SCHEMATIC WIRING DIAGRAMS

HYBRID/EV CONTROLS WIRING SCHEMATICS

Power, Ground and Serial Data

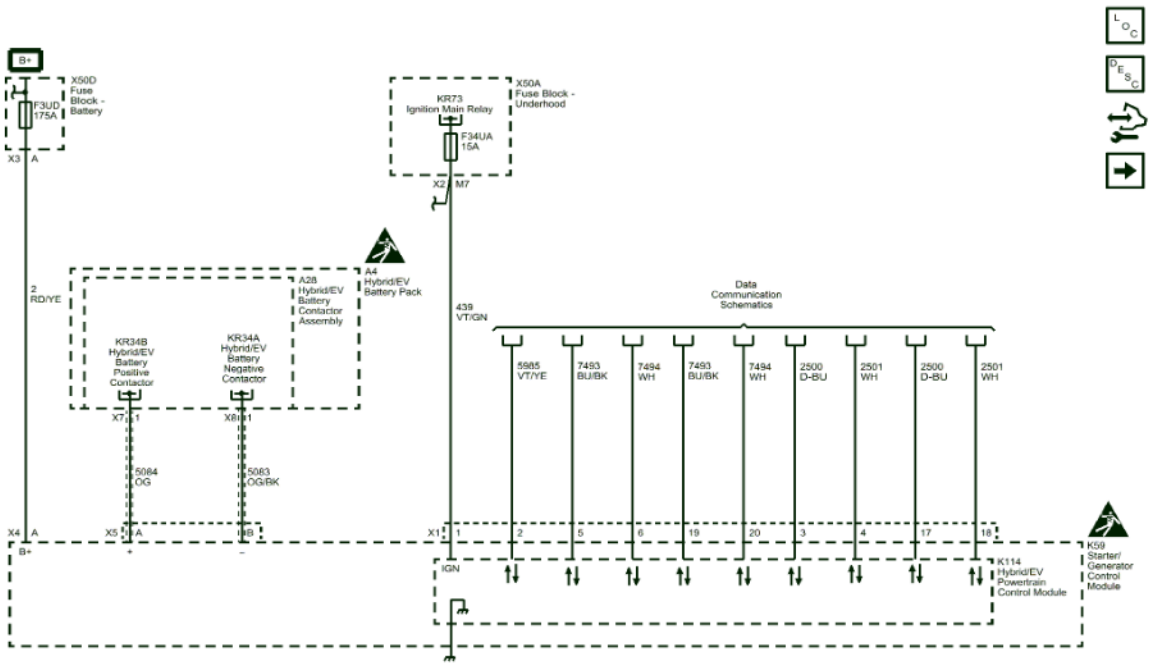


Fig. 1: Power, Ground and Serial Data
Courtesy of GENERAL MOTORS COMPANY

Starter/Generator Monitoring

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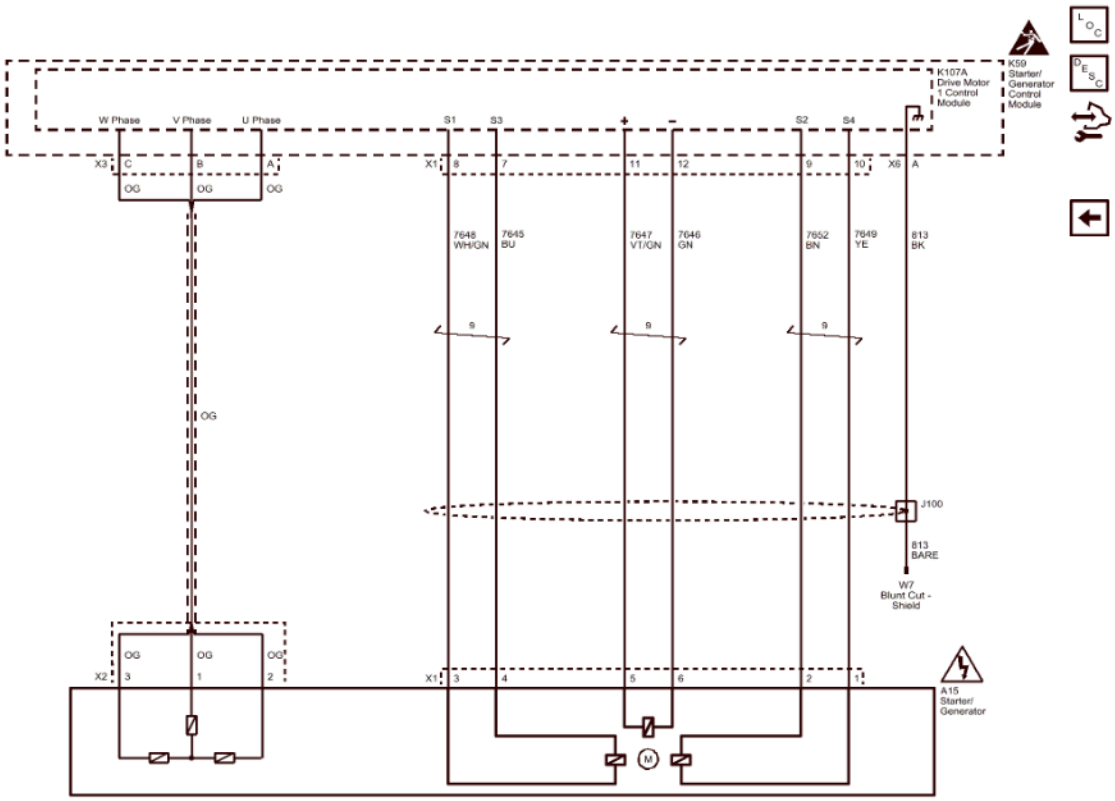


Fig. 2: Starter/Generator Monitoring
Courtesy of GENERAL MOTORS COMPANY

COMPONENT LOCATOR

HYBRID CONTROLS COMPONENT VIEWS

Starter/Generator, K59 Starter/Generator Control Module, and Components

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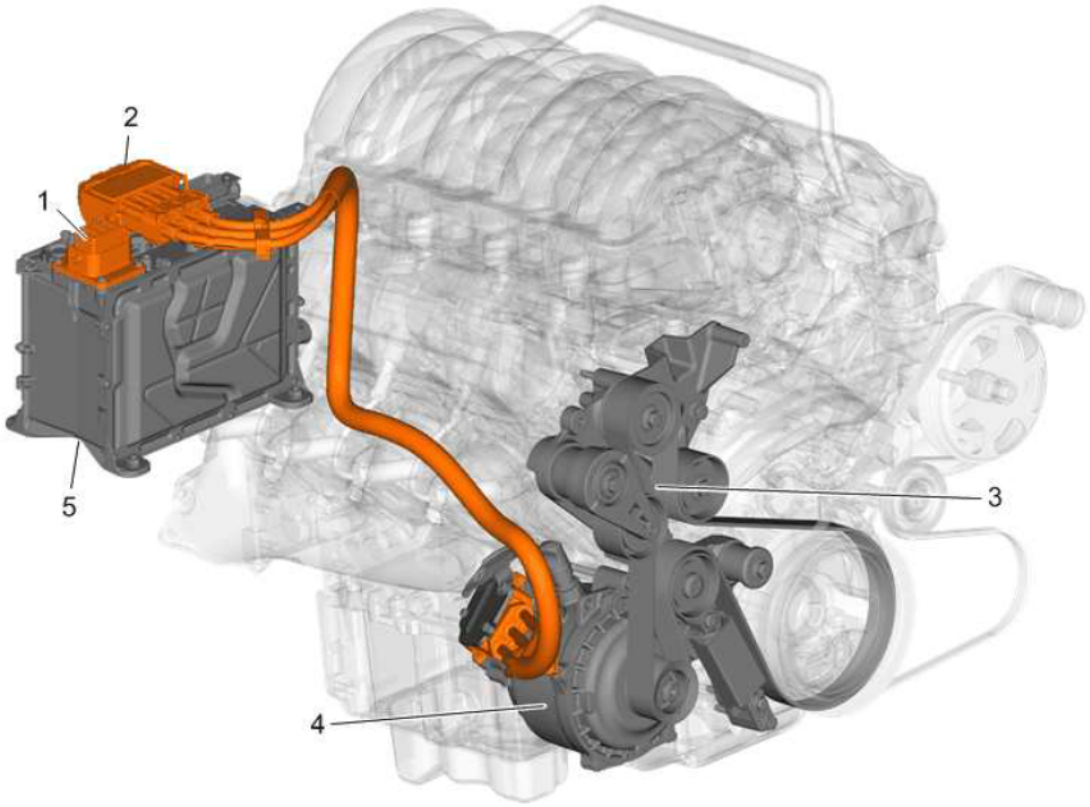


Fig. 3: Starter/Generator, K59 Starter/Generator Control Module, and Components
Courtesy of GENERAL MOTORS COMPANY

Callout	Component Name
1	High Voltage DC Connector
2	High Voltage 3 Phase AC Connector
3	Generator Drive Belt and Tensioner Assembly
4	A15 Starter/Generator
5	K59 Starter/Generator Control Module

DIAGNOSTIC INFORMATION AND PROCEDURES

DTC P057B-P057E: BRAKE PEDAL POSITION SENSOR

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 P057B

Brake Pedal Position Sensor Performance

DTC P057C

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Brake Pedal Position Sensor Circuit Low Voltage

DTC P057D

Brake Pedal Position Sensor Circuit High Voltage

DTC P057E

Brake Pedal Position Sensor Circuit Erratic

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Brake Pedal Position Sensor 5V Reference	P057C, P0651	P057C	P057C, P0651	-
Brake Pedal Position Sensor Signal	P057C	P057C	P057D	P057B
Brake Pedal Position Sensor Low Reference	-	P057D	-	-

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The brake pedal position (BPP) sensor is used to sense the action of the driver application of the brake pedal. The BPP sensor provides an analog voltage signal that will increase as the brake pedal is applied. The BBP sensor contains two independent sensor assemblies. The hybrid/EV powertrain control module 1 located within the generator control module, and the body control module are connected to their respective sensor assembly. Each module provides a low reference, signal and a 5-volt reference voltage to their respective BPP sensor. The hybrid/EV powertrain control module 1 also monitors the PRNDL state for inferred brake pedal application when transitioning in and out of the Park position.

Conditions for Running the DTC

- The run/crank voltage is greater than 10.0 V.
- 12V starter is not engaged.
- Engine start is not pending.

P057B

- The vehicle speed is greater than 5 km/h (3 MPH).
- Transmission has been in Park at least once this ignition cycle.
- Accelerator pedal position less than 5 percent.
- DTC P0722, P0723, P077C, P077D, P182E, P1915, U0101, U0073 = Not set.
- Calculated brake pedal position delta sample counter is greater than 1,000.00.
- Calculated brake pedal position delta is greater than 8 percent.

Conditions for Setting the DTC

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DTC P057B

The hybrid/EV powertrain control module 1 detects no change in brake pedal position after brake applied 2 times per ignition cycle.

DTC P057C

- The hybrid/EV powertrain control module 1 detects a short to voltage in the BPP sensor 5 V reference circuit.
- The hybrid/EV powertrain control module 1 detects a short to ground or an open/high resistance in the BPP sensor 5 V reference circuit.
- The hybrid/EV powertrain control module 1 detects a short to ground or an open/high resistance in the BPP sensor signal circuit.

DTC P057D

- The hybrid/EV powertrain control module 1 detects a short to voltage in the BPP sensor signal circuit.
- The hybrid/EV powertrain control module 1 detects an open/high resistance in the BPP sensor low reference circuit.

DTC P057E

The hybrid/EV powertrain control module 1 detects the BPP sensor signal is changing faster than possible under normal operating conditions.

Actions Taken When the DTC Sets

- The hybrid/EV powertrain control module 1 disables the following functions: Autostop, Autostart, and Regenerative Braking.
- The transmission will operate in a default gear.
- DTCs P057B, P057C, P057D and P057E are Type A DTCs.

Conditions for Clearing the DTC

DTCs P057B, P057C, P057D and P057E are Type A DTCs.

Diagnostic Aids

DTC P057B

Inspect the connector at the Brake Pedal Position sensor for a high resistance connection.

Reference Information

Schematic Reference

Exterior Lights Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

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- **Exterior Lighting Systems Description and Operation**
- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

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

Scan Tool Reference

Control Module References

Circuit/System Testing

DTC P057C, P057D

1. Verify DTC P0562, P0563 is not set.
   - **If DTC P0562, P0563 is set**

     Refer to:**DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563** for Hybrid (HP5).

   - **If DTC P0562 or P0563 is not set**
2. Ignition/Vehicle - Offdisconnect the harness connector at the B22 Brake Pedal Position Sensor .
3. Ignition/Vehicle - Onverify that a test lamp illuminates between B+ and the Brake Apply Sensor Low Reference circuit terminal 5.
   - **If the test lamp does not illuminate**

     Test the Brake Apply Sensor Low Reference circuit for a short to voltage or an open/high resistance.

     If the circuit tests normal-Replace the component: K59 Starter/Generator Control Module

   - **If the test lamp illuminates**
4. Ignition/Vehicle - OnTest for 4.8 to 5.2 V between the test points: Brake Apply Sensor 5V reference circuit terminal 6 and ground.
   - **If less than the specified range**

     Test the Brake Apply Sensor 5V reference circuit for a Short to Ground or an Open/High Resistance.

     If the circuit tests normal- Replace the component:K59 Starter/Generator Control Module

   - **If greater than the specified range**

     Test the Brake Apply Sensor 5V reference circuit for a Short to Voltage.

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If the circuit tests normal-Replace the component:K59 Starter/Generator Control Module.

- **If within the specified range**

5. Test for less than 0.3 V between the test points: Brake Apply Sensor Signal Circuit terminal 4 & Ground
   - **If greater than 0.3 V**

     Test the Brake Apply Sensor Signal circuit for a Short to Voltage

     If the circuit tests normal-Replace the component:K59 Starter/Generator Control Module.

   - **If less than 0.3 V**
6. Test for 4.8 to 5.2 V between the test points: Brake Apply Sensor 5V reference Circuit terminal 6 & Brake Apply Sensor Signal Circuit terminal 4.
   - If less than the specified range, test the Brake Apply Sensor Signal circuit for an open/high resistance. If the circuit tests normal-Replace the component:K59 Starter/Generator Control Module.
7. Ignition/Vehicle - Offdisconnect the X1 harness connector at the K59 Starter/Generator Control Module.
8. Test for infinite resistance between the test points: Brake Apply Sensor Signal Circuit terminal 4 & Ground
   - **If less than the specified range**

     Test the Brake Apply Sensor Signal circuit for a short to ground.

   - **If greater than the specified range**
9. If all circuits test normal -Replace the component:B22 Brake Pedal Position Sensor .

DTC DTC P057B

Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.

- If DTC P057B resets as current-Replace the component:B22 Brake Pedal Position Sensor .

DTC P057E

1. Replace the component:Brake Pedal Position Sensor.
2. Perform the brake pedal position sensor calibration procedure. Refer to: **Brake Pedal Position Sensor Calibration** .
3. Operate the vehicle within the Conditions for Running and Setting the DTC and verify the DTC does not reset.
   - If DTC P057E resets as current-Replace the component:K59 Starter/Generator Control Module.

Repair Instructions

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

- **Brake Pedal Position Sensor Calibration**
- **Brake Pedal Position Sensor Replacement**
- **Control Module References** for Generator Control Module, also called the K59 Starter/Generator Control Modulereplacement, programming and setup

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DTC P0601-P0604, P0606, P061B, OR P062F: CONTROL MODULE/MEMORY (HYBRID/EV POWERTRAIN CONTROL MODULE 1)

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 P0601

Control Module Read Only Memory Performance

DTC P0602

Control Module Not Programmed

DTC P0603

Control Module Long Term Memory Reset

DTC P0604

Control Module Random Access Memory Performance

DTC P0606

Control Module Processor Performance

DTC P061B

Control Module Torque Calculation Performance

DTC P062F

Control Module Long Term Memory Performance

Circuit/System Description

The starter/generator control module, often referred to as the generator control module, is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 volt power module and the drive motor control module. These three control modules are non-serviceable parts of the starter/generator control module. This is an internal fault detection of the starter/generator control module and no external circuits are involved.

Conditions for Running the DTC

Ignition On

DTC P0606

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The run/crank voltage is 9.5V or greater.

OR

The 12V battery voltage is greater than 11.1V.

DTC P061B

The run/crank voltage is 9.5V or greater.

OR

The ignition run/crank voltage is 11.1V or greater.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

DTC P0602

A service module has been installed but not yet programmed.

Actions Taken When the DTC Sets

- DTCs P0601-P0604, P0606, and P061B are Type A DTCs.
- DTC P062F is a Type B DTC.

DTC P0601, P0602, P0604, P0606, P061B

The hybrid/EV powertrain control module 1 requests the hybrid/EV battery contactors open.

Conditions for Clearing the DTC

- DTCs P0601-P0604, P0606, and P061B are Type A DTCs.
- DTC P062F is a Type B DTC.

Diagnostic Aids

DTC P0606 may cause DTCs U0073 or U0074 to set.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

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1. Verify DTC P0562 is not set.
    - **If DTC is set**

      Refer to: **DTC B1325, B1330, B1420, B1424, B1517, C0800, C0895, C0899, C0900, C12E1, C12E2, P0560, P0562, or P0563** .

    - **If the DTC does not set**
2. Verify P0601-P0604, P0606, P061B, or P062F is not set.
    - **If any of the DTCs are set**
    1. Program the control module: K59 Starter/Generator Control Module.
    2. Verify the DTC does not set.
        - If the DTC sets - Replace the component: K59 Starter/Generator Control Module.
        - If the DTC does not set
    3. All OK.
    - **If none of the DTCs are set**
3. All OK.

Repair Instructions

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

Control Module References for Generator Control Module, also called the K59 Starter/Generator Control Module, replacement, programming and setup.

DTC P0651 OR P0697: 5V REFERENCE

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 P0651

5V Reference 2 Circuit

DTC P0697

5V Reference 3 Circuit

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid/EV powertrain control module 1 has two internal 5 V reference circuits. Each internal reference circuit provides a 5 V reference for one or more sensors. A short to ground or short to voltage on one external 5

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V reference circuit can affect all components connected to the same internal 5 V reference circuit.

Conditions for Running the DTC

- Ignition On .
- 12 V starter is not engaged.

Conditions for Setting the DTC

DTC P0651

The Hybrid/EV Powertrain Control Module 1 detects a voltage out of range on the 5 V reference 2 circuit for greater than 1 second.

DTC P0697

The Hybrid/EV Powertrain Control Module 1 detects a voltage out of range on the 5 V reference 3 circuit for greater than 1 second.

Actions Taken When the DTC Sets

DTCs P0651 and P0697 are Type A DTCs.

Conditions for Clearing the DTC

DTCs P0651 and P0697 are Type A DTCs.

Diagnostic Aids

- DTC P0651 or P0697 may set due to a heavily discharged 12 V battery.
- The 5 V reference 2 circuit provides 5 V to the brake pedal position sensor. The 5 V reference 3 circuit provides 5 V to the internal 14 V power module input current sensor and drive motor 3-phase current sensors.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Exterior Lights Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Circuit/System Verification

1. Ignition Off , measure and record the battery at the C1 12 V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
    - **If not within the specified range**

      Refer to: **Battery Inspection/Test** for Hybrid (HP5).

    - **If within the specified range**
2. Ignition On . If the DTC is set , replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called K59 Starter/Generator Control Module, replacement, programming and setup.

DTC P06AF: TORQUE MANAGEMENT SYSTEM

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 P06AF

Torque Management System Performance - Forced Engine Shutdown

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non-serviceable and are part of the generator control module.

The hybrid/EV powertrain control module 1 monitors a state of health message that the ECM transmits to verify

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the ECM is functioning properly.

Conditions for Running the DTC

- Ignition On .
- The run/crank voltage is 9.5V or greater.

  or

  The ignition run/crank voltage is 11.0V or greater.

Conditions for Setting the DTC

The Hybrid/EV Powertrain Control Module 1 does not detect a valid state of health message from the ECM.

Actions Taken When the DTC Sets

DTC is a Type A DTC.

Conditions for Clearing the DTC

DTC P06AF is a Type A DTC.

Reference Information

Schematic Reference

Data Communication Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

1. Verify that ECM DTC P0606 is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**
2. Ignition Off , Disconnect the component: K59 Starter/Generator Control ModuleX1 connector and the K20 ECM X1 connector.
3. Using the data communication schematic as a guide, test for less than 1 Ω between the serial data circuits listed below:
   - K59 Starter/Generator Control ModuleX1 connector terminal and K20 ECM X1 connector terminal for circuit 2500

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- K59 Starter/Generator Control ModuleX1 connector terminal and K20 ECM X1 connector terminal for circuit 2501
- If greater than the specified range, test the serial data circuit for an open/high resistance condition. If the circuit tests normal, replace the K20 ECM.

4. If the DTC resets, program the K59 Starter/Generator Control Module. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for ECM or Generator Control Module, also called the Starter/Generator Control Module , replacement, programming and setup.

DTC P06B1 OR P06B2: SENSOR SUPPLY VOLTAGE

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 P06B1

Sensor Supply Voltage Circuit Low Voltage

DTC P06B2

Sensor Supply Voltage Circuit High Voltage

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module uses an internal 15 V reference power supply in order to operate the drive motor sensors and processor. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- The drive motor control module is awake.
- The run/crank voltage is greater than 9.5V.

  or

  The 12V battery voltage is greater than 11.0V.

Conditions for Setting the DTC

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DTC P06B1

The reference voltage is less than 8.8V for 1 second.

DTC P06B2

The reference voltage is greater than 18.6V for 1 second.

Actions Taken When the DTC Sets

DTCs P06B1 and P06B2 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P06B1 and P06B2 are Type B DTCs.

Diagnostic Aids

This DTC may set due to low or high 12 V system voltage.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTC P0562, P0563 is not set.
    - **If any of the DTCs are set**

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

    - **If none of the DTCs are set**
2. Verify DTC P06B1, P06B2 is not set

   If the DTC is set

    1. Verify the K59 Starter/Generator Control Module has the latest calibration in Calibration Information.

       If the K59 Starter/Generator Control Module does not have the latest calibration

        1. Program the control module: K59 Starter/Generator Control Module.

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If the K59 Starter/Generator Control Module does not have the latest calibration

2. Verify the DTC does not set.

   If the DTC sets, Replace the component:K59 Starter/Generator Control Module

   If the DTC does not set

3. All OK.

   If the K59 Starter/Generator Control Module has the latest calibration

2. Replace the component:K59 Starter/Generator Control Module.

   If the DTC is not set

3. All OK.

Repair Instructions

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

Control Module References for Generator Control Module, also called the K59 Starter/Generator Control Module, replacement, programming and setup

DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, OR P1B03: DRIVE MOTOR POSITION SENSOR

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 P06B2

Drive Motor Position Sensor Circuit

DTC P0A40

Drive Motor Position Sensor Performance

DTC P0C52

Drive Motor Position Sensor Circuit 1 Low Voltage

DTC P0C53

Drive Motor Position Sensor Circuit 1 High Voltage

DTC P0C5C

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Drive Motor Position Sensor Circuit 2 Low Voltage

DTC P0C5D

Drive Motor Position Sensor Circuit 2 High Voltage

DTC P1B03

Drive Motor Position Sensor Circuit Tracking Lost

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Signal * S1/S3	DTC P0C5C, P0A3F, P0A40, P1B03	DTC P1B03, P0A3F	DTC P0C53, P0A3F	DTC P1B03, P0A40
Signal * S2/S4	DTC P0C52, P0A3F, P0A40, P1B03	DTC P1B03, P0A3F	DTC P0C5D, P0A3F	DTC P1B03, P0A40
Reference* +/-	DTC P0A3F, P0A40, P1B03	DTC P0A3F	DTC P0A3F	DTC P1B03, P0A40
* Represents a differential circuit consisting of a pair of wires. See Circuit/System Description and schematic for detailed description.				

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The generator control module monitors the angular position, speed and direction of the starter generator rotor based upon the signals of the resolver-type motor position sensor. The position sensor contains a drive coil, two driven coils, and an irregular shaped metallic rotor. The metallic rotor is mechanically attached to the shaft of the starter generator.

At ignition ON, an AC voltage, 10 kHz excitation signal is output to the drive coil. The drive coil excitation signal creates a magnetic field surrounding the two driven coils and the irregular shaped rotor. The generator control module then monitors the two driven coil circuits for a return signal. The position of the irregular metallic rotor causes the magnetically-induced return signals of the driven coils to vary in size and shape. A comparison of the two driven coils signals allows the generator control module to determine the exact position, speed and direction of the starter generator rotor. The position sensor is a non-serviceable part of the starter generator.

Conditions for Running the DTC

- The drive motor control module and hybrid/EV powertrain control module 1 are awake.
- The run/crank voltage is greater than 9.5 V.
- The 12 V battery voltage is greater than 11.0 V.

Conditions for Setting the DTC

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DTC P0A3F

Sin or Cos signal is less than 2.3 V.

DTC P0A40

Sin or Cos signal is greater than 4 V or Sin or Cos amplitude mismatch is greater than 0.385V.

DTC P0C52

Drive Motor Position Sensor Circuit 1 reference voltage is less than 0.1 V.

DTC P0C53

Drive Motor Position Sensor Circuit 1 reference voltage is greater than 4.9 V.

DTC P0C5C

Drive Motor Position Sensor Circuit 2 reference voltage is less than 0.1 V.

DTC P0C5D

Drive Motor Position Sensor Circuit 2 reference voltage is greater than 4.9 V.

DTC P1B03

The generator control module tracking error is greater than 5 degrees.

Actions Taken When the DTC Sets

- DTCs P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, and P1B03 are Type B DTCs.
- Starter generator torque is limited.
- Autostop/Autostart operation is disabled.
- Regenerative braking and eAssist operation is disabled.
- The 14 V power module remains active and contactors remain closed. The hybrid battery will not reach a minimum state of charge and contactors will not open.

Conditions for Clearing the DTC

DTCs P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, and P1B03 are Type B DTCs.

Diagnostic Aids

- The starter generator position sensor circuits operate at very low current. These circuits are susceptible to moisture intrusion, coolant contamination, corrosion, and terminal damage. Extreme care must be taken when removing the starter generator, probing terminals and manipulating harnesses. Poor terminal connections can result in intermittent operation.
- If the customer comments that the problem occurs only during moist environmental conditions: rain, snow, vehicle wash, etc., inspect the sensor wiring and seals for signs of water intrusion.
- The sensor and reference circuit loops are a twisted pair with each pair covered in a grounded foil shield.
- The shield circuits are grounded on the starter/generator control module case. Improperly grounded shield circuits may cause inaccurate sensor signals.

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Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

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

Circuit/System Testing

NOTE: **If moist environmental conditions: rain, snow, vehicle wash, etc. are present please refer to the appropriate Diagnostic Aids section above before doing tests.**

1. Ignition Off , disconnect the X1 harness connector at the K59 Starter/Generator Control Module.
2. Test for 10-35 Ω between the reference terminal 7 and the reference terminal 8.
    - **If not within the specified range**
    1. Disconnect the X1 harness connector at the A15 Starter/Generator.
    2. Test for less than 2 Ω in the signal circuit end to end.
        - If 2 Ω or greater, repair the open/high resistance in the circuit.
        - If less than 2 ohms
    3. Replace the A15 Starter/Generator.
    - **If within the specified range**
3. Test for 25-55 Ω between the signal (S1) terminal 10 and the signal (S3) terminal 9.
    - **If not within the specified range**

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1. Disconnect the X1 harness connector at the A15 Starter/Generator.
2. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω
3. Replace the A15 Starter/Generator.

- **If within the specified range**

4. Test for 25-55 Ω between the signal (S4) terminal 12 and the signal (S2) terminal 11.

- **If not within the specified range**

1. Disconnect the X1 harness connector at the A15 Starter/Generator.
2. Test for less than 2 Ω in the signal circuit end to end.
    - If 2 Ω or greater, repair the open/high resistance in the circuit.
    - If less than 2 Ω
3. Replace the A15 Starter/Generator.

- **If within the specified range**

5. Test for greater than 10,000 Ω between the terminals listed below and A15 Starter/Generator case:
    - Reference terminal 7
    - Reference terminal 8
    - Signal (S3) terminal 9
    - Signal (S1) terminal 10
    - Signal (S2) terminal 11
    - Signal (S4) terminal 12
    - **If less than 10,000 ohms**

1. Disconnect the X1 harness connector at the A15 Starter/Generator.
2. Test for infinite resistance between the signal circuit and chassis ground.
    - If less than infinite resistance, repair the short to ground on the circuit.
    - If infinite resistance
3. Replace the A15 Starter/Generator.

- **If 10,000 ohms or greater**

6. Test for infinite resistance between the terminals listed below:
    - Terminals 10 and 8
    - Terminals 10 and 12
    - Terminals 8 and 12
    - **If less than infinite resistance**

1. Disconnect the X1 harness connector at the A15 Starter/Generator.
2. Test for infinite resistance between the appropriate terminals.
    - If less than infinite resistance, repair the short on the circuit.
    - If infinite resistance
3. Replace the A15 Starter/Generator.

- **If infinite resistance**

7. Connect the X1 harness connector at the K59 Starter/Generator Control Module. Disconnect the X1

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harness connector at the A15 Starter/Generator.

8. Ignition On
9. Test for 0.8-1.6 V between the signal circuit terminals listed below and ground:
    - Signal (S1) circuit terminal 1
    - Signal (S3) circuit terminal 2
    - Signal (S2) circuit terminal 5
    - Signal (S4) circuit terminal 6
    - **If less than 0.8 V**

      Replace the component: K59 Starter/Generator Control Module.

    - **If greater than 1.6 V**
    1. Ignition Off , disconnect the X1 harness connector at the K59 Starter/Generator Control Module, Ignition On .
    2. Test for less than 1 V between the signal circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V
    3. Replace the component: K59 Starter/Generator Control Module.
    - **If between 0.8 and 1.6 V**
10. Test for 6.5-7.5 V between the reference circuit terminals listed below and ground:
    - Reference terminal 3
    - Reference terminal 4
    - **If less than 6.5 V**

      Replace the component: K59 Starter/Generator Control Module.

    - **If greater than 7.5 V**
    1. Ignition Off , disconnect the X1 harness connector at the K59 Starter/Generator Control Module, Ignition On .
    2. Test for less than 1 V DC between the reference circuit and ground.
        - If 1 V or greater - Repair the short to voltage on the circuit.
        - If less than 1 V
    3. Replace the component: K59 Starter/Generator Control Module.
    - **If between 6.5 and 7.5 V**
11. Verify DTC P0A3F, P0A40, P0C52, P0C53, P0C5C, P0C5D, P1B03 is not set.
    - **If any of the DTCs are set**
    1. Program the K59 Starter/Generator Control Module.
    2. Verify the DTC does not set..
        - If the DTC sets - Replace the component:K59 Starter/Generator Control Module.
        - If the DTC does not set
    3. All OK.
    - **If none of the DTCs are set**
12. All OK.

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Repair Instructions

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

- **Starter Generator Replacement**
- **Control Module References** for Generator Control Module, also called the K59 Starter/Generator Control Module, replacement, programming and setup

DTC P0A5E, P0A61, OR P0A64: DRIVE MOTOR PHASE

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 P0A5E

Drive Motor Phase U Low Current

DTC P0A61

Drive Motor Phase V Low Current

DTC P0A64

Drive Motor Phase W Low Current

Circuit/System Description

The generator control module, also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. The drive motor control module monitors the current of each phase in order to detect fault conditions.

Conditions for Running the DTC

- Drive state is RUN.
- Drive motor inverter is not discharging.
- Drive motor inverter voltage is greater than 48V.
- None of the following DTCs are set: P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, P0BEC, or P0BFD.

Conditions for Setting the DTC

P0A5E

The drive motor control module detects less than 9 amps on drive motor phase U for greater than 1 second.

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P0A61

The drive motor control module detects less than 9 amps on drive motor phase V for greater than 1 second.

P0A64

The drive motor control module detects less than 9 amps on drive motor phase W for greater than 1 second.

Actions Taken When the DTC Sets

- DTCs P0A5E, P0A61, and P0A64 are Type A DTCs.
- The 14 V power module remains active until the hybrid battery reaches a minimum state of charge or the 14 V power module power limits are exceeded, after which the hybrid/EV battery contactors are opened.

Conditions for Clearing the DTC

DTCs P0A5E, P0A61, and P0A64 are Type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

Equivalent regional tools:, Refer to: **Special Tools**.

Circuit/System Verification

If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the Ignition ON. , Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

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The High Voltage Disabling procedure includes the following steps:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

NOTE: **Perform Circuit/System Verification before Circuit/System Testing.**

1. Ignition Off , disable the high voltage at the K59 Starter/Generator Control Module. Refer to: **High Voltage Disabling** .
2. Remove the 3-phase cables from the K59 Starter/Generator Control Module.
3. Test for infinite resistance between the 3-Phase cable terminals listed below and ground for each phase of the drive motor generator battery cable:
   - X3 phase U terminal A
   - X3 phase V terminal B
   - X3 phase W terminal C
   - **If less than infinite resistance**

     Test each phase of the drive motor generator battery cable for a short to ground. If the cables test normal, replace the A15 Starter/Generator.

   - **If infinite resistance**
4. Disconnect the 3-phase cables from the A15 Starter/Generator.
5. Test for infinite resistance between the 3-Phase circuits listed below for each phase of the drive motor generator battery cable:
   - Phase U and phase V
   - Phase V and phase W
   - Phase W and phase U
   - **If less than infinite resistance**

     Replace the Drive Motor Generator Battery Cable.

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- **If infinite resistance**

6. Replace the A15 Starter/Generator and retest for the DTC. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

- **Starter Generator Replacement** for starter/generator replacement.
- **Generator Control Module 3-Phase Cable Assembly Replacement** for 3-Phase Cable Assembly replacement.
- **Control Module References** for Generator Control Module, also called the K59 Starter/Generator Control Module, replacement, programming, and setup.

DTC P0A78: DRIVE MOTOR INVERTER

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 P0A78

Drive Motor Inverter Performance

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter/generator, also referred to as the drive motor, based upon hybrid/EV powertrain control module 1 commands. The drive motor control module controls the speed and output torque of the starter/generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for fault conditions. The motor control module is part of the generator control module and is not serviced separately.

Conditions for Running the DTC

Drive Motor Inverter PWM output is enabled.

Conditions for Setting the DTC

The drive motor control module detects excessive current flow through the switched portion of the insulated gate bipolar transistor.

Actions Taken When the DTC Sets

- DTC P0A78 is a Type A DTC.

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- The 14 V power module remains active until the hybrid battery reaches a minimum state of charge or the 14 V power module power limits are exceeded, after which the hybrid/EV battery contactors are opened.

Conditions for Clearing the DTC

DTC P0A78 is a Type A DTC.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Hybrid/EV Energy Storage Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

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

Circuit/System Verification

If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be**

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followed.

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** procedure.
2. Remove the 3-phase cables from the K59 Starter/Generator Control Module.
3. Test for infinite resistance between the 3-phase cable terminals listed below and ground for each phase of the drive motor generator 3-phase cable:
    - X3 phase U terminal A
    - X3 phase V terminal B
    - X3 phase W terminal C
        - If less than infinite resistance, test each phase of the drive motor generator 3-phase cable for a short to ground. If the cables test normal, replace the A15 Starter/Generator.
4. Disconnect the 3-phase cables from the A15 Starter/Generator.
5. Test for infinite resistance between the 3-phase circuits listed below for each phase of the drive motor generator 3-phase cable:
    - Phase U and phase V
    - Phase V and phase W
    - Phase W and phase U
        - If less than infinite resistance, replace the drive motor generator 3-phase cable.
6. Replace A15 Starter/Generator and retest for the DTC. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

- **Starter Generator Replacement** for starter/generator replacement.
- **Generator Control Module 3-Phase Cable Assembly Replacement** for 3-Phase Cable Assembly replacement.
- **Control Module References** for Generator Control Module, also called the K59 Starter/Generator Control Module replacement, programming and setup.

DTC P0A87-P0A89: 14V POWER MODULE INPUT CURRENT SENSOR

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 P0A87

14V Power Module Input Current Sensor Performance

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DTC P0A88

14V Power Module Input Current Sensor Circuit Low Current

DTC P0A89

14V Power Module Input Current Sensor Circuit High Current

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14 V power module has 1 current sensor for input current measurements. This diagnostic checks the input current sensor. The current sensor is internal to the 14 V power module and is not serviced separately from the generator control module.

Conditions for Running the DTC

P0A87

- DTC P0A88 or P0A89 is not set.
- The high voltage contactors are all open for 0.625 s and then transition to precharge mode.

P0A88

- The ignition is ON.
- 14V power module is commanded ON.
- The run/crank voltage is greater than 9 V.
- The hood is closed.
- The 14 V power module setpoint target voltage is 13 V or greater; OR less than 13 V for 1 hour.

P0A89

- The ignition is ON.
- 14 V power module is commanded ON.
- The run/crank voltage is greater than 9 V.

Conditions for Setting the DTC

DTC P0A87

14 V power module average input current greater than 0.5 amp for greater than 1 s.

DTC P0A88

14 V power module input current is less than 0.5 amp for greater than 20 s.

DTC P0A89

14 V power module input current is greater than 45.3 amps for greater than 5 s.

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Actions Taken When the DTC Sets

- DTCs P0A87, P0A88 and P0A89 are Type B DTCs.
- DTC P0BFD is prevented from running.

Conditions for Clearing the DTC

DTCs P0A87, P0A88 and P0A89 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set - Replace the component: K59 Starter/Generator Control Module

Repair Instructions

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

Control Module References for Generator Control Module, also called K59 Starter/Generator Control Module replacement, programming and setup.

DTC P0A8F: 14V POWER MODULE SYSTEM VOLTAGE

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 P0A8F

14V Power Module System Voltage Performance

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following

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three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14V power module has a voltage sensor that constantly monitors system output voltage. This diagnostic is designed to test the performance of the voltage sensor. This sensor is internal to the 14V power module and is not serviced separately from the generator control module.

Conditions for Running the DTC

- The ignition is ON.
- 14V Power Module Status parameter is Normal.

Conditions for Setting the DTC

The difference between the 14V Power Module output voltage and the set point voltage value is greater than 3.5 volts for greater than 38 seconds.

OR

The 14V Power Module Status is Voltage Conversion Disabled - Not Due to Operating Temperature.

OR

The 14V Power Module Status is Voltage Conversion Disabled or Limited - Due to High Operating Temperature.

Actions Taken When the DTC Sets

- The charging system light will illuminate, and Service Battery Charging System will display on the Driver Information Center.
- DTC P0A8F is a Type C DTC.

Conditions for Clearing the DTC

DTC P0A8F is a Type C DTC.

Diagnostic Aids

- This DTC may set due to low 12 V system voltage.
- This DTC may set due to voltage stress to the underhood 175A fuse and junction block.
- This DTC may set due to excessive aftermarket 12V accessories installed on the vehicle that are overloading the 14V power module.
- This DTC may set due to inadequate cooling of the 14V power module. A faulty hybrid/EV electronics coolant pump, hybrid/EV electronics coolant fan, or restricted coolant lines could cause high 14V power module operating temperatures.

Reference Information

Schematic Reference

- **Hybrid/EV Controls Schematics**
- **Starting and Charging Schematics**

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Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**
- **Hybrid/EV Cooling System Description and Operation**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

Equivalent regional tools:, Refer to: **Special Tools**.

Circuit/System Verification

1. Ignition OFF, measure and record the battery voltage at the C1 12V battery terminals. The battery voltage should stabilize between 12.4 and 12.8 V within a few minutes of turning the ignition OFF.
   - **If not within the specified range**

     Refer to **Battery Inspection/Test** for Hybrid (HP5).

   - **If within the specified range**
2. Engine ON, verify that DTC U0074 or U1818 is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**
3. Engine ON, check the scan tool 14V Power Module Status parameter in the 14V Power Module data list. The parameter should be Normal.
   - **If the parameter is Voltage Conversion Disabled or Limited - Due to High Operating Temperature**

     Test for proper coolant level and operation of the hybrid/EV electronics cooling system.

   - **If the parameter is Normal or Voltage Conversion Disabled - Not Due to Operating Temperature**
4. Check the scan tool Ignition 1 Signal parameter in the 14V Power Module data list. The parameter should be within 3.5 volts of the voltage measured at the C1 12V battery.
   - **If the voltage is not within the specified range**

     Refer to Circuit/System Testing.

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- **If the voltage is within the specified range**

5. All OK.

Circuit/System Testing

WARNING: **Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.**

The High Voltage Disabling procedure includes the following steps:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

1. Ignition Off , disable the high voltage at the K59 Starter/Generator Control Module. Refer to:**High Voltage Disabling** .
2. Remove the X4 B+ cable at the K59 Starter/Generator Control Module, and tape the cable ring terminal.
3. Connect a 3A fused jumper wire between C1 12-volt positive battery post and the K59 Starter/Generator Control Module X4 B+ terminal.
4. Connect C1 12V battery negative terminal.

NOTE: **Do not turn the Engine to Crank.**

5. Ignition On - Engine Off , observe the Ignition 1 Signal in the 14V Power Module data list. The parameter should be within 0.5 volt of the actual 12-volt battery voltage.
   - **If the voltage is not within the specified range**

     Replace the component:K59 Starter/Generator Control Module.

   - **If the voltage is within the specified range**
6. Ignition OFF, remove the 3A fused jumper wire at the C1 12-volt battery.
7. Disconnect the C1 12V battery positive terminal and measure the resistance of the 14 V Power Module

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positive harness between the X4 connector at the K59 Starter/Generator Control Module and the C1 12V battery positive terminal.

- **If the resistance is greater than 1.0 Ω**

  Repair the high resistance condition in the 12-volt circuit.

- **If the resistance is less than 1.0 Ω**

  Replace the component:K59 starter/generator control module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the K59 Starter/Generator Control Module, replacement, programming and setup.

DTC P0A90: DRIVE MOTOR

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 P0A90

: Drive MotorPerformance

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has a starter/generator also called a drive motor. The starter/generator is mounted to the front of the engine and is mechanically connected to the crankshaft pulley by a serpentine belt.

The hybrid/EV powertrain control module 1 receives an engine RPM signal over serial data and compares that value to the starter/generator RPM received from the drive motor control module. The hybrid/EV powertrain control module 1 uses a ratio of these two speeds to determine if the drive belt is missing or slipping.

Conditions for Running the DTC

- Engine is Running .
- Engine speed is greater than 200 rpm.
- DTCs P0A3F, P0A40, P0C19, P16EB, P1B03, or P1E0A are not set.

Conditions for Setting the DTC

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The hybrid/EV powertrain control module 1 detects a speed difference between the engine and the starter/generator of greater than 1500 RPM for greater than 6 seconds.

OR

The hybrid/EV powertrain control module 1 detects a speed difference between the engine and the starter/generator of greater than 1000 RPM for greater than 3 seconds.

OR

The hybrid/EV powertrain control module 1 detects a speed difference between the engine and the starter/generator of greater than 350 RPM multiple times on two consecutive ignition cycles with a Engine Off time of 30 minutes between key cycles.

Actions Taken When the DTC Sets

DTC P0A90 is a Type A DTC.

Conditions for Clearing the DTC

- DTC P0A90 is a Type A DTC.
- The hybrid/EV powertrain control module 1 detects a speed difference between the engine and the starter/generator of less than 250 RPM.

  AND

  The hybrid/EV powertrain control module 1 detects the starter/generator torque is greater than 20 or less than -35 .

Diagnostic Aids

- The ratio between the drive motor and the crankshaft speeds is 3.0 to 1.
- Inspect the drive belt for cracks and oil contamination.
- A low mileage vehicle may exhibit drive belt slip due to belt break in.
- Test drive the vehicle through the different modes of operation, performing Autostop and Autostart cycles. Accelerate up to 50 mph and brake moderately. Using a scan tool, monitor the hybrid powertrain control module Drive Motor Belt Slip parameter. A value of 0% indicates no slip, whereas a positive or negative value indicates slip.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

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1. Inspect the accessory drive, refer to **Drive Belt Tensioner Diagnosis (L83, L86)** **Drive Belt Tensioner Diagnosis (L8B)** .
2. Inspect the drive belt for cracks, wear and contamination.
    - **If the belt is not OK, replace the drive belt.**
3. If the DTC resets, replace the A15 Starter/Generator.

Repair Instructions

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

- **Starter Generator Replacement**
- **Drive Belt Replacement - Accessory**

DTC P0AB9: P0AB9

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 P0AB9

Hybrid/EV System Performance

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has the ability to crank and start the engine using two different methods. The first method is a conventional 12 volt system. On every initial start up the conventional 12 volt starter and 12 volt battery are used to crank and start the engine.

The second starting method uses both the 86 volt hybrid/EV battery pack, and the starter/generator, also called the drive motor. The drive motor is a 3 phase AC induction machine. This device not only serves as an 86-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. If the system is in the auto-stop mode and fails to restart with the drive motor, the 12 volt conventional starter will automatically be engaged to start the engine.

The drive motor can quickly rotate the engine to operating speed (550 RPM). The hybrid/EV powertrain control module 1 can detect a condition where the engine is stalling and command the drive motor to rotate the engine to prevent a stall.

Conditions for Running the DTC

Engine Running .

Conditions for Setting the DTC

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The hybrid/EV powertrain control module 1 detects that engine speed has fallen below a specific minimum speed indicating the engine has stalled.

Actions Taken When the DTC Sets

DTC P0AB9 is a Type C DTC.

Conditions for Clearing the DTC

- DTC P0AB9 is a Type C DTC.
- Engine restarts with key cycle.

Diagnostic Aids

Any condition that causes the engine to stall and/or not start may set this DTC. Possible conditions include:

- Fuel conditions such as low level, low pressure, or contamination.
- Engine conditions such as low compression.
- Restricted exhaust or air intake systems.

Always inspect for DTCs that would cause an engine stall and/or no start condition.

This DTC may set if the ignition is turned off while driving.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Circuit/System Verification

1. Verify that no other DTCs are set.
    - If other DTCs are set, diagnose them first. Refer to **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Start the engine. The engine should start and run.
    - If the engine fails to start, or stalls, diagnose the engine system. Refer to: **Engine Cranks But Does Not Run** .
3. If the DTC is set, and the engine is running smoothly, program the K59 Starter/Generator Control Module.
    - If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

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Control Module References for Generator Control Module, also called K59 Starter/Generator Control Module, replacement, programming and setup.

DTC P0AEE, P0AEF, OR P0AF0: DRIVE MOTOR INVERTER TEMPERATURE SENSOR

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 P0AEE

Drive Motor Inverter Temperature Sensor Performance

DTC P0AEF

Drive Motor Inverter Temperature Sensor Circuit Low Voltage

DTC P0AF0

Drive Motor Inverter Temperature Sensor Circuit High Voltage

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

The drive motor control module and the hybrid/EV powertrain control module 1 are awake.

DTC P0AEE

- The engine OFF time is greater than 8 hours.
- DTCs P0AEF and P0AF0 are not set.

Conditions for Setting the DTC

DTC P0AEE

The temperature average of the engine coolant and hybrid battery are 20Â°C (68Â°F) different from the Phase U DC/AC Inverter Temperature value.

DTC P0AEE

The inverter phase temperature sensor 1 is greater than 150Â°C (302Â°F) for 9 seconds.

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DTC P0AF0

The inverter phase temperature sensor 1 is less than -54Â°C (-65Â°F) for 99 seconds.

Actions Taken When the DTC Sets

- DTCs P0AEE, P0AEF, and P0AF0 are Type B DTCs.
- The power inverter module limits the maximum torque of the starter/generator to 10.8 N.m (95.6 lb in).
- Autostop will be disabled.

Conditions for Clearing the DTC

DTCs P0AEE, P0AEF, and P0AF0 are Type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Allow the vehicle to cool to ambient temperature by leaving the ignition OFF for at least 8 hours.
2. Ignition ON, if the DTC is set, program the K59 Starter/Generator Control Module. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called Starter/Generator Control Module replacement, programming and setup.

DTC P0BE6-P0BE8 OR P0BEA-P0BEC: DRIVE MOTOR PHASE U/V

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

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DTC P0BE6

Drive Motor Phase U Current Sensor Performance

DTC P0BE7

Drive Motor Phase U Current Sensor Circuit Low Voltage

DTC P0BE8

Drive Motor Phase U Current Sensor Circuit High Voltage

DTC P0BEA

Drive Motor Phase V Current Sensor Performance

DTC P0BEB

Drive Motor Phase V Current Sensor Circuit Low Voltage

DTCP0BEC

Drive Motor Phase V Current Sensor Circuit High Voltage

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

- The control module runs the program to detect an internal fault when the drive motor control module is awake and the engine is off.
- The run/crank voltage is greater than 9.5V.
- The 12V battery voltage is greater than 11.0V.

P0BE6

DTCs P0BE7, P0BE8, P1AEC, P1AE9, P1AE8, P1B41, P1AF5, or P1B0C are not set.

P0BEA

DTCs P0BEB, P0BEC, P1AEC, P1AE9, P1AE8, P1B41, P1AF5, or P1B0C are not set.

Conditions for Setting the DTC

P0BE6, P0BEA

The control module has detected an internal malfunction.

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P0BE7, P0BE8

The motor phase U current is greater than 440 amps or less than -440 amps.

P0BEB, P0BEC

The motor phase V current is greater than 440 amps or less than -440 amps.

Actions Taken When the DTC Sets

- DTCs P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, and P0BEC are Type B DTCs.
- The generator control module operates in a reduced power mode.
- Regenerative breaking torque is reduced.
- Autostop and electric power assist are disabled.
- Cruise control is disabled.

Conditions for Clearing the DTC

DTCs P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, and P0BEC are Type B DTCs.

Diagnostic Aids

If DTC P0BE6 and P0BEA are both set, inspect the 12V battery for low capacitance. Voltage swings during crank or a slow crank may be observed.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Ignition On .

   NOTE: **Both DTC P0BE6 and P0BEA set together may indicate 12 V Battery low capacitance.**

2. Verify DTC P0BE6, P0BEA is not set.
   - **If both DTCs are set**

     Refer to:**Battery Inspection/Test** .

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- **If both DTCs are not set**

3. If the DTC is set -Program the control module: K59 Starter/Generator Control Module.
   - **If the DTC resets**
4. Replace the component: K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the K59 Starter/Generator Control Module, replacement, programming and setup.

DTC P0BFD: DRIVE MOTOR PHASE U-V-W NOT PLAUSIBLE

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 P0BFD

Drive Motor Phase U-V-W Not Plausible

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter/generator, also referred to as the drive motor, based upon hybrid/EV powertrain control module 1 commands. The drive motor control module controls the speed and output torque of the starter/generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. The starter/generator operates utilizing 3-phase alternating current (AC) electricity. Each insulated gate bipolar transistors operates a single phase of the starter/generator. Each phase is individually identified as U, V and W. The drive motor control module monitors the current of phase U and W. The drive motor control module uses logic to calculate phase V current values. This information is used in order to detect over current conditions.

Because all starter/generator phase circuits are electrically joined together, they should each flow about the same amount of current. The drive motor control module performs a mathematical calculation to verify that the phase current sensors are accurate. If the current sensors indicate about the same amount of phase current, the sum of the calculation should be near zero. If the currents are not similar, this DTC will set.

Conditions for Running the DTC

- Ignition is ON.
- The hybrid/EV battery contactors are closed.
- DTCs P0A87, P0A88, P0A89, P0AC1, P0AC2, P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, P0BEC, or

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P1EBA are not set.

Conditions for Setting the DTC

The sum of the 3-phase current calculations is greater than 40 A.

Actions Taken When the DTC Sets

- DTC P0BFD is a Type A DTC.
- The generator control module is disabled.
- The 14 V power module remains active until the hybrid battery reaches a minimum state of charge or the 14 V power module power limits are exceeded, after which the hybrid/EV battery contactors are opened.

Conditions for Clearing the DTC

DTC P0BFD is a Type A DTC.

Diagnostic Aids

Non-characteristic accessory drive vibration may cause DTC P0BFD to set. If the DTC is not currently active or the DTC does not come back after a code clear, the actual failure may be related to broken engine mounts, misaligned accessory drive pulleys, bad pulley bearings, etc. In this situation, perform a road test and listen for growling or grinding noises from the accessory drive under different driving conditions.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

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

Circuit/System Verification

If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

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WARNING: **Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.**

The High Voltage Disabling procedure will perform the following tasks:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** procedure.
2. Remove the 3-phase cables from the K59 Starter/Generator Control Module.
3. Test for infinite resistance between each of the 3-phase circuit terminals listed below and ground:
   - X3 phase U terminal
   - X3 phase V terminal
   - X3 phase W terminal
   - **If less than infinite resistance**

     Test each phase of the drive motor generator 3-phase cable for a short to ground.

   - **If the cables test normal**
4. Replace the A15 Starter/Generator and retest for the DTC.
   - **If the DTC resets**

     Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

- **Starter Generator Replacement**
- **Generator Control Module 3-Phase Cable Assembly Replacement** for 3-Phase Cable Assembly replacement
- **Control Module References** for Generator Control Module, also called the K59 Starter/Generator Control Module replacement, programming and setup.

DTC P0C01: DRIVE MOTOR HIGH CURRENT

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**

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DTC Descriptor

DTC P0C01

Drive Motor High Current

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter/generator, also referred to as the drive motor based upon hybrid/EV powertrain control module 1 commands. The drive motor control module controls the speed and output torque of the starter/generator through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. Each insulated gate bipolar transistor assembly is monitored for overcurrent conditions.

Conditions for Running the DTC

- The drive motor control module is awake.
- DTC P0BFD, P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, or P0BEC is not set.

Conditions for Setting the DTC

One or more phase currents are greater than Â±385 A.

Actions Taken When the DTC Sets

- DTC P0C01 is a Type A DTC.
- The starter/generator regeneration and power assist functions are disabled.

Conditions for Clearing the DTC

DTC P0C01 is a Type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Electrical Information Reference

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

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTCs P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, P0BEC, and P0BFD are not set.
2. If the DTC is set, clear DTC; Turn the ignition OFF for 2 minutes. Turn the ignition ON, Operate vehicle within conditions for running and setting DTC. If the DTC resets, go to Circuit/System Testing.

Circuit/System Testing

WARNING: Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.

The High Voltage Disabling procedure will perform the following tasks:

- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Failure to follow the procedures exactly as written may result in serious injury or death.

1. Perform the **High Voltage Disabling** .
2. Ignition OFF, disconnect the 3-phase cables from the K59 Starter/Generator Control Module.
3. Test for infinite resistance to 3-phase circuit terminals listed below and ground:
   - X3 phase U terminal A
   - X3 phase V terminal B
   - X3 phase W terminal C
   - If not the specified value, disconnect the 3-phase cables from the A15 Starter/Generator, and test the 3-phase circuit for a short to ground. If the circuit tests normal, replace the A15 Starter/Generator motor.
4. Replace the component: K59 Starter/Generator Control Module. If the DTC resets, Replace the component:A15 Starter/Generator.

Repair Instructions

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

- **Starter Generator Replacement**
- **Generator Control Module 3-Phase Cable Assembly Replacement** for 3-Phase Cable Assembly replacement
- **Control Module References** for Generator Control Module, also called the Starter/Generator Control Module , replacement, programming and setup.

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DTC P0C0B: DRIVE MOTOR INVERTER SUPPLY VOLTAGE

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 P0C0B

Drive Motor Inverter Supply Voltage Circuit

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The inverter supply voltage circuit detects the loss of the bias power supply to the insulated gateway bi-polar transistors. This is an internal fault detection of the generator control module. This fault is handled inside the generator control module and no external circuits are involved.

Conditions for Running the DTC

The run/crank voltage is greater than 9.5V.

Conditions for Setting the DTC

The generator control module does not detect voltage at the insulated gate bi-polar transistor bias supply.

Actions Taken When the DTC Sets

- DTC P0C0B is a Type A DTC.
- The drive motor will be disabled.

Conditions for Clearing the DTC

DTC P0C0B is a Type A DTC.

Diagnostic Aids

The 14V power module remains active.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**

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- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify DTC P0562 is not set.
   - If the DTC is set , Refer to: **Diagnostic Trouble Code (DTC) List - Vehicle** .
2. Verify DTC P0C0B is not set.

   If the DTC is set

   1. Verify the K59 Starter/Generator Control Module has the latest calibration in Calibration Information.

      If the K59 Starter/Generator Control Module does not have the latest calibration

      1. Program the control module: K59 Starter/Generator Control Module.
      2. Verify the DTC does not set

         If the DTC sets, Replace the component:K59 Starter/Generator Control Module

         If the DTC does not set

      3. All OK.

         If the K59 Starter/Generator Control Module has the latest calibration

   2. Replace the component:K59 Starter/Generator Control Module.

      If the DTC is not set

3. All OK

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter/Generator Control Module , replacement, programming and setup.

DTC P0C11: DRIVE MOTOR INVERTER PHASE U HIGH TEMPERATURE

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**

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DTC Descriptor

DTC P0C11

Drive Motor Inverter Phase U High Temperature

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter/generator, also referred to as the drive motor, based upon hybrid/EV powertrain control module 1 commands. The drive motor control module controls the speed and output torque of the drive motor through the sequencing actuation of high current switching transistors called insulated gate bipolar transistors. The drive motor operates utilizing 3 phase AC. Each insulated gate bipolar transistor operates a single phase of the drive motor. Each phase is individually identified as U, V and W. The drive motor control module monitors the temperature of the switching transistors in order to detect inverter module overtemperature conditions. The generator control module is liquid cooled.

Conditions for Running the DTC

- The drive motor control module and hybrid/EV powertrain control module 1 are awake.
- DTC P0AEE, P0AEF, P0AF0, and P190A are not set.

Conditions for Setting the DTC

The Phase U DC/AC Inverter Temperature 1 is greater than 115Â°C (239Â°F) for 8 s.

Actions Taken When the DTC Sets

- DTC P0C11 is a Type B DTC.
- The system starts to reduce the maximum torque beginning at 110Â°C (230Â°F) down to 75 percent torque capability when the drive motor inverter temperature reaches 115Â°C (239Â°F). As the drive motor inverter temperature continues to increase, maximum torque is further reduced down to 0 N.m (0 lb in) at 120Â°C (248Â°F).

Conditions for Clearing the DTC

DTC P0C11 is a Type B DTC.

Diagnostic Aids

Ask about the customer's driving habits, trailer towing, etc.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**

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- **Generator Control Module Description and Operation**
- **Hybrid/EV Cooling System Description and Operation**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Inspect for proper coolant level in the radiator surge tank.
   - **If coolant level is low**

     Refer to **Cooling System Draining and Filling (Vac N Fill L8B)** . Repair the cause of low coolant level.

   - **If coolant level is OK**
2. Inspect for evidence that the engine cooling system also overheated.
   - **If the engine overheated**

     Refer to **Engine Overheating** .

   - **If the engine did not also overheat**
3. Inspect the hybrid/EV cooling system for leaks.
   - **If a leak is found**

     Repair or replace the leaking component. Refer to the appropriate repair.

   - **If a leak is not found**
4. Inspect the hybrid/EV cooling hoses for pinches or obstructions.
   - **If a concern is found**

     Repair or replace hoses as necessary.

   - **If a concern is not found**
5. Inspect the hybrid/EV electronics cooling system radiator for debris or obstruction.
   - **If a concern is found**

     Repair or replace the restricted or damaged components as necessary.

   - **If a concern is not found**
6. Inspect for proper operation of the hybrid/EV system coolant pump.
   - **If a concern is found**

     Repair or replace the coolant pump as necessary.

   - **If a concern is not found**
7. If the DTC resets, Replace the component:K59 Starter/Generator Control Module

Repair Instructions

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

Control Module References for Generator Control Module, also called the K59 Starter/Generator Control Module replacement, programming and setup.

DTC P0C19: DRIVE MOTOR TORQUE

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 P0C19

Drive Motor Torque Delivered Performance

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The starter/generator also called the drive motor is controlled by the drive motor control module. The drive motor control module constantly monitors the requested torque and the delivered torque of the drive motor.

Conditions for Running the DTC

- DTCs P0BE6, P0BE7, P0BE8, P0BEA, P0BEB, P0BEC, P0BFD, P1AE8, P1AE9, and P1AEC are not set.
- Drive motor is commanded to develop torque.

Conditions for Setting the DTC

The drive motor control module has detected that the difference between drive motor torque commanded and delivered is greater than 36 N.m (27 lb ft).

Actions Taken When the DTC Sets

- DTC P0C19 is a Type B DTC.
- Commanded motor torque is limited to below 36 N.m (27 lb ft).

Conditions for Clearing the DTC

DTC P0C19 is a Type B DTC.

Diagnostic Aids

- Seized or binding engine
- Seized or binding accessory drive belt

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- Seized or binding starter/generator

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Start the engine. DTC P0C19 should not be set.
2. Verify DTC P0A90 is not set.
   - **If the DTC is set**

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

   - **If the DTC is not set**
3. Verify the engine or AC compressor is not seized or binding.
   - If the engine is seized or binding, refer to **Symptoms - Engine Mechanical** .
   - If the AC Compressor is seized or binding, refer to **Noise Diagnosis - Air Conditioning (A/C) System** .
4. Verify the A15 Starter/Generator is not seized or binding.
5. If DTC P0C19 is set, Replace the component: A15 Starter/Generator

Repair Instructions

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

Starter Generator Replacement for starter/generator replacement.

DTC P0C76: HYBRID/EV BATTERY SYSTEM HIGH VOLTAGE

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

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DTC P0C76

Hybrid/EV Battery System High Voltage Present

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid/EV battery pack contains 3 high voltage contactors. The high voltage contactors allow the high voltage DC batteries to be connected to the vehicle and safely contain the high voltage DC within the hybrid/EV battery pack. The 3 high voltage contactors are a main positive high voltage contactor, main negative high voltage contactor, and a precharge high voltage contactor.

Conditions for Running the DTC

The hybrid/EV battery contactors have been open for 3.5 seconds after ignition ON.

Conditions for Setting the DTC

The high voltage circuit is greater than 60 V after the contactor has been commanded open and active discharge has completed.

Actions Taken When the DTC Sets

- DTC P0C76 is a Type A DTC.
- A clear DTC command will not clear this DTC or the Action Taken.

Conditions for Clearing the DTC

DTC P0C76 is a Type A DTC.

Diagnostic Aids

- A clear DTC command will not clear this DTC or the Action Taken.
- The DTC may set due to a low 12 V battery condition.
- The DTC may set due to an intermittent stuck high voltage contactor.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Connect charger to 12 V Battery.
2. Ignition ON, perform the hybrid/EV powertrain control module scan tool Clear DTC output control. Cycle the ignition twice.
3. Refer to:**Hybrid/EV Battery Voltage Present** . If the contactors test normal, open the scan tool Freeze Frame/Failure Records data for DTC P0C76. Check if Drive Motor Inverter Supply Voltage Circuit parameter is 86 V or less.
    - **If the parameter is greater than 86 V**

      Replace the component: A28 Hybrid/EV Battery Contactor Assembly

    - **If the parameter is 86 V or less**

      Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

- **Generator Battery Disconnector Relay Replacement** for A28 Hybrid/EV Battery Contactor Assembly replacement
- **Control Module References** for Generator Control Module, also called K59 Starter/Generator Control Module replacement, programming and setup.

DTC P156F: HIGH VOLTAGE ALLOWED SIGNAL MESSAGE COUNTER

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 P156F

High Voltage Allowed Signal Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid/EV powertrain control module 2 is constantly sending the hybrid/EV powertrain control module 1 serial data messages containing high voltage allowed data. These serial data messages are sent through circuits which are part of a communication network called the controller area network (CAN). The hybrid/EV powertrain control module 1 sets DTC P156F when it detects a discrepancy in the structure of this message

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causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P156F to set.

Conditions for Running the DTC

- Ignition is ON.
- The ignition run/crank voltage is 11.0 V or greater.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects a discrepancy in the high voltage allowed data sent from the hybrid/EV powertrain control module 2.

Actions Taken When the DTC Sets

- DTC P156F is a Type A DTC.
- The Hybrid/EV Powertrain Control Module 1 opens the Hybrid/EV Battery Contactors .

Conditions for Clearing the DTC

DTC P156F is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other DTCs are set except for DTC P156F.
    - **If any other DTCs are set**

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

    - **If only DTC P156F is set**
2. Replace the component: K114B Hybrid/EV Powertrain Control Module 2.
3. 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.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the component:K59 Starter/Generator Control Module

    - **If the DTC does not set**

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5. All OK.

Repair Instructions

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

Control Module References for K114B Hybrid/EV Powertrain Control Module 2 or K59 Starter/Generator Control Module replacement programming and setup.

DTC P15F0: ENGINE TORQUE DELIVERED SIGNAL MESSAGE COUNTER

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 P15F0

Engine Torque Delivered Signal Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The engine control module is constantly sending the hybrid/EV powertrain control module 1 serial data messages containing engine torque data. These serial data messages are sent through circuits which are part of a communication network called the controller area network (CAN). The hybrid/EV powertrain control module 1 sets DTC P15F0 when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

Conditions for Running the DTC

- Ignition/Vehicle is ON.
- The run/crank voltage is 9.5 V or greater.

OR

The ignition run/crank voltage is 11.0 V or greater.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects a discrepancy in the engine torque data sent from the engine control module.

Actions Taken When the DTC Sets

- DTC P15F0 is a Type A DTC.
- The hybrid/EV powertrain control module 1 opens the hybrid/EV battery contactors.

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Conditions for Clearing the DTC

DTC P15F0 is a Type A DTC.

Diagnostic Aids

An intermittent fault in the controller area network (CAN) circuits will cause DTC P15F0 to set.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other DTCs are set except for DTC P15F0.
    - **If any other DTCs are set**

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

    - **If only DTC P15F0 is set**
2. Replace the component:K20 Engine Control Module.
3. 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.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the component:K59 Starter/Generator Control Module.

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

Repair Instructions

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

Control Module References for K20 Engine Control Module or K59 Starter/Generator Control Module replacement programming and setup.

DTC P15F1: AXLE TORQUE REQUEST SIGNAL MESSAGE COUNTER

Diagnostic Instructions

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

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- 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 P15F1

Axle Torque Request Signal Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The engine control module is constantly sending the hybrid/EV powertrain control module 1 serial data messages containing requested axle torque data. These serial data messages are sent through circuits which are part of a communication network called the controller area network (CAN). The hybrid/EV powertrain control module 1 sets DTC P15F1 when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P15F1 to set.

Conditions for Running the DTC

- Ignition is ON.
- The run/crank voltage is 9.5 V or greater.

  OR

  The ignition run/crank voltage is 11.0 V or greater.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects a discrepancy in the requested axle torque data sent from the engine control module.

Actions Taken When the DTC Sets

- DTC P15F1 is a Type B DTC.
- The hybrid/EV powertrain control module 1 opens the hybrid/EV battery contactors.

Conditions for Clearing the DTC

DTC P15F1 is a Type B DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other DTCs are set except for DTC P15F1.
    - **If any other DTCs are set**

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

    - **If only DTC P15F1 is set**
2. Replace the component:K20 Engine Control Module.
3. 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.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the component:K50 Starter/Generator Control Module.

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

Repair Instructions

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

Control Module References for K20 Engine Control Module or K59 Starter/Generator Control Module replacement programming and setup.

DTC P15F4: DRIVE MOTOR TORQUE DELIVERED SIGNAL MESSAGE COUNTER

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 P15F4

Drive Motor Torque Delivered Signal Message Counter Incorrect

Circuit/System Description

The generator control module, also called the starter/generator control module, is comprised of the following three control modules; the hybrid/EV powertrain control module 1,14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid/EV powertrain control module 1 and no external circuits are

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involved.

Conditions for Running the DTC

- Ignition is ON.
- The system voltage is greater than 9.5 V.
- DTC U1817 is not set.

Conditions for Setting the DTC

The control module has detected an internal malfunction.

Actions Taken When the DTC Sets

- DTC P15F4 is a Type A DTC.
- The hybrid/EV powertrain control module 1 commands the hybrid/EV powertrain control module 2 to open the high voltage contactor relays.

Conditions for Clearing the DTC

DTC P15F4 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Testing

NOTE: **Diagnose and repair any communication DTCs prior to performing this testing.**

1. Ignition On .
2. Verify DTC P15F4 is not set.
    - **If the DTC is set**
    1. Program the K59 Starter/Generator Control Module.
    2. Verify the DTC does not set.
        - If the DTC sets, Replace the component:K59 Starter/Generator Control Module
        - If the DTC does not set
    3. All OK.
    - **If the DTC is not set**
3. All OK.

Repair Instructions

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

Control Module References for K59 Starter/Generator Control Module replacement, programming and setup

DTC P15F5: CRANKSHAFT TORQUE COMMAND SIGNAL MESSAGE COUNTER

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 P15F5

Crankshaft Torque Command Signal Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The engine control module is constantly sending the hybrid/EV powertrain control module 1 serial data messages containing commanded engine crankshaft data. These serial data messages are sent through circuits which are part of a communication network called the controller area network (CAN). The hybrid/EV powertrain control module 1 sets DTC P15F5 when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P15F5 to set.

Conditions for Running the DTC

- Ignition is ON.
- The run/crank voltage is 9.5 V or greater.

  OR

  The ignition run/crank voltage is 11.0 V or greater.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects a discrepancy in the commanded engine crankshaft data sent from the engine control module.

Actions Taken When the DTC Sets

- DTC P15F5 is a Type A DTC.
- The hybrid/EV powertrain control module 1 opens the hybrid/EV battery contactors.

Conditions for Clearing the DTC

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DTC P15F5 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other DTCs are set except for DTC P15F5.
   - **If any other DTCs are set**

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

   - **If only DTC P15F5 is set**
2. Replace the component:K20 Engine Control Module.
3. 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.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Replace the component:K59 Starter/Generator Control Module.

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

Repair Instructions

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

Control Module References for K20 Engine Control Module or K59 Starter/Generator Control Module replacement, programming and setup.

DTC P15FC: HYBRID/EV BATTERY CONTACTOR STATUS MESSAGE COUNTER

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 P15FC

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Hybrid/EV Battery Contactor Status Message Counter Incorrect

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid/EV powertrain control module 2 is constantly sending the hybrid/EV powertrain control module 1 serial data messages containing contactor status data. These serial data messages are sent through circuits which are part of a communication network called the controller area network (CAN). The hybrid/EV powertrain control module 1 sets DTC P15FC when it detects a discrepancy in the structure of this message causing its integrity to be questioned.

An intermittent fault in the controller area network (CAN) circuits will cause DTC P15FC to set.

Conditions for Running the DTC

- Ignition is ON.
- The ignition run/crank voltage is 11.0 V or greater.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects a discrepancy in the contactor status data sent from the hybrid/EV powertrain control module 2.

Actions Taken When the DTC Sets

- DTC P15FC is a Type A DTC.
- The hybrid/EV powertrain control module 1 opens the hybrid/EV battery contactors.

Conditions for Clearing the DTC

DTC P15FC is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that no other DTCs are set except for DTC P15FC.
   - **If any other DTCs are set**

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

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- **If only DTC P15FC is set**

2. Replace the component:K114B Hybrid/EV Powertrain Control Module 2
3. 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.
4. Verify the DTC does not set.
    - **If the DTC sets**

      Replace the component: K59 Starter/Generator Control Module

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

Repair Instructions

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

Control Module References for K114B Hybrid/EV Powertrain Control Module 2 or K59 Starter/Generator Control Modulereplacement, programming and setup.

DTC P16F3: CONTROL MODULE REDUNDANT MEMORY

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 P16F3

Control Module Redundant Memory Performance

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the hybrid/EV powertrain control module 1 and no external circuits are involved.

Conditions for Running the DTC

- Ignition is ON.
- The run/crank voltage is 11.0V or greater.

Conditions for Setting the DTC

The control module has detected that the redundant data does not match the primary data.

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Actions Taken When the DTC Sets

- DTC P16F3 is a Type A DTC.
- The hybrid/EV powertrain control module 1 opens the hybrid/EV battery contactors.

Conditions for Clearing the DTC

DTC P16F3 is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set , program the K59 Starter/Generator Control Module. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called Starter/Generator Control Module , replacement, programming and setup.

DTC P171A-P171C: TRANSMISSION FLUID PRESSURE ACCUMULATOR SOLENOID

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 P171A

Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit

DTC P171B

Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Low Voltage

DTC P171C

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Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Ignition	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141, P171B*	P0030, P0036, P0132, P0134, P0135, P0138, P0140, P0141, P171A	-
Control	P171B	P171A	P171C
*Will open the fuse			

Typical Scan Tool Data

Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Low Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On **Parameter Normal Range:** OK or Not Run			
Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Low Voltage Test Status	Malfunction	OK/Not Run	OK/Not Run

Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit High Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On **Parameter Normal Range:** OK or Not Run			
Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit High Voltage Test Status	OK/Not Run	OK/Not Run	Malfunction

Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Open Voltage Test Status

Circuit	Short to Ground	Open	Short to Voltage
Operating Conditions: Ignition On **Parameter Normal Range:** OK or Not Run			
Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Open Test Status	Malfunction	OK/Not Run	OK/Not Run

Circuit/System Description

The automatic transmission auxiliary fluid accumulator is used to supply transmission fluid line pressure following an Autostop event. The accumulator is externally mounted to the transmission case assembly. The accumulator has a solenoid valve which controls the charging and discharge of the accumulator pressure. Power to the solenoid is provided from an ignition circuit. Thehybrid/EV powertrain control module 1 controls the accumulator solenoid by providing the ground path to the control circuit.

Conditions for Running the DTC

- Ignition voltage is 9.5V or greater.
- Runs continuously when above condition is met.

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Conditions for Setting the DTC

DTC 171A

The hybrid/EV powertrain control module 1 detects an open circuit on the transmission surge solenoid circuit for 1 s.

DTC 171B

The hybrid/EV powertrain control module 1 detects a short to ground on the transmission surge solenoid circuit for 1 s.

DTC 171C

The hybrid/EV powertrain control module 1 detects a short to power on the transmission surge solenoid circuit for 1 s.

Actions Taken When the DTC Sets

- DTCs P171A, P171B, and P171C are Type B DTCs.
- Autostop is disabled.

Conditions for Clearing the DTC

DTCs P171A, P171B, and P171C are Type B DTCs.

Diagnostic Aids

- The Autostart/Autostop command is located in the scan tool hybrid/EV powertrain control module 1 control functions menu.
- The hood must be closed when commanding Autostart/Autostop, or an error message will be displayed on the scan tool.
- The automatic transmission accumulator solenoid valve is part of the auxiliary fluid accumulator and is serviced as an assembly.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: Refer to Parking Brake and Drive Wheels Warning .

1. Ignition ON.
2. Verify the scan tool parameters listed below do not display Malfunction when commanding the Transmission Fluid Pressure Accumulator Solenoid Valve On and Off with a scan tool.
   - Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit High Voltage Test Status
   - Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Low Voltage Test Status
   - Transmission Fluid Pressure Accumulator Solenoid Valve Control Circuit Open Test Status
   - **If Malfunction is displayed**

     Refer to Circuit/System Testing.

   - **If Malfunction is not displayed**
3. 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.
4. Verify the DTC does not set.
   - **If the DTC sets**

     Refer to Circuit/System Testing.

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

Circuit/System Testing

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

1. Ignition ON.
2. Verify a test lamp illuminates on both test points of the ignition circuit fuse that provides power to the B280 Automatic Transmission Accumulator Solenoid Valve.
   - **If the test lamp does not illuminate on either test point of the fuse**

     Refer to:**DTC P0685-P0687, P0689, P0690, or P1682** .

   - **If the test lamp illuminates on 1 test point and the fuse is open**
   1. Ignition Off .

      NOTE: There are multiple ignition circuits protected by this fuse.

   2. Disconnect all components protected by this fuse.

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3. 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, determine which component on the ignition circuit is causing the fuse to open, and replace the component.
    - **If the test lamp illuminates on both test points**
3. Ignition OFF, disconnect the harness connector at the B280 Automatic Transmission Accumulator Solenoid Valve. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 1 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, replace the X50A Fuse Block - Underhood.
    - **If the test lamp illuminates at each terminal**
5. Connect a test lamp between the ignition circuit terminal 1 and the control circuit terminal 2.
6. Verify the test lamp turns ON and OFF when commanding the Transmission Fluid Pressure Accumulator Solenoid Valve On and Off with a scan tool.
    - **If the test lamp is always Off**
    1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter/Generator Control Module, Ignition On .
    2. Test for less than 1 V between the control circuit and ground.
        - If 1 V or greater, repair the short to voltage on the circuit.
        - If less than 1 V.
    3. Ignition Off .
    4. 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 K59 Starter/Generator Control Module.
    - **If the test lamp is always On**
    1. Ignition OFF, disconnect the X1 harness connector at the K59 Starter/Generator Control Module.
    2. Test for infinite resistance between the control circuit and ground.
        - If less than infinite resistance, repair the short to ground on the circuit.
        - If infinite resistance, replace the K59 Starter/Generator Control Module.
    - **If the test lamp turns On and Off**
7. Test or replace the B280 Automatic Transmission Accumulator Solenoid Valve. Refer to Component Testing.

Component Testing

1. Perform the Circuit/System Verification and Circuit/System Testing first.
2. Ignition OFF, disconnect the harness connector at the B280 Automatic Transmission Accumulator Solenoid Valve.
3. Test for 16-20 Ω between ignition circuit terminal 1 and control circuit 2.
    - **If not between 16 and 20 ohms**

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Replace the component:B280 Automatic Transmission Accumulator Solenoid Valve.

- **If between 16 and 20 ohms**

4. Test for infinite resistance between each terminal and the B280 Automatic Transmission Accumulator Solenoid Valvecase.
   - **If less than infinite resistance**

     Replace the component:B280 Automatic Transmission Accumulator Solenoid Valve.

   - **If infinite resistance**
5. All OK.

Repair Instructions

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

- Perform the **Transmission Service Fast Learn Procedure** following all transmission repairs
- **Auxiliary Fluid Accumulator Removal (WIth Stop/Start)** , and **Auxiliary Fluid Accumulator Installation (With Stop/Start)** for automatic transmission accumulator solenoid valve replacement
- **Control Module References** - for control module replacement, programming and setup

DTC P171D: TRANSMISSION FLUID PRESSURE ACCUMULATOR

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 P171D

Transmission Fluid Pressure Accumulator System Performance

Circuit/System Description

The automatic transmission auxiliary fluid accumulator is used to provide transmission fluid line pressure to the transmission during an autostart event. The accumulator is externally mounted to the transmission case assembly. The hybrid/EV powertrain control module 1 controls the automatic transmission auxiliary fluid accumulator solenoid valve by providing a ground path to the solenoid valve control circuit.

When the engine is shut off during an autostop event, there is no transmission line pressure. During an autostart event, the hybrid/EV powertrain control module 1 commands the automatic transmission auxiliary fluid accumulator solenoid valve on, allowing transmission fluid to discharge from the accumulator, supplying line pressure to the transmission. The accumulator will start to recharge when the transmission fluid pump increases line pressure higher than accumulator pressure. Transmission fluid will flow through the solenoid valve until the hybrid/EV powertrain control module 1 turns the solenoid off and also flow through a check valve.

The hybrid/EV powertrain control module 1 monitors clutch slip during an autostart event. The DTC will set if the hybrid/EV powertrain control module 1 detects that the accumulator system is not capable of supplying

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adequate pressure during autostart.

Conditions for Running the DTC

- DTCs P171A, P171B, P171C, P182E, P1915 or U0101 is not set.
- Transmission shift lever is in a forward range.
- Ignition voltage is 9-18V.
- Transmission fluid temp is 0-110Â°C (32-230Â°F).
- Engine is OFF for 0.5 s or greater.
- During auto stop, engine speed was 5 RPM or less.
- Runs during auto start event.

Conditions for Setting the DTC

Hybrid/EV powertrain control module 1 detects excessive transmission slip during an autostart. This must occur 15 times, with 3 of the times on separate autostart events.

Actions Taken When the DTC Sets

- P171D is a type B DTC.
- Autostop is disabled.

Conditions for Clearing the DTC

P171D is a type B DTC.

Diagnostic Aids

- The Autostart/Autostop command is located in the scan tool hybrid/EV powertrain control module 1 control functions menu.
- The hood must be closed when commanding Autostart/Autostop, or an error message will be displayed on the scan tool.

Reference Information

Schematic Reference

Automatic Transmission Controls Schematics

Connector End View Reference

- **COMPONENT CONNECTOR END VIEWS - INDEX**
- **INLINE HARNESS CONNECTOR END VIEWS - INDEX**

Description and Operation

- **Electronic Component Description**
- **Transmission Component and System Description**
- **Transmission General Description**

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Verification

WARNING: **Refer to Parking Brake and Drive Wheels Warning .**

NOTE: **If other DTCs are set, diagnose those DTCs first.**

1. Engine idling, transmission in Park, with parking brake applied and drive wheels chocked.
2. Verify the transmission fluid level and condition is correct. Refer to **Transmission Fluid Level and Condition Check** .
   - **If the transmission fluid level and condition is not correct**

     Repair as necessary.

   - **If the transmission fluid level and condition is correct**
3. Clear the hybrid/EV powertrain control module 1 DTCs with a scan tool.
4. Verify DTC P171D does not set while performing a road test. Refer to:**Road Test** .
   - **If DTC P171D sets**

     Replace the Transmission Fluid Pressure Accumulator.

   - **If DTC P171D does not set**
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**

     Replace the Transmission Fluid Pressure Accumulator.

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

Repair Instructions

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

- Perform the **Transmission Service Fast Learn Procedure** following all transmission repairs
- **Auxiliary Fluid Accumulator Removal (WIth Stop/Start)** , and **Auxiliary Fluid Accumulator Installation (With Stop/Start)** for transmission fluid pressure accumulator replacement
- **Control Module References** - for control module replacement, programming and setup

DTC P190A: DRIVE MOTOR INVERTER PHASE U TEMPERATURE

Diagnostic Instructions

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- 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 P190A

Drive Motor Inverter Phase U Temperature Erratic

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of the generator control module and no external circuits are involved.

Conditions for Running the DTC

The drive motor control module is communicating.

Conditions for Setting the DTC

The drive motor control module has detected an erratic temperature on inverter phase U for greater than 28 s.

Actions Taken When the DTC Sets

DTC P190A is a Type B DTC.

Conditions for Clearing the DTC

DTC P190A is a Type B DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set-Program the control module:K59 Starter/Generator Control Module. If the DTC resets-Replace the component:K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called Starter/Generator Control Module , replacement, programming and setup.

DTC P1A6F: DRIVE MOTOR NO CRANK AT RESTART

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 P1A6F

Drive Motor No Crank at Restart

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The eAssist hybrid system has the ability to crank and start the engine using two different methods. The first method is a conventional 12 volt system. On every initial start up the conventional 12 volt starter and 12 volt battery are used to crank and start the engine.

The second starting method uses the 86 volt hybrid/EV battery pack and the starter/generator also called the drive motor. The drive motor is a 3 phase AC induction machine. This device not only serves as an 86-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. If the system is in the auto-stop mode and fails to restart with the drive motor, the 12 volt conventional starter will automatically be engaged to start the engine.

Conditions for Running the DTC

Ignition is ON and the vehicle is in autostop.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects that an autostart failed to take place successfully.

Action Taken When the DTC Sets

- DTC P1A6F is a Type B DTC.
- The 12 V starter will be engaged to start the engine and autostop will be disabled.

Conditions for Clearing the DTC

DTC P1A6F is a Type B DTC.

Diagnostic Aids

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- A slipping drive motor belt can cause belt noise on an AutoStart, inspect the drive belt tensioner assembly for proper operation and installation.
- A low mileage vehicle may exhibit drive belt slip due to belt break in.
- To check if drive belt slip is present, perform the hybrid powertrain control module scan tool Autostart/Autostop output control while monitoring Drive Motor Belt Slip parameter. A value of 0% indicates no slip, whereas a positive or negative value indicates slip.

NOTE: **Always inspect for DTCs that would cause an engine stall and/or no start condition.**

- Any condition that causes the engine to stall and/or not start may set this DTC. Possible conditions include:
  - Fuel conditions such as low level, low pressure, or contamination
  - Engine conditions such as low compression
  - Restricted exhaust or air intake systems

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

Circuit/System Verification

1. Inspect the accessory drive, refer to **Drive Belt Tensioner Diagnosis (L83, L86)** **Drive Belt Tensioner Diagnosis (L8B)** .
2. Inspect the drive belt for cracks, wear and contamination.
   - **If the belt is not OK**

     Replace the drive belt.

   - **If the belt is OK**
3. Verify that no other hybrid control module or engine control modules DTCs are set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
4. If the DTC is set, program the K59 starter/generator control module.
   - **If the DTC resets**

     Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

- **Drive Belt Replacement - Accessory**
- **Control Module References** for Generator Control Module, also called K59 Starter/Generator Control Module replacement, programming and setup.

DTC P1AE8 OR P1AE9: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE SENSE CIRCUIT LOW/HIGH VOLTAGE

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 P1AE8

Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit Low Voltage

DTC P1AE9

Drive Motor Control Module Hybrid/EV Battery Voltage Sense Circuit High Voltage

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter/generator based upon generator control module commands. The hybrid/EV powertrain control module 1 is able to detect out of range low or out of range high conditions on the high voltage sensor circuit.

Conditions for Running the DTC

- Ignition is ON.
- The hybrid/EV battery contactors are closed.

Conditions for Setting the DTC

DTC P1AE8

With the hybrid/EV battery contactors closed, the starter/generator control module detects high voltage sensor voltage less than 30V.

DTC P1AE9

The drive motor control module detects high voltage sensor voltage greater than 190V.

Actions Taken When the DTC Sets

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- DTCs P1AE8 and P1AE9 are Type A DTCs.
- The hybrid/EV powertrain control module 1 opens the hybrid/EV battery contactors.
- The battery indicator light will illuminate.

Conditions for Clearing the DTC

DTCs P1AE8 and P1AE9 are Type A DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

If the DTC is set, program the K59 Starter/Generator Control Module. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter/Generator Control Module , replacement, programming and setup.

DTC P1AEC OR P1AEE: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY SYSTEM VOLTAGE

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 P1AEC

Drive Motor Control Module Hybrid/EV Battery System Voltage

DTC P1AEE

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Drive Motor Control Module Hybrid/EV Battery System Voltage High Voltage

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor control module operates the starter/generator based upon generator control module commands. The hybrid/EV powertrain control module 1 monitors the high voltage measurement and then will broadcast the high voltage measurement over serial data.

P1AEC

The drive motor control module compares the values in order to verify the hybrid/EV battery high voltage measurement is accurate.

P1AEE

The hybrid/EV powertrain control module 1 monitors for high voltage that is greater than the system allows during normal operation.

Conditions for Running the DTC

P1AEC

- DTC P1AE8 or P1AE9 is not set.
- Drive motor control module initialization is complete.
- The hybrid/EV battery contactors are closed.

P1AEE

- Drive motor control module initialization is complete.
- The 12 V battery voltage is greater than 7.0 V.

Conditions for Setting the DTC

P1AEC

The difference between high voltage sensed and high voltage battery voltage measured is 39 V or greater.

OR

The difference between high voltage sensed and the sum of the mid-pack voltages is 39 V or greater.

P1AEE

The high voltage sensor voltage is greater than 140 V.

OR

Hardware Overvoltage is detected.

Actions Taken When the DTC Sets

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- DTC P1AEC is a Type B DTC.
- DTC P1AEE is a Type A DTC.
- Starter/Generator torque is limited to provide the minimum amount necessary to support the 14V power module current draw.
- The hybrid/EV powertrain control module 1 requests the hybrid/EV battery contactors open.
- Drive motor control module is disabled.

Conditions for Clearing the DTC

- DTC P1AEC is a Type B DTC.
- DTC P1AEE is a Type A DTC.

Diagnostic Aids

NOTE: **DTC P1AEE may set due to hybrid/EV battery contactor issues, such as contactors opening due to a failure or contactors failing to close.**

Conditions such as loss of hybrid/EV powertrain control module 2 power or ground or removal of the high voltage manual service disconnect while the vehicle was driving could create a voltage surge that may set DTC P1AEE. History DTC P1AEE may indicate that the hybrid/EV battery contactors opened while large current flow was present.

Reference Information

Schematic Reference

- **Hybrid/EV Energy Storage Schematics**
- **Hybrid/EV Controls Schematics**

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify that DTC P0A11, P0AA4, P0ABB, P0ABC, P0ABD, or P0C78 is not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
2. Inspect the high voltage manual service disconnect for damage. Refer to:**High Voltage System Inspection** .
   - If damaged, replace the manual service disconnect.

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3. If DTC P1AEC or P1AEE is set, program the K59 Starter/Generator Control Module. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

- **Drive Motor Battery High Voltage Manual Disconnect Lever Replacement (with Center Console)** **Drive Motor Battery High Voltage Manual Disconnect Lever Replacement (with Front Center Seat)** for manual service disconnect replacement.
- **Control Module References** for Generator Control Module, also called the Starter/Generator Control Module replacement, programming and setup.

DTC P1AF0: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE SYSTEM ISOLATION LOST

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 P1AF0

Drive Motor Control Module Hybrid/EV Battery Voltage System Isolation Lost

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way: The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. The ratio of these voltages is monitored by the Starter/Generator Control Module. If the ratio is outside of an acceptable range, a high voltage isolation fault has occurred.

Conditions for Running the DTC

- Drive motor control module initialization is complete.
- The hybrid/EV battery contactors are closed.
- Drive motor inverter voltage is greater than 48V.
- None of the following DTCs are set: P1AE8, P1AE9, P1AEC, P1AF5, P1B0C, P1B41.

Conditions for Setting the DTC

The ratio between Negative Supply Isolation Voltage and Positive Supply Isolation Voltage is greater than 4.53V or less than 0.21V for greater than 2.5 s in a 4 s window.

Actions Taken When the DTC Sets

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- DTC P1AF0 is a Type B DTC.
- If the DTC sets while there is a loss of communication with the Sensing and Diagnostic Module (SDM), the Starter/Generator Control Module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTC P1AF0 is a Type B DTC.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

- **Hybrid/EV Energy Storage Schematics**
- **Hybrid/EV Controls Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

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 On .
2. Verify DTC P0AA6 is not set.
   - **If the DTC is set**

     Refer to:**DTC P0AA6** .

   - **If the DTC is not set**
3. Verify DTC P0A78, P0BFD, P0C01 is not set.
   - **If any of the DTCs are set**

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

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

4. Verify DTC P1AF0 is not set.
   - **If the DTC is set**

     Refer to:**Loss of Isolation on the High Voltage Main Bus** .

   - **If the DTC is not set**
5. All OK.

Repair Instructions

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

DTC P1AF4 OR P1AF5: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING 1 LOW/HIGH VOLTAGE

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 P1AF4

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage

DTC P1AF5

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The Starter/Generator Control Module places an AC signal on the high voltage system and monitors its amplitude. A reduced amplitude return signal indicates a loss of resistance to chassis ground. This isolation monitor method is sometimes referred to as the active isolation monitor.

Conditions for Running the DTC

- Power mode is RUN or CRANK.
- Drive motor control module initialization is complete.
- The hybrid/EV battery contactors are closed.

Conditions for Setting the DTC

DTC P1AF4

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The positive mid-pack voltage is less than 5 V for 1.25 s.

DTC P1AF5

The positive mid-pack voltage minus the high voltage is greater than 10 V for 1.25 s.

Actions Taken When the DTC Sets

DTCs P1AF4 and P1AF5 are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1AF4 and P1AF5 are Type B DTCs.

Reference Information

Schematic Reference

- **Hybrid/EV Energy Storage Schematics**
- **Hybrid/EV Controls Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

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

Special Tools

EL-48900 HEV Safety Kit

Equivalent regional tools:**Special Tools** .

Circuit/System Verification

1. Ignition On .

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2. Verify DTC P1AF4, P1AF5 is not set.
    - **If DTC P1AF4, P1AF5 is set**

      Replace the component:K59 Starter/Generator Control Module

    - **If DTC P1AF4, P1AF5 is not set**
3. All OK.

Repair Instructions

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

Control Module References for K59 Starter/Generator Control Module replacement, programming, and setup

DTC P1B0B OR P1B0C: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING 2 LOW/HIGH VOLTAGE

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 P1B0B

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage

DTC P1B0C

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way. The Starter/Generator Control Module places an AC signal on the high voltage system and monitors its amplitude. A reduced amplitude return signal indicates a loss of resistance to chassis ground. This isolation monitor method is sometimes referred to as the active isolation monitor.

Conditions for Running the DTC

- Power mode is RUN or CRANK.
- Drive motor control module initialization is complete.
- The hybrid/EV battery contactors are closed.

Conditions for Setting the DTC

DTC P1B0B

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The negative mid-pack voltage is less than 5 V.

DTC P1B0C

The negative mid-pack voltage minus the high voltage is greater than 10 V.

Actions Taken When the DTC Sets

DTCs P1B0B and P1B0C are Type B DTCs.

Conditions for Clearing the DTC

DTCs P1B0B and P1B0C are Type B DTCs.

Reference Information

Schematic Reference

- **Hybrid/EV Energy Storage Schematics**
- **Hybrid/EV Controls Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

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

Special Tools

EL-48900 HEV Safety Kit

Equivalent regional tools:**Special Tools** .

Circuit/System Verification

1. Ignition On .

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2. Verify DTC P1B0B, P1B0C is not set.
    - **If DTC P1B0B, P1B0C is set**

      Replace the component:K59 Starter/Generator Control Module

    - **If P1B0B and P1B0C are not set**
3. All OK.

Repair Instructions

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

Control Module References for K59 Starter/Generator Control Module replacement, programming, and setup

DTC P1B0D: DRIVE MOTOR CONTROL MODULE DRIVE MOTOR OVERSPEED

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 P1B0D

Drive Motor Control Module Drive Motor Overspeed

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The drive motor position sensor is monitored by the generator control module. The generator control module monitors the angular position, speed and direction of the starter/generator based upon the signals of the resolver-type position sensor. The position sensor allows the drive motor control module to determine the exact position and speed of the starter/generator.

Conditions for Running the DTC

The drive motor control module and hybrid/EV powertrain control module 1 are awake.

Conditions for Setting the DTC

Starter/generator speed is greater than 20,500 RPM.

Actions Taken When the DTC Sets

DTC P1B0D is a Type B DTC.

Conditions for Clearing the DTC

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DTC P1B0D is a Type B DTC.

Diagnostic Aids

Check for broken or missing drive belt.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

1. Verify if DTC P0A3F, P0A40, P1B03, P0C52, P0C53, P0C5C, and P0C5D are not set.
    - If DTC P0A3F, P0A40, P1B03, P0C52, P0C53, P0C5C, P0C5D is set

      Refer to:**Diagnostic Trouble Code (DTC) List - Vehicle** .
2. If the DTC is set, program the generator control module. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called Starter/Generator Control Module replacement, programming and setup.

DTC P1B11: DRIVE MOTOR CONTROL MODULE HYBRID/EV AC VOLTAGE SYSTEM ISOLATION LOST

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 P1B11

Drive Motor Control Module Hybrid/EV AC Voltage System Isolation Lost

Circuit/System Description

The vehicle is equipped with a high voltage isolation monitor feature. The purpose of the isolation monitor is to

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test the resistance between the high voltage positive and negative direct current (DC) bus and chassis ground. The isolation monitoring system measures the resistance between the high voltage system and chassis ground in the following way: The isolation monitoring system measures voltage potential difference between the positive battery mid pack voltage and chassis ground as well as the voltage difference between negative battery mid pack voltage and chassis ground. Additionally, the isolation monitor detects high frequency AC voltage between negative battery mid pack voltage and chassis ground. If any of the phases of the starter/generator lose isolation to chassis ground, a DC offset is created, causing the negative battery mid pack voltage to increase.

Conditions for Running the DTC

- The hybrid/EV battery contactors are closed.
- None of the following DTCs are set: P1AE8, P1AE9, P1AEC, P1B0B, P1B0C, P1B41.

Conditions for Setting the DTC

The AC component of the voltage potential difference between the negative battery mid pack voltage and chassis ground is greater than 10 V for 1 s.

Actions Taken When the DTC Sets

- DTC P1B11 is a Type A DTC.
- If the DTC sets while there is a loss of communication with the Sensing and Diagnostic Module (SDM), the Starter/Generator Control Module will record the fault as a crash event and the DTC will become latched.

Conditions for Clearing the DTC

- DTC P1B11 is a Type A DTC.
- If the DTC is set as a latched DTC, the crash event must be cleared before the DTC will clear.

Reference Information

Schematic Reference

- **Hybrid/EV Energy Storage Schematics**
- **Hybrid/EV Controls Schematics**

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Circuit/System Testing

1. Ignition On .
2. Verify DTC P0AA6 is not set.
   - **If the DTC is set**

     Refer to:**DTC P0AA6** .

   - **If the DTC is not set**
3. Verify DTC P0A78, P0BFD, P0C01 is not set.
   - **If any of the DTCs are set**

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

   - **If none of the DTCs are set**
4. Verify DTC P1AF0 is not set.
   - **If the DTC is set**

     Refer to:**Loss of Isolation on the High Voltage Main Bus** .

   - **If the DTC is not set**
5. All OK.

Repair Instructions

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

DTC P1B41: DRIVE MOTOR CONTROL MODULE HYBRID/EV BATTERY VOLTAGE ISOLATION SENSING

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 P1B41

Drive Motor Control Module Hybrid/EV Battery Voltage Isolation Sensing Performance

Circuit/System Description

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The vehicle is equipped with a high voltage isolation sensor rationality or performance fault detection. The purpose of the isolation voltage sensor monitor is to test the rationality between the sum of the high voltage positive and negative current sensed voltages against the high voltage sensed value and also against the high voltage value from the hybrid/EV powertrain control module 2. This is part of the passive isolation monitor.

Conditions for Running the DTC

- Power mode is RUN or CRANK.
- Drive motor control module initialization is complete.
- The hybrid/EV battery contactors are closed.
- None of the following DTCs are set: P1AE8, P1AE9, P1AEC, P1AF4, P1AF5, P1B0B, P1B0C.

Conditions for Setting the DTC

All the following conditions exist:

- The mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage battery voltage is greater than 39 V, or the mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage is greater than 39 V.
- The mid-pack positive voltage minus the mid-pack negative voltage minus the high voltage is greater than 39 V.

Actions Taken When the DTC Sets

DTC P1B41 is a Type B DTC.

Conditions for Clearing the DTC

DTC P1B41 is a Type B DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References

Special Tools

EL-48900 HEV Safety Kit

Equivalent regional tools:Refer to:**Special Tools** .

Circuit/System Verification

1. Ignition On .
2. Verify DTC P1B41 is not set.
   - **If DTC P1B41 is set**

     Replace the component:K59 Starter/Generator Control Module.

   - **If P1B41 is not set**
3. All OK.

Repair Instructions

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

Control Module References for Starter/Generator Control Module replacement, programming, and setup

DTC P1E0A: DRIVE MOTOR CONTROL MODULE TORQUE CALCULATION

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 P1E0A

Drive Motor Control Module Torque Calculation Performance

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

This is an internal fault detection of generator control module and no external circuits are involved.

Conditions for Running the DTC

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Power mode is RUN.

Conditions for Setting the DTC

The difference between the redundant torque calculation and the primary calculation is greater than 55 N.m (41 lb ft).

Actions Taken When the DTC Sets

- DTC P1E0A is a Type A DTC.
- Drive motor control module is disabled.
- The hybrid/EV battery contactors will remain closed during vehicle operation until the hybrid battery reaches a minimum state of charge. Once the minimum state of charge is reached, the hybrid/EV battery contactors will open.

Conditions for Clearing the DTC

P0815, P0816, and P0826 are Type C DTCs.

DTC P1E0A is a Type A DTC.

Reference Information

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

Program the K59 Starter/Generator Control Module. If the DTC resets, replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Generator Control Module, also called the Starter/Generator Control Module replacement, programming and setup.

DTC P2534 OR P2535: IGNITION ON/START SWITCH

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**

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DTC Descriptor

DTC P2534

Ignition On/Start Switch Circuit Low Voltage

DTC P2535

Ignition On/Start Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition 1 Voltage	P2534	P2534	P2535	-
Ground	-	P2534	-	-

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module. The hybrid/EV powertrain control module 1 monitors the system voltage on the Ignition 1 voltage circuit.

Conditions for Running the DTC

NOTE: The generator control module is communicating on the serial data circuits.

P2534

The generator control module ignition voltage signal is valid, with the ignition ON.

P2535

The generator control module ignition voltage signal is valid, with the ignition OFF.

Conditions for Setting the DTC

P2534

The hybrid/EV powertrain control module 1 detects 2 volts or less on the ignition 1 voltage circuit at the generator control module for greater than 10 seconds, with the ignition turned ON.

P2535

The hybrid/EV powertrain control module 1 detects greater than 5 volts on the ignition 1 voltage circuit at the generator control module for greater than 7 seconds, with the ignition turned OFF.

Actions Taken When the DTC Sets

DTCs P2534 and P2535 are Type A DTCs.

Conditions for Clearing the DTC

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DTCs P2534 and P2535 are Type A DTCs.

Diagnostic Aids

A short to voltage in the ignition circuit will keep the vehicle modules awake, which can drain the vehicle's battery.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

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 DTC B144B is not set.
    - **If the DTC is set**

      Refer to:**DTC B144B** .

    - **If the DTC is not set**
3. Verify the scan tool hybrid powertrain control module Ignition 1 Signal parameter is between 12.6-15 V.
    - **If not between 12.6 and 15 V**

      Refer to Circuit/System Testing.

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- **If between 12.6 and 15 V**

4. Verify that the DTC does not reset by operating the vehicle within the Conditions for Running the DTC. You may also operate the vehicle within the conditions you observe from the Freeze Frame/Failure Records data. If the vehicle passes the Circuit/System Verification procedure, then STOP. Do not perform the Circuit/System Testing or Component Testing as this may result in an unnecessary part replacement. Refer to **Testing for Intermittent Conditions and Poor Connections** .

Circuit/System Testing

1. Ignition OFF, and all vehicle systems OFF, disconnect K59 starter/generator control module X1 connector.
2. Test for less than 1 V between the ignition circuit terminal 1 and ground.
   - **If 1 V or greater**

     Repair the short to voltage on the circuit.

   - **If less than 1 V**
3. Ignition On
4. Verify a test lamp illuminates between the ignition circuit terminal 1 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, replace the X50A Fuse Block - Underhood.
   - **If the test lamp does not illuminate and the circuit fuse is open**
   1. Ignition OFF remove the test lamp
   2. Test for infinite resistance between the ignition circuit and ground.
      - If less than infinite resistance, repair the short to ground on the circuit.
   - **If the test lamp illuminates**
5. Replace the K59 Starter/Generator Control Module.

Repair Instructions

- Perform the Diagnostic Repair Verification after completing the repair:**Diagnostic Repair Verification**
- **Underhood Electrical Center or Junction Block Replacement**
- Refer to:**Control Module References** for Generator Control Module, also called K59 Starter/Generator Control Module replacement, programming, and setup.

DTC P2537: IGNITION ACCESSORY SWITCH

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

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DTC P2537

Ignition Accessory Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Accessory Voltage	P2537	P2537	-

Typical Scan Tool Data

Ignition Input Accessory

Circuit	Short to Ground	Open/High Resistance	Short to Voltage
Operating Conditions: Key ON **Parameter Normal Range:** Active			
Accessory	Inactive	Inactive	Active

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The hybrid/EV powertrain control module 1 monitors the system voltage on the accessory voltage circuit.

Conditions for Running the DTC

- The Ignition is ON.
- The generator control module is communicating on the serial data circuits.

Conditions for Setting the DTC

The hybrid/EV powertrain control module 1 detects less than 2 volts on the accessory voltage circuit at the generator control module for greater than 1 seconds.

Actions Taken When the DTC Sets

DTC P2537 is a Type C DTC.

Conditions for Clearing the DTC

DTC P2537 is a Type C DTC.

Diagnostic Aids

Verify the charging system is functioning correctly.

Reference Information

Schematic Reference

Hybrid/EV Controls Schematics

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Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

- **Starter Generator Description and Operation**
- **Generator Control Module Description and Operation**
- **Hybrid Modes of Operation Description**

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

Circuit/System Testing

1. Ignition Off -Disconnect K59 Starter/Generator Control Module X2 connector.
2. Ignition On -Test for 8 to 18 V between the test points:K59 Starter/Generator Control Module X1 connector accessory voltage circuit terminal 2 & Ground
    - If not within the specified range, test the accessory voltage circuit for a short to ground or an open/high resistance. If the circuit tests normal replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for Starter/Generator Control Module replacement, programming and setup.

SYMPTOMS - HYBRID CONTROLS

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

1. Perform the **Diagnostic System Check - Vehicle** before using the symptom tables in order to verify that all of the following are true:
    - There are no DTCs set.
    - The control modules can communicate via the serial data link.
2. Review the system operation in order to familiarize yourself with the system functions.

    Refer to the following procedures:

    - **Generator Control Module Description and Operation**
    - **High Voltage Monitoring Systems Description**
    - **Hybrid Modes of Operation Description**

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- **Starter Generator Description and Operation**
- **Transmission General Description**

Visual/Physical Inspection

- Inspect for aftermarket devices which could affect the operation of the Hybrid System. 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:

DC Power Conversion Test

DC POWER CONVERSION TEST

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**

Circuit/System Description

The generator control module also called the starter/generator control module is comprised of the following three control modules; the hybrid/EV powertrain control module 1, 14 V power module and the drive motor control module. These three control modules are non serviceable and are part of the generator control module.

The 14 V power module supplies the energy that flows between the high voltage (86 V) direct current (DC) and low voltage (14 V) DC to charge the 12 V battery and power accessories. The 14 V power module receives a wake-up signal from the hybrid/EV powertrain control module 1 when the ignition/vehicle is switched to On. After a successful initialization, the 14 V power module receives an enable command from the hybrid/EV powertrain control module 1 to begin power conversion.

Diagnostic Aids

A poor connection at the B+ terminal of the generator control module or open 175 Amp Mega-Fuse in the engine compartment, will prevent the internal 14 V power module from operating.

Using a carbon pile tester is the preferred method to test the 14 V power module output. The carbon pile tester can put an increasing load on the system to reach a target current level. If a carbon pile tester is not available, the alternative method is using the scan tool ECM 14 V power module setpoint.

Reference Information

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Schematic Reference

Hybrid/EV Controls Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Generator Control Module Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Circuit/System Verification

NOTE: **To accurately diagnose the charging system, the C1 Battery must be fully charged and capable of passing the Battery Inspection/Test.**

1. Perform the **Battery Inspection/Test** .

NOTE: **The engine must be started at least once during a key cycle to enable high voltage and the 14 V Power Module. The 14 V Power Module and high voltage will remain enabled during any subsequent Autostops.**

2. Engine running.
3. Verify that no DTCs are set that would cause a charging system concern.
   - **If an applicable DTC is set**

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

   - **If no applicable DTCs are set**
4. Ignition Off .
5. Measure and record the C1 Battery Voltage at the C1 Battery terminals. The C1 Battery Voltage should stabilize within a few minutes of turning the ignition/vehicle OFF.
6. Engine running, daytime running lamps and all accessories OFF.
7. Measure and record the C1 Battery Voltage at the C1 Battery terminals. The voltage should be at least 1 V greater than the voltage measured previously recorded in step 5, but less than 15.5 V.
   - **If not within the specified range**

     Refer to Circuit/System Testing.

   - **If within the specified range**
8. All OK.

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Circuit/System Testing

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

NOTE: **If a carbon pile tester is available, refer to With Carbon Pile Tester section. Otherwise, refer to Without Carbon Pile Tester section.**

With Carbon Pile Tester

1. Ignition Off
2. Connect a carbon pile tester to the C1 Battery.
3. Engine running and all accessories OFF. Observe the voltage reading on the tester and the Body Control Module Battery Voltage parameter in the Electric Power Management Data list. The voltage should read between 12.6-15.5 V.
4. Adjust the carbon pile tester so that the Body Control Module Battery Current Sensor parameter in the Electric Power Management Data list is reading 120 A.
5. Verify the voltage reading remains between 12.6-15.5 V.
    - **If not within the specified range**

      Replace the component: K59 Starter/Generator Control Module

    - **If within the specified range**
6. All OK.

Without Carbon Pile Tester

1. Engine running.
2. Verify the scan tool Engine Control Module Ignition 1 Signal parameter continually increases and decreases when controlling the Engine Control Module 14 V Power Module Setpoint up and down with a scan tool. It may take up to 10 s for the battery voltage to stabilize between each setpoint change.
    - **If the battery voltage does not continually increase**

      Replace the K59 Starter/Generator Control Module.

    - **If the battery voltage continually increases**
3. All OK.

Repair Instructions

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

Control Module References for Generator Control Modulealso called the K59 Starter/Generator Control Modulereplacement, programming, and setup.

REPAIR INSTRUCTIONS

STARTER GENERATOR REPLACEMENT

Removal Procedure

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WARNING: **Always perform the High Voltage Disabling procedure prior to servicing any High Voltage component or connection. Personal Protection Equipment (PPE) and proper procedures must be followed.**

The High Voltage Disabling procedure includes the following steps:

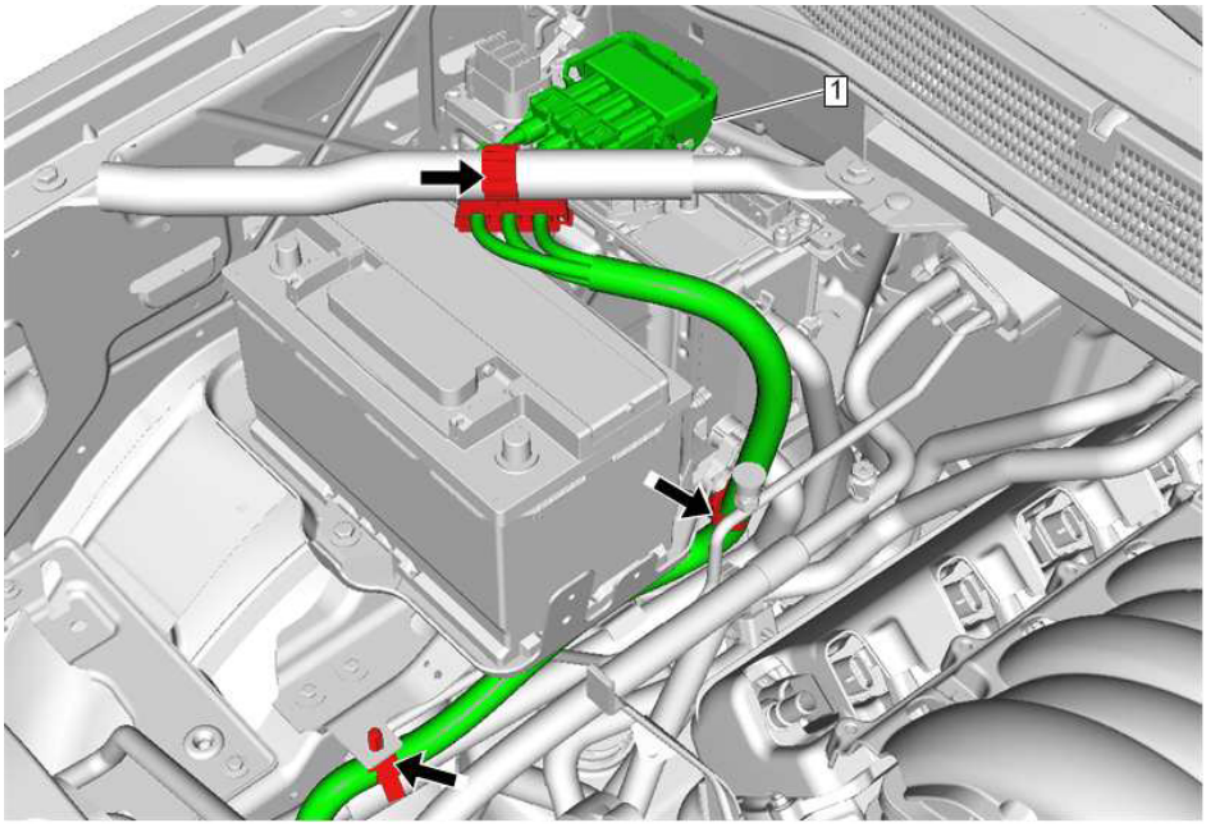
- **Identify how to disable high voltage.**
- **Identify how to test for the presence of high voltage.**
- **Identify condition under which high voltage is always present and personal protection equipment (PPE) and proper procedures must be followed.**

Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 15 meters (50 feet) of the vehicle, either indoors or outdoors.**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors.**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves with leather protectors at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedures may result in serious injury or death.

1. Disable the high voltage system. **High Voltage Disabling**



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Fig. 4: Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

2. Harness Connector 1 -Disconnect

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

3. Detach the harness retainers where indicated.
4. Drive Belt Tensioner-Remove - **Drive Belt Tensioner Replacement - Accessory (L8B Lower)** **Drive Belt Tensioner Replacement - Accessory (L8B Upper)**

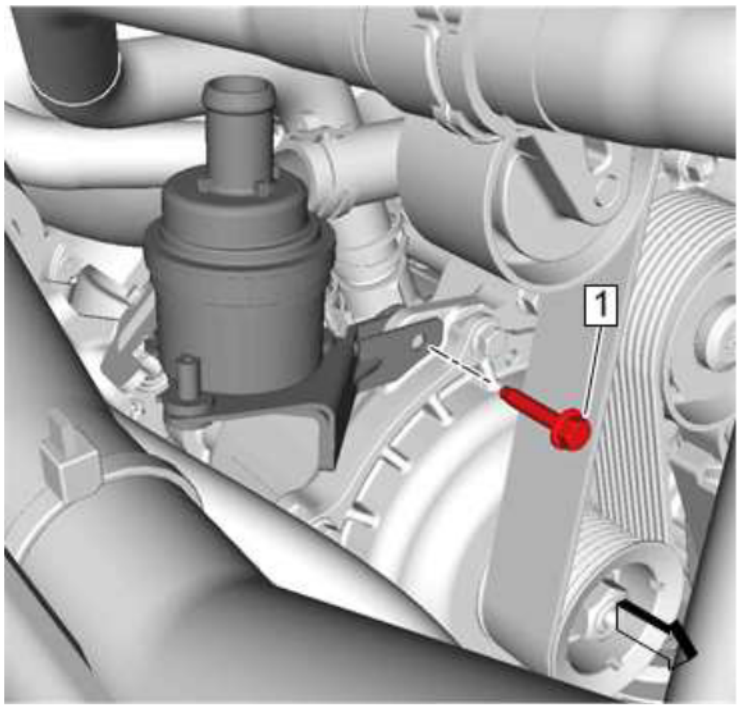


Fig. 5: Engine Coolant Heater Pump Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

5. Remove the engine coolant heater bracket bolt (1) and reposition the auxiliary water pump, refer to **Auxiliary Water Pump Replacement (L8B)**
6. Front Wheelhouse Liner - Right Side-Remove - **Front Wheelhouse Liner Replacement - Right Side**
7. Drain the cooling system. **Cooling System Draining and Filling (Vac N Fill L8B)**

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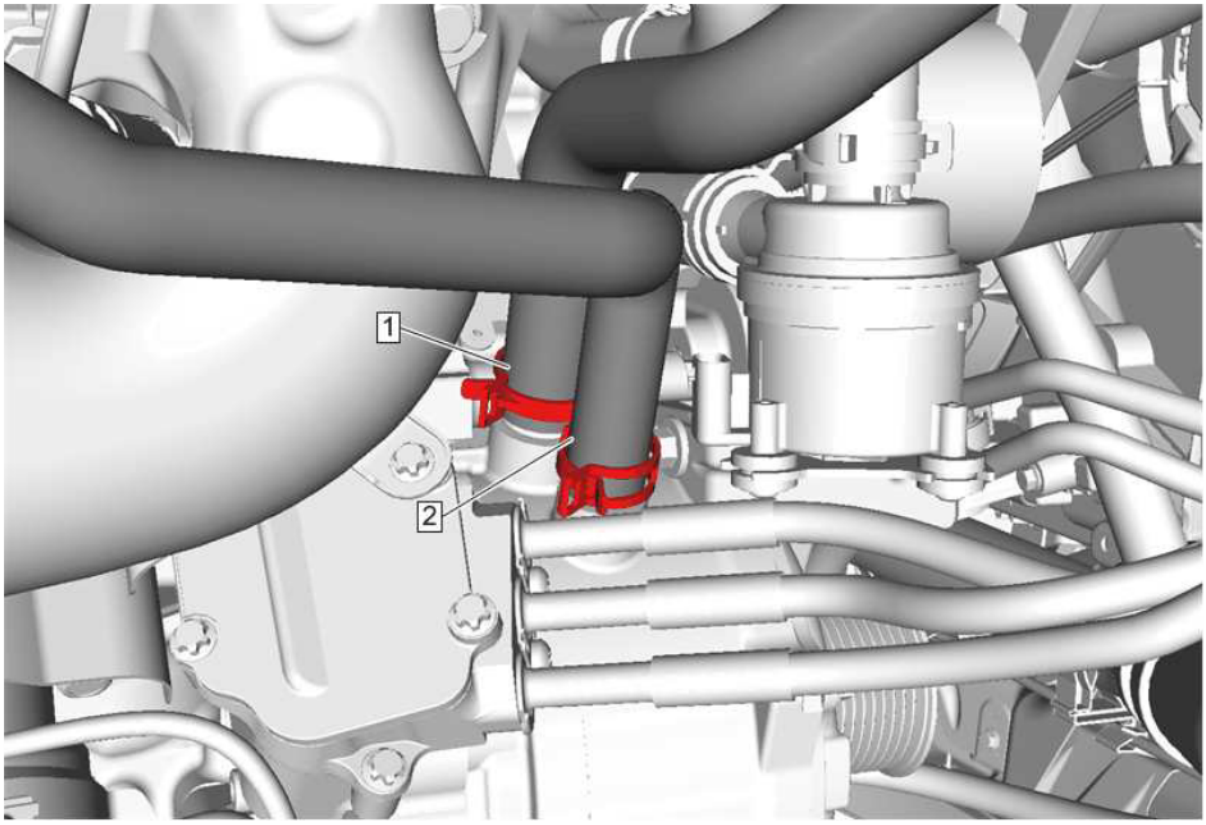


Fig. 6: Coolant Hose
Courtesy of GENERAL MOTORS COMPANY

8. Coolant Hose (1, 2) -Remove @Generator - **Hose Clamp Replacement Guidelines - Spring Type**

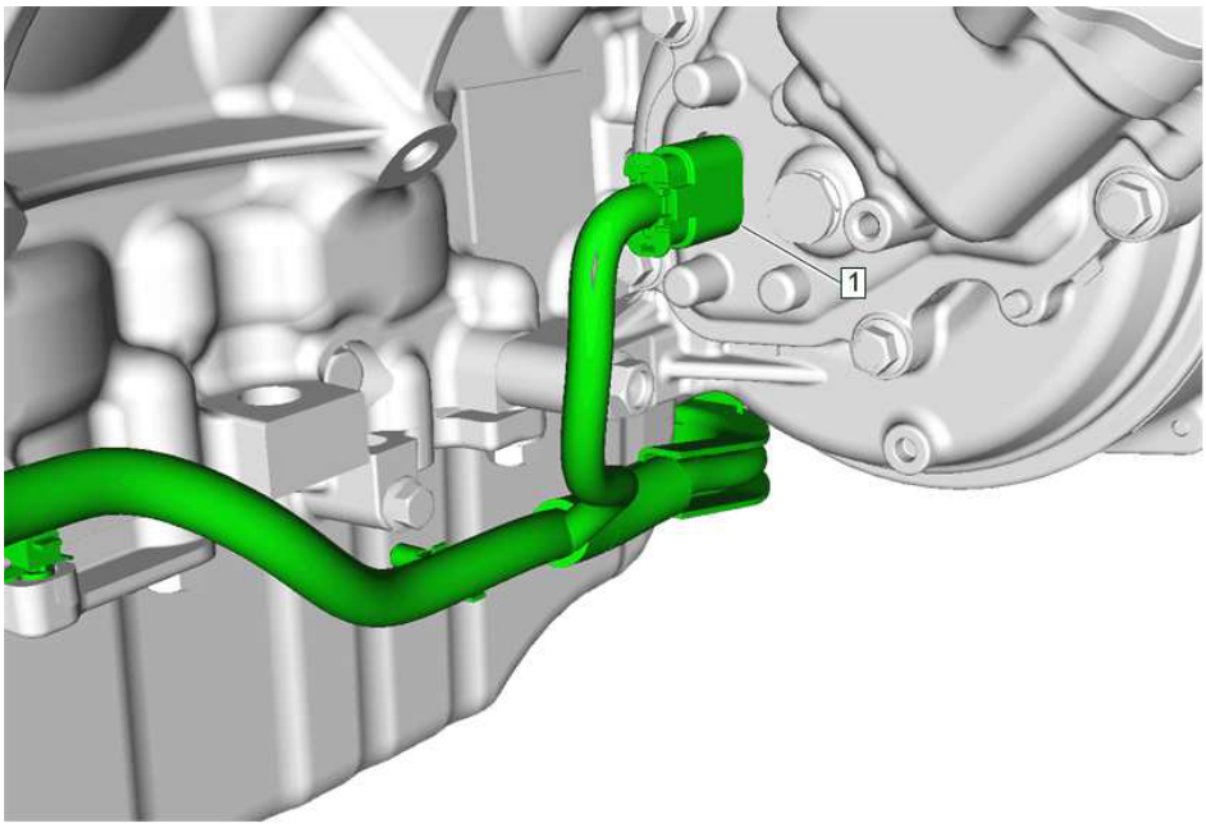


Fig. 7: Harness Connector

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Courtesy of GENERAL MOTORS COMPANY

9. Harness Connector 1 -Disconnect
10. Steering Gear Skid Shield-Remove - **Steering Gear Skid Shield Replacement**

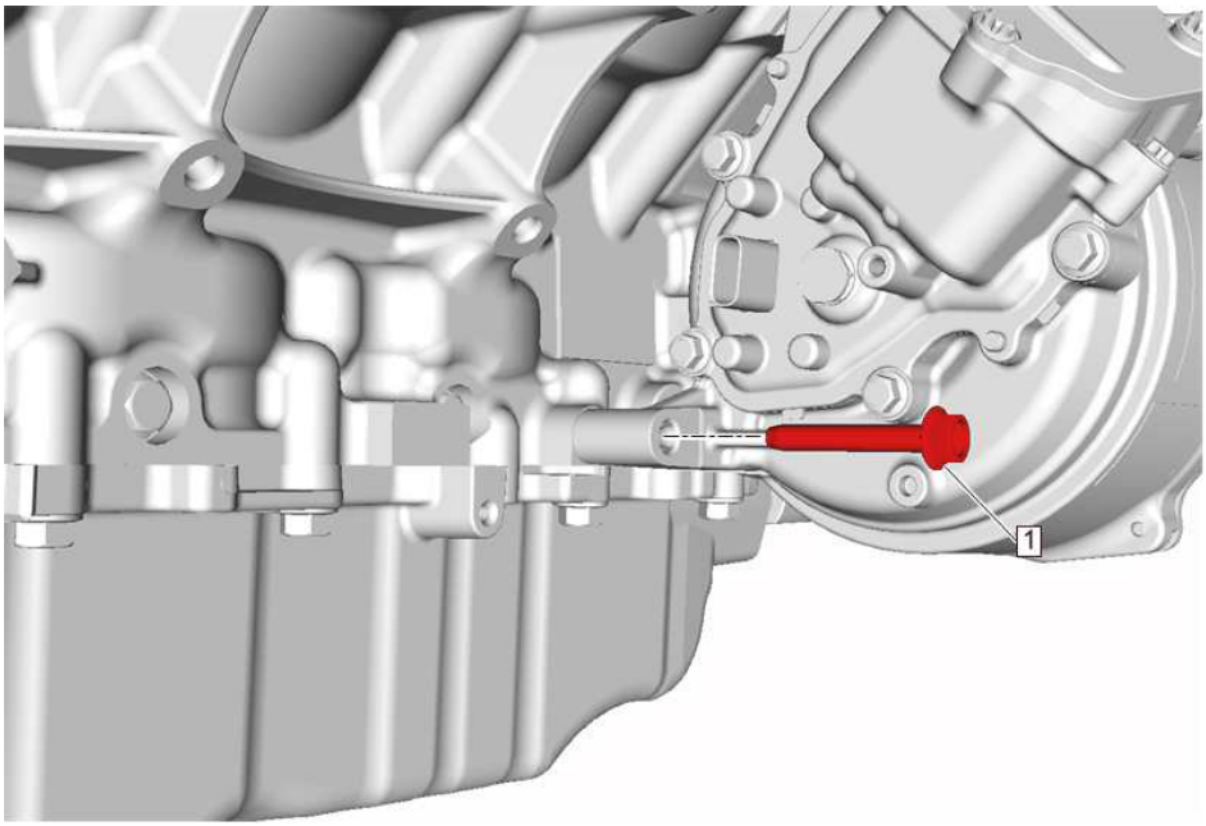


Fig. 8: Generator Bolt
Courtesy of GENERAL MOTORS COMPANY

11. Generator Bolt 1 -Remove and DISCARD

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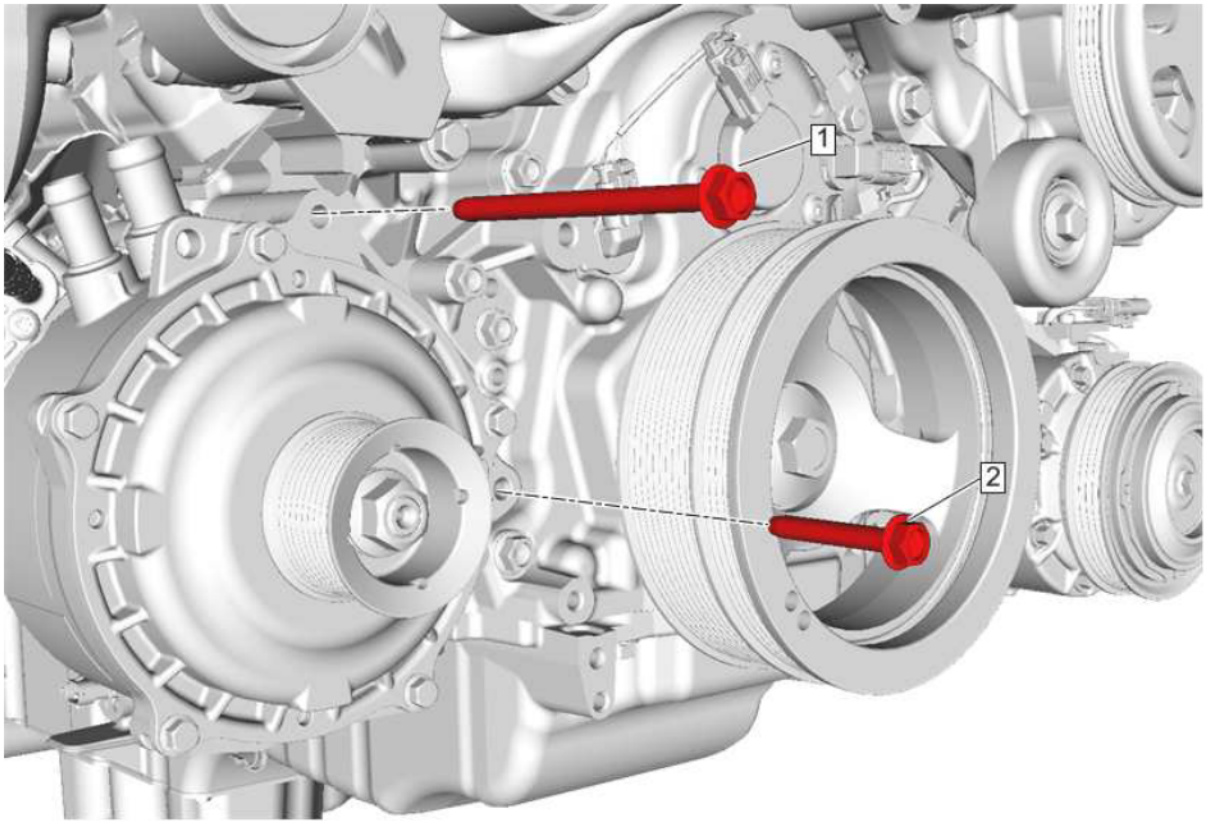


Fig. 9: Generator Bolt
Courtesy of GENERAL MOTORS COMPANY

12. Generator Bolt (1, 2) -Remove and DISCARD

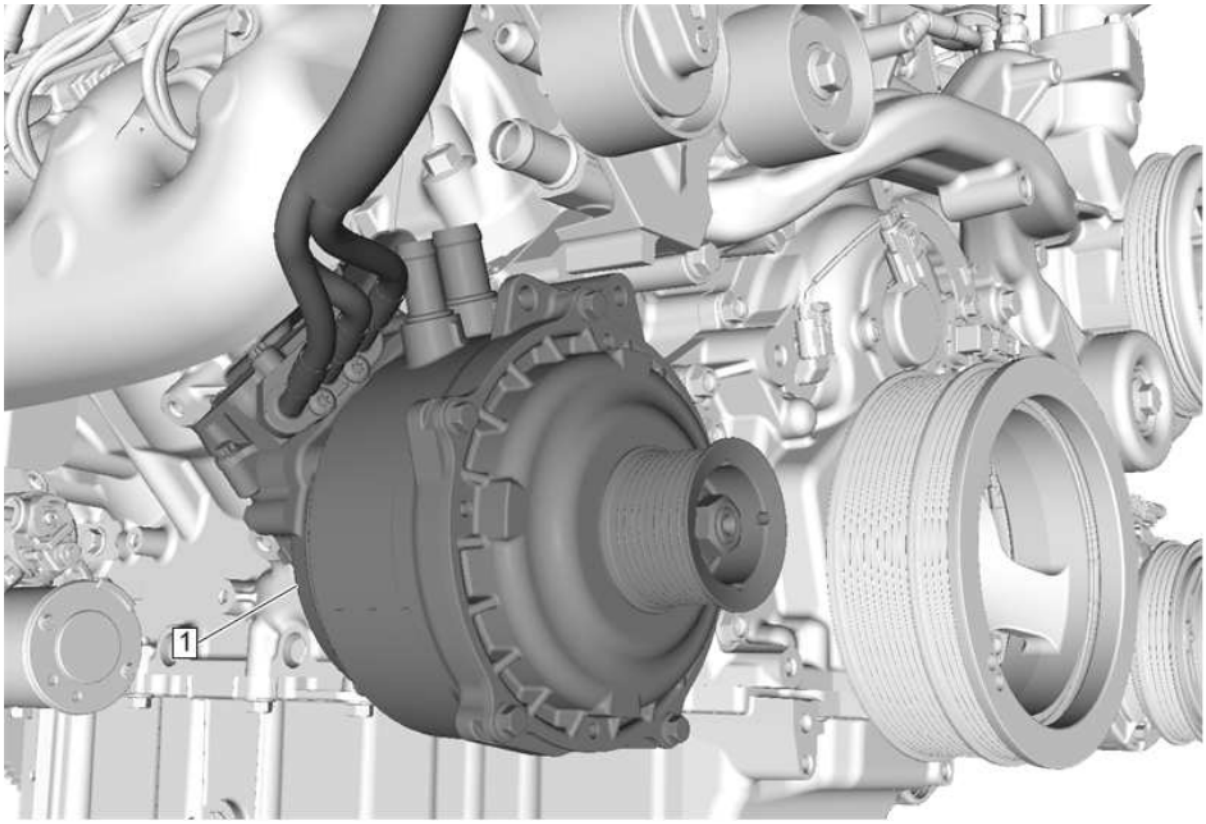


Fig. 10: Starter Generator

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Courtesy of GENERAL MOTORS COMPANY

13. Generator 1 -Remove

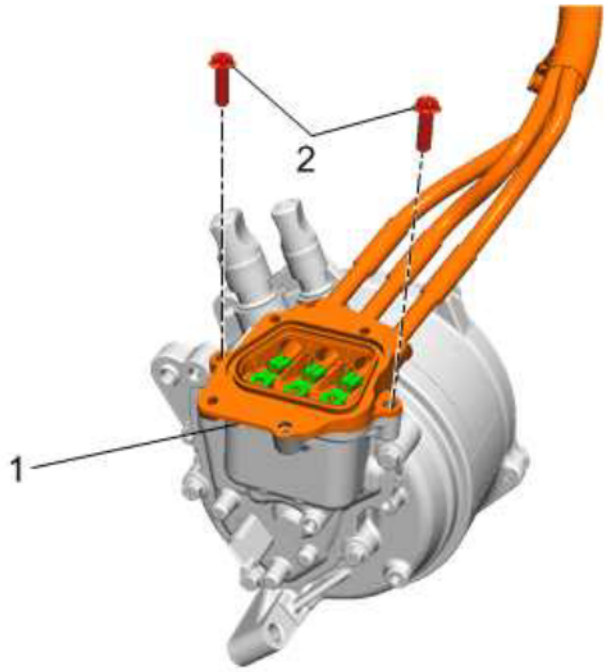


Fig. 11: Generator Control Module 3--Phase Cable
Courtesy of GENERAL MOTORS COMPANY

14. Generator Control Module 3-Phase Cable 1 -Remove - **Generator Control Module 3-Phase Cable Assembly Replacement**

Installation Procedure

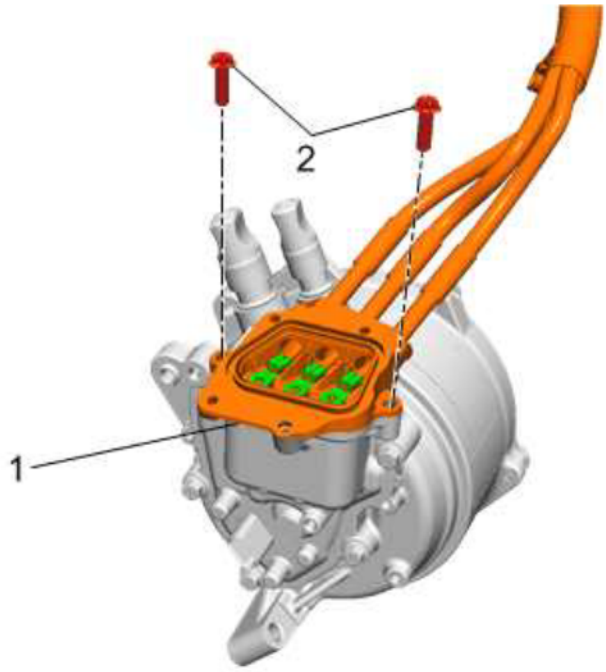


Fig. 12: Generator Control Module 3--Phase Cable

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Courtesy of GENERAL MOTORS COMPANY

1. Generator Control Module 3-Phase Cable 1 -Install - **Generator Control Module 3-Phase Cable Assembly Replacement**

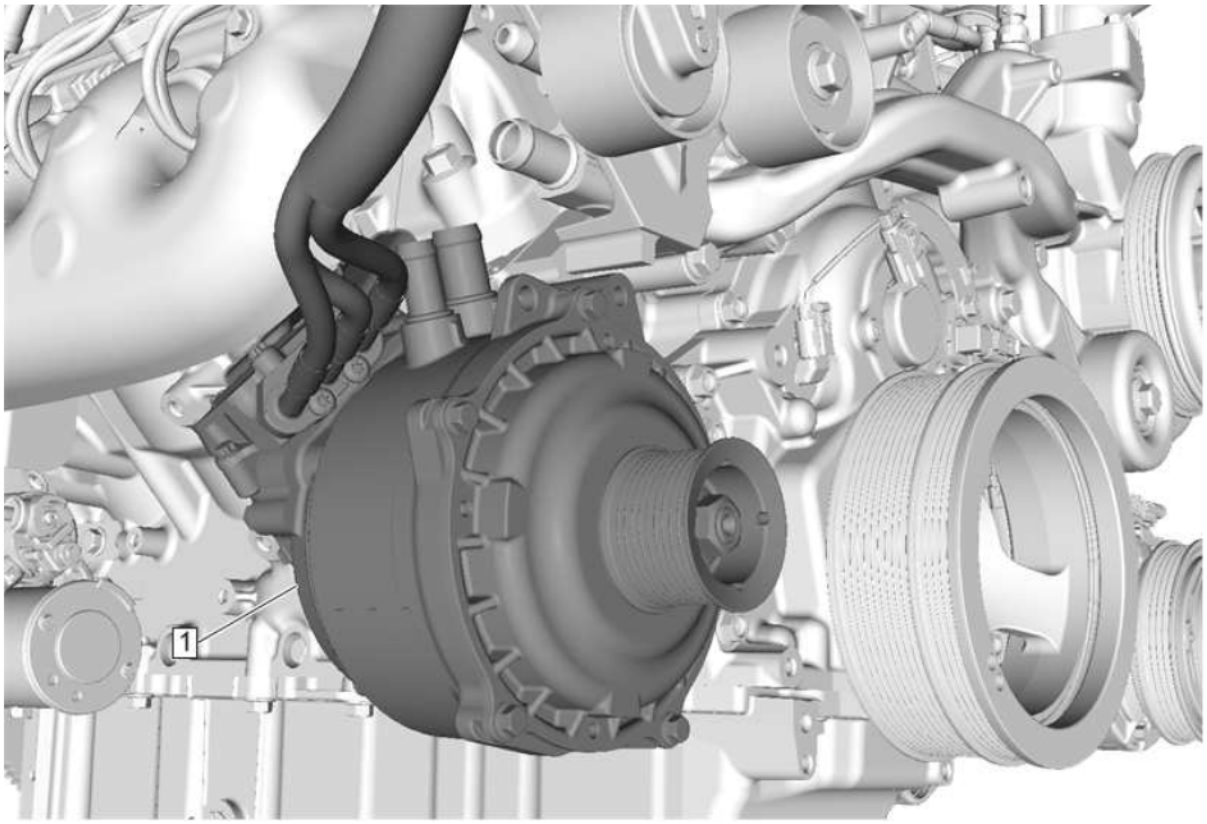


Fig. 13: Starter Generator
Courtesy of GENERAL MOTORS COMPANY

2. Generator 1 -Install

CAUTION: **Refer to Fastener Caution**

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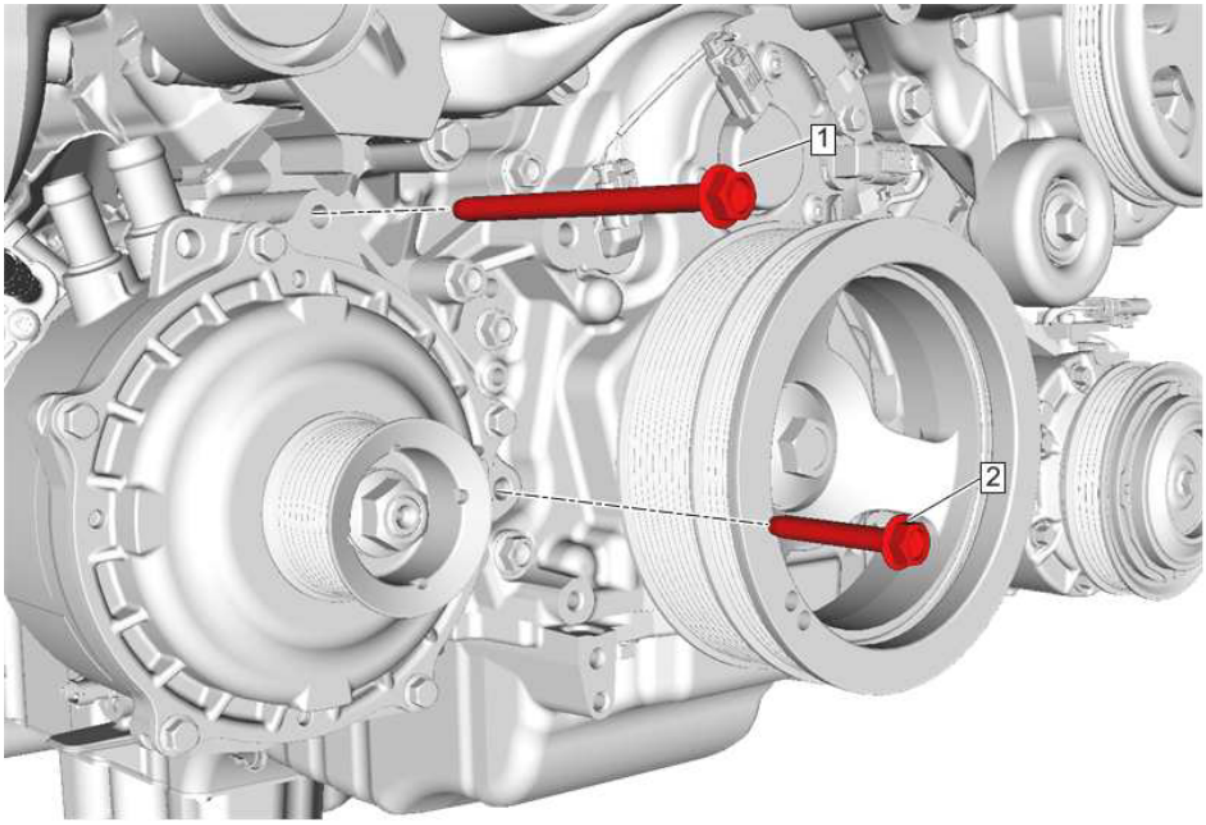


Fig. 14: Generator Bolt
Courtesy of GENERAL MOTORS COMPANY

3. Generator Bolt (1, 2) -Install NEW

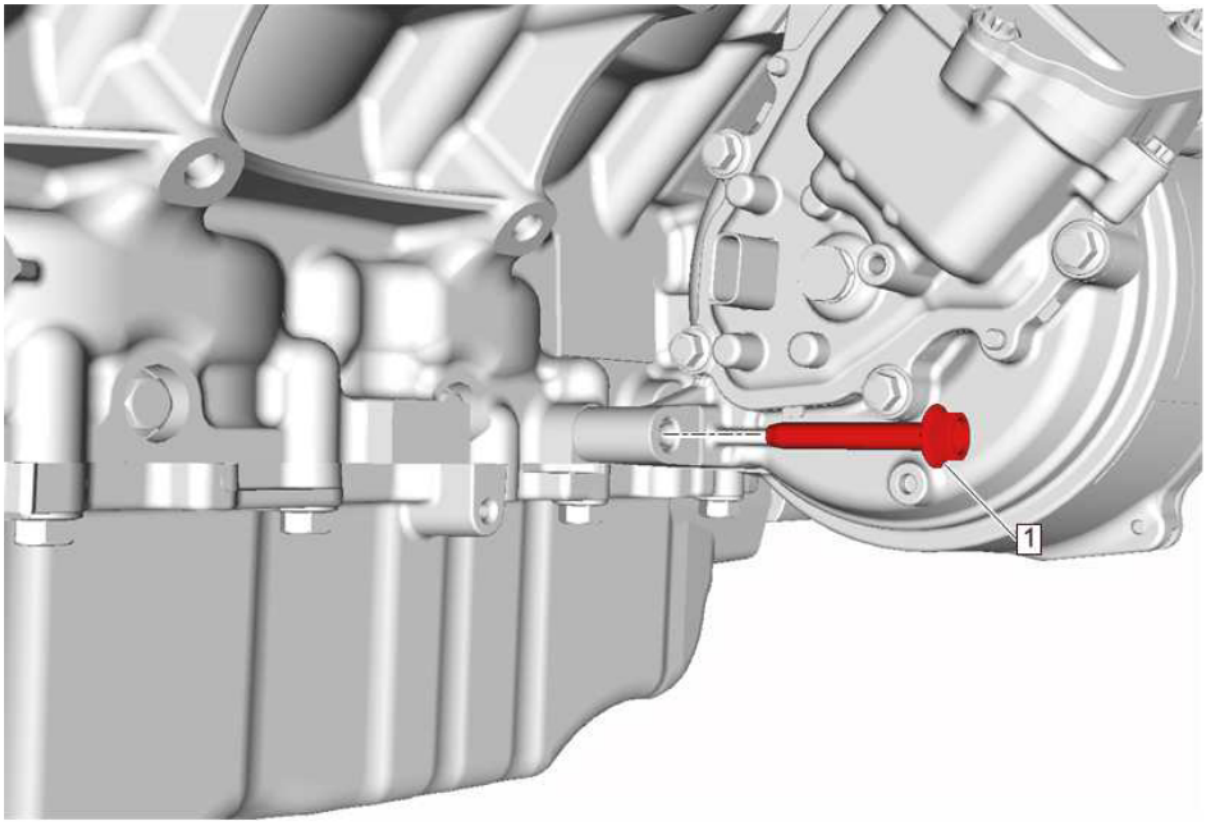


Fig. 15: Generator Bolt

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Courtesy of GENERAL MOTORS COMPANY

4. Generator Bolt 1 -Install NEW
5. Generator Bolt-Tighten 36 N.m (27 lb ft)
6. Steering Gear Skid Shield-Install - **Steering Gear Skid Shield Replacement**

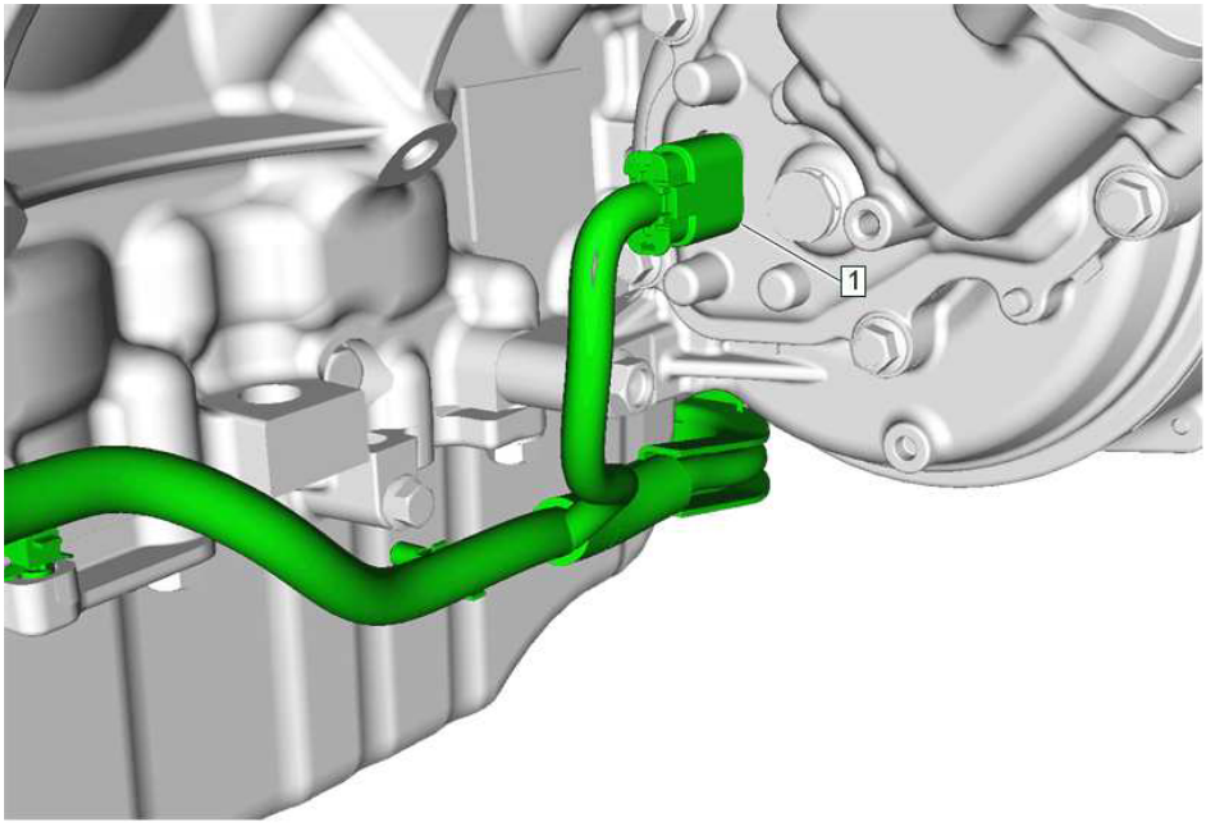


Fig. 16: Harness Connector
Courtesy of GENERAL MOTORS COMPANY

7. Harness Connector 1 -Connect

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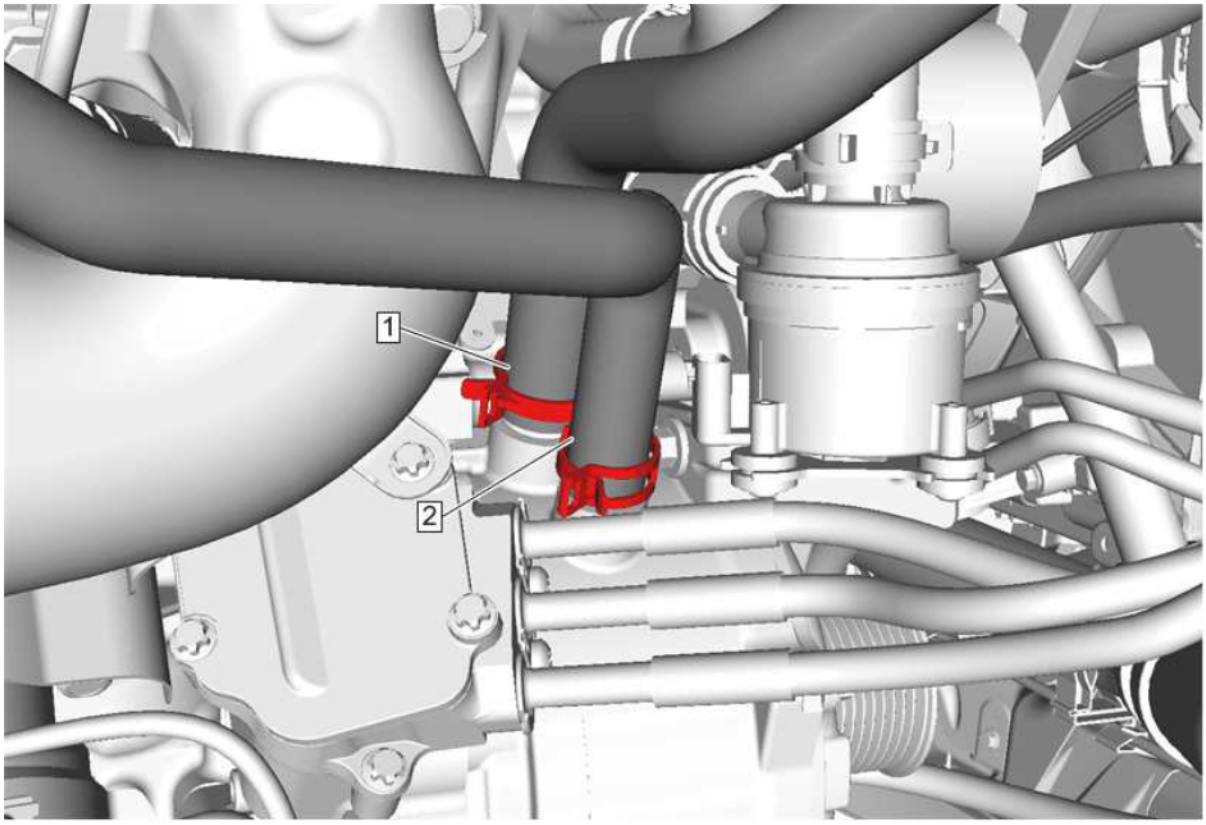


Fig. 17: Coolant Hose
Courtesy of GENERAL MOTORS COMPANY

8. Coolant Hose (1, 2) -Install @Generator - **Hose Clamp Replacement Guidelines - Spring Type**
9. Front Wheelhouse Liner - Right Side-Install - **Front Wheelhouse Liner Replacement - Right Side**

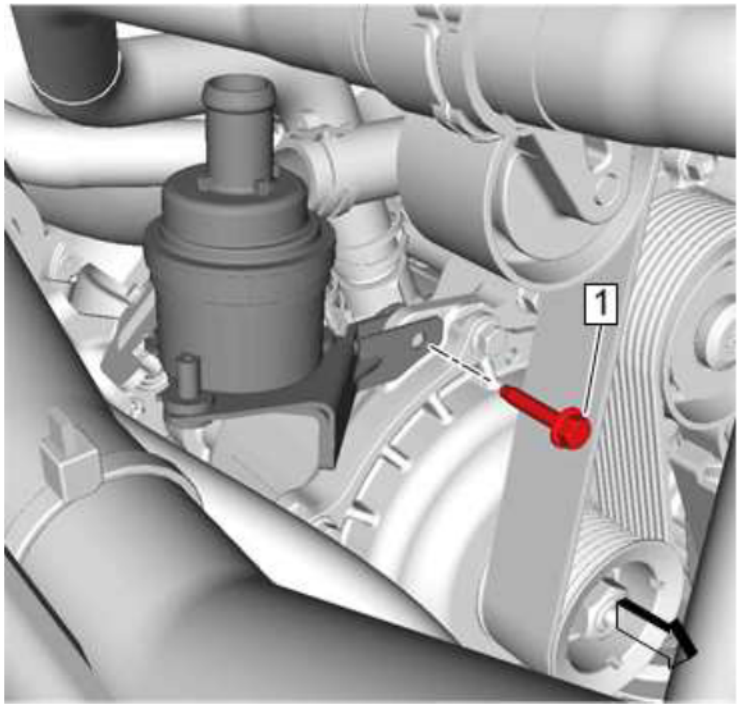


Fig. 18: Engine Coolant Heater Pump Bracket Bolt
Courtesy of GENERAL MOTORS COMPANY

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10. Engine Coolant Heater Pump Bracket Bolt 1 -Install - **Auxiliary Water Pump Replacement (L8B)**
11. Drive Belt Tensioner-Install - **Drive Belt Tensioner Replacement - Accessory (L8B Lower)** **Drive Belt Tensioner Replacement - Accessory (L8B Upper)**

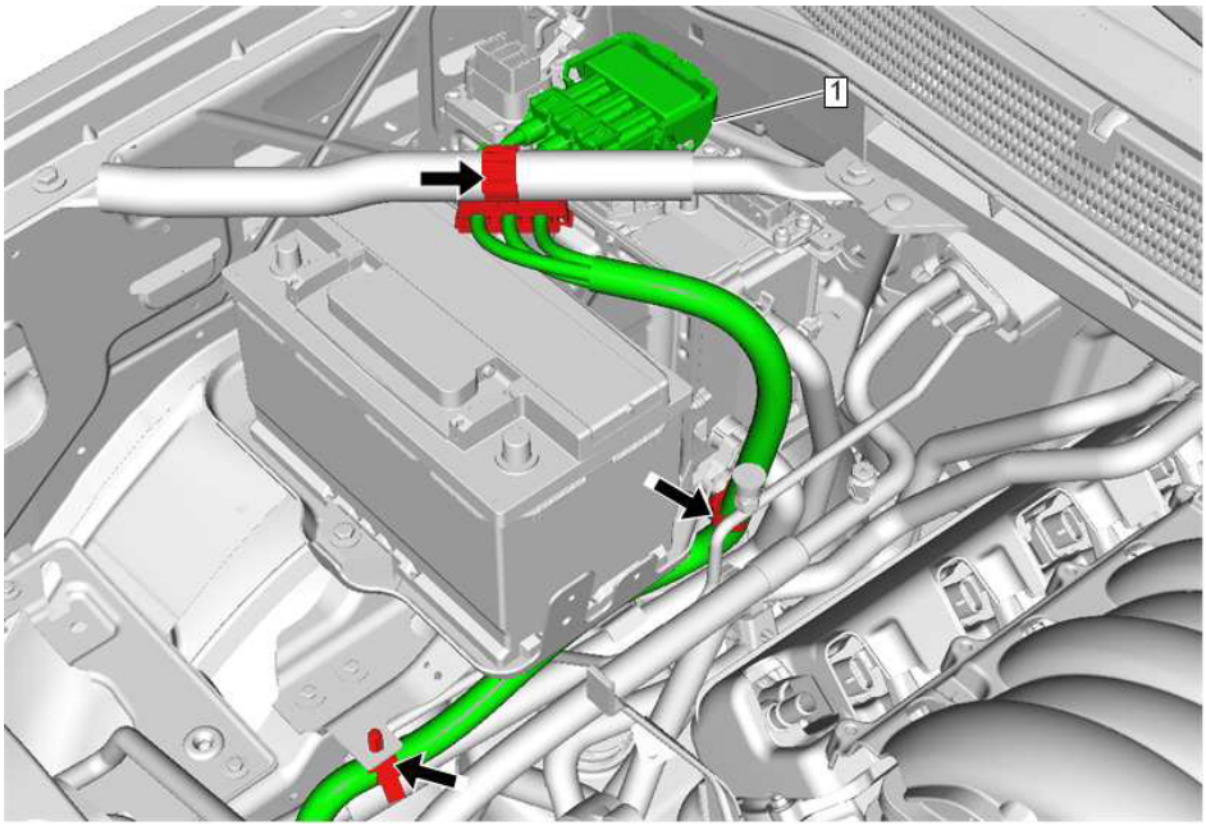


Fig. 19: Harness Retainers
Courtesy of GENERAL MOTORS COMPANY

12. Attach the harness retainers where indicated.
13. Harness Connector 1 -Connect
14. Fill the cooling system to the proper level. **Cooling System Draining and Filling (Vac N Fill L8B)**
15. Enable the high voltage system. **High Voltage Enabling**

GENERATOR CONTROL MODULE 3-PHASE CABLE ASSEMBLY REPLACEMENT

WARNING: Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.

WARNING: Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:

- **Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.**

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Failure to follow the procedure exactly as written may result in serious injury or death.

Removal Procedure

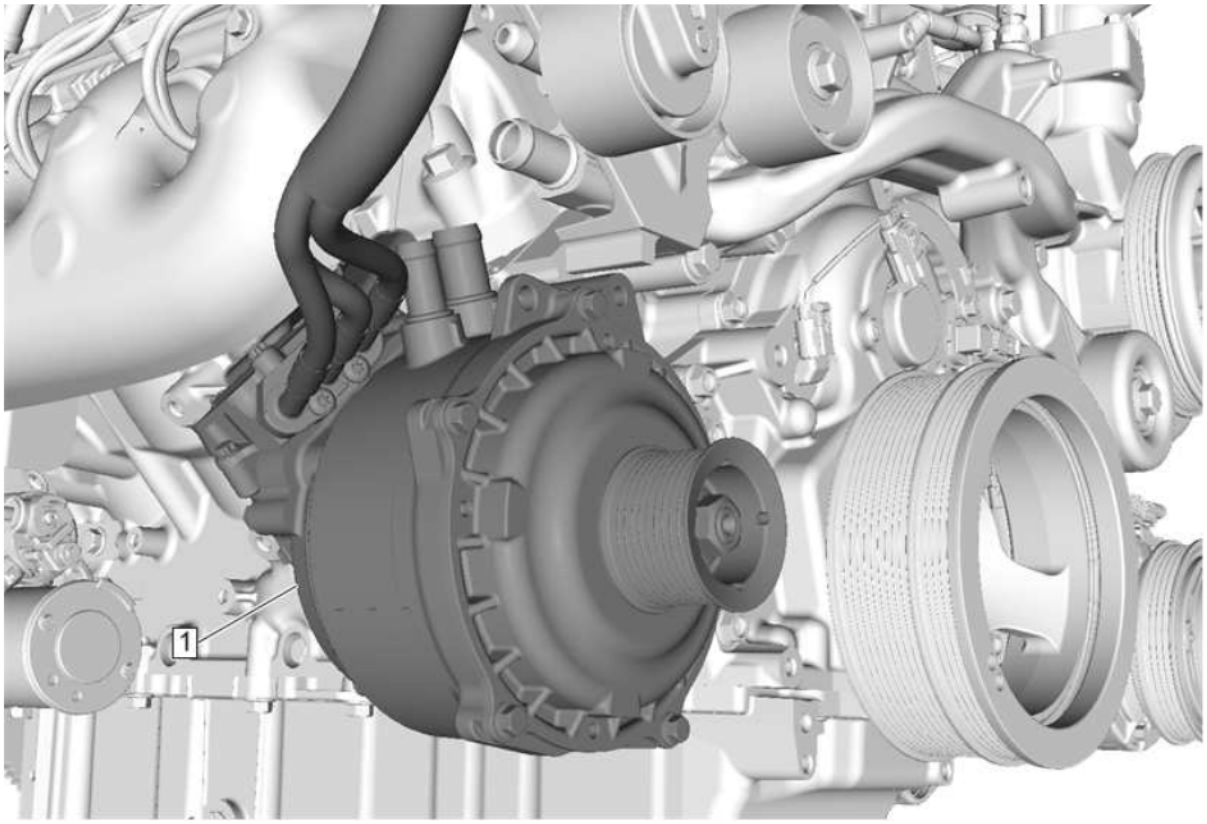


Fig. 20: Starter Generator
Courtesy of GENERAL MOTORS COMPANY

1. Starter Generator 1 -Remove - **Starter Generator Replacement**



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Fig. 21: Heat Shield Bolt
Courtesy of GENERAL MOTORS COMPANY

2. Heat Shield Bolt 1 -Remove
3. Heat Shield 2 -Remove

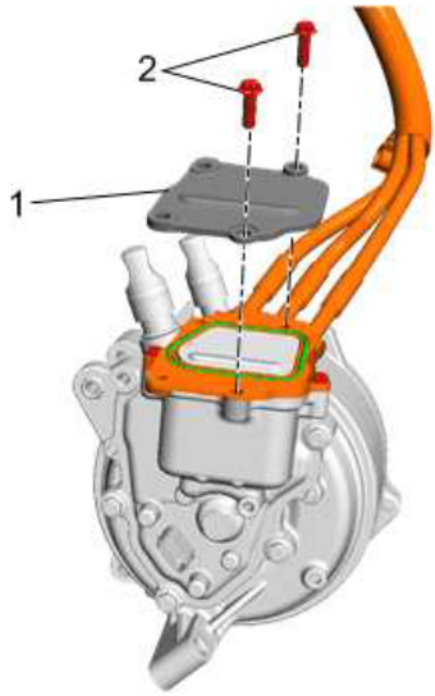
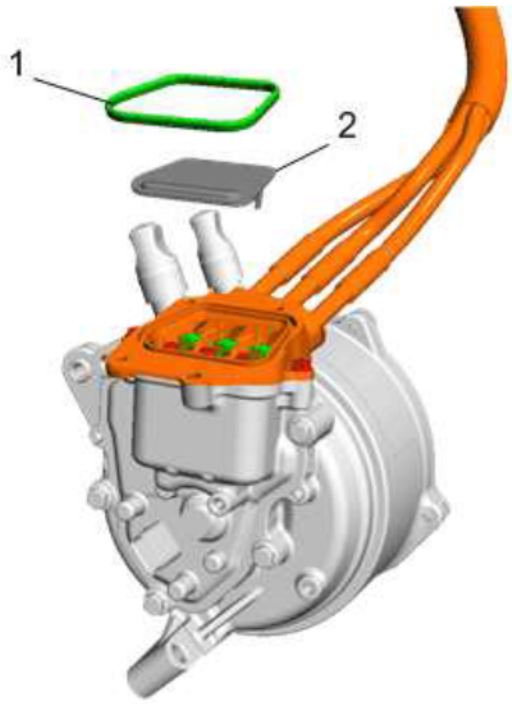


Fig. 22: Cover Bolt
Courtesy of GENERAL MOTORS COMPANY

4. Cover Bolt 2 -Remove
5. Cover 1 -Remove



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Fig. 23: Terminal Cover Seal And Dust Cover
Courtesy of GENERAL MOTORS COMPANY

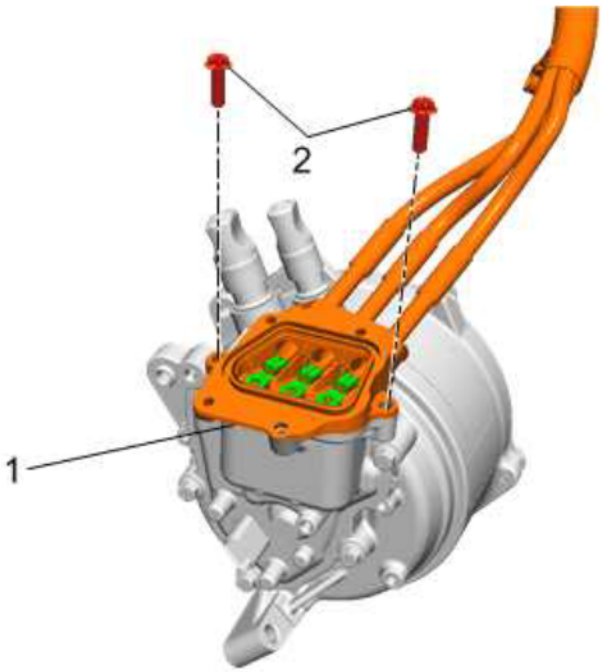
NOTE: **Clean and inspect the seal for damage.**

6. Terminal Cover Seal 1 -Remove
7. Dust Cover 2 -Remove



Fig. 24: Generator Control Module 3 Phase Cable Terminal Bolt
Courtesy of GENERAL MOTORS COMPANY

8. Generator Control Module 3 Phase Cable Terminal Bolt 1 -Remove



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Fig. 25: Generator Control Module 3--Phase Cable
Courtesy of GENERAL MOTORS COMPANY

9. Generator Control Module 3 Phase Cable Mounting Bolt 2 -Remove
10. Generator Control Module 3 Phase Cable 1 -Remove

Installation Procedure

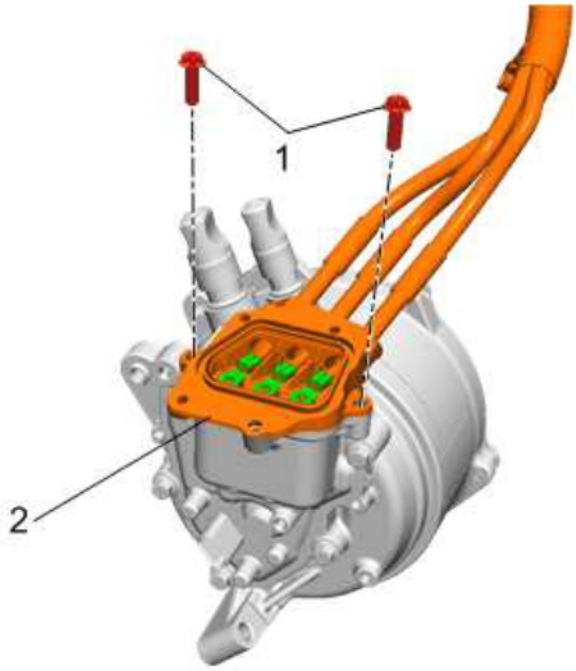


Fig. 26: Generator Control Module 3 Phase Cable
Courtesy of GENERAL MOTORS COMPANY

1. Generator Control Module 3 Phase Cable 2 -Install
2. Loosely install the generator control module 3 phase cable mounting bolts. 1

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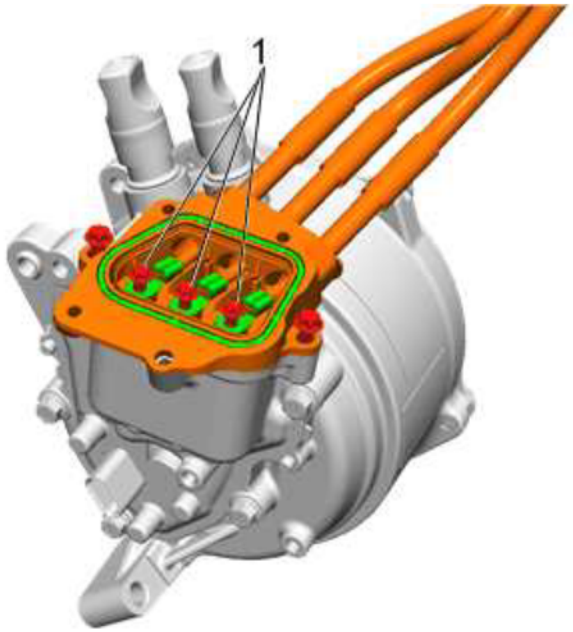


Fig. 27: Generator Control Module 3 Phase Cable Terminal Bolts
Courtesy of GENERAL MOTORS COMPANY

3. Loosely install the generator control module 3 phase cable terminal bolts. 1

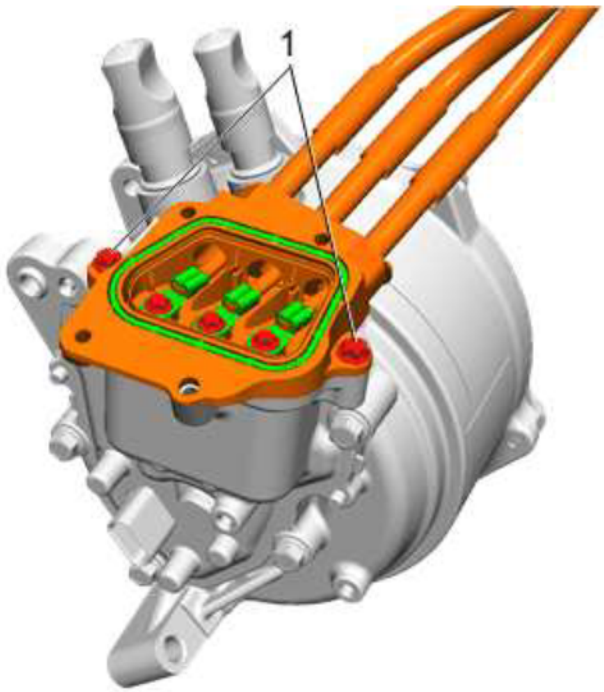


Fig. 28: Generator Control Module 3 Phase Cable Mounting Bolt
Courtesy of GENERAL MOTORS COMPANY

CAUTION: **Refer to Fastener Caution**

4. Generator Control Module 3 Phase Cable Mounting Bolt 1 -Tighten 9 N.m (80 lb in)

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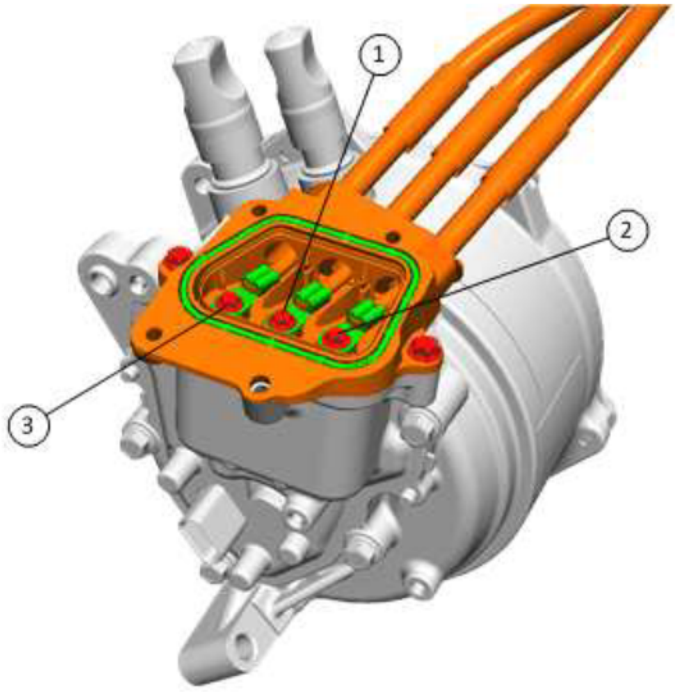


Fig. 29: Control Module 3 Phase Cable Bolt Tightening Sequence
Courtesy of GENERAL MOTORS COMPANY

5. Tighten the bolts in the sequence shown.8 N.m (71 lb in)

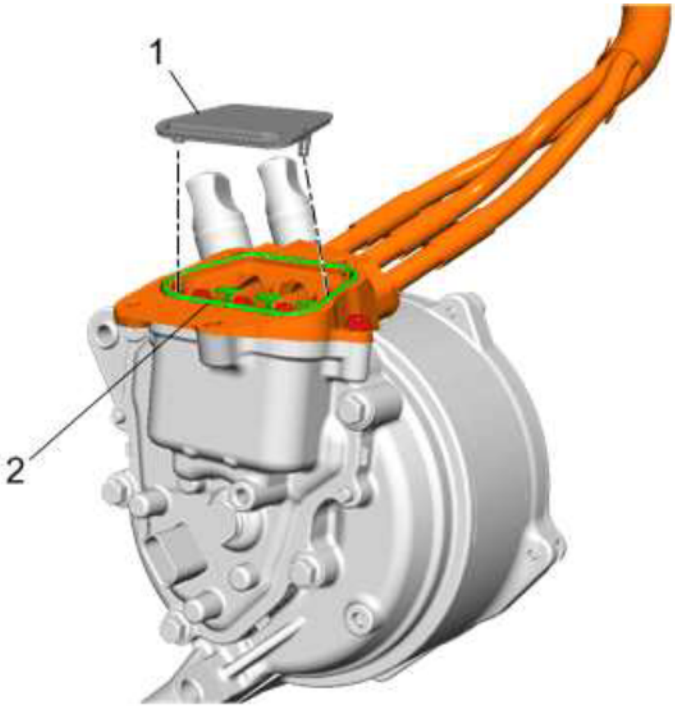


Fig. 30: Terminal Cover Seal
Courtesy of GENERAL MOTORS COMPANY

6. Terminal Cover Seal 2 -Install
7. Dust Cover 1 -Install

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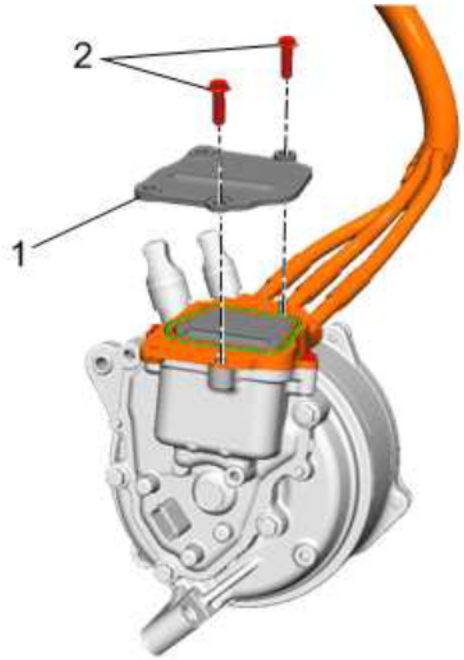


Fig. 31: Cover
Courtesy of GENERAL MOTORS COMPANY

8. Cover 1 -Install
9. Loosely install the cover bolts. 2

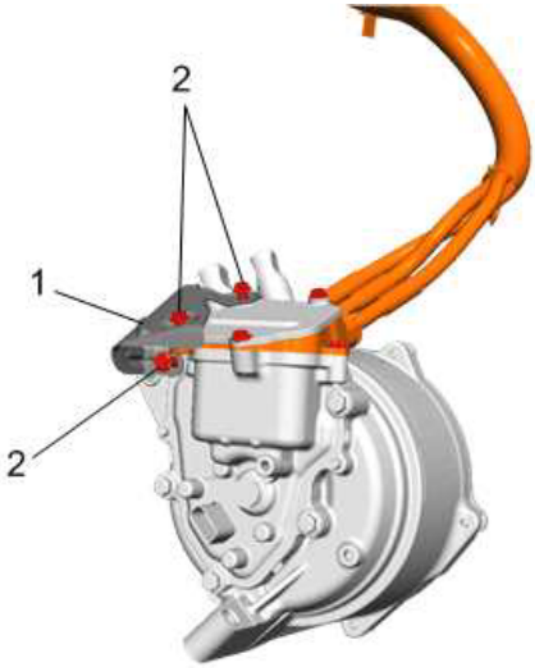


Fig. 32: Terminal Cover Seal
Courtesy of GENERAL MOTORS COMPANY

10. Heat Shield 1 -Install
11. Loosely install the heat shield bolts. 2

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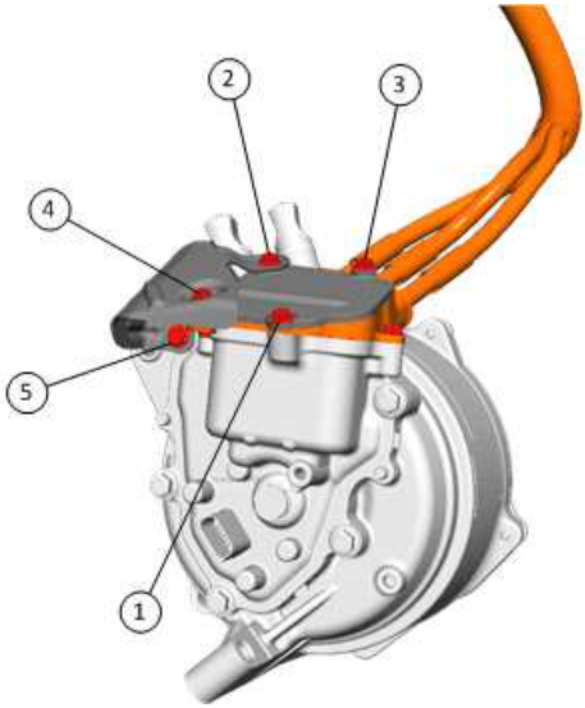


Fig. 33: Cover Bolt TIghtening Sequence
Courtesy of GENERAL MOTORS COMPANY

12. Tighten the bolts in the sequence shown.9 N.m (80 lb in)

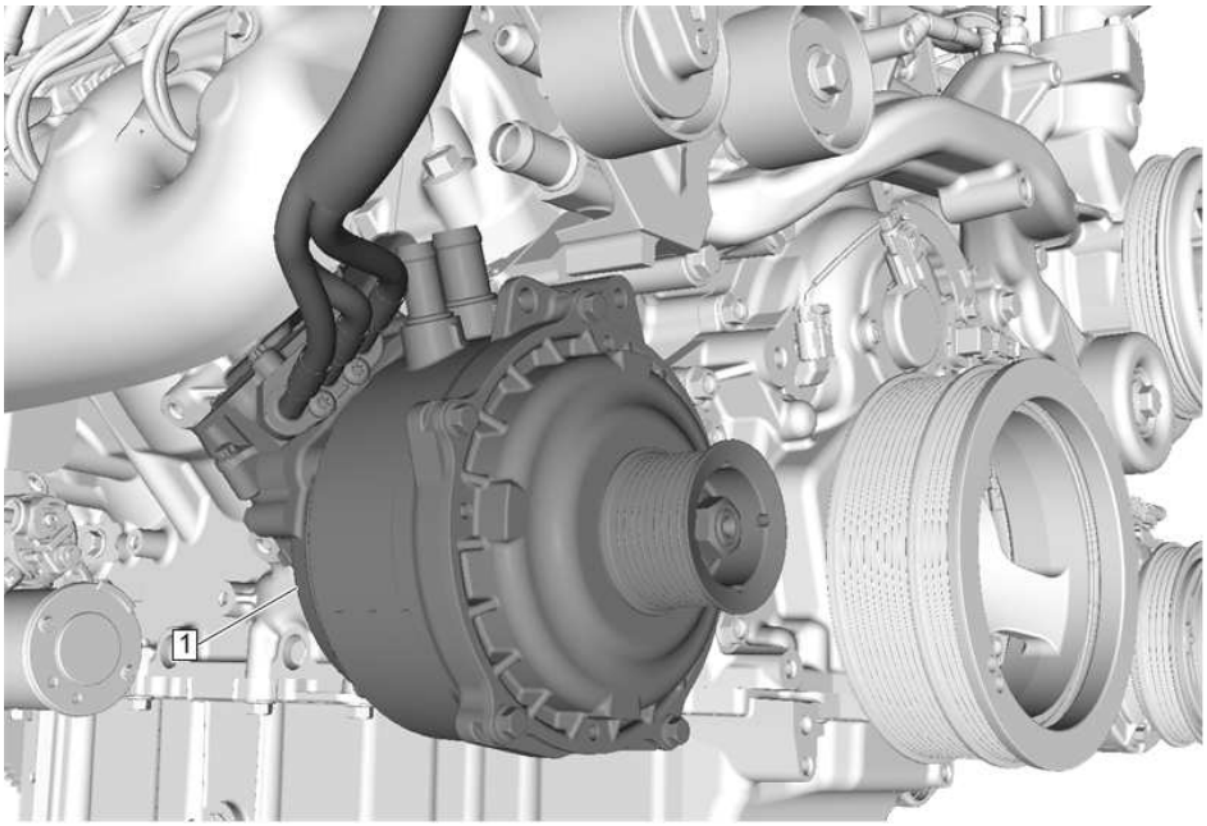


Fig. 34: Starter Generator
Courtesy of GENERAL MOTORS COMPANY

13. Starter Generator 1 - Install - **Starter Generator Replacement**

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GENERATOR CONTROL MODULE REPLACEMENT

WARNING: **Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.**

WARNING: **Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:**

- **Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedure exactly as written may result in serious injury or death.

Removal Procedure

1. Disable the high voltage system. **High Voltage Disabling**

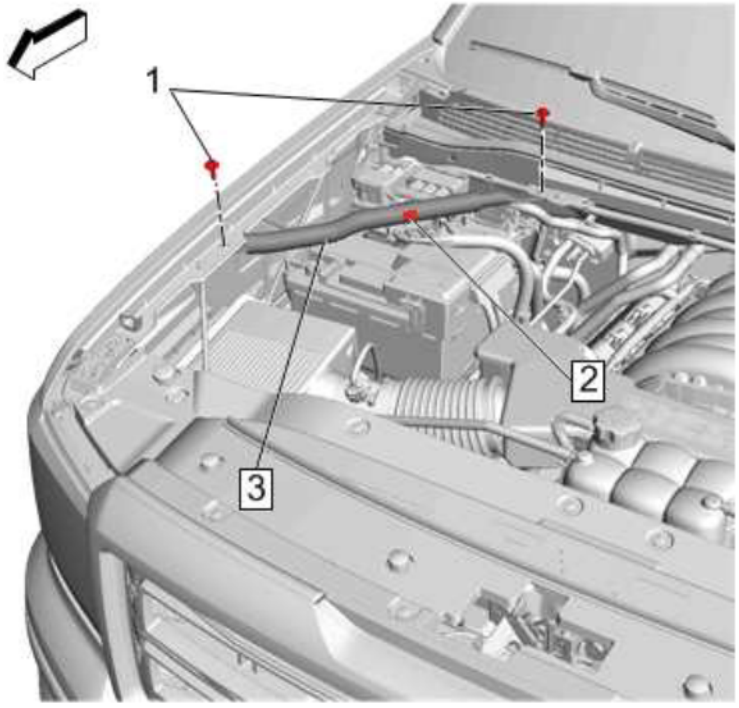


Fig. 35: Front End Sheet Metal Diagonal Brace
Courtesy of GENERAL MOTORS COMPANY

2. Front End Sheet Metal Diagonal Brace Bolt 1 -Remove
3. Retainer Clip 2 -Disengage
4. Front End Sheet Metal Diagonal Brace 3 -Remove

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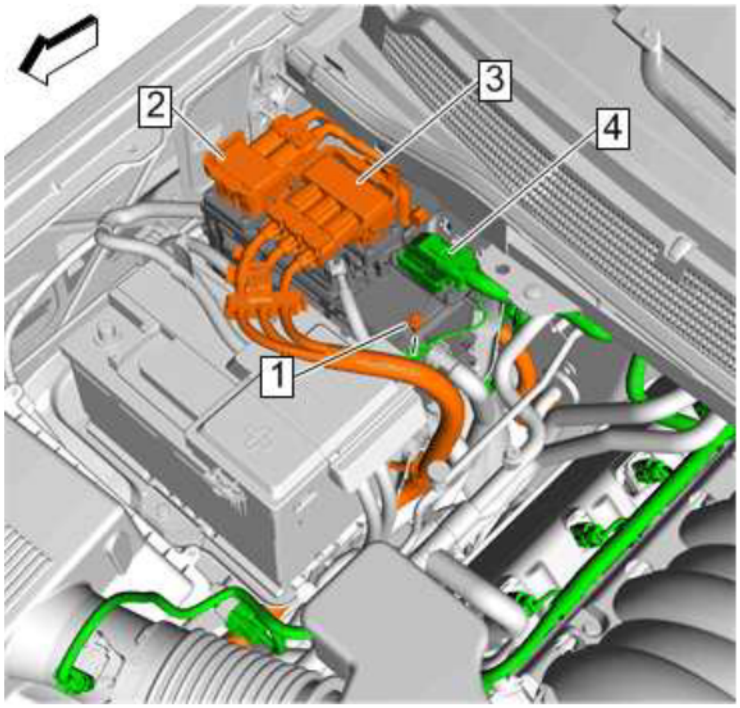


Fig. 36: High Voltage Battery Pack Positive Cable And Starter Generator High Voltage Cable
Courtesy of GENERAL MOTORS COMPANY

5. High Voltage Battery Pack Positive Cable Connector 2 -Disconnect
6. Starter Generator High Voltage Cable Connector 3 -Disconnect
7. Electrical Connector 4 -Disconnect
8. Ground Terminal Fastener 1 -Remove

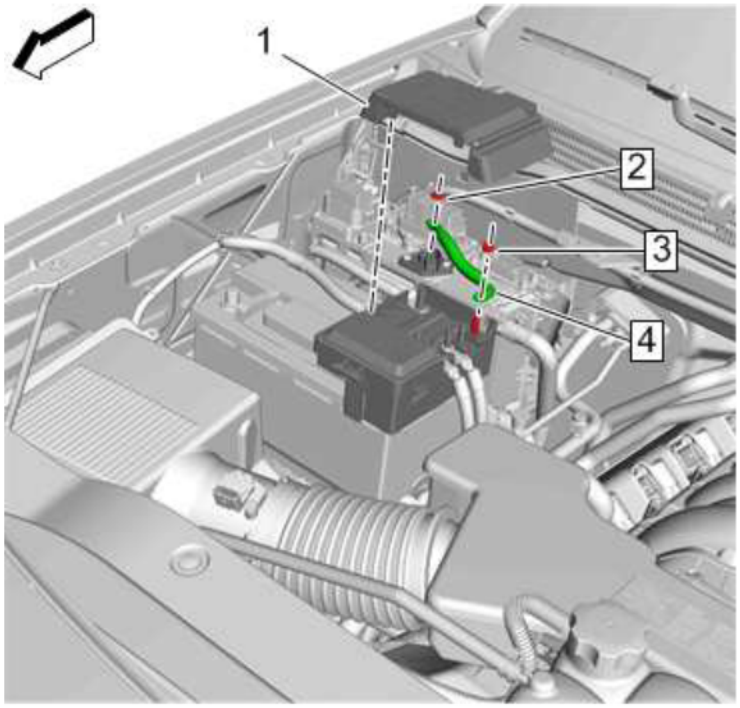


Fig. 37: Battery Positive Junction Block Cable
Courtesy of GENERAL MOTORS COMPANY

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9. Fuse Block Cover 1 -Remove
10. Battery Positive Junction Block Cable Nut 2 -Remove
11. Battery Distribution Engine Compartment Fuse Block Nut 3 -Remove
12. Battery Positive Junction Block Cable 4 -Remove

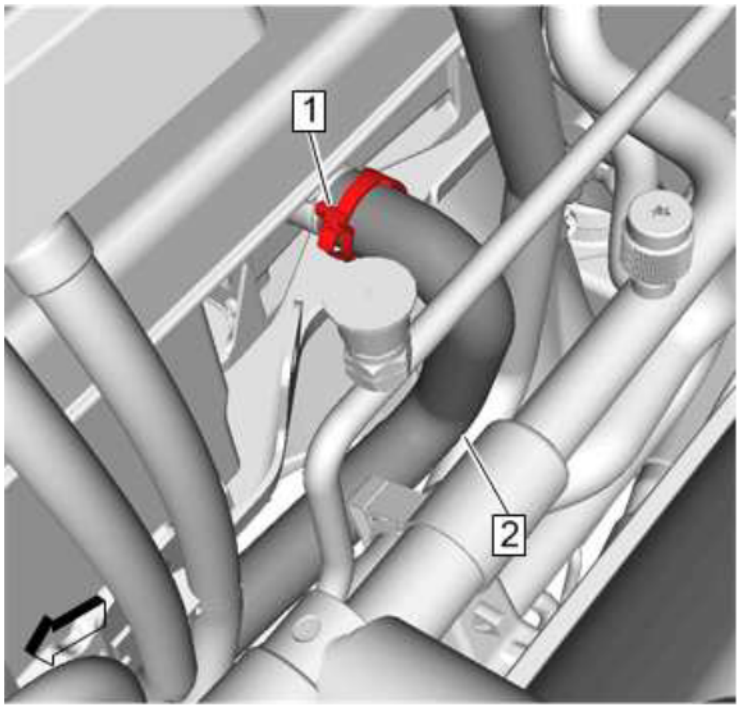
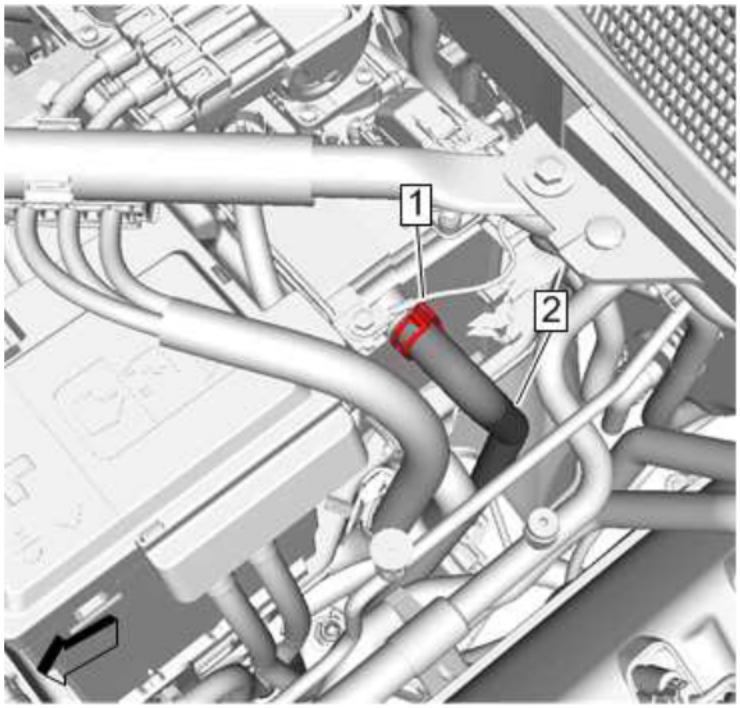


Fig. 38: Generator Control Module Coolant Tank Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

13. Generator Control Module Coolant Tank Hose 2 @Generator Control Module-Disengage - **Generator Control Module Coolant Tank Hose Replacement (Bottom L8B)** **Generator Control Module Coolant Tank Hose Replacement (Low Temp Radiator to Generator Control Module L8B)**



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Fig. 39: Generator Control Module Coolant Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

14. Generator Control Module Coolant Outlet Hose 2 @Generator Control Module-Disengage - **Generator Control Module Coolant Outlet Hose Replacement (Starter Generator to Generator Control Module L8B)** **Generator Control Module Coolant Outlet Hose Replacement (Starter Generator to Drive Motor Battery Surge Tank Inlet Hose L8B)**

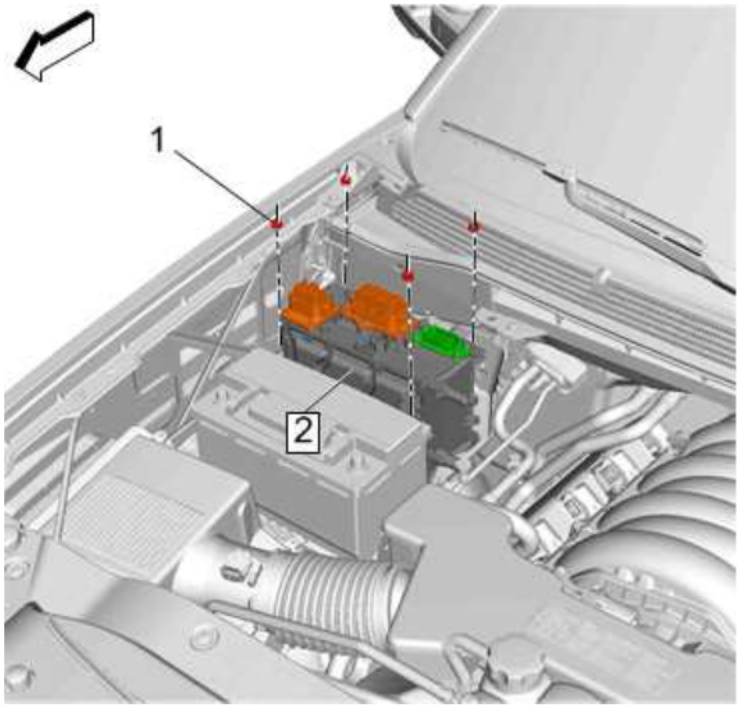


Fig. 40: Generator Control Module
Courtesy of GENERAL MOTORS COMPANY

15. Generator Control Module Mounting Nut 1 -Remove
16. Generator Control Module 2 -Remove

Installation Procedure

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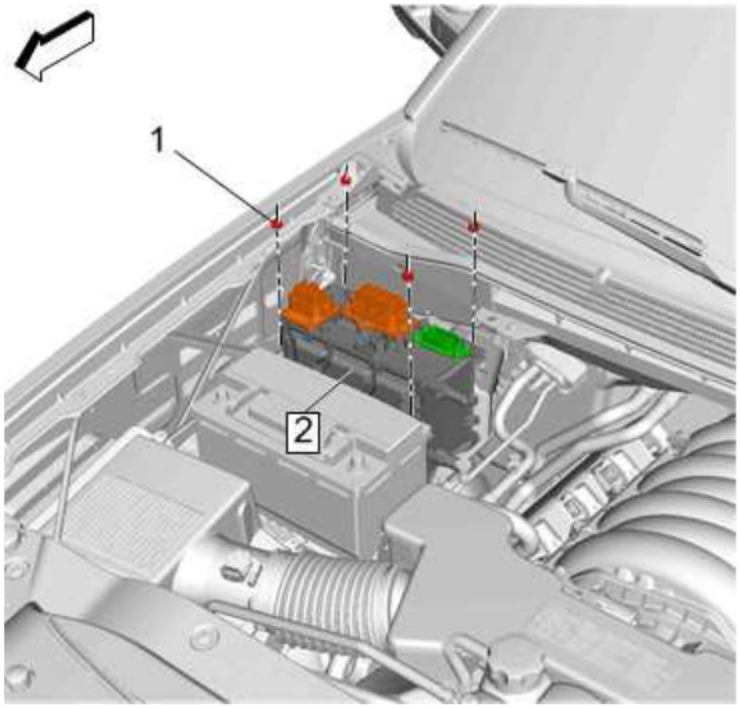


Fig. 41: Generator Control Module
Courtesy of GENERAL MOTORS COMPANY

1. Generator Control Module 2 -Install

CAUTION: **Refer to Fastener Caution**

2. Generator Control Module Mounting Nut 1 -Install and tighten 22 N.m (16 lb ft)

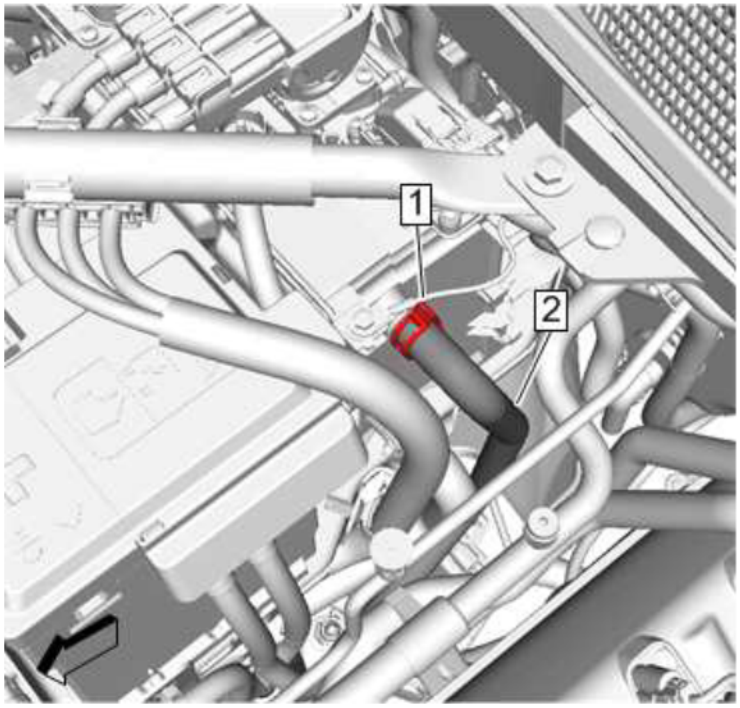


Fig. 42: Generator Control Module Coolant Outlet Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

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3. Generator Control Module Coolant Outlet Hose 2 @Generator Control Module-Engage - **Generator Control Module Coolant Outlet Hose Replacement (Starter Generator to Generator Control Module L8B)** **Generator Control Module Coolant Outlet Hose Replacement (Starter Generator to Drive Motor Battery Surge Tank Inlet Hose L8B)**

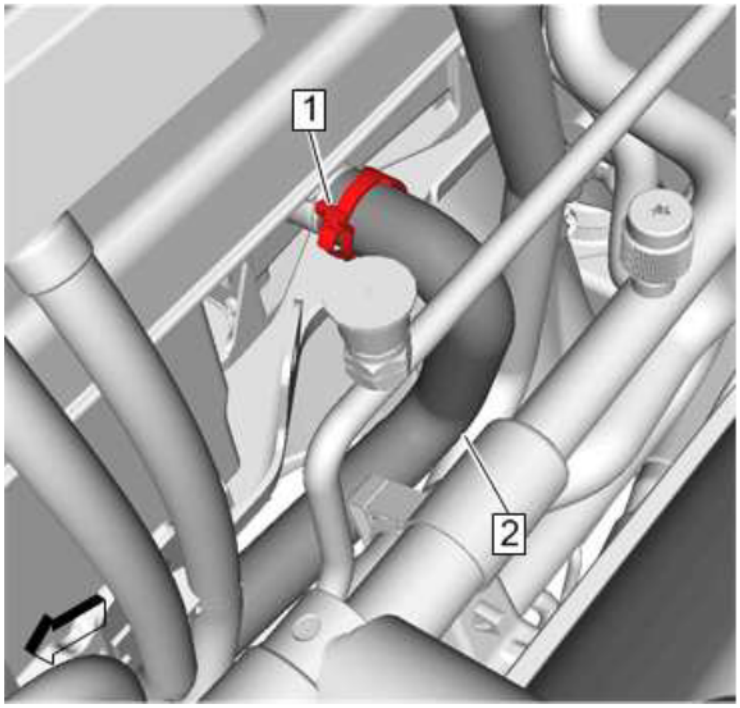
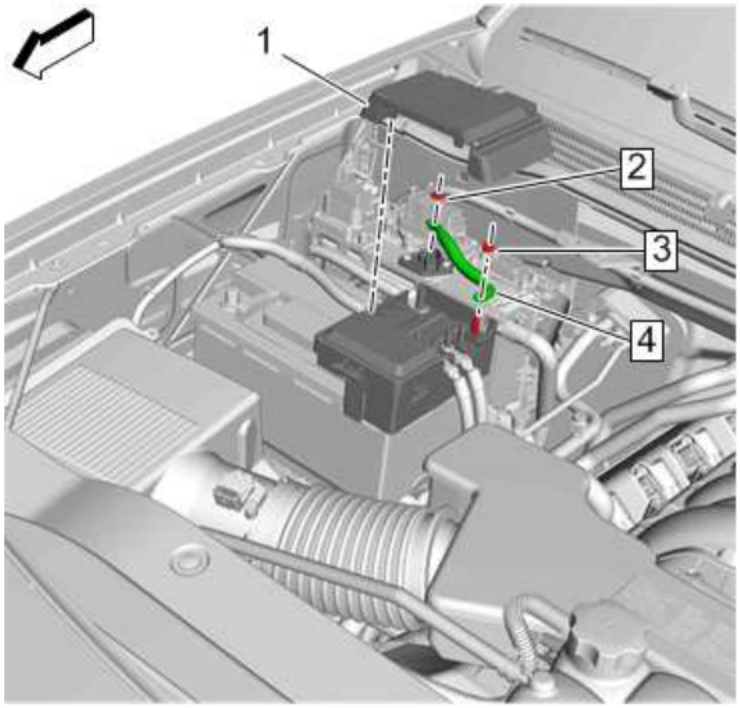


Fig. 43: Generator Control Module Coolant Tank Hose Clamp
Courtesy of GENERAL MOTORS COMPANY

4. Generator Control Module Coolant Tank Hose 2 @Generator Control Module-Engage - **Generator Control Module Coolant Tank Hose Replacement (Bottom L8B)** **Generator Control Module Coolant Tank Hose Replacement (Low Temp Radiator to Generator Control Module L8B)**



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Fig. 44: Battery Positive Junction Block Cable
Courtesy of GENERAL MOTORS COMPANY

5. Battery Positive Junction Block Cable 4 -Install
6. Battery Positive Junction Block Cable Nut 2 -Install and tighten 9 N.m (80 lb in)
7. Battery Distribution Engine Compartment Fuse Block Nut 3 -Install and tighten 15 N.m (11 lb ft)
8. Fuse Block Cover 1 -Install

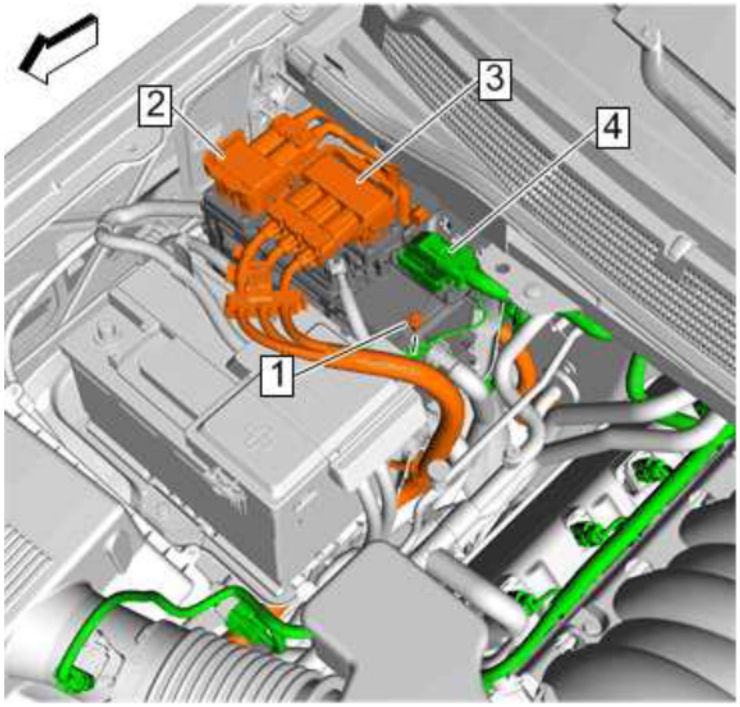


Fig. 45: High Voltage Battery Pack Positive Cable And Starter Generator High Voltage Cable
Courtesy of GENERAL MOTORS COMPANY

9. High Voltage Battery Pack Positive Cable Connector 2 -Connect
10. Starter Generator High Voltage Cable Connector 3 -Connect
11. Electrical Connector 4 -Connect
12. Ground Terminal Fastener 1 -Install and tighten 9 N.m (80 lb in)

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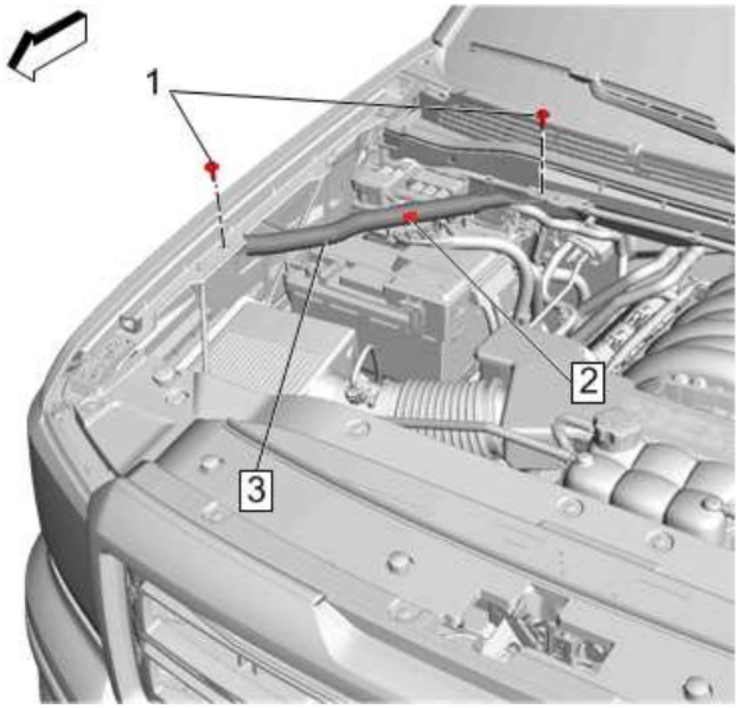


Fig. 46: Front End Sheet Metal Diagonal Brace
Courtesy of GENERAL MOTORS COMPANY

13. Front End Sheet Metal Diagonal Brace 3 -Install
14. Retainer Clip 2 -Engage
15. Front End Sheet Metal Diagonal Brace Bolt 1 -Install and tighten 25 N.m (18 lb ft)
16. Enable the high voltage system. **High Voltage Enabling**

ACCESSORY DC POWER CONTROL MODULE TRAY REPLACEMENT

WARNING: **Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.**

WARNING: **Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:**

- **Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedure exactly as written may result in serious injury or death.

Removal Procedure

1. Remove the battery. **Battery Replacement**

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2. Remove the generator control module. **Generator Control Module Replacement**
3. Remove the air cleaner assembly. **Air Cleaner Assembly Replacement**

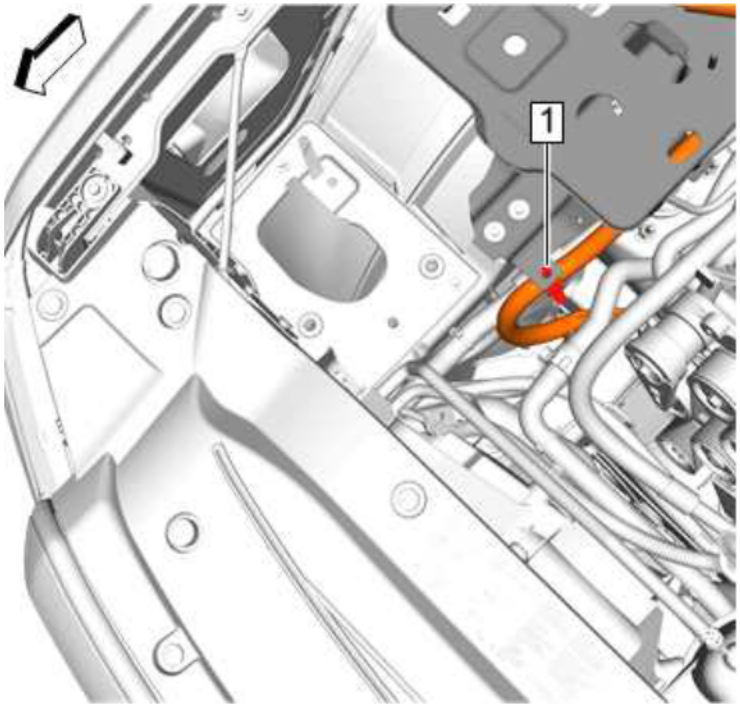


Fig. 47: Retainer
Courtesy of GENERAL MOTORS COMPANY

4. Retainer 1 -Disengage

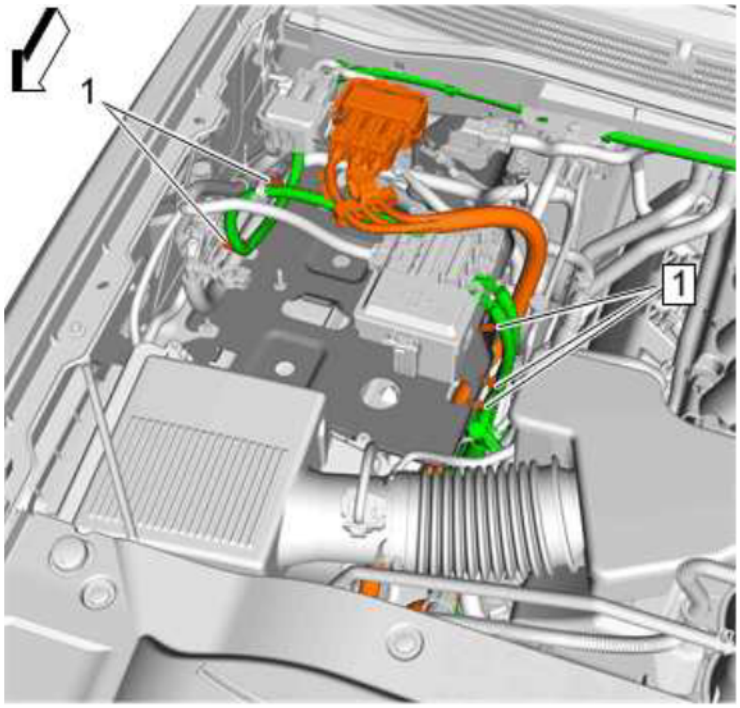


Fig. 48: Retainer
Courtesy of GENERAL MOTORS COMPANY

5. Retainer 1 -Disengage

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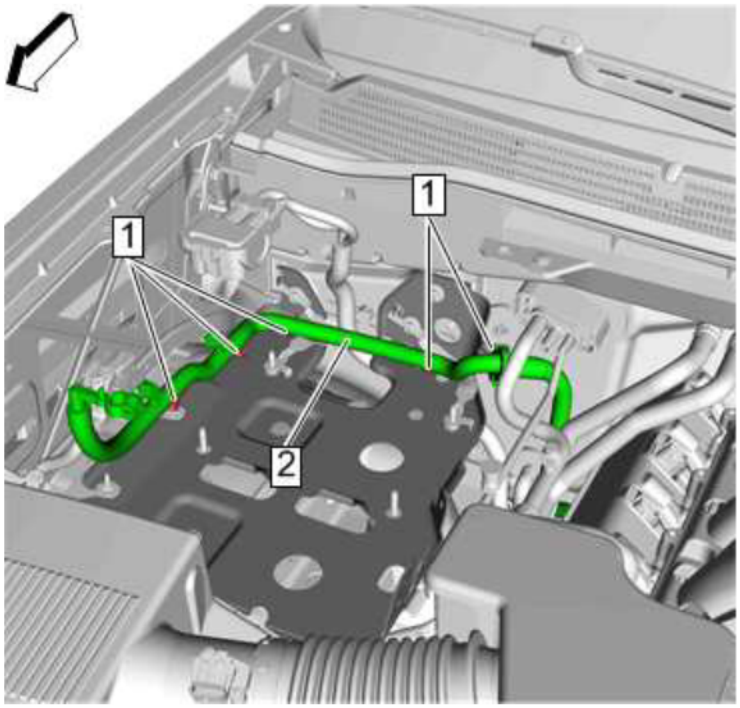


Fig. 49: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Retainer 1 -Disengage

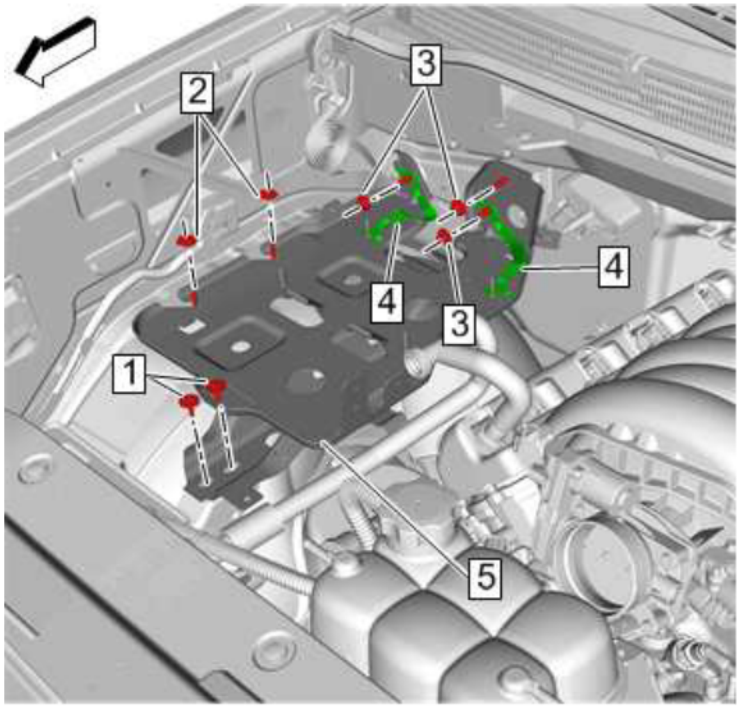


Fig. 50: Accessory DC Power Control Module Tray
Courtesy of GENERAL MOTORS COMPANY

7. Accessory DC Power Control Module Bolt 1 -Remove
8. Accessory DC Power Control Module Nut 2 -Remove
9. Accessory DC Power Control Module Nut 3 -Remove

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10. Accessory DC Power Control Module Tray 5 -Remove
11. If replacing the accessory DC power control module tray, transfer the battery negative cable extension cable straps (4) to the new tray.

Installation Procedure

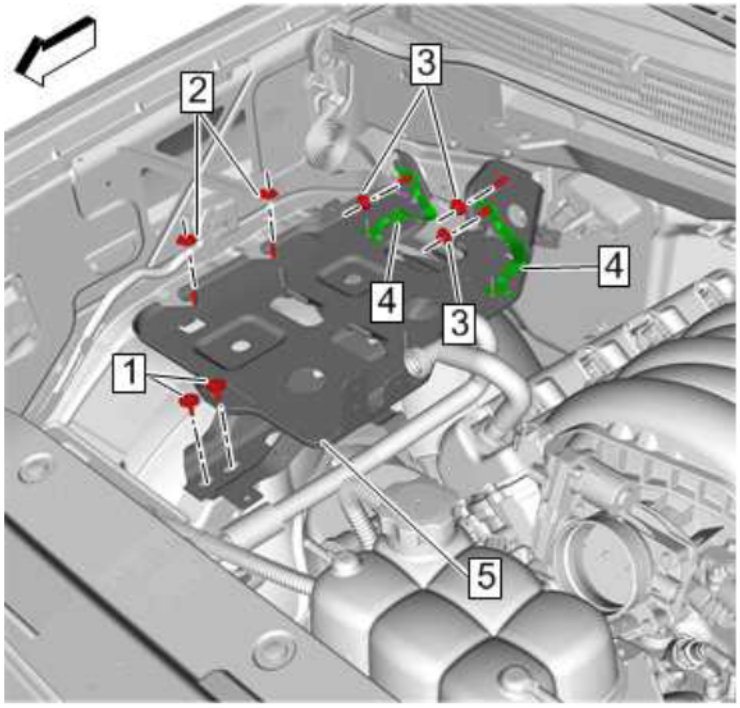


Fig. 51: Accessory DC Power Control Module Tray
Courtesy of GENERAL MOTORS COMPANY

1. Accessory DC Power Control Module Tray 5 -Install
2. Battery Negative Cable Extension Cable Strap 4 -Install

CAUTION: **Refer to Fastener Caution**

3. Accessory DC Power Control Module Nut 2 -Install and tighten 9 N.m (80 lb in)
4. Accessory DC Power Control Module Nut 3 -Install and tighten 22 N.m (16 lb ft)
5. Accessory DC Power Control Module Bolt 1 -Install and tighten 9 N.m (80 lb in)

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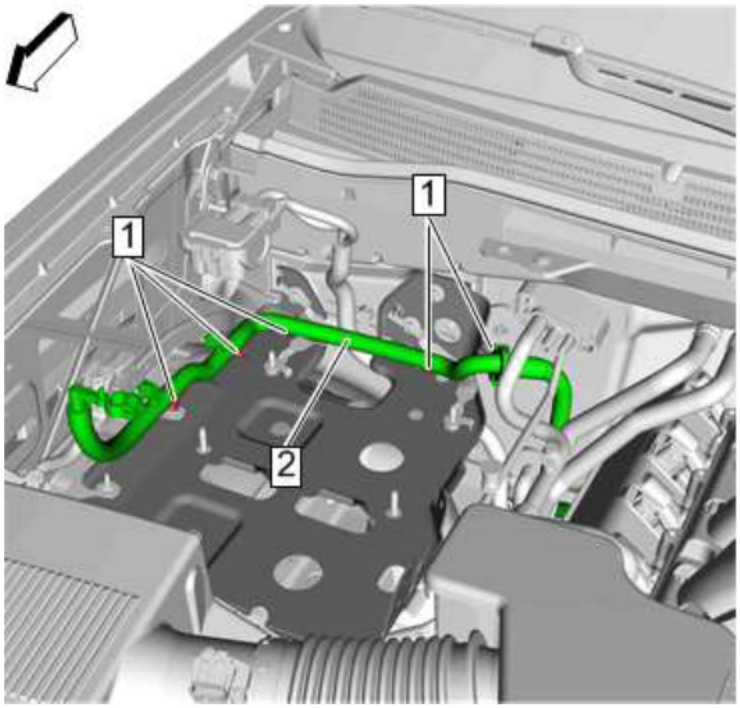


Fig. 52: Retainer
Courtesy of GENERAL MOTORS COMPANY

6. Retainer 1 -Engage

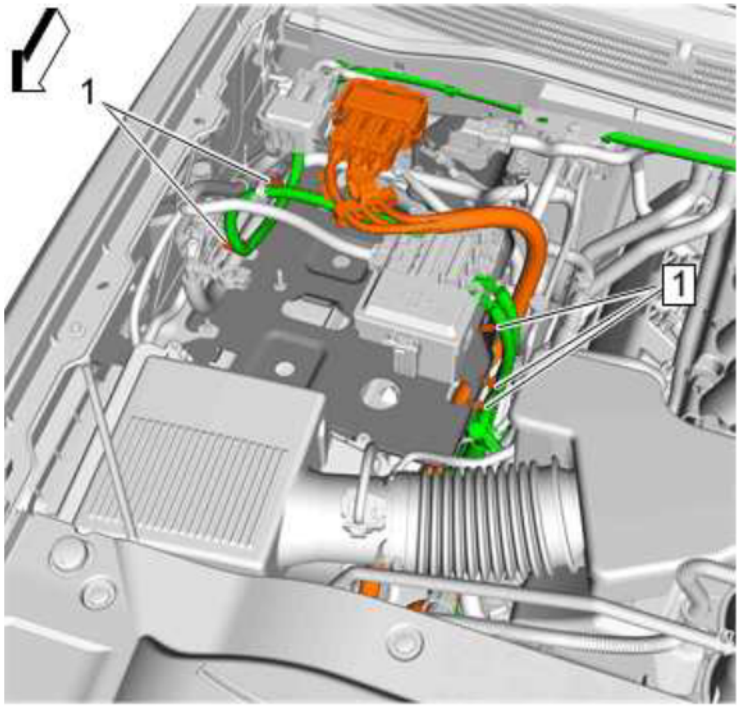


Fig. 53: Retainer
Courtesy of GENERAL MOTORS COMPANY

7. Retainer 1 -Engage

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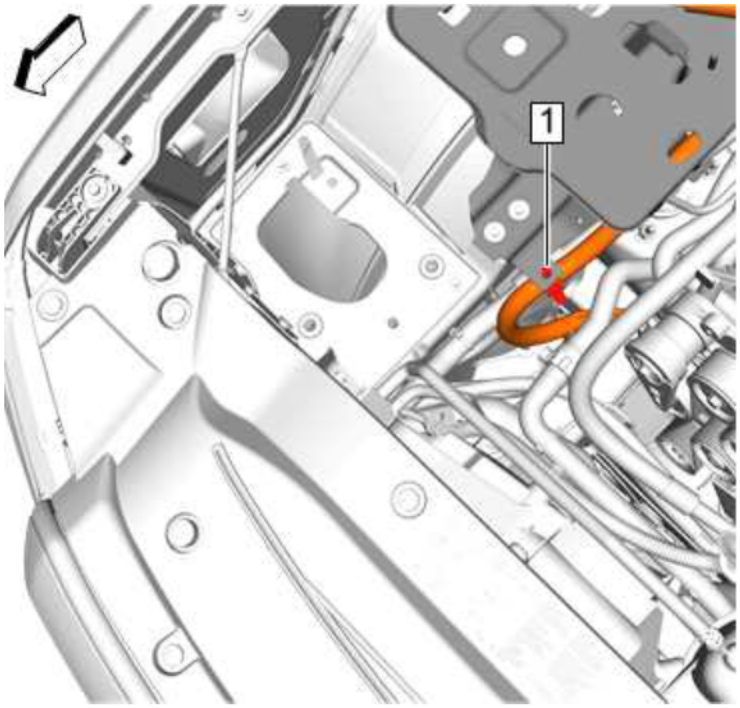


Fig. 54: Retainer
Courtesy of GENERAL MOTORS COMPANY

8. Retainer 1 -Engage
9. Install the generator control module. **Generator Control Module Replacement**
10. Install the battery. **Battery Replacement**
11. Install the air cleaner assembly. **Air Cleaner Assembly Replacement**

HIGH VOLTAGE BATTERY INTERFACE CONTROL MODULE REPLACEMENT (CELL BATTERY MODULE 1)

WARNING: **Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.**

WARNING: **Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:**

- **Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedure exactly as written may result in serious injury or death.

Removal Procedure

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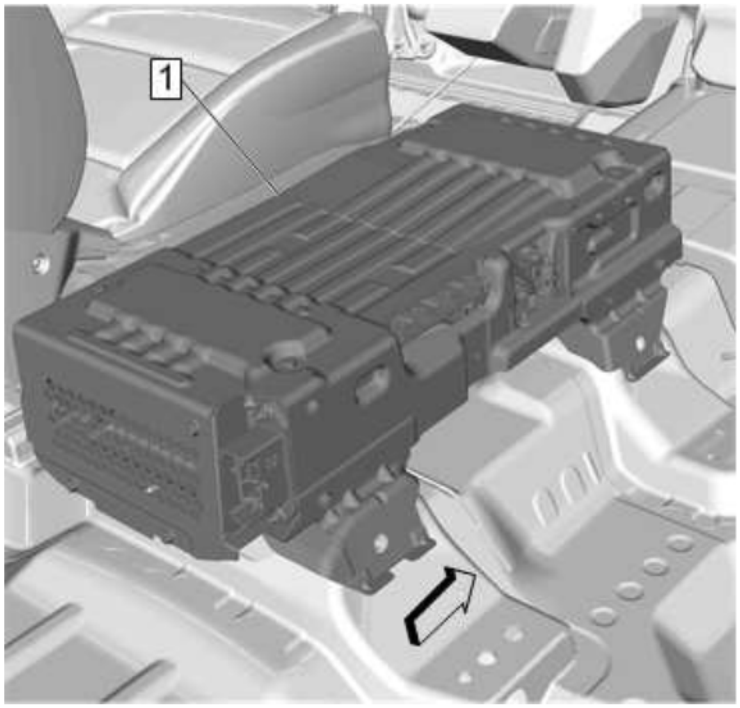


Fig. 55: High Voltage Battery
Courtesy of GENERAL MOTORS COMPANY

1. High Voltage Battery 1 -Remove - **High Voltage Battery Replacement and Shipping Preparation (with Center Console)** **High Voltage Battery Replacement and Shipping Preparation (with Front Center Seat)**

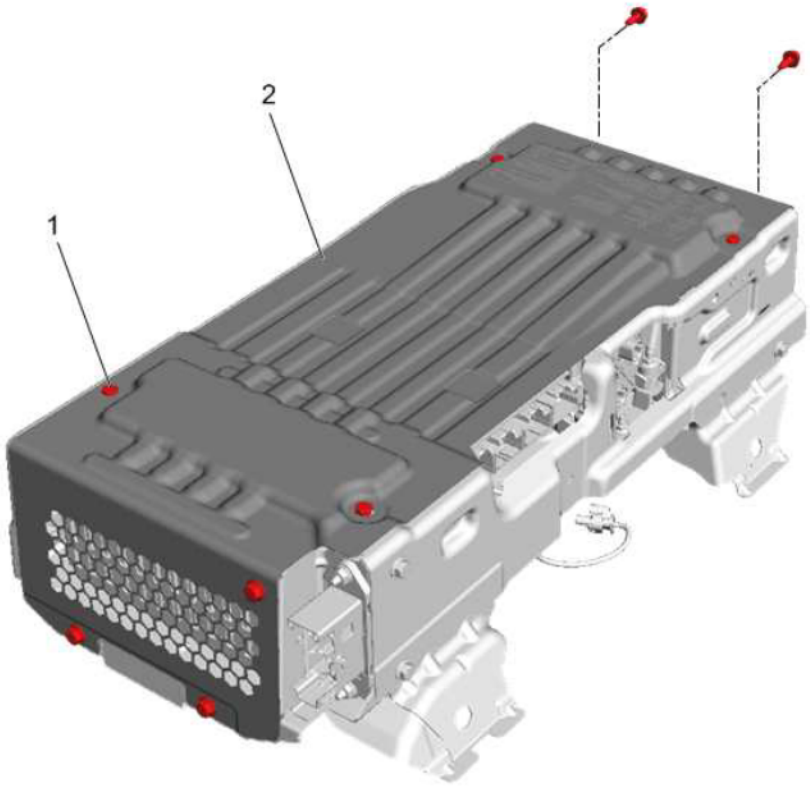


Fig. 56: High Voltage Battery Top Cover
Courtesy of GENERAL MOTORS COMPANY

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2. High Voltage Battery Top Cover 2 -Remove - **High Voltage Battery Cover Replacement (Battery Positive and Negative Cable)** **High Voltage Battery Cover Replacement**

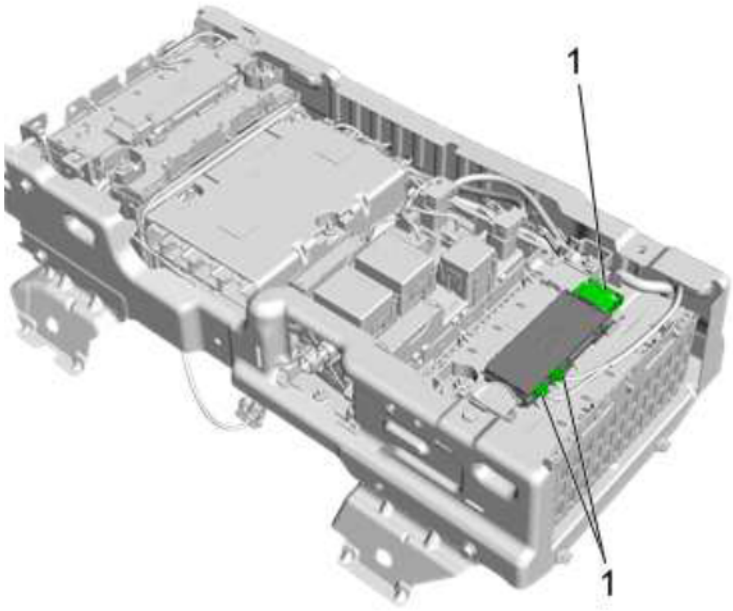


Fig. 57: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Electrical Connector 1 -Disconnect

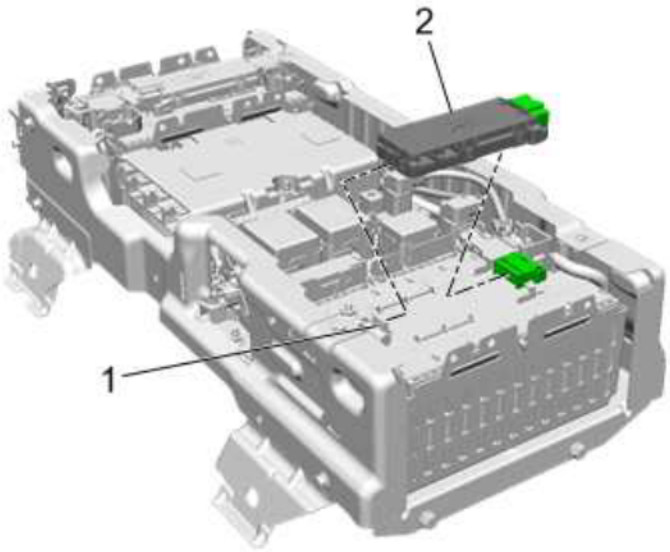


Fig. 58: High Voltage Battery Interface Control Module
Courtesy of GENERAL MOTORS COMPANY

4. Retaining Tab 1 -Disengage

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5. High Voltage Battery Interface Control Module 2 -Remove

Installation Procedure

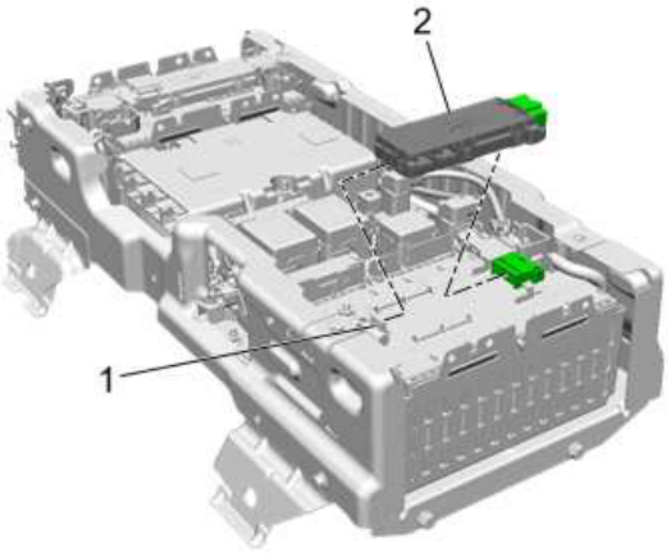


Fig. 59: High Voltage Battery Interface Control Module
Courtesy of GENERAL MOTORS COMPANY

1. High Voltage Battery Interface Control Module 2 -Install
2. Retaining Tab 1 -Engage

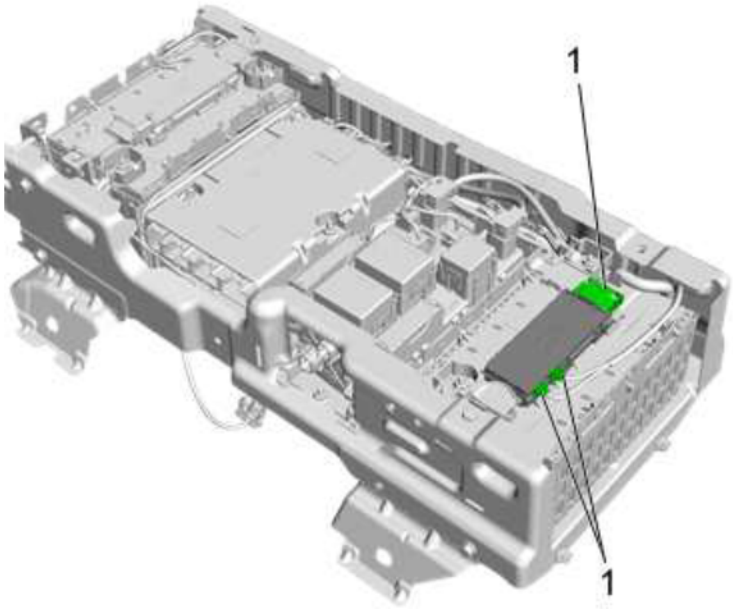


Fig. 60: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

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3. Electrical Connector 1 -Connect

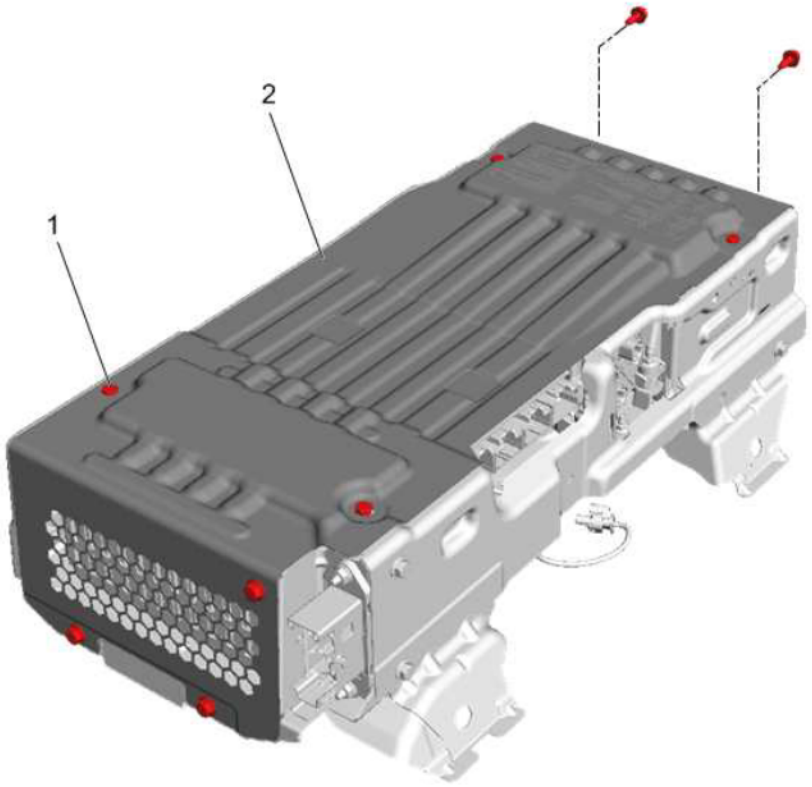


Fig. 61: High Voltage Battery Top Cover
Courtesy of GENERAL MOTORS COMPANY

4. High Voltage Battery Top Cover 2 -Install - **High Voltage Battery Cover Replacement (Battery Positive and Negative Cable)** **High Voltage Battery Cover Replacement**

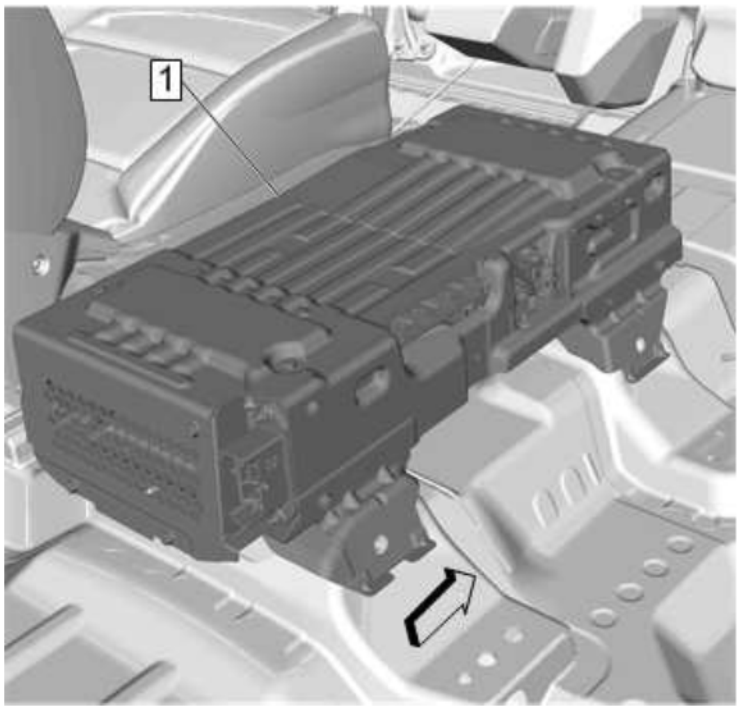


Fig. 62: High Voltage Battery

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Courtesy of GENERAL MOTORS COMPANY

5. High Voltage Battery 1 - Install - **High Voltage Battery Replacement and Shipping Preparation (with Center Console)** **High Voltage Battery Replacement and Shipping Preparation (with Front Center Seat)**
6. Enable the high voltage system. **High Voltage Enabling**
7. Reprogram the high voltage interface control module. **Control Module References**

HIGH VOLTAGE BATTERY INTERFACE CONTROL MODULE REPLACEMENT (CELL BATTERY MODULE 2)

WARNING: **Ensure all High Voltage safety procedures are followed. Failure to follow the procedure exactly as written may result in serious injury or death.**

WARNING: **Before working on any high voltage system, be sure to wear the following Personal Protection Equipment:**

- **Safety glasses with appropriate side shields when within 50 feet of the vehicle, either indoors or outdoors**
- **Certified and up-to-date Class "0" Insulation gloves rated at 1000V with leather protectors**
  - **Visually and functionally inspect the gloves before use.**
  - **Wear the Insulation gloves at all times when working with the high voltage battery assembly, whether the system is energized or not.**

Failure to follow the procedure exactly as written may result in serious injury or death.

Removal Procedure

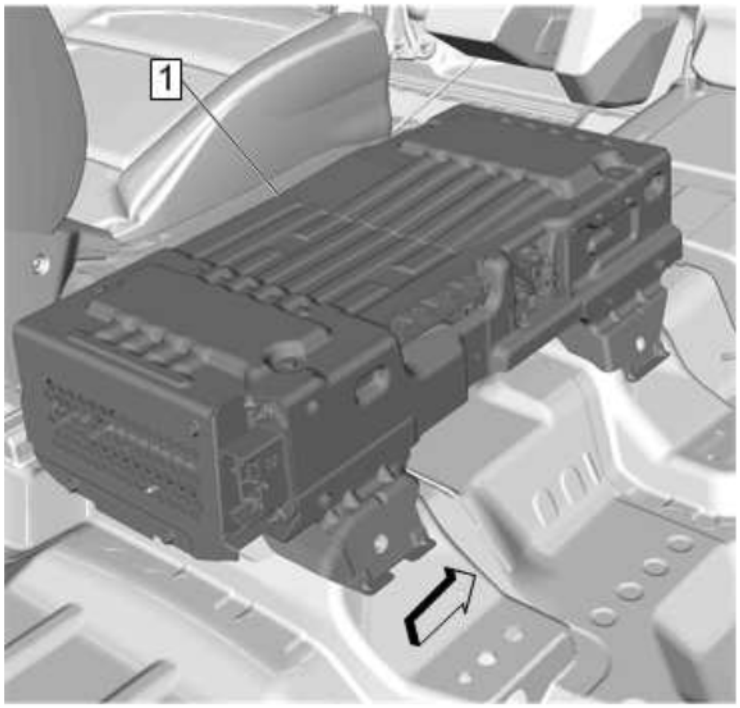


Fig. 63: High Voltage Battery

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Courtesy of GENERAL MOTORS COMPANY

1. High Voltage Battery 1 -Remove - **High Voltage Battery Replacement and Shipping Preparation (with Center Console)** **High Voltage Battery Replacement and Shipping Preparation (with Front Center Seat)**

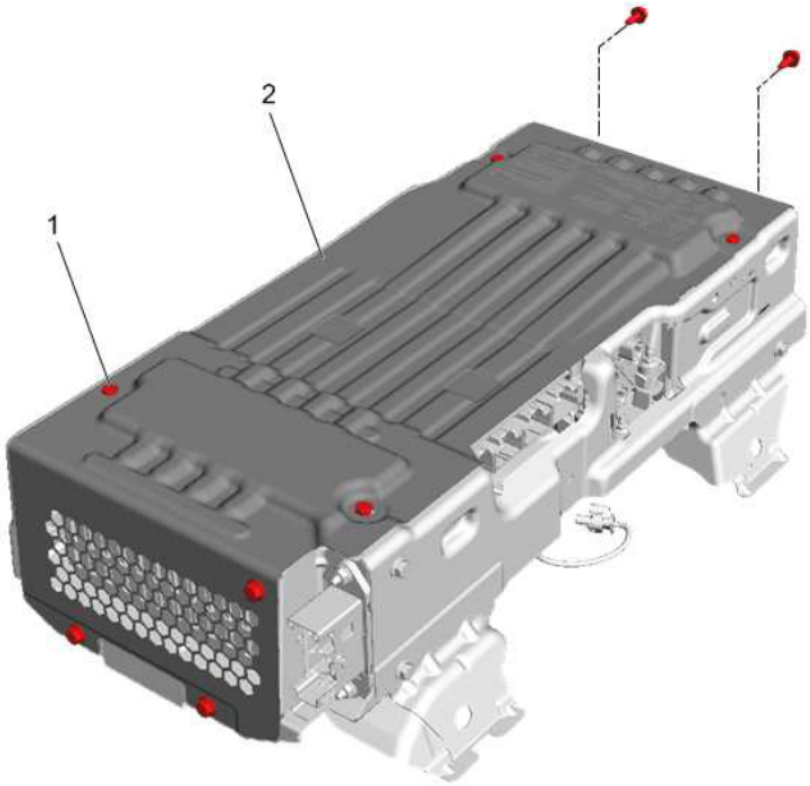


Fig. 64: High Voltage Battery Top Cover
Courtesy of GENERAL MOTORS COMPANY

2. High Voltage Battery Top Cover 2 -Remove - **High Voltage Battery Cover Replacement (Battery Positive and Negative Cable)** **High Voltage Battery Cover Replacement**

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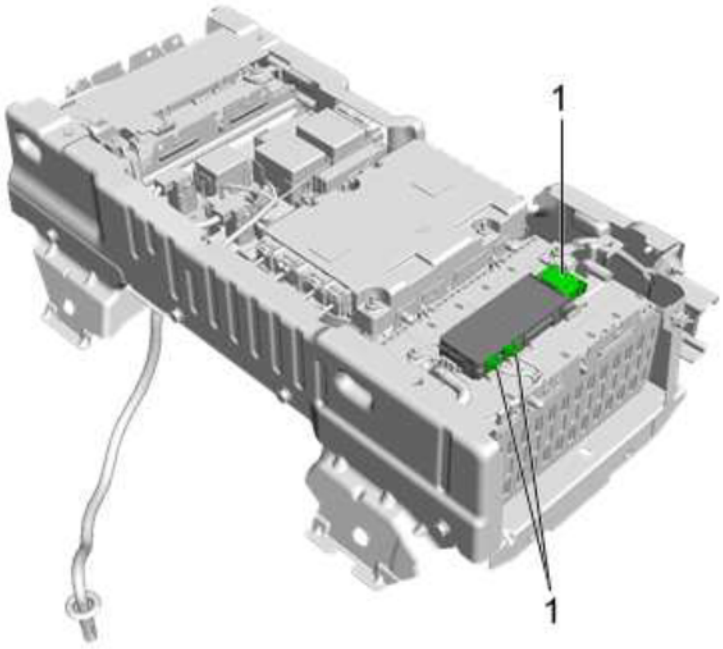


Fig. 65: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Electrical Connector 1 -Disconnect

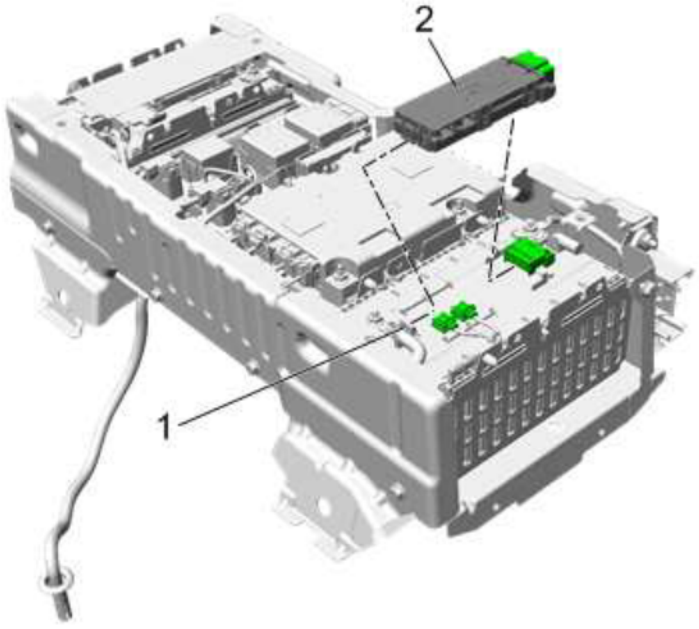


Fig. 66: Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

4. Retaining Tab 1 -Disengage
5. High Voltage Battery Interface Control Module 2 -Remove

Installation Procedure

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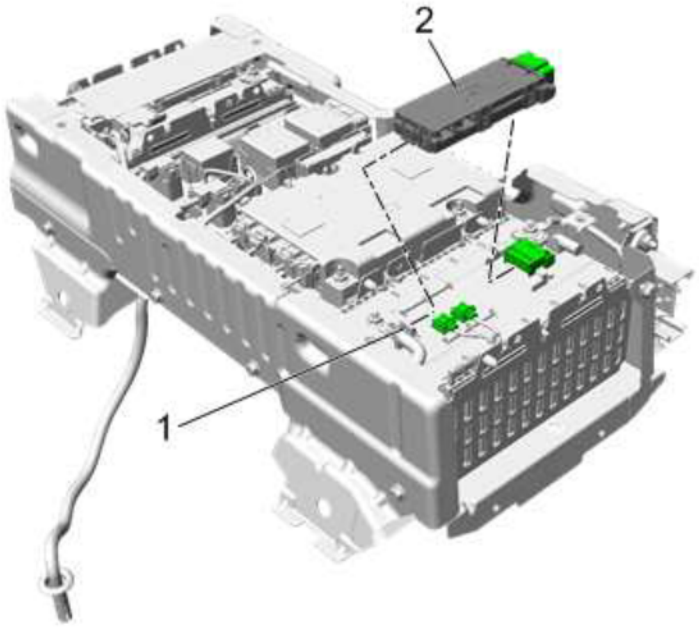


Fig. 67: Retaining Tab
Courtesy of GENERAL MOTORS COMPANY

1. High Voltage Battery Interface Control Module 2 -Install
2. Retaining Tab 1 -Engage

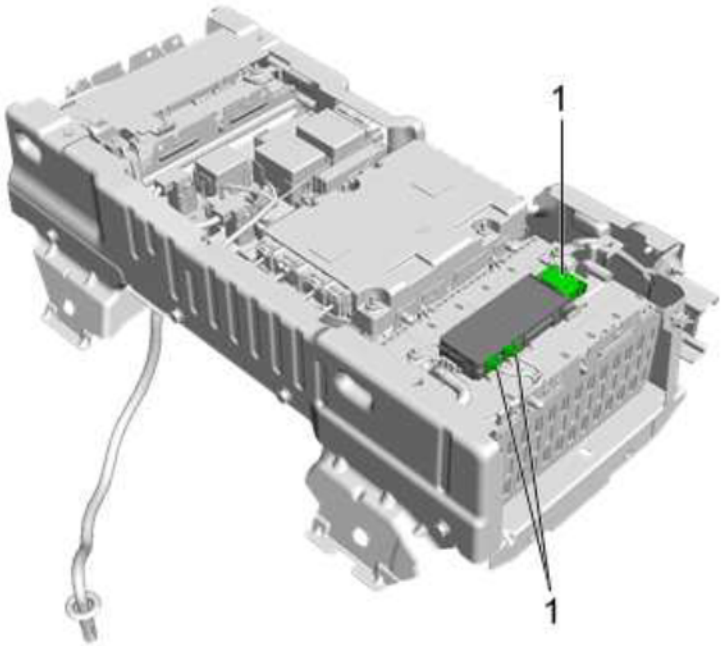


Fig. 68: Electrical Connector
Courtesy of GENERAL MOTORS COMPANY

3. Electrical Connector 1 -Connect

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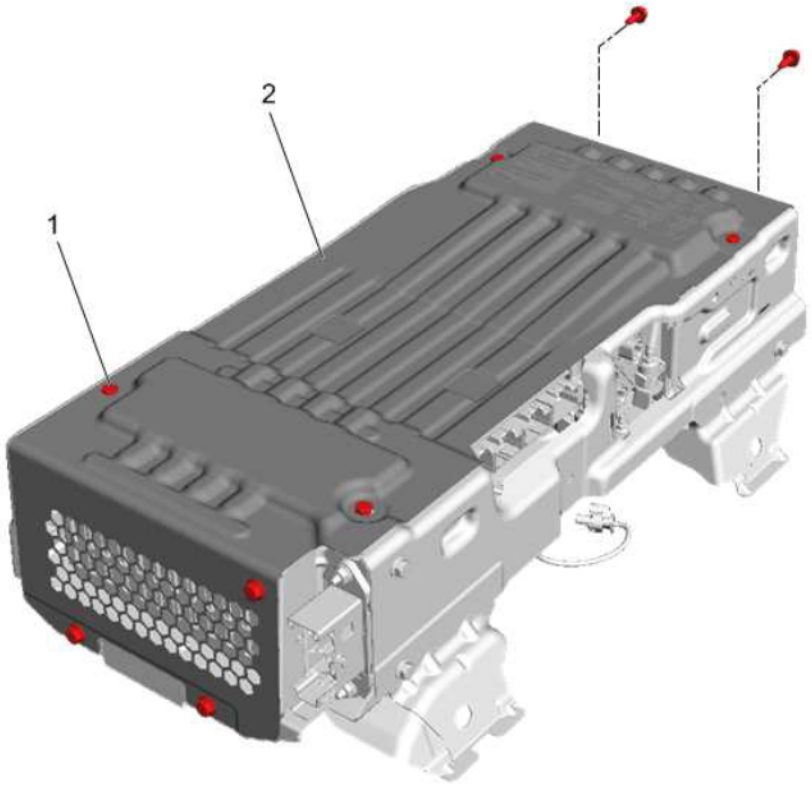


Fig. 69: High Voltage Battery Top Cover
Courtesy of GENERAL MOTORS COMPANY

4. High Voltage Battery Top Cover 2 -Install - **High Voltage Battery Cover Replacement (Battery Positive and Negative Cable)** **High Voltage Battery Cover Replacement**

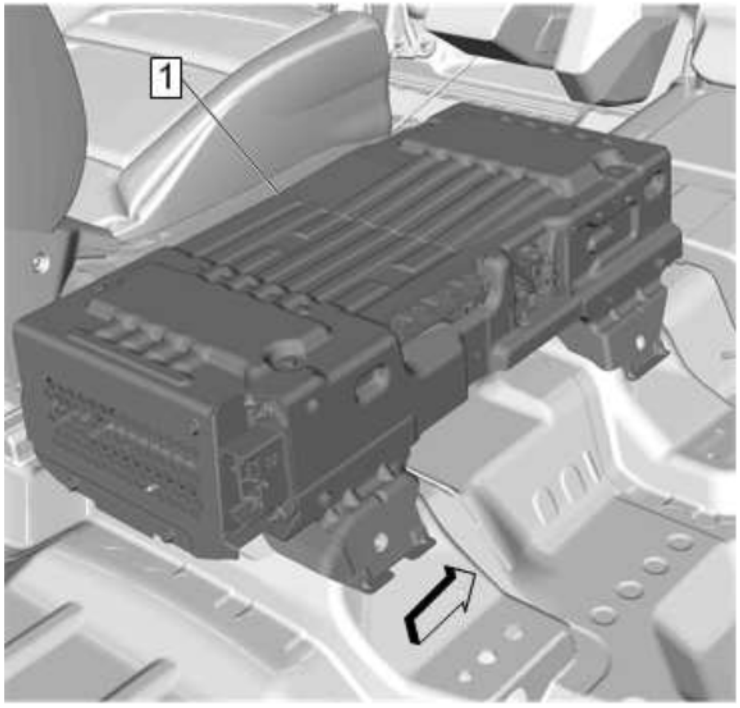


Fig. 70: High Voltage Battery
Courtesy of GENERAL MOTORS COMPANY

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5. High Voltage Battery 1 - Install - **High Voltage Battery Replacement and Shipping Preparation (with Center Console)** **High Voltage Battery Replacement and Shipping Preparation (with Front Center Seat)**
6. Enable the high voltage system. **High Voltage Enabling**
7. Reprogram the high voltage interface control module, refer to **Control Module References**

DESCRIPTION AND OPERATION

STARTER GENERATOR DESCRIPTION AND OPERATION

Location

The starter/generator, also referred to as the drive motor, is located in the engine compartment. The drive motor is mounted to the front of the engine in place of the alternator. The drive motor is connected to the crankshaft pulley using a specially designed serpentine belt and drive belt tensioner.

Operating Functions

The drive motor is a 3 phase AC induction machine. This device not only serves as an 86-volt AC generator, it is also used to provide engine power assist and to start the engine when in auto-stop mode. The 86-volt AC current flows between the drive motor and the generator control module, also referred to as the starter/generator control module, through a three phase cable assembly.

As a generator, the drive motor provides up to 12 kW of AC power to the drive motor control module.

As a motor, the drive motor provides up to 10 kW of electric power assistance and engine starting. The motor receives three phase AC power from the drive motor control module which is internal and part of the generator control module.

The drive motor has an internal sensor that is not serviceable, the drive motor position sensor.

The ratio between the drive motor pulley and the crankshaft pulley is 3.0 to 1. The generator control module is capable of checking the integrity of the drive motor belt by receiving an engine RPM input from the ECM over serial data and comparing that against the drive motor speed input signal from the drive motor position sensor.

ELECTROMAGNETIC COMPATIBILITY DESCRIPTION

Overview

Vehicles are typically subject to certain legal requirements that limit the amount of electromagnetic interference (EMI) that can be generated by the vehicles electronic devices. Additionally, the electronic devices within the vehicle must be able to withstand a certain amount of EMI without affecting their operation. EMI is generated whenever electrical current flows through a circuit. The amount of EMI generated, or amplitude, is usually dependent upon the amount of current flow, amperage, and the on-off pattern of current flow through the circuit, frequency. The EMI requirements are generally referred to as electromagnetic compatibility.

There are many ways of ensuring the vehicle meets electromagnetic compatibility requirements. These include:

- Adding capacitors and resistors to certain electrical circuits
- Regulating the frequency at which a component may operate
- Shielding the wires, cables and components

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Circuit Design

The generator control module, often referred to as the drive motor control module, and the 14V power module, often referred to as the accessory DC power control module, each contain filter capacitors connected to the high voltage circuits. These capacitors are necessary to reduce the voltage spikes that occur as a result of the switching of current On and Off. Reducing voltage spikes reduces EMI. The frequency of current switching is also closely regulated. Too high a frequency can cause an increase in EMI generation.

Wiring/Cable Design

Different types of wire/cable shielding methods are utilized in the vehicle. Common types of circuit shielding include twisted-pair and internal braid or foil. Twisted pair is typically used in circuits such as serial data circuits. The wire pair is twisted together at a particular turns-per-length ratio. Shielded cable is utilized for all other circuits requiring either protection from external EMI or to reduce EMI radiation of the cable itself into other nearby components or circuits.

High Voltage Cable

86-Volt Battery Positive and Negative Cable and Drive Motor Generator Battery 3 Phase Cable Assembly

The high voltage cables utilize internal braid shielding. Typically, both ends of the internal braid shield are attached to chassis ground. All of the shielded high voltage cables are grounded at their cable end attachment points. Mounting blocks, where used, perform the shield to chassis ground connection. Connection points not serviced with a mounting block utilize a separate ring terminal.

Low and Intermediate Voltage Wiring

The drive motor position sensor circuit utilizes internal foil shielding.

Component Shielding

Certain components utilize their structure to effectively shield EMI. Metal covers, chassis grounded metal cases and electro-magnetically conductive gaskets may all be part of a component's electromagnetic compatibility design.

Shielding Loss

A loss of proper shielding may result in poor AM band radio reception and/or incorrect sensor circuit readings depending upon the location of the shield loss. Damage that has penetrated to the insulated conductor of high voltage cables is not repairable. Certain Low and Intermediate voltage shielded wiring harnesses may be repairable. Refer to **Wiring Repairs** , and **Splicing Twisted or Shielded Cable** .

GENERATOR CONTROL MODULE DESCRIPTION AND OPERATION

Overview

The generator control module is also referred to as the starter/generator control module. The generator control module is located in the engine compartment.

The generator control module is comprised of the following control modules:

- Hybrid/EV powertrain control module 1
- 14V power module
- Drive motor control module

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The generator control module functions as an inverter, inverting high voltage direct current (DC) electrical energy to 3 phase alternating current (AC) electrical energy and vice versa. The generator control module also functions as a DC to DC converter, converting high voltage DC to 14 volts DC. The generator control module is liquid cooled.

High Voltage Circuits

Direct Current (DC)

The generator control module is connected to the positive and negative terminals of the high voltage DC hybrid/EV battery pack. Both of the negative and positive high voltage DC battery poles are isolated from the vehicle chassis. Each high voltage DC bus is switched ON or OFF by a high voltage, high current contactor relay contained within the hybrid/EV battery pack. All high voltage DC negative and positive DC cables are orange in color to alert the technician to the potential presence of high voltage.

Three Phase Alternating Current (AC)

A single shielded cable connects the drive motor to the generator control module. This cable contains 3 individual wires that are connected to the 3 phases of the drive motor. The cable is orange in color to alert the technician to the potential presence of high voltage.

Low Voltage Circuits

The 14V power module is an electronic device that converts high voltage (86V) DC to low voltage (14V) DC for operation of all low voltage modules and to charge the 12 volt accessory battery. The 14V power module is not serviced separately and is part of the generator control module.

Low Voltage (12V) Direct Current

Low voltage (12V) cables on the hybrid vehicle do not require unique coloring or servicing procedures.

Hybrid/EV Powertrain Control Module 1

Location

The hybrid/EV powertrain control module 1 is a non-serviceable, flash-programmable micro-processor that is part of the generator control module.

Operating Functions

The hybrid/EV powertrain control module 1 is the main controller of powertrain operation. The hybrid/EV powertrain control module 1 determines when to perform normal operating modes such as auto stop, launch assist mode, and regenerative braking. The hybrid/EV powertrain control module 1 also operates in conjunction with the hybrid/EV powertrain control module 2 to determine when to enable and disable the DC high voltage circuits. The motor control module operates the drive motor based upon hybrid/EV powertrain control module 1 commands.

Communication and Hosted Diagnostics

The hybrid/EV powertrain control module 1 is the host controller for DTC and scan tool parameter information for the following control modules:

- 14V power module

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- Drive motor control module

These modules diagnose their own operation and determine when a fault condition is present. The 14V power module communicates diagnostic status to the hybrid/EV powertrain control module 1 over serial data.

The drive motor control module and the hybrid/EV powertrain control module 1 exchange information and commands on a serial peripheral interface bus internal communication circuit as well as the hi-speed serial data communication circuit.

In the event the hybrid/EV powertrain control module 2 communicates a fault condition, the hybrid/EV powertrain control module 1 will determine if one or more operating modes are affected and notify the vehicle operator by requesting the MIL illuminate and/or by displaying a message in the Driver Information Center. In addition, the hybrid/EV powertrain control module 1 will store the associated DTC information for retrieval by a scan tool. Some hosted modules may require an ignition cycle to clear certain DTCs from the hybrid/EV powertrain control module 1.

Circuit Inputs

In addition to data parameters, the hybrid/EV powertrain control module 1 directly monitors the following signal circuits:

- Engine crankshaft position sensor signal (via serial data message from ECM - not direct)
- High voltage interlock circuit
- Brake Pedal Position
- Drive Motor Position (via motor control module)
- Hood switch
- Various internal signals (temps, etc.)

Circuit Outputs

In addition to control through other controllers, the hybrid/EV powertrain control module 1 directly controls:

- Automatic transmission auxiliary fluid accumulator
- Drive Motor
- Drive Motor Cooling pump

Drive Motor Control Module

Location

The drive motor control module is a flash-programmable micro-processor. The drive motor control module is non serviceable and is part of the generator control module.

Operating Functions

The drive motor control module's main function is to monitor the drive motor input/output circuits and to control the insulated gate bipolar transistors that control the drive motor by inverting the high voltage DC electrical energy to 3 phase AC electrical energy and vice versa.

Communication and Hosted Diagnostics

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The hybrid/EV powertrain control module 1 communicates with the drive motor control module using an internal serial data circuit. The drive motor control module does not store its own diagnostic trouble code (DTC) information. The hybrid/EV powertrain control module 1 will store the drive motor control module associated DTC information for retrieval by a scan tool. The scan tool can communicate directly with the drive motor control module in order to retrieve data parameters only.

Circuit Inputs

In addition to data parameters, the drive motor control module monitors the drive motor for:

- Voltage
- Current
- Speed and direction

Additionally, the drive motor control module monitors the insulated gate bipolar transistor components for temperature and proper operation. Some of the drive motor control modules operation data is shared with the hybrid/EV powertrain control module 1.

Circuit Outputs

The drive motor control module controls the insulated gate bipolar transistor driver board which is located in the drive motor control module, that in-turn controls the drive motor. The drive motor is controlled by the 3-phase alternating current (AC). Three cables connect the drive motor to the drive motor control module which is part of the generator control module.

14V Power Module

Location

The 14V power module is a non-serviceable device that is part of the generator control module.

Operating Functions

The 14V power module is the device which converts high voltage (86V) DC to low voltage (12V) DC for accessory electrical operation and to charge the 12 volt accessory battery. The 14V power module will typically charge the 12 volt system at approximately 14.5 volts with a max power output of 1800 watts. The 14V power module is not programmable.

HIGH VOLTAGE MONITORING SYSTEMS DESCRIPTION

The drive motor control module and hybrid/EV powertrain control module 2 monitor the hybrid/EV system for loss of isolation detection. A minimum amount of isolation resistance is maintained at all times between both negative and positive poles of the hybrid/EV battery and the vehicle chassis.

High Voltage DC Chassis Isolation

Vehicles equipped with high voltage storage and propulsion capability are designed with the high voltage circuits isolated from the vehicle chassis. If either the positive or negative high voltage Direct Current (DC) circuits or any of the high voltage Alternating Current (AC) phase circuits lose this isolation to the vehicle chassis, one or more diagnostic trouble codes (DTCs) may set. Additional information can be found in **Hybrid/EV System High Voltage Isolation Description** .

HYBRID MODES OF OPERATION DESCRIPTION

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Automatic Engine Start/Stop

WARNING: Exiting the vehicle without first shifting into P (Park) may cause the vehicle to move. You or others may be injured. Because the vehicle has the automatic engine stop/start feature, the vehicle's engine may seem to be shut off; however, once the brake pedal is released, the engine will start up again.

Shift to P (Park) and turn the ignition to LOCK/OFF, before exiting the vehicle.

Vehicles with eAssist have an automatic (auto) engine start/stop feature. After the engine has started and reached operating temperature the auto stop feature may cause the engine to turn off when brakes are applied and the vehicle has come to a complete stop. When the brake is released or the accelerator pedal applied, the engine will start. The engine will continue to run until the next auto stop or until the ignition switch is turned OFF.

AUTO STOP on the tachometer signifies that the engine is in auto stop mode. When the vehicle is turned off, the tachometer will move to OFF. If the driver door is opened while in auto stop mode, a chime will sound.

To restart the engine during auto stop, release the brake pedal or press the accelerator pedal. The engine starts immediately. The engine continues to run until the next stop.

There are several conditions which may prevent an auto stop or cause an auto start.

The Engine Will Remain Running When:

- The engine, transmission, or hybrid battery is not warmed up.
- The outside temperature is less than -20Â°C (-4Â°F).
- The air conditioning or defrost system requires the A/C compressor to maintain vehicle comfort.
- The shift lever is in any position other than DRIVE.
- The hybrid battery pack charge is low.
- The 12-volt vehicle battery charge is low, or loads are high.
- The hood is not fully closed.

The Engine Will Restart When:

- The brake pedal is released.
- The accelerator pedal is applied.
- Shifting out of D (Drive) to any other gear.
- If the eco air conditioning button is selected, the duration of the auto stop will mainly depend on the outside temperature along with some other factors. This economy mode improves fuel economy by limiting the effects of the air conditioning. The warmer it is outside, the shorter the time before the engine is restarted to provide cabin cooling.
- The climate control system is turned from off to normal air conditioning or defrost.
- The engine is required to run for either heater or climate control performance.
- The hybrid battery pack charge is low and requires recharging.
- Auto stop time is greater than two minutes.

Regenerative Braking

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Regenerative braking takes some of the energy from the moving vehicle and turns it into electrical energy. This energy is then used to charge the vehicle's hybrid battery system, which increases fuel efficiency.

The torque converter stays locked allowing the drive motor to be coupled to the wheels (through engine and trans) to recharge the hybrid batteries via regenerative braking.

The system works whenever you take your foot off the accelerator pedal while the vehicle is moving in a forward gear. This causes the vehicle to slow down more quickly. It may feel like the brake pedal is being pressed, even when it is not. When the brake pedal is depressed the system will deliver a higher percent of regenerative energy to the hybrid battery system than when in coast down.

Electric Power Assist

Significant internal transmission changes to clutch controls and hardware provide reduced spin losses while improving shift quality. The added electric power provided by the eAssist system allows for higher gearing to improve steady state efficiency without impacting acceleration performance or driveability. The system's capability of providing up to 10 kW of electric power assist at cruising speeds allows the driver to accelerate lightly, ascend mild grades without the transmission downshifting and helps performance during wide open throttle maneuvers.

Torque Smoothing

While not unique to the eAssist hybrid vehicle, expanded operational range is possible because the drive motor can react quickly to smooth driveline disturbances that would otherwise be objectionable.

Deceleration Fuel Cut-Off

When the driver releases the accelerator pedal, air flow into the engine is reduced. The ECM monitors the corresponding changes in the throttle position, MAP, and MAF. The ECM shuts OFF fuel completely if the deceleration is very rapid, or for long periods, such as closed-throttle coast-down. The fuel shuts OFF in order to prevent damage to the catalytic converter and saves fuel by not running the engine. This mode is activated quickly and for a longer duration in the eAssist hybrid vehicle.

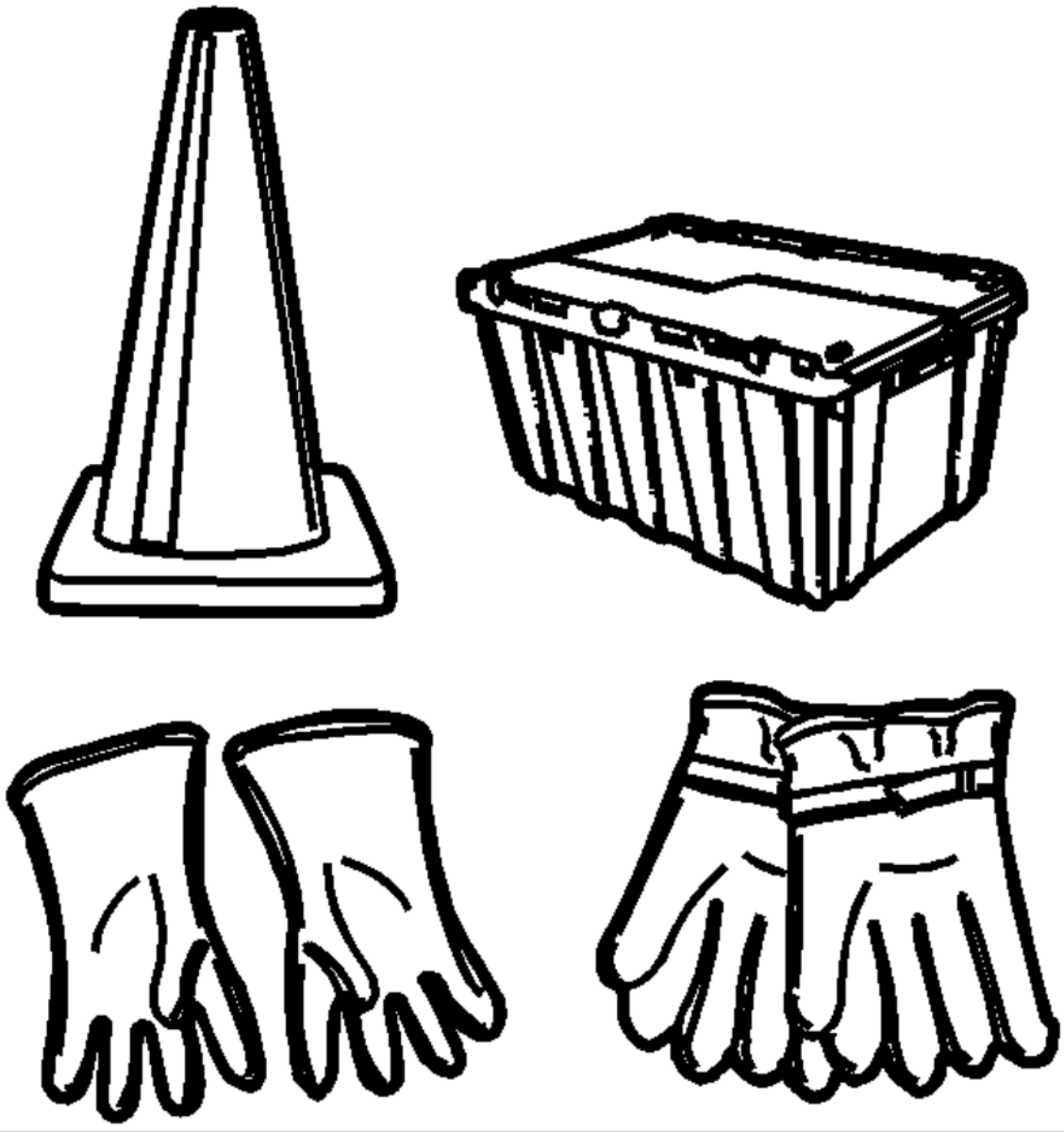
While in deceleration fuel cut-off mode, the torque converter stays locked allowing the drive motor to be coupled to the wheels (through engine and trans) to recharge the hybrid batteries via regenerative braking. The drive motor can also quickly react to help smooth driveline disturbances (downshifts), or provide assist for a smooth take off when the accelerator is depressed. If the vehicle is brought to a complete stop the drive motor spins the engine bringing it to a smooth stop and is properly positioned for a smooth restart.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description

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Illustration	Tool Number/ Description
	EL-48900 HEV Safety Kit

Article GUID: A00854577

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