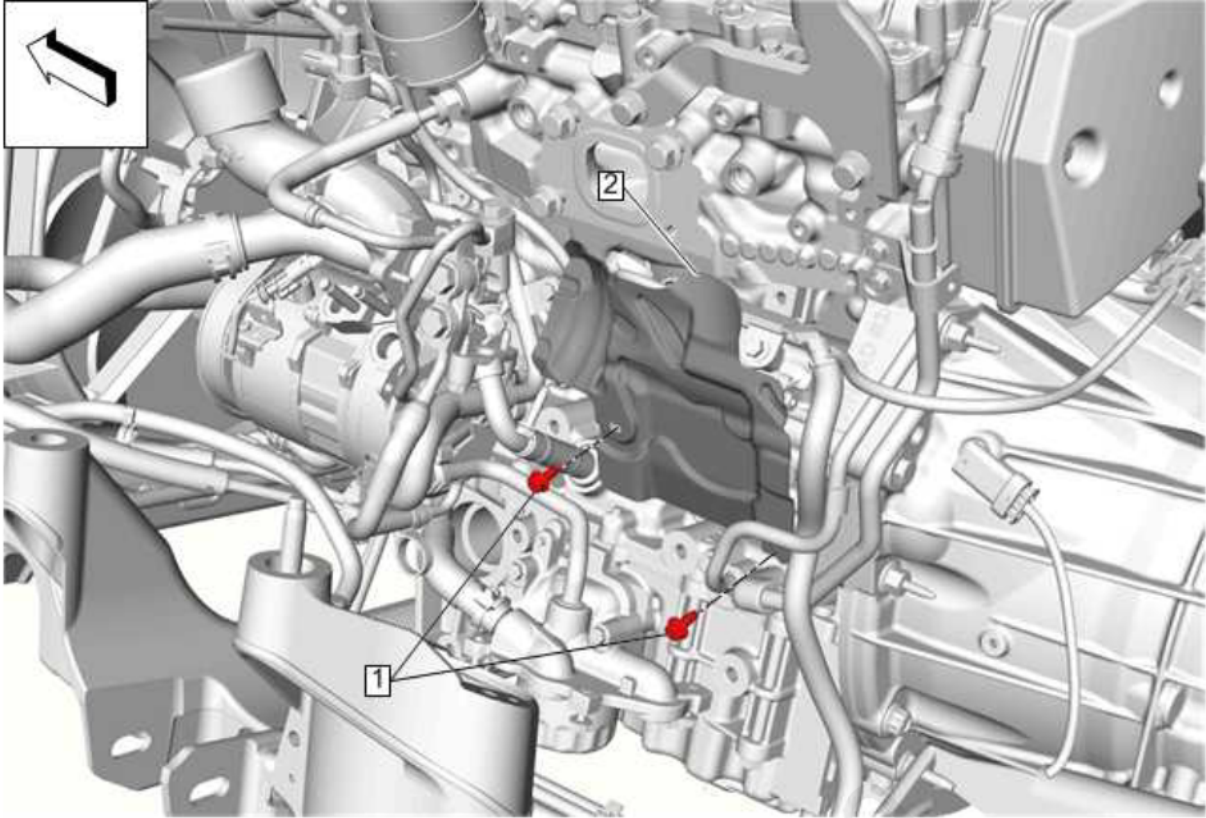


Fig. 209: Starter Heat Shield

Courtesy of GENERAL MOTORS COMPANY

3. Vacuum Pump Pipe (2) » Remove - **Vacuum Pump Pipe Removal (LGX)**

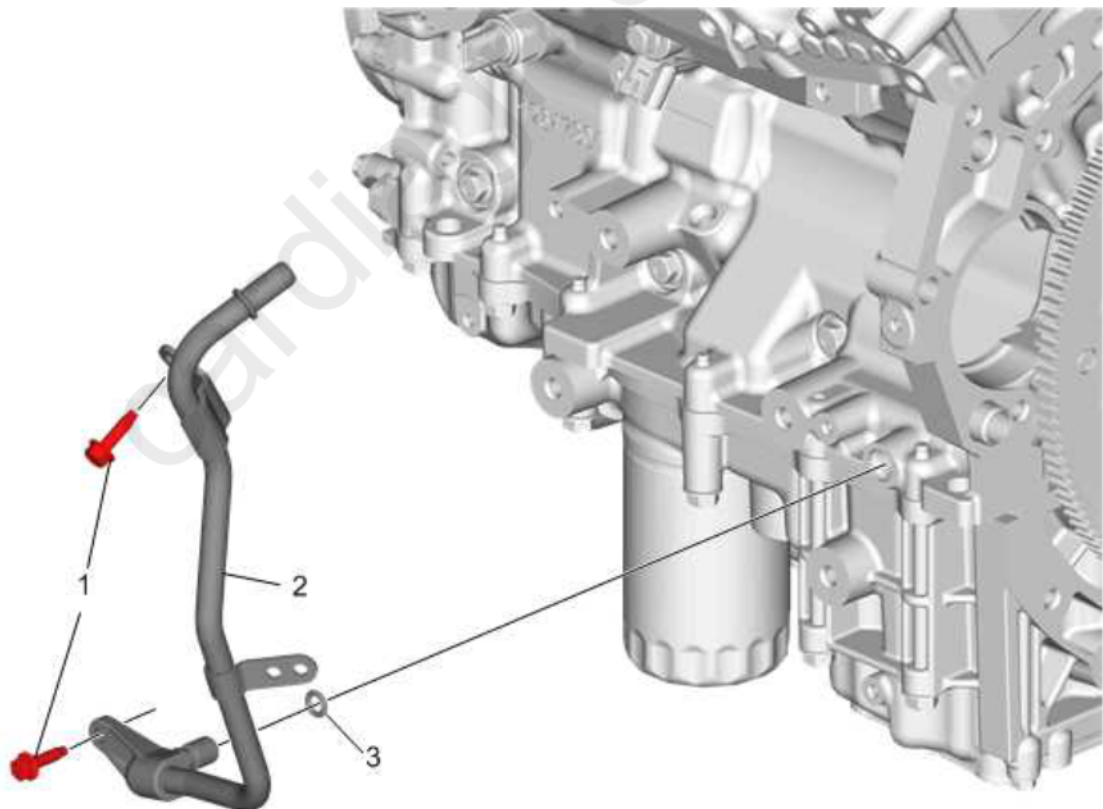


Fig. 210: Vacuum Pump Pipe

Courtesy of GENERAL MOTORS COMPANY

4. Starter Solenoid Cable Nut (1) » Remove

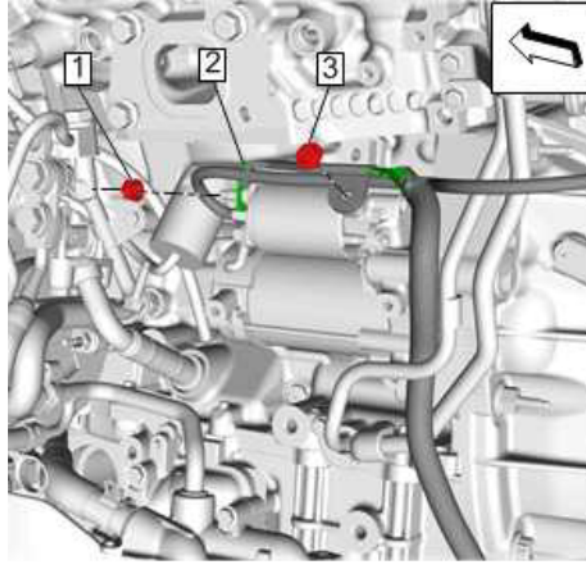


Fig. 211: Starter Solenoid Cable

Courtesy of GENERAL MOTORS COMPANY

5. Harness Retainer Fastener (3) » Remove
6. Starter Solenoid Cable (2) » Remove
7. Starter Mounting Bolt (1) » Remove [2x]

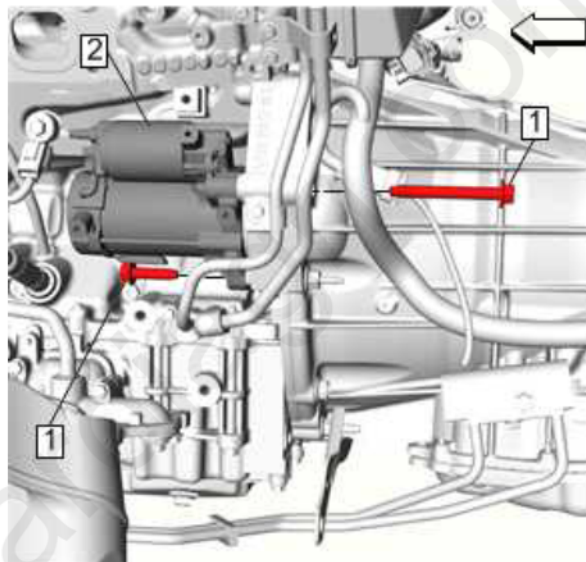


Fig. 212: Starter Mounting Bolt

Courtesy of GENERAL MOTORS COMPANY

8. Starter (2) » Remove
9. Rotate the starter to access the electrical connector.
10. Starter Solenoid Connector (1) » Disconnect

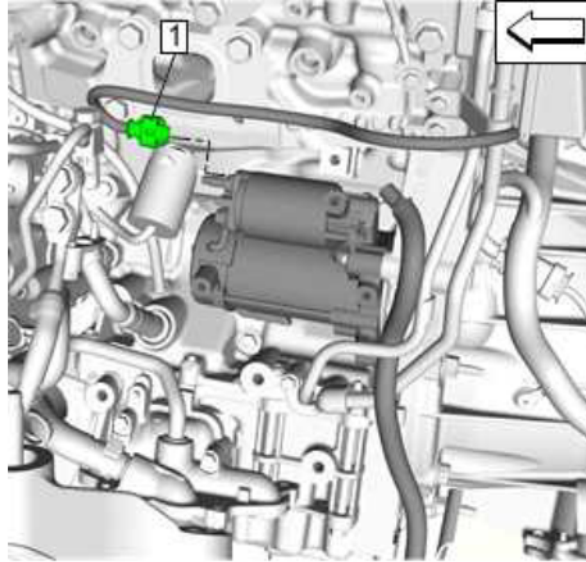


Fig. 213: Starter Solenoid Connector
Courtesy of GENERAL MOTORS COMPANY

11. Remove the starter.

Installation Procedure

1. Starter Solenoid Connector (1)» Connect

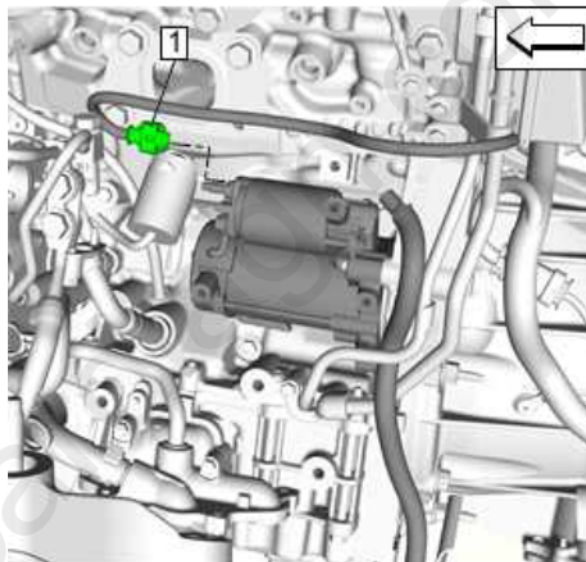


Fig. 214: Starter Solenoid Connector
Courtesy of GENERAL MOTORS COMPANY

2. Starter (2)» Install

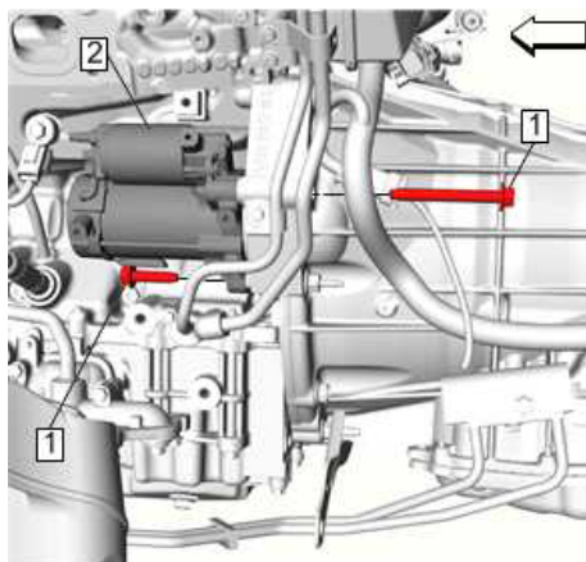


Fig. 215: Starter Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Starter Mounting Bolt (1)» Install and tighten [2x] 58 N.m (43 lb ft)

CAUTION: Refer to [Fastener Caution](#)

4. Starter Solenoid Cable (2)» Install

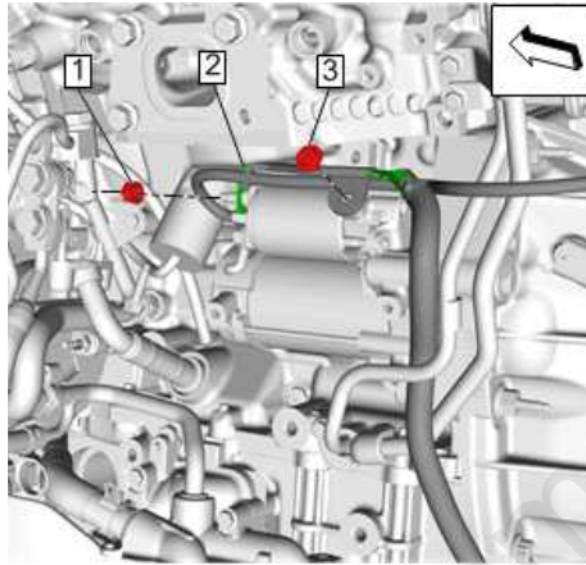


Fig. 216: Starter Solenoid Cable
Courtesy of GENERAL MOTORS COMPANY

5. Harness Retainer Fastener (3)» Install and tighten 9 N.m (80 lb in)
6. Starter Solenoid Cable Nut (1)» Install and tighten 12 N.m (106 lb in)
7. Starter Heat Shield (2)» Install - [Starter Shield Replacement \(LGX\)](#)

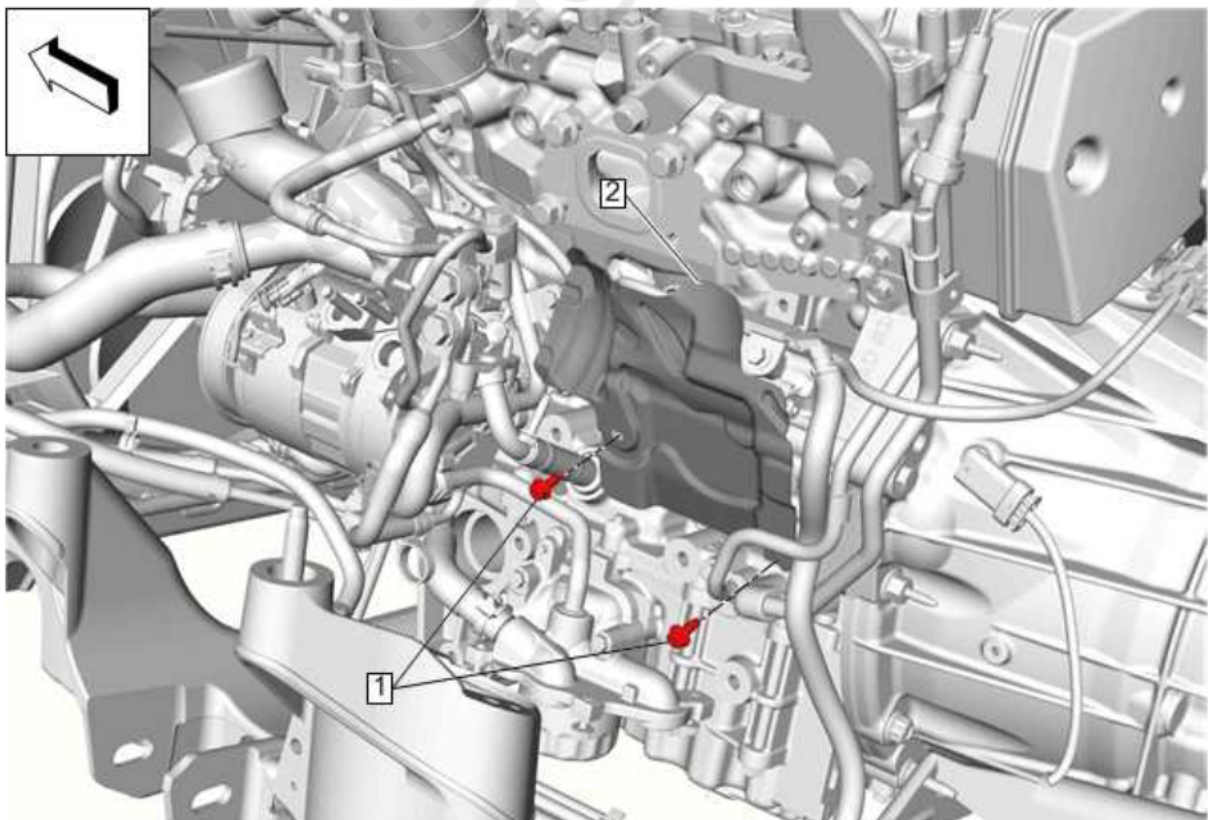


Fig. 217: Starter Heat Shield
Courtesy of GENERAL MOTORS COMPANY

8. Vacuum Pump Pipe (2)» Install - [Vacuum Pump Pipe Installation \(LGX\)](#)

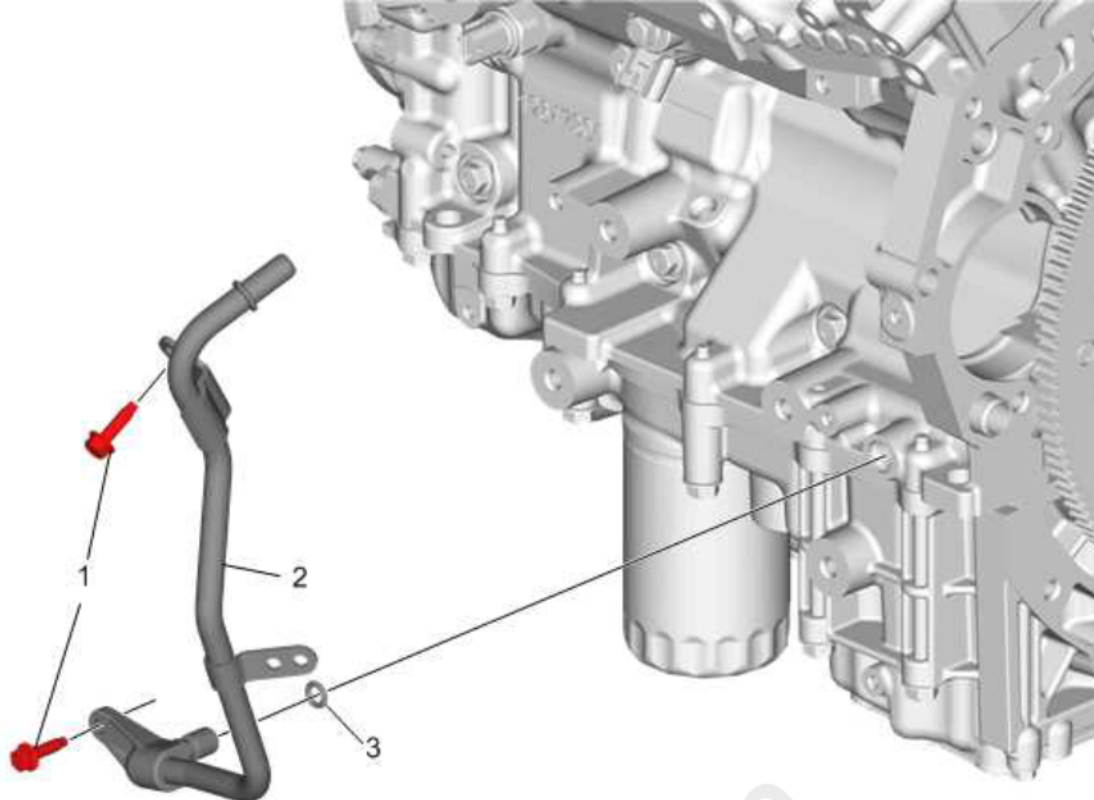


Fig. 218: Vacuum Pump Pipe

Courtesy of GENERAL MOTORS COMPANY

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

STARTER SHIELD REPLACEMENT (LGW)

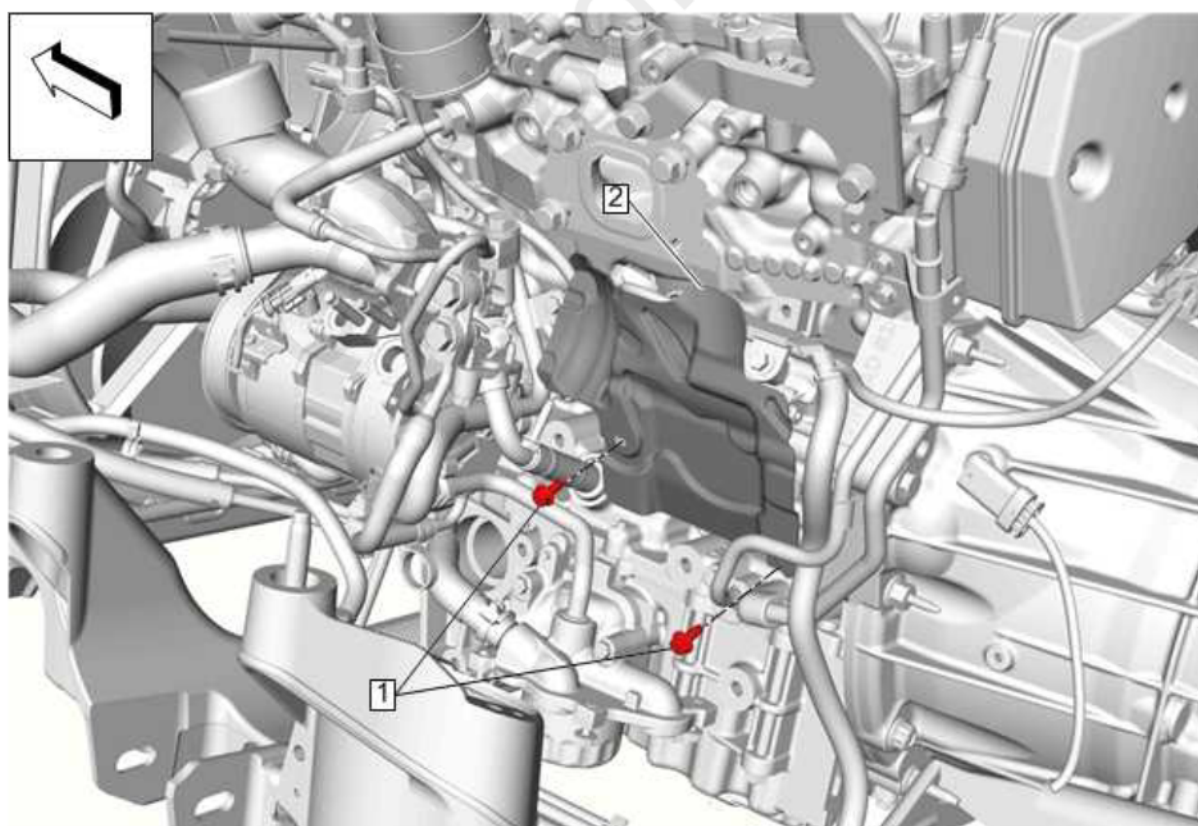


Fig. 219: Starter Heat Shield (LGW)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Turbocharger - Left Side» Remove - Turbocharger Replacement (Left Side)	

Callout	Component Name
1	Starter Heat Shield Fastener [2x] CAUTION: Refer to Fastener Caution Tighten 9 N.m (80 lb in)
2	Starter Heat Shield

STARTER SHIELD REPLACEMENT (LGX)

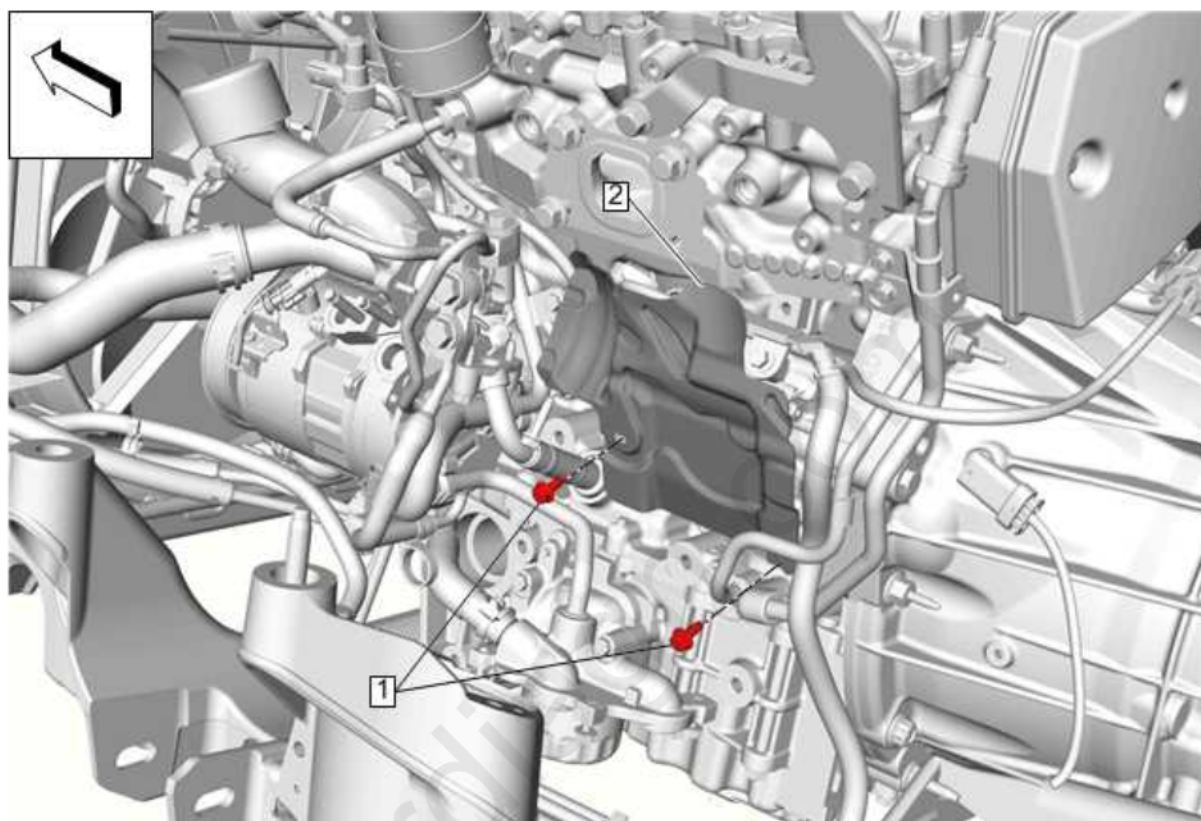


Fig. 220: Starter Heat Shield (LGX)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure Warm Up Three-Way Catalytic Converter - Left Side & Remove - Warm Up Three-Way Catalytic Converter Replacement (Right, LGX)	
1	Starter Heat Shield Fastener [2x] CAUTION: Refer to Fastener Caution Tighten 9 N.m (80 lb in)
2	Starter Heat Shield

GENERATOR BRACKET REPLACEMENT (LGW)

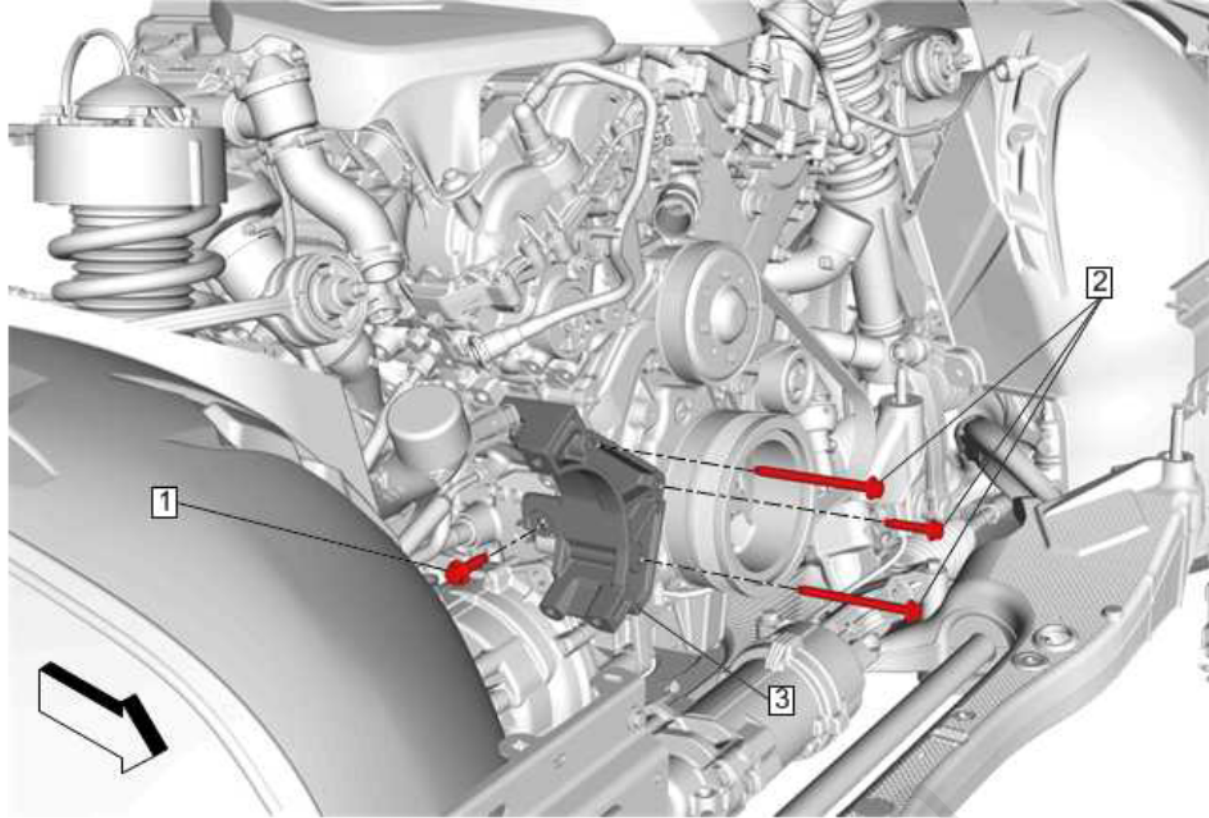


Fig. 221: Generator Bracket (LGW)

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
Preliminary Procedure	
Remove the generator. Refer to Generator Replacement (LGW)	
1	Generator Bracket Bolt CAUTION: Refer to Fastener Caution Tighten 58 N.m (43 lb ft)
2	Generator Bracket Bolt [3x] Tighten 22 N.m (16 lb ft)
3	Generator Bracket

GENERATOR REPLACEMENT (LTG)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Drive Belt (1)» Remove - [Drive Belt Replacement \(Except Hybrid\)](#)

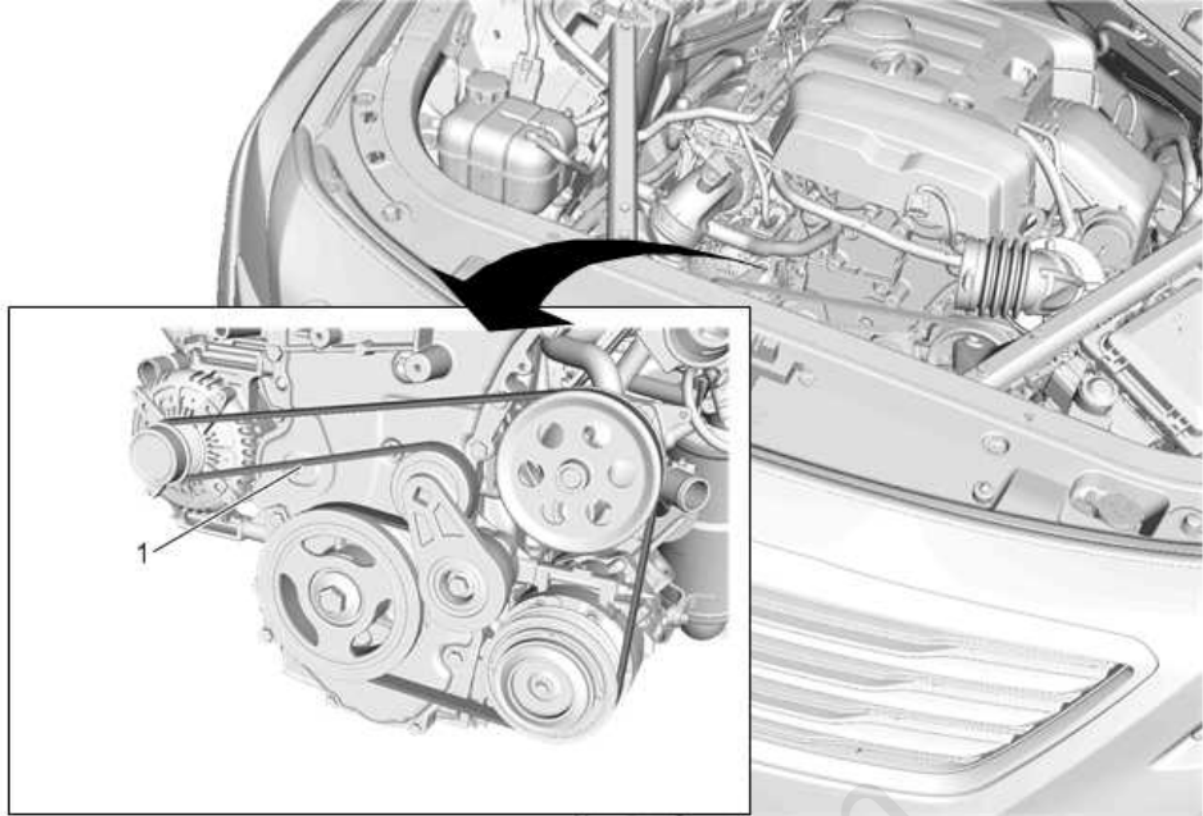


Fig. 222: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

3. Front Wheelhouse Panel Brace - Front (2)» Remove - **Front Wheelhouse Panel Brace Replacement (Front)**

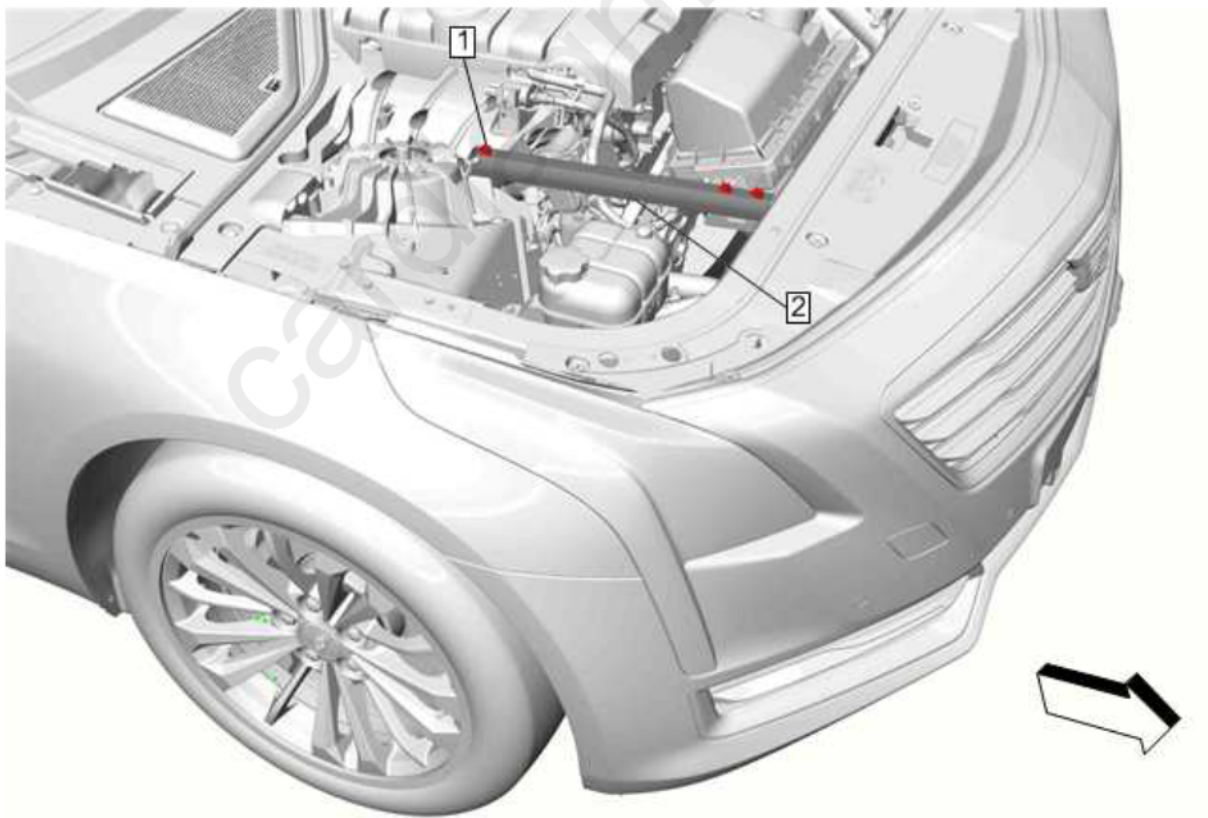


Fig. 223: Front Wheelhouse Panel Brace (Front)

Courtesy of GENERAL MOTORS COMPANY

4. Wiring Harness Retainer (1)» Disengage

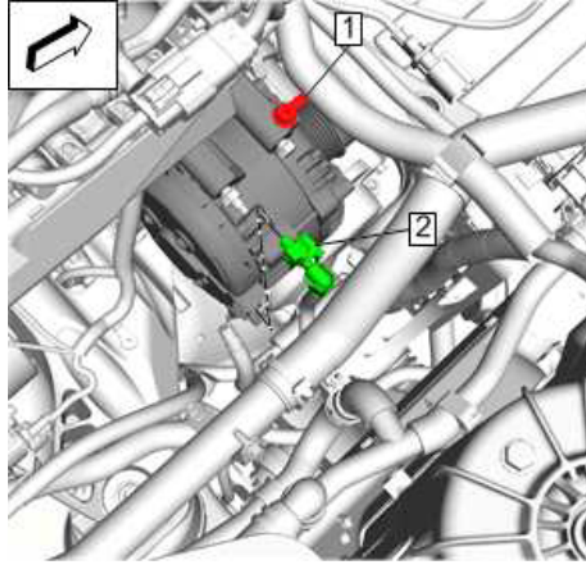


Fig. 224: Wiring Harness Retainer
 Courtesy of GENERAL MOTORS COMPANY

5. Electrical Connector (2) » Disconnect
6. Generator Nut (1) » Remove

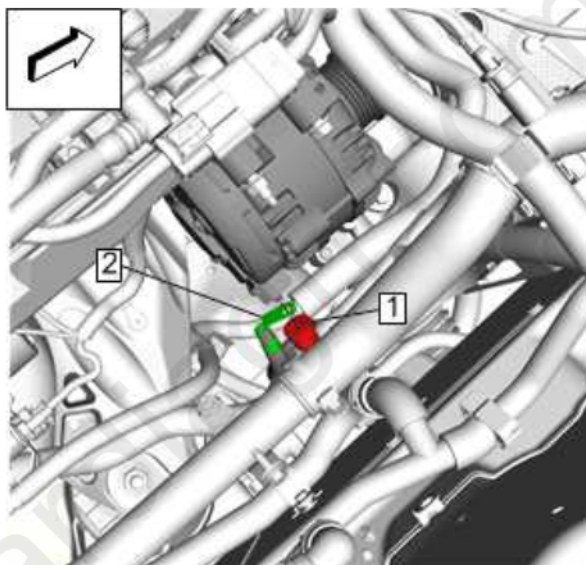


Fig. 225: Generator Nut
 Courtesy of GENERAL MOTORS COMPANY

7. Generator Battery Jumper Cable (2) » Remove
8. Generator Bolt (1) » Remove [2x]

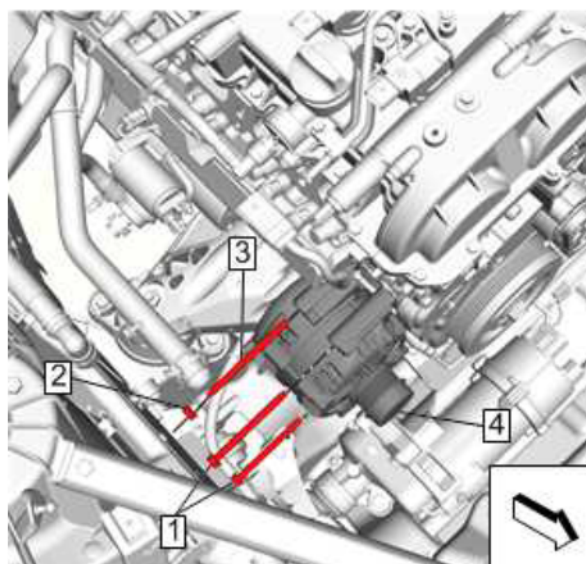


Fig. 226: Generator Bolt
Courtesy of GENERAL MOTORS COMPANY

9. Generator Mounting Nut (2)» Remove
10. Generator Mounting Stud (3)» Remove
11. Generator (4)» Remove

Installation Procedure

1. Generator (4)» Install

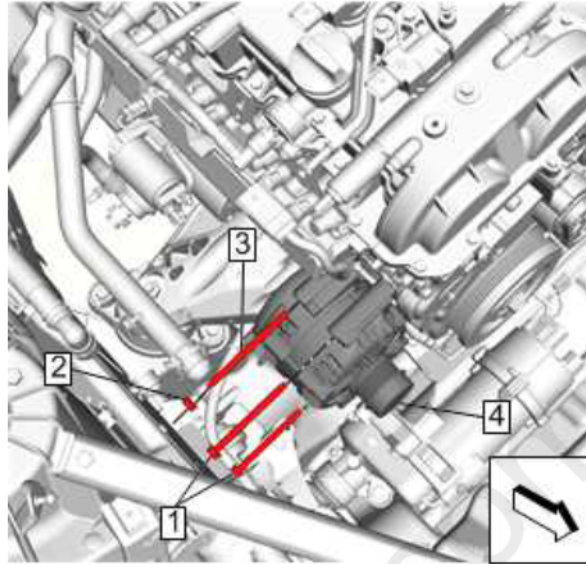


Fig. 227: Generator Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Generator Mounting Bolt (1)» Install and tighten [2x] 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

3. Generator Mounting Stud (3)» Install and tighten 9 N.m (80 lb in)
4. Generator Mounting Nut (2)» Install and tighten 22 N.m (16 lb ft)
5. Generator Battery Jumper Cable (2)» Install

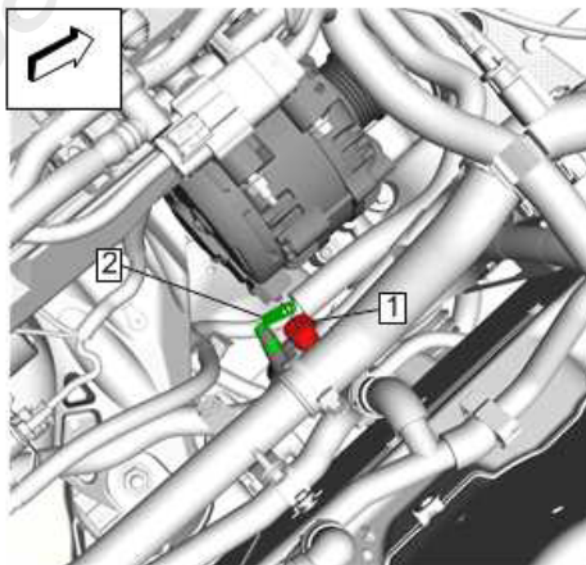


Fig. 228: Generator Nut
Courtesy of GENERAL MOTORS COMPANY

6. Generator Nut (1)» Install and tighten 15 N.m (11 lb ft)
7. Wiring Harness Retainer (1)» Engage

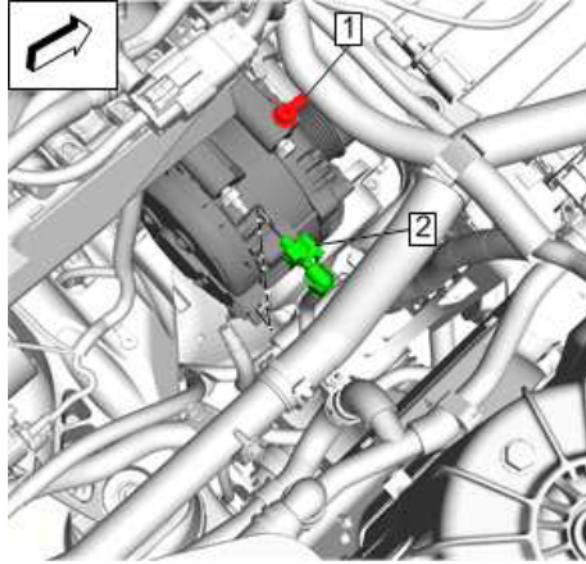


Fig. 229: Wiring Harness Retainer

Courtesy of GENERAL MOTORS COMPANY

8. Electrical Connector (2)» Connect
9. Front Wheelhouse Panel Brace - Front (2)» Install - **Front Wheelhouse Panel Brace Replacement (Front)**

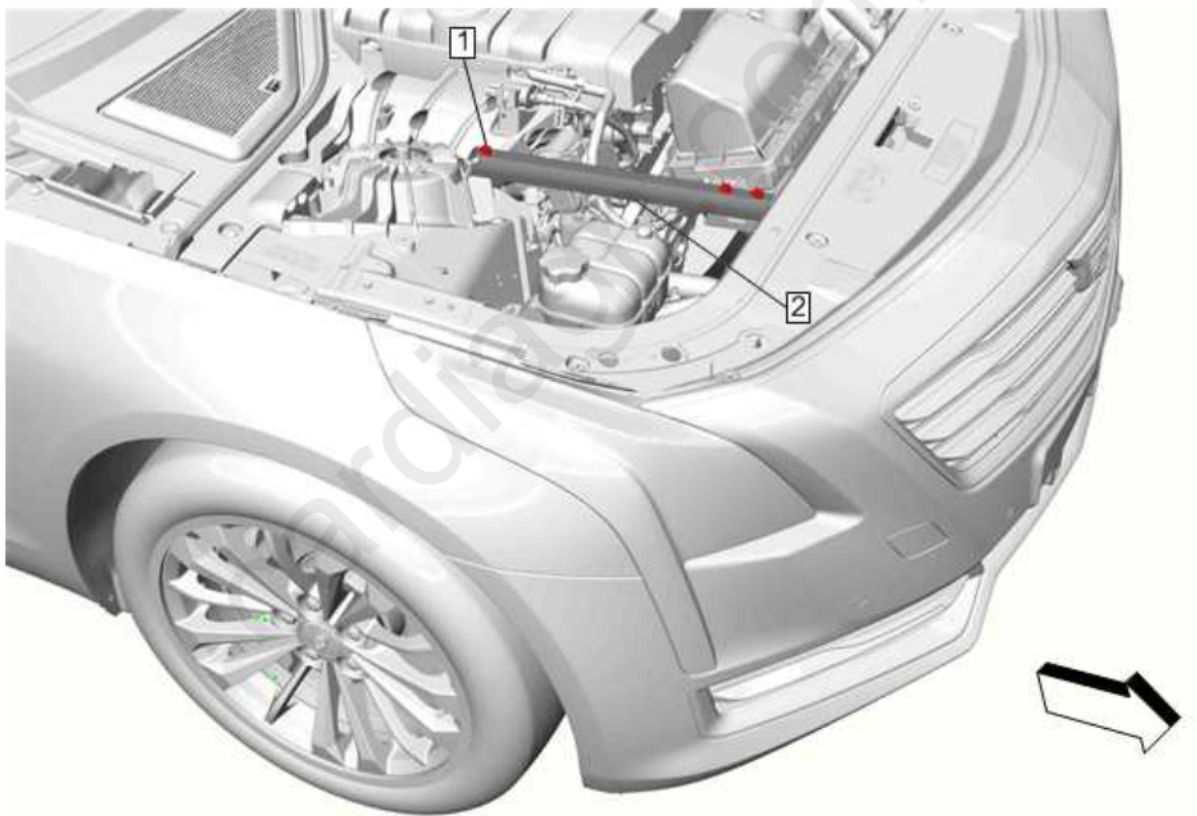


Fig. 230: Front Wheelhouse Panel Brace (Front)

Courtesy of GENERAL MOTORS COMPANY

10. Drive Belt (1)» Install - **Drive Belt Replacement (Except Hybrid)**

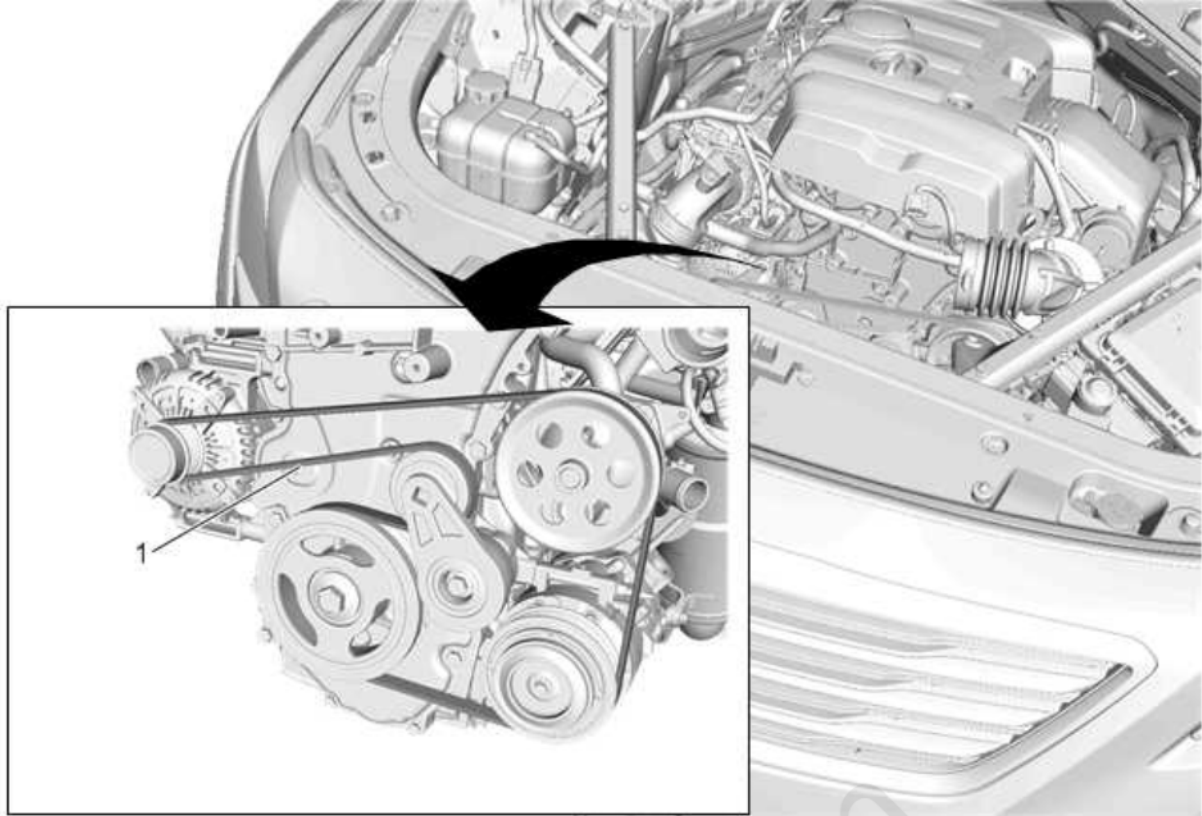


Fig. 231: Drive Belt

Courtesy of GENERAL MOTORS COMPANY

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

GENERATOR REPLACEMENT (LGW)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Fan and Generator Belt (1) » Remove - [Fan and Generator Belt Replacement](#)

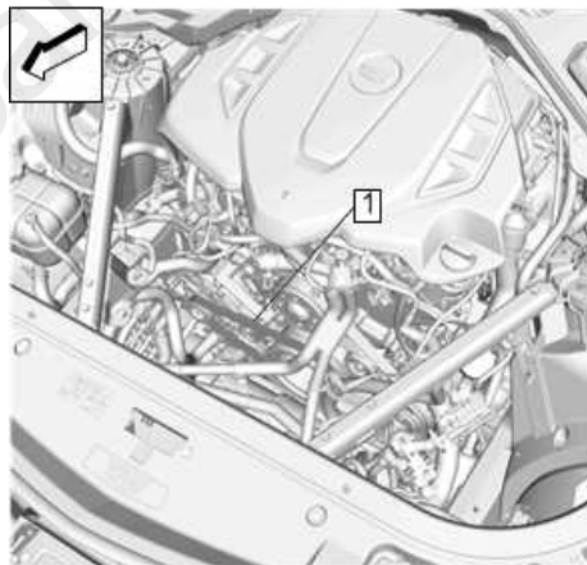


Fig. 232: Fan and Generator Belt

Courtesy of GENERAL MOTORS COMPANY

3. Heater Coolant Pump (1) » Remove - [Heater Coolant Pump Replacement \(LGW\)](#)

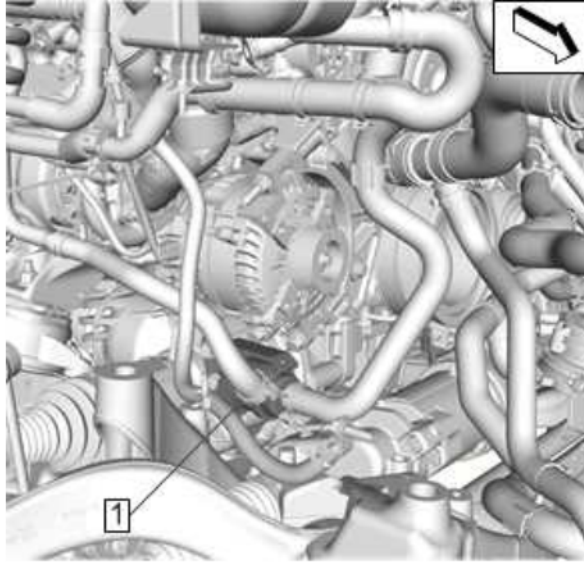


Fig. 233: Heater Coolant Pump

Courtesy of GENERAL MOTORS COMPANY

4. Radiator Inlet Hose (2) » Remove - **Radiator Inlet Hose Replacement (LGW)**

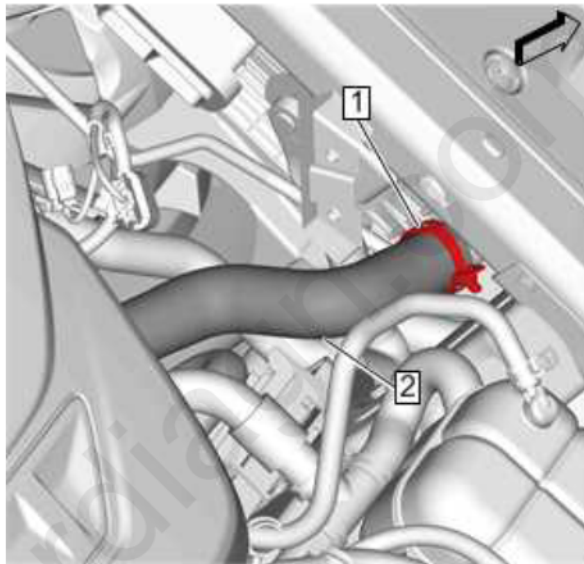


Fig. 234: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

5. Engine Front Splash Shield - Right Side (3) » Remove - **Engine Front Splash Shield Replacement - Right Side (Rear)** **Engine Front Splash Shield Replacement - Right Side (Front)**

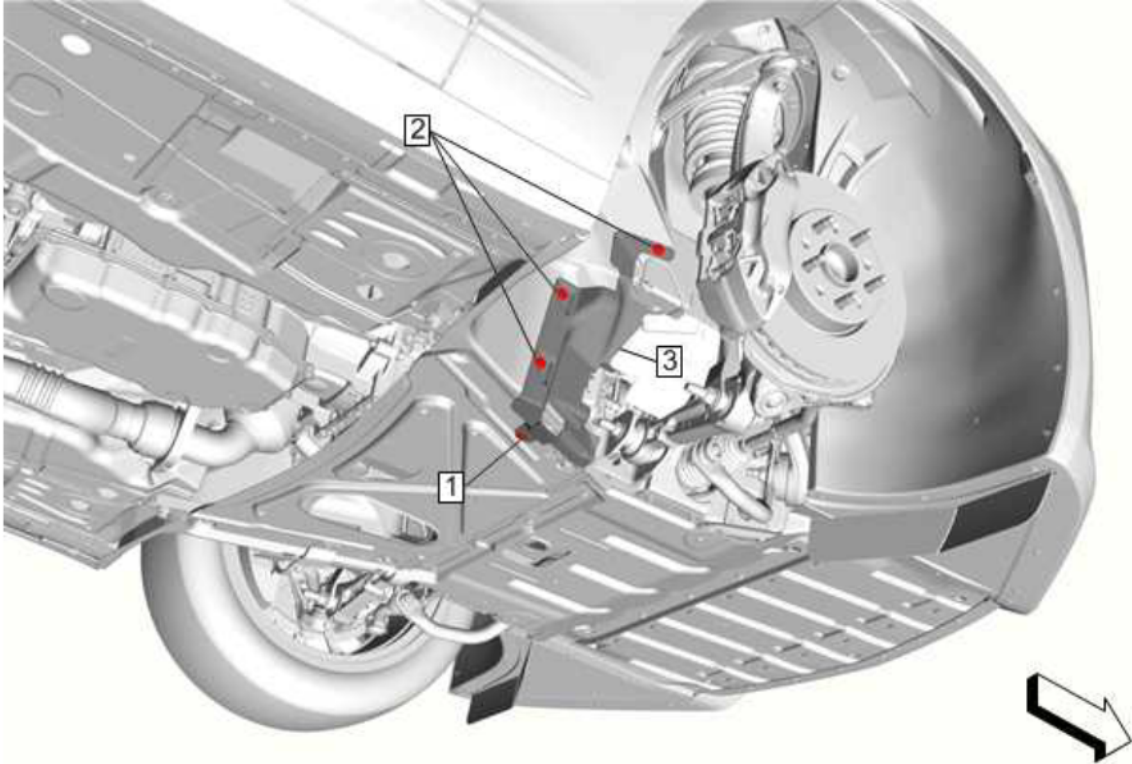


Fig. 235: Front Splash Shield

Courtesy of GENERAL MOTORS COMPANY

6. Generator Nut (1)» Remove

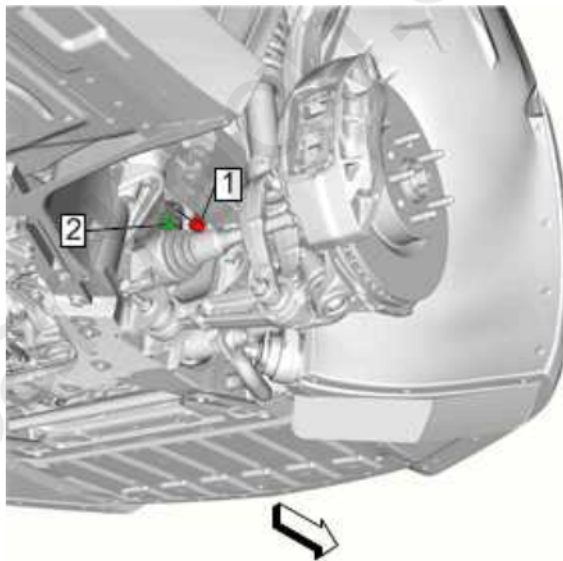


Fig. 236: Generator Battery Jumper Cable

Courtesy of GENERAL MOTORS COMPANY

7. Generator Battery Jumper Cable (2)» Remove
8. Electrical Connector (1)» Disconnect

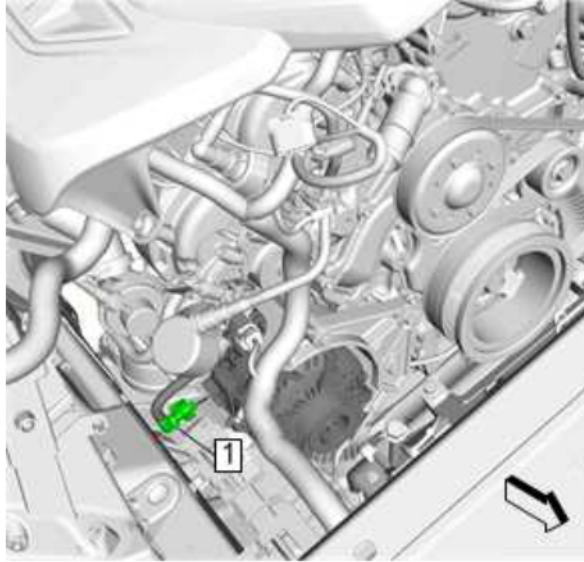


Fig. 237: Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

9. Generator Bolt (1)» Remove [2x]

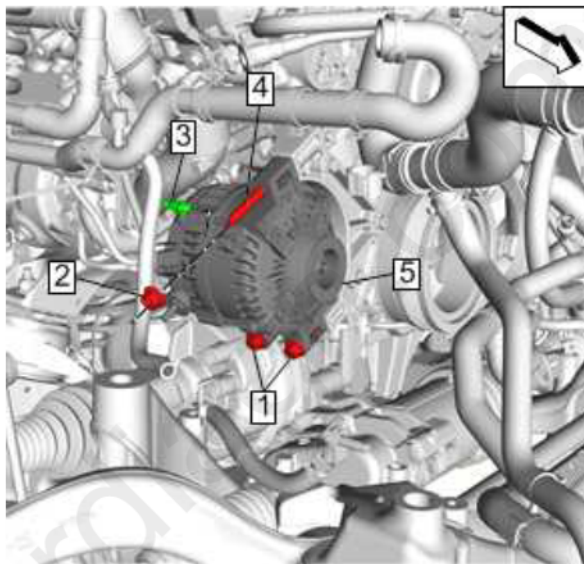


Fig. 238: Generator Bolt

Courtesy of GENERAL MOTORS COMPANY

10. Generator Mounting Nut (2)» Remove
11. Wiring Harness Retainer (3)» Disengage
12. Generator Mounting Stud (4)» Remove
13. Generator (5)» Remove

Installation Procedure

1. Generator (5)» Install

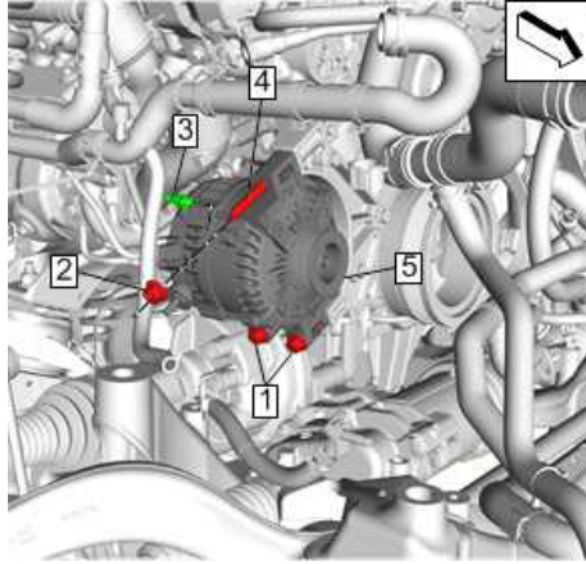


Fig. 239: Generator Bolt

Courtesy of GENERAL MOTORS COMPANY

2. Generator Mounting Bolt (1)» Install and tighten [2x] 58 N.m (43 lb ft)

CAUTION: Refer to **Fastener Caution**

3. Generator Mounting Stud (4)» Install and tighten 9 N.m (80 lb in)
4. Generator Mounting Nut (2)» Install and tighten 58 N.m (43 lb ft)
5. Wiring Harness Retainer (3)» Engage
6. Electrical Connector (1)» Connect

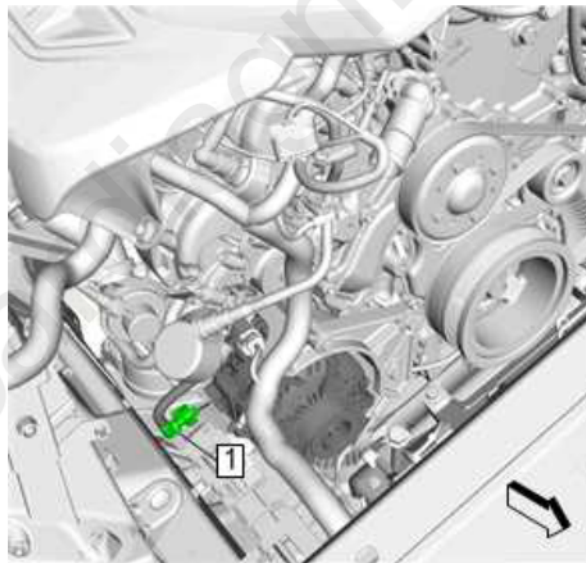


Fig. 240: Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

7. Generator Battery Jumper Cable (2)» Install

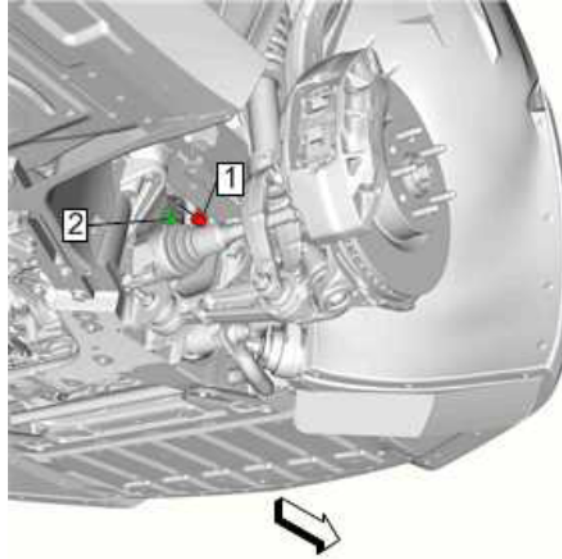


Fig. 241: Generator Battery Jumper Cable
 Courtesy of GENERAL MOTORS COMPANY

8. Generator Nut (1)» Install and tighten 15 N.m (11 lb ft)
9. Engine Front Splash Shield - Right Side (3)» Install - **Engine Front Splash Shield Replacement - Right Side (Rear) Engine Front Splash Shield Replacement - Right Side (Front)**

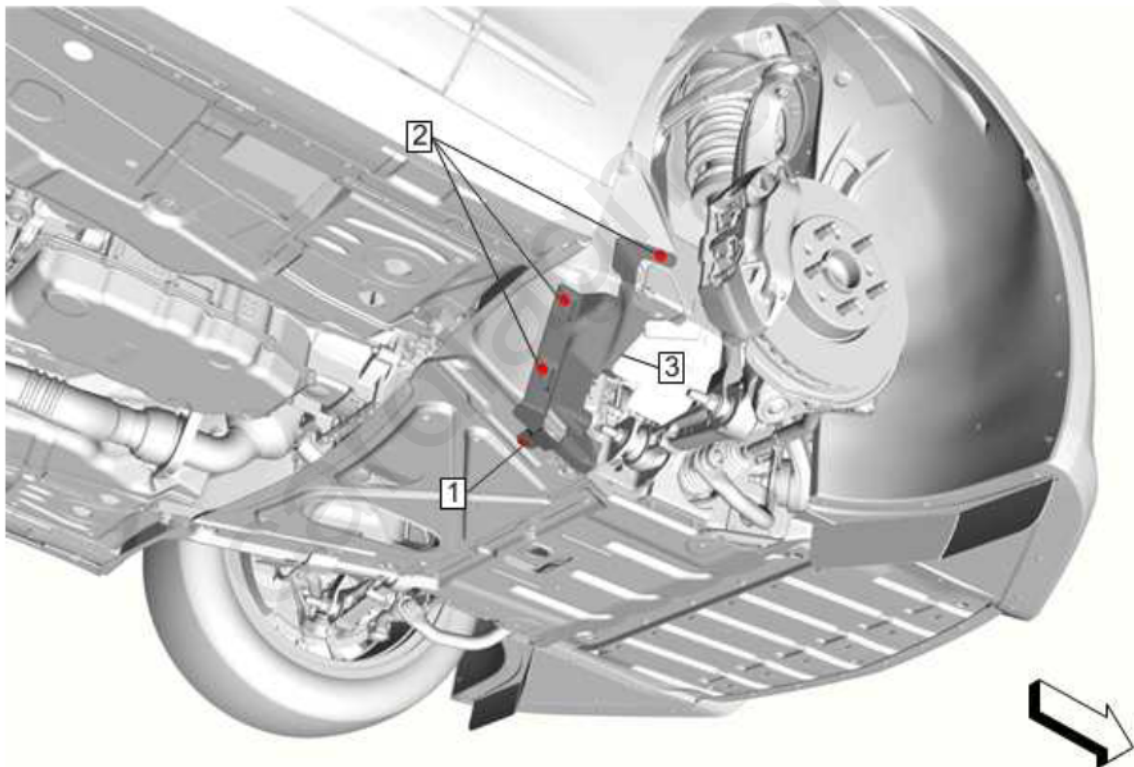


Fig. 242: Front Splash Shield
 Courtesy of GENERAL MOTORS COMPANY

10. Fan and Generator Belt (1)» Install - **Fan and Generator Belt Replacement**

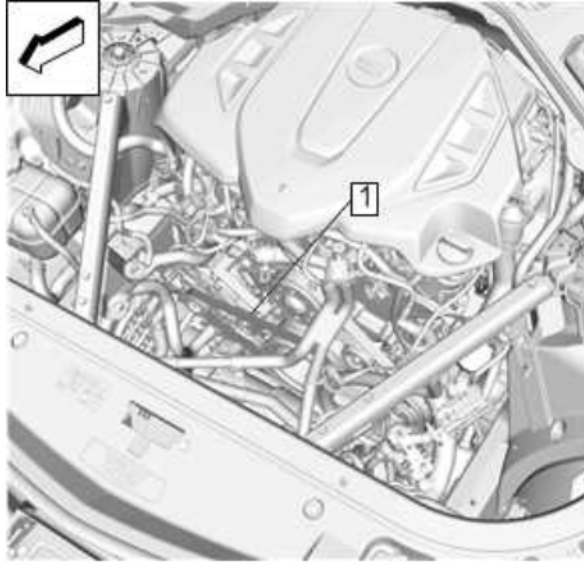


Fig. 243: Fan and Generator Belt

Courtesy of GENERAL MOTORS COMPANY

11. Heater Coolant Pump (1) » Install - [Heater Coolant Pump Replacement \(LGW\)](#)

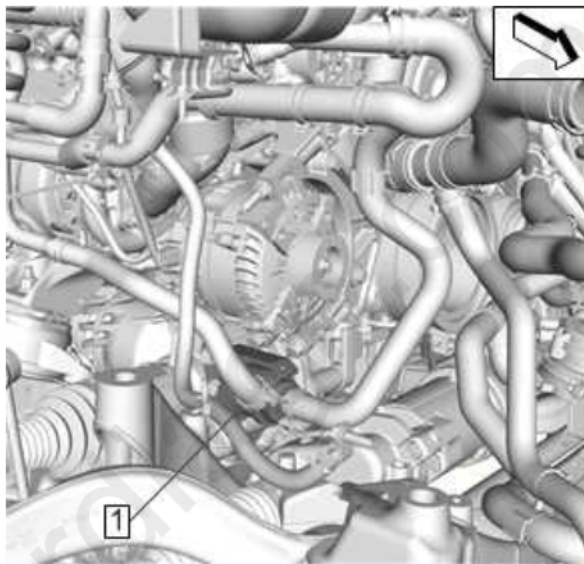


Fig. 244: Heater Coolant Pump

Courtesy of GENERAL MOTORS COMPANY

12. Radiator Inlet Hose (2) » Install - [Radiator Inlet Hose Replacement \(LGW\)](#)

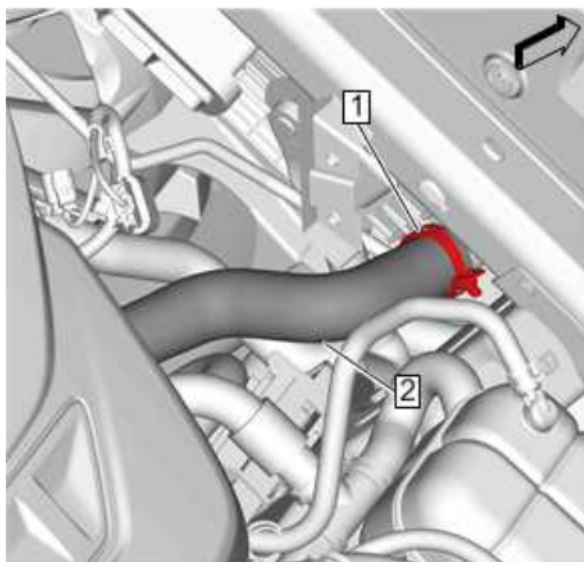


Fig. 245: Radiator Inlet Hose

Courtesy of GENERAL MOTORS COMPANY

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

GENERATOR REPLACEMENT (LGX)

Removal Procedure

1. Disconnect the negative battery cable. Refer to [Battery Negative Cable Disconnection and Connection](#)
2. Drive Belt (1)» Remove - [Drive Belt Replacement \(LGX\)](#)

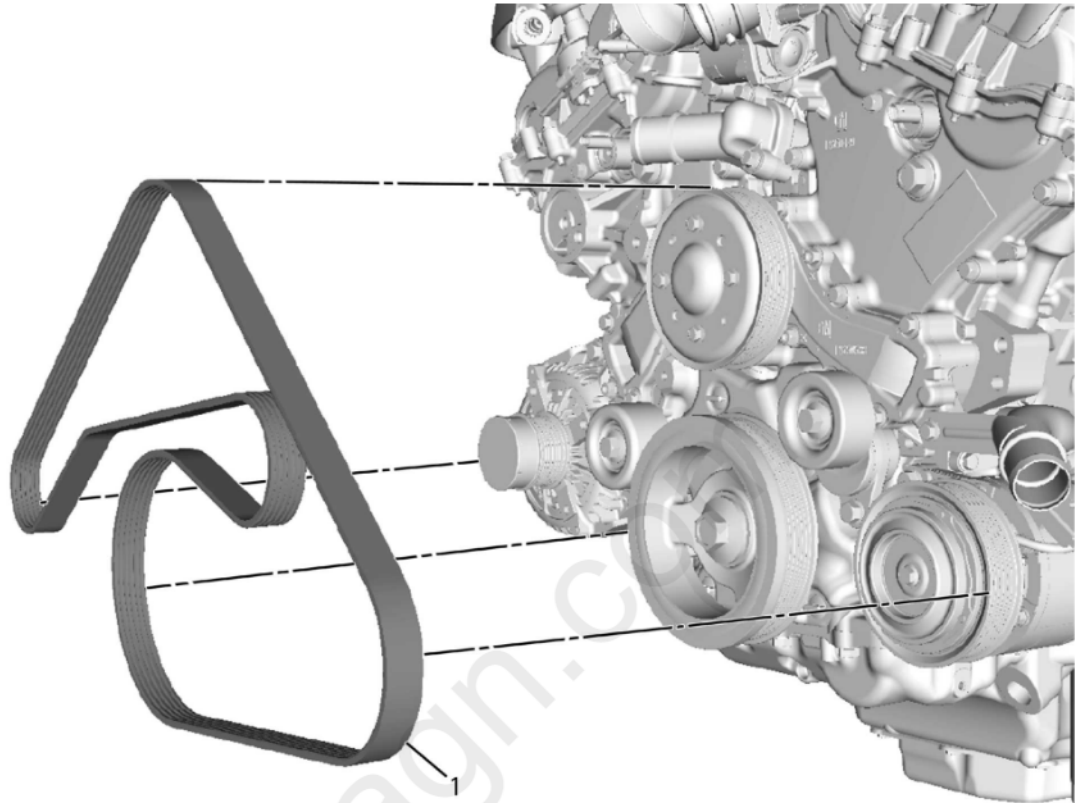


Fig. 246: Drive Belt (LGX)

Courtesy of GENERAL MOTORS COMPANY

3. Electrical Connector (1)» Disconnect

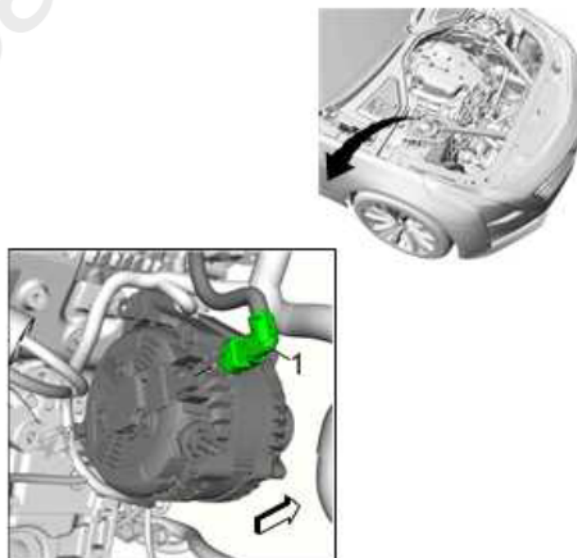


Fig. 247: Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

4. Generator Nut (1)» Remove

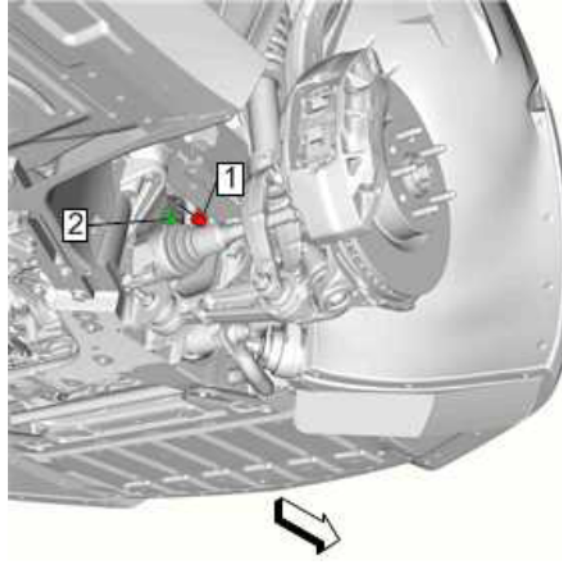


Fig. 248: Generator Battery Jumper Cable
Courtesy of GENERAL MOTORS COMPANY

5. Generator Battery Jumper Cable (2)» Remove
6. Generator Bolt (1)» Remove [2x]

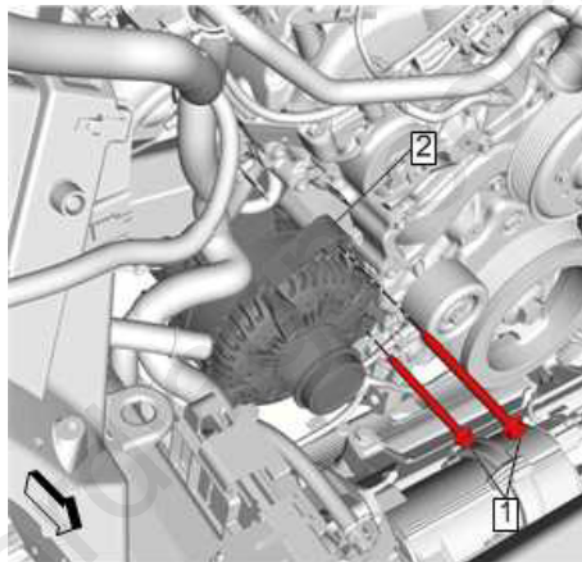


Fig. 249: Generator
Courtesy of GENERAL MOTORS COMPANY

7. Generator (2)» Remove

Installation Procedure

1. Generator (2)» Install

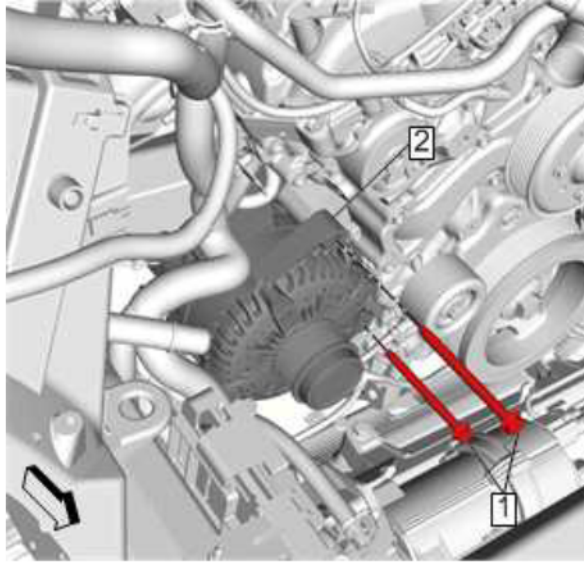


Fig. 250: Generator

Courtesy of GENERAL MOTORS COMPANY

2. Generator Mounting Bolt (1)» Install and tighten [2x] 22 N.m (16 lb ft)

CAUTION: Refer to **Fastener Caution**

3. Generator Battery Jumper Cable (2)» Install

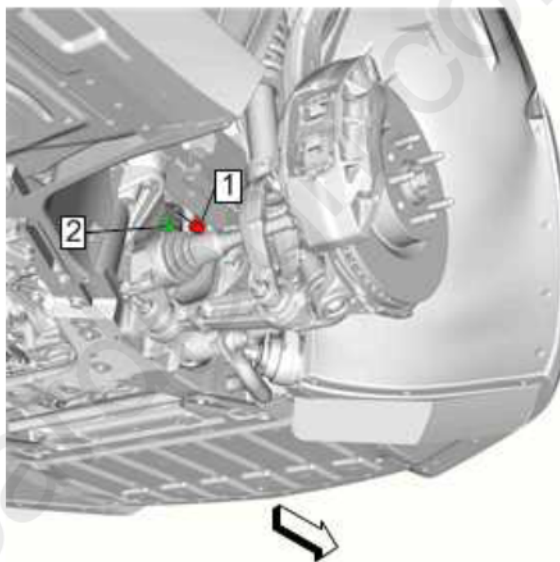


Fig. 251: Generator Battery Jumper Cable

Courtesy of GENERAL MOTORS COMPANY

4. Generator Nut (1)» Install and tighten 15 N.m (11 lb ft)
5. Electrical Connector (1)» Connect

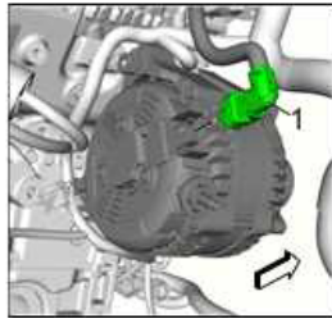


Fig. 252: Electrical Connector

Courtesy of GENERAL MOTORS COMPANY

6. Drive Belt (1) » Install - **Drive Belt Replacement (LGX)**

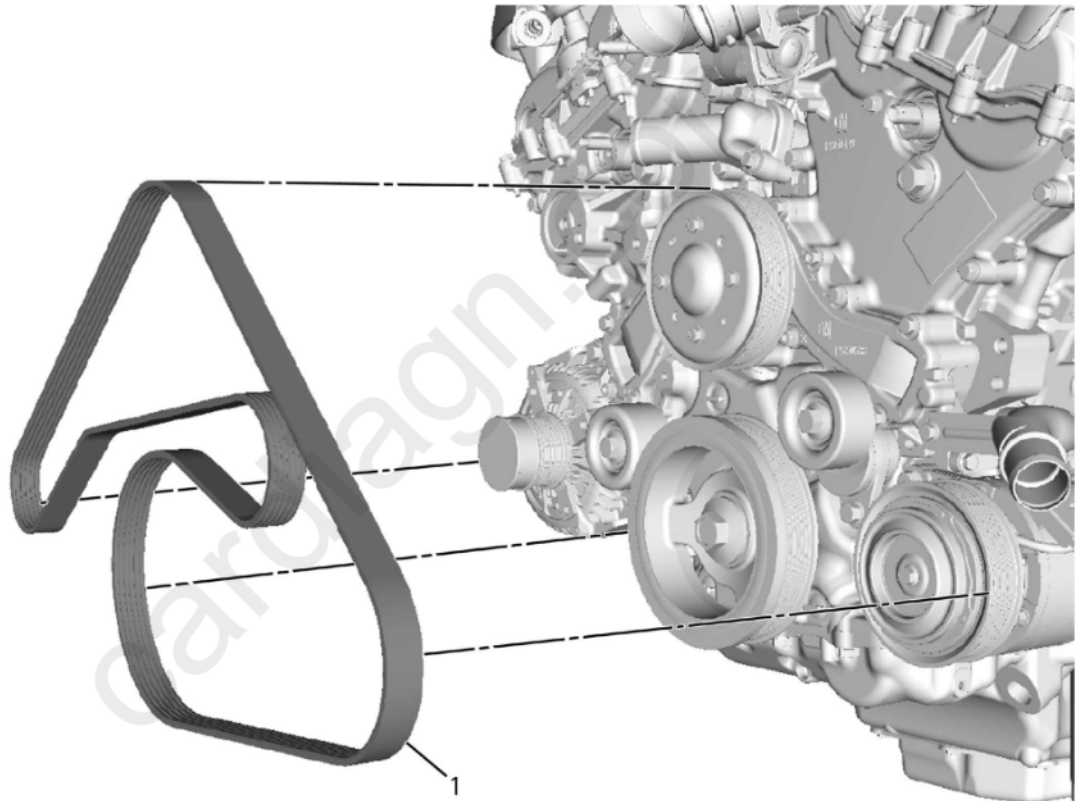


Fig. 253: Drive Belt (LGX)

Courtesy of GENERAL MOTORS COMPANY

7. Connect the negative battery cable. Refer to **Battery Negative Cable Disconnection and Connection**

DESCRIPTION AND OPERATION

BATTERY DESCRIPTION AND OPERATION

WARNING:

Batteries produce explosive gases, contain corrosive acid and supply levels of electrical current high enough to cause burns. Therefore, to reduce the risk of personal injury when working near a battery:

- Always shield your eyes and avoid leaning over the battery whenever possible.
- Do not expose the battery to open flames or sparks.

- Do not allow the battery electrolyte to contact the eyes or the skin. Flush immediately and thoroughly any contacted areas with water and get medical help.
- Follow each step of the jump starting procedure in order.
- Treat both the booster and the discharged batteries carefully when using the jumper cables.

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

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

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

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

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

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

Battery Low Start Vehicle Message

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

Battery Ratings

A battery has 2 ratings:

- Cold cranking amperage
- Amperage hours

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

Amperage Hours

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

Cold Cranking Amperage

The cold cranking amperage is an indication of the ability of the battery to crank the engine at cold temperatures. The cold cranking amperage rating is the minimum amperage the battery must maintain for 30 seconds at -18°C (0°F) while maintaining at least 7.2 V. See battery label for the cold cranking amperage rating of this battery.

Electrical Power Management Overview

The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

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

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

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

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

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

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

Charging System Components

Generator

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

Body Control Module (BCM)

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

Battery Current Sensor (If applicable)

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

Battery Sensor Module (If applicable)

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

Engine Control Module (ECM)

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

Instrument Panel Cluster

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

Charging System Block Diagram

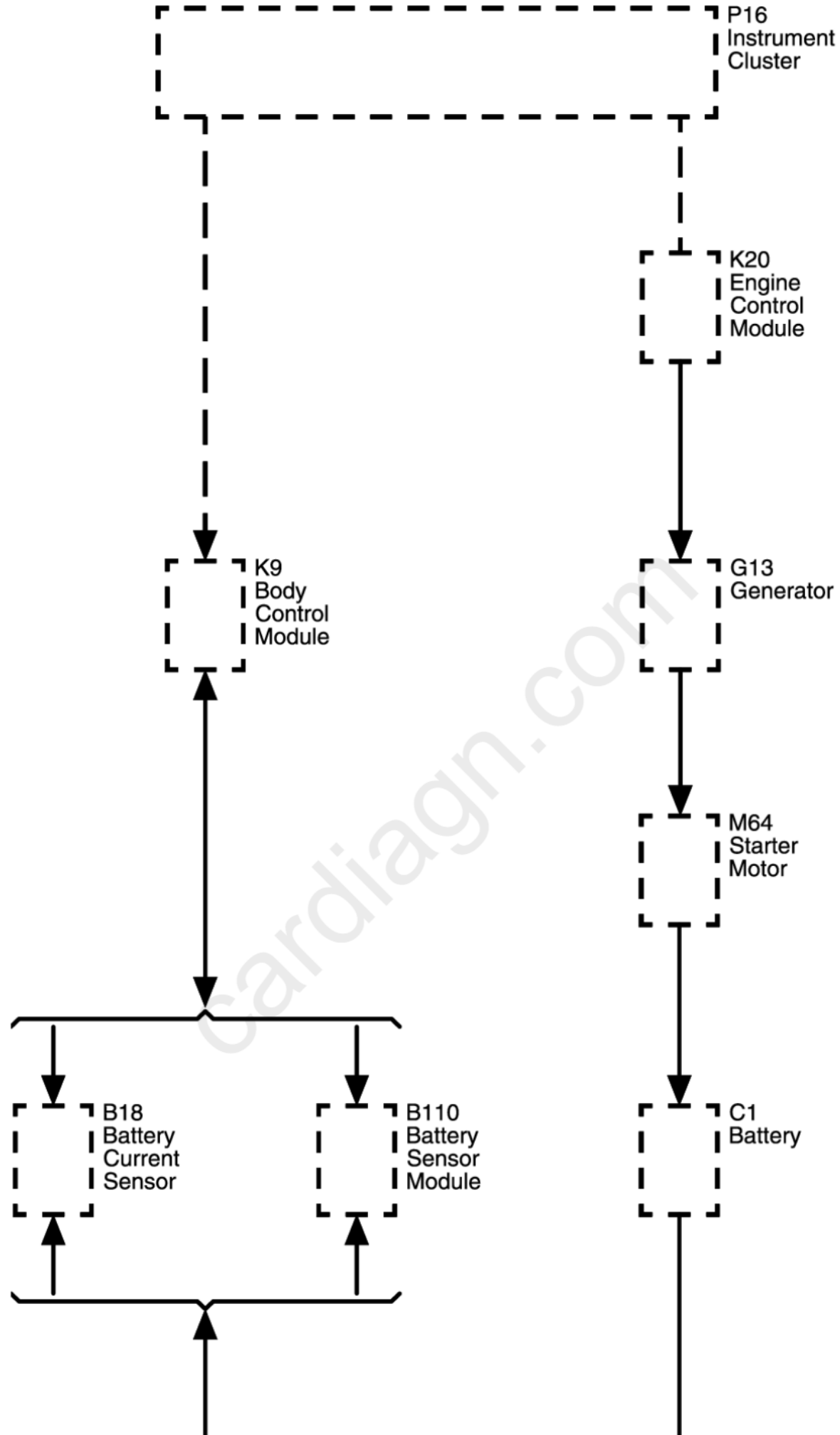


Fig. 254: Charging System Block Diagram

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
P16	P16 Instrument Cluster

Callout	Component Name
K20	K20 Engine Control Module
G13	G13 Generator
M64	M64 Starter Motor
C1	C1 Battery
B18	B18 Battery Current Sensor
K9	K9 Body Control Module
B110	B110 Battery Sensor Module

Charging System Operation

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

- Battery Sulfation Mode
- Charge Mode
- Fuel Economy Mode
- Head lamp Mode
- Start Up Mode
- Voltage Reduction Mode

The engine control module (ECM) controls the generator through the generator turn ON signal circuit. The ECM monitors the generator performance 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

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

- The wipers are ON for more than 3 seconds.
- GMLAN (Climate Control Voltage Boost Mode Request) is true, as sensed by the HVAC control head. High speed cooling fan, rear defogger and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0Å,Å°C (32Å,Å°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 (If applicable)

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

Instrument Panel Cluster Operation

Charge Indicator Operation

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

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

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

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

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

Electrical Power Management

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

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

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

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

Electrical Power Management Block Diagram

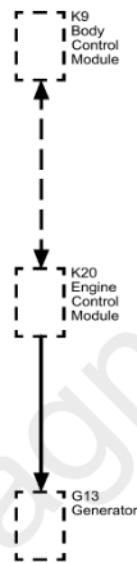


Fig. 255: Electrical Power Management Block Diagram

Courtesy of GENERAL MOTORS COMPANY

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

Idle Boost and Load Shed With Current Sensor

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -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

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 End	Greater Than -10 $\hat{\text{A}}$, $\hat{\text{A}}$ °C (14 $\hat{\text{A}}$, $\hat{\text{A}}$ °F)	Greater Than 12 V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 11 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12 V	Battery has a net loss of less than 2 Ah	Clear Load Shed 1
Idle Boost 3 Start	-	-	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 11 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	-	-	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
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 -15Å, Å°C (5Å, Å°F)	Less Than 13 V	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 12.6 V	First level Idle boost requested
Idle Boost 1 End	Greater Than -15Å, Å°C (5Å, Å°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

Function	Battery Temperature Calculation	Battery Voltage Calculation	Action Taken
Load Shed 2 Start	-	Less Than 12.1 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.2 V	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.0 V	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

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

As soon as the solenoid switch contacts close, current stops flowing thorough the pull-in winding because battery voltage is applied to both ends of the windings. The hold-in winding remains energized. Its magnetic field is strong enough to hold the plunger, shift lever, starter drive assembly and solenoid switch contacts in place to continue cranking the engine. When the engine starts, pinion overrun protects the armature from excessive speed until the switch is opened.

When the ignition switch is released from the START position, the START relay opens and battery voltage is removed from the starter solenoid S terminal. Current flows from the motor contacts through both windings to the ground at the end of the hold-in winding. However, the direction of the current flow through the pull-in winding is now opposite the direction of the current flow when the winding was first energized.

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

Circuit Description (Key Start)

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

With KL9

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

Starting System Block Diagram

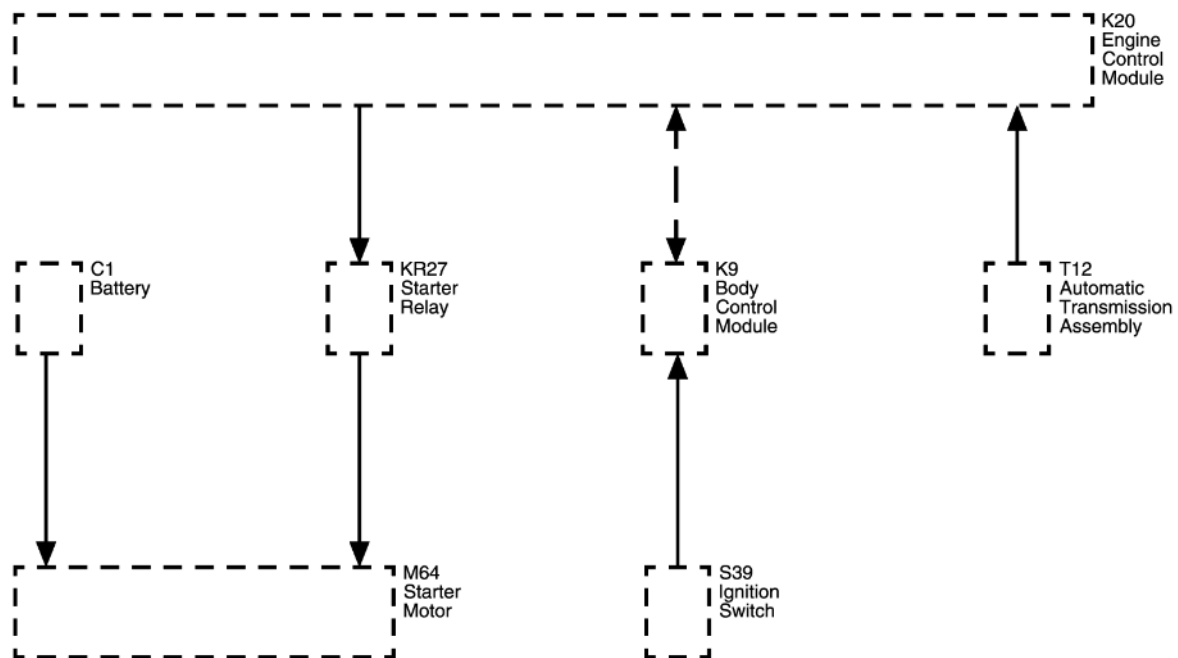


Fig. 256: Starting System Block Diagram

Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
K20	K20 Engine Control Module
C1	C1 Battery
KR27	KR27 Starter Relay
K9	K9 Body Control Module
T12	T12 Automatic Transmission Assembly
M64	M64 Starter Motor
S39	S39 Ignition Switch

STOP/START SYSTEM DESCRIPTION AND OPERATION

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

As soon as the driver prepares to move away (by releasing the brake pedal and/or depressing the accelerator pedal), the engine will start; it only takes the system around 0.3 s to start the engine.

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

Along with the upgraded starter motor, advanced battery technology is required to ensure the vehicles battery can handle the frequent charge and discharge cycles common with stop/start operation. There is battery sensor module connected to the battery which continually monitors the battery charge and healthy state. The engine control module (ECM) uses this information from the battery sensor module to determine if the battery charge and health is sufficient for an Stop/Start condition.

The Stop/Start system can reduce fuel consumption and carbon dioxide (CO₂) emissions by up to 5% in mixed driving conditions. In an urban environment and in heavy traffic with frequent stops the savings may increase to as much as 10%.

There are also sophisticated controls in place to help ensure the Stop/Start System does not compromise the needs of either the driver or vehicle. For the engine to shutdown, the vehicle must be below 5 km/h (3 MPH), the selector lever in position D and brake pedal depressed. To restart, the driver simply releases the brake pedal and the enhanced starter motor engages the engine. When the engine has been shut down by the Stop/Start System, a control indicator will be illuminated in the Driver Information Center (DIC). When the engine is restarted, the control indicator in the DIC extinguishes.

To ensure neither the needs of the driver or vehicle are compromised the engine will not shut down in the following circumstances:

- Ambient and coolant temperature correlation does not match specified values.
- Ambient temperature is less than -10°C (14°F)
- Battery temperature is less than 0°C (32°F) or greater than 55°C (131°F)
- Driver seat belt is not fastened and the drivers door is not fully closed (not applicable to vehicles in North America)
- HVAC system demand is high
- HVAC defrost has been selected
- Battery charge is low

Likewise the engine will automatically restart if:

- Driver door opened and driver seat belt unbuckled (not applicable to vehicles in North America)
- Engine hood opened
- Battery charge is low
- HVAC demand increases
- Vehicle speed increases
- Brake booster vacuum has been reduced
- Engine coolant temperature is greater than 125°C (257°F)
- Economy mode turned OFF by driver
- Autostop time exceeded 2 min

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

Autostop Criteria

The ECM will send an Autostop state message to the body control module (BCM) and shut down the engine when all of the following criteria is met. The BCM will transmit the Autostop state message to the instrument cluster which will display the Autostop indicator in the tachometer display.

- Initial minimum vehicle speed during drive cycle must be 19 km/h (12 MPH) or greater. Subsequent autostop minimum speed may vary from 2-10 km/h (1-6 MPH), depending on vehicle
- Ambient and engine coolant temperature correlation meets specified values.
- Ambient and transmission fluid temperature correlation meets specified values.
- Hood switch status is closed
- Brake booster vacuum is greater than 45 kPa (7 PSI)
- Transmission gear selector is in the Drive position
- Vehicle speed is less than 5 km/h (3 MPH)
- Engine speed is below 1, 500 RPM
- Engine coolant temperature is less than 120°C (248°F)
- Ambient temperature is greater than -10°C (14°F)
- No A/C compressor request from HVAC (A/C or Defrost modes)
- Battery voltage greater than 12 V
- Battery state of charge greater than 75% (changes with state of health)

Autostop Enable Ambient and Engine Coolant Temperature Table

Ambient Temperature	Minimum Coolant Temperature	Autostop Enable

Ambient Temperature	Minimum Coolant Temperature	Autostop Enable
-10Å, Å°C (14Å, Å°F)	60Å, Å°C (140Å, Å°F)	Yes
0Å, Å°C (32Å, Å°F)	50Å, Å°C (122Å, Å°F)	Yes
6Å, Å°C (43Å, Å°F)	40Å, Å°C (104Å, Å°F)	Yes
12Å, Å°C (54Å, Å°F)	30Å, Å°C (86Å, Å°F)	Yes
20Å, Å°C (68Å, Å°F)	18Å, Å°C (64Å, Å°F)	Yes
30Å, Å°C (86Å, Å°F)	18Å, Å°C (64Å, Å°F)	Yes

Autostart Criteria

The ECM will send an Autostart state message to the BCM. If all of the following conditions are true the ECM and BCM will restart the vehicle.

Driver Enabled Conditions that will engage Autostart:

- Driver removes pressure from the brake or depresses the accelerator pedal while the vehicle is in the forward Drive gear

System Enabled Conditions that will engage Autostart

NOTE: If one or more of the following conditions occur, the system will force the engine to restart.

- Brake booster vacuum is less than 40 kPa (6 PSI)
- A/C compressor request from HVAC (A/C or Defrost modes)
- Battery voltage less than 11 V,
- Battery state of charge is less than 73% (changes with state of health)
- Driver door status changes to open and driver seat belt status changes to unbuckled (not applicable to vehicles in North America)
- Hood switch status changes to open
- Autostop time exceeded 2 min

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

System Components

Engine Control Module (ECM)

The engine control module (ECM) monitors the inputs from the engine coolant temperature (ECT) sensor, vehicle speed sensor (VSS), hood ajar switch, brake booster vacuum sensor, the clutch pedal position sensor, the manual transmission neutral position switch and engine speed to determine Autostart and Autostop conditions. The ECM also controls the auxiliary coolant pump motor.

Transmission Control Module (TCM)

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

Engine Coolant Temperature sensor

The ECT sensor is used to determine engine operating temperature.

Intake Air Temperature Sensor

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

Inside air temperature sensor

The HVAC control module monitors the passenger compartment temperature sensor to determine the temperature inside the passenger compartment. The HVAC control module sends this temperature

reading to the ECM on the data communication circuit. The ECM uses this temperature values to determine if a restart is required based on the temperature inside the passenger compartment.

Vehicle speed sensor

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

Hood Ajar Switch

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

Brake Booster Vacuum Sensor

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

Brake Pedal Position Sensor & Accelerator Pedal Position Sensor

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

Transmission Gear Shift Position Switch

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

Coolant Pump Motor

The ECM will turn on the auxiliary coolant pump motor during Autostop to maintain engine operating temperature and also maintain HVAC temperature. Once the engine is running, the ECM will turn off the coolant pump motor.

Body Control Module (BCM)

The body control module (BCM) is the master of the low speed communication bus and transfers the appropriate messages to the instrument cluster and the HVAC.

Battery Sensor Module

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

Auto Stop Mode Switch

The stop/start function can be disabled using the switch to the left of the infotainment display. The indicator on the switch will illuminate when the engine starts. The driver can toggle between On/Off stop/start mode. Stop/Start mode is enabled at every ignition cycle.

Power Supply Transformer

The DC to DC converter monitors battery voltage and will maintain operating voltage to the radio, instrument cluster and instrument panel displays. The DC to DC converter will provide a boosted

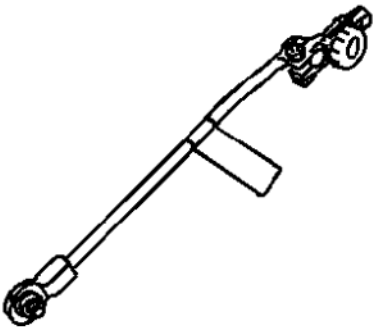
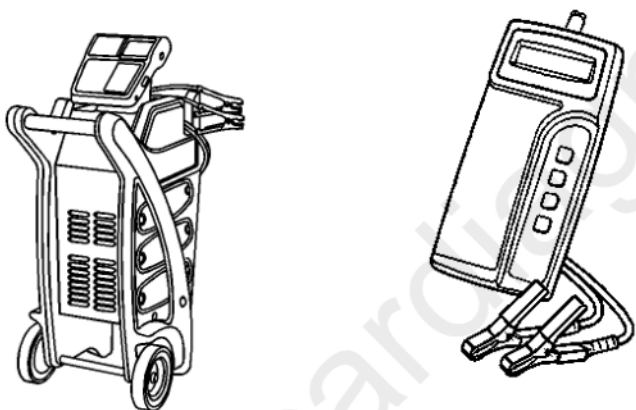
voltage to sensitive loads during Autostart to ensure proper operation of the driver informational displays.

Instrument Cluster

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

SPECIAL TOOLS AND EQUIPMENT

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