

2018 ELECTRICAL

12 V Starting And Charging - Traverse

SPECIFICATIONS

FASTENER SPECIFICATIONS

Reusable Threaded Fastener Tightening Specifications

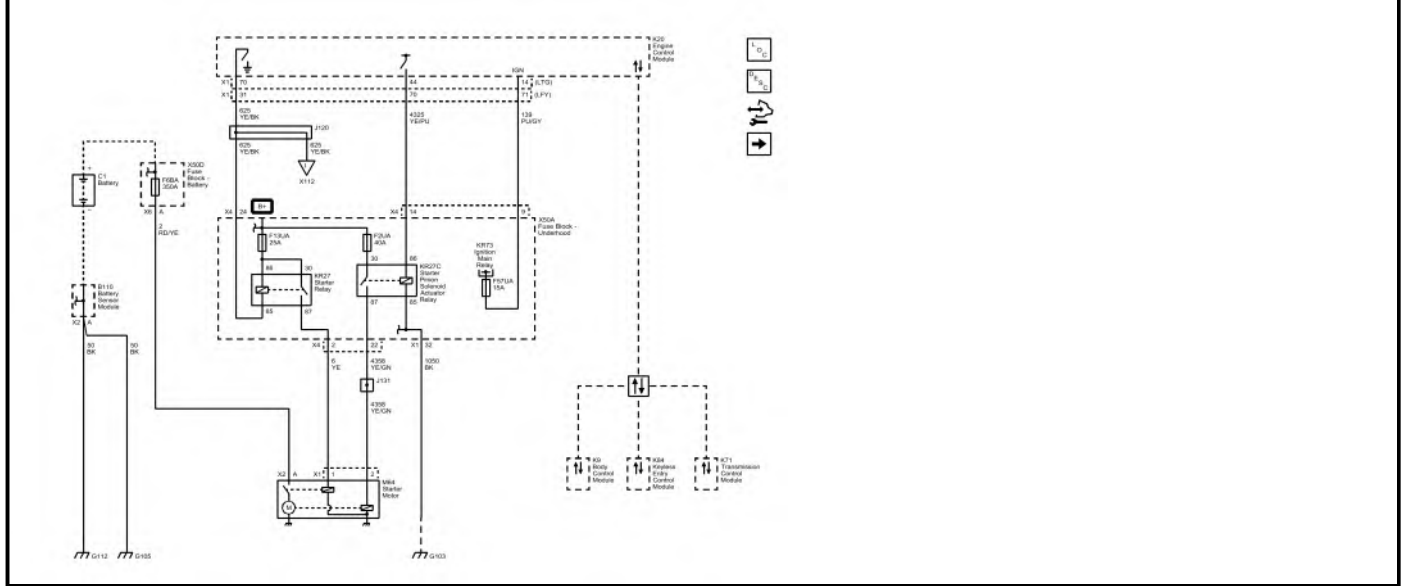
NOTE: <i>All fasteners listed in this table can be reused after removal.</i>	
Application	Specification
	Metric (English)
Battery Hold Down Bolt	22 N.m (16 lb ft)
Battery Hold Down Retainer Bolt	9 N.m (80 lb in)
Battery Negative Cable Bolt @ Transfer Case (LFY)	22 N.m (16 lb ft)
Battery Negative Cable Ground Bolt (LTG)	22 N.m (16 lb ft)
Battery Negative Cable Ground Nut @ Front Wheel Well Extension (LFY, LTG)	9 N.m (80 lb in)
Battery Negative Cable Nut @ Battery Sensor	11 N.m (97 lb in)
Battery Negative Post Clamp Nut	4.5 N.m (40 lb in)
Battery Positive and Negative Cable Conduit Bolt (LFY)	9 N.m (80 lb in)
Battery Positive Cable Nut @ Generator (LTG)	15 N.m (11 lb ft)
Battery Positive Cable Nut @ Starter Solenoid (LFY, LTG)	12.5 N.m (111 lb in)
Battery Positive Post Clamp Nut	9 N.m (80 lb in)
Battery Tray Mounting Bolt	22 N.m (16 lb ft)
Engine Wiring Harness Junction Block Nut	16 N.m (12 lb ft)
Fuse Block Wiring Harness Terminal Nut (m6)	9 N.m (80 lb in)
Fuse Block Wiring Harness Terminal Nut (m8)	16 N.m (12 lb ft)
Generator Bolt (LTG)	22 N.m (16 lb ft)
Generator Fastener (LFY)	15 N.m (11 lb ft)
Generator Mounting Nut (LFY)	58 N.m (43 lb ft)
Generator Mounting Stud (LFY, LTG)	9 N.m (80 lb in)
Generator Nut (LTG)	22 N.m (16 lb ft)
Â	Â
Starter Heat Shield Fastener (LFY)	9 N.m (80 lb in)
Starter Mounting Bolt (LFY)	58 N.m (43 lb ft)
Starter Mounting Bolt (LTG)	22 N.m (16 lb ft)

SCHEMATIC WIRING DIAGRAMS

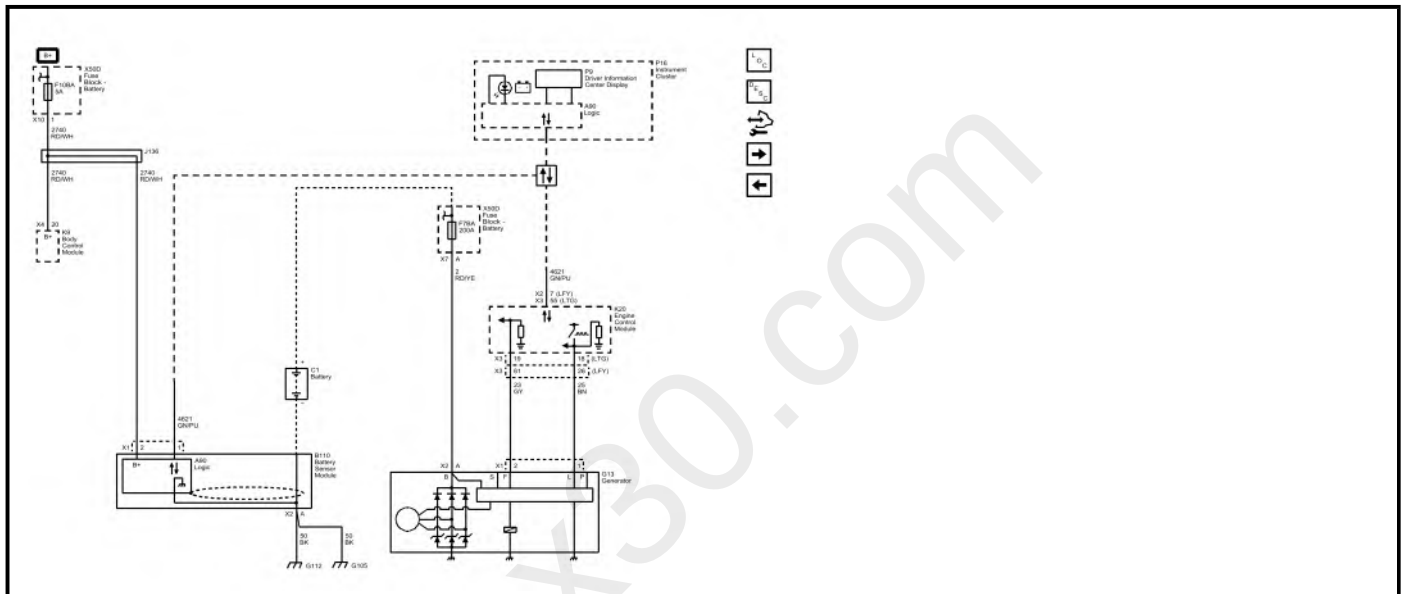
STARTING AND CHARGING WIRING SCHEMATICS

Starting

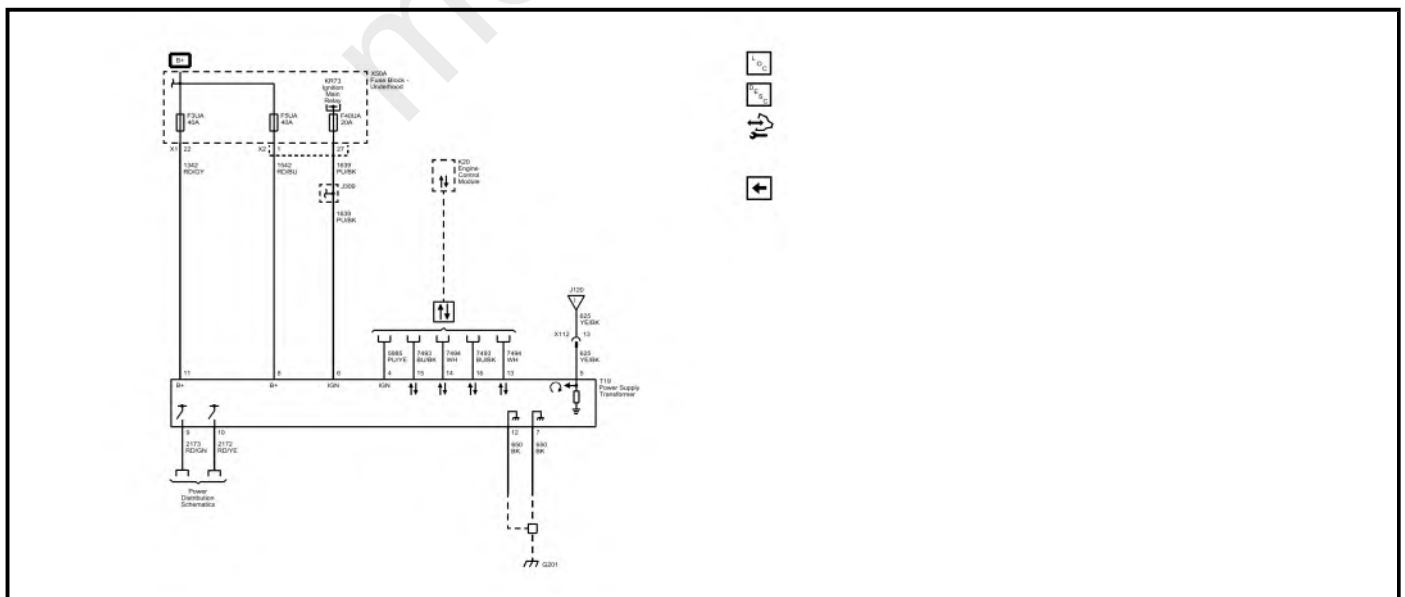




Charging



Stop/Start System



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, C1300, P0560, P0561, P0562, P0563, P0611, P1002, P129B, P129C, P1465, P1466, P15AE, P15AF, P17B0, P17B1, P17B2, P17DD, P17DE, P17DF, P1A0C, P1A0D, P1E19, P1E1A, OR U2800

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

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 C1300

Power Transfer Unit Supply Circuit

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 P1002

Fuel Pump Driver Control Module System Voltage Performance

DTC P129B

Fuel Pump Driver Control Module System Voltage Low Voltage

DTC P129C

Fuel Pump Driver Control Module System Voltage High Voltage

DTC P1465

Reductant Control Module System Voltage Low

DTC P1466

Reductant Control Module 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

Transmission Range Control Module System Voltage Low

DTC P17B1

Transmission Range Control Module System Voltage Performance

DTC P17B2

Transmission Range Control Module System High Voltage

DTC P17DD

Transmission Range Control Module System Voltage Low

DTC P17DE

Transmission Range Control Module System Voltage Performance

DTC P17DF

Transmission Range Control Module System High Voltage

DTC P1A0C

Battery Energy Control Module System Voltage Low Voltage

DTC P1A0D

Battery Energy Control Module System Voltage High Voltage

DTC P1E1A

Auxiliary Transmission Fluid Pump Control Module System Voltage High Voltage

DTC P1E19

Auxiliary Transmission Fluid Pump Control Module System Voltage Low Voltage

DTC U2800

Control Module Current Not Plausible

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.
 - **Go to next step: 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.
 - **Go to next step: 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

- **Go to next step: 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

- **Go to next step: 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.

- **Go to next step: 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.

- **Go to next step: 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.
- **Go to next step: 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

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

Battery Capacity Performance

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

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 Wiring Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

Description and Operation

[Charging System Description and Operation](#)

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

DTC B1527

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

Parasitic Load

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

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 Wiring Schematics](#)

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Charging System Description and Operation

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

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

DTC P0561

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

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 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](#).
 - **Go to next step: 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.
 - **Go to next step: 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.
 - **Go to next step: 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.
 - **Go to next step: 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.
 - **Go to next step: 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.
 - **Go to next step: 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

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 Motor Relay Control Circuit

DTC P0616

Starter Motor Relay Control Circuit Low Voltage

DTC P0617

Starter Motor Relay Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Relay Switch B+ Terminal 30	1	2	-	-
Relay Coil Control Terminal 85	P0616	P0615	P0617	-
Relay Switch Control Terminal 87	2	2	3	-
Relay Switch B+ Terminal 86	1	2	-	-
1. Opens fuse, Starter Solenoid does not click. 2. Starter Solenoid does not click. 3. Cranks all the time.				

Circuit/System Description

When the ignition is activated to start the vehicle, a discrete signal is supplied to the body control module (BCM). The BCM then sends a message to the engine control module (ECM) that crank has been requested. The ECM then verifies that the clutch pedal is pressed or the transmission is in park/neutral. If it is, the ECM then supplies 12 V to the control circuit of the 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 Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

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 \(Within an Electrical Center\)](#)

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 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.
 - Go to next step: If infinite resistance,
 3. Disconnect the 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.
 - **Go to next step: If the test lamp illuminates**
3. Ignition ON.
4. Verify a test lamp illuminates between the B+ circuit terminal 86 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Ignition OFF, remove the test lamp.
 2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , refer to [Power Mode Mismatch](#)
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Ignition OFF, remove the test lamp.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance,
 3. Connect the KR27 Starter Relay.
 4. Verify the fuse does not open when connecting or working the KR27 Starter Relay.
 - If the fuse opens, replace the KR27 Starter Relay

- Go to next step: If the fuse is OK

5. All OK

- **Go to next step: If the test lamp illuminates**

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

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

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

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module and disconnect the harness connector at 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.
- Go to next step: 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, 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
- Go to next step: If infinite resistance

3. Reconnect the K20 Engine Control Module

4. Test for infinite resistance between control circuit and ground.

- If less than infinite resistance, replace the K20 Engine Control Module.
- If infinite resistance, replace the T19 Power Supply Transformer

- **Go to next step: If the test lamp turns ON and OFF**

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

8. Verify the M64 Starter Motor is activated.

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

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

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

- If less than infinite resistance, repair the short to ground on the circuit.
- Go to next step: 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.

- **Go to next step: If the M64 Starter Motor activates**

9. 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.

- **Go to next step: 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.

- **Go to next step: 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.

- **Go to next step: 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

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

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

Diagnostic Fault Information

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

Circuit/System Description

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

Conditions for Running the DTC

- Ignition ON, engine OFF (Prior to Ignition ON, the ignition must have been OFF for at least 5 s).
- The engine is running for the run test.

Conditions for Setting the DTC

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

Action Taken When the DTC Sets

DTC P0621 is a type C DTC.

Conditions for Clearing the DTC

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

Reference Information

Schematic Reference

Starting and Charging Wiring 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](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

Circuit/System Verification

1. Operate the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions that you observed from the Freeze Frame/Failure Records data.
2. Verify the DTC does not set.
 - **If the DTC sets**
 1. Verify the scantool parameter Generator L-Terminal Signal = 5-95%
 - **Go to next step: If the expected value**
 2. Disconnect the connector X1 while engine running
 - **If not the expected value**
3. Verify the scantool parameter Generator L-Terminal Signal = between 89 and 92%

- **If not the expected value**

4. Refer to Circuit/System Testing.

- **Go to next step: If the DTC does not set**

5. All OK.

Circuit/System Testing

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X1, A X2, B X2, 1 X1 or 1 X2 and ground.

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

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

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

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

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

1. Remove the test lamp, disconnect the 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.

- **Go to next step: If the test lamp illuminates**

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

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

- **If less than 1 V**

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

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

- If less than infinite resistance, repair the short to ground on the circuit.
- Go to next step: If infinite resistance

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

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

- **Go to next step: If 1 V or greater**

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

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

- **If greater than 1 V**

Repair the short to voltage on the circuit.

- **Go to next step: If 1 V or less**

6. Test or replace the G13 Generator.

Repair Instructions

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

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

DTC P0622

Diagnostic Instructions

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

DTC P0622

Generator F-Terminal Circuit

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

Diagnostic Fault Information

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

Circuit/System Description

The K20 Engine Control Module (ECM) uses the G13 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 P0622 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 Wiring 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](#)

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.
 - **Go to next step: If between 5 - 90%**
3. Verify the scan tool Generator F-Terminal Signal parameter changes when commanding the headlamps ON and OFF.
 - **If the parameter does not change**
Refer to Circuit/System Testing.
 - **Go to next step: 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.
 - **Go to next step: If the DTC does not set**
6. All OK.

[Circuit/System Testing](#)

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal A X1, A X2, B X2, 1 X1 or 1 X2 and ground.
 - **If the test lamp does not illuminate and the circuit fuse is good**
 1. Remove the test lamp and disconnect the B+ cable at the G13 Generator.
 2. Test for less than 2 Ω in the B+ circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , verify the fuse is not open and there is voltage at the fuse.
 - **If the test lamp does not illuminate and the circuit fuse is open**
 1. Remove the test lamp, disconnect the 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.
 - **Go to next step: If the test lamp illuminates**
2. Ignition Off, Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Verify the scan tool Engine Control Module Generator F-Terminal Signal parameter is less than 5%.
 - **If 5% or greater**

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

Repair Instructions

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

- [Generator Replacement \(LFY\)](#)[Generator Replacement \(LTG\)](#)
- [Control Module References](#) for 20 Engine Control Module replacement, programming, and setup

DTC P0625 OR P0626

Diagnostic Instructions

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

DTC Descriptors

DTC P0625

Generator F-Terminal Circuit Low Voltage

DTC P0626

Generator F-Terminal Circuit High Voltage

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

Diagnostic Fault Information

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

Circuit/System Description

The engine control module (ECM) uses the generator field duty cycle signal circuit, or F-terminal circuit, to monitor the duty cycle of the generator. The generator field duty cycle signal circuit connects to high side of the field windings in the generator. A pulse width modulated (PWM) high side driver in the voltage regulator turns the field

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

Conditions for Running the DTC

P0625

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

P0626

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

Conditions for Setting the DTC

P0625

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

P0626

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

Action Taken When the DTC Sets

DTC P0625 and P0626 are C type DTCs.

Conditions for Clearing the DTC

DTC P0625 and P0626 are C type DTCs.

Reference Information

Schematic Reference

Starting and Charging Wiring 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](#)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

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

[Circuit/System Verification](#)

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

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

Circuit/System Testing

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

Repair Instructions

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

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

DTC P100C OR P100D

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

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

Circuit/System Description

The B110 Battery Sensor Module monitors the battery module and 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 Wiring 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](#)

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**
 Replace the B110 Battery Sensor Module
 - **Go to next step: If the DTC is not set**
3. All OK

[Repair Instructions](#)

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

[Battery Monitor Module Replacement](#) for B110 Battery Sensor Module replacement

DTC P155E, P155F, OR P156E

[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

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

[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 Engine Control Module (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

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start System Description and Operation (with KL9)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

1. Ignition ON.
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**

- **Go to next step: 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.

- Go to next step: 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 P156D

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 P156D

DC/DC Converter Ignition Switch Run/Start Position Signal Message Counter Incorrect.

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

Circuit/System Description

The DC/DC converter provides continuous power to certain devices during a stop start event to achieve uninterrupted performance during engine cranking. The ECM monitors the ignition status of the DC/DC converter during start stop events.

Conditions for Running the DTC

- The ignition is ON.
- Ignition voltage is greater than 11 V.

Conditions for Setting the DTC

The engine control module detects a corrupted data message from the DC/DC converter. Communication of the Alive Rolling Count from the DC/DC Converter over CAN bus is incorrect for at least 10 counts for greater than a 3 s period.

Action Taken When the DTC Sets

DTC P156D is a Type B DTC.

Conditions for Clearing the DTC

DTC P156D is a Type B DTC.

Reference Information

Schematic Reference

[Starting and Charging Wiring Schematics](#)

Connector End View Reference

[COMPONENT CONNECTOR END VIEWS - INDEX](#)

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 Testing

1. Verify that no other DTCs are set except for DTC P156D.

- **If any other DTCs are set**

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

- **Go to next step: If only DTC P156D is set**

2. Replace the T19 Power Supply Transformer.

3. Verify the DTC does not set while operating the vehicle within the Conditions for Running the DTC.

- **If DTC sets**

Replace the K20 Engine Control Module.

- **Go to next step: If DTC does not set**

4. All OK.

Repair Instructions

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

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

DTC P15FF

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

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

Circuit/System Description

The B110 Battery Sensor Module monitors battery module and performs internal diagnostics. The Battery Sensor Module also communicates to the K20 Engine Control Module (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

Starting and Charging Wiring 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

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
 - **Go to next step: If the DTC is not set**
3. All OK

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Battery Monitor Module Replacement for Battery Sensor Module replacement

DTC P058A, P058B, P058C, P058D, P058F, P16D4, P16D5, P16D6, P16DC, P16DD, P16DE, P16DF, P16E1, P16E2, OR P16E3

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

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

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 9.0 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 μ 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 $^{\circ}$ C (50.0 $^{\circ}$ F) for 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 $^{\circ}$ C (248.0 $^{\circ}$ F) or more for 4 out of 5 samples.

DTC P058F

The Battery Sensor Module detects a raw temperature 2 value of -43 $^{\circ}$ C (-45.4 $^{\circ}$ F) or less for 4 out of 5 samples.

DTC P16DC

The Battery Sensor Module does not properly execute wake ups 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 $^{\circ}$ C (248.0 $^{\circ}$ F) or more for 4 out of 5 samples.

DTC P16DF

The Battery Sensor Module detects an internal temperature of -43 $^{\circ}$ C (-45.4 $^{\circ}$ F) 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

- 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 B DTCs.
- Stop/Start system will be disabled while the fault is current.

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 B DTCs.

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.
- The B110 Battery Sensor Module is connected to the LIN bus, if there is an intermittent fault with any device or circuits that are connected to the same LIN bus as the Battery sensor module, it can cause the DTC P16DC to set intermittently.
- A loose battery clamp to post connection can cause Battery Sensor Module DTCs to set.

Reference Information

Schematic Reference

Starting and Charging Wiring 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**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

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

Circuit/System Verification

NOTE: Verify Stop/Start system related campaigns or special policies have been completed prior to performing 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](#).
 - **Go to next step: 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](#).
 - **Go to next step: If the voltage is at least 1 V greater than the voltage measured in step 1, but less than 15 V.**
5. Inspect the wiring circuits to the B110 Battery Sensor Module for proper routing and/or damage.
 - **If a condition is found**
Repair the condition.
 - **Go to next step: If no condition is found**
6. Verify there are no current or history DTCs set for the Battery Sensor Module or any devices on the same LIN bus.
 - **If any LIN Bus DTCs are set**
Refer to [Diagnostic Trouble Code \(DTC\) List - Vehicle](#).
 - **If any Battery Sensor Module DTCs are set**
Refer to Circuit/System Testing.
 - **Go to next step: If no DTCs are set**
7. All OK

Circuit/System Testing

NOTE:

- **Circuit/System Verification MUST be performed prior to performing Circuit/System Testing.**
- **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 C1 Battery negative post and clamp.
 - **If 2 Ω or greater**
Repair the high resistance in the connection.

- **Go to next step: If less than 2 Ω**

3. Disconnect the C1 Battery.

4. Test for less than 2 Ω between the B110 Battery Sensor Module clamp and B110 Battery Sensor Module ground terminal 1 X2.

- **If 2 Ω or greater**

Replace B110 Battery Sensor Module.

- **Go to next step: If less than 2 Ω**

5. Reconnect the C1 Battery.

6. Disconnect the X1 harness connector at the B110 Battery Sensor Module.

7. 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. Disconnect the C1 Battery.

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 , 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. Disconnect the C1 Battery

3. 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.

- **Go to next step: If the test lamp illuminates**

8. Replace the B110 Battery Sensor Module.

Repair Instructions

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

[Battery Monitor Module Replacement](#) for B110 Battery Sensor Module replacement

DTC P26E4, P26E5, P26E6

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

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

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 Wiring 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)

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

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.
 - **Go to next step: 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.
 - Go to next step: 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.
 - **Go to next step: 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.
 - Go to next step: 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.
 - **Go to next step: 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.
 - Go to next step: 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.

- **Go to next step: 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.

- **Go to next step: 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.

- **Go to next step: 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.

- **Go to next step: 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

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](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P3051

DC/DC Converter Output Voltage Sensor Circuit 1 Low Voltage

DTC P3053

DC/DC Converter Output Voltage Sensor Circuit 1 High Voltage

DTC P3055

DC/DC Converter Output Voltage 1 Performance

Symptom Byte Information: [Symptom Byte List](#)

Diagnostic Fault Information

Control Module Voltage Output Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Terminal 11 @ T19 Power Supply Transformer	DTC P3051, P3055	DTC P3051, P3055	-	-
Control - Terminal 10 @ T19 Power Supply Transformer	DTC P3051	DTC P3055	DTC P3053	DTC 3055
Ground - Terminal 7, 12 @ T19 Power Supply Transformer	-	DTC P3051, P3055	-	-
Ground - Terminal @ K20 Engine Control Module	-	DTC P3051, P3055	-	-

Circuit/System Description

For an overview of the component/system, refer to: [Stop/Start System Description and Operation \(with KL9\)](#)

Circuit	Description
B+ - Terminal 11 @ T19 Power Supply Transformer	12V Regulated Supply Voltage 1
Control - Terminal 10 @ T19 Power Supply Transformer	Regulated voltage supplied by the control module.
Ground - Terminal 7, 12 @ T19 Power Supply Transformer	Device Ground Circuit
Ground - Terminal @ K20 Engine Control Module	Device Ground Circuit

Component	Description
T19 Power Supply Transformer	DC to DC voltage power supply that maintains a steady output voltage.

Conditions for Running the DTC

Ignition On

Conditions for Setting the DTC

DTC P3051

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

DTC P3053

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

DTC P3055

The K20 ECM detects the difference between the ECM IGN voltage and the DC/DC converter output is greater than or equal to 1 V.

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

- If P3055 is set, verify ECM and T19 Power Supply Transformer grounds are clean and tight.
- Ground circuits for the area of customer concern are clean, tight, and in the correct location.
- 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 12 V regulated supply voltage 1.

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Master Electrical Component List

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition/Vehicle & All vehicle systems - Off

NOTE: **The battery voltage should stabilize after a few minutes of turning the ignition/vehicle Off.**

2. Test for 12.4 to 12.8 V between the test points: Battery Positive Post & Battery Negative Post
 - **If not between 12.4 and 12.8 V**

Refer to: **Battery Inspection/Test**

- **Go to next step: If between 12.4 and 12.8 V**

3. Inspect the electrical connectors and the ground circuits of the component for poor connections. - K20 Engine Control Module & T19 Power Supply Transformer

- **If a condition exists**

Repair as necessary - Wiring / Terminal (s) / Electrical Connector (s)

- **Go to next step: If no condition exists**

4. Engine - Running - For greater than 15 s
5. Headlamp - ON
6. Test for 13.4 to 15 V between the test points: Battery Positive Post & Battery Negative Post

- **If not between 13.4 and 15 V**

Refer to: [Charging System Test](#)

- **Go to next step: If between 13.4 and 15 V**

7. Verify the component activates: - Ignition On.

- A11 Radio
- P16 Instrument Cluster
- **If the component does not activate**

Refer to: Circuit/System Testing

- **Go to next step: If the component activates**

8. Verify DTC P3051, P3053, P3055 is not set.

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

Refer to: Circuit/System Testing

- **Go to next step: If the DTC does not set**

9. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: T19 Power Supply Transformer
3. Test for less than 10 ohms between the test points:
 - Ground circuit terminal 7 @ T19 Power Supply Transformer & Ground
 - Ground circuit terminal 12 @ T19 Power Supply Transformer & Ground
 - **If 10 ohms or greater**
 1. Disconnect the appropriate ground connection:
 2. Test for less than 2 ohms between the test points: Each ground circuit terminal @ T19 Power Supply Transformer & The other end of the circuit
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Repair the open/high resistance in the ground connection.
 - **Go to next step: If less than 10 ohms**
4. Verify a test lamp turns On between the test points:
 - B+ circuit terminal 8 @ T19 Power Supply Transformer & Ground
 - B+ circuit terminal 11 @ T19 Power Supply Transformer & Ground
 - **If the test lamp does not turn On and the circuit fuse is OK**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for less than 2 ohms between the test points:
 - B+ circuit terminal 8 @ T19 Power Supply Transformer & Output terminal @ Fuse
 - B+ circuit terminal 11 @ T19 Power Supply Transformer & Output terminal @ Fuse
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not turn On and the circuit fuse is open**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for infinite resistance between the test points:
 - B+ circuit terminal 8 @ T19 Power Supply Transformer & Ground

- B+ circuit terminal 11 @ T19 Power Supply Transformer & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component: T19 Power Supply Transformer
 - **Go to next step: If the test lamp turns On**
5. Verify a test lamp turns On between the test points: Ignition circuit terminal 6 @ T19 Power Supply Transformer & Ground
- **If the test lamp does not turn On and the circuit fuse is OK**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for less than 2 ohms between the test points: Ignition circuit terminal 6 @ T19 Power Supply Transformer & KR73 Ignition Main Relay
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not turn On and the circuit fuse is open**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for infinite resistance between the test points: Ignition circuit terminal 6 @ T19 Power Supply Transformer & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component: T19 Power Supply Transformer
 - **Go to next step: If the test lamp turns On**
6. Ignition/Vehicle - Off & Remove - Test lamp
7. Connect all electrical connectors.
8. Clear DTCs
9. Operate the vehicle under the following conditions: Autostart/Autostop
10. Verify DTC P3051, P3053, P3055 is not set.
- **If any of the DTCs are set**

Test or replace the component: T19 Power Supply Transformer
 - **Go to next step: If no DTC is set**
11. All OK.

Repair Instructions

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

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

DTC P3052, P3054, OR P3056

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](#)
- An overview of each diagnostic category can be found here: [Diagnostic Procedure Instructions](#)

DTC Descriptor

DTC P3052

DC/DC Converter Output Voltage Sensor Circuit 2 Low Voltage

DTC P3054

DC/DC Converter Output Voltage Sensor Circuit 2 High Voltage

DTC P3056

Symptom Byte Information: [Symptom Byte List](#)**Diagnostic Fault Information**

Control Module Voltage Output Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+ - Terminal 8 @ T19 Power Supply Transformer	DTC P3052, P3056	DTC P3052, P3056	-	-
Control - Terminal 9 @ T19 Power Supply Transformer	DTC P3052	DTC 3056	DTC P3054	DTC 3056
Ground - Terminal 7, 12 @ T19 Power Supply Transformer	-	DTC P3052, P3056	-	-
Ground - Terminal @ K20 Engine Control Module	-	DTC P3052, P3056	-	-

Circuit/System Description

For an overview of the component/system, refer to: [Stop/Start System Description and Operation \(with KL9\)](#)

Circuit	Description
B+ - Terminal 8 @ T19 Power Supply Transformer	12V Regulated Supply Voltage 2
Control - Terminal 9 @ T19 Power Supply Transformer	Regulated voltage supplied by the control module.
Ground - Terminal 7, 12 @ T19 Power Supply Transformer	Device Ground Circuit
Ground - Terminal @ K20 Engine Control Module	Device Ground Circuit

Component	Description
T19 Power Supply Transformer	DC to DC voltage power supply that maintains a steady output voltage.

Conditions for Running the DTC

Ignition On

Conditions for Setting the DTC**DTC P3052**

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

DTC P3054

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

DTC P3056

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

Actions Taken When the DTC Sets

DTCs listed in the DTC Descriptor Category = Type B DTC

Conditions for Clearing the DTC

DTCs listed in the DTC Descriptor Category = Type B DTC

Diagnostic Aids

- If DTC P3056 is set, verify K20 ECM and T19 Power Supply Transformer grounds are clean and tight.
- Ground circuits for the area of customer concern are clean, tight, and in the correct location.
- Verify all devices powered by the T19 Power Supply Transformer are operating properly.
- B+ circuit terminal 8 supplies voltage to output circuit terminal 9, function 12 V regulated supply voltage 2

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Component View Reference

Master Electrical Component List

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition/Vehicle & All vehicle systems - Off

NOTE: The battery voltage should stabilize after a few minutes of turning the ignition/vehicle Off.

2. Test for 12.4 to 12.8 V between the test points: Battery Positive Post & Battery Negative Post
 - **If not between 12.4 and 12.8 V**

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

- **Go to next step: If between 12.4 and 12.8 V**

3. Inspect the electrical connectors and the ground circuits of the component for poor connections. - K20 Engine Control Module & T19 Power Supply Transformer

- **If a condition exists**

Repair as necessary - Wiring / Terminal (s) / Electrical Connector (s)

- **Go to next step: If no condition exists**

4. Engine - Running - For greater than 15 s

5. Headlamp - ON

6. Test for 13.4 to 15 V between the test points: Battery Positive Post & Battery Negative Post

- **If not between 13.4 and 15 V**

Refer to: [Charging System Test](#)

- **Go to next step: If between 13.4 and 15 V**

7. Verify the component activates:

- A11 Radio
- P16 Instrument Cluster

- **If the component does not activate**

Refer to: Circuit/System Testing

- **Go to next step: If the component activates**

8. Verify DTC P3052, P3054, P3056 is not set.

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

Refer to: Circuit/System Testing

- **Go to next step: If the DTC does not set**

9. All OK.

Circuit/System Testing

NOTE: **Circuit/System Verification must be performed before proceeding with Circuit/System Testing.**

1. Ignition/Vehicle & All vehicle systems - Off
2. Disconnect the electrical connector: T19 Power Supply Transformer
3. Test for less than 10 ohms between the test points:
 - Ground circuit terminal 7 @ T19 Power Supply Transformer & Ground
 - Ground circuit terminal 12 @ T19 Power Supply Transformer & Ground
 - **If 10 ohms or greater**
 1. Disconnect the appropriate ground connection: The other end of the circuit
 2. Test for less than 2 ohms between the test points: Each ground circuit terminal @ T19 Power Supply Transformer & The other end of the circuit
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Repair the open/high resistance in the ground connection.
 - **Go to next step: If less than 10 ohms**
4. Verify a test lamp turns On between the test points:
 - B+ circuit terminal 8 @ T19 Power Supply Transformer & Ground
 - B+ circuit terminal 11 @ T19 Power Supply Transformer & Ground
 - **If the test lamp does not turn On and the circuit fuse is OK**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for less than 2 ohms between the test points:
 - B+ circuit terminal 8 @ T19 Power Supply Transformer & Output terminal @ Fuse
 - B+ circuit terminal 11 @ T19 Power Supply Transformer & Output terminal @ Fuse
 - If 2 ohms or greater - Repair the open/high resistance in the circuit.
 - If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.
 - **If the test lamp does not turn On and the circuit fuse is open**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for infinite resistance between the test points:
 - B+ circuit terminal 8 @ T19 Power Supply Transformer & Ground
 - B+ circuit terminal 11 @ T19 Power Supply Transformer & Ground
 - If less than infinite resistance - Repair the short to ground on the circuit.
 - If infinite resistance - Replace the component: T19 Power Supply Transformer
 - **Go to next step: If the test lamp turns On**
5. Verify a test lamp turns On between the test points: Ignition circuit terminal 6 @ T19 Power Supply Transformer & Ground
 - **If the test lamp does not turn On and the circuit fuse is OK**
 1. Ignition/Vehicle - Off & Remove - Test lamp
 2. Test for less than 2 ohms between the test points: Ignition circuit terminal 6 @ T19 Power Supply Transformer & KR73 Ignition Main Relay

- If 2 ohms or greater - Repair the open/high resistance in the circuit.
- If less than 2 ohms - Verify the fuse is OK and there is voltage at the fuse.

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

1. Ignition/Vehicle - Off & Remove - Test lamp
2. Test for infinite resistance between the test points: Ignition circuit terminal 6 @ T19 Power Supply Transformer & Ground

- If less than infinite resistance - Repair the short to ground on the circuit.
- If infinite resistance - Replace the component: T19 Power Supply Transformer

• **Go to next step: If the test lamp turns On**

6. Ignition/Vehicle - Off & Remove - Test lamp
7. Connect all electrical connectors.
8. Clear DTCs
9. Operate the vehicle under the following conditions: Autostart/Autostop
10. Verify DTC P3052, P3054, P3056 is not set.

• **If any of the DTCs are set**

Test or replace the component: T19 Power Supply Transformer

• **Go to next step: If no DTC is set**

11. All OK.

Repair Instructions

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

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

DTC P305D OR P305E

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 is a type B DTC.
- DTC P305E is a type A DTC.

Conditions for Clearing the DTC

- DTC P305D is a type B DTC.
- DTC P305E is a type A DTC.

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

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start System Description and Operation (with KL9)

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition OFF and all vehicle systems OFF, disconnect the KR27 Starter Relay. It may take up to 2 minutes for all vehicle systems to power down, Ignition ON.
2. Verify a test lamp illuminates between the ignition circuit terminal 86 and ground.

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

1. Ignition OFF, remove the test lamp.
2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , refer to [Power Mode Mismatch](#).

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

1. Ignition OFF, remove the test lamp.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance
3. Connect the KR27 Starter Relay and replace the fuse.
4. Verify the fuse does not open when connecting the KR27 Starter Relay.
 - If the fuse opens, replace the KR27 Starter Relay.
 - Go to next step: If the fuse is OK

5. All OK

- **Go to next step: 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 ignition circuit terminal 86 and the control circuit terminal 85 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 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - Go to next step: 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.
 - Go to next step: 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

- **Go to next step: 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.
 - Go to next step: 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.
 - Go to next step: 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
 - **Go to next step: 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

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 Wiring 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](#)

- **Go to next step: If Service Message is not present.**

2. 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 Wiring Schematics](#)

Electrical Information Reference

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

Special Tools

Circuit/System Testing

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

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

- **Go to next step: If voltage is between 12.0 - 15.0 V**
3. Test for less than 0.5 V between the positive battery terminal and positive terminal at the X50D Fuse Block - Battery with the ignition in the CRANK/START position.
 - **If 0.5 V or greater**

Replace the positive battery cable.

- **Go to next step: If less than 0.5 V**
4. Test for less than 0.5 V between the positive battery cable at the X50D Fuse Block - Battery and the Terminal 1 X2 or A X2 at the M64 Starter Motor with the ignition in the CRANK/START position.
 - **If 0.5 V or greater**

Replace the positive battery cable.

- **Go to next step: 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 CRANK/START position.
 - **If 0.5 V or greater**

Replace the negative battery cable.

- **Go to next step: If less than 0.5 V**
6. Replace the Battery.

Repair Instructions

- Perform the Diagnostic Repair Verification after completing the repair: [Diagnostic Repair Verification](#)
- [Battery Replacement](#)
- [Battery Positive and Negative Cable Replacement \(LFY\)](#)[Battery Positive and Negative Cable Replacement \(LTG\)](#)
- [Starter Replacement \(LTG - All Wheel Drive\)](#)[Starter Replacement \(LTG - Front Wheel Drive\)](#)[Starter Replacement \(LFY\)](#)

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 Wiring 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
 - **Go to next step: 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 Wiring 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. Ignition OFF, measure and record the C1 Battery voltage at the terminals.
2. Verify the measured voltage is between 12.0 - 15.0 V.
 - **If voltage is less than 12.0 V or greater than 15.0 V**
Refer to Battery Inspection/Test.
 - **Go to next step: If voltage is between 12.0 - 15.0 V**
3. Test for less than 0.5 V between the positive battery terminal and positive terminal at the X50D Fuse Block - Battery with the ignition in the CRANK/START position.
 - **If 0.5 V or greater**
Replace the positive battery cable.
 - **Go to next step: If less than 0.5 V**
4. Test for less than 0.5 V between the positive battery cable at the X50D Fuse Block - Battery and terminal 1 X2 or A X2 at the M64 Starter Motor with the ignition in the CRANK/START position.
 - **If 0.5 V or greater**
Replace the positive battery cable.
 - **Go to next step: 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 CRANK/START position.
 - **If 0.5 V or greater**
Replace the negative battery cable.
 - **Go to next step: If less than 0.5 V**
6. Replace the Starter.

Repair Instructions

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

- [Battery Replacement](#)
- [Battery Positive and Negative Cable Replacement \(LFY\)](#)[Battery Positive and Negative Cable Replacement \(LTG\)](#)
- [Starter Replacement \(LTG - All Wheel Drive\)](#)[Starter Replacement \(LTG - Front Wheel Drive\)](#)[Starter Replacement \(LFY\)](#)

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.

Reference Information

Schematic Reference

[Starting and Charging Wiring 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. Ignition OFF, measure and record the C1 Battery voltage at the terminals.
2. Verify the measured voltage is between 12.0 - 15.0 V.

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

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

- **Go to next step: If voltage is between 12.0 - 15.0 V**

3. Test for less than 0.5 V between the positive battery terminal and positive terminal at the X50D Fuse Block - Battery with the ignition in the CRANK/START position.

- **If 0.5 V or greater**

Replace the positive battery cable.

- **Go to next step: If less than 0.5 V**

4. Test for less than 0.5 V between the positive battery cable at the X50D Fuse Block - Battery and terminal 1 X2 or A X2 at the M64 Starter Motor with the ignition in the CRANK/START position.

- **If 0.5 V or greater**

Replace the positive battery cable.

- **Go to next step: 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 CRANK/START position.

- **If 0.5 V or greater**

Replace the negative battery cable.

- **Go to next step: If less than 0.5 V**

6. Perform Battery Inspection/Test Using the EL-50313 Midtronics Battery Tester/Charger.

- **If Battery Fails the Test**

Replace the C1 battery.

- **Go to next step: If the Battery Passes the Test**

Go to next step: Replace the M64 Starter Motor.

Repair Instructions

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

- [Battery Replacement](#)
- [Battery Positive and Negative Cable Replacement \(LFY\)](#)[Battery Positive and Negative Cable Replacement \(LTG\)](#)
- [Starter Replacement \(LTG - All Wheel Drive\)](#)[Starter Replacement \(LTG - Front Wheel Drive\)](#)[Starter Replacement \(LFY\)](#)

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 lists.

1. Perform the Diagnostic System Check prior to using this diagnostic procedure: [Diagnostic System Check - Vehicle](#)
 - Verify that no DTCs are 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 \(with KL9\)](#).

Visual/Physical Inspection

- Inspect for aftermarket devices which may affect the operation of the Stop/Start System. [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 the appropriate diagnostic procedure listed below:

[Stop/Start System Malfunction](#)

BATTERY INSPECTION/TEST

Diagnostic Instructions

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

Diagnostic Aids

NOTE: For Warranty repairs you must use regionally required battery test equipment for warranty repairs.

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

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

Reference Information

Schematic Reference

Starting and Charging Wiring 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 or C1B Battery - Auxiliary (if equipped) case is not cracked, broken, or damaged, which may be indicated by battery acid leakage.
 - If there is any apparent damage

Replace the C1 Battery or C1B Battery - Auxiliary.

- **Go to next step: 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.

- **Go to next step: 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 or C1B Battery - Auxiliary.

- **Go to next step: If the test result is not REPLACE BATTERY or BAD CELL-REPLACE**

9. All OK.

Repair Instructions

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

Battery Replacement

BATTERY CHARGING

Special Tools

EL 50313 Battery Tester

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

Diagnostic Aids

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

Battery State of Charge

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

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

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

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

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

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

Use the state of charge information as follows:

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

Charging Time Required

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

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

Charging Procedure

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

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

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

1. Ensure that all of the battery terminal connections are clean and tight.
2. Connect the charger positive lead to the battery positive terminal on the battery or the remote jumper stud underhood.

CAUTION: Do not connect the negative charger lead to the housings of other vehicle electrical accessories or equipment. The action of the battery charger may damage such equipment.

3. Connect the negative charger lead to a solid engine ground or to a ground stud in the engine compartment that is connected directly to the battery negative terminal, but away from the battery. If the negative battery cable is disconnected and a terminal adapter is being used, connect directly to the adapter.
4. Select "Charging," "PDI" and "In Vehicle" when setting up the charger.
5. Select the proper battery type, Flooded, AGM, Spiral AGM or Stop/Start AGM.
6. Enter the CCA as shown on the battery label.

BATTERY ELECTRICAL DRAIN/PARASITIC LOAD TEST

12 V Battery

The following procedure is for the 12 V battery only.

Diagnostic Instructions

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

Circuit/System Description

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

Diagnostic Aids

- Rule out any possible aftermarket equipment causing an unacceptable parasitic current drain. Aftermarket accessories installed into the courtesy lamp circuit can cause the inadvertent power timer in the body control module (BCM) to keep resetting. This may cause the BCM to remain awake and cause a current drain on the battery.
- Rule out customer driving habits such as regular short trips that do not allow enough time to properly charge the battery. Refer to [Battery Description and Operation](#).
- Verify that the battery and charging system are in proper working order. Refer to [Battery Charging](#), and [Charging System Test](#).
- A battery discharging for no apparent reason while the vehicle is parked can be caused by an intermittent draw, such as a module waking up, or a continuous draw, such as a dome light or stuck relay.
- Some systems and modules such as OnStar[®], and regulated voltage control, if equipped, are designed to wake up, perform a task, and go back asleep at regular intervals. Refer to [Body Control System Description and Operation](#) for the system or modules description and operation.
- An engine off natural vacuum evaporative test can occur if the engine control module (ECM) determines the drive cycle has met the appropriate criteria immediately after key off. The ECM will stay awake and the vent solenoid will stay energized for as long as 45 min. The typical current draw for this is about 1 A.
- Digital OnStar generation 6 and later vehicle communication interface module do not "wake up" every 10 min for the first 48 h as the generation 5 and prior. generation 6 and later vehicle communication interface module current draw is very low, less than 40 mA, so the OnStar system is left in that state for up to the first 48 h. Parasitic draw of up to 40 mA with an occasional spike as high as 80 mA through the vehicle communication interface module for the first 48 h 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 FOBs in the vicinity, the remote keyless entry receiver will have a 100 mA spike. These spikes are normal and occur too briefly to have a significant effect on battery drain. Competing signals may cause remote keyless entry performance issues such as jamming but should not cause excessive battery draw.
- If an excessive current draw is not present during initial testing, continue periodic testing over a 1 - 2 hour period to see if the current draw increases and stays above an unacceptable level.

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

- The battery run down time will vary depending on the batteries reserve capacity. If the reserve capacity is higher, then the battery run down time may be longer. If the reserve capacity is lower, then the battery run down time may be shorter. The graph below indicates roughly how many days a 690 cold cranking amperage battery with a 110 min reserve capacity starting at 80% state of charge will last with a constant current draw until it reaches 50% state of charge. Differences in battery reserve capacity and temperature will affect the results.

Current Drain	Days
25 mA	33
50 mA	16.5
75 mA	11
100 mA	8.25
250 mA	3.3
500 mA	1.65
750 mA	1
1 A	0.8
2 A	0.4

Reference Information

Schematic Reference

Control Module References

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Electrical Information Reference

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

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL 38758 Parasitic Draw Test Switch

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

NOTE:

- Most vehicle systems will go to sleep within 30 min but it can take up to 2 h before all systems power down allowing the parasitic draw test to pass. An occasional increase in the parasitic draw is normal as long as it returns within 1 s.
- Closing the door latches/ajar switch while leaving the doors open is recommended, this allows the vehicle systems to perform in a "doors closed" mode while allowing vehicle interior access that may be needed to complete the diagnostic steps.
- Locking doors will arm the vehicle content theft deterrent system if equipped. Failure to arm the system may cause a theft system fault to not be present during testing.
- There are many things that can prevent the vehicle from completely going to sleep and passing the parasitic draw test. Make sure all the conditions listed below are met before performing the parasitic current draw test.
 - Ignition OFF
 - Key out of the ignition switch - when not equipped with keyless access and start
 - Retained Accessory Power OFF - open and close the driver door after ignition OFF
 - Scan tool not communicating with a vehicle control module - in some cases it may need to be disconnected from the DLC
 - All access doors closed
 - Headlamps OFF - auto headlamps disabled
 - Any delay lighting OFF
 - If equipped with an under hood lamp disable it
 - HVAC after blow OFF
 - Any accessory that can work with ignition OFF inactive or OFF
 - Wait up to 2 min or longer, after all other listed conditions are met

Using an Inductive Pickup Probe

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

Using the EL 38758 Parasitic Draw Test Switch

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

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

NOTE:

- The switch knob on the EL 38758 switch is marked ON and OFF. When the switch knob is in the ON position, the circuit is closed and electrical current will pass through the switch. When the switch knob is in the OFF position, the circuit is open and electrical current will not pass through the switch.
- When diagnosing an intermittent battery draw, if the battery voltage is interrupted by disconnecting the battery, it may cause the condition to clear. You may want to connect the EQPMSK6211 Battery Booster Pack or equivalent to the positive and negative battery cables prior disconnecting the negative battery cable to prevent a current concern from temporarily correcting itself.

1. Ignition OFF, disconnect the battery negative cable from the battery. Refer to [Battery Negative Cable Disconnection and Connection \(KL9\)](#).
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.
 - Go to next step: Passed
10. Turn the **EL 38758** switch knob to the ON position. Remove the fused jumper wire.
11. Connect a DMM set to the 10 A DC scale between the test switch tool terminals.
12. Turn the **EL 38758** switch knob to the OFF position. The current now flows through the DMM.
13. As the vehicle systems shut down test for less than 30 mA of parasitic current drain.
 - If greater than the specified range, refer to Circuit/System Testing.

Circuit/System Testing

NOTE:

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

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

- Stuck switch
- Stuck relay
- Control module

Repair Instructions

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

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

CHARGING SYSTEM TEST

Diagnostic Instructions

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

Diagnostic Fault Information

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

Circuit/System Description

The K20 Engine Control Module (ECM) uses the G13 Generator turn ON control circuit, or L-terminal circuit, to control the load of the Generator on the engine. A high side driver in the ECM applies a 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 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%.

Diagnostic Aids

- Verify the following component is properly installed: Drive Belt
- If necessary, perform the following steps: [Battery Electrical Drain/Parasitic Load Test](#)
- To save fuel, the generator does not charge when the following parameter shows the given state: Fuel Economy Mode is Active
- When an accessory is switched on, the response of the charge current (respectively the battery voltage) is not instantaneous. The generator slowly ramps up the charge current. If the battery is fully charged, the charge current may not increase at all. This behavior can make it difficult to measure the charge current or a change in battery voltage.
- Voltmeter gauge fluctuation is not an indicator of a charging system malfunction. Depending on the charging system mode and system loading, battery voltage can fluctuate between 12.0 V to 15.8 V. Refer to Description and Operation.
- A charging system malfunction is indicated by illuminating the charge indicator, and/or a Driver Information Center Message: BATTERY NOT CHARGING SERVICE CHARGING SYSTEM or SERVICE BATTERY CHARGING SYSTEM.
- The generator will default to a voltage output of 13.8 V if the G13 Generator X1 connector is disconnected.

Reference Information

Schematic Reference

[Starting and Charging Wiring 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](#)

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

1. Ignition - On / Vehicle - In Service Mode
2. Verify the charge indicator is On while the instrument cluster performs the bulb check. Approximately 4 seconds.

- **If the indicator is Off during the bulb check. Approximately 4 seconds**

Replace P16 Instrument Cluster

- **Go to next step: If the indicator is On during the bulb check. Approximately 4 seconds**

3. Verify there are no DTCs set related to the following system/component:

- B18 Battery Current Sensor (If applicable)
- B110 Battery Sensor Module (If applicable)
- G13 Generator
- Energy Management
- Stop/Start System (KL9)
- **If any DTC is set**

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

- **Go to next step: If no DTC is set**

4. Increase the engine speed slowly to 2500 RPM. All accessories OFF.

5. Verify the scan tool Battery Voltage parameter is between 12.0 - 15.8 V

- **If not between 12.0 - 15.8 V**

Refer to Circuit System Testing

- **Go to next step: If between 12.0 - 15.8 V**

6. Turn the following components ON:

- Headlamps
- Rear Defogger
- Blower Motor at maximum speed

7. Increase the engine speed slowly to 2500 RPM. Verify the scan tool Battery Voltage parameter is between 12.6 - 15.8 V.

- **If not between 12.6 - 15.8 V**

Refer to Circuit System Testing

- **Go to next step: If between 12.6 - 15.8 V**

8. Verify the charge indicator on the instrument cluster is Off and the Driver Information Center (DIC) does not display any charging system error message.

- **If the indicator is On**

Refer to Circuit System Testing

- **Go to next step: If the indicator is Off**

9. Verify the scan tool Body Control Module Battery Voltage parameter increases when controlling the Body Control Module Generator Regulator Setpoint from 40% to 80% with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each Setpoint change.

Refer to [Charging System Description and Operation](#).

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

Refer to Circuit/System Testing.

- **Go to next step: If the battery voltage increases**

Circuit/System Testing

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

1. Verify a test lamp illuminates between the G13 Generator B+ circuit terminal 1 X2 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.
 - **Go to next step: If the test lamp illuminates**
2. Disconnect the X1 harness connector at the G13 Generator, engine running.
3. Test for 13.4 V to 14 V between the engine block and B+ circuit at G13 Generator.
 - If not between 13.4 and 14 V, Test or replace the G13 Generator.
 - Go to next step: If between 13.4 and 14 V
4. Verify the scan tool Engine Control Module Generator F - Terminal Signal parameter is less than 5%.
 - **If 5% or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the K20 Engine Control Module, ignition ON.
 2. Test for less than 1 V between the G13 Generator signal circuit terminal 2 X1 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K20 Engine Control Module.
 - **Go to next step: If less than 5%**
5. Install a 3 A fused jumper wire between the signal circuit terminal 2 X1 and B+, engine running.
6. 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.
 - Go to next step: 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.
 - **Go to next step: If greater than 95%**
7. Remove jumper wire. X1 disconnected at G13 Generator, engine running.
8. Test for 1 V or greater between the control circuit terminal 1 X1 and ground.
 - **If less than 1 V**
 1. Ignition OFF, disconnect the harness connectors at the K20 Engine Control Module.
 2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance
 3. Test for less than 2 Ω in the control circuit end to end.
 - If greater than 2 Ω , repair the open/high resistance in the circuit.

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

- **Go to next step: If 1 V or greater**

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

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

- **If greater than 1 V**

Repair the short to voltage on the circuit.

- **Go to next step: If 1 V or less**

11. Test or replace the G13 Generator.

Repair Instructions

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

- [Control Module References](#) Control Module replacement, programming and setup.
- [Generator Replacement \(LFY\)](#)[Generator Replacement \(LTG\)](#)

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. 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.
5. Start the engine, with the drive belt removed. Verify that the noise goes away. Operate the engine for no longer than 30-40 seconds.
 - If the noise is still present, the generator is not the cause of the noise.
6. Loosen all generator mounting bolts and ensure the generator is properly aligned. Tighten the mounting bolts to specification, refer to [Generator Replacement \(LFY\)](#)[Generator Replacement \(LTG\)](#).

Repair Instructions

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

- [Drive Belt Replacement](#)
- [Drive Belt Tensioner Replacement](#)
- [Generator Replacement \(LFY\)](#)[Generator Replacement \(LTG\)](#)

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 off. The engine will automatically restart when the driver presses the clutch pedal (manual transmission) or when the driver releases the brake pedal (automatic transmission).

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 draw 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

Reference Information

Schematic Reference

Starting and Charging Wiring Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Stop/Start System Description and Operation (with KL9)

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 no DTCs are set.

- **If any DTCs are set**

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

- **Go to next step: If no DTCs are set**

2. Ignition ON.

3. Test for greater than 12 V between the battery positive terminal and negative terminal.

- **If 12 V or less**

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

- **Go to next step: If greater than 12 V**

4. Verify the scan tool parameter:

- Battery Sensor Module Battery State Information parameter reads Available.
- Battery Sensor Module Reset Occurred - Using Estimated State of Charge reads No.
- **If not the specified value**

1. Disconnect and reconnect the C1 Battery Negative cable.

NOTE:

Allowing the vehicle to sit undisturbed for 3 h will automatically perform a Battery Sensor Learn upon the next engine cranking event. This will allow the battery state of charge to be relearned.

2. Wait a minimum of 3 hours.

3. Start the engine.

4. Test drive the vehicle.

Verify the Stop/Start System is functioning correctly.

- if a condition exists

Refer to [Stop/Start Disable, Inhibit, and Restart Reasons](#)

- Go to next step: If No Conditions exists

5. All OK.

- **Go to next step: If the Specified Value**

5. Test drive the vehicle.

Verify the Stop/Start System is functioning correctly.

- **if a condition exists**

Refer to [Stop/Start Disable, Inhibit, and Restart Reasons](#)

- **Go to next step: If No Conditions exists**

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

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

Refer to Circuit/System Testing - Power Supply Transformer Circuit Malfunction

- **Go to next step: If the infotainment system remains active during a start/stop event**

7. All OK.

Circuit/System Testing

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.
 - **Go to next step: If less than 10 Ω**
3. Ignition ON.
4. 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, test or replace the T19 Power Supply Transformer.
 - **Go to next step: If the test lamp illuminates**
5. Verify a test lamp illuminates between each ignition circuit and ground.

NOTE: **Unplug the connector with the ignition on. If unplugged with the ignition off the vehicle will not power up. Verify the malfunction indicator lamp is illuminated on the P16 instrument cluster after disconnecting the connector to verify the vehicle is still powered up.**

- **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](#).
 - **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.
 - **Go to next step: 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.
 2. Test for infinite resistance between the control circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: 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.
- **Go to next step: If the test lamp illuminates**
8. Test or 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

STOP/START DISABLE, INHIBIT, AND RESTART REASONS

NOTE: Not all parameters may be available in all vehicles

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

Autostop Disable

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

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - Vehicle Inclination	Engine Running	Vehicle Grade indicates that an autostop was prevented (or an autostart was commanded) due to the current grade level of the vehicle.	No	Verify vehicle is not on level ground.	If not OK: Verify Multi-Axis Accelerator Sensor.
Autostop Disable Reason - Remote Vehicle Start Request	Engine Running	Remote Start indicates the internal combustion engine has been requested to run through a remote start command.	No	Verify remote start operation.	If OK: Inform Customer - Normal Disable Condition
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
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

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

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - High Engine Rotating Torque	Engine Running	Engine Friction indicates a requested inhibit due to cold engine, friction high.	No	Wait for vehicle to reach proper temperature	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - BARO Pressure Too Low	Engine Running	Ambient Air Pressure indicates a requested inhibit due to low Barometric Pressure	No	Ensure barometric temperature isn't too low in scan tool	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Fuel Temperature Too High	Engine Running	Boil Off Diagnostics indicates a requested inhibit due to Fuel Boil Off diagnostics.	No	Ensure fuel temperature isn't too high	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - System Malfunction	Engine Running	Starting System indicates that a condition in the starting system has been detected that would prevent a re-start of the vehicle and thus, autostops, have been disabled.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Turbocharger Temperature Too High	Engine Running	Turbo Temp indicates an inhibit due to high Turbo Temp.	No	Check ECM DTC's	If OK: Inform Customer - Normal Disable Condition
Autostop Disable Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If OK: Refer to Hood Ajar Malfunction. If not OK: close hood.
Autostop Disable Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Run/Crank Not Active	Engine Running	Vehicle must be in Run Mode	No	Verify ECM Run/Crank signal	If OK: Inform Customer - Normal Disable Condition If not OK: refer to Power Mode Mismatch.
Autostop Disable Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	None

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
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
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.

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostop Disable Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Low-Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery State of Health Low	Engine Running	12V battery has low state of health	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery State of Charge Low	Engine Running	12V battery state of charge is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostop Disable Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Intake Manifold Weak Vacuum	Engine Running	Low manifold vacuum	No	Verify manifold vacuum	Check DTCs, refer to SI
Autostop Disable Reason - Engine Speed High	Engine Running	High idle condition	No	Correct cause of high idle	Check DTCs, refer to SI
Autostop Disable Reason - Wheel Slip Detected	Engine Running	Slippery road conditions	No	Ensure good road conditions	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Vehicle Speed Threshold Not Reached	Engine Running	Vehicle must reach a minimum speed	No	Operate at sufficient speeds	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Maximum Vehicle Stop Time Exceeded	Engine Running	Engine was shut off for maximum allowable off time	No	Operate at sufficient speeds to reactivate	Inform Customer - Normal Disable Condition
Autostop Disable Reason - Starter System Malfunction	Engine Running	Starter System Inoperable	No	Check ECM DTCs, refer to SI	As Required
Autostop Disable Reason - System Malfunction	Engine Running	Starter System Inoperable	No	Check for Vehicle DTCs	As Required

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

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

Autostart Inhibit

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Inhibit Reason - Hood Ajar	Engine off	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Inhibit Reason - ECM Request	Engine off	ECM tasks are currently running that will not allow an autostart	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition

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

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

Autostart Reasons

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - TCM Demand	Engine Running	TCM has requested an autostart	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - Reduced Engine Power Active	Engine Running	ECM has requested Reduced Engine Power	No	Check ECM DTCs.	As required.
Autostart Reason - Maximum Autostop Time Exceeded	Engine Running	Maximum autostop time is limited.	No	Maximum autostop time is typically 2 minutes.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Transmission Fluid Temperature Out of Range	Engine Running	Transmission temperature too hot or cold	No	Verify transmission temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - System Malfunction	Engine Running	Vehicle System Issue	No	Check for Vehicle DTCs	As required.
Autostart Reason - Transmission in Reverse	Engine Running	Transmission was placed in reverse.	No	Ensure transmission is in drive.	If OK: Inform Customer - Normal Disable Condition. If not OK: Refer to transmission diagnostics.
Autostart Reason - Invalid Data Received	Engine Running	ECM has received invalid data	No	Check ECM DTCs.	As required.
Autostart Reason - Vehicle Speed Too High	Engine Running	Vehicle speed detected	No	Ensure vehicle is at a complete stop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Optimization	Engine Running	ECM has determined that the engine needs to be started.	No	Check DTCs.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - System Voltage Low	Engine Running	12V battery state of charge is low.	No	Charge and test battery, operate vehicle for longer drives, check generator operation	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Acceleration Request	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Minimum Engine Run Time Not Met	Engine Running	Engine must run a minimum time before stop/start is allowed.	No	Autostop will function once the minimum run time is met	Inform Customer - Normal Disable Condition
Autostart Reason - Control Function Active	Engine Running	Scantool control function active	No	Release control function in scantool	As Required

Scantool Parameter - Current Inhibit Reason	System State	Description	Expected Value	Recommended Check	Next Step
Autostart Reason - Auxiliary Transmission Fluid Pump/Accumulator Not Available	Engine Running	Transmission aux pump or accumulator not available	No	Check for transmission DTCs, refer to automatic transmission service information	As Required
Autostart Reason - Engine Coolant Temperature Out of Range	Engine Running	Coolant temperature too hot or cold	No	Verify cooling temperature is within normal operating values	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Transmission Range	Engine Running	Transmission not in Drive	No	Ensure transmission is in drive. Stop/start will not function in manual mode.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Hood Ajar	Engine Running	Hood not latched	No	Ensure hood is closed and latched.	If not OK: close hood.
Autostart Reason - ECM Request	Engine Running	ECM tasks are currently running that will not allow an autostop	No	Autostop will function once the task is complete.	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Discharge Current High	Engine Running	Excessive current draw is placing a high demand on the generator	No	Check electrical loads, turn off unnecessary loads	Inform Customer - Normal Disable Condition
Autostart Reason - Brake Pedal Released	Engine Running	Brake pedal not pressed (enough)	No	Ensure brake pedal is pressed sufficiently to active autostop	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Brake Booster Weak Vacuum	Engine Running	Weak brake booster vacuum	No	Ensure brake booster vacuum is within normal operating values	Check DTCs. Refer to brake booster diagnostics.
Autostart Reason - Accelerator Pedal Pressed	Engine Running	Accelerator pedal pressed	No	Ensure accelerator pedal is fully released	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - A/C Request	Engine Running	HVAC system is requesting AC compressor due to high cabin temperature and/or humidity	No	Allow cabin temperature/humidity to reach setpoint, change setpoint, turn off blower	Inform Customer - Normal Disable Condition
Autostart Reason - Low-Voltage Battery Voltage Low	Engine Running	12V battery voltage is low	No	Charge and test battery, operate vehicle for longer drives, check generator operation	As Required
Autostart Reason - Driver Exited Vehicle	Engine Running	Seat belt unbuckled and driver's door opened.	No	Not in all vehicles. Verify seat belt and driver's door switches.	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Passenger Compartment Heater On	Engine Running	Passenger Compartment Heater On	No	Check Vehicle DTCs	If OK: Inform Customer - Normal Disable Condition
Autostart Reason - Stop/Start select Switch	Engine Running	Stop/Start select Switch off	No	Not in all vehicles.	If OK: Inform Customer - Normal Disable Condition

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

STARTER SOLENOID DOES NOT CLICK

Diagnostic Instructions

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

Diagnostic Fault Information

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

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ground (KR27C Starter Pinion Solenoid Relay Terminal 86)	-	1, DTC P0615	1	-
1. Starter Solenoid Does Not Click 2. Starter pinion solenoid is applied all the time				

Circuit/System Description

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

Reference Information

Schematic Reference

- [Starting and Charging Wiring 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 ON.
2. Verify that no ignition, starter pinion solenoid actuator relay, starter motor 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](#) .

- **Go to next step: 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 [Power Mode Mismatch](#)

- **Go to next step: If parameter displays Crank Request**
4. Verify the scan tool ECM Crankshaft Position Active Counter parameter is not incrementing.
 - **If the counter increments**

Replace the B26 Crankshaft Position Sensor.

- **Go to next step: If the counter does not increment**

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

- **If the KR27C Starter Pinion Solenoid Actuator Relay does not click**

Refer to Circuit/System Testing.

- **Go to next step: If the KR27C Starter Pinion Solenoid Actuator Relay clicks**

6. 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.
- Go to next step: 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.

- **Go to next step: If greater than 10 V**

3. 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.

4. 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.

- **Go to next step: If less than 10 Ω**

5. 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, remove the test lamp.

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

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

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

1. Ignition OFF.

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

- If less than infinite resistance, repair the short to ground on the circuit.
- Go to next step: 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.

- **Go to next step: If the test lamp illuminates**

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

7. 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).

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

1. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module.
2. Test for infinite resistance between the control circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: 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**
4. Ignition OFF, remove the test lamp, disconnect the harness connector at the K20 Engine Control Module, ignition ON.
5. 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.
 - **Go to next step: If the test lamp turns ON and OFF**
8. 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.
9. 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.
 - **Go to next step: If the M64 Starter Motor pinion engages**
10. Ignition OFF, reconnect the KR27C Starter Pinion Solenoid Actuator Relay, ignition CRANK.
11. Verify the M64 Starter Motor is activated.
 - **If the M64 Starter Motor does not activate**

Replace M64 Starter Motor.
 - **Go to next step: If the M64 Starter Motor activates**
12. 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.
 - **Go to next step: 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.
 - **Go to next step: 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.
 - **Go to next step: If less than 5.0 Ω**
6. All OK

Repair Instructions

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

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

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 Wiring 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 Testing

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

Refer to [Battery Inspection/Test](#).
 - **Go to next step: If voltage is between 12 - 15V**
3. Remove the drive belts. Refer to [Drive Belt Replacement](#) for 3.6L engine
4. Verify the crankshaft rotates rotate the crankshaft by hand using the appropriate tools.
 - **If the crankshaft does not rotate**

- **Go to next step: 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.

- **Go to next step: If the engine does not crank**

6. Verify that a test lamp illuminates between the M64 Starter Motor B+ terminal 1 X2 or A X2 and ground.

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

1. Ignition OFF.

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

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

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

1. Ignition OFF.

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

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

- **Go to next step: If the test lamp illuminates**

7. Test for less than 0.5 V between the positive battery cable and M64 Starter Motor B+ terminal 1 X2 or A X2 with the ignition in the START position.

- **If 0.5 V or greater**

Replace the positive battery cable.

- **Go to next step: 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.

- **Go to next step: less than 0.5 V**

9. 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, Ignition ON.

10. 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.
- Go to next step: If infinite resistance

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

4. Test for infinite resistance between the control circuit terminal 86 and ground.

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

- **Go to next step: If the test lamp illuminates**

11. Verify a test lamp illuminates between the ignition circuit terminal 85 and ground.

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

1. Ignition OFF, remove the test lamp.
2. Test for less than 2 Ω in the ignition circuit end to end.
 - If 2 Ω or greater, repair the open/high resistance in the circuit.
 - If less than 2 Ω , refer to **Power Mode Mismatch**.

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

1. Ignition OFF, remove the test lamp.
2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - Go to next step: If infinite resistance
3. Connect the KR27 Starter Relay and replace the fuse.
4. Verify the fuse does not open when connecting the KR27 Starter Relay.
 - If the fuse opens, replace the KR27 Starter Relay.
 - Go to next step: If the fuse is OK

5. All OK

- **Go to next step: If the test lamp illuminates**

12. Connect a test lamp between ignition 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).

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

1. Ignition OFF, disconnect the harness connector at the K20 Engine Control Module and disconnect the harness connector at 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.
 - Go to next step: 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, 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
 - Go to next step: If infinite resistance
 3. Reconnect the K20 Engine Control Module
 4. Test for infinite resistance between control circuit and ground.
 - If less than infinite resistance, replace the K20 Engine Control Module.
 - If infinite resistance, replace the T19 Power Supply Transformer
- **Go to next step: If the test lamp turns ON and OFF**

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

14. Verify the M64 Starter Motor is activated.

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

1. Ignition OFF, 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 2 Ω or greater, repair the open/high resistance in the circuit.

- If less than 2 Ω , replace the M64 Starter Motor.

- **Go to next step: If the M64 Starter Motor activates**

15. Test or replace the KR27 Starter Relay.

Repair Instructions

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

- [Starter Replacement \(LTG - All Wheel Drive\)](#)[Starter Replacement \(LTG - Front Wheel Drive\)](#)[Starter Replacement \(LFY\)](#)

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.

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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 OFF, measure and record the battery voltage at the terminals. The voltage should be between 12.0 - 15.0 V.
 - If not within the specified range, refer to [Battery Inspection/Test](#).
2. Verify that a test lamp illuminates between the starter motor B+ terminal T X1 and ground.
 - If the test lamp does not illuminate, test the B+ circuit for a short to ground or an open/high resistance.
3. Test for less than 0.5 V between the positive battery cable and terminal T X1 at the starter motor as ignition is switched to start position.
 - If greater than the specified value, replace the positive battery cable.
4. Test for less than 0.5 V between the negative battery cable and the starter motor case as ignition is switched to start position.
 - If greater than the specified value, replace the negative battery cable.
5. Remove the drive belts. Refer to one of the following:
 - [Drive Belt Tensioner Replacement](#)
 - [Drive Belt Replacement](#)
6. Ignition Start, verify the engine does not crank normal.

- If the engine cranks normal, inspect the engine and belt drive system for mechanical binding, seized generator etc.

7. If all circuits test normal, replace the starter motor.

Repair Instructions

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

- [Starter Replacement \(LTG - All Wheel Drive\)](#)[Starter Replacement \(LTG - Front Wheel Drive\)](#)[Starter Replacement \(LFY\)](#)

STARTER NOISE DIAGNOSIS

Diagnostic Instructions

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

Circuit/System Description

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

Reference Information

Description and Operation

[Starting System Description and Operation](#)

Circuit/System Verification

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

Circuit/System Testing

1. Remove the flywheel inspection cover.
2. Inspect the flywheel for the following:
 - Loose flywheel bolts
 - Chipped gear teeth
 - Missing gear teeth
 - Bent flywheel
 - Debris in the bell housing
 - If not within specifications, remove the debris, tighten the flywheel bolts, or repair or replace the flywheel.
3. If all inspections were within specification, replace the starter motor.

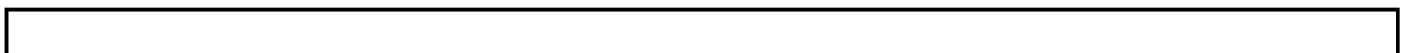
Repair Instructions

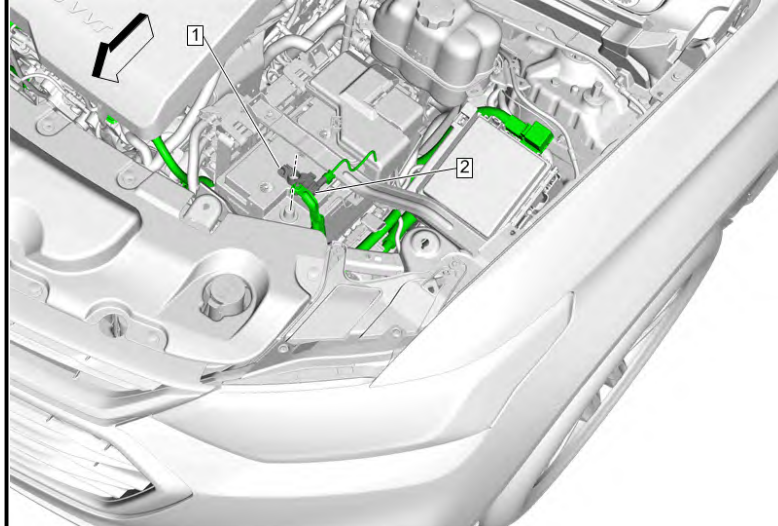
Perform the [Diagnostic Repair Verification](#) after completing the diagnostic procedure.

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

REPAIR INSTRUCTIONS

BATTERY NEGATIVE CABLE DISCONNECTION AND CONNECTION (KL9)





Callout	Component Name
1	WARNING: Unless directed otherwise, the ignition must be OFF with the key removed, and all electrical loads must be OFF before servicing any electrical component. Disconnect the negative battery cable to prevent an electrical spark should a tool or equipment come in contact with an exposed electrical terminal. Failure to follow these precautions may result in personal injury and/or damage to the vehicle or its components. For Vehicles equipped with OnStar® (UE1) with Back Up Battery: The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained accessory power should be allowed to time out or be disabled (simply opening the driver door should disable retained accessory power) before disconnecting power. Disconnecting power to the OnStar® module in any way while the ignition is On or with retained accessory power activated may cause activation of the OnStar® Back-Up Battery system and will discharge and permanently damage the back-up battery. Once the Back-Up Battery is activated it will stay on until it has completely discharged. The back-up battery is not rechargeable and once activated the back-up battery must be replaced. CAUTION: Refer to Fastener Caution . Battery Negative Post Clamp Nut Tighten 4.5 N.m (40 lb in)
2	Battery Negative Cable

BATTERY MONITOR MODULE REPLACEMENT

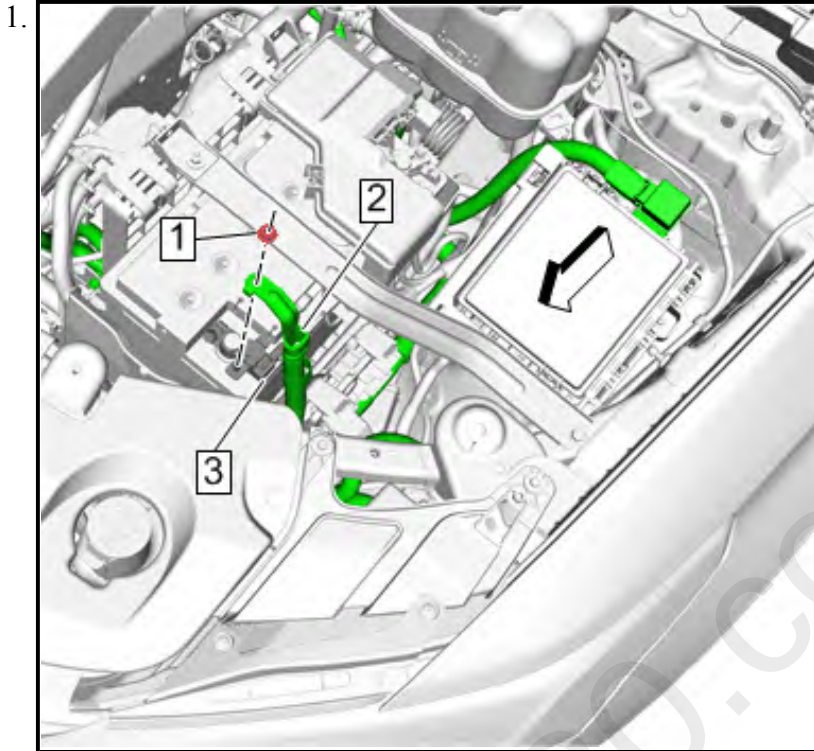
Removal Procedure

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:

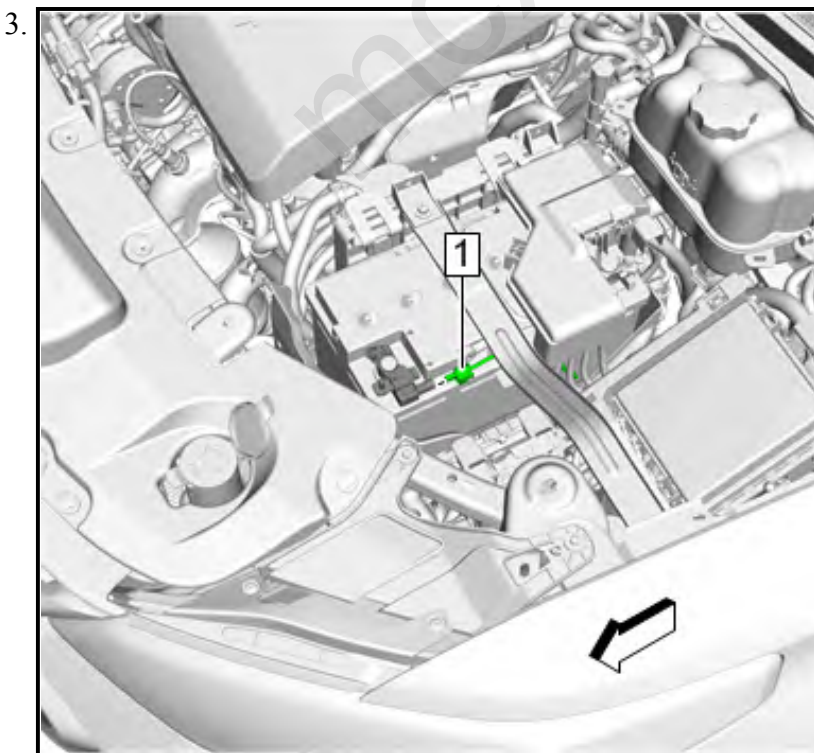
The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or

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.

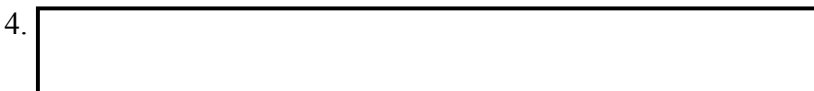


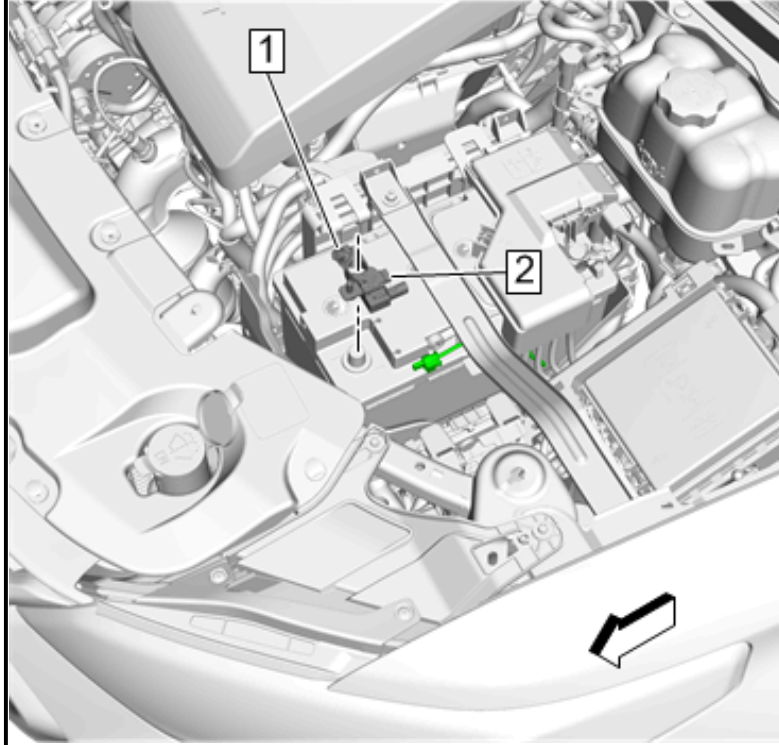
Battery Negative Cable Nut (1) @ Battery Sensor Module (3) - Remove

2. Battery Negative Cable (2) - Reposition away



Electrical Connector (1) - Disconnect

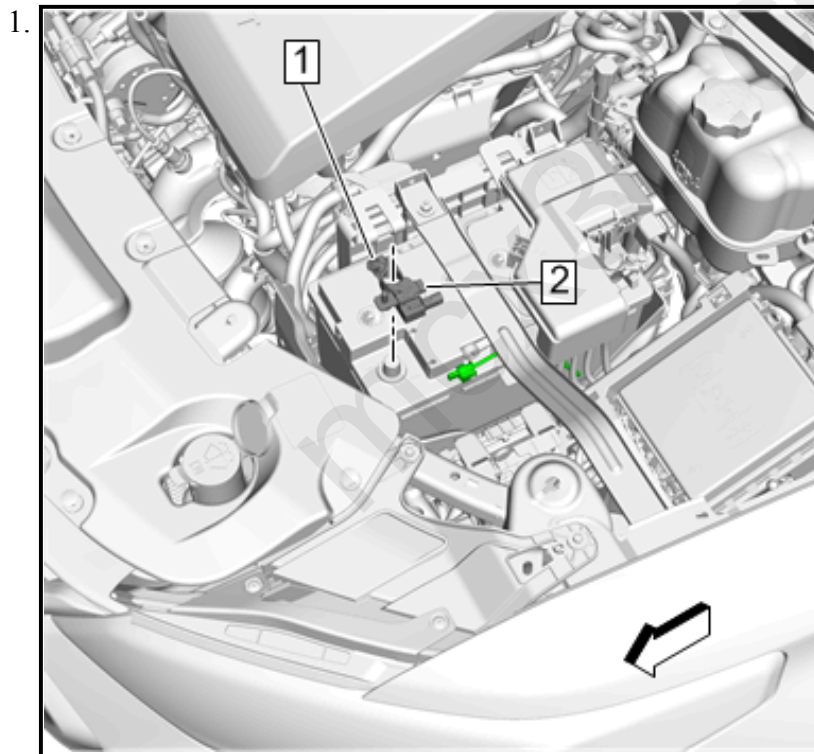




Battery Negative Post Clamp Nut (1) - Loosen

5. Battery Sensor Module (2) - Remove

Installation Procedure

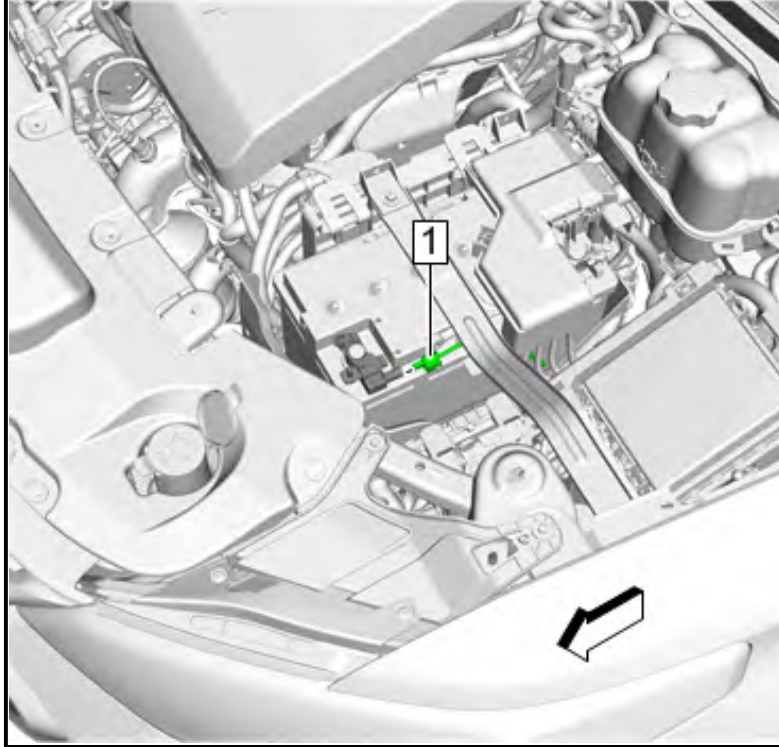


Battery Sensor Module (2) - Install

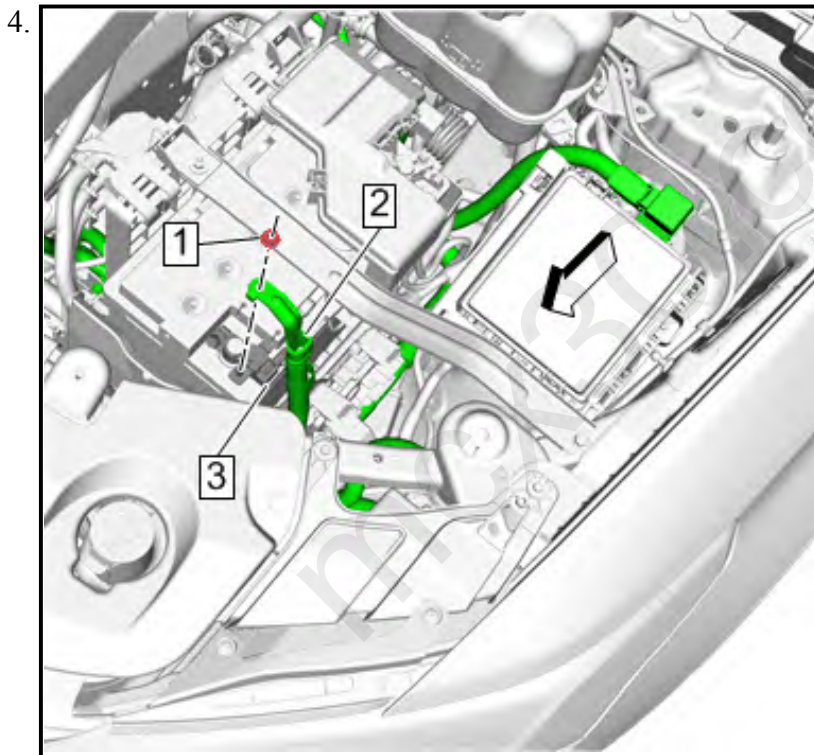
CAUTION: Refer to Fastener Caution

2. Battery Negative Post Clamp Nut (1) - Tighten 4.5 N.m (40 lb in)





Electrical Connector (1) - Connect



Battery Negative Cable (2) - Install

5. Battery Negative Cable Nut (1) @ Battery Sensor Module (3) - Install and tighten 11 N.m (97 lb in)

BATTERY SENSOR MODULE LEARN

Calibration Criteria

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

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

Some instances that will require this procedure to be performed include

- The battery was replaced
- The battery negative cable was disconnected and reconnected
- The battery was improperly charged:

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

- The Battery Sensor Module was not calibrated correctly
- The Battery Sensor Module was disconnected and reconnected
- Vehicle has not been allowed to sit for at least 3 hours over 1 week.

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

Calibration Procedure

NOTE: To complete the battery sensor module calibration, there must be no significant parasitic electrical drain on the battery. If the parasitic electrical drain does not remain below 100 mA during vehicle rest, the calibration will not be completed successfully. Refer to [Battery Electrical Drain/Parasitic Load Test](#)

NOTE: If diagnosing a Stop/Start concern and the negative battery cable was disconnected and reconnected, the Stop/Start feature should function after a power cycle. Please allow vehicle to sit undisturbed for 3 hours to allow the system to relearn successfully.

1. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
2. Let the vehicle rest for a minimum of 3 hours without any interruptions (e.g. without opening vehicle doors, operating vehicle components, using fob buttons etc.).
3. Engine CRANK.
4. Verify the scan tool parameter - Battery Sensor Module Battery State Information parameter reads Available.
 - **If not the specified value**
 - Refer to [Battery Electrical Drain/Parasitic Load Test](#)
 - **Go to next step: If the Specified Value**
5. Verify the scan tool parameter - Battery Sensor Module Reset Occurred - Using Estimated State of Charge reads No.
 - **If not the specified value**
6. Verify if the battery was disconnected for any reason or recently discharged, otherwise check for intermittent battery connections.
 - **Go to next step: If the Specified Value**
7. All OK

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT (LFY)

Removal Procedure

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.

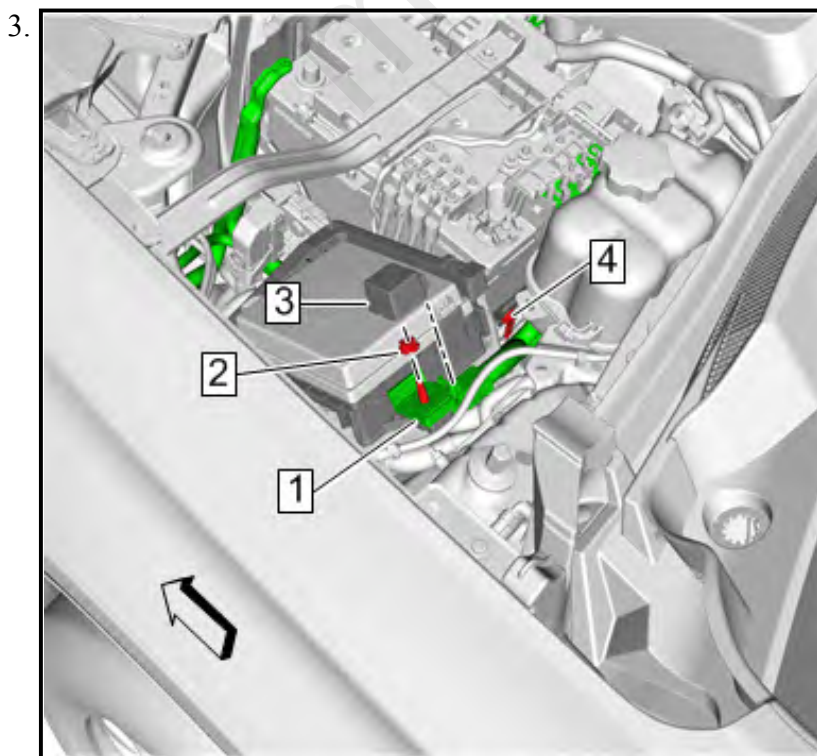
For Vehicles equipped with OnStar® (UE1) with Back Up Battery:

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.



Battery Negative Cable Nut (1) @ Battery Sensor Module (3) - Remove

2. Battery Negative Cable (2) - Reposition away



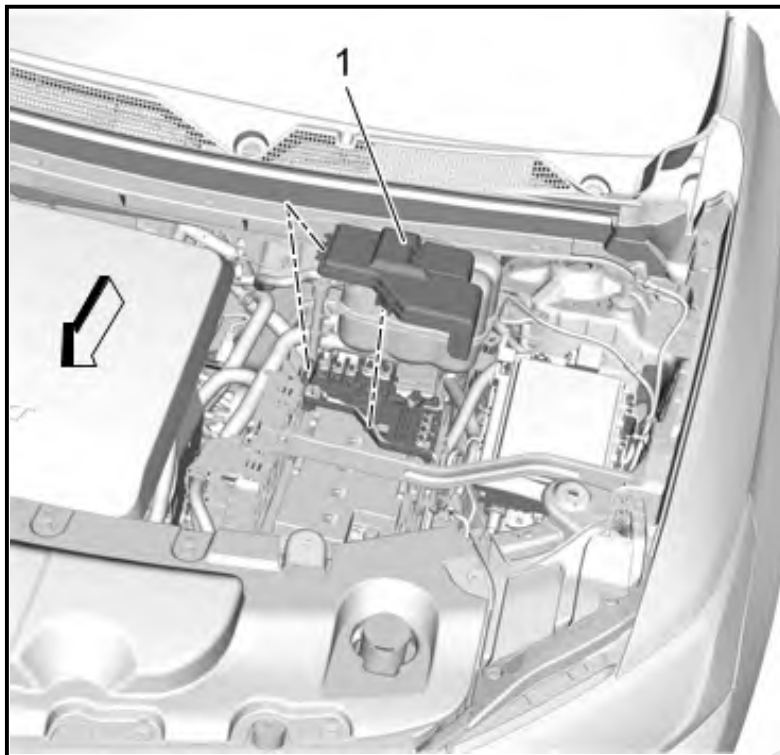
Terminal Cover (3) @ Engine Wiring Harness Junction Block - Remove

4. Engine Wiring Harness Junction Block Nut (2) - Remove

5. Battery Positive Cable (1) - Remove

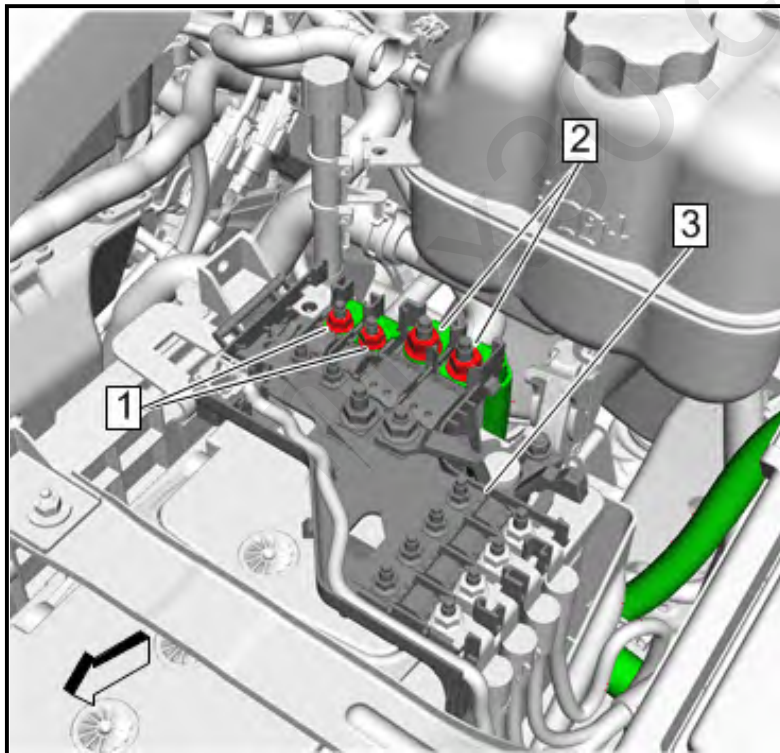
6. Retainer (4) - Disengage

7.



Fuse Block Cover (1) - Remove

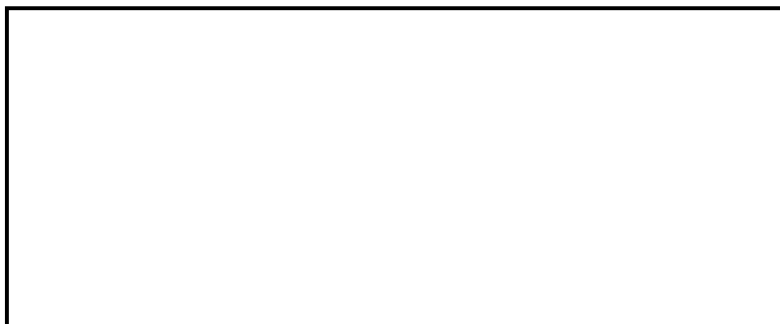
8.

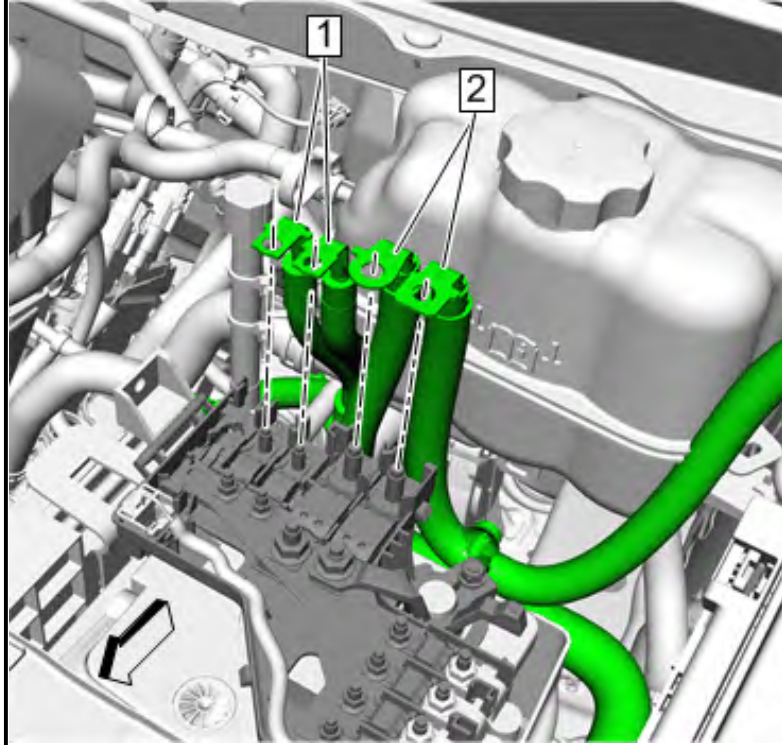


Fuse Block Nut (1) @ Battery Fuse Block (3) - Remove [2x]

9. Fuse Block Nut (2) @ Battery Fuse Block (3) - Remove [2x]

10.

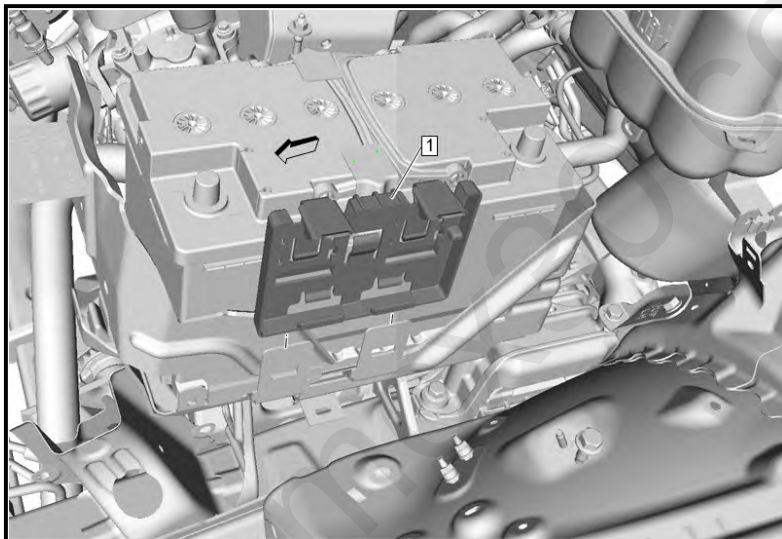




Battery Positive Cable (1) - Remove [2x]

11. Battery Positive Cable (2) - Remove [2x]

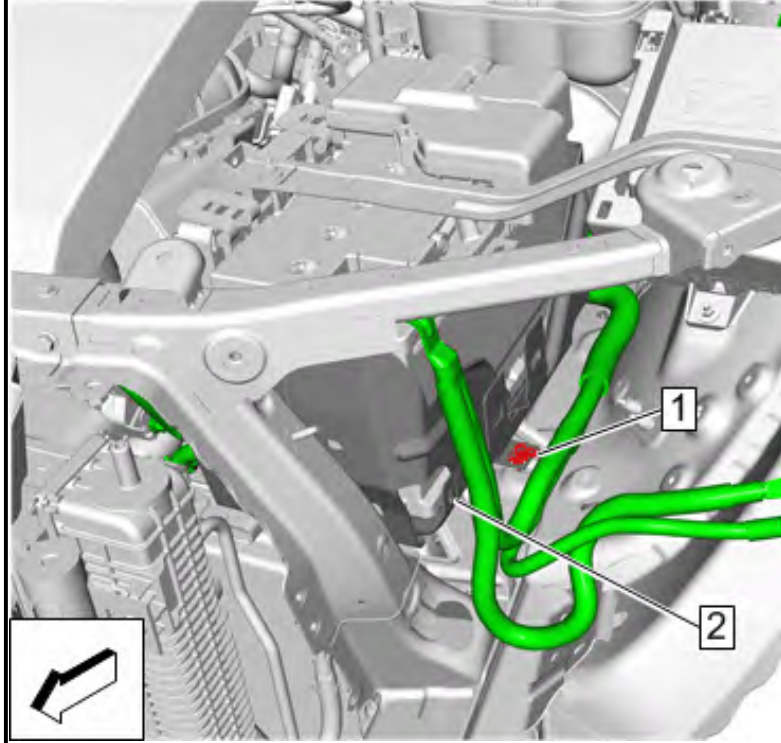
12.



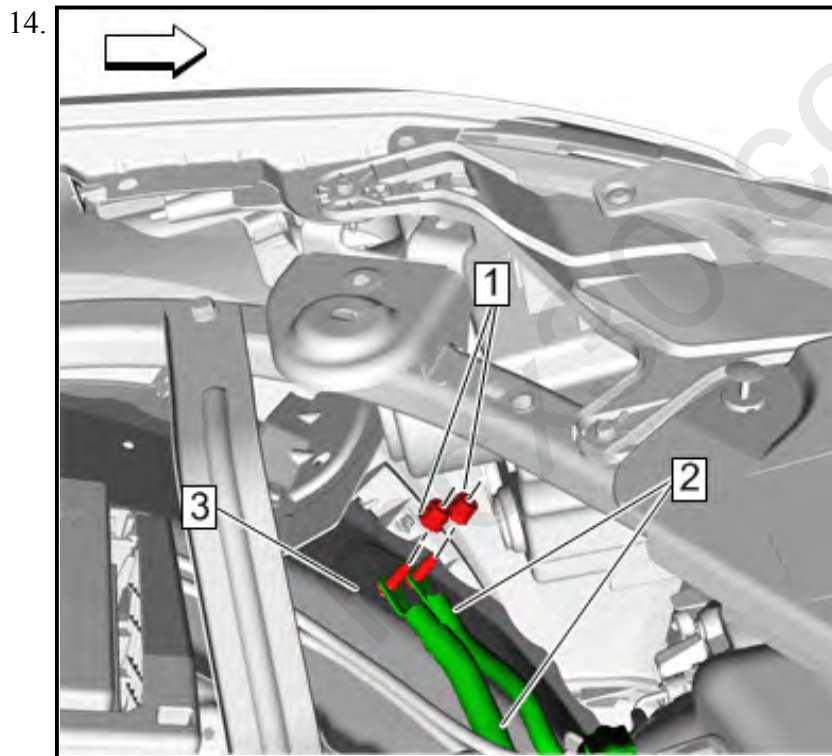
Transmission Control Module Bracket (1) - Remove - [Transmission Control Module Bracket Replacement](#)

13.





Retainer (1) @ Battery Tray (2) - Disengage



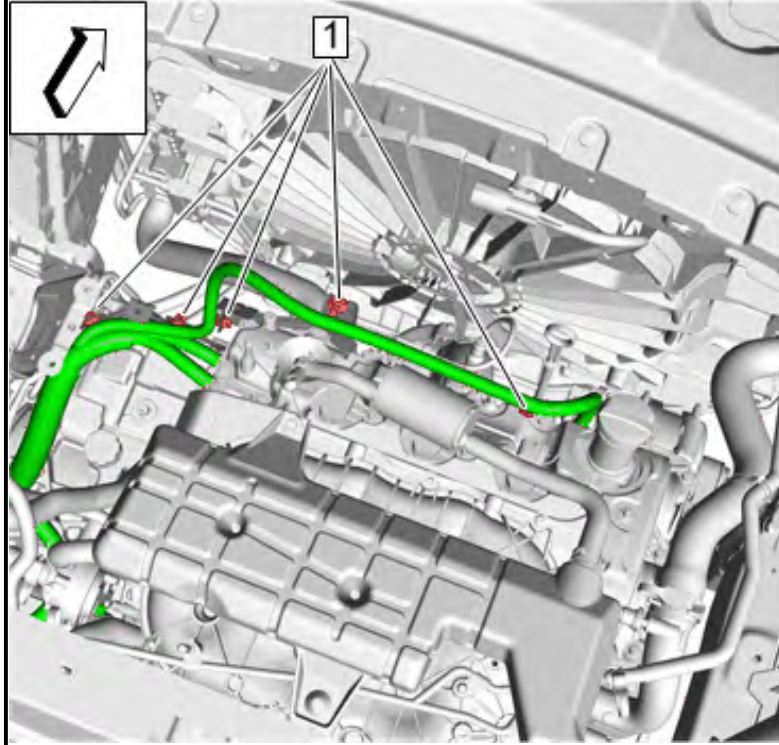
Battery Negative Cable Ground Nut (1) @ Front Wheel Well Extension (3) - Remove [2x]

15. Battery Negative Cable (2) - Remove [2x]

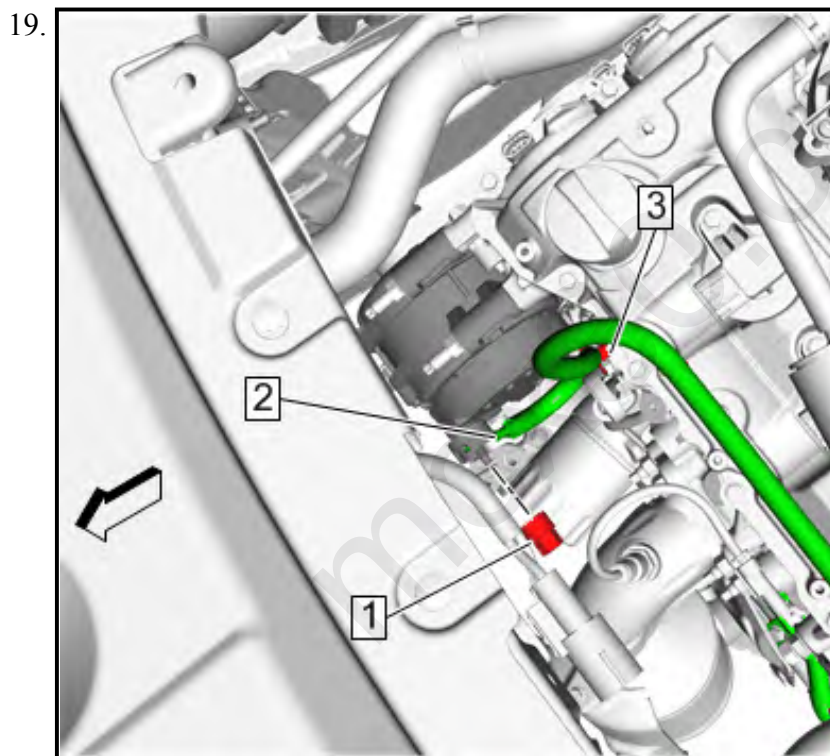
16. Remove the battery tray. [Battery Tray Replacement](#)

17. Remove the intake manifold cover. [Intake Manifold Cover Replacement](#)





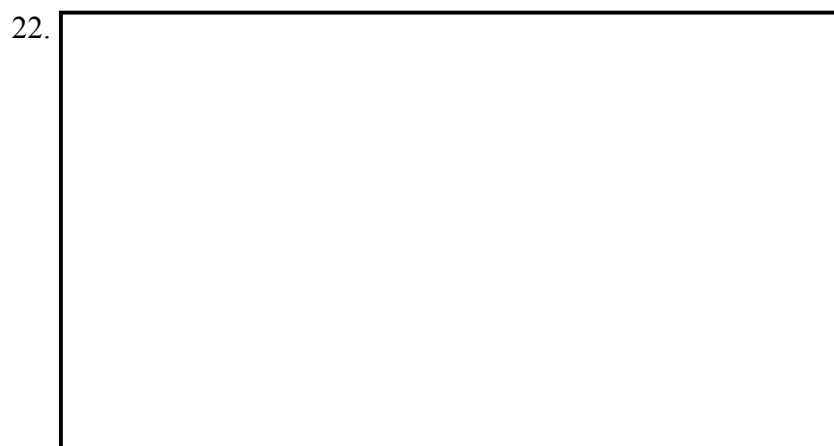
Retainer (1) - Disengage [5x]

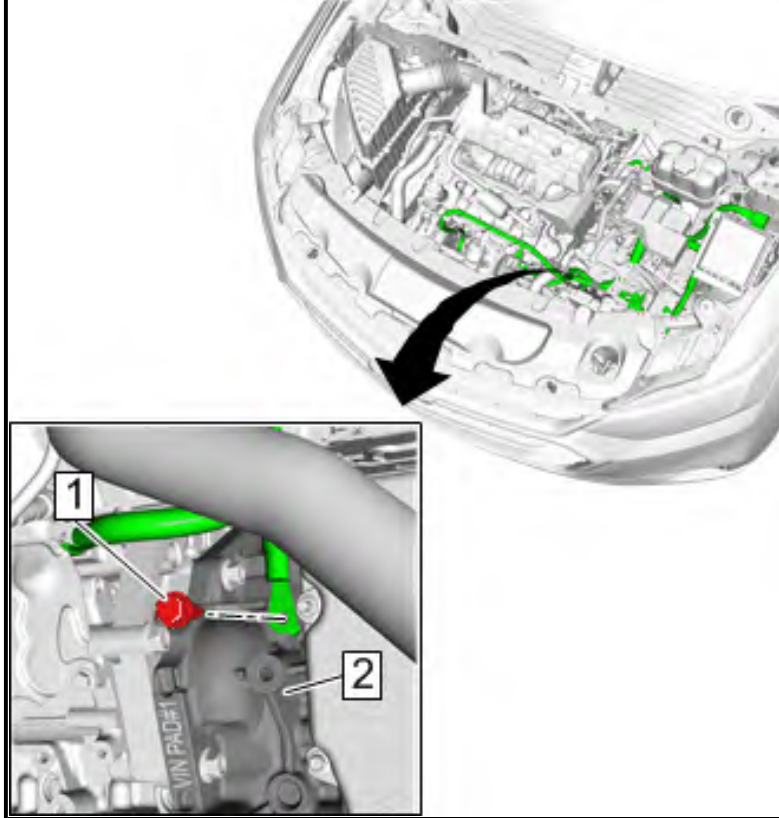


Generator Fastener (1) - Remove

20. Battery Positive Cable (2) - Remove

21. Retainer (3) - Disengage

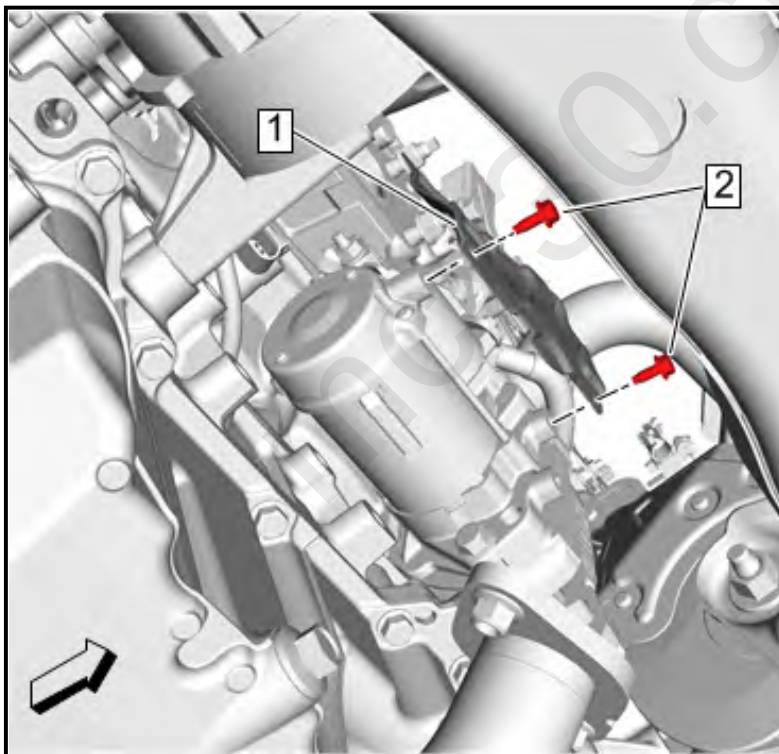




Battery Negative Cable Bolt (1) @ Transfer Case (2) - Remove

23. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

24.



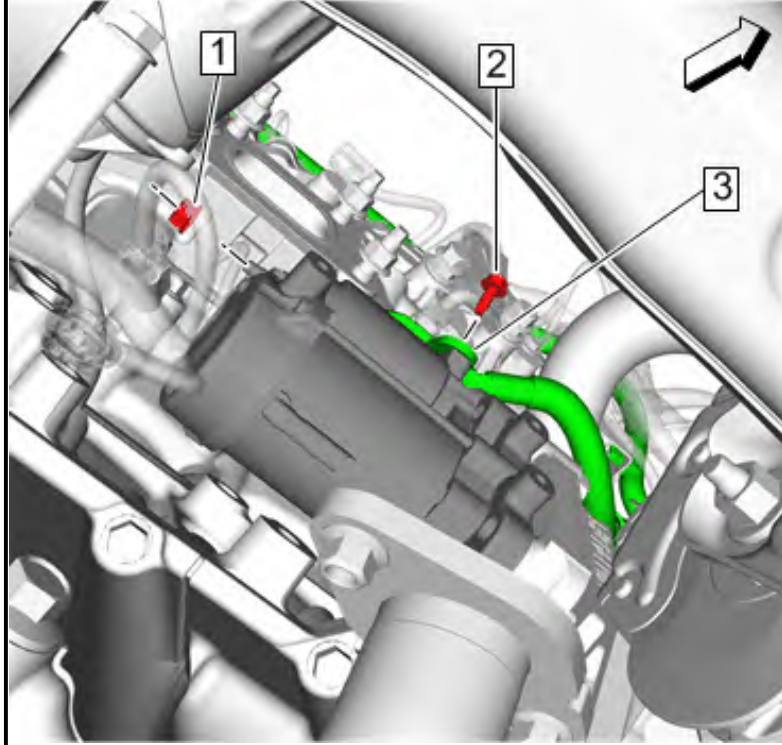
NOTE: Catalytic converter removed for graphic clarity.

Starter Heat Shield Fastener (2) - Remove [2x]

25. Starter Heat Shield (1) - Remove

26.



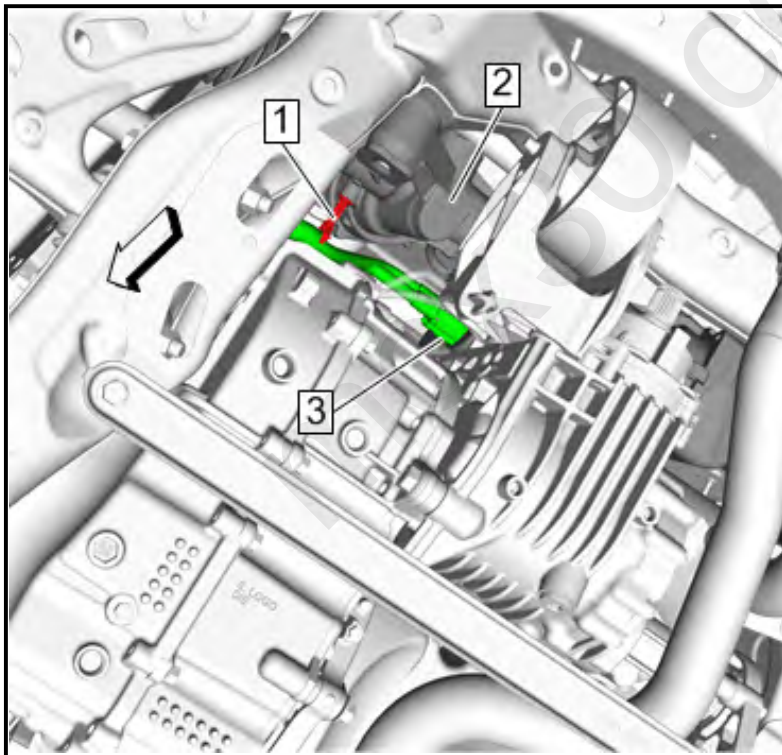


Battery Positive and Negative Cable Conduit Bolt (2) - Remove

27. Battery Positive Cable Nut (1) @ Starter Solenoid - Remove

28. Battery Positive Cable (3) - Remove

29.



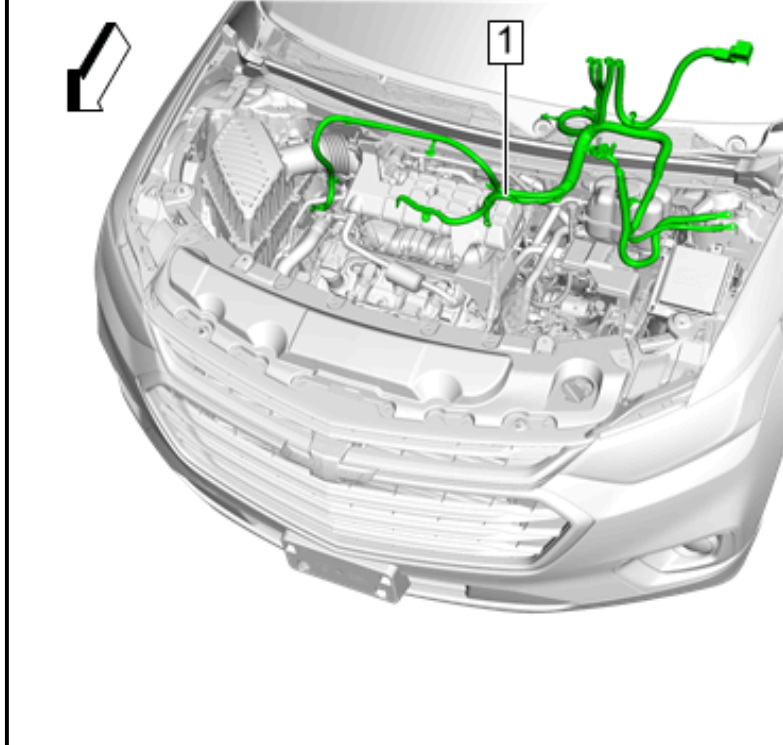
Electrical Connector (3) @ Steering Gear Assembly (2) - Disconnect

30. Retainer (1) - Disengage

31. Lower the vehicle.

32.



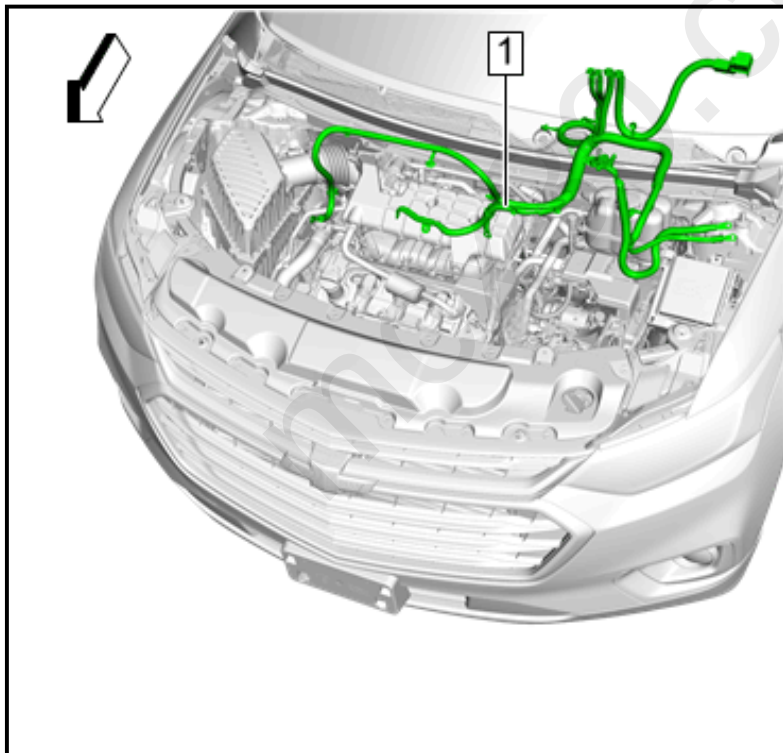


NOTE: Note the routing of battery positive and negative cable for ease of installation.

Battery Positive and Negative Cable (1) - Remove

Installation Procedure

1.

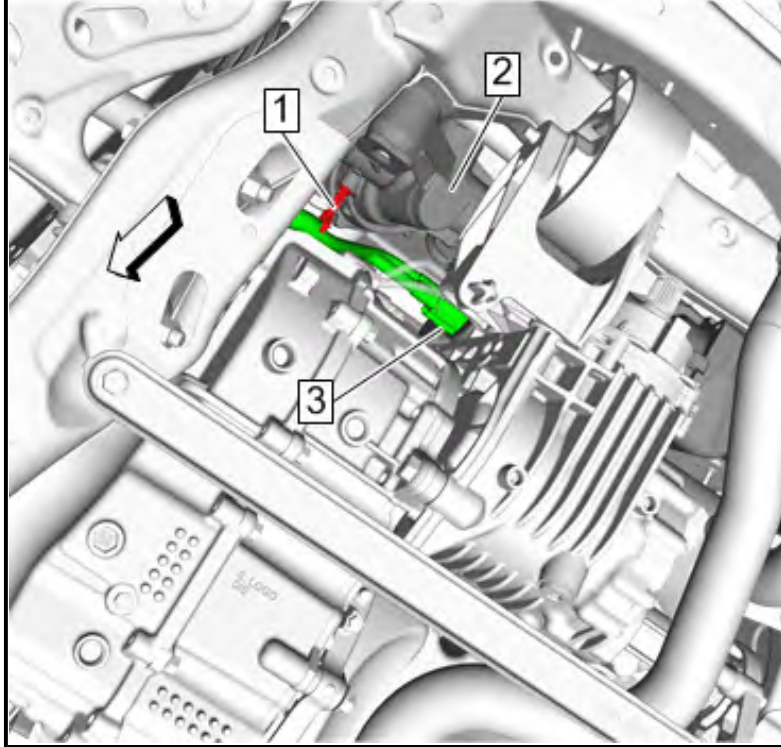


Battery Positive and Negative Cable (1) - Install

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

3.

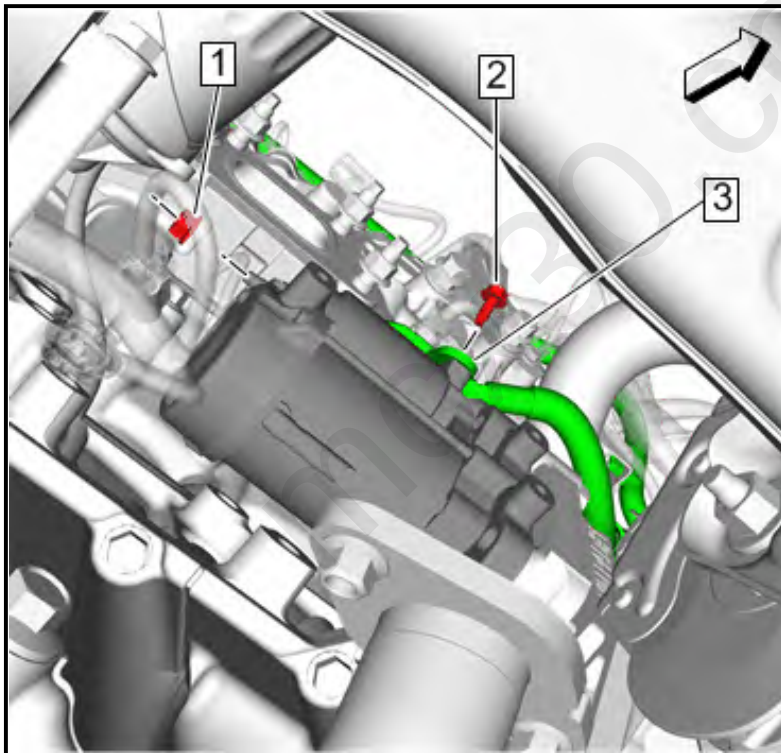




Electrical Connector (3) @ Steering Gear Assembly (2) - Connect

4. Retainer (1) - Engage

5.



Battery Positive Cable (3) - Install

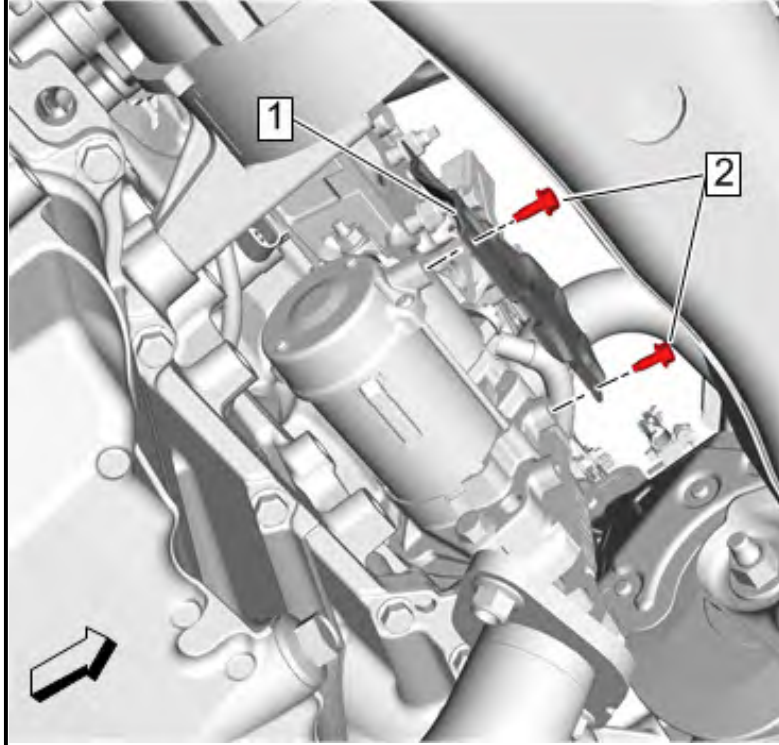
CAUTION: Refer to Fastener Caution

6. Battery Positive Cable Nut (1) @ Starter Solenoid - Install and tighten 12.5 N.m (111 lb in)

7. Battery Positive and Negative Cable Conduit Bolt (2) - Install and tighten 9 N.m (80 lb in)

8.

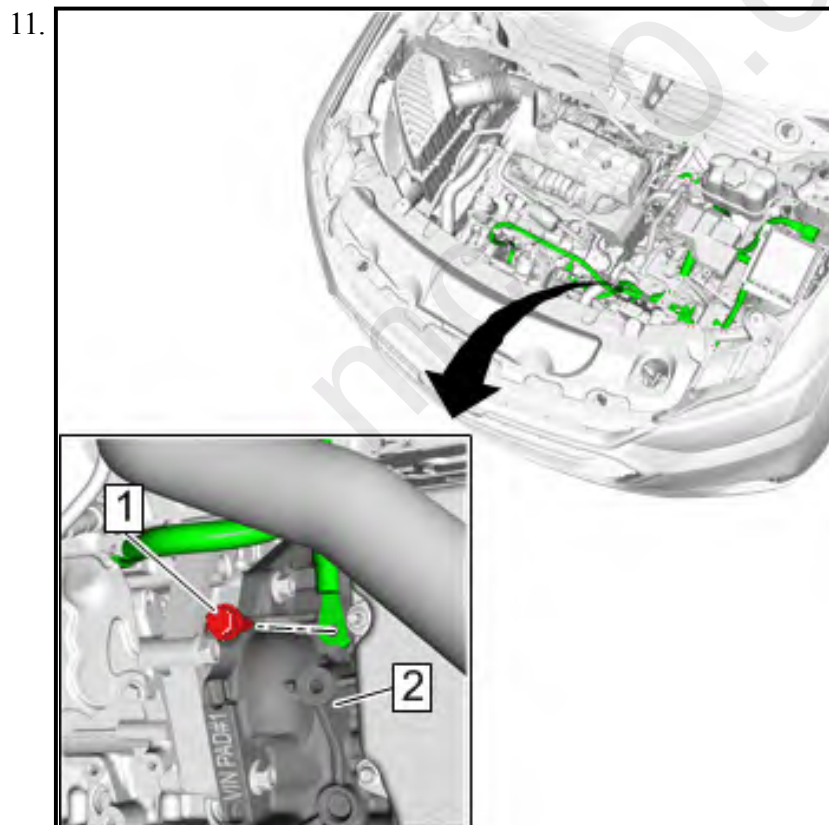




NOTE: Catalytic converter removed for graphic clarity.

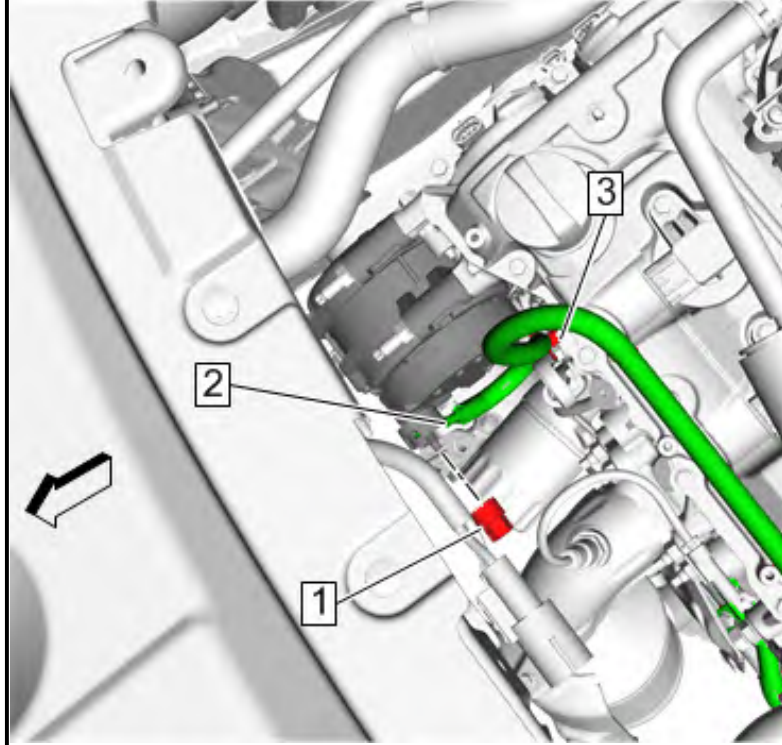
Starter Heat Shield (1) - Install

9. Starter Heat Shield Fastener (2) - Install and tighten [2x] 9 N.m (80 lb in)
10. Lower the vehicle.



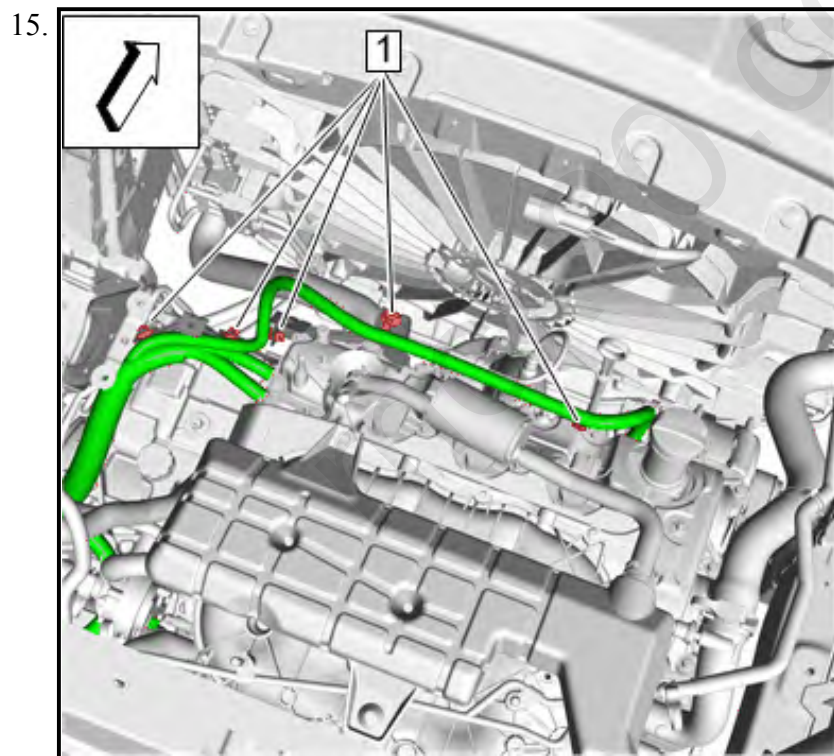
Battery Negative Cable Bolt (1) @ Transfer Case (2) - Install and tighten 22 N.m (16 lb ft)



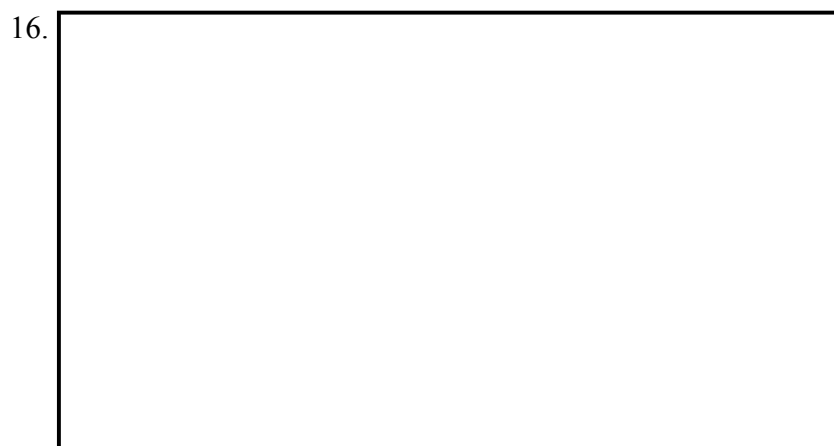


Battery Positive Cable (2) - Install

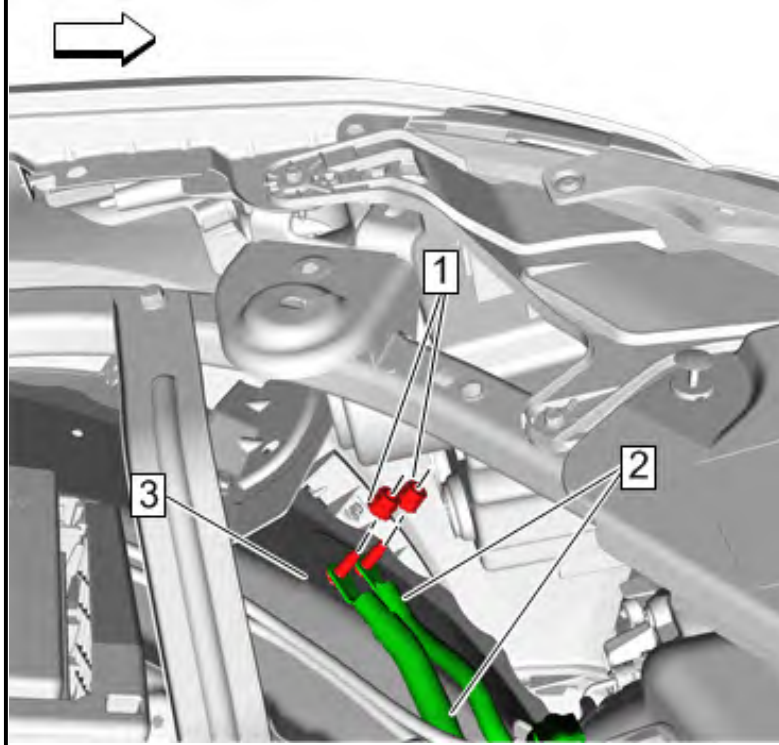
13. Generator Fastener (1) - Install and tighten 15 N.m (11 lb ft)
14. Retainer (3) - Engage



Retainer (1) - Engage [5x]

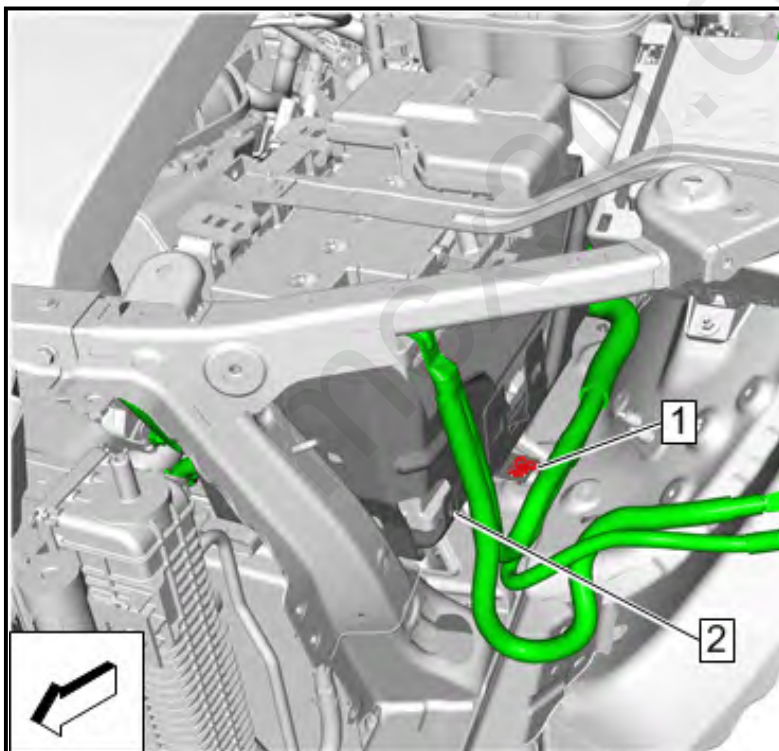


- 16.



Battery Negative Cable (2) - Install [2x]

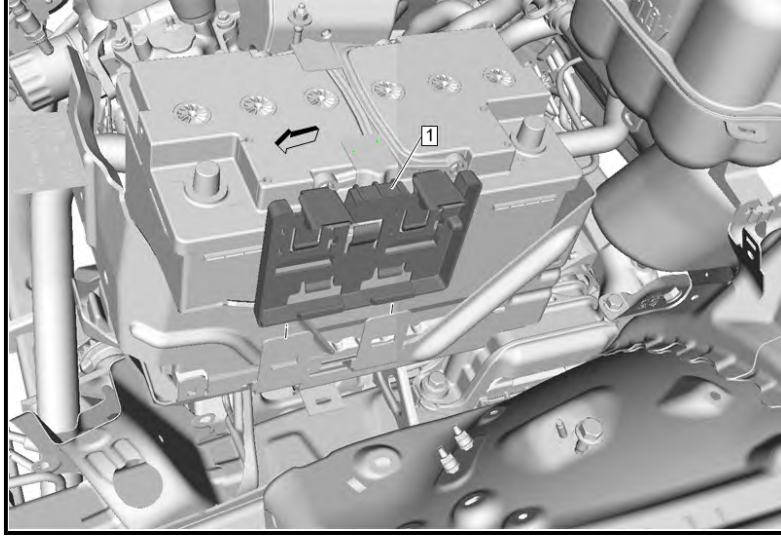
17. Battery Negative Cable Ground Nut (1) @ Front Wheel Well Extension (3) - Install and tighten [2x] 9 N.m (80 lb in)
18. Install the battery tray. [Battery Tray Replacement](#)
- 19.



Retainer (1) @ Battery Tray (2) - Engage

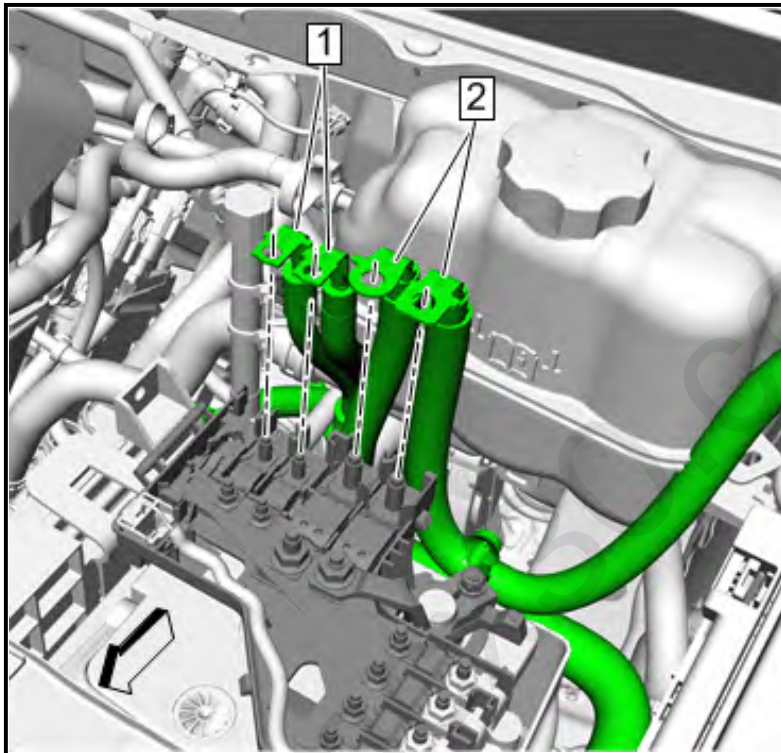
- 20.





Transmission Control Module Bracket (1) - Install - [Transmission Control Module Bracket Replacement](#)

21.

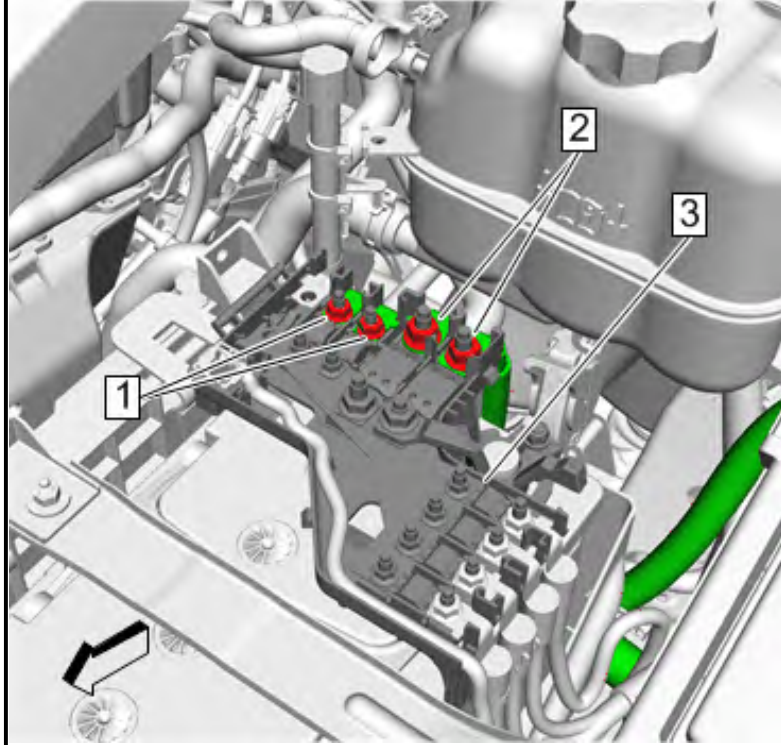


Battery Positive Cable (1) - Install [2x]

22. Battery Positive Cable (2) - Install [2x]

23.

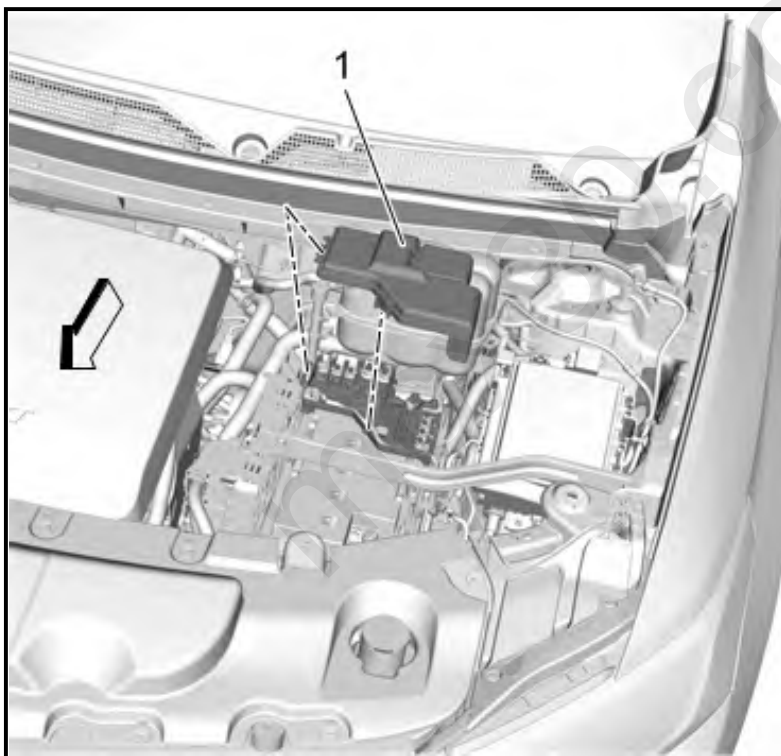




Fuse Block Nut (2) @ Battery Fuse Block (3) - Install and tighten [2x] 16 N.m (12 lb ft)

24. Fuse Block Nut (1) @ Battery Fuse Block (3) - Install and tighten [2x] 9 N.m (80 lb in)

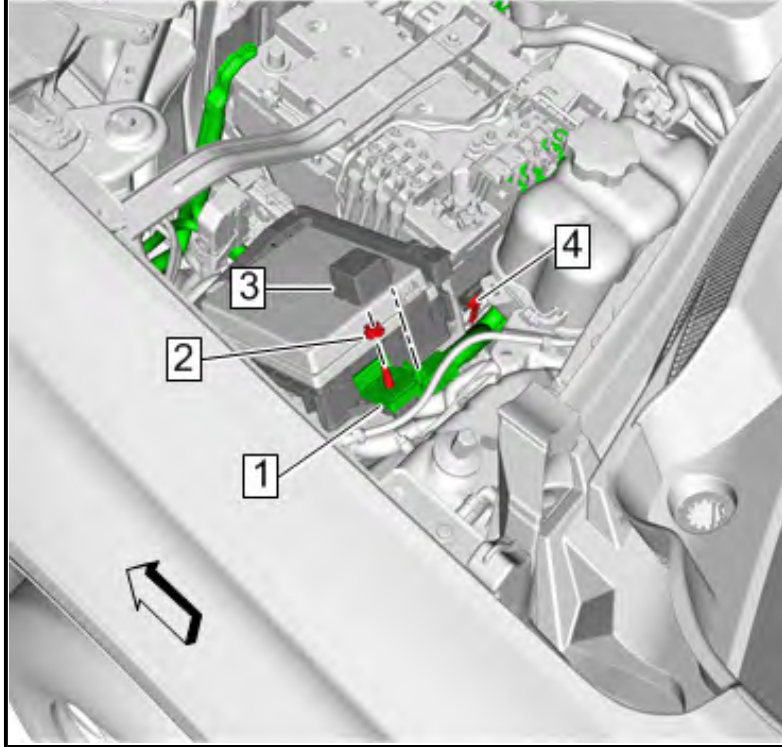
25.



Fuse Block Cover (1) - Install

26.

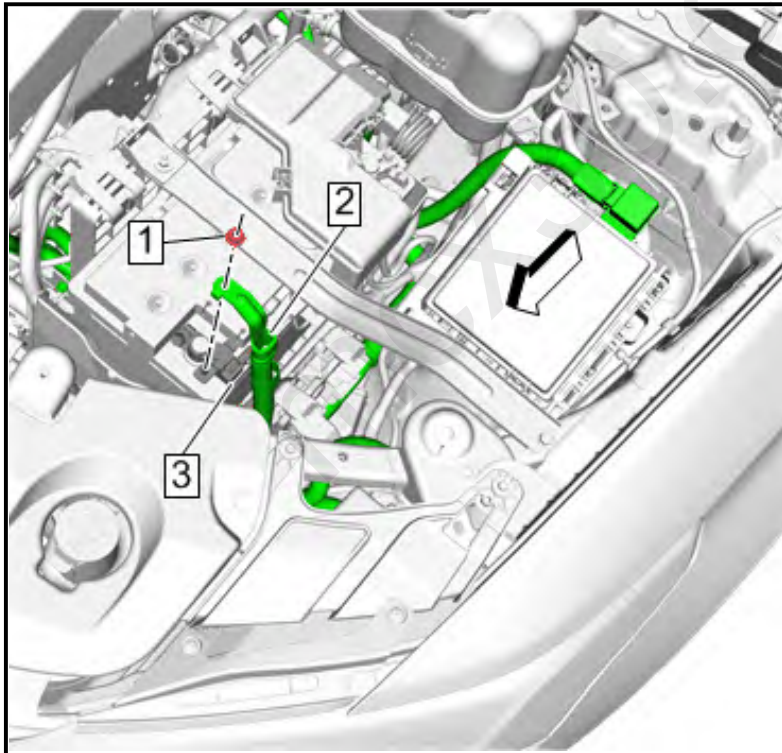




Battery Positive Cable (1) - Install

27. Engine Wiring Harness Junction Block Nut (2) - Install and tighten 16 N.m (12 lb ft)
28. Terminal Cover (3) @ Engine Wiring Harness Junction Block - Install
29. Retainer (4) - Engage

30.



Battery Negative Cable (2) - Install

31. Battery Negative Cable Nut (1) @ Battery Sensor Module (3) - Install and tighten 11 N.m (97 lb in)

BATTERY POSITIVE AND NEGATIVE CABLE REPLACEMENT (LTG)

Removal Procedure

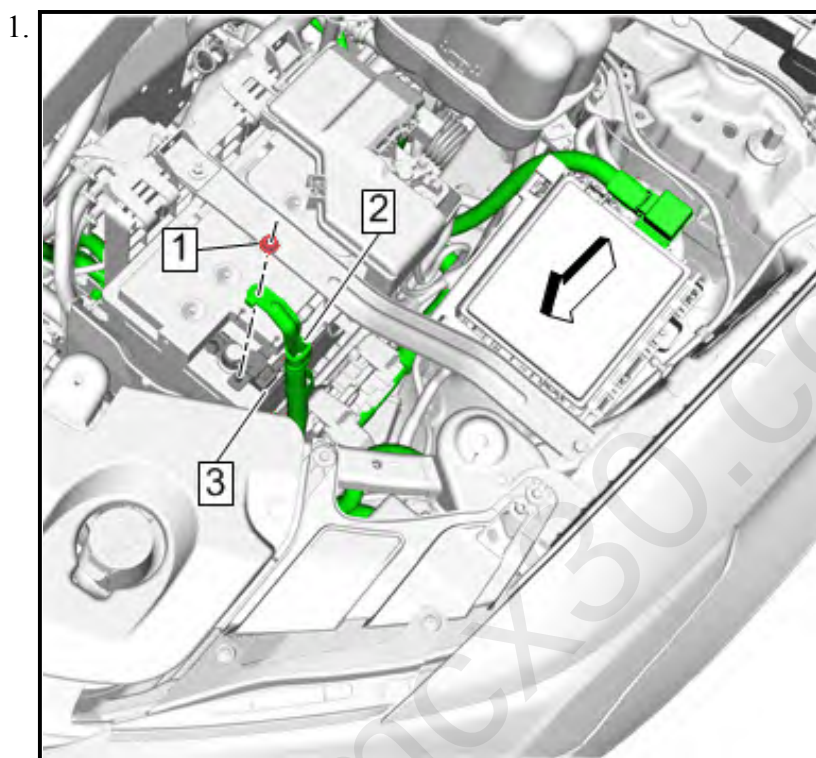
WARNING:

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:

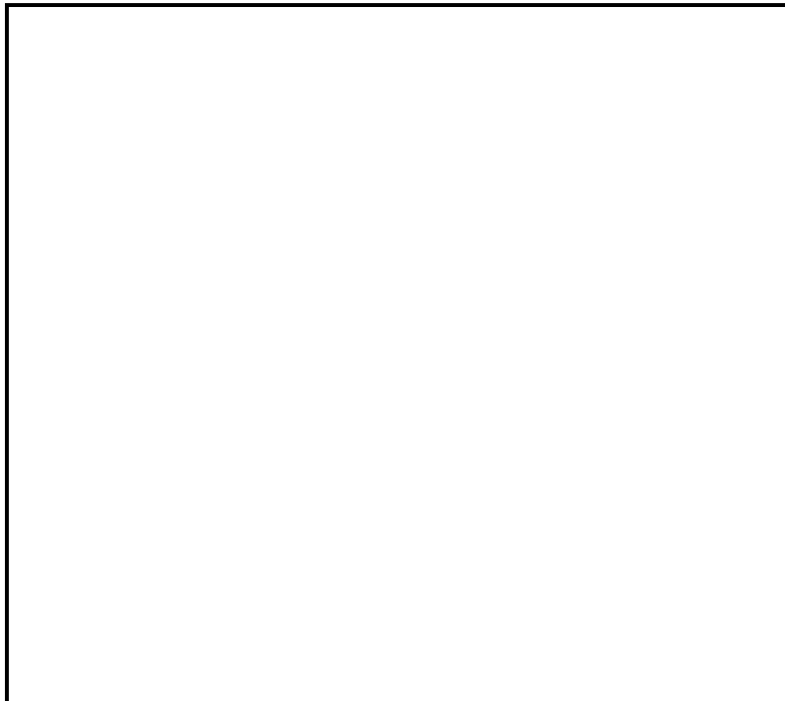
The Back Up Battery is a redundant power supply to allow limited OnStar® functionality in the event of a main vehicle battery power disruption to the VCIM (OnStar® module). Do not disconnect the main vehicle battery or remove the OnStar® fuse with the ignition key in any position other than OFF. Retained 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.

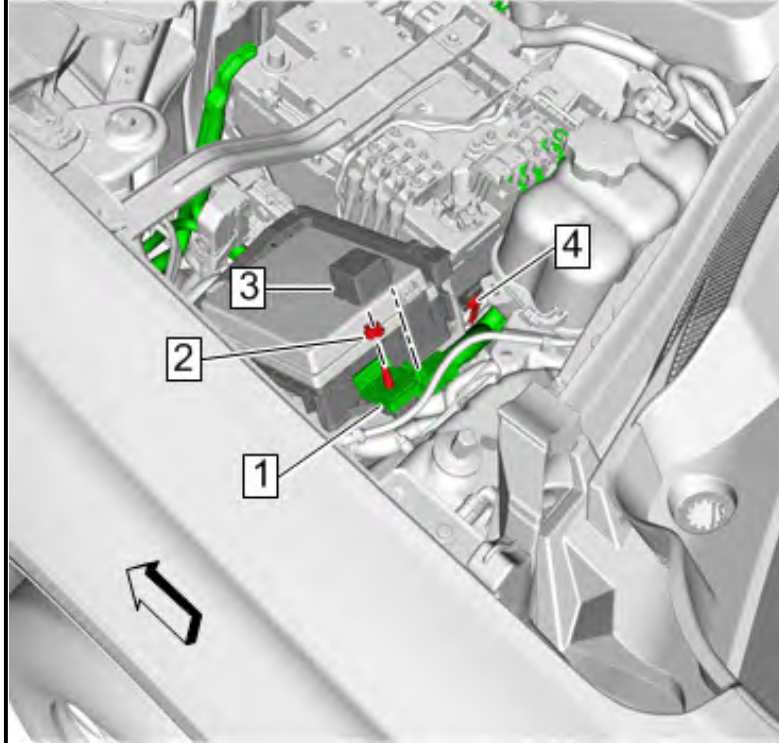


Battery Negative Cable Nut (1) @ Battery Sensor Module (3) - Remove

2. Battery Negative Cable (2) - Reposition away

3.

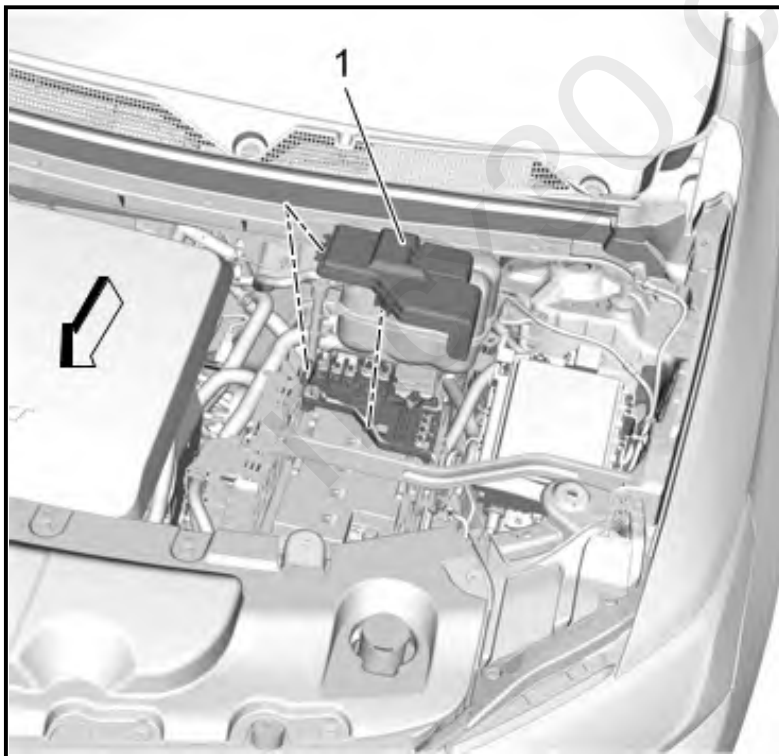




Terminal Cover (3) @ Engine Wiring Harness Junction Block - Remove

4. Engine Wiring Harness Junction Block Nut (2) - Remove
5. Battery Positive Cable (1) - Remove
6. Retainer (4) - Disengage

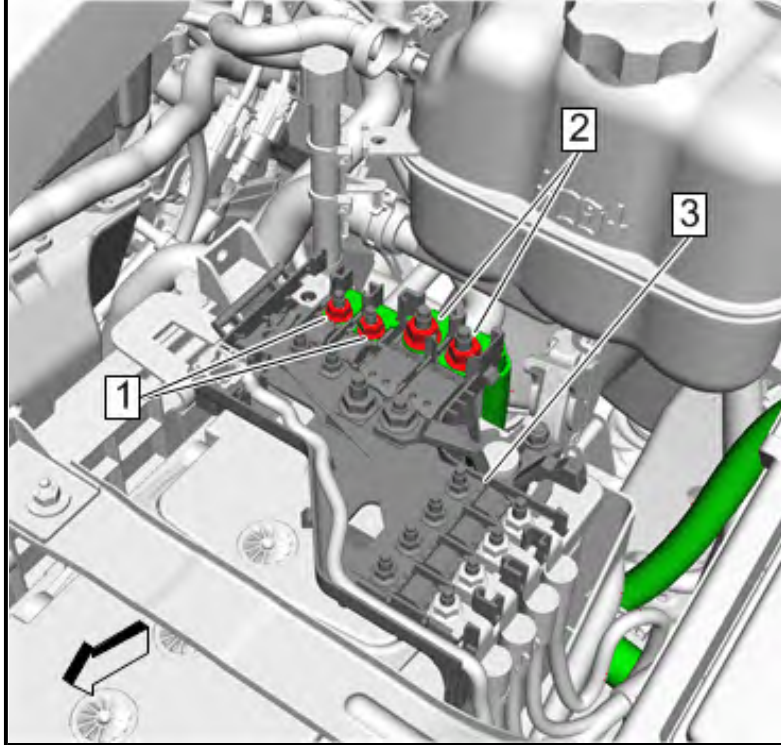
7.



Fuse Block Cover (1) - Remove

8.

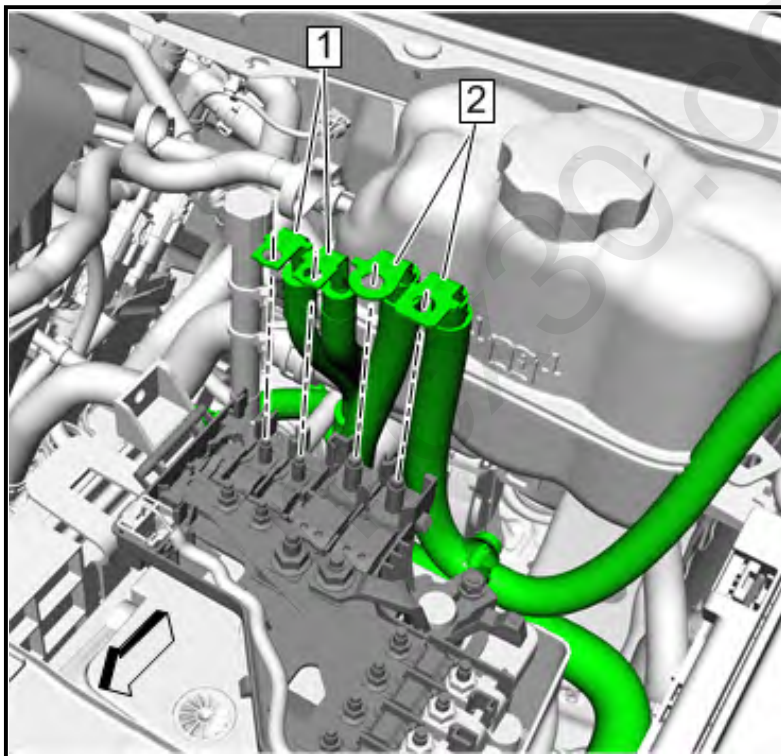




Fuse Block Nut (1) @ Battery Fuse Block (3) - Remove [2x]

9. Fuse Block Nut (2) @ Battery Fuse Block (3) - Remove [2x]

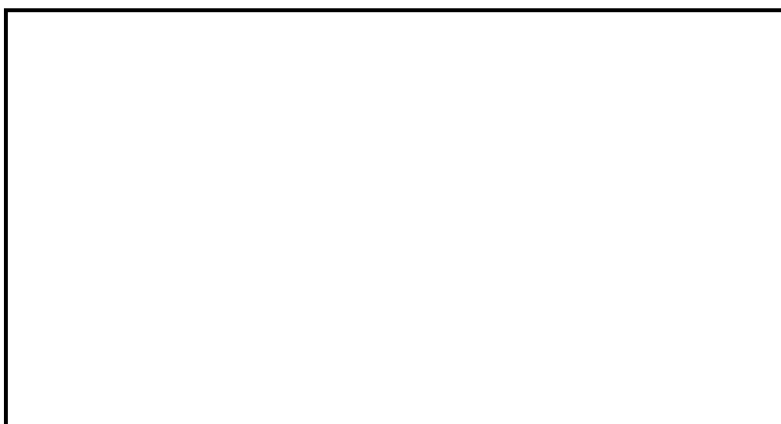
10.

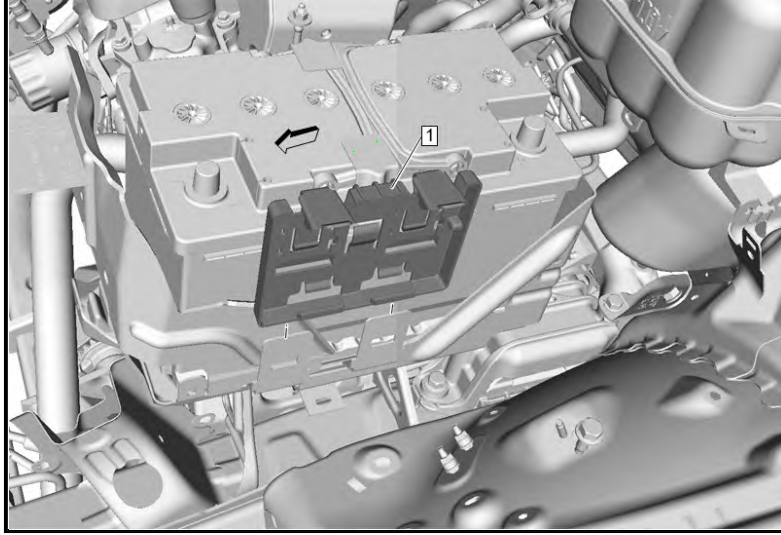


Battery Positive Cable (1) - Remove [2x]

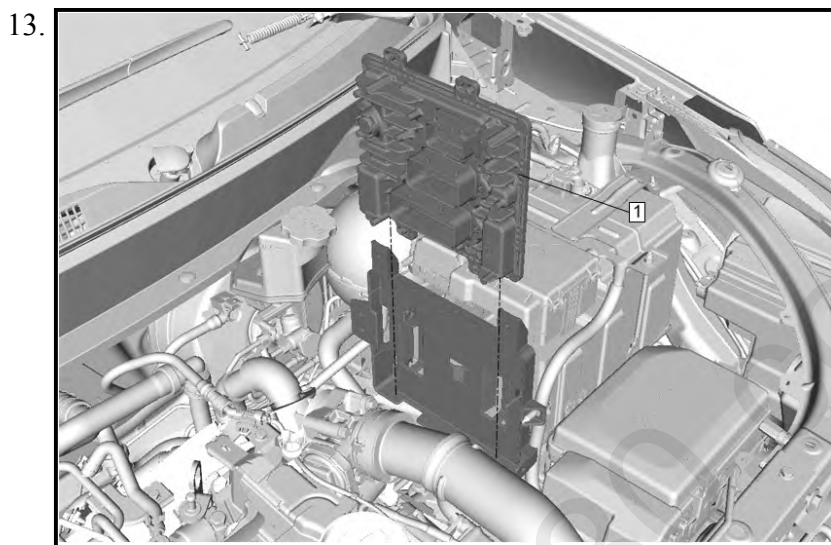
11. Battery Positive Cable (2) - Remove [2x]

12.

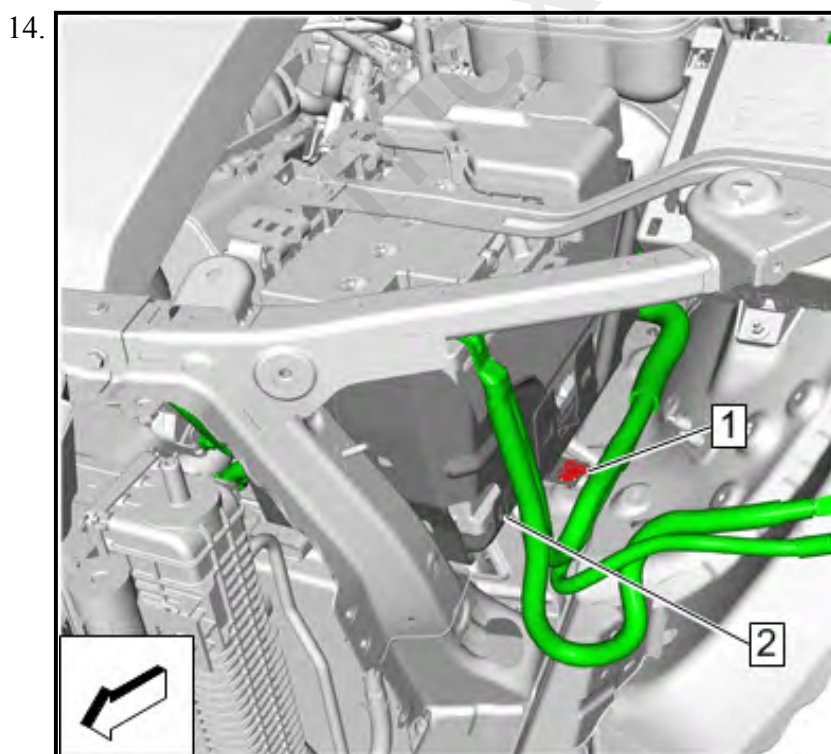




Transmission Control Module Bracket (1) - Remove - [Transmission Control Module Bracket Replacement](#)

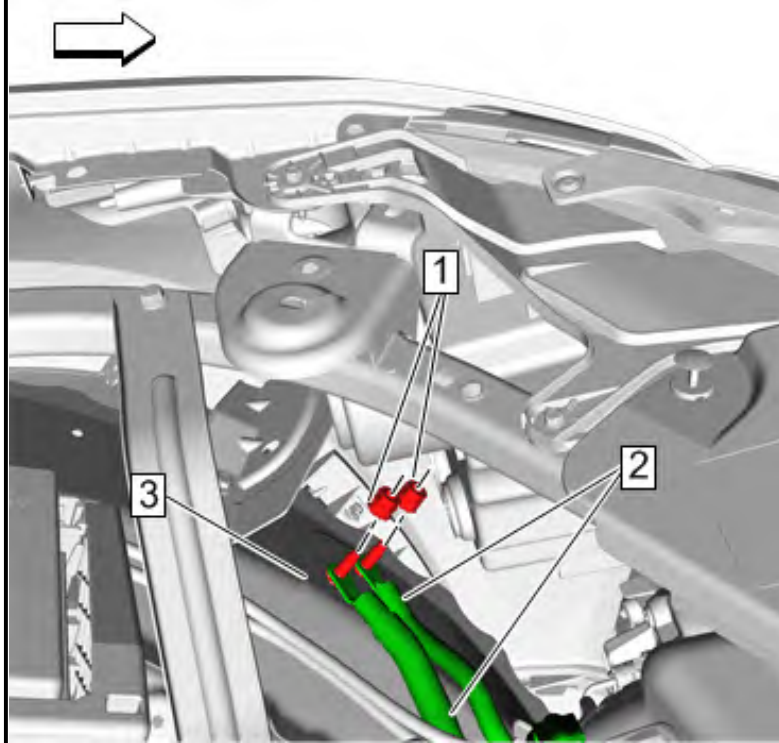


Engine Control Module (1) - Remove - [Engine Control Module Replacement](#)



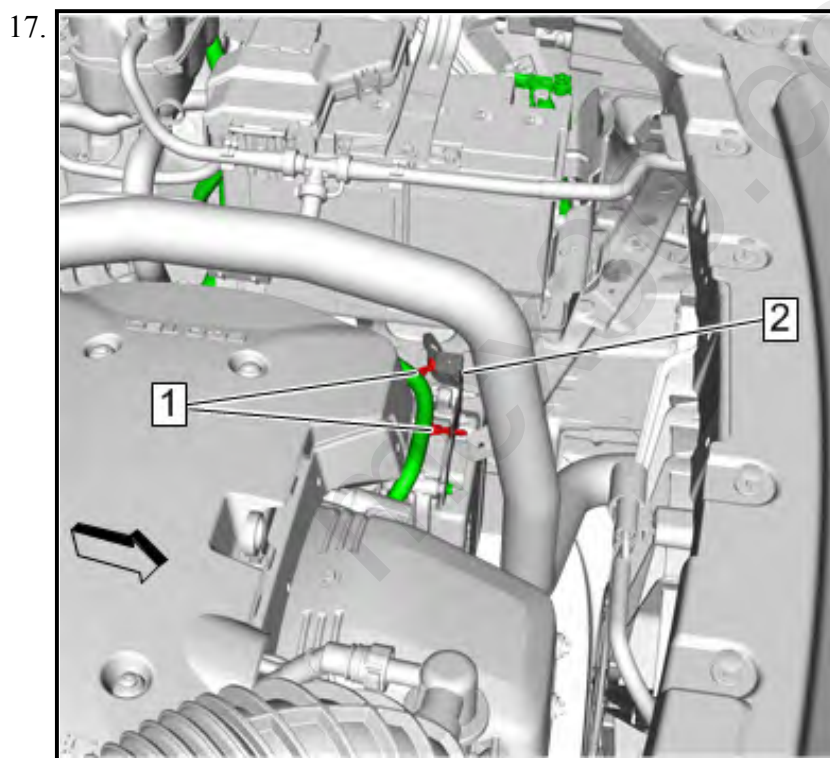
Retainer (1) @ Battery Tray (2) - Disengage





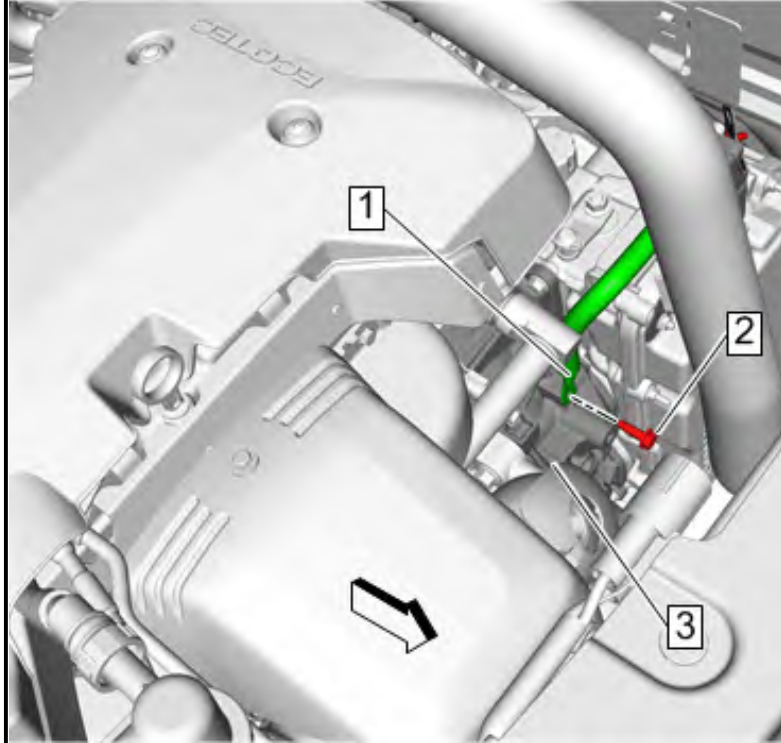
Battery Negative Cable Ground Nut (1) @ Front Wheel Well Extension (3) - Remove [2x]

16. Battery Negative Cable (2) - Remove [2x]



Retainer (1) @ Transmission Wiring Harness Bracket (2) - Disengage [2x]



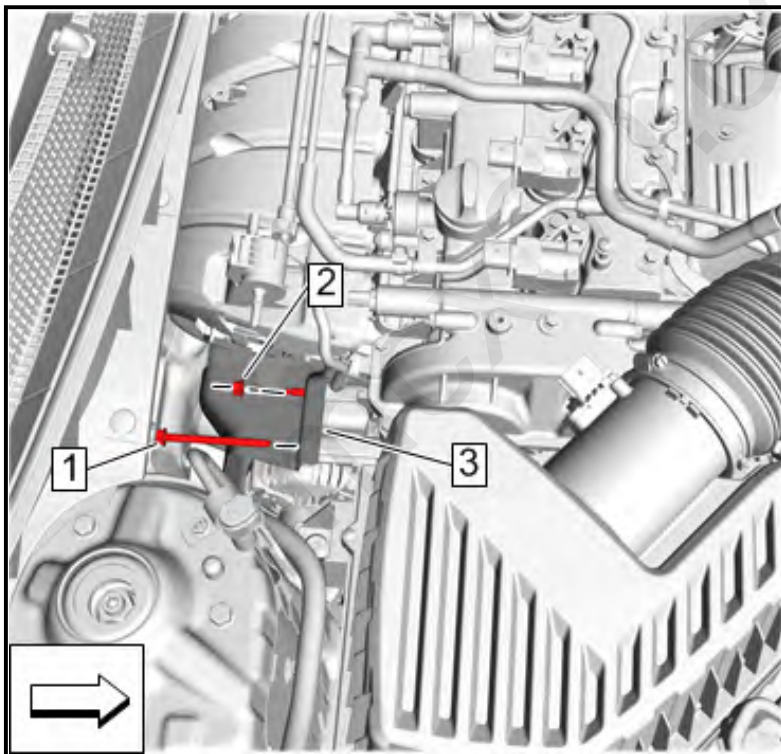


Battery Negative Cable Ground Bolt (2) @ Transmission (3) - Remove

19. Battery Negative Cable (1) - Remove

20. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

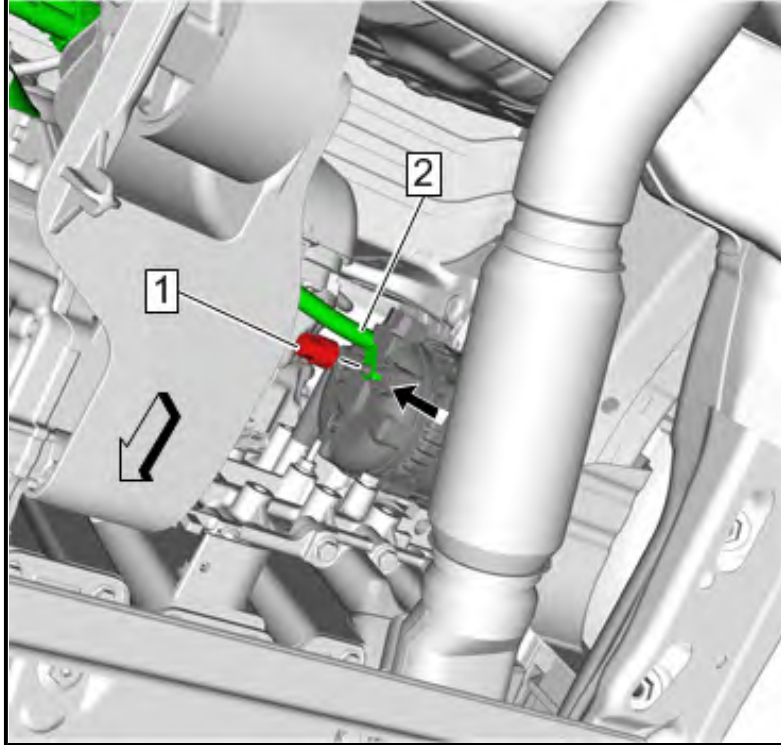
21.



Generator Shield (3) - Remove - [Generator Shield Replacement \(LTG\)](#)

22.

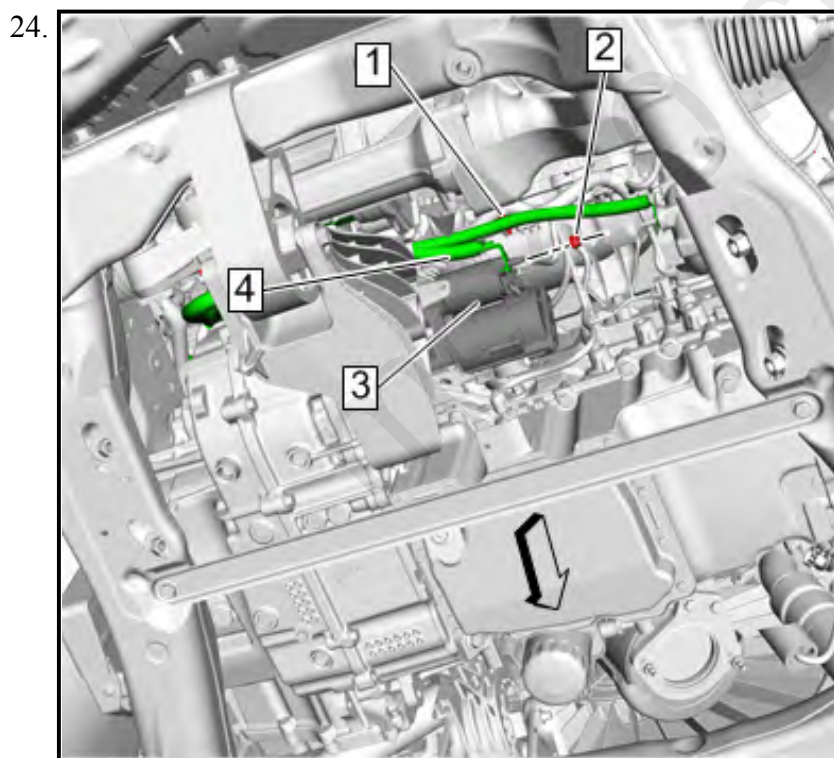




NOTE: Note the orientation of the terminal locking tab in the 4 o'clock position.

Battery Positive Cable Nut (1) - Remove

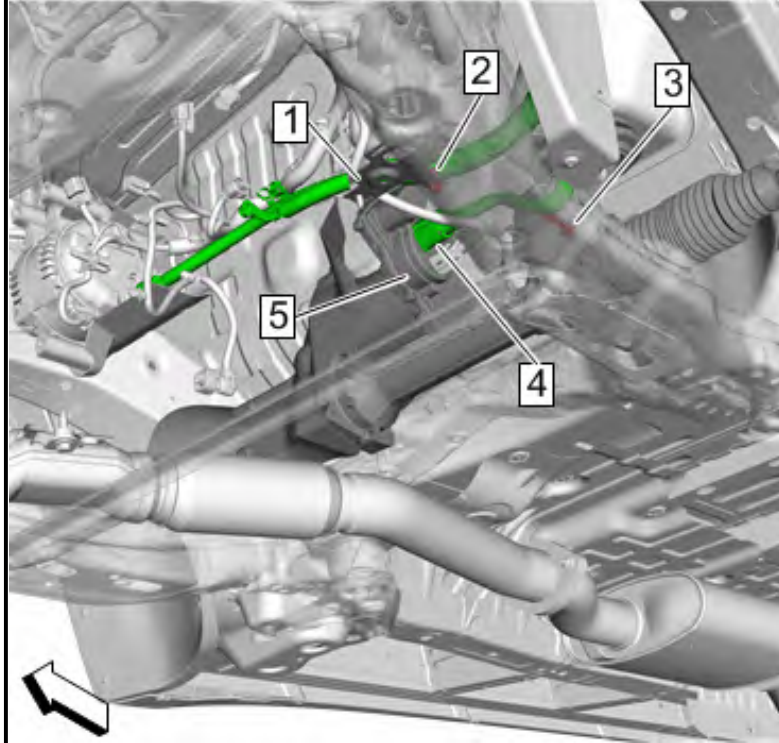
23. Battery Positive Cable (2) - Remove



Battery Positive Cable Nut (2) @ Starter Solenoid (3) - Remove

25. Battery Positive Cable (4) - Remove





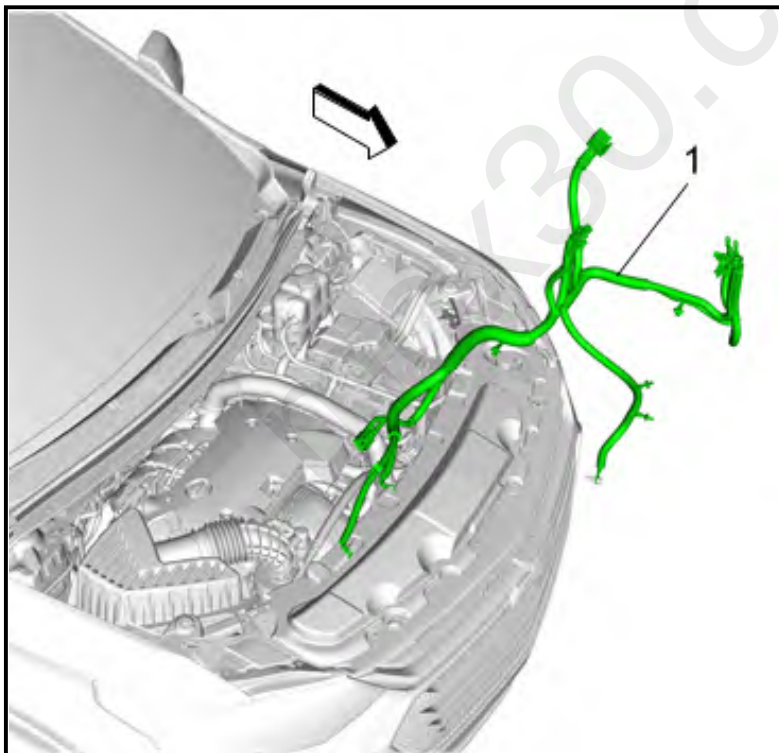
Electrical Connector (4) @ Steering Gear Motor (5) - Disconnect

27. Retainer (2) @ Heater Water Auxiliary Pump Bracket (1) - Disengage

28. Retainer (3) @ Steering Gear Assembly - Disengage

29. Lower the vehicle.

30.



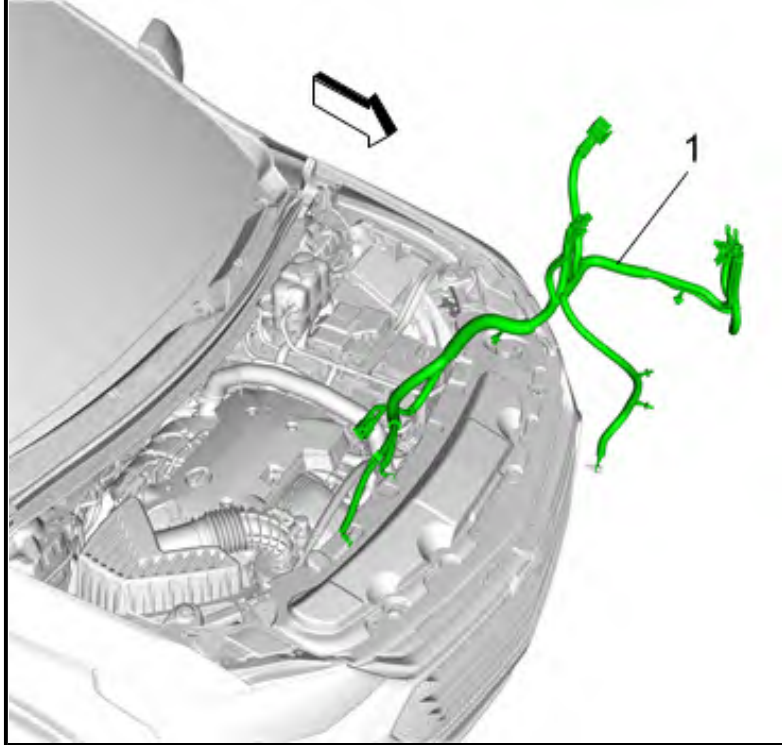
NOTE: Note the routing of battery positive and negative cable for ease of installation.

Battery Positive and Negative Cable (1) - Remove

Installation Procedure

1.

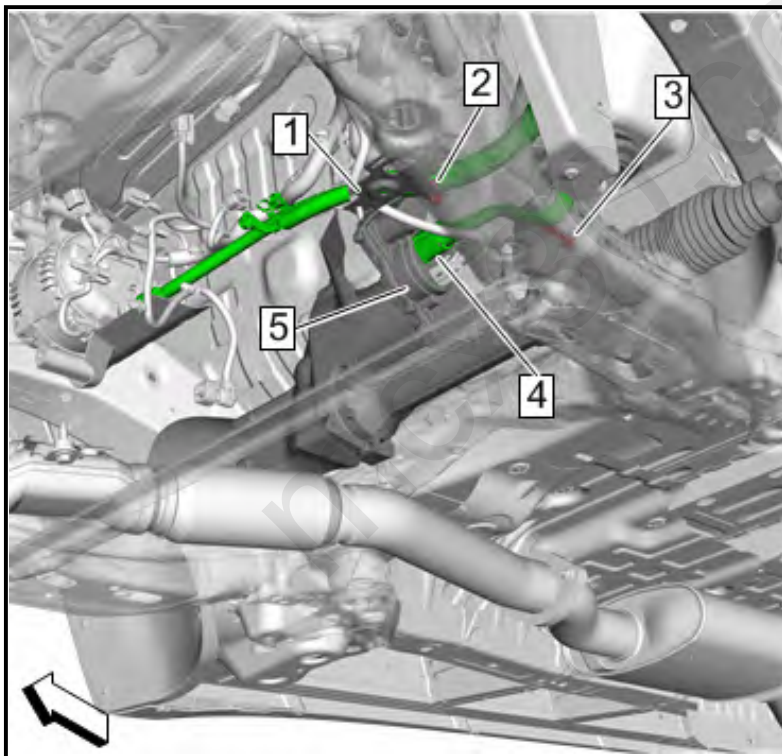




Battery Positive and Negative Cable (1) - Install

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

3.



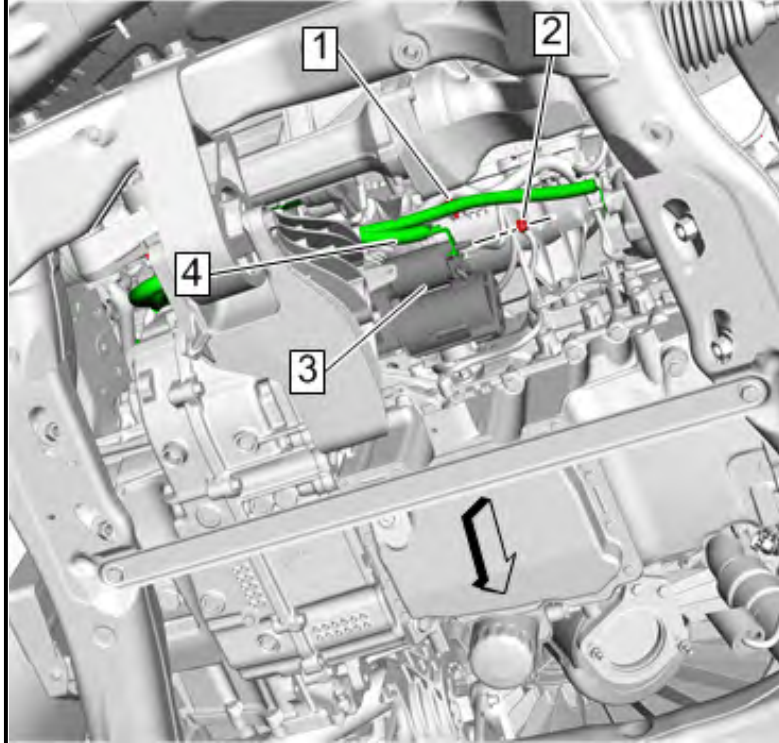
Electrical Connector (4) @ Steering Gear Motor (5) - Connect

4. Retainer (2) @ Heater Water Auxiliary Pump Bracket (1) - Engage

5. Retainer (3) @ Steering Gear Assembly - Engage

6.



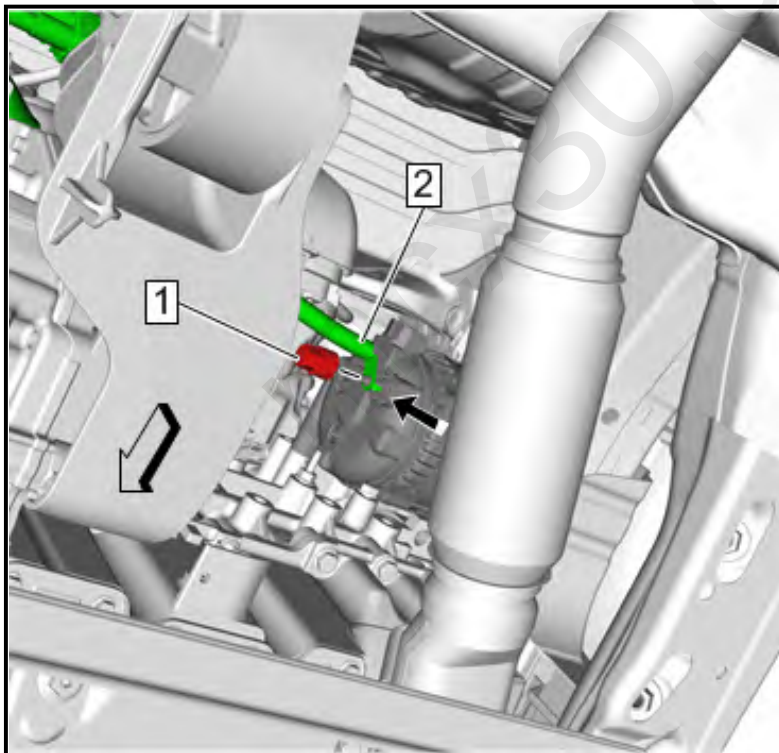


Battery Positive Cable (4) - Install

CAUTION: Refer to Fastener Caution

7. Battery Positive Cable Nut (2) @ Starter Solenoid (3) - Install and tighten 12.5 N.m (111 lb in)
8. Lower the vehicle.

9.

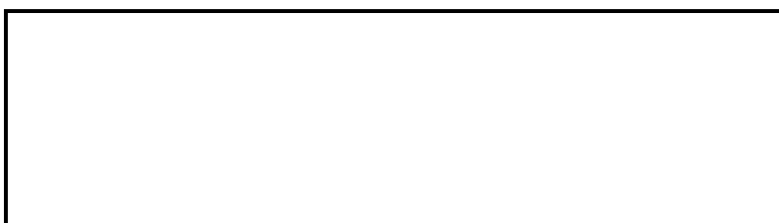


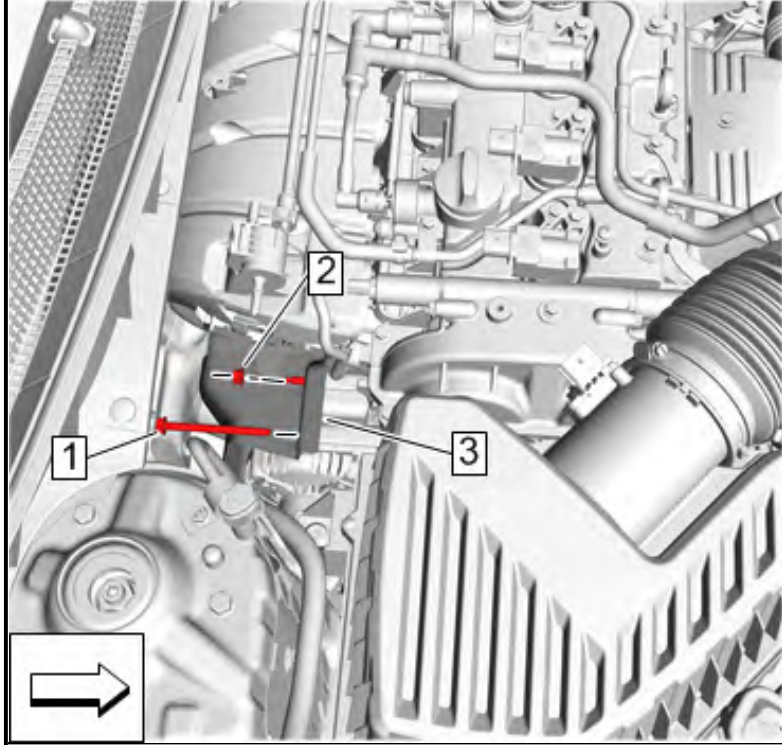
NOTE: Install the terminal locking tab in the 4 o'clock position.

Battery Positive Cable (2) - Install

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

11.

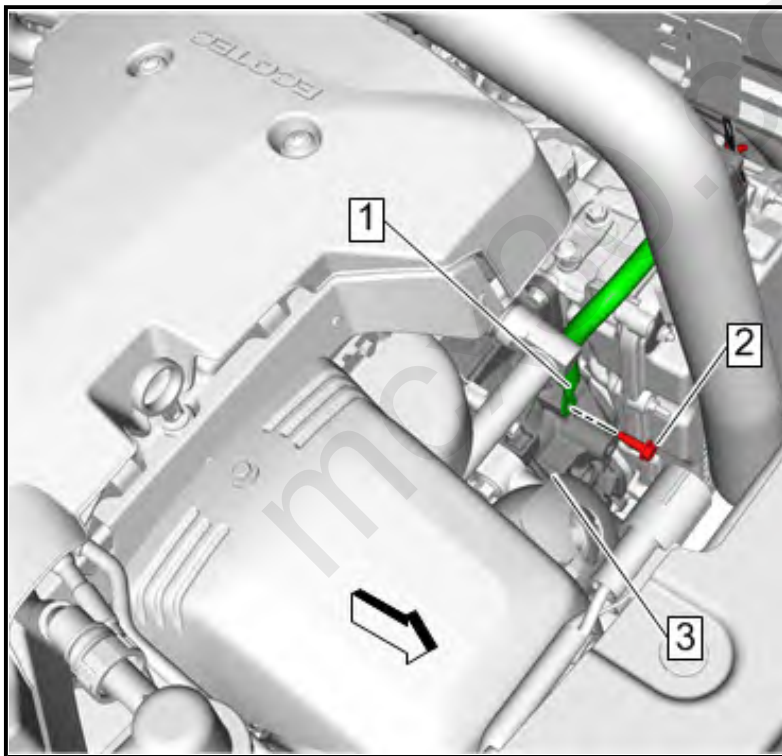




Generator Shield (3) - Install - [Generator Shield Replacement \(LTG\)](#)

12. Lower the vehicle.

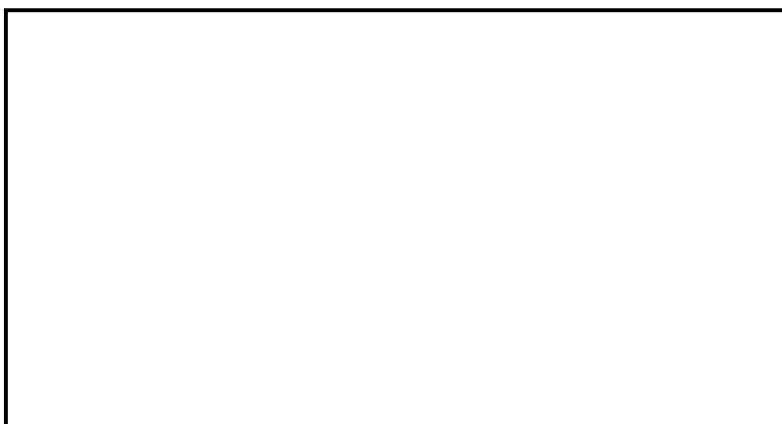
13.

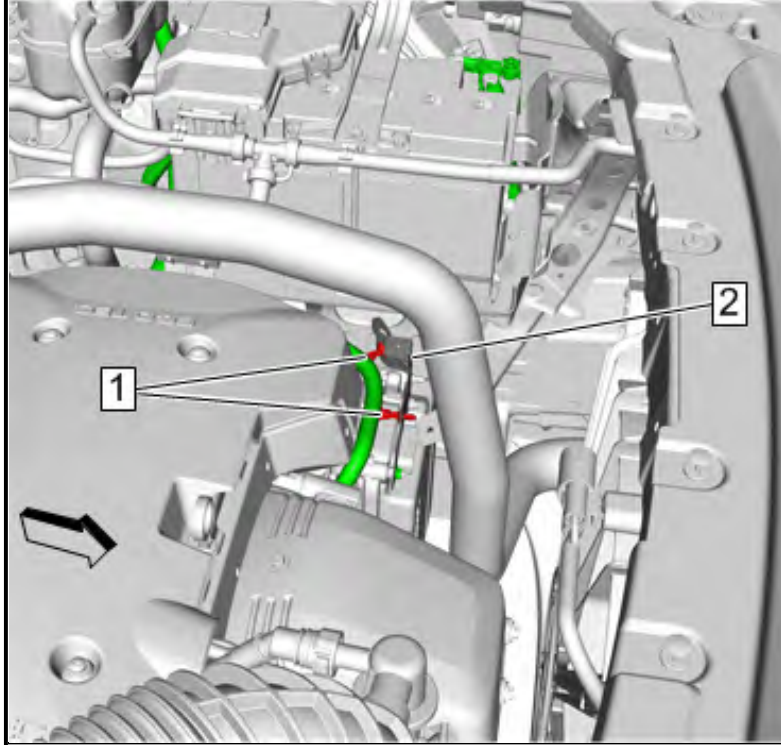


Battery Negative Cable (1) - Install

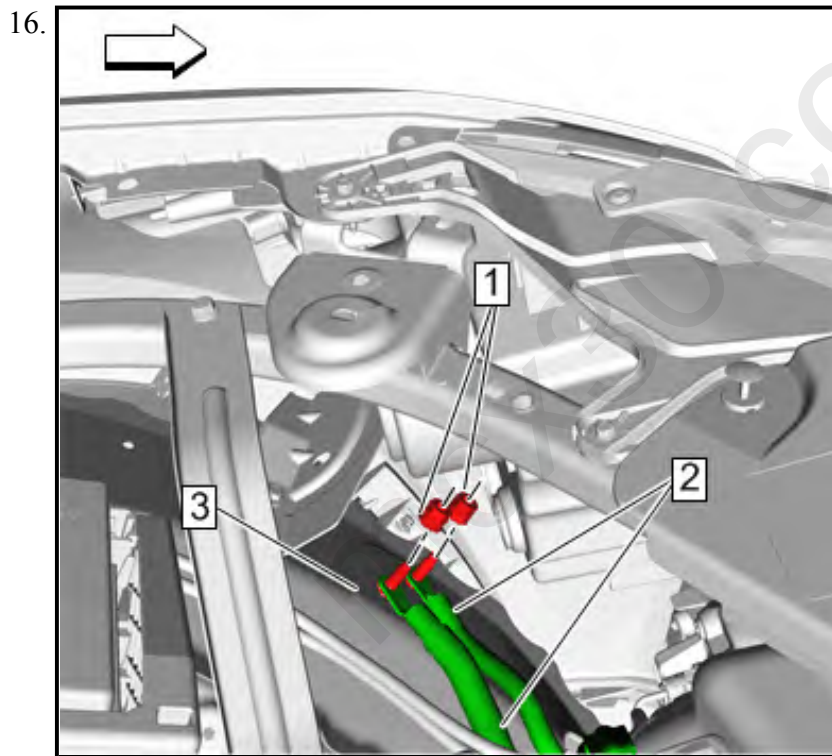
14. Battery Negative Cable Ground Bolt (2) @ Transmission (3) - Install and tighten 22 N.m (16 lb ft)

15.





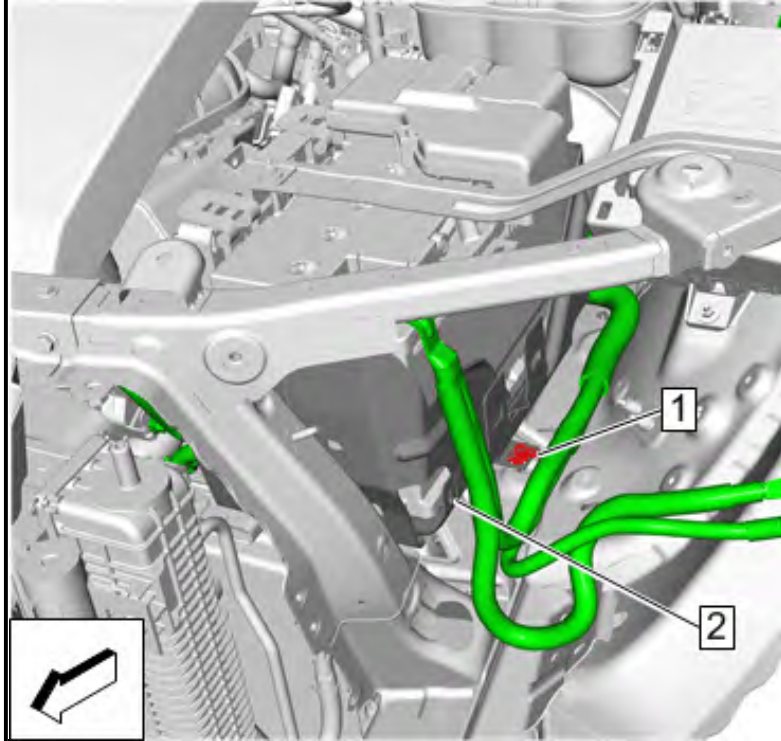
Retainer (1) @ Transmission Wiring Harness Bracket (2) - Engage [2x]



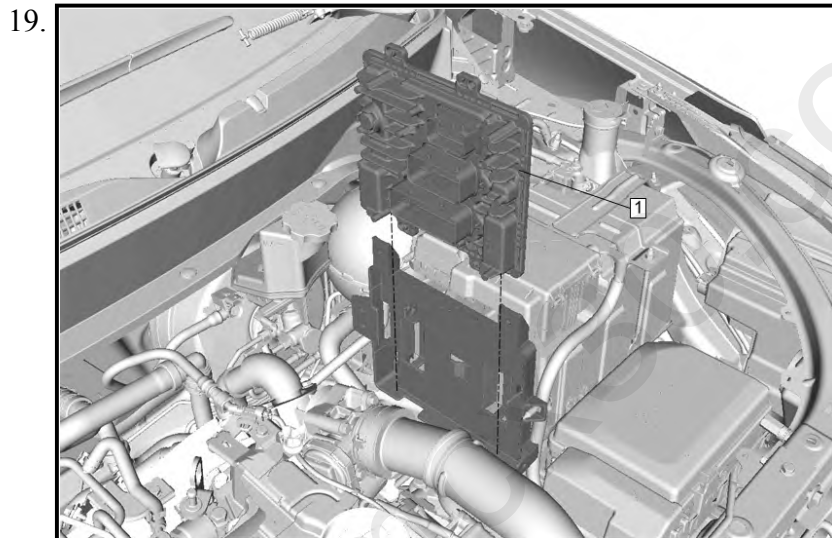
Battery Negative Cable (2) - Install [2x]

17. Battery Negative Cable Ground Nut (1) @ Front Wheel Well Extension (3) - Install and tighten [2x] 9 N.m (80 lb in)

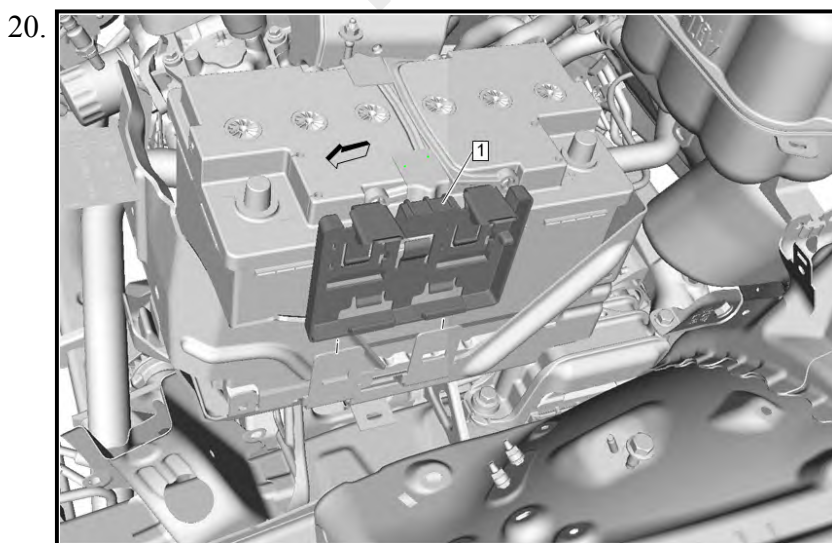




Retainer (1) @ Battery Tray (2) - Engage

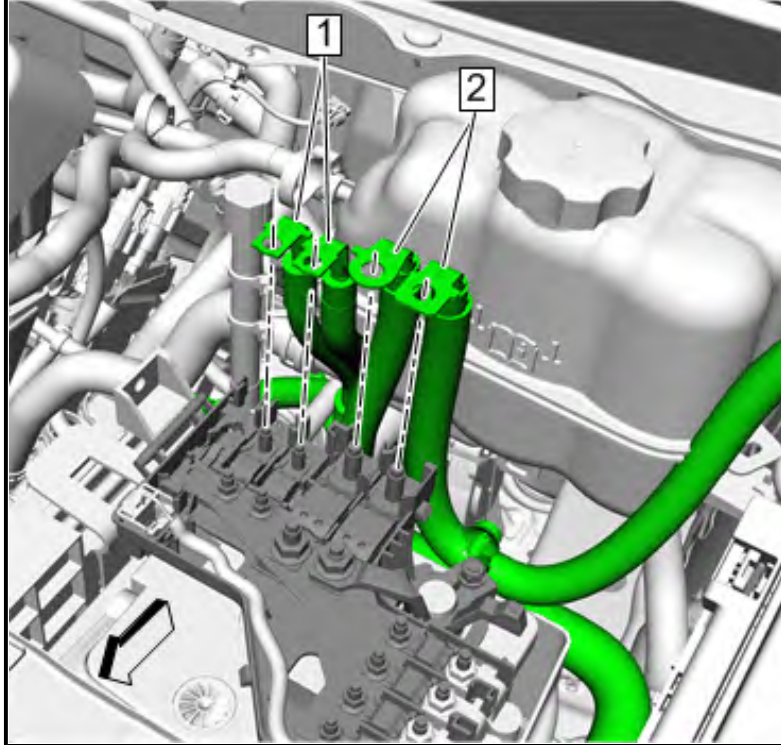


Engine Control Module (1) - Install - [Engine Control Module Replacement](#)



Transmission Control Module Bracket (1) - Install - [Transmission Control Module Bracket Replacement](#)

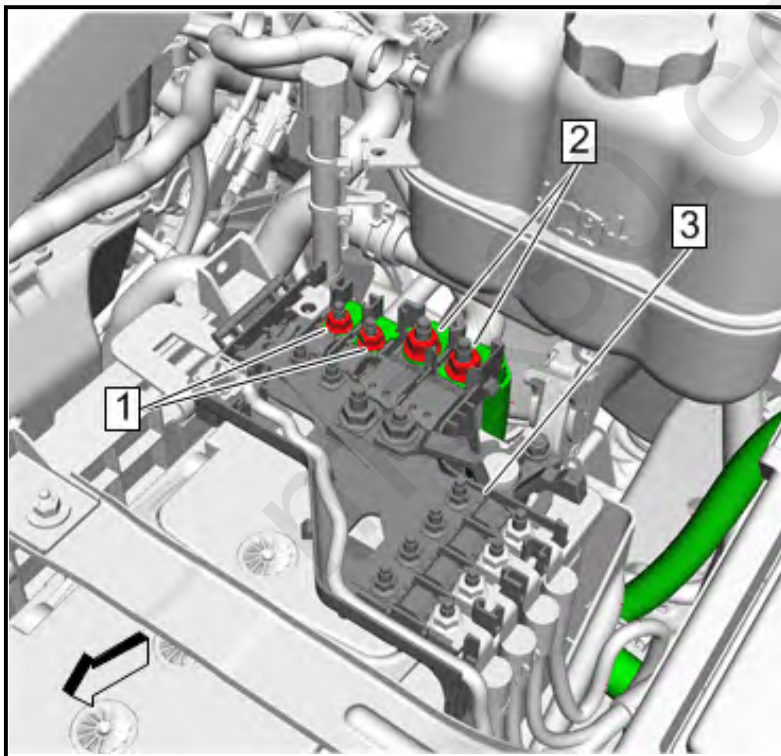




Battery Positive Cable (1) - Install [2x]

22. Battery Positive Cable (2) - Install [2x]

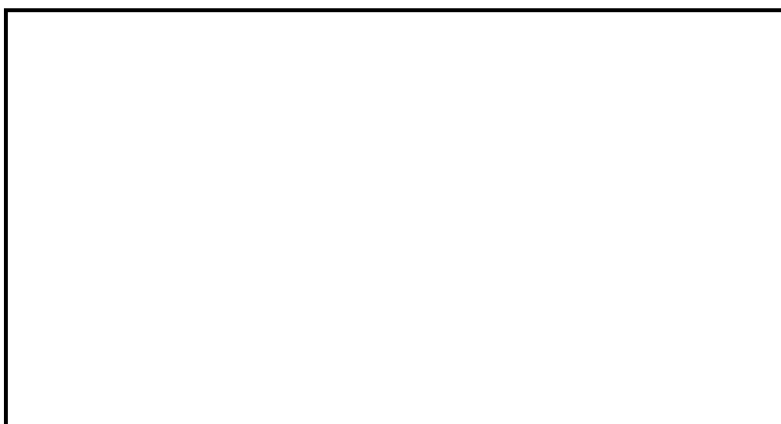
23.

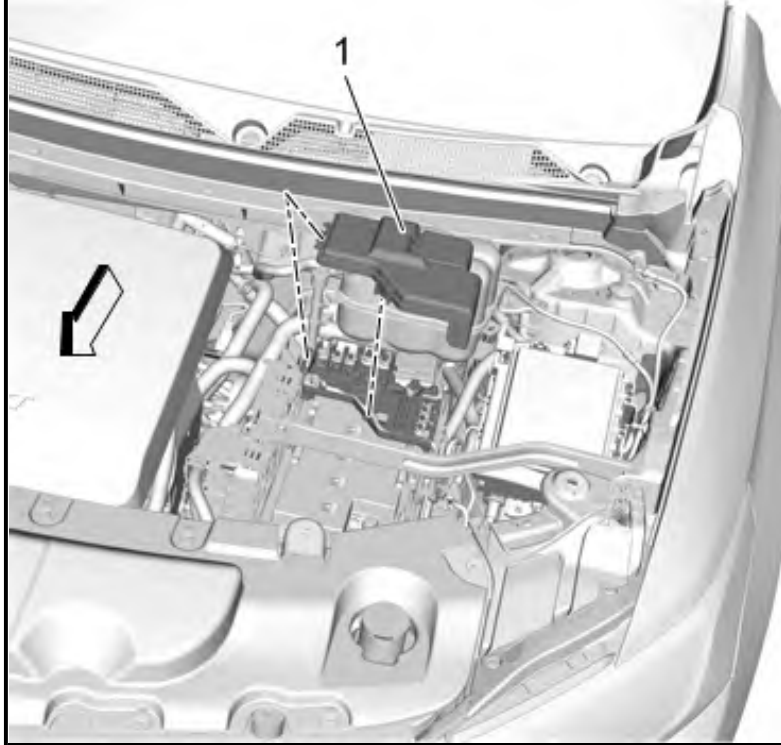


Fuse Block Nut (2) @ Battery Fuse Block (3) - Install and tighten [2x] 16 N.m (12 lb ft)

24. Fuse Block Nut (1) @ Battery Fuse Block (3) - Install and tighten [2x] 9 N.m (80 lb in)

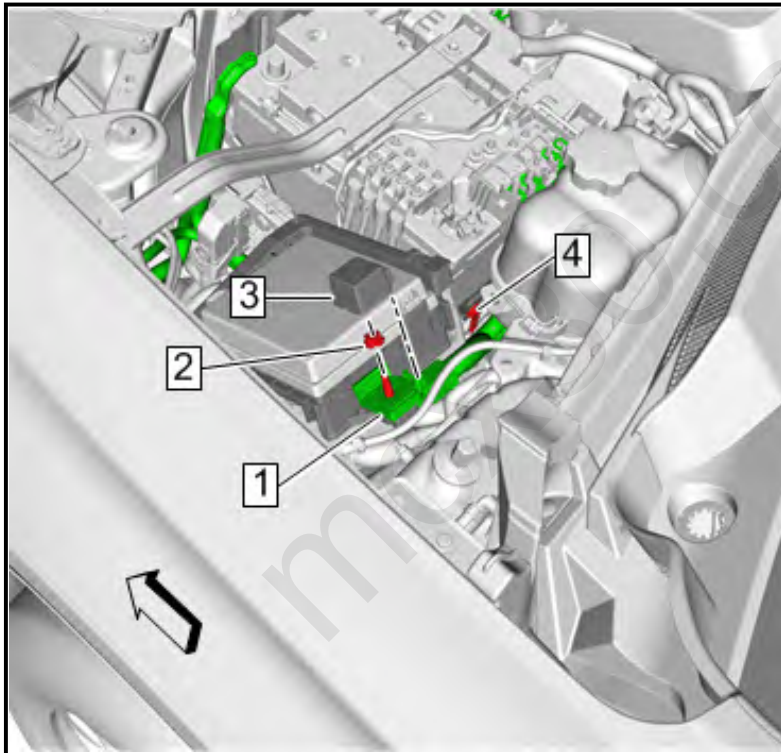
25.





Fuse Block Cover (1) - Install

26.



Battery Positive Cable (1) - Install

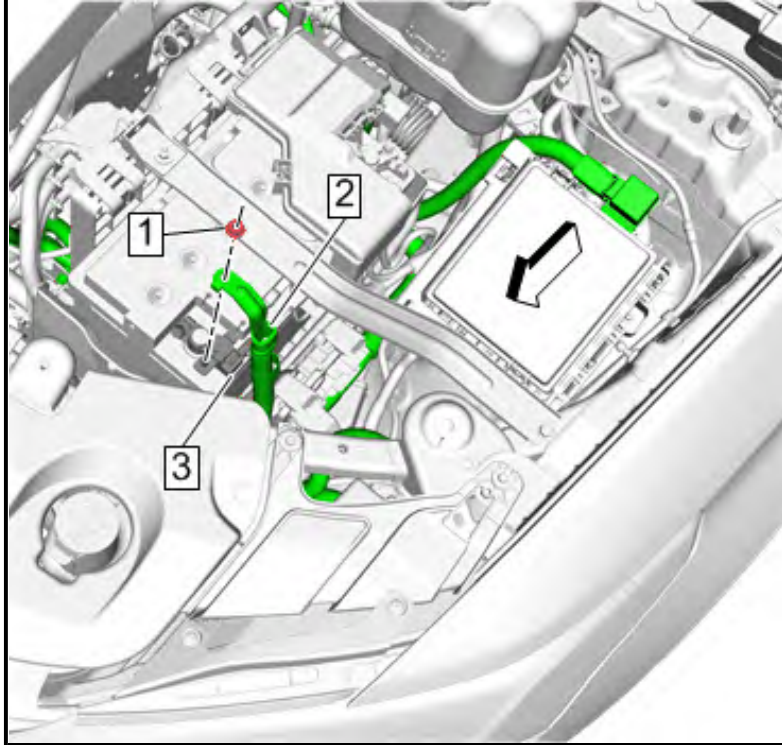
27. Engine Wiring Harness Junction Block Nut (2) - Install and tighten 16 N.m (12 lb ft)

28. Terminal Cover (3) @ Engine Wiring Harness Junction Block - Install

29. Retainer (4) - Engage

30.





Battery Negative Cable (2) - Install

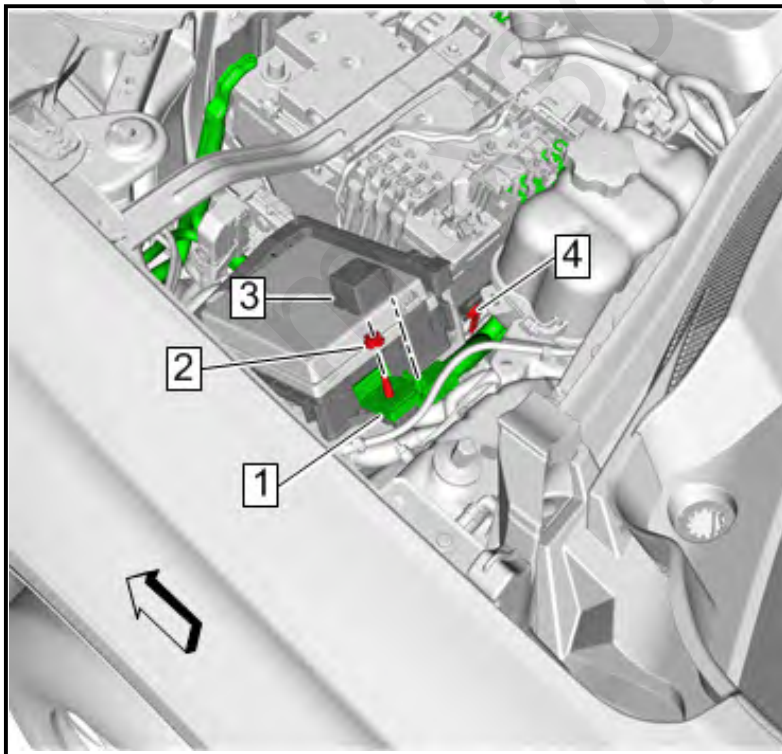
31. Battery Negative Cable Nut (1) @ Battery Sensor Module (3) - Install and tighten 11 N.m (97 lb in)

ENGINE WIRING HARNESS JUNCTION BLOCK REPLACEMENT

Removal Procedure

1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

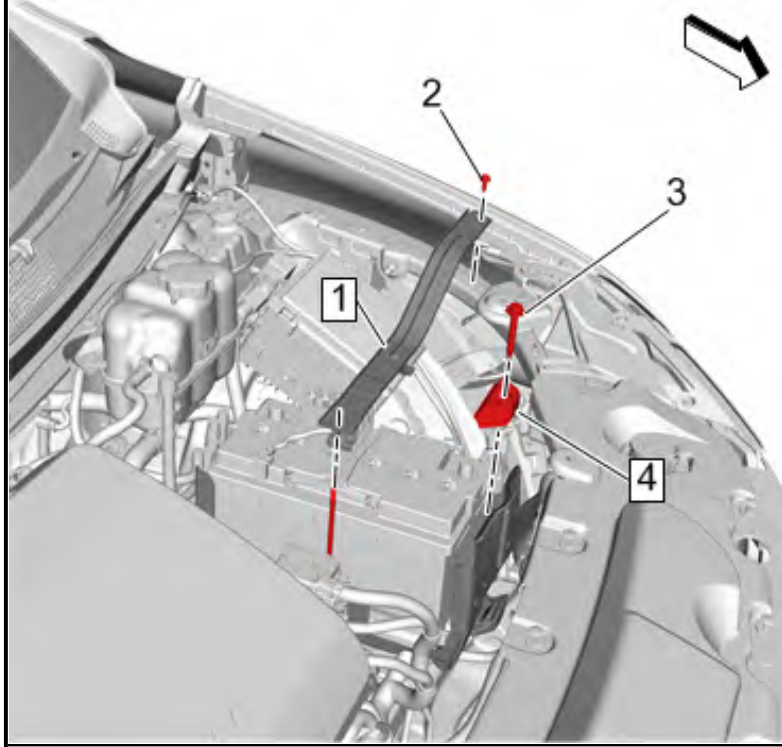
2.



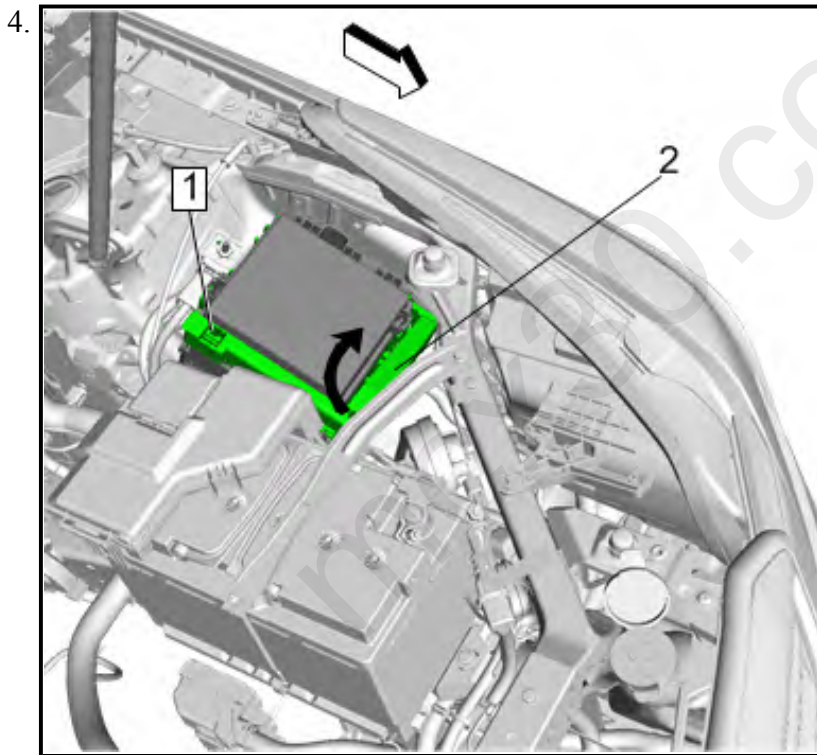
Battery Positive Cable (1) @ Engine Wiring Harness Junction Block - Remove - [Battery Positive and Negative Cable Replacement \(LFY\)](#)[Battery Positive and Negative Cable Replacement \(LTG\)](#)

3.



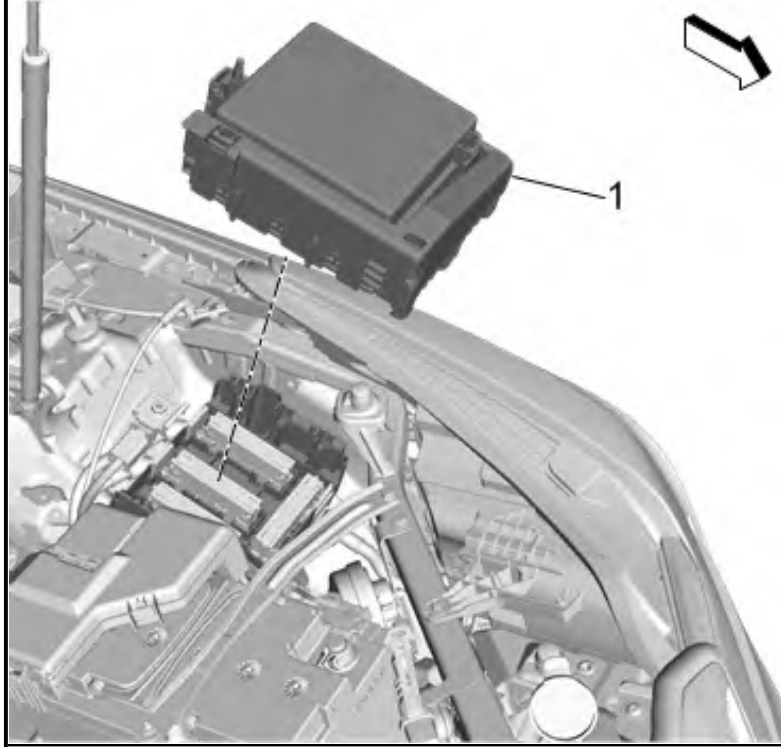


Battery Hold Down Retainer (1) - Remove - [Battery Replacement](#)



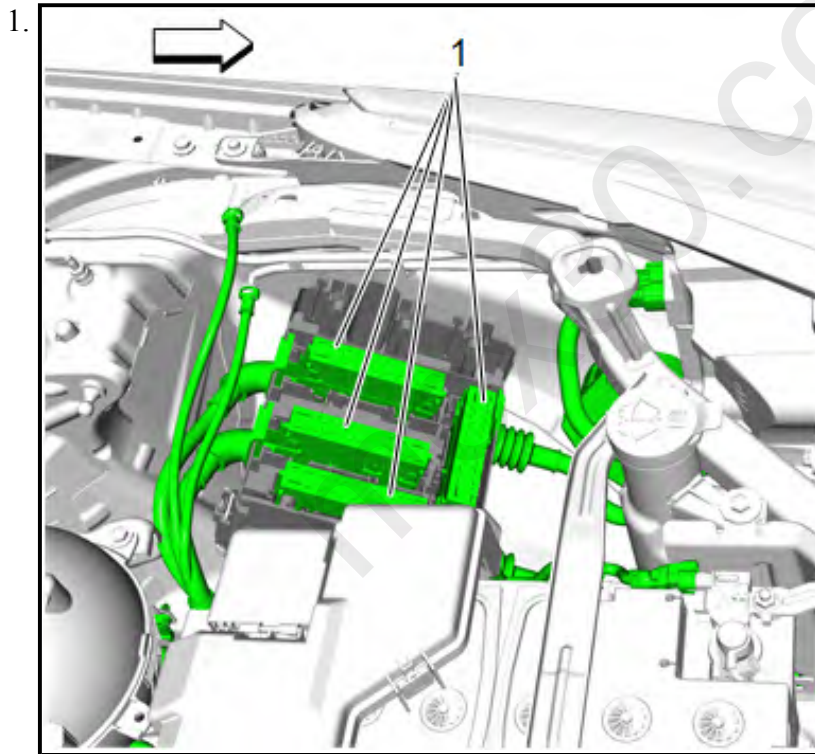
Release the lever lock (1) and rotate handle (2) upwards.





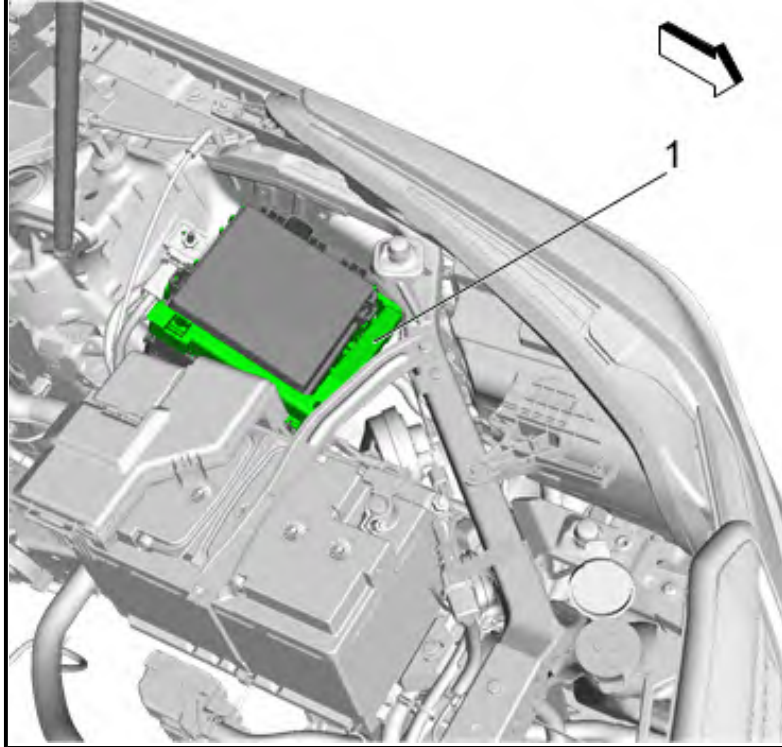
Engine Wiring Harness Junction Block - Remove

Installation Procedure

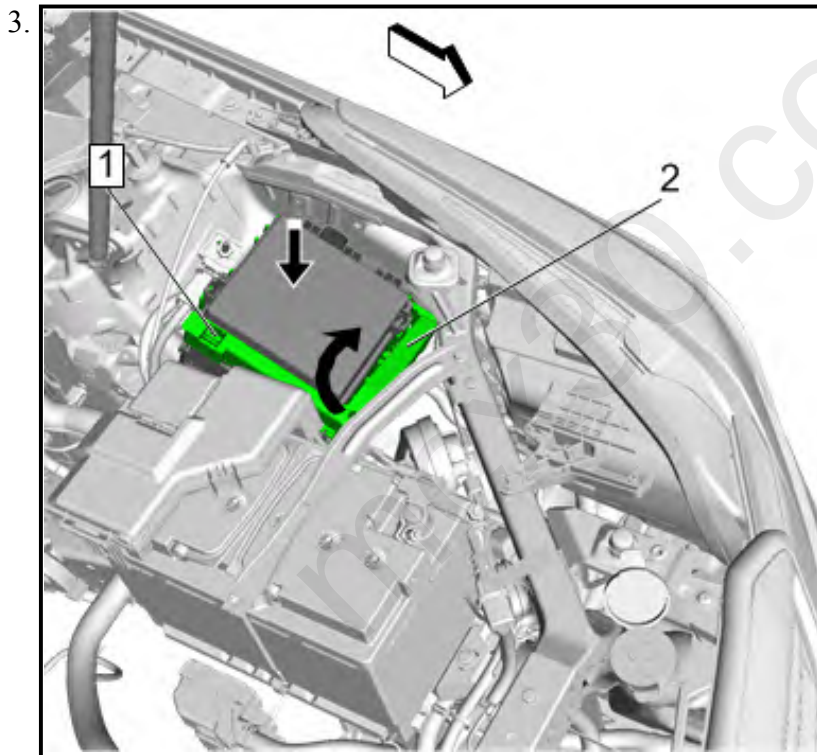


Ensure all electrical connectors (1) are properly seated in the bracket assembly cavity.





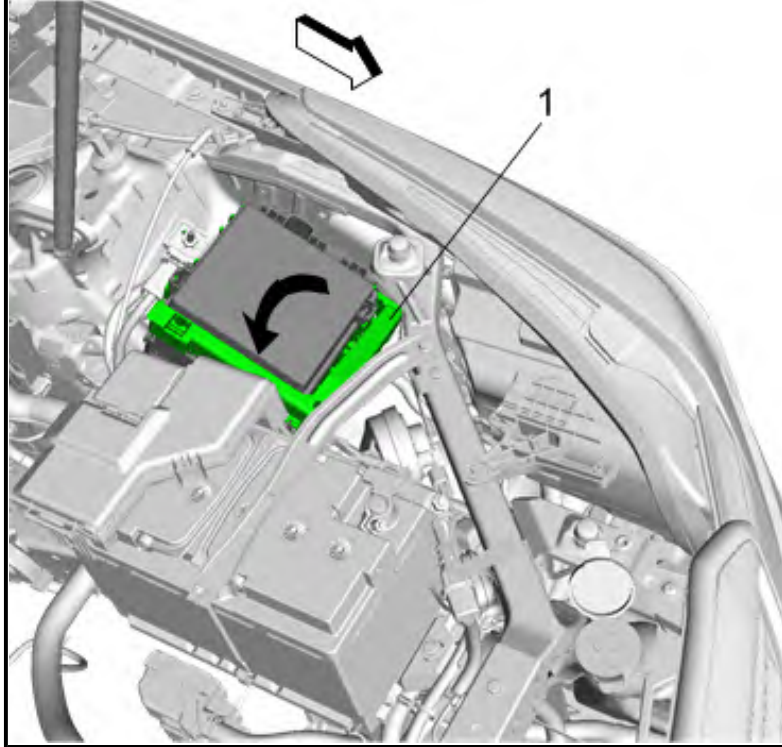
Ensure the lever (1) is in the fully closed position prior to pre-set to the bracket assembly.



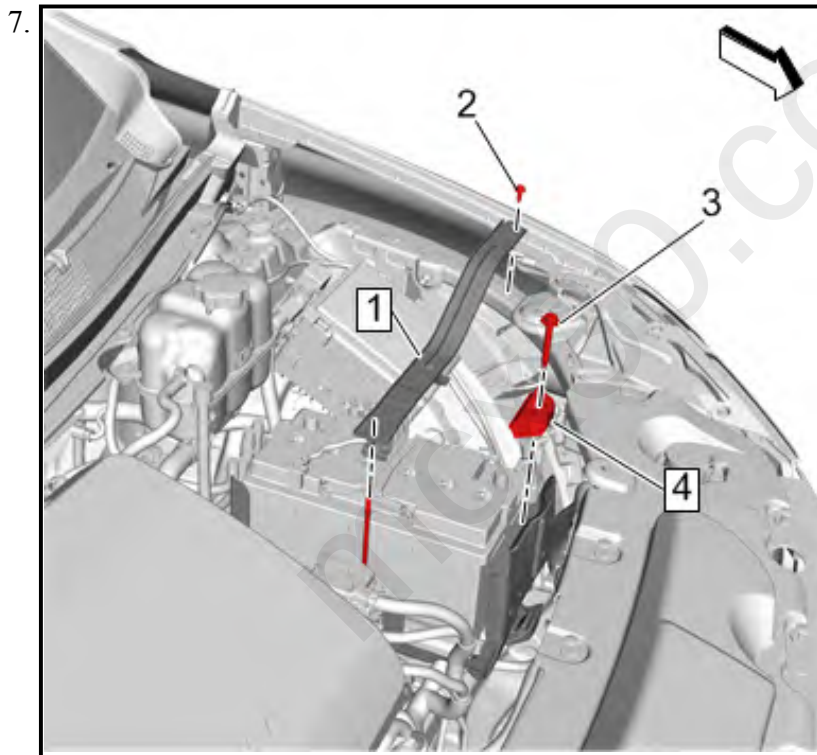
Pre-set the engine wiring harness junction block, ensuring that the 4 integral T-features are properly aligned prior to applying downward force.

4. Release the lever lock (1) and pull the handle (2) upwards.
5. Pull lever when it is fully open, while at the same time, push down lightly on the top cover to engage the lever side features.



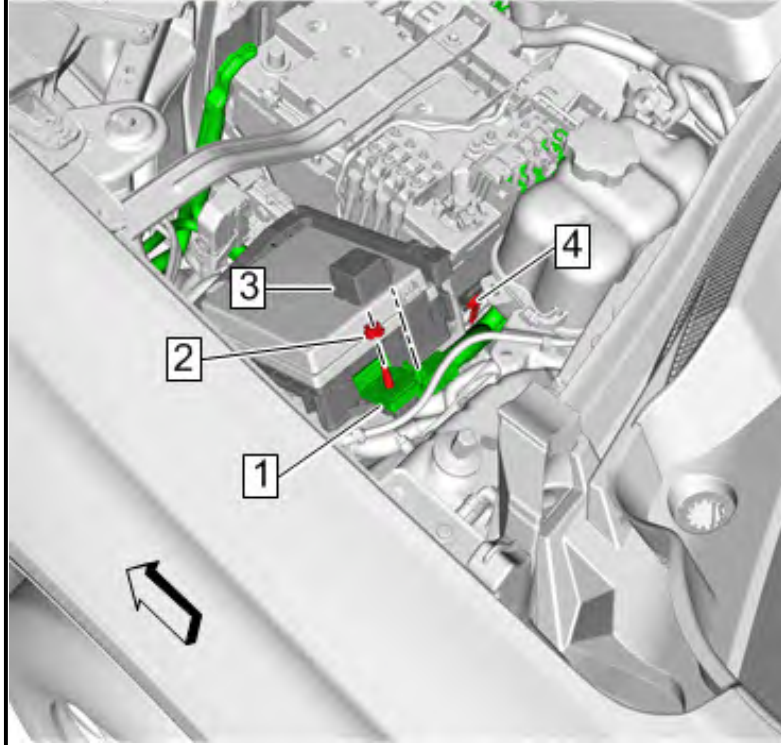


Push the lever (1) closed to secure the block assembly to the bracket assembly and connectors.



Battery Hold Down Retainer (1) - Install - [Battery Replacement](#)

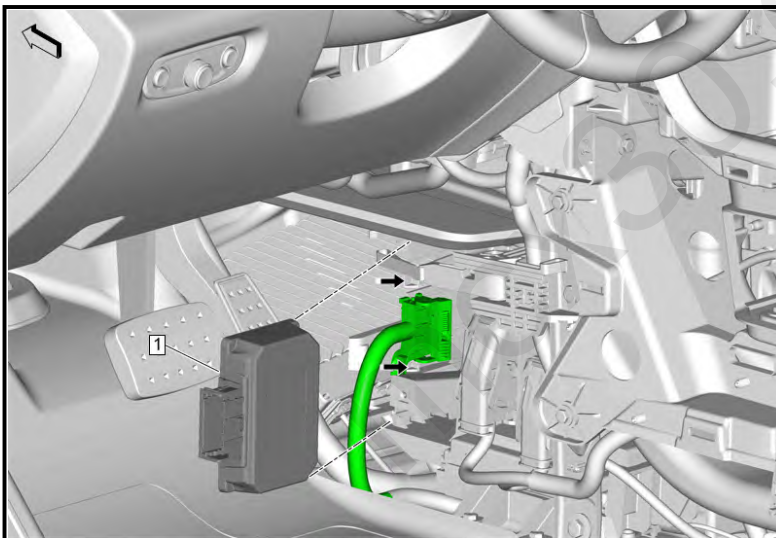




Battery Positive Cable (1) @ Engine Wiring Harness Junction Block - Install - [Battery Positive and Negative Cable Replacement \(LFY\)](#)[Battery Positive and Negative Cable Replacement \(LTG\)](#)

9. Connect the battery negative cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

MULTIFUNCTION POWER SUPPLY CONVERTER REPLACEMENT

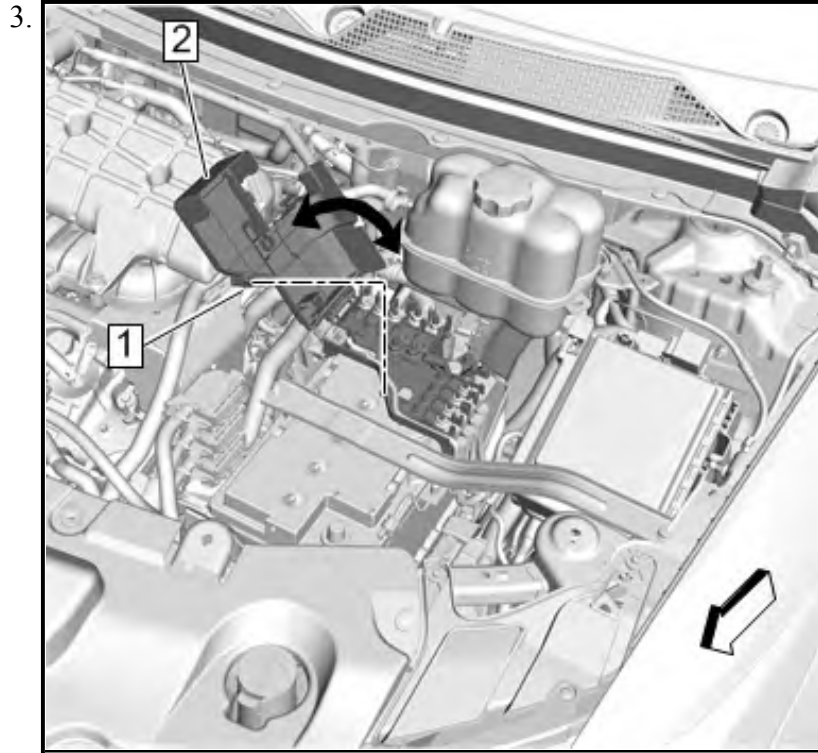


Callout	Component Name
Preliminary Procedure Front Floor Console Extension Panel Replacement - Left Side	
1	Multifunction Power Supply Converter Procedure 1. Disconnect the electrical connector. 2. Release the retaining tabs.

BATTERY REPLACEMENT

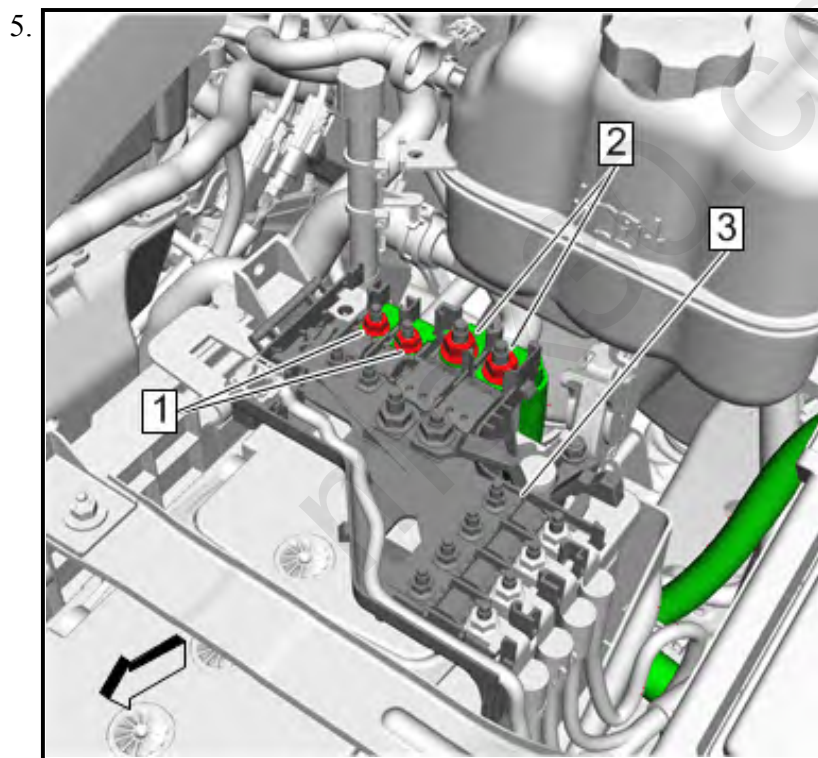
Removal Procedure

1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)
2. Remove the engine control module bracket. [Engine Control Module Bracket Replacement](#)



Retainer (1) - Disengage

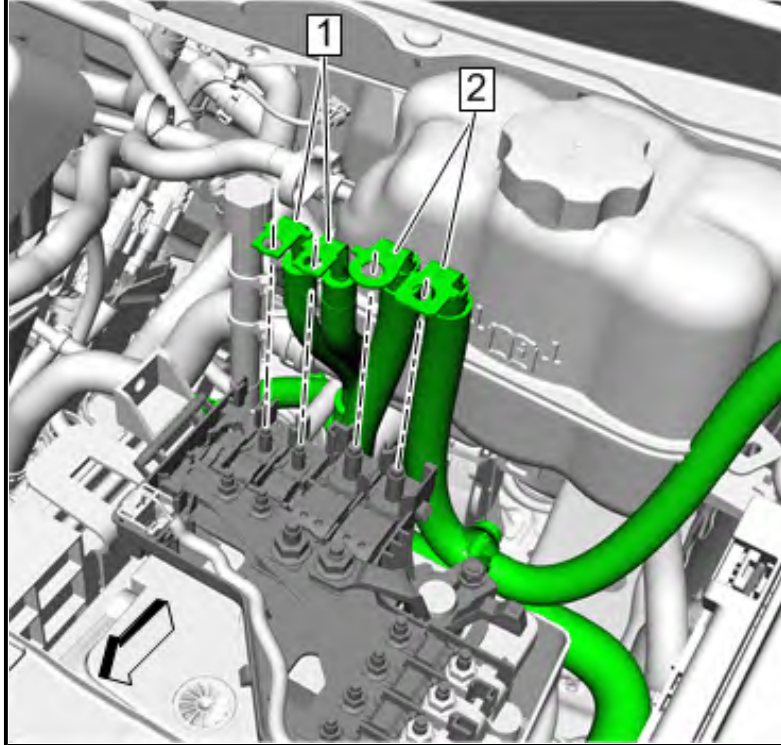
4. Fuse Block Cover (2) - Open



Fuse Block Nut (1) @ Battery Fuse Block (3) - Remove [2x]

6. Fuse Block Nut (2) @ Battery Fuse Block (3) - Remove [2x]

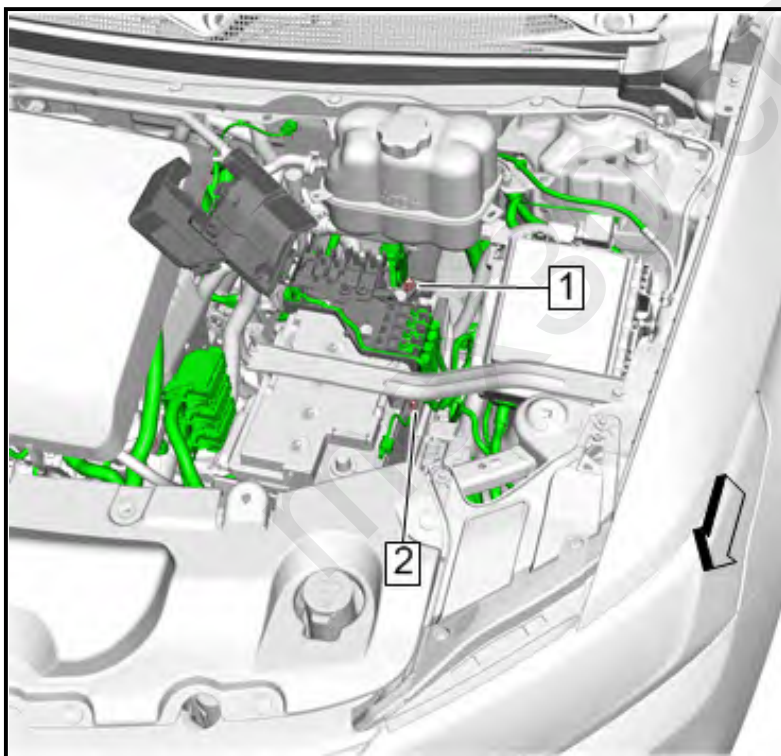




Battery Positive Cable (1) - Remove [2x]

8. Battery Positive Cable (2) - Remove [2x]

9.

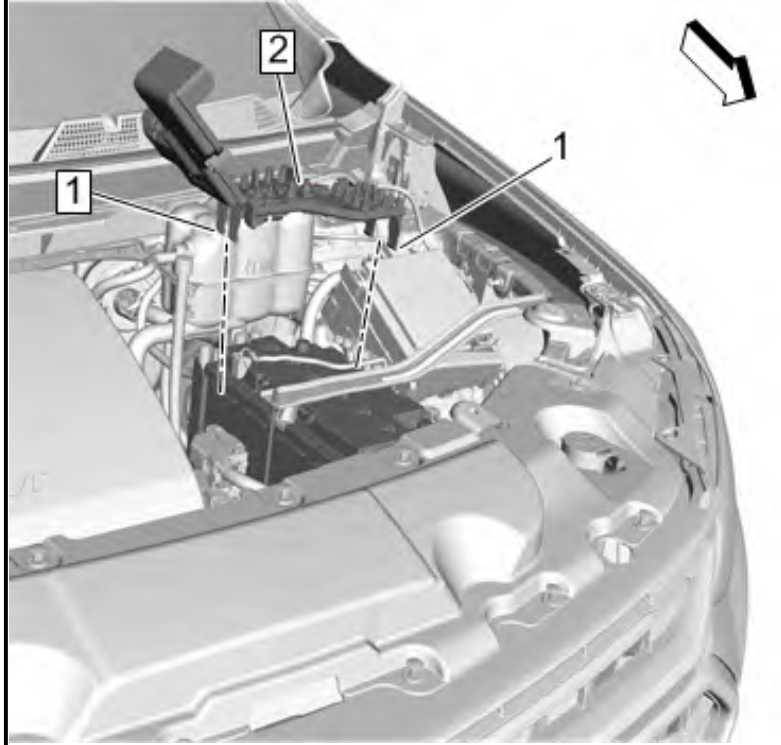


Battery Positive Post Clamp Nut (1) - Loosen

10. Retainer (2) - Disengage

11.

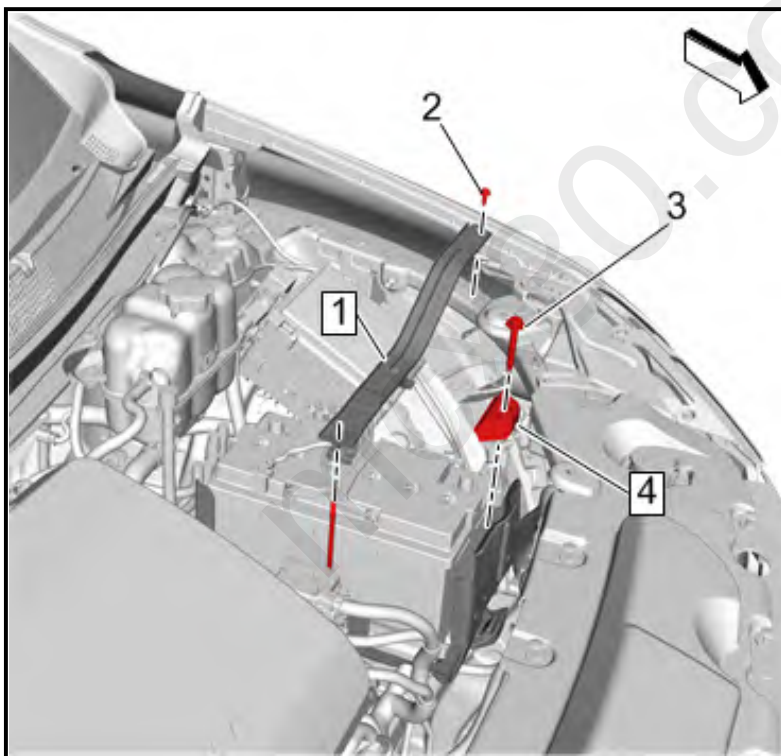




Retaining Tab (1) - Disengage [2x]

12. Fuse Block (2) - Reposition away

13.



Battery Hold Down Retainer Bolt (2) - Remove

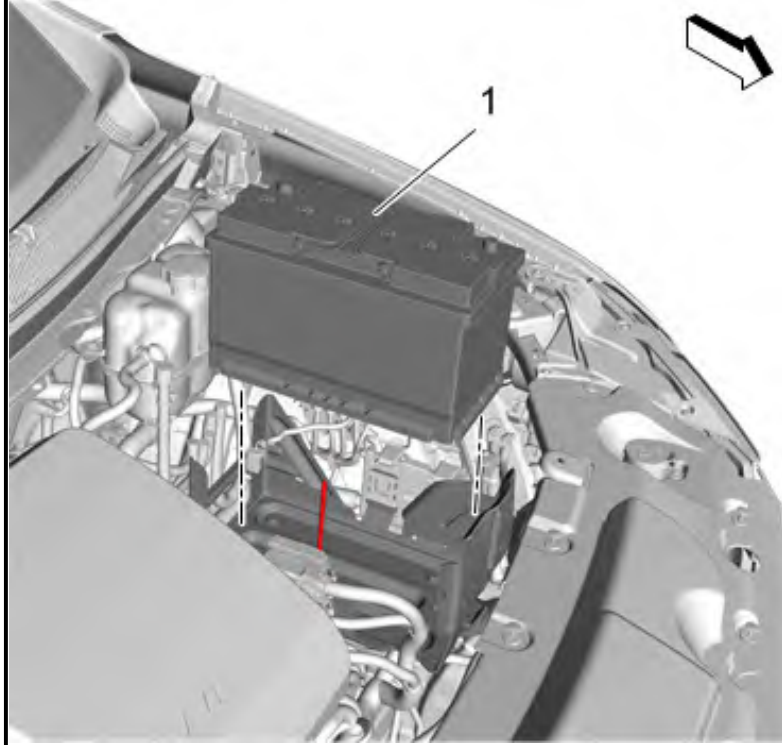
14. Battery Hold Down Retainer (1) - Remove

15. Battery Hold Down Bolt (3) - Remove

16. Battery Hold Down Retainer (4) - Remove

17.

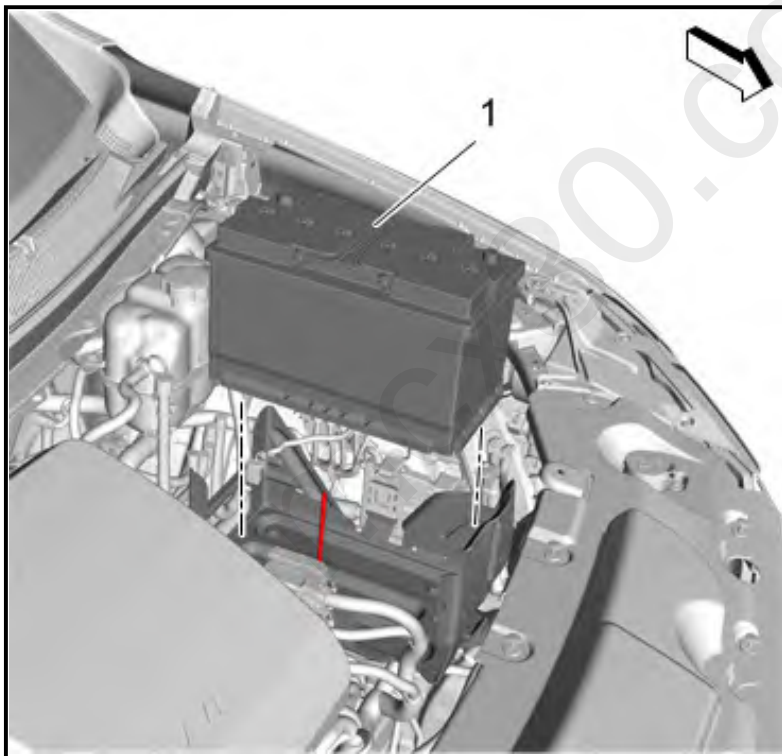




Battery (1) - Remove

Installation Procedure

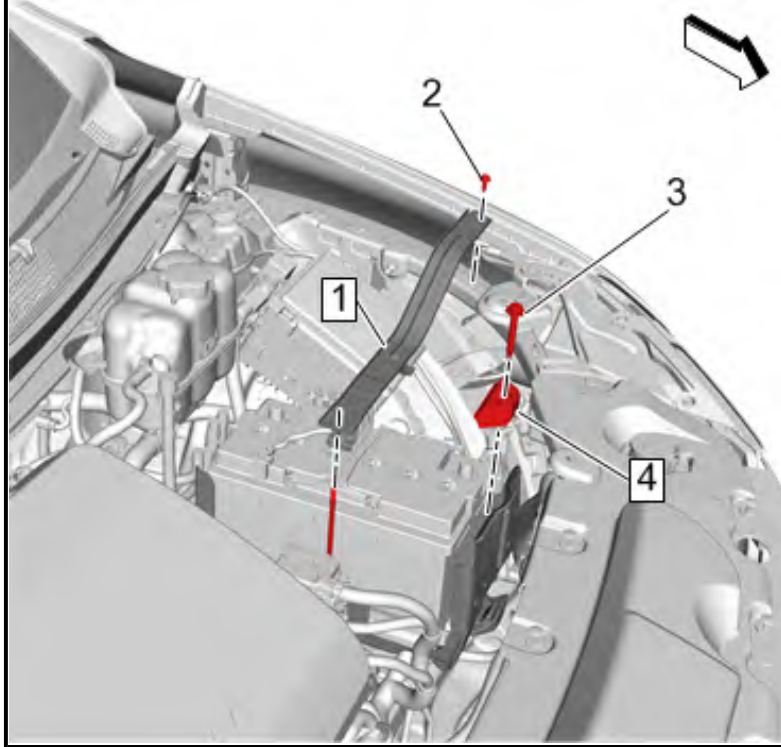
1.



Battery (1) - Install

2.

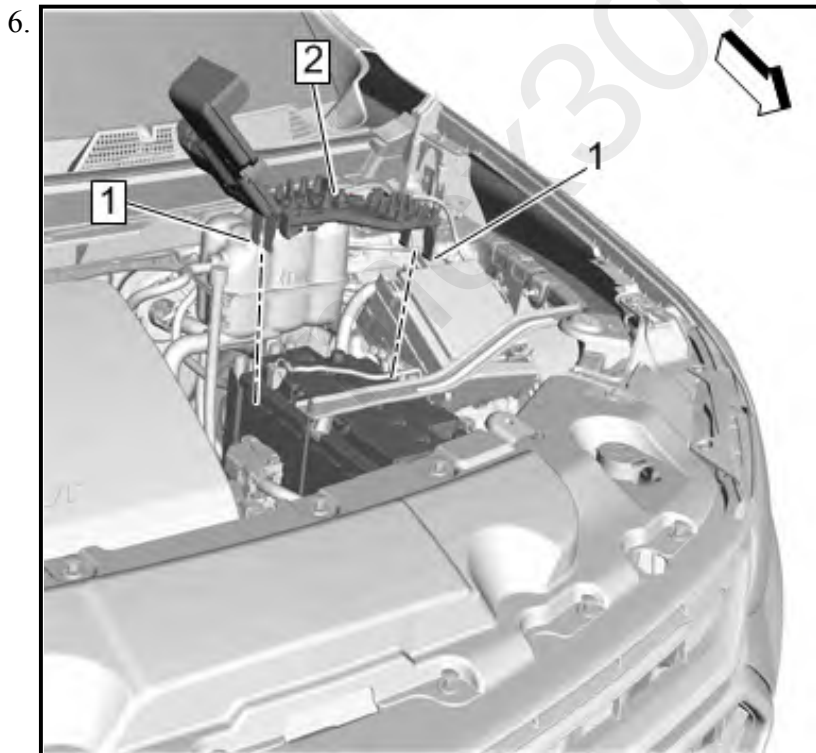




Battery Hold Down Retainer (4) - Install

CAUTION: Refer to [Fastener Caution](#)

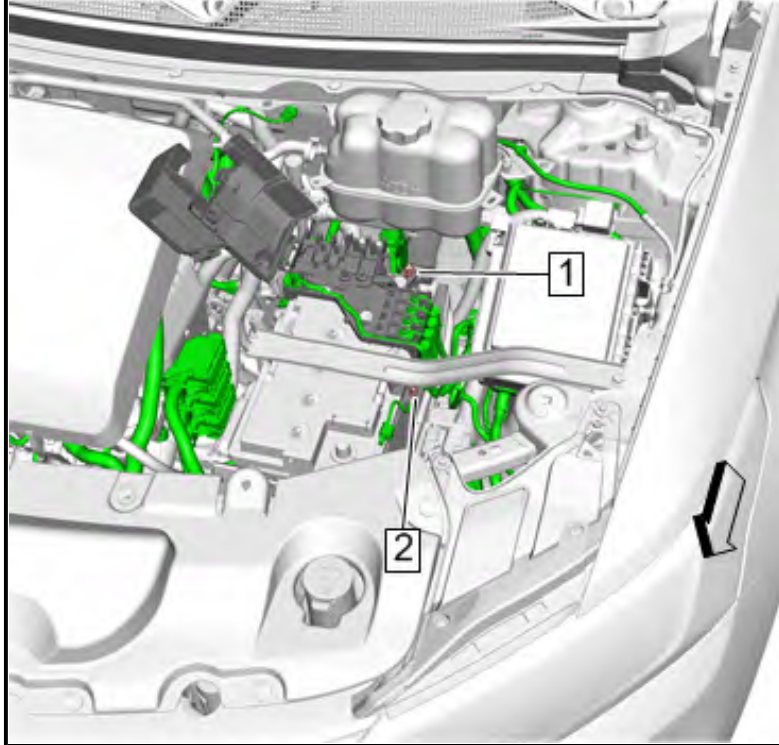
3. Battery Hold Down Bolt (3) - Install and tighten 22 N.m (16 lb ft)
4. Battery Hold Down Retainer (1) - Install
5. Battery Hold Down Retainer Bolt (2) - Install and tighten 9 N.m (80 lb in)



Fuse Block (2) - Install

7. Retaining Tab (1) - Engage [2x]

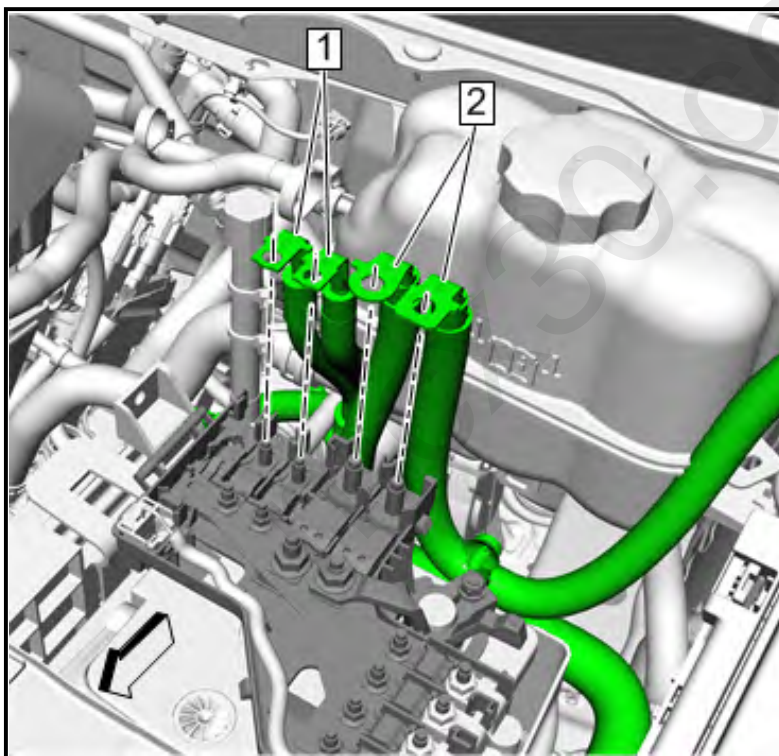




Battery Positive Post Clamp Nut (1) - Tighten 4.5 N.m (40 lb in)

9. Retainer (2) - Engage

10.

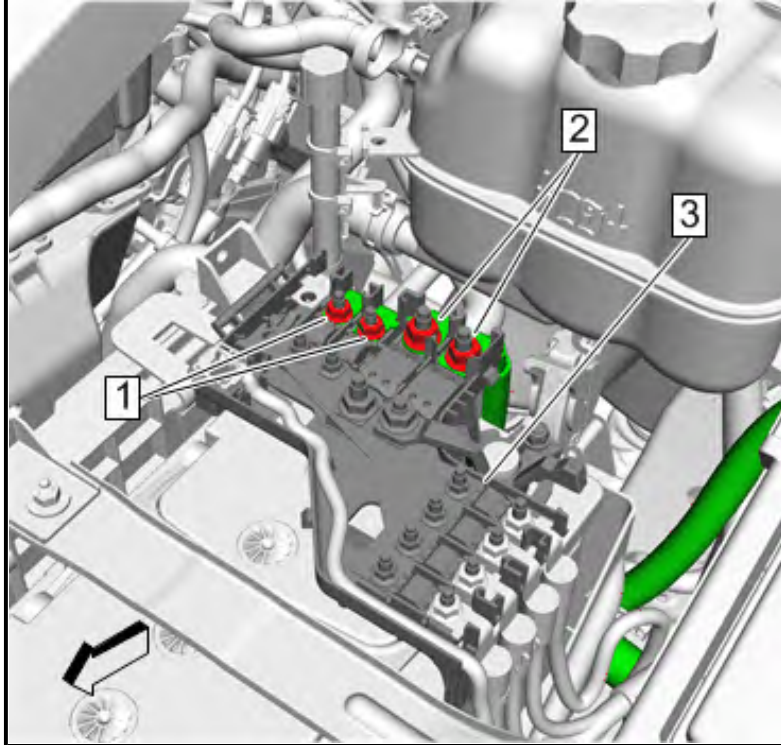


Battery Positive Cable (1) - Install [2x]

11. Battery Positive Cable (2) - Install [2x]

12.

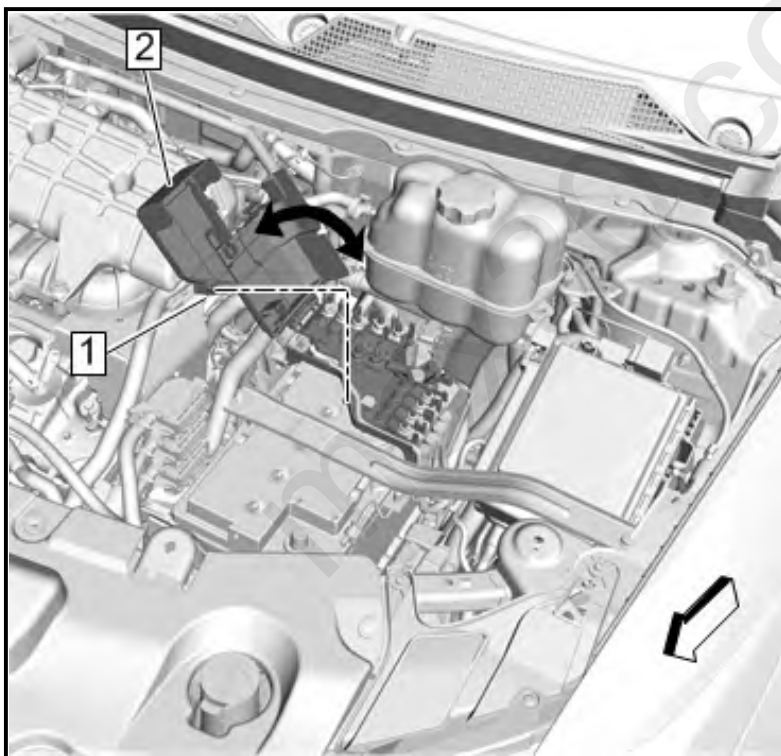




Fuse Block Nut (2) @ Battery Fuse Block (3) - Install and tighten [2x] 16 N.m (12 lb ft)

13. Fuse Block Nut (1) @ Battery Fuse Block (3) - Install and tighten [2x] 9 N.m (80 lb in)

14.



Close the battery fuse block cover. (2)

15. Retainer (1) - Engage

16. Install the engine control module bracket along with the engine control module to the battery tray. [Engine Control Module Bracket Replacement](#)

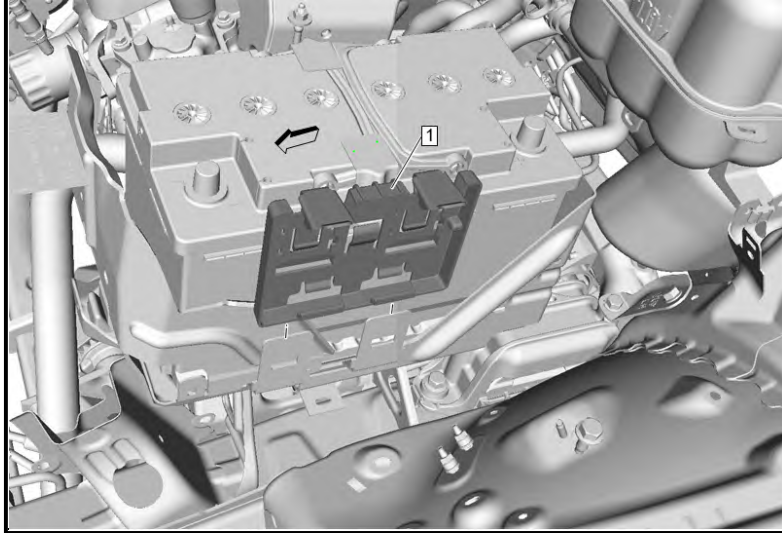
17. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

BATTERY TRAY REPLACEMENT

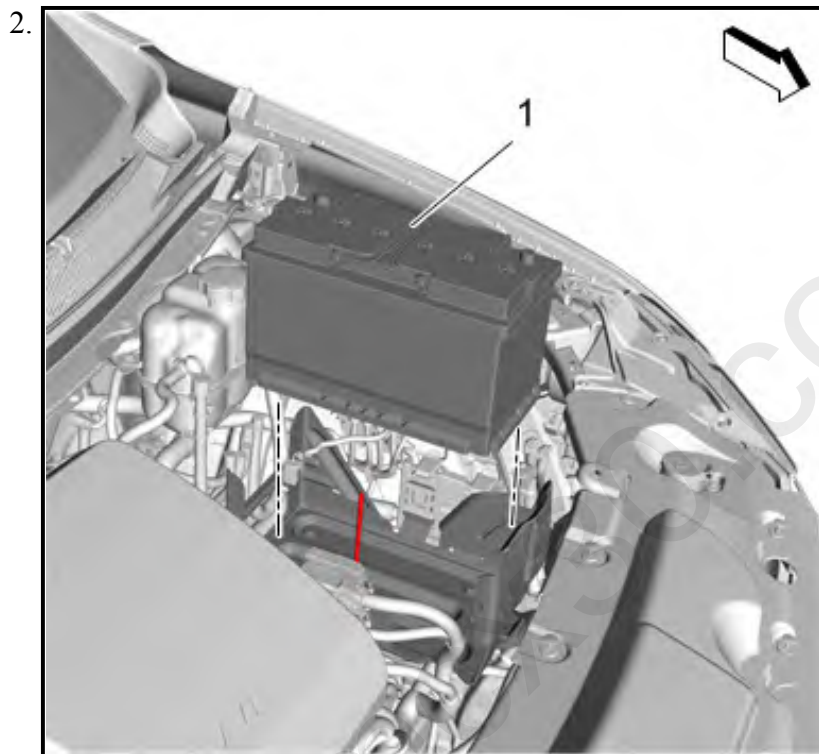
Removal Procedure

1.

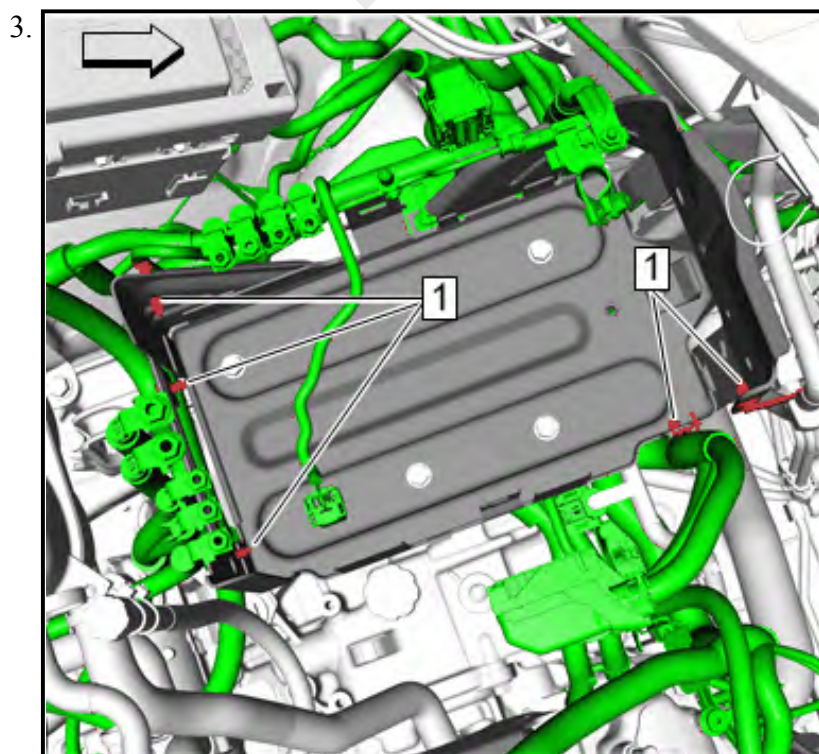




Transmission Control Module Bracket (1) - Remove - [Transmission Control Module Bracket Replacement](#)

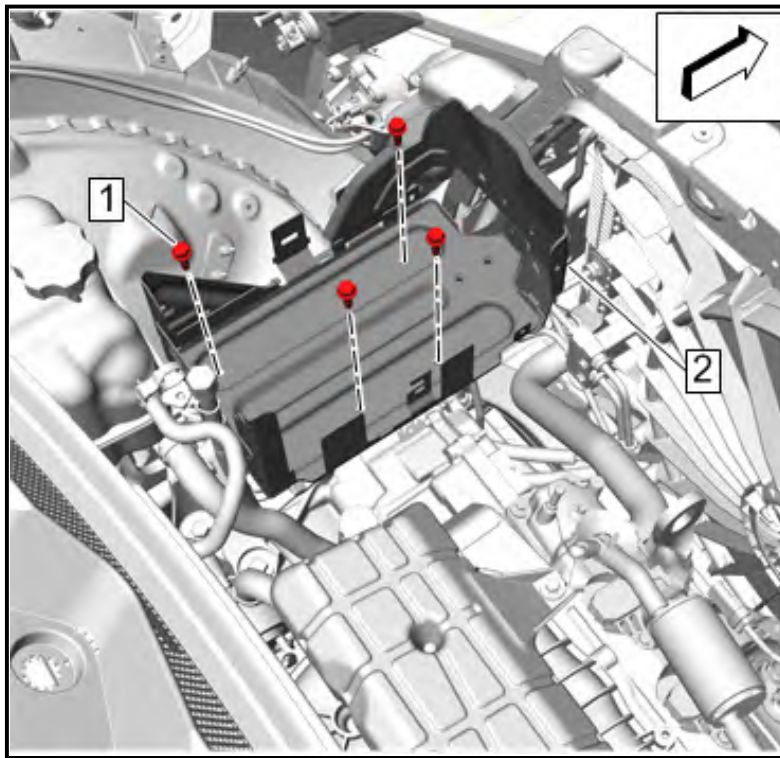


Battery (1) - Remove - [Battery Replacement](#)



Retainer (1) @ Battery Tray - Disengage [5x]

4.

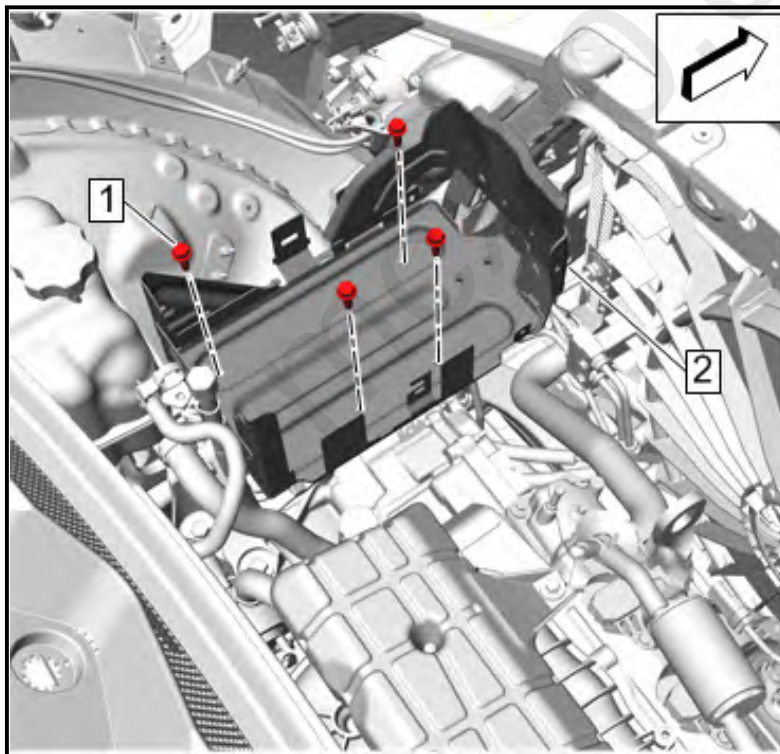


Battery Tray Mounting Bolt (1) - Remove [4x]

5. Battery Tray (2) - Remove

Installation Procedure

1.



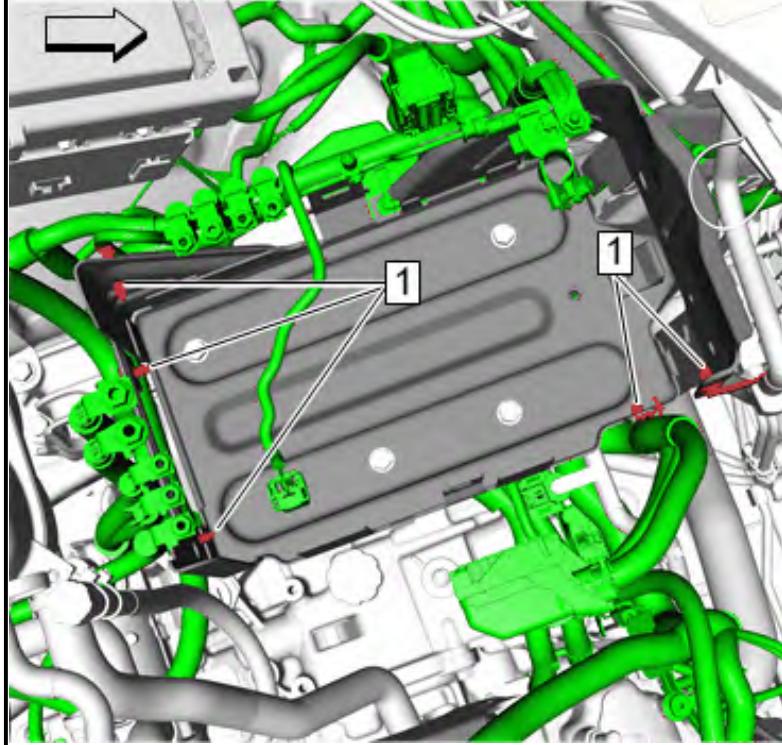
Battery Tray (2) - Install

CAUTION: Refer to Fastener Caution

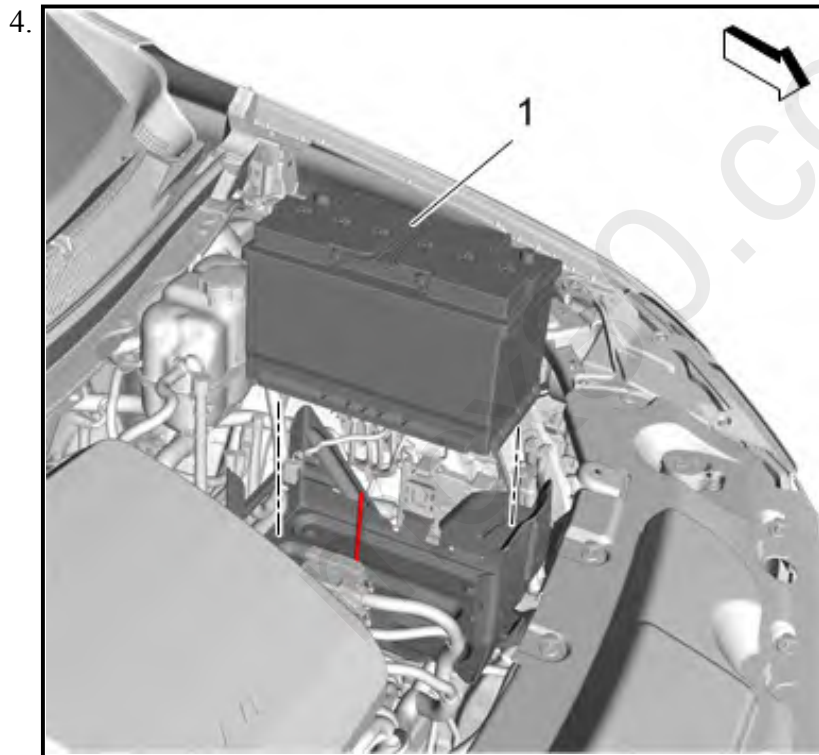
2. Battery Tray Mounting Bolt (1) - Install and tighten [4x] 22 N.m (16 lb ft)

3.

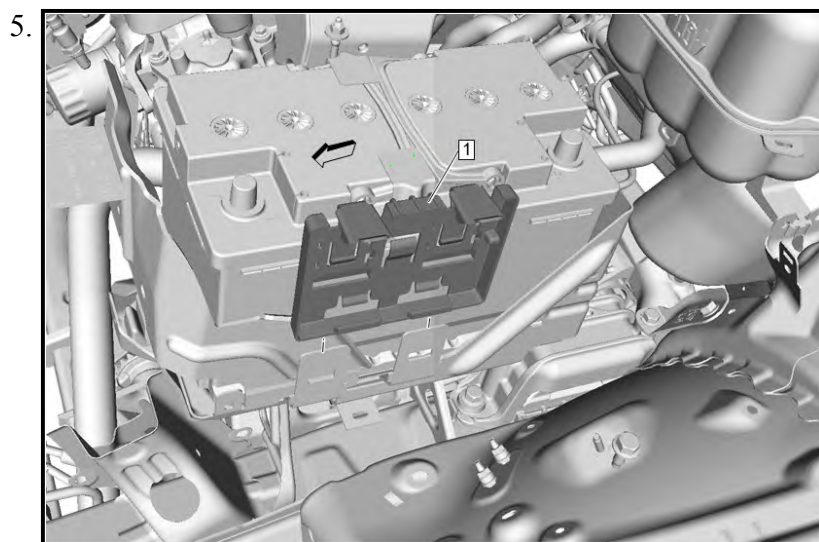




Retainer (1) @ Battery Tray - Engage [5x]



Battery (1) - Install - **Battery Replacement**

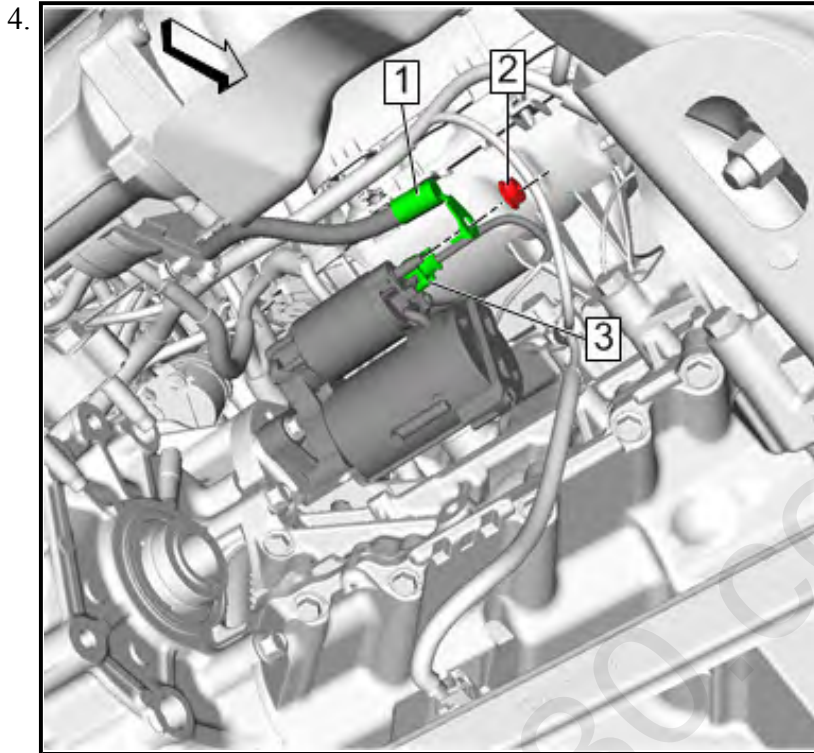


STARTER REPLACEMENT (LTG - ALL WHEEL DRIVE)

Removal Procedure

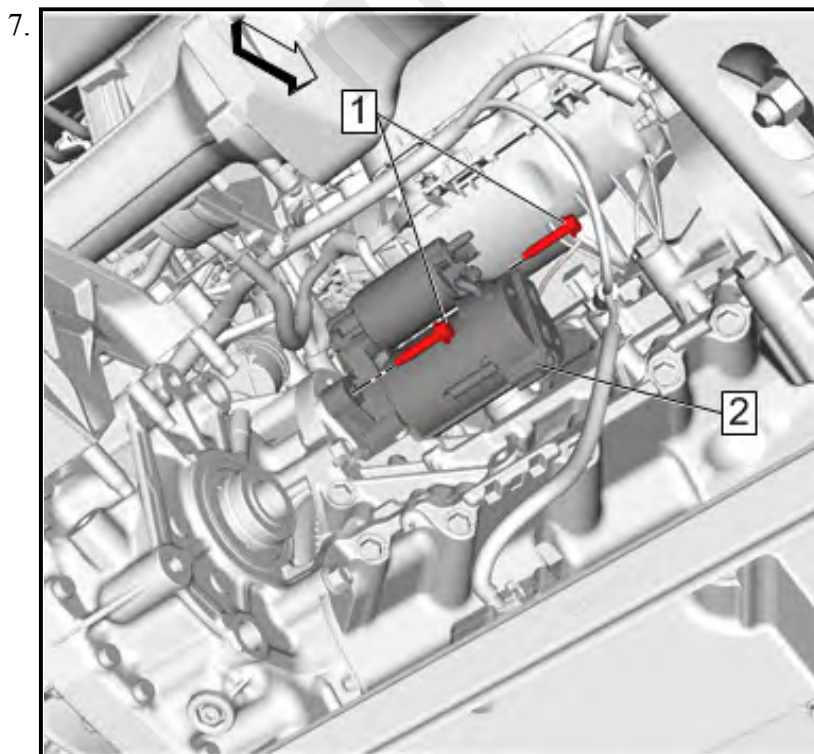
1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)
2. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)
3. Power Transfer Unit Case - Remove - [Power Transfer Unit Case Replacement](#)

NOTE: Exhaust front pipe and front wheel drive half shaft removed for clarity.



Battery Positive Cable Nut (2) - Remove

5. Battery Positive Cable (1) - Remove
6. Electrical Connector (3) - Disconnect

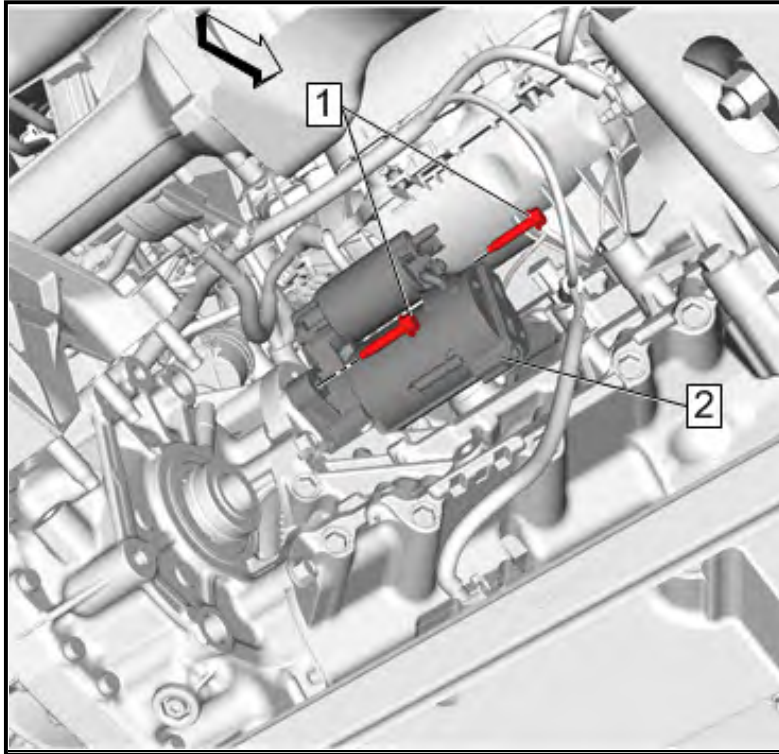


Starter Mounting Bolt (1) - Remove [2x]

8. Starter (2) - Remove

Installation Procedure

1.

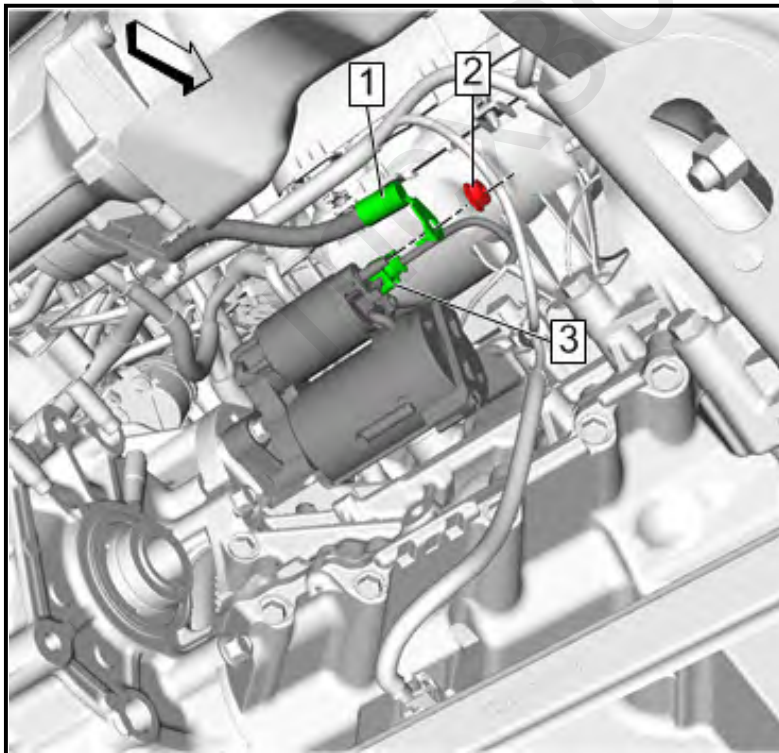


Starter (2) - Install

CAUTION: Refer to [Fastener Caution](#)

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

3.



Battery Positive Cable (1) - Install

4. Battery Positive Cable Nut (2) - Install and tighten 12.5 N.m (111 lb in)

5. Electrical Connector (3) - Connect

6. Power Transfer Unit Case - Install - [Power Transfer Unit Case Replacement](#)

7. Lower the vehicle.

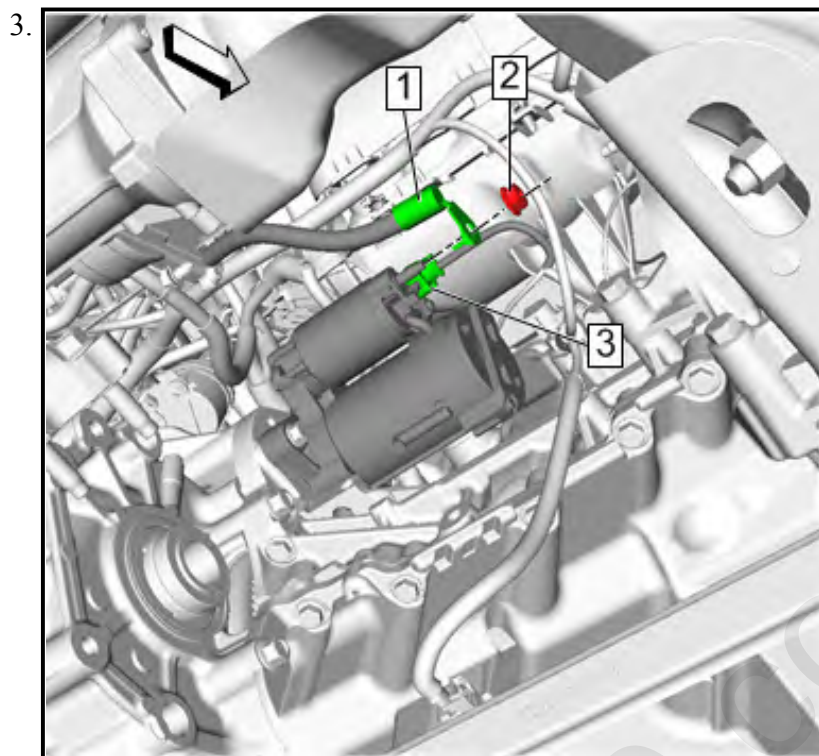
8. Connect the battery negative cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

STARTER REPLACEMENT (LTG - FRONT WHEEL DRIVE)

Removal Procedure

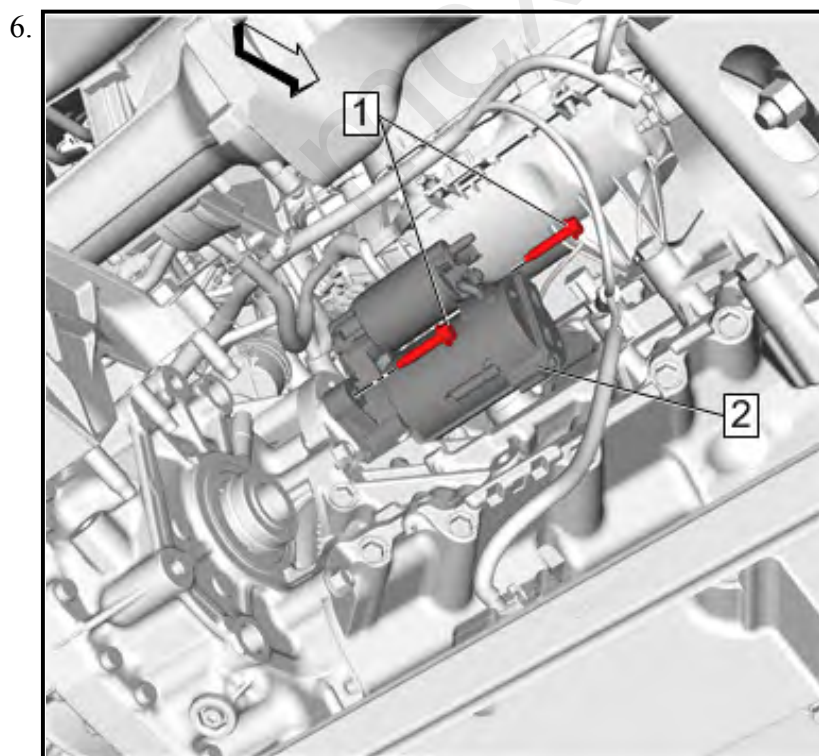
1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)
2. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

NOTE: Exhaust front pipe and front wheel drive shaft removed for clarity.



Battery Positive Cable Nut (2) - Remove

4. Battery Positive Cable (1) - Remove
5. Electrical Connector (3) - Disconnect

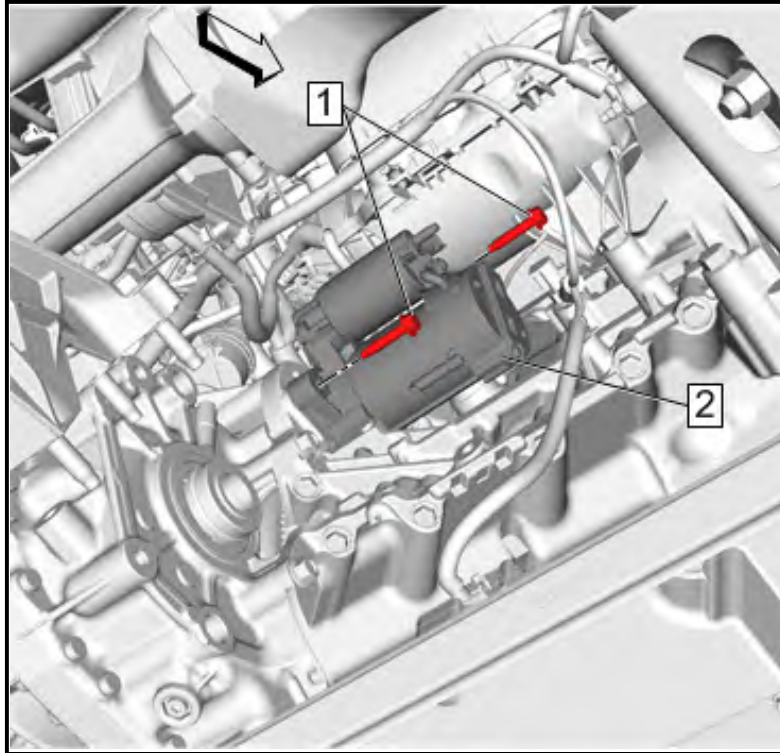


Starter Mounting Bolt (1) - Remove [2x]

7. Starter (2) - Remove

Installation Procedure

1.

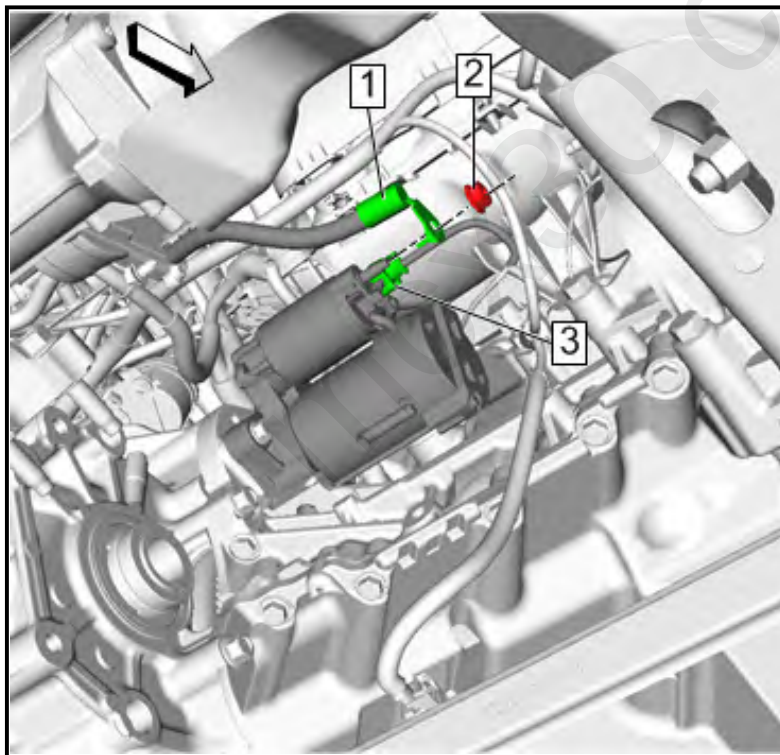


Starter (2) - Install

CAUTION: Refer to [Fastener Caution](#)

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

3.



Battery Positive Cable (1) - Install

4. Battery Positive Cable Nut (2) - Install and tighten 12.5 N.m (111 lb in)

5. Electrical Connector (3) - Connect

6. Lower the vehicle.

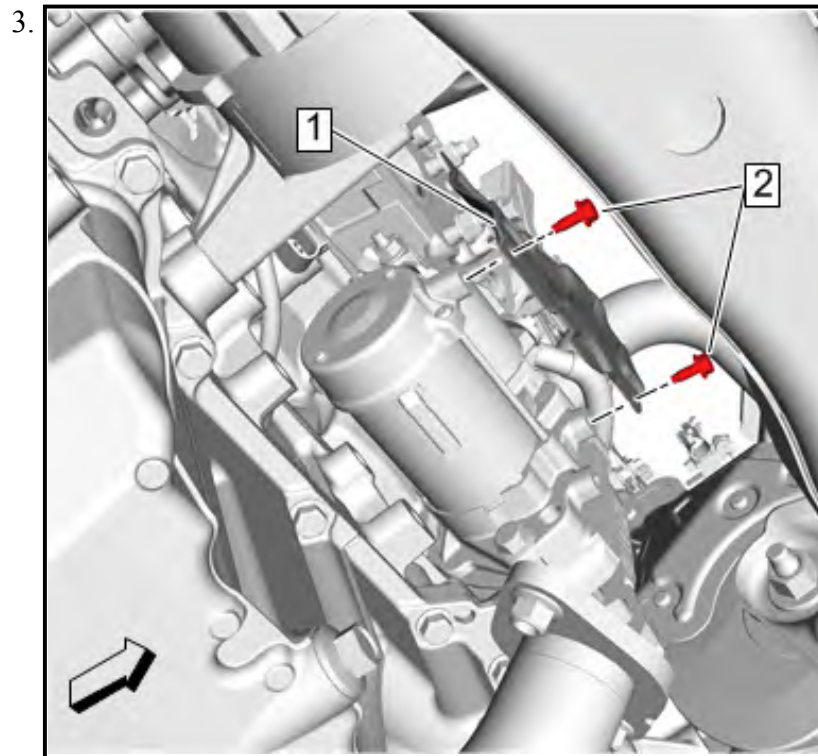
7. Connect the battery negative cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

STARTER REPLACEMENT (LFY)

Removal Procedure

1. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

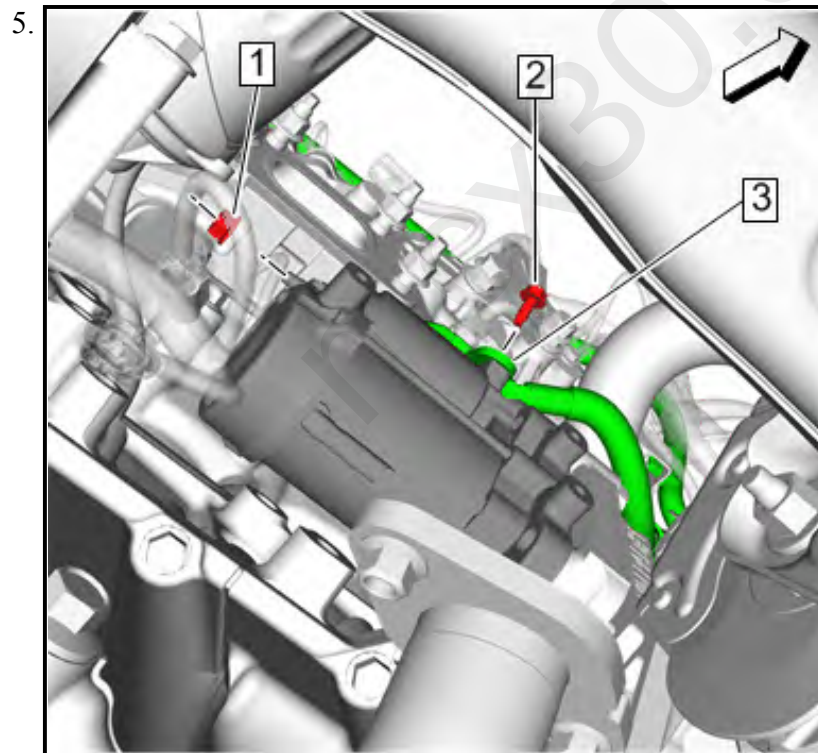
2. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)



NOTE: Catalytic converter removed for graphic clarity.

Starter Heat Shield Fastener (2) - Remove [2x]

4. Starter Heat Shield (1) - Remove

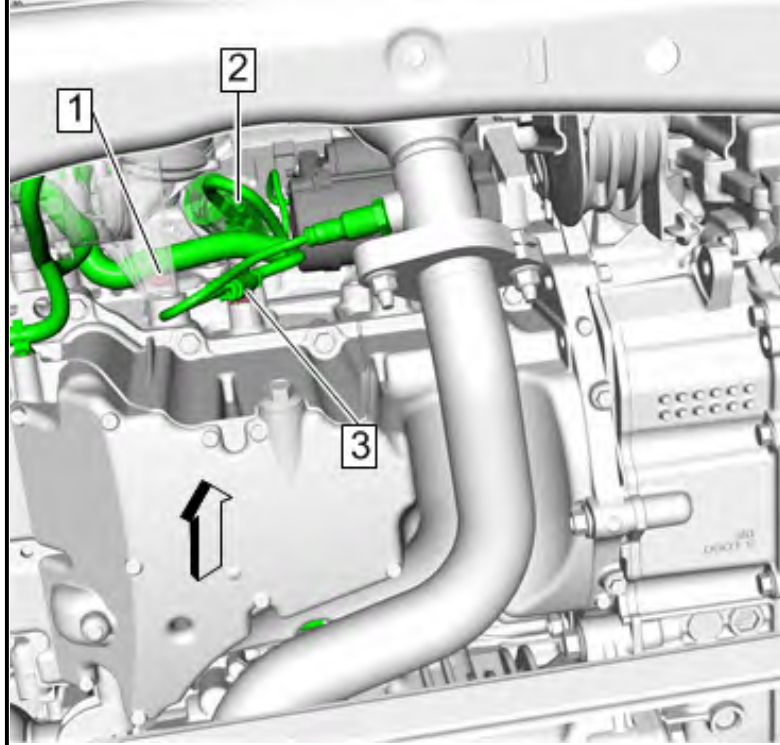


Battery Positive and Negative Cable Conduit Bolt (2) - Remove

6. Battery Positive Cable Nut (1) @ Starter Solenoid - Remove

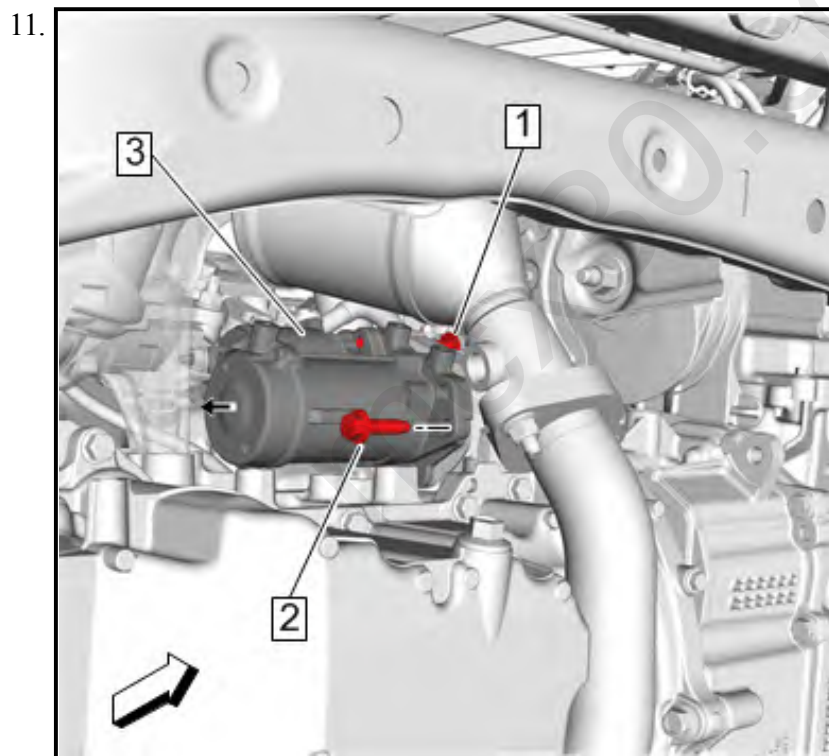
7. Battery Positive Cable (3) - Remove





Electrical Connector (2) - Disconnect

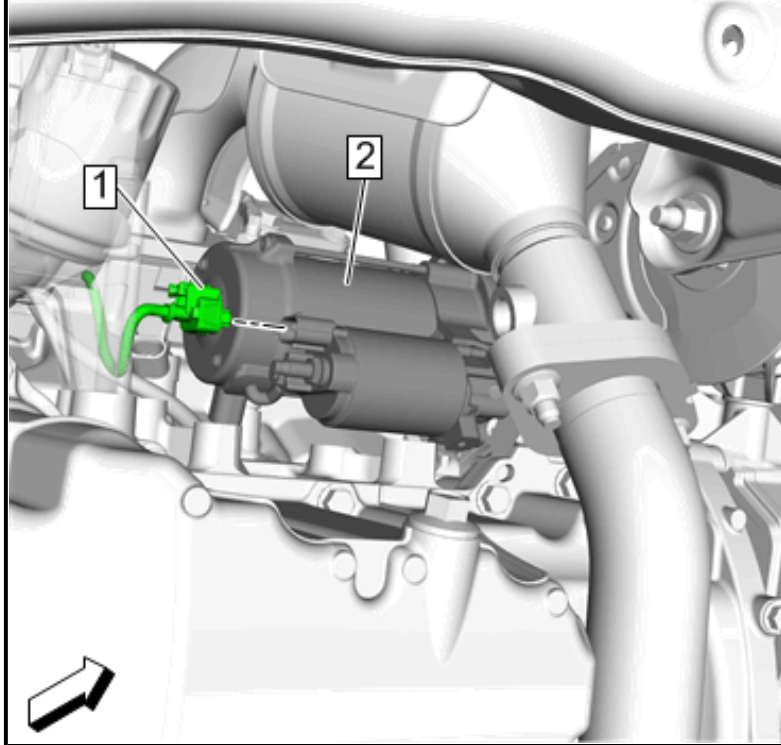
- 9. Retainer (1) - Disengage
- 10. Electrical Connector Retainer (3) - Disengage



Starter Mounting Bolt (2) - Remove

- 12. Loosen the starter mounting bolt (1) while working the starter (3) away from the engine block.



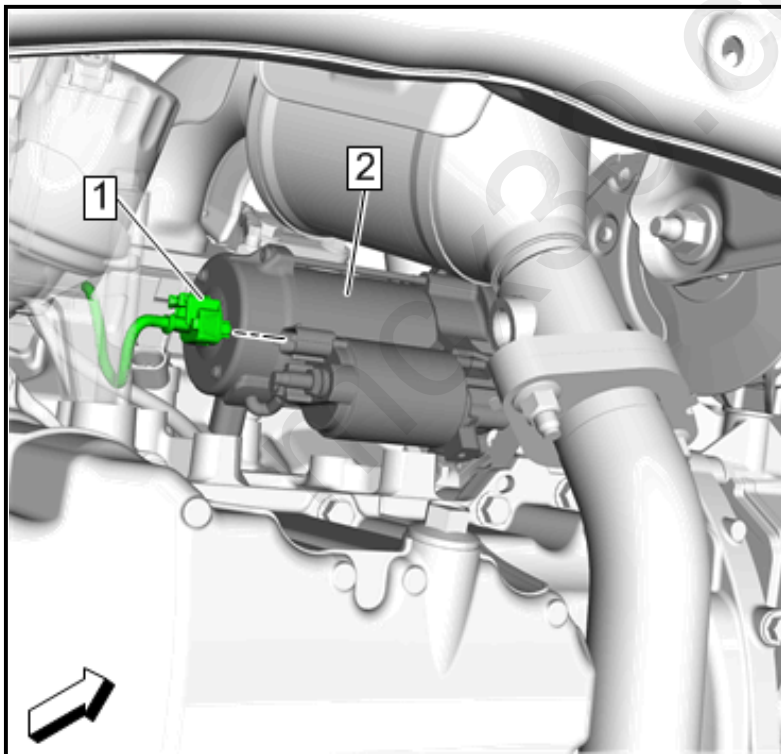


Rotate the starter (2) and disconnect the electrical connector (1).

14. Starter (2) - Remove

Installation Procedure

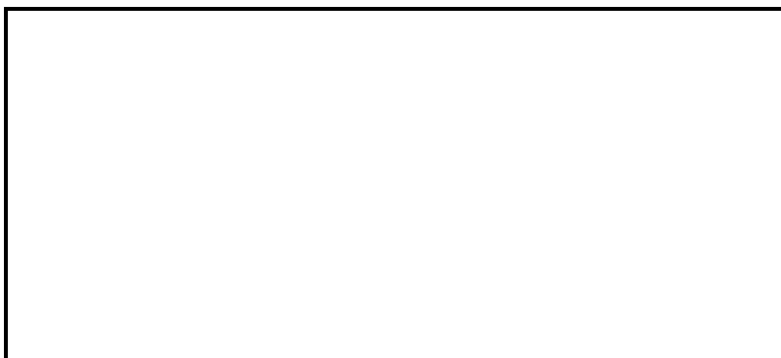
1.

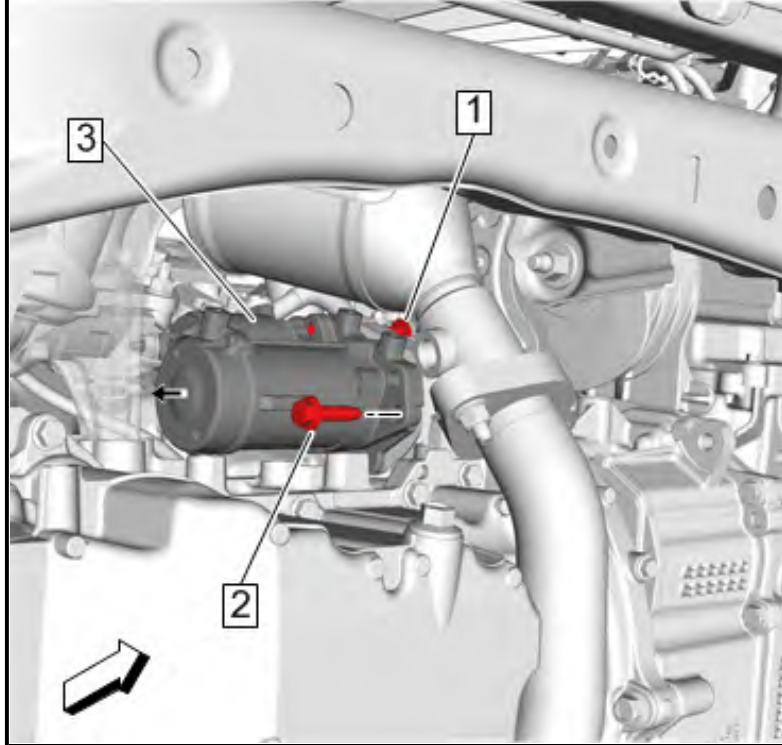


Electrical Connector (1) - Connect

2. Starter (2) - Install

3.



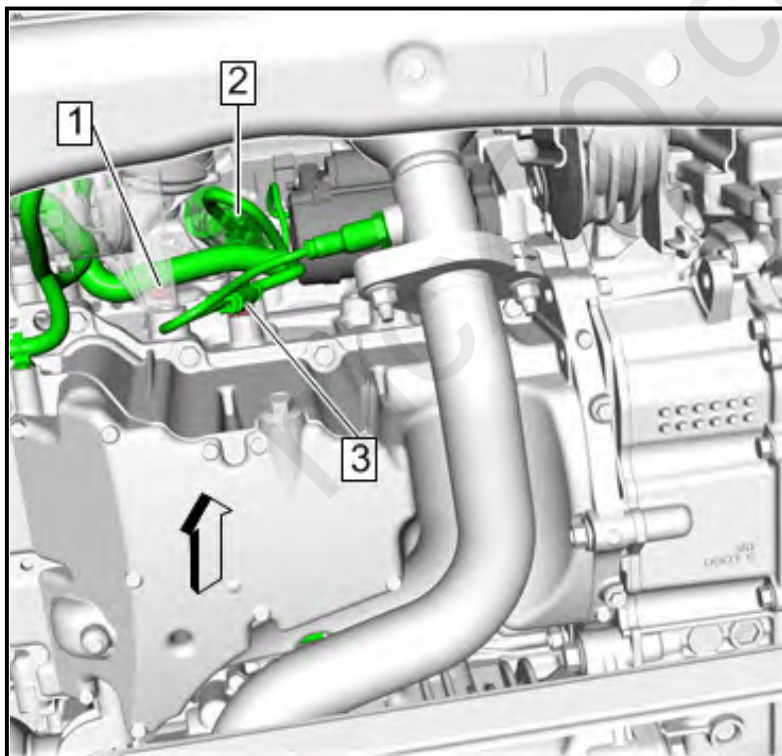


CAUTION: Refer to [Fastener Caution](#)

Starter Mounting Bolt (1) - Install and tighten 58 N.m (43 lb ft)

4. Starter Mounting Bolt (2) - Install and tighten 58 N.m (43 lb ft)

5.



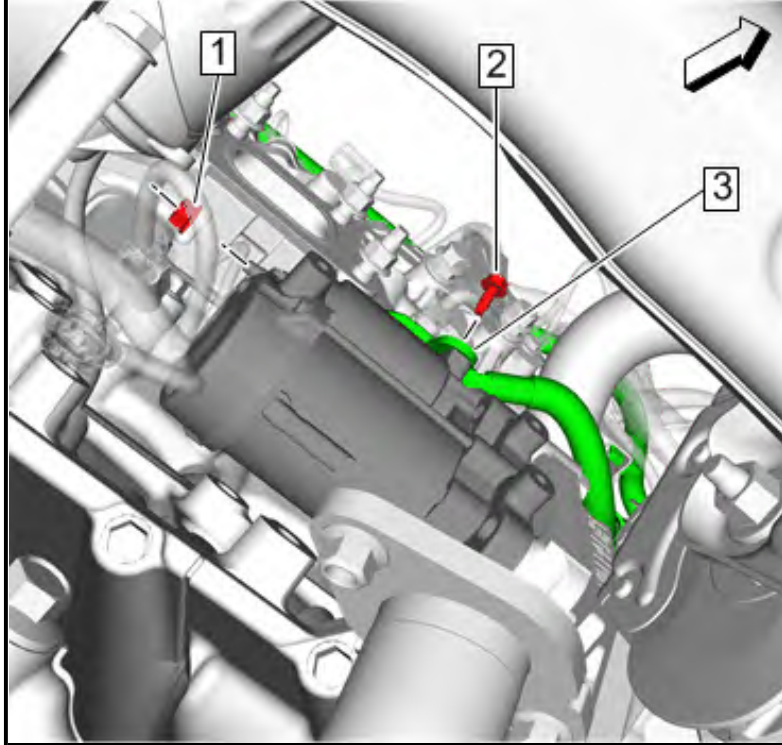
Electrical Connector (2) - Connect

6. Retainer (1) - Engage

7. Electrical Connector Retainer (3) - Engage

8.

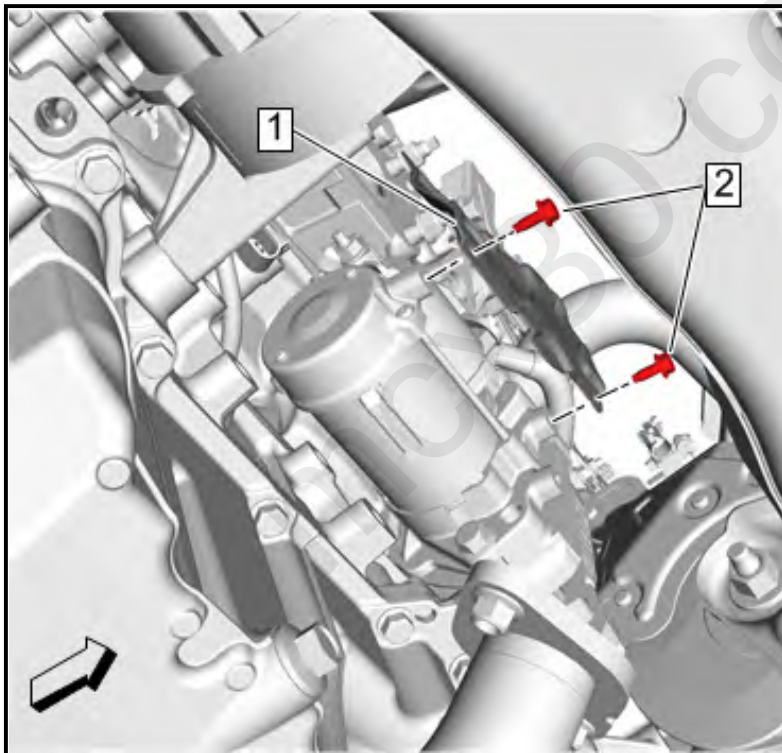




Battery Positive Cable Nut (1) @ Starter Solenoid - Install and tighten 12.5 N.m (111 lb in)

9. Battery Positive and Negative Cable Conduit Bolt (2) - Install and tighten 9 N.m (80 lb in)

10.



NOTE: Catalytic converter removed for graphic clarity.

Starter Heat Shield (1) - Install

11. Starter Heat Shield Fastener (2) - Install and tighten [2x] 9 N.m (80 lb in)

12. Lower the vehicle.

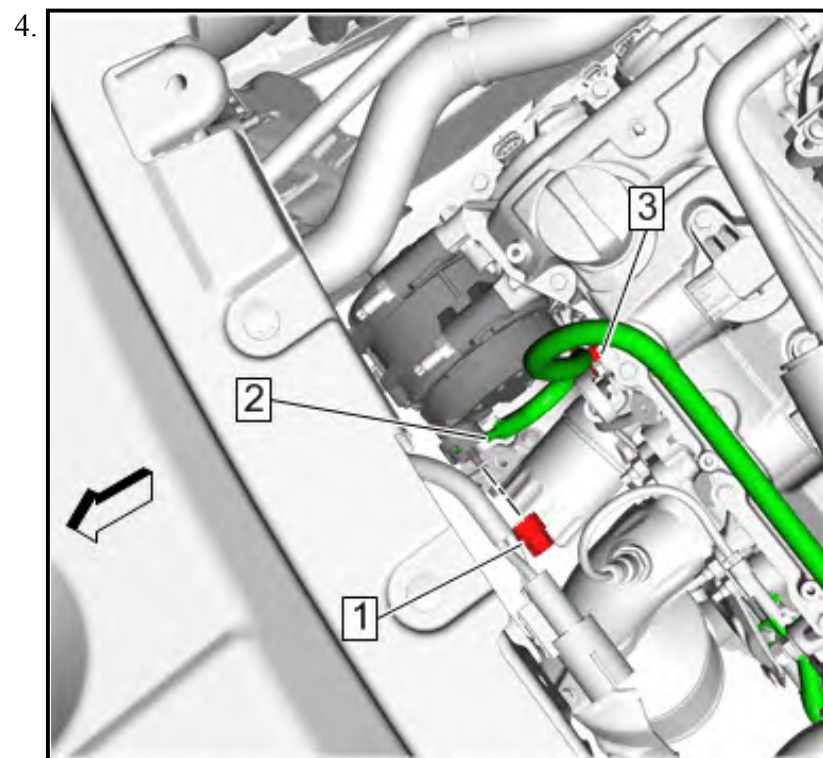
13. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

GENERATOR REPLACEMENT (LFY)

Removal Procedure

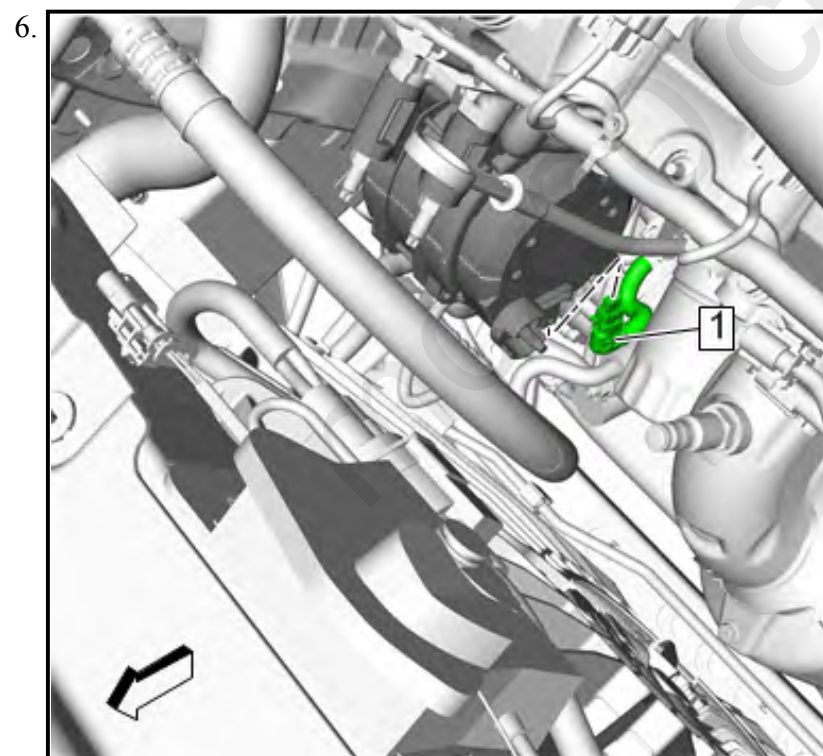
1. Disconnect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)
2. Remove the intake manifold cover. [Intake Manifold Cover Replacement](#)

3. Belt Idler Pulley - Remove - [Belt Idler Pulley Replacement](#)



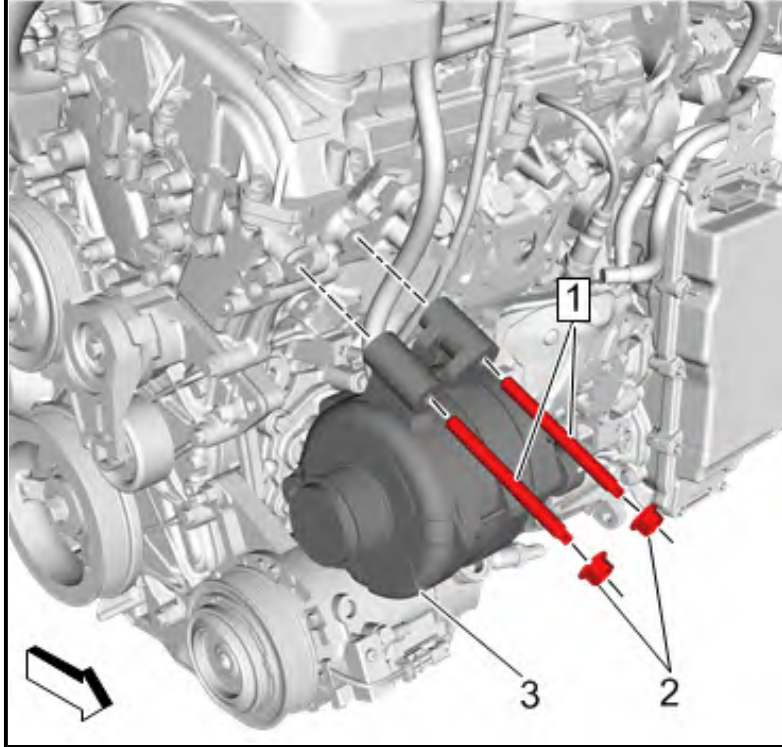
Generator Fastener (1) - Remove

5. Battery Positive Cable (2) - Remove



Electrical Connector (1) - Disconnect



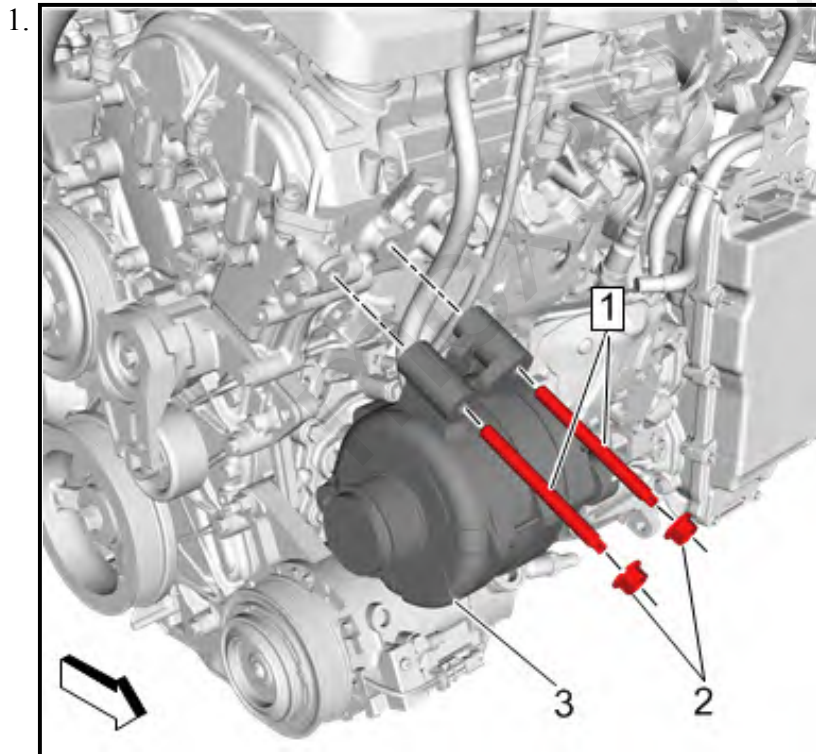


Generator Mounting Nut (2) - Remove [2x]

8. Generator Mounting Stud (1) - Remove [2x]

9. Generator (3) - Remove

Installation Procedure



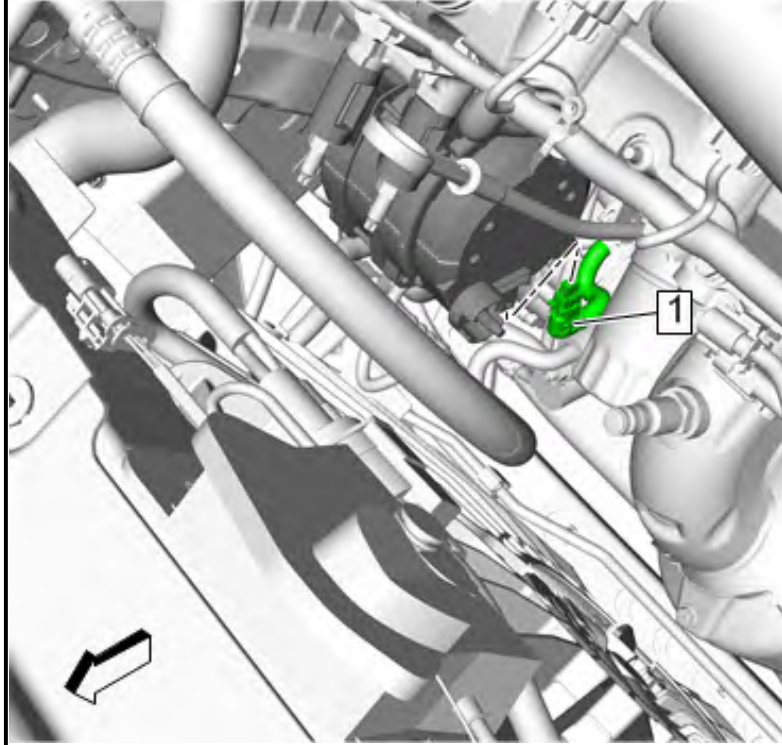
Generator (3) - Install

CAUTION: Refer to **Fastener Caution**

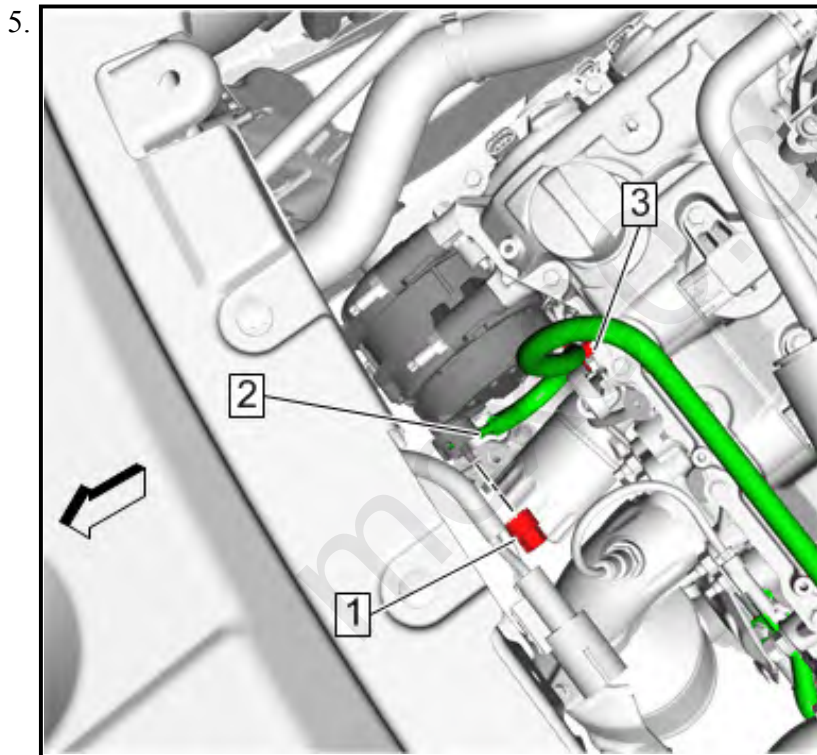
2. Generator Mounting Stud (1) - Install and tighten [2x] 9 N.m (80 lb in)

3. Generator Mounting Nut (2) - Install and tighten [2x] 58 N.m (43 lb ft)

4.



Electrical Connector (1) - Connect



Battery Positive Cable (2) - Install

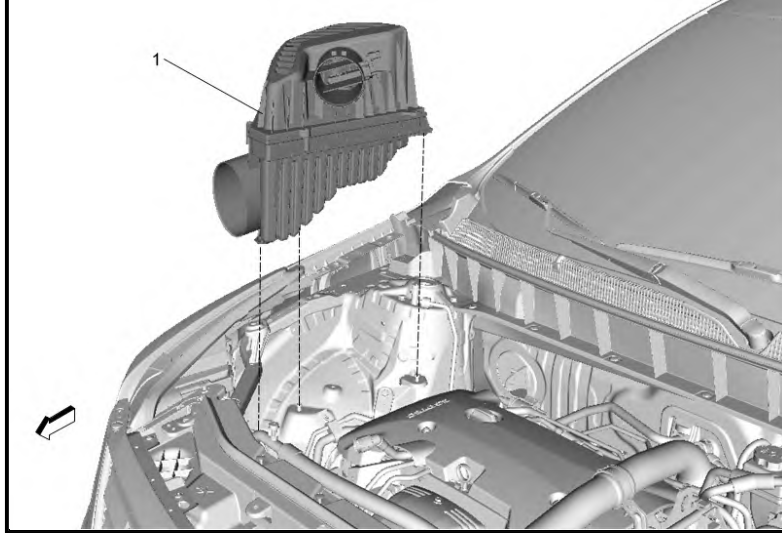
6. Generator Fastener (1) - Install and tighten 15 N.m (11 lb ft)
7. Belt Idler Pulley - Install - [Belt Idler Pulley Replacement](#)
8. Install the intake manifold cover. [Intake Manifold Cover Replacement](#)
9. Connect the battery negative cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

GENERATOR REPLACEMENT (LTG)

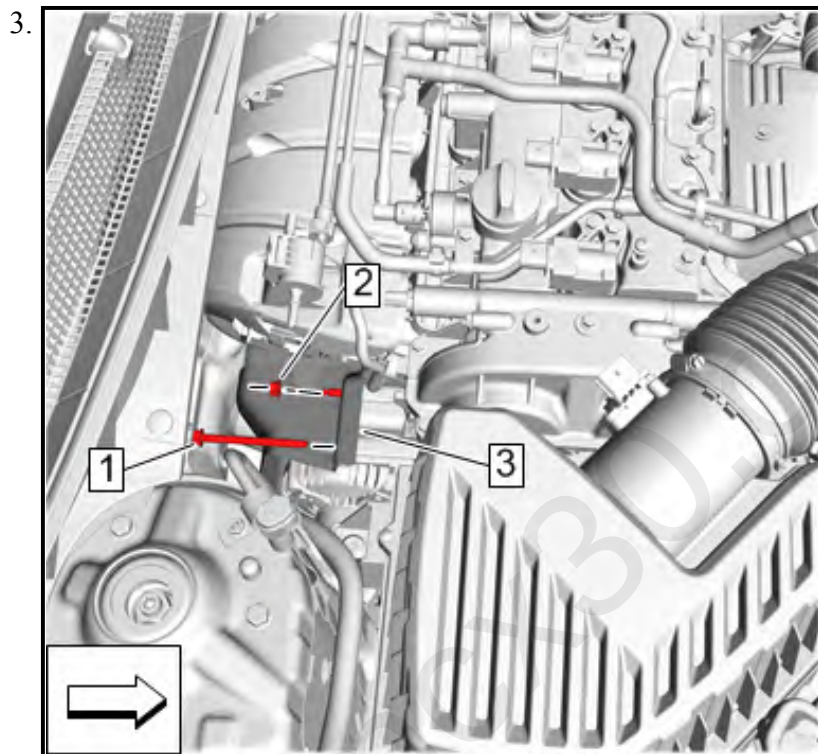
Removal Procedure

1. Disconnect the battery negative cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

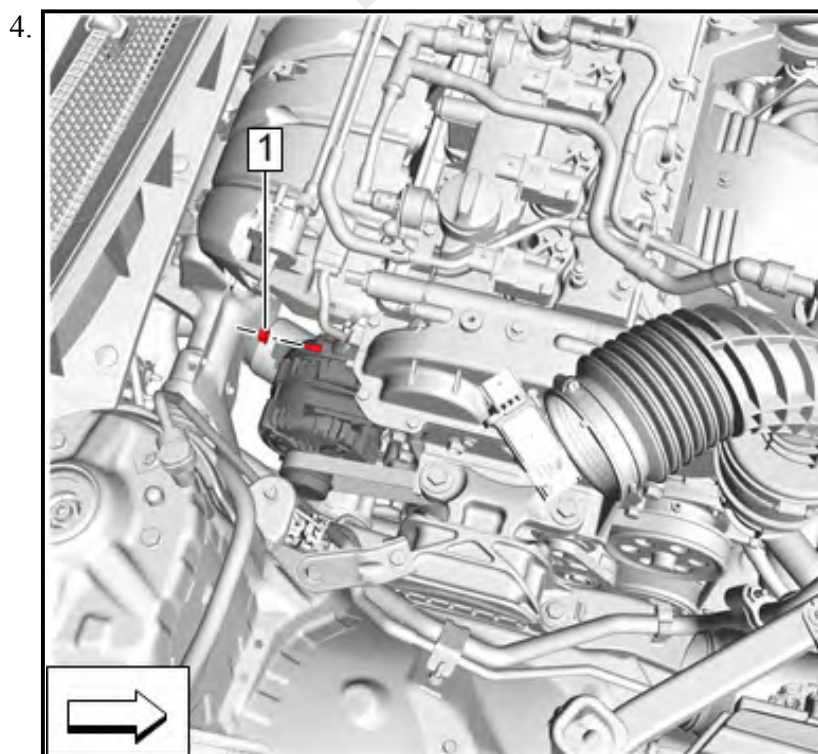




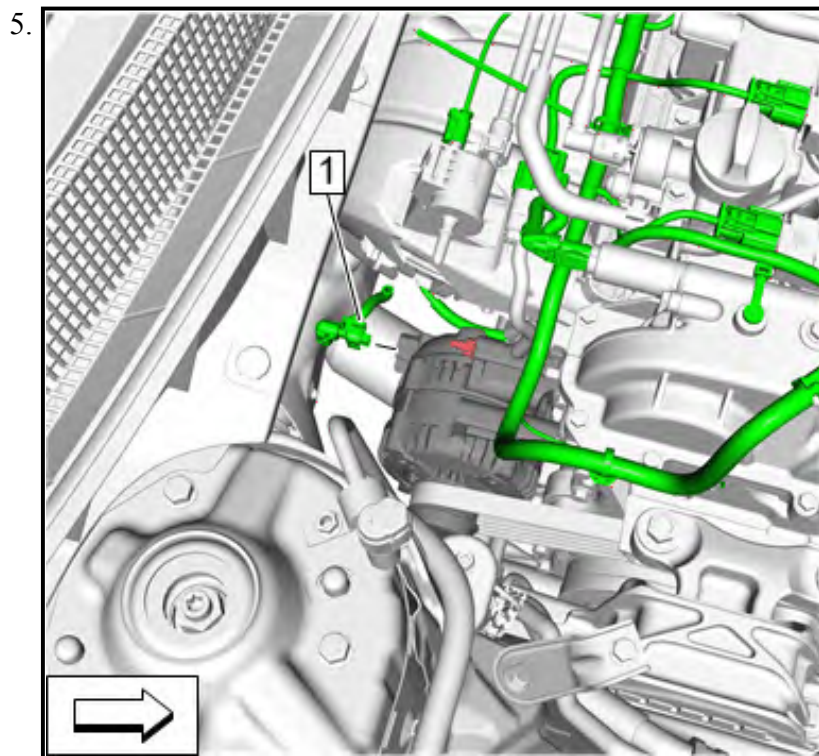
Air Cleaner Assembly (1) - Remove - [Air Cleaner Assembly Replacement](#)



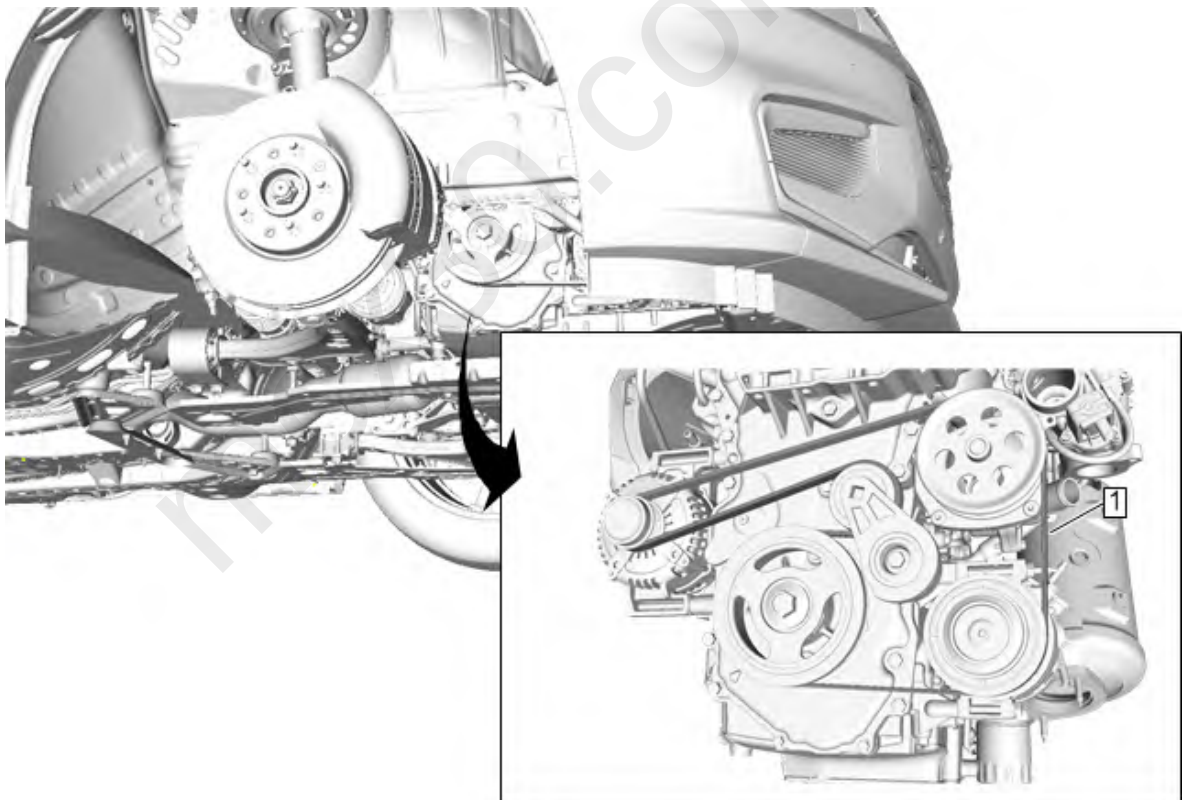
Generator Shield (3) - Remove - [Generator Shield Replacement \(LTG\)](#)



Install the generator nut (1) and finger tighten.



Electrical Connector (1) - Disconnect



6.

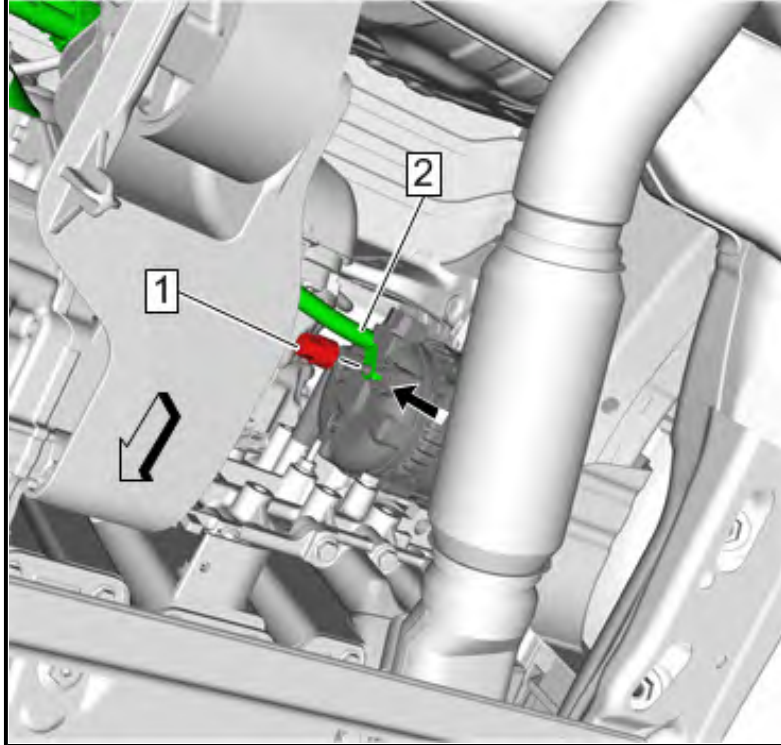
Fig. 1: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

Drive Belt (1) - Remove - [Drive Belt Replacement](#)

7. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)





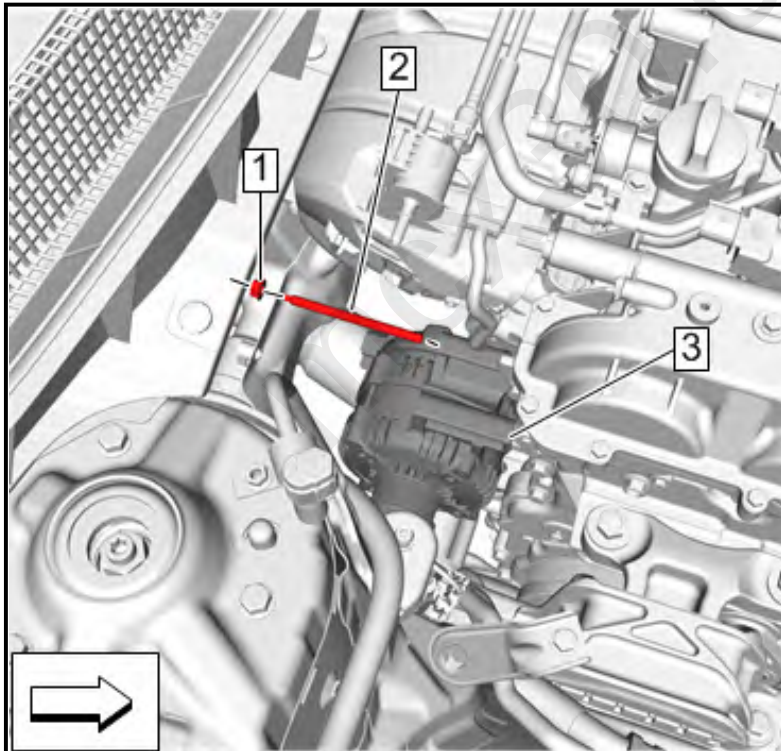
Battery Positive Cable Nut (1) - Remove

NOTE: Anti-rotation tab is in the 4 o'clock position (arrow).

9. Battery Positive Cable (2) - Remove

10. Lower the vehicle.

11.



Generator Nut (1) - Remove

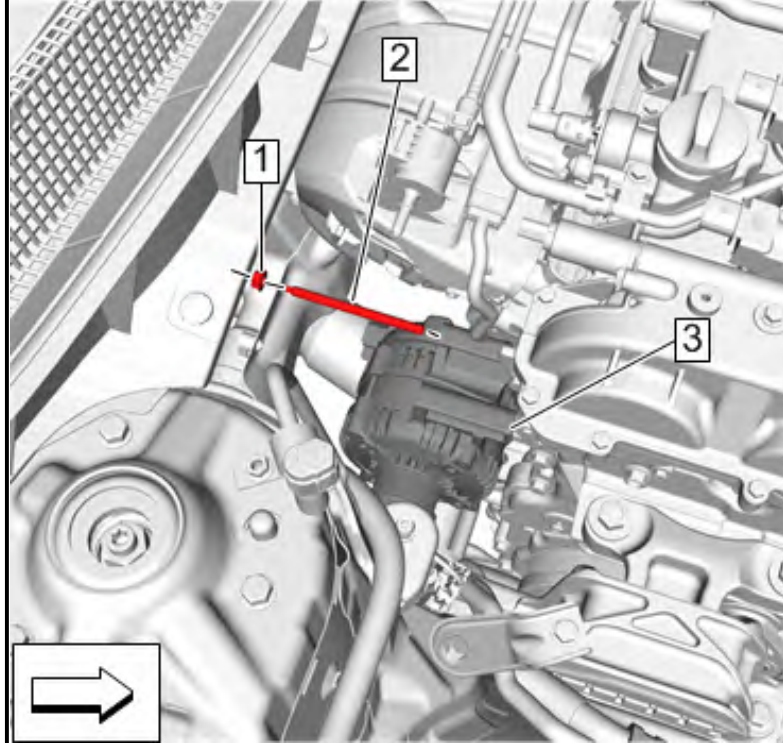
12. If necessary, remove the generator mounting stud (2).

13. Generator (3) - Remove

Installation Procedure

1.



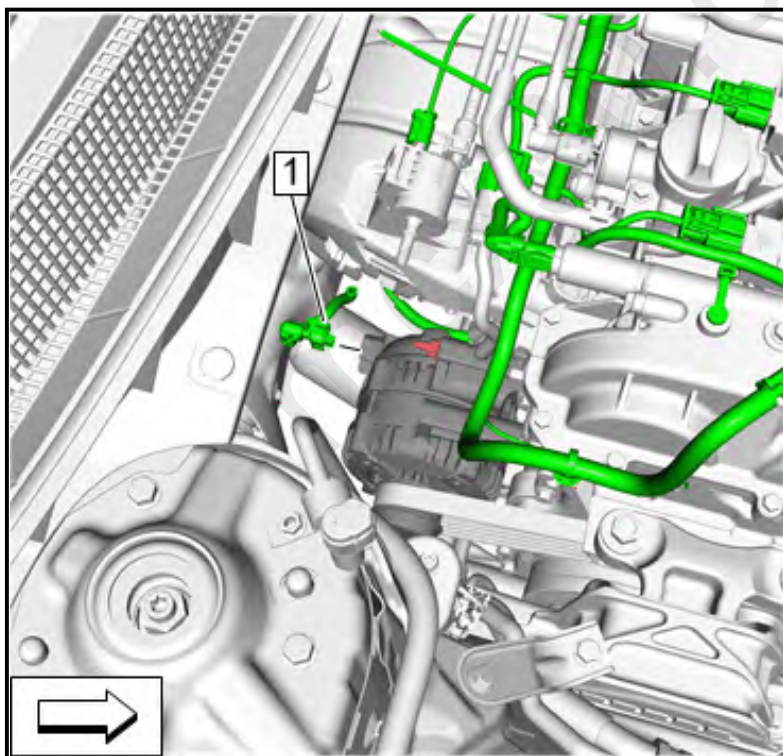


Generator (3) - Install

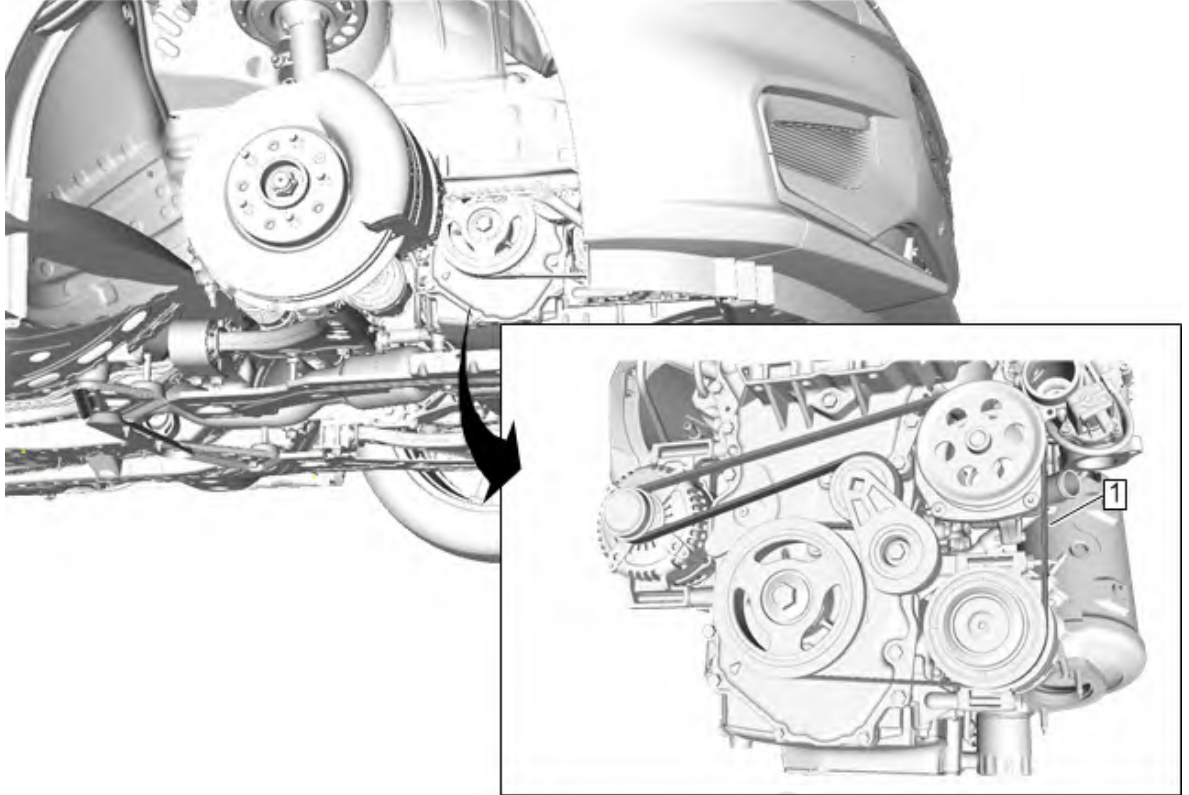
CAUTION: Refer to [Fastener Caution](#)

2. If necessary, install the generator mounting stud. (2) - Tighten 9 N.m (80 lb in)
3. Generator Nut (1) - Hand tighten

4.



Electrical Connector (1) - Connect



5.

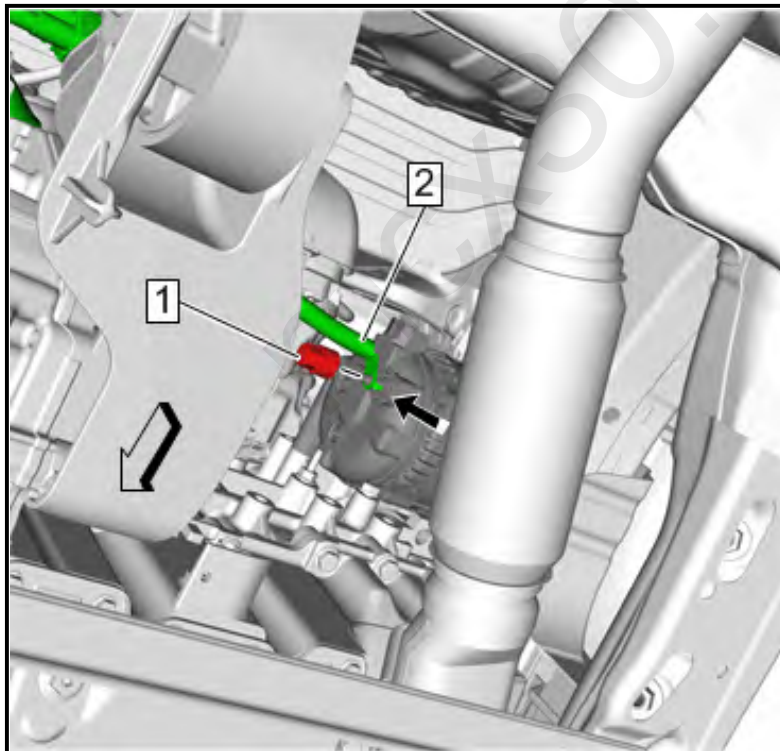
Fig. 2: Drive Belt Routing

Courtesy of GENERAL MOTORS COMPANY

Drive Belt (1) - Install - [Drive Belt Replacement](#)

6. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)

7.



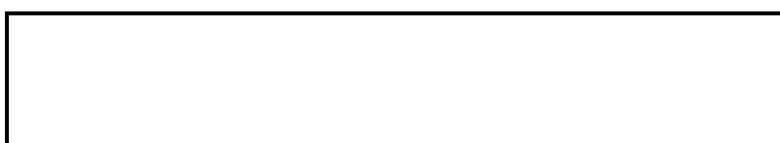
NOTE: Anti-rotation tab is in the 4 o'clock position (arrow).

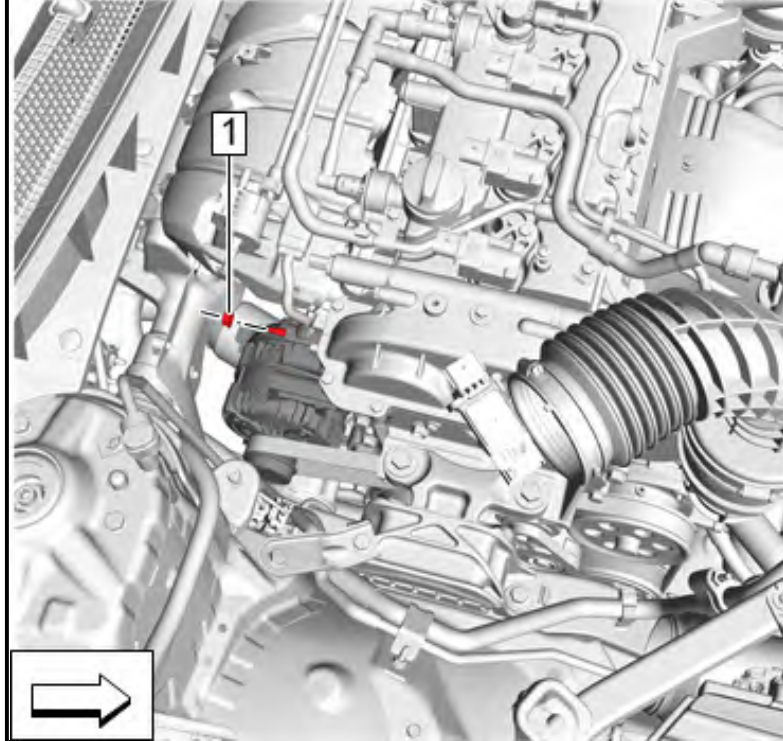
Battery Positive Cable (2) - Install

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

9. Lower the vehicle.

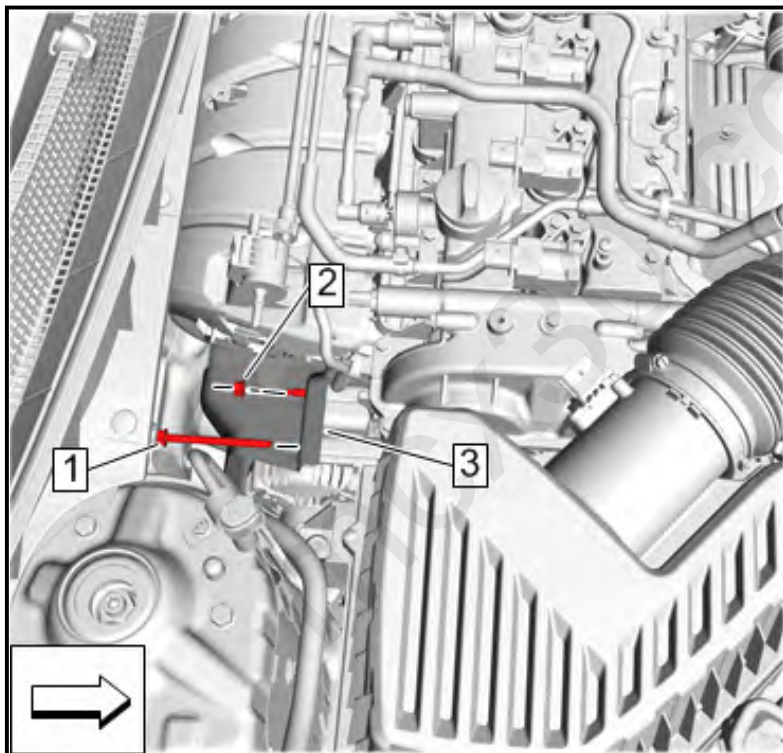
10.





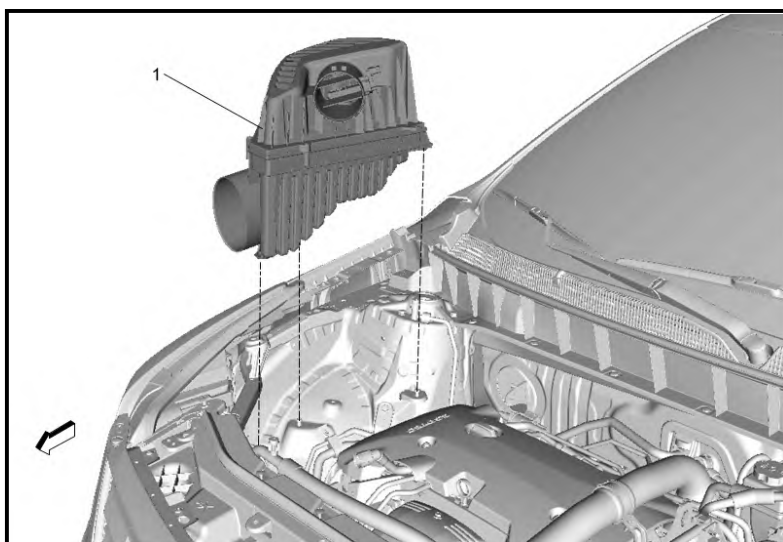
Remove the generator nut (1).

11.



Generator Shield (3) - Install - **Generator Shield Replacement (LTG)**

12.

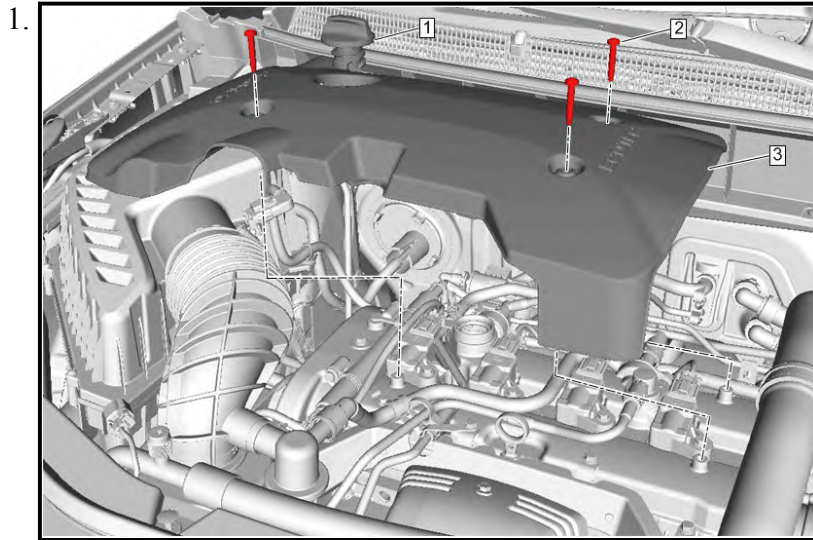


Air Cleaner Assembly (1) - Install - [Air Cleaner Assembly Replacement](#)

13. Connect the negative battery cable. [Battery Negative Cable Disconnection and Connection \(KL9\)](#)

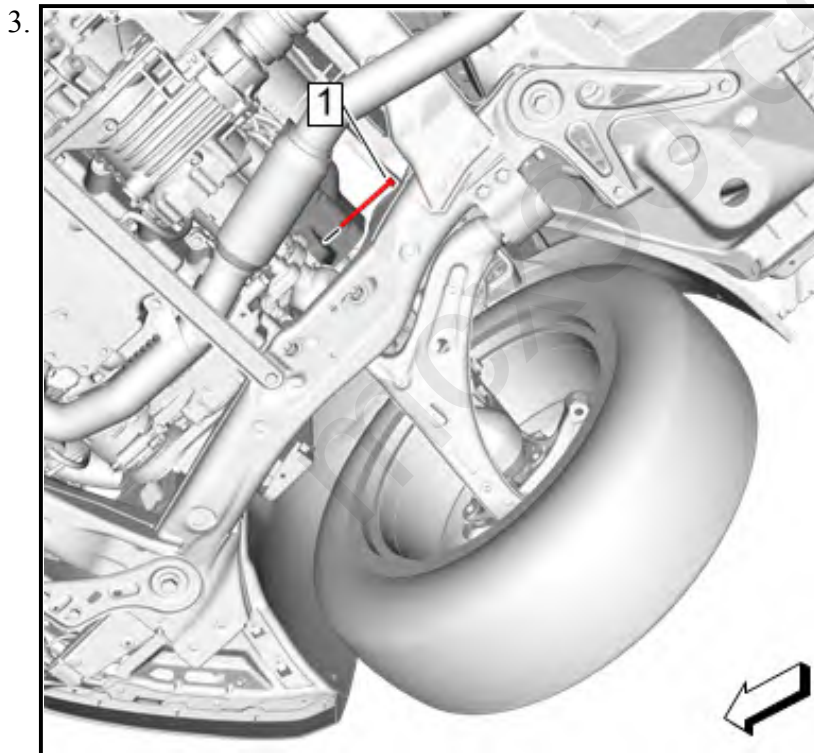
GENERATOR SHIELD REPLACEMENT (LTG)

Removal Procedure



Intake Manifold Cover (3) - Remove - [Intake Manifold Cover Replacement](#)

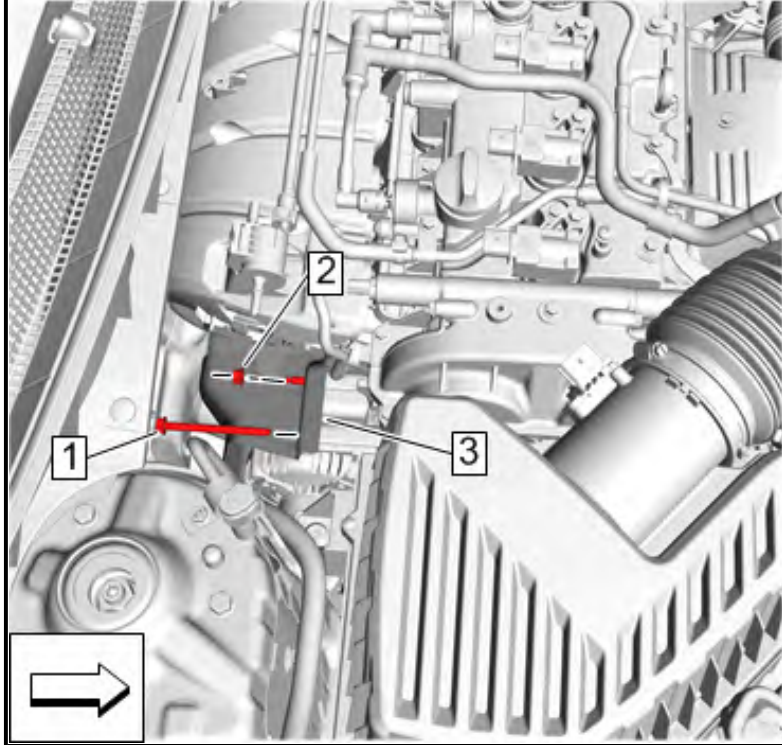
2. Raise and support the vehicle. [Lifting and Jacking the Vehicle](#)



Generator Bolt (1) - Remove

4. Lower the vehicle.

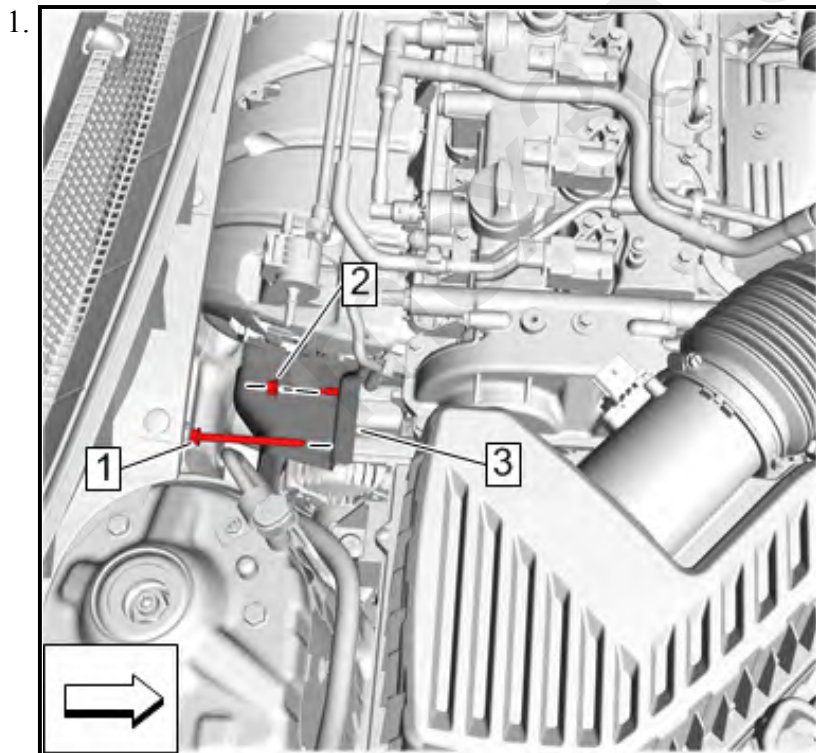




Generator Bolt (1) - Remove

6. Generator Nut (2) - Remove
7. Generator Shield (3) - Remove
8. Re-install generator nut (2) to hold generator in place.

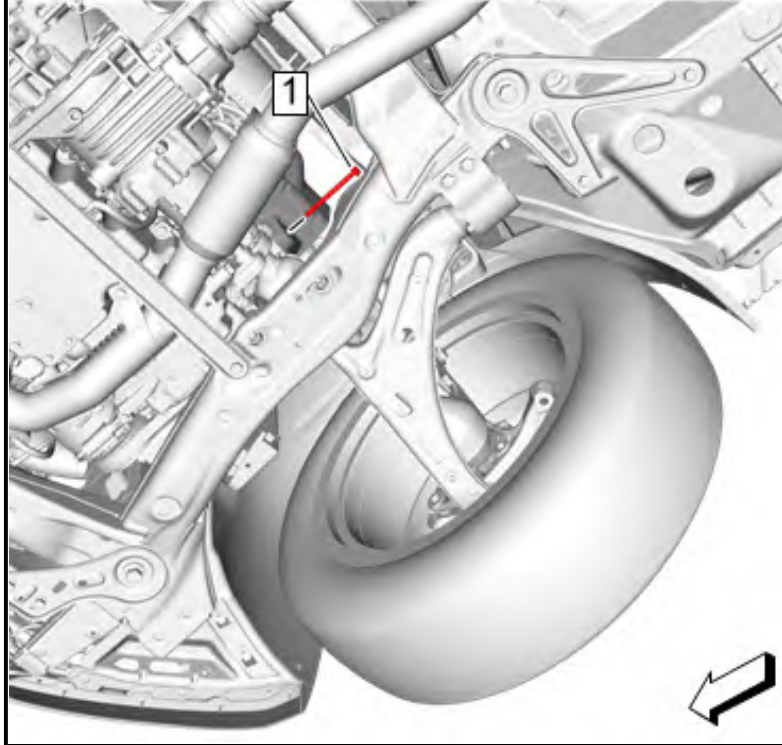
Installation Procedure



Generator Shield (3) - Install

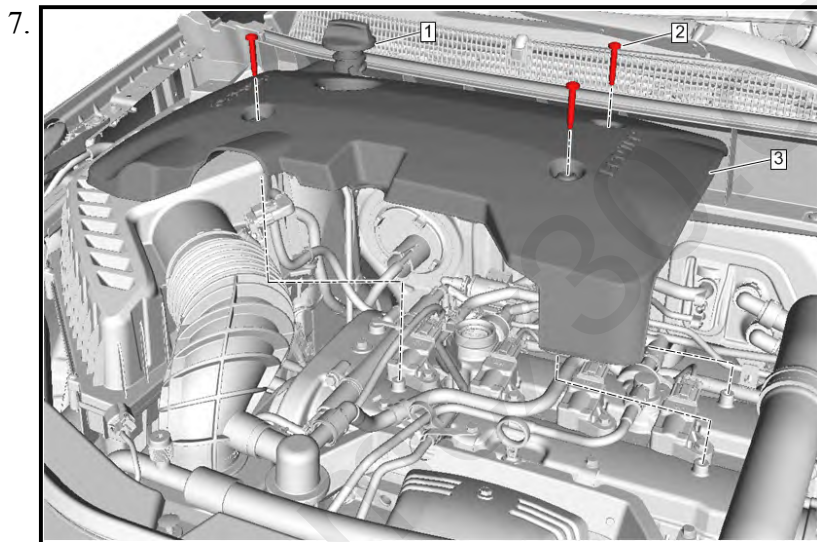
CAUTION: Refer to **Fastener Caution**

2. Generator Nut (2) - Install and tighten 22 N.m (16 lb ft)
3. Generator Bolt (1) - Install and tighten 22 N.m (16 lb ft)
4. Raise and support the vehicle. **Lifting and Jacking the Vehicle**
- 5.



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

6. Lower the vehicle.



Intake Manifold Cover (3) - Install - [Intake Manifold Cover Replacement](#)

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.

CHARGING SYSTEM DESCRIPTION AND OPERATION

Electrical Power Management Overview

The electrical power management system is designed to monitor and control the charging system and send diagnostic messages to alert the driver of possible problems with the battery and generator. This electrical power management system primarily utilizes existing on-board computer capability to maximize the effectiveness of the generator, to manage the load, improve battery state-of-charge and life, and minimize the system's impact on fuel economy. The electrical power management system performs 3 functions:

- Monitor the battery voltage and estimate the battery condition
- Take corrective actions by boosting idle speeds, and adjusting the regulated voltage
- Perform diagnostics and driver notification

The battery condition is estimated during ignition/vehicle off and during ignition/vehicle on. During ignition/vehicle 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.

Any time the ignition/vehicle is on, the vehicle algorithm continuously estimates battery state-of-charge based on adjusted net amp hours, battery capacity, initial state-of-charge, and calculated temperature.

While the engine is running, the battery degree of discharge is primarily determined by the integrated battery current sensor, 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.

Charging System Components

Generator

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 fault, the generator defaults to an output voltage of 13.8 V.

The generator is serviced as a complete assembly. If there is a diagnosed fault in the generator, it must be replaced as an assembly.

Generator Pulley

The pulley drives the Generator via the engine drive belt. There are 2 types of pulleys:

1. Conventional solid Pulley which is bolted to the Generator stator shaft. This Pulley can be serviced separately.
2. One Way Clutch Pulley or Overrunning Alternator Decoupler Pulley allows the Generator to spin freely when the engine rapidly slows down on sudden deceleration. This part is not serviceable and the Generator needs to be replaced as an assembly.

Body Control Module (BCM)

The BCM communicates with the Engine Control Module (ECM) and the instrument cluster for 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 the battery current sensor, the battery positive voltage circuit, and estimates battery temperature to determine battery state of charge. The BCM also 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%. Normal duty cycle is between 5 - 95%. Between 0 - 5% and 95 - 100% 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 serial data. If the battery is determined to be in poor state of health or having a low state of charge, the BCM will not allow the ECM to perform an auto-stop.

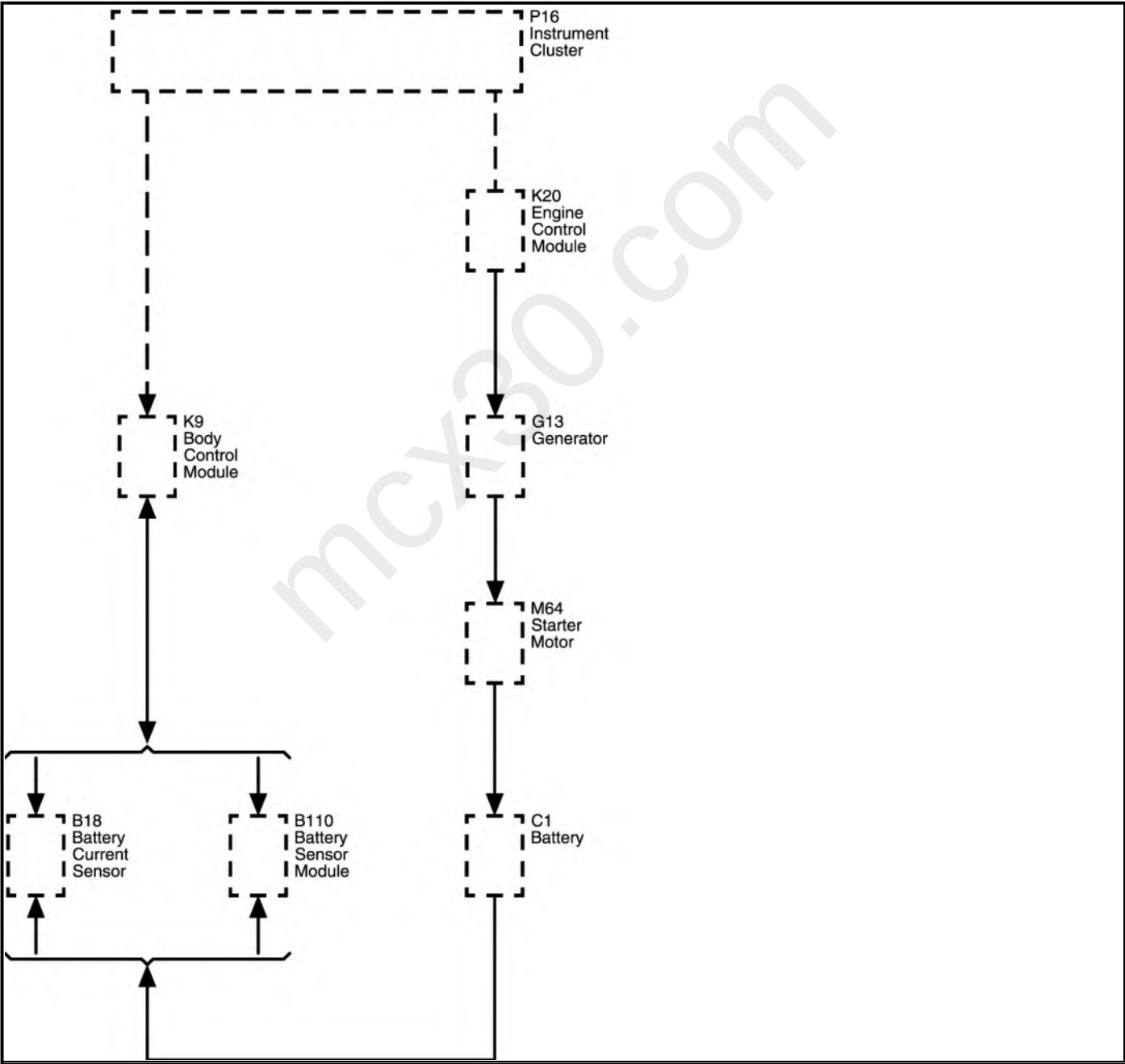
Engine Control Module (ECM)

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 Cluster

As a means of displaying the charging system functions, some vehicles may be equipped with a voltmeter gauge on the instrument cluster and/or a system voltage display in the driver information center. These will indicate the current vehicle system voltage.

The instrument cluster also provides customer notification if there is a concern with the charging system. There are two means of notification: a charge indicator on the instrument cluster and/or a service system message displayed on the Driver Information Center (DIC) if equipped.



Callout	Component Name
P16	P16 Instrument Cluster
K20	K20 Engine Control Module
G13	G13 Generator

Callout	Component Name
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 ECM Controls the Generator through the generator turn - on signal circuit, also known as the Generator L-terminal. The ECM monitors the generator performance through the Generator field duty cycle signal circuit, also known as the generator F-terminal.

The Generator turn - on signal (Generator L-terminal) is a Pulse Width Modulation (PWM) signal of 128 Hz with a duty cycle of 0 - 100%. Normal duty cycle is between 5 - 95%. 0 - 5% and 95 - 100% are for diagnostic purposes, with 0 - 5% monitoring for an open circuit and 95 - 100% monitoring for a short to ground at a fixed 13.8 V. The following table shows the commanded duty cycle and output voltage of the Generator:

Commanded Duty Cycle	Generator Output Voltage (+/- .25 V)
0 - 5%	13.8 V
10%	11 V
20%	11.56 V
30%	12.13 V
40%	12.69 V
50%	13.25 V
60%	13.81 V
70%	14.38 V
80%	14.94 V
90%	15.5 V
95 - 100%	13.8 V

The Generator provides a PWM 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 Generator field duty cycle signal (Generator F-terminal) is a PWM signal of 60 - 460 Hz with a duty cycle of 0 - 100%. Normal duty cycle is between 5 - 100%. 0 - 5% is reserved for diagnostic purposes.

As the charging system works to maintain the battery charge and manage vehicle electrical loads, it is normal for the voltmeter gauge on the instrument cluster or the system voltage displayed in the DIC to fluctuate or change. This does not indicate a malfunction. Depending on the battery state of charge and the vehicle electrical load, these values may be anywhere from 12.5 V to 15.5 V.

Charging System Modes

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:

- Windshield wipers are ON for more than 3 s.
- Climate Control Voltage Boost Mode Request is true, as sensed by the HVAC control module via serial data. High speed cooling fan, rear defogger, and HVAC high speed blower operation can cause the BCM to enter the Charge Mode.
- The estimated battery temperature is less than 0°C (32°F).
- Battery State of Charge is less than 80%.
- Vehicle speed is greater than 145 km/h (90 mph)
- A current sensor malfunction exists.
- System voltage is 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 A and greater than -8 A, and the battery state-of-charge is greater than or equal to 80%. Its targeted generator output voltage is the open circuit voltage of the battery and can be between 12.5 - 13.1 V. When fuel economy mode is active, the generator is not charging, only maintaining open circuit battery voltage. The BCM will exit this mode and enter Charge Mode when any of the conditions described above are present.

Headlamp Mode

The BCM will enter Headlamp 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 s.

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 headlamps 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 Cluster Operation

Charge Indicator Operation

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

Driver Information Center 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 displayed when a charging system DTC is a current DTC. The message is turned off when the conditions for clearing the DTC have been met.

Voltmeter Gauge and/or System Voltage Display (if equipped)

As a means of displaying the charging system functions, some vehicles may be equipped with a voltmeter gauge on the instrument cluster and/or a system voltage display in the driver information center. These will indicate the current vehicle system voltage.

As the charging systems works to maintain the battery charge and manage vehicle electrical loads, it is normal for the voltmeter gauge on the instrument cluster or the system voltage display in the driver information center to fluctuate or change. This does not indicate a malfunction. Depending on the battery state of charge and the vehicle electrical load, these values may be anywhere from 12.5 V to 15.5 V.

ELECTRICAL POWER MANAGEMENT DESCRIPTION AND OPERATION

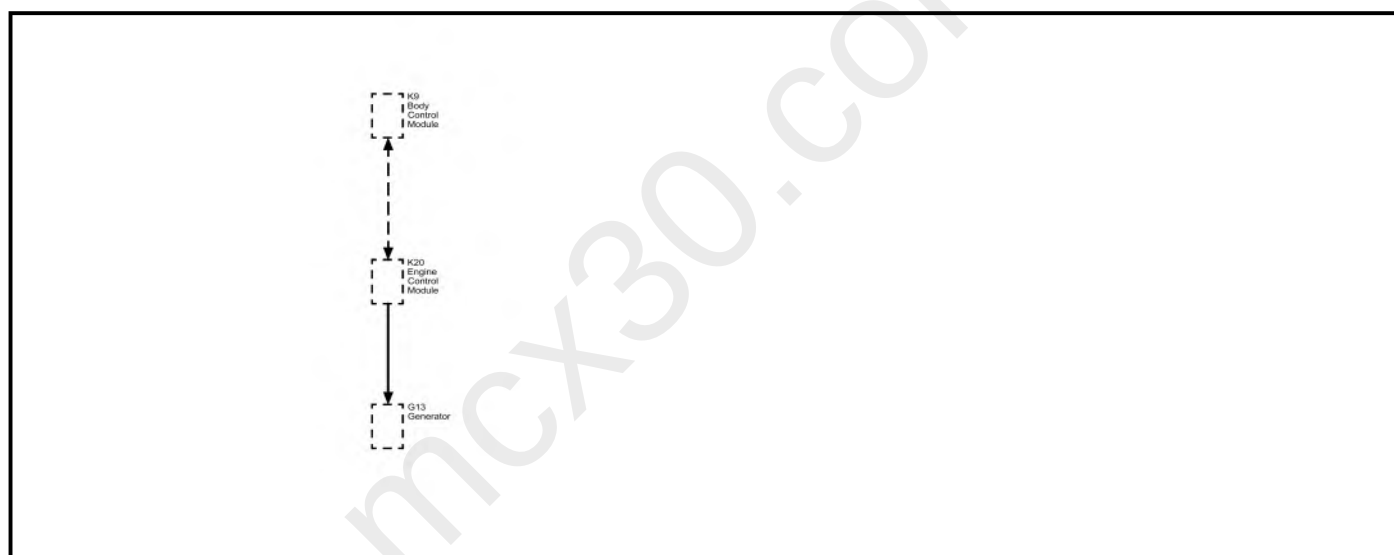
Electrical Power Management

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:



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
Idle Boost 1 End	Greater Than -10°C (14°F)	Greater Than 12 V	Battery has a net loss less than 0.2 Ah	First level Idle boost request cancelled
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 Ah	Second level Idle boost requested

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 2 Start	-	Less Than 11 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 Ah	Second level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12 V	Battery has a net loss of less than 2 Ah	Clear Load Shed 1
Idle Boost 3 Start	-	-	Battery has a net loss of 10 Ah	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 11 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 Ah	Third level Idle boost request cancelled
Load Shed 2 Start	-	-	Battery has a net loss greater than 12 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 Start	-	Less Than 11 V	-	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12 V	Battery has a net loss of less than 8 Ah	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20 Ah	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
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 -15°C (5°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 -15°C (5°F)	-	First level Idle boost request cancelled
Idle Boost 1 End	-	Greater Than 13 V	First level Idle boost request cancelled
Idle Boost 2 Start	-	Less Than 12.4 V	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12.5 V	Second level Idle boost request cancelled
Load Shed 1 Start	-	Less Than 12.3 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12.4 V	Clear Load Shed 1
Idle Boost 3 Start	-	Less Than 10 V	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12.3 V	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 12.1 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.2 V	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Rear Defrost, Heated Mirrors, Heated Seats, HVAC cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.0 V	Clear Load Shed 3

LOAD SHED SYSTEM 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 discrete. No two functions are active at the same time. Idle boost is activated in incremental steps, idle boost 1 must be active before idle boost 2 can be active. The criteria used by the body control module (BCM) to regulate electrical power management are outlined below:

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Idle Boost 1 Start	Less Than -15°C (5°F)	Less Than 13 V	-	First level Idle boost requested
Idle Boost 1 Start	-	-	Battery has a net loss greater than 0.6 AH	First level Idle boost requested
Idle Boost 1 Start	-	Less Than 10.9 V	-	First level Idle boost requested
Idle Boost 1 End	Greater Than -15°C (5°F)	Greater Than 12 V	Battery has a net loss less than 0.2 AH	First level Idle boost request cancelled
Load Shed 1 Start	-	-	Battery has a net loss of 4 AH	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle
Load Shed 1 Start	-	Less Than 10.9 V	-	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 20% of their cycle
Load Shed 1 End	-	Greater Than 12 V	Battery has a net loss of less than 2 AH	Clear Load Shed 1
Idle Boost 2 Start	-	-	Battery has a net loss greater than 1.6 AH	Second level Idle boost requested
Idle Boost 2 Start	-	Less Than 10.9 V	-	Second level Idle boost requested
Idle Boost 2 End	-	Greater Than 12 V	Battery has a net loss less than 0.8 AH	Second level Idle boost request cancelled
Idle Boost 3 Start	-	-	Battery has a net loss of 10.0 AH	Third level Idle boost requested
Idle Boost 3 Start	-	Less Than 10.9 V	-	Third level Idle boost requested
Idle Boost 3 End	-	Greater Than 12 V	Battery has a net loss of less than 6.0 AH	Third level Idle boost request cancelled
Load Shed 2 Start	-	Less Than 10.9 V	Battery has a net loss greater than 12 AH	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC

Function	Battery Temperature Calculation	Battery Voltage Calculation	Amp-Hour Calculation	Action Taken
Load Shed 2 Start	-	Less Than 10.9 V	-	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 50% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 2 End	-	Greater Than 12.6 V	Battery has a net loss of less than 10.5 AH	Clear Load Shed 2
Load Shed 3 Start	-	Less Than 11.9 V	Battery has a net loss greater than 20 AH	Rear Defrost, Heated Mirrors, Heated Seats cycled OFF for 100% of their cycle. The BATTERY SAVER ACTIVE message will be displayed on the DIC
Load Shed 3 End	-	Greater Than 12.6 V	Battery has a net loss of less than 15 AH	Clear Load Shed 3

STARTING SYSTEM DESCRIPTION AND OPERATION

Starter Motor Operation (Without KL9)

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.

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 crank signal is removed, the starter 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.

Enhanced Starter Motor Operation (KL9)

The Engine Stop/Start system in GM vehicles automatically turns off the engine when the vehicle comes to a stop under certain driving conditions, and can quickly restart the engine in about 0.3 seconds when commanded to do so.

In order to smoothly restart the engine as quickly as possible while managing the greater number of engine starts, the Stop/Start system uses an enhanced starter motor that operates differently from a conventional starter motor. It has a high performance electric motor and a stronger pinion engagement mechanism than a conventional starter. It also has independent control of the pinion and motor.

The enhanced starter motor continues using the typical pinion engagement mechanism with a starter solenoid that drives the pinion gear to engage or disengage the flywheel of the engine. When engaged, the starter motor can rotate the engine flywheel and, in turn, the crankshaft.

On the enhanced starter of a Stop/Start system the operation is done in two separate functions inside the solenoid, Starter Motor and Pinion Actuator. Each function controlled individually by the ECM. There are two separate relays to control the two separate parts of the enhanced solenoid:

- KR27 Starter Motor Relay
- KR27C Starter Pinion Actuator Relay

The two individually-controlled relays allow for smooth engagement of the pinion gear into the flywheel with minimum noise and wear.

When the vehicle is coming to a stop, just before the engine stops rotating (at approximately 50 RPM) during stop/start operation, the ECM energizes the Starter Pinion Solenoid Actuator Relay to easily push the pinion gear into the flywheel gear without gear clash. (Fig. 8) When the engine stops rotating during Stop/Start operation (Auto Stop mode), the starter pinion gear is fully engaged, ready for the starter motor to become energized to quickly start the engine again.

A secondary need for the starter pinion to be driven into the flywheel gear before the engine stops rotating is to address quickly changing demands on the engine. For example, when a driver is slowing nearly to a stop - and the Stop/Start system is preparing for Auto Stop mode - but suddenly decides to release the brake and accelerate

In this situation, the engine has already stopped rotating, or nearly so. A conventional starter cannot restart the engine until the engine has completely stopped. However, with the enhanced starter, the starter pinion gear is fully engaged and ready to begin rotating the engine even before it fully stops turning. Otherwise, the engine would actually have to stop rotating before the pinion can engage smoothly to begin a restart.

To prevent a lag in engine operation, the ECM uses predictive speed matching of the flywheel gear speed and the pinion gear speed to engage the pinion gear into the flywheel gear without gear clash before the engine fully stops. By predicting how long it takes the starter motor to spin up using an algorithm, the pinion gear speed can be matched to the flywheel gear speed. The result is an almost instant restart that is possible at extremely low engine speeds.

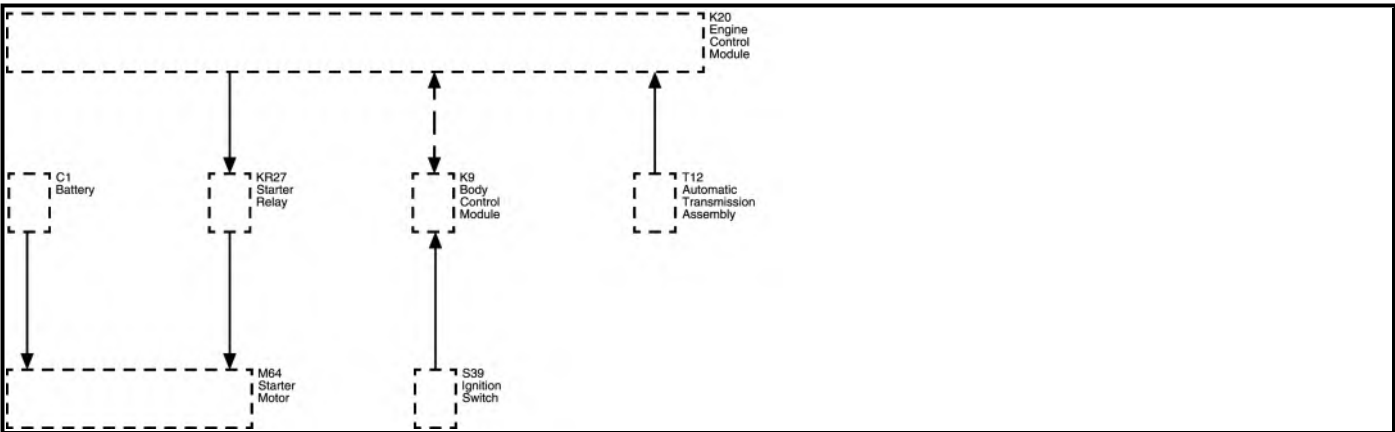
Circuit Description

Keyless Start

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

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.



Callout	Component Name

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 (WITH KL9)

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 -10Â°C (14Â°F)
- Battery temperature is less than 0Â°C (32Â°F) or greater than 55Â°C (131Â°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 125Â°C (257Â°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 engine's internal coolant pump to circulate the engine coolant. The Stop/Start System is automatically activated each time the ignition switch is turned on.

Through the climate control system, the vehicle can be cycled between off, comfort, and eco air conditioning modes (if equipped). In comfort mode, the priority for Stop/Start operation is on customer comfort. Depending on ambient temp, humidity, cabin temperature and cabin temperature setpoint, the least amount of autostops occur in this mode. In eco mode, the priority is on fuel economy. There are more frequent autostops with some sacrificing of cabin temperature control. With the HVAC turned off, the maximum autostops occur since there will be no A/C compressor requests.

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
- Driver door status is closed
- Driver seat belt status is buckled
- 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 1500 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
-10°C (14°F)	60°C (140°F)	Yes
0°C (32°F)	50°C (122°F)	Yes
6°C (43°F)	40°C (104°F)	Yes
12°C (54°F)	30°C (86°F)	Yes
20°C (68°F)	18°C (64°F)	Yes
30°C (86°F)	18°C (64°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

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 and 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) monitors the ECO switch in order to enable or disable the system. It is also 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.

ECO Switch (if Equipped)

The ECO switch can change the vehicle air conditioning mode (off, comfort, and eco). In comfort mode, the priority for Stop/Start operation is on customer comfort. In eco mode, the priority is on fuel economy.

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, or the ECO button has disengaged Autostop, the tachometer will function normally.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/Description

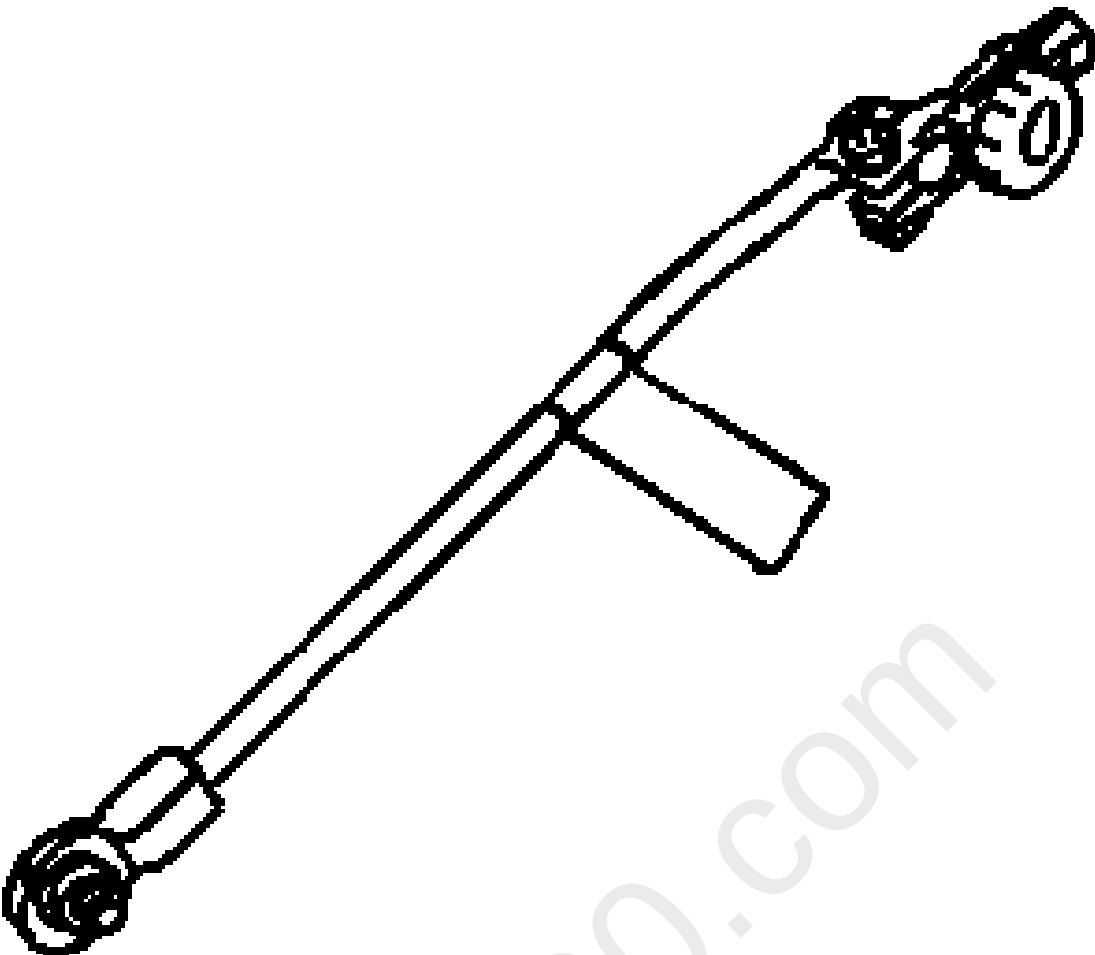
Illustration	Tool Number/Description
 mcx30.com	EL 38758 EL 50074 J 38758 Parasitic Draw Test Switch

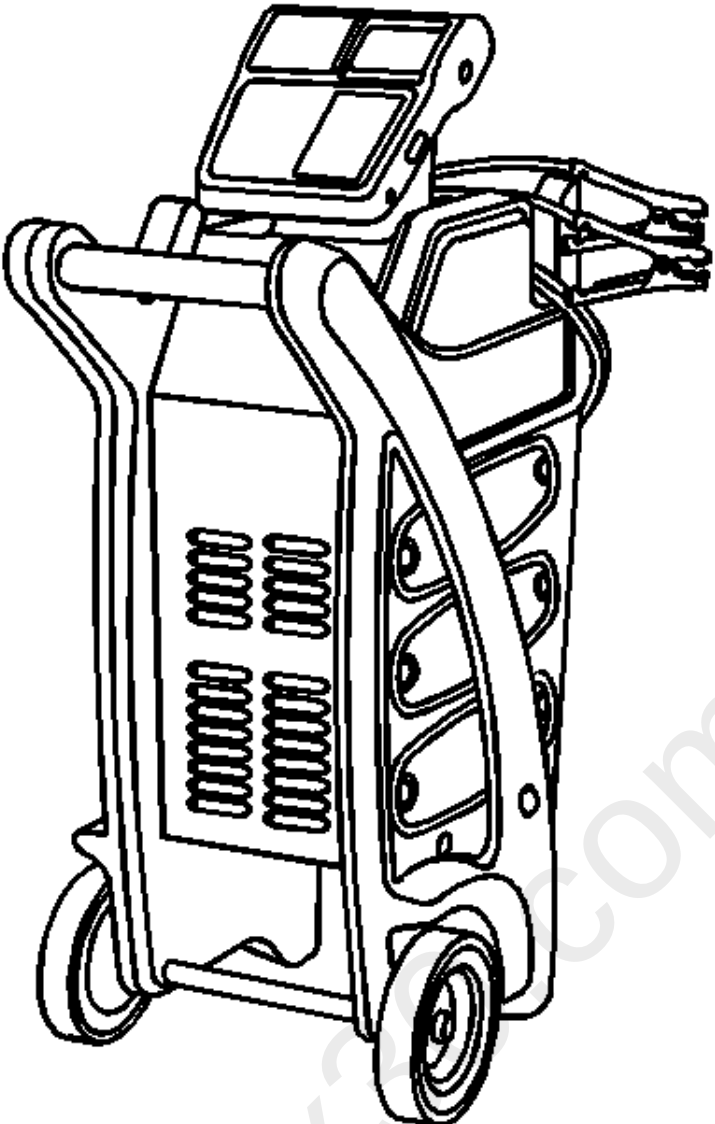
Illustration	Tool Number/Description
	BC 800 W BC 800 WP EL 50313 EL 42000 EL 50076 Battery Tester
	J 42000 Battery Tester

Illustration	Tool Number/Description
