

2013 ELECTRICAL

Hybrid/EV Energy Storage - Malibu

SPECIFICATIONS

FASTENER TIGHTENING SPECIFICATIONS

Fastener Tightening Specifications

Application	Specification	
	Metric	English
Battery Auxiliary Tray Fasteners	22 N.m	16 lb ft
Battery Energy Control Module Fasteners	9 N.m	80 lb in
Battery Energy Control Module Wiring Junction Block Fasteners	9 N.m	80 lb in
BDU Housing Fasteners	6 N.m	53 lb in
Cut-Off Switch Screw	4 N.m	35 lb in
Disconnect High Voltage Switch Mounting Fastener	9 N.m	80 lb in
Drive Motor Generator Battery Cable Bracket Fasteners	22 N.m	16 lb ft
Drive Motor Generator Battery Cable Tray Fasteners	22 N.m	16 lb ft
Drive Motor Generator Battery Cable U V W Terminal Fasteners	9 N.m	80 lb in
Generator Battery Disconnect Relay Fasteners	9 N.m	80 lb in
Generator Battery Fasteners	22 N.m	16 lb ft
Generator Battery Fuse Fasteners	9 N.m	80 lb in
Generator Control and Battery Module Mounting Fasteners	22 N.m	16 lb ft
Generator Control Module Cable Cover Fasteners	9 N.m	80 lb in
Generator Control Module Cover Fasteners	9 N.m	80 lb in
Generator Control Module Fasteners	9 N.m	80 lb in
High Voltage Cables-to-Battery Block Fasteners	9 N.m	80 lb in
HVIL Connector	4 N.m	35 lb in
Intermediate Duct to Power Pack Tray	9 N.m	80 lb in
Outlet Duct Adapter Fasteners	6 N.m	53 lb in

SCHEMATIC WIRING DIAGRAMS

HYBRID/EV ENERGY STORAGE WIRING SCHEMATICS

Power, Ground and Serial Data Wiring Schematics

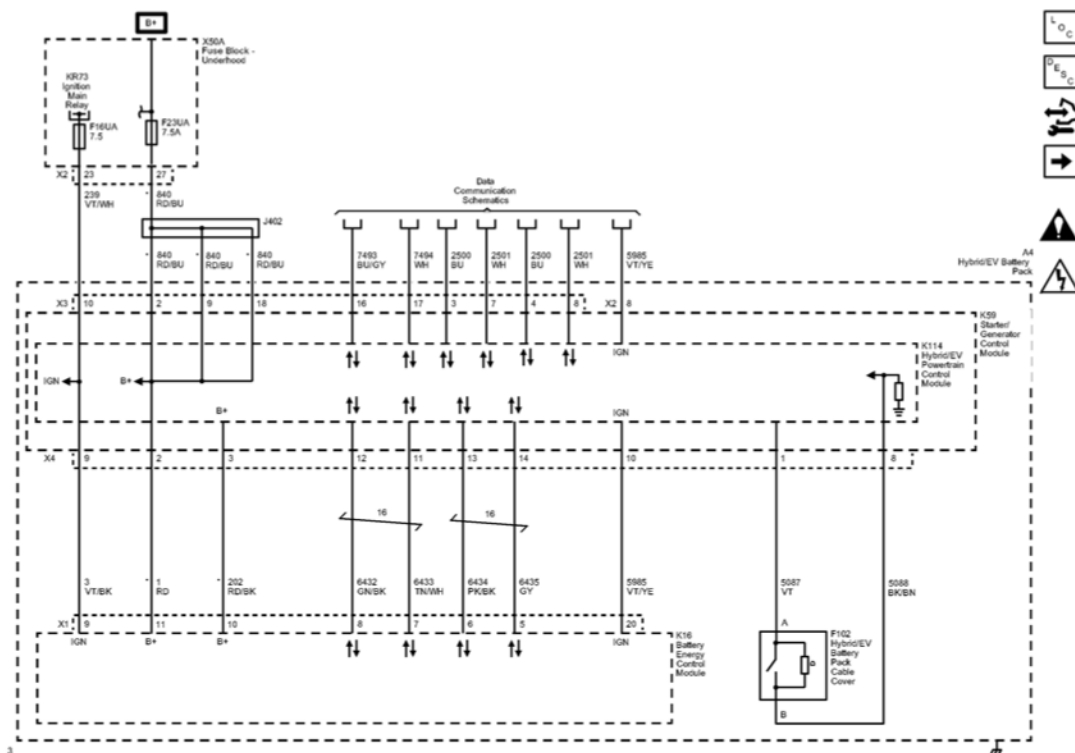


Fig. 1: Power, Ground and Serial Data Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY

Contactors Wiring Schematics

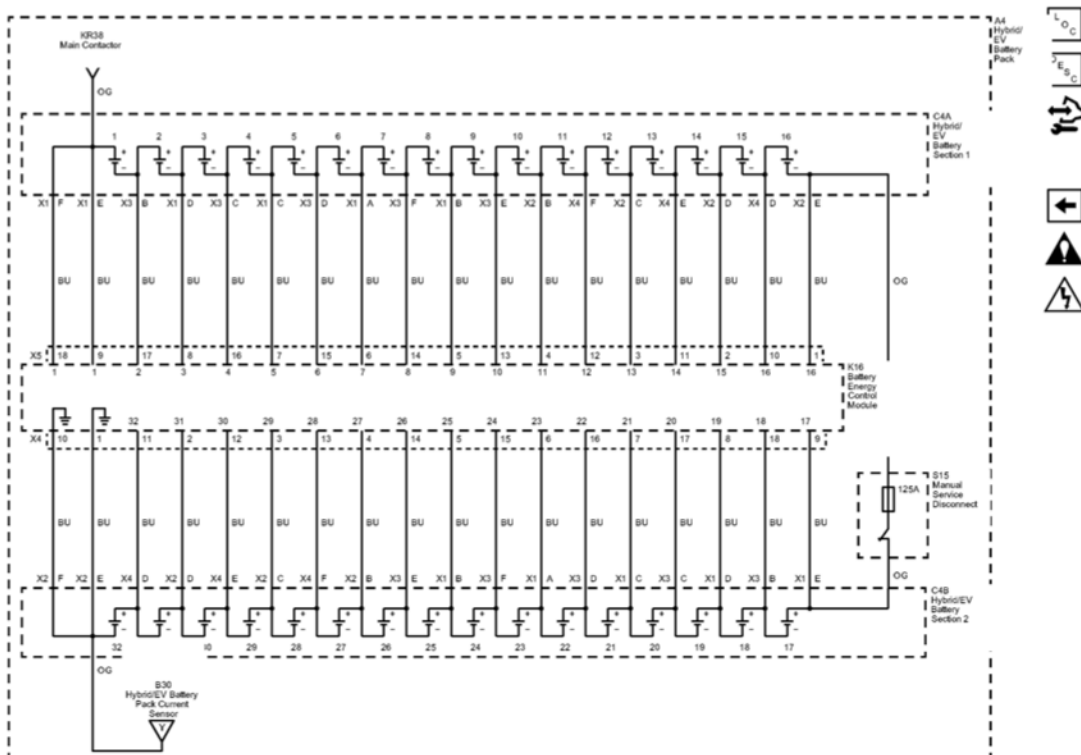


Fig. 3: Hybrid Battery Pack Monitoring Wiring Schematics
 Courtesy of GENERAL MOTORS COMPANY

DIAGNOSTIC INFORMATION AND PROCEDURES

HIGH VOLTAGE SAFETY

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.

WARNING: High voltage circuits should only be tested using a digital multimeter (DMM) and test leads with at least a CAT III rating, such as the J 39200-A Digital Multimeter. Failure to follow the procedures may result in serious injury or death.

WARNING: This vehicle is equipped with a high voltage battery that is completely isolated from the chassis ground. Never utilize AC powered test equipment to probe the high voltage system. Serious injury, death and component damage could occur if the high voltage system is grounded through the electric utility.

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

Special Tools

EL-48900 HEV Safety Kit

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

Precautions when Performing Service or Inspections

- Always verify that the high voltage has been disabled before working on or around high voltage components, wires, cables, or harnesses.
- Remove all metal objects such as rings and watches.
- The **EL-48900** HEV safety kit contains safety cones. Place the safety cones around the vehicle to alert other technicians that you are working on the high voltage system.
- Remove all vehicle keys and secure in a location outside the vehicle. If the vehicle is equipped with push button start, the keys must remain at least 3 meters (15 feet) from the vehicle.
- Ensure that the manual service disconnect lever is secured in the open position with a zip tie.
- Always wear certified and tested high voltage insulation gloves when inspecting or testing any high voltage wires and components.
- Use the "One Hand" rule:
 - Work with only one hand whenever possible.

- Keep the other hand behind your back.
- DO NOT carry any metal objects such as a mechanical pencil or a measuring tape that could fall and cause a short circuit.
- After removing any high voltage wires, protect and insulate the terminal ends immediately with UL® Listed or equivalent insulation tape rated at a minimum of 600 V.
- Always tighten the high voltage terminal fasteners to the specified torque. Insufficient or excessive torque will cause malfunctions or damage.
- After finishing work on the high voltage systems and before closing the manual service disconnect lever, inspect for the following:
 - Verify high voltage system integrity and that all connectors are installed.
 - Verify that all tools or loose components have been removed.

Labels for Components, Wire Harness, and Connectors

The wire harnesses and cables for high voltage circuits are encased in an orange colored covering. In addition, the high voltage energy storage device (battery) is affixed with a RED DANGER label and other high voltage components (e.g. Starter/Generator) are affixed with ORANGE WARNING labels.

High Voltage Insulation Glove Inspection Procedure

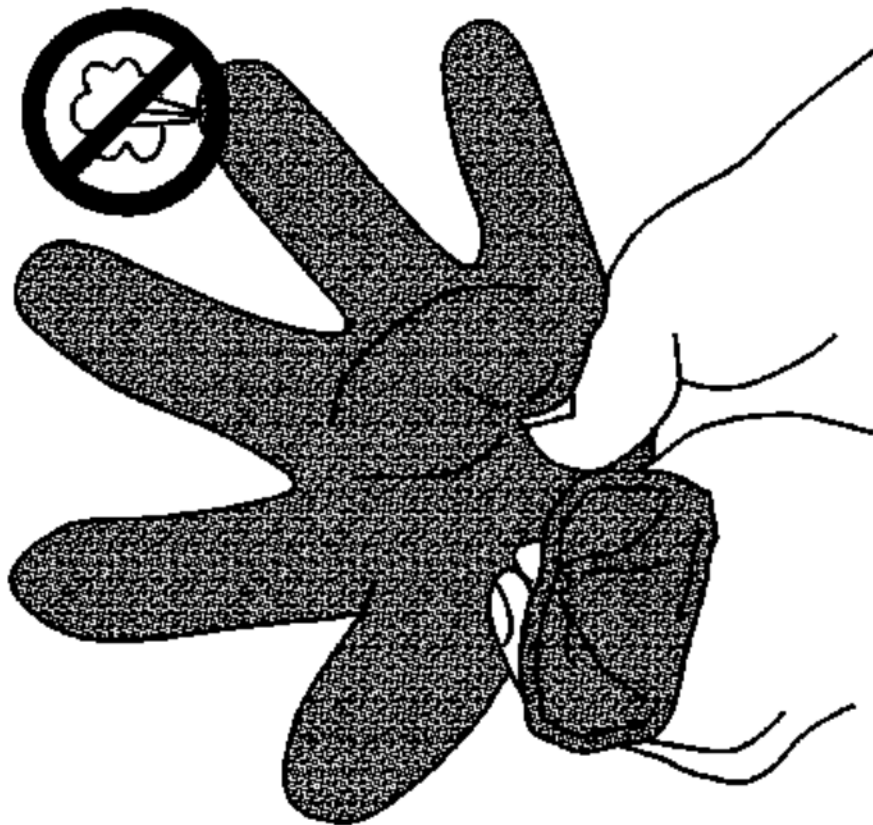


Fig. 4: Glove Inspection Procedure
Courtesy of GENERAL MOTORS COMPANY

The following procedure visually and functionally inspects the insulation gloves to be used while performing service on high voltage systems. This inspection procedure should be performed prior to any procedure that requires the use of class "0" insulation gloves rated at 1000 V.

1. Remove glove from leather protector.
2. Inflate glove and seal opening. Pinch the opening closed tightly to prevent any air loss.
3. Press glove to increase pressure.
4. Inspect for any of the following conditions:
 - Pin holes
 - Air leaks
 - Wear, tears, or abrasions
 - Damp or wet material
 - Certified up-to-date
 - If any of the above conditions exist, do not use the gloves.

HIGH VOLTAGE DISABLING

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: 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.

Servicing the A4 Hybrid/EV Battery Pack, A15 Starter/Generator, High Voltage 3-Phase Cables, and General Vehicle Servicing

This disabling procedure should only be used when service is being performed on components that are located outside of the A4 Hybrid/EV Battery Pack, such as the A15 Starter/Generator and high voltage 3-phase cables, or when the A4 Hybrid/EV Battery Pack is being replaced as a complete assembly. This procedure will only verify that high voltage has been removed from locations outside the A4 Hybrid/EV Battery Pack. If testing or replacement requires disassembling the A4 Hybrid/EV Battery Pack and accessing any components within, Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack, located below, must be used. The Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack procedure must be used because of the constant presence of high voltage when the A4 Hybrid/EV Battery Pack is disassembled.

1. Review the high voltage safety information. Refer to **High Voltage Safety**.
2. Disconnect and remove any 12 V battery chargers.
3. Turn the ignition OFF and wait 5 minutes to allow the high voltage capacitors to discharge.
4. Remove all vehicle keys and secure in a location outside the vehicle. If the vehicle is equipped with push button start, the keys must remain at least 3 meters (10 feet) away from the vehicle.
5. Disconnect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection**.
6. Lower the rear seatback and reposition the trunk liner to gain access to the A4 Hybrid/EV Battery Pack.

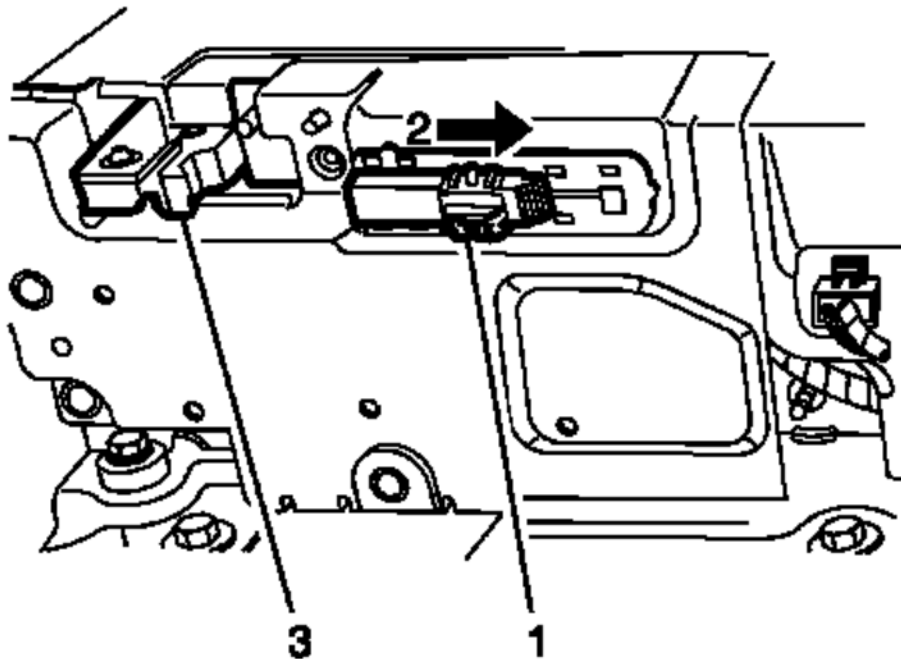


Fig. 5: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

7. Disengage the blue connector position assurance (1) from the high voltage interlock switch by pulling the CPA straight out. Do not fully remove the CPA from the switch or damage to the CPA will result.

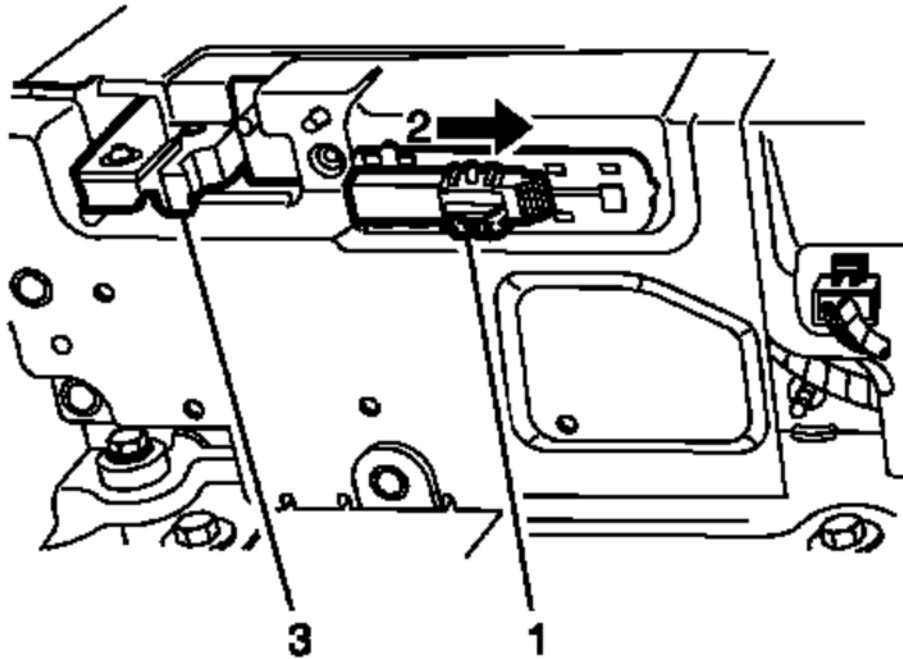


Fig. 6: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

8. Depress the tab on the high voltage interlock switch and slide the interlock switch toward the left side of the vehicle (2).

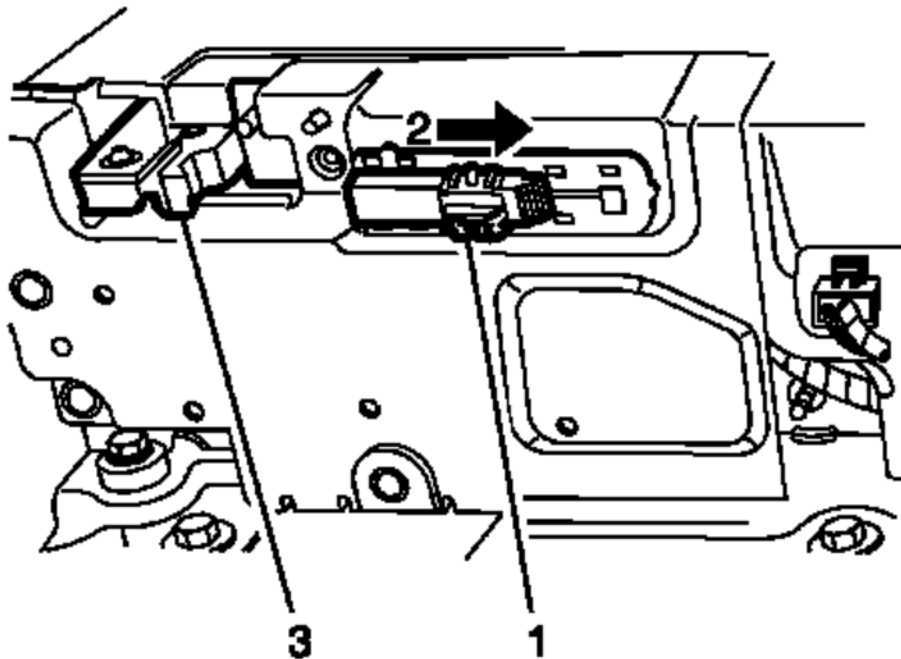


Fig. 7: Blue Connector Position Assurance
 Courtesy of GENERAL MOTORS COMPANY

9. Flip the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, located on the A4 Hybrid/EV Battery Pack, toward the right side of the vehicle and secure in the open position with a zip tie (3).

WARNING: Wear high voltage insulation gloves with leather protectors until it has been determined that a high voltage exposure risk is no longer present. Failure to follow the procedures exactly as written may result in serious injury or death.

10. Remove the F102 Hybrid/EV Battery Pack Cable Cover from the A4 Hybrid/EV Battery Pack.

NOTE: A 9 V DC battery can be used to test the DMM.

11. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.
 - If the DMM does not properly measure a 12 V battery

Repair or replace the DMM.

- If the DMM properly measures a 12 V battery

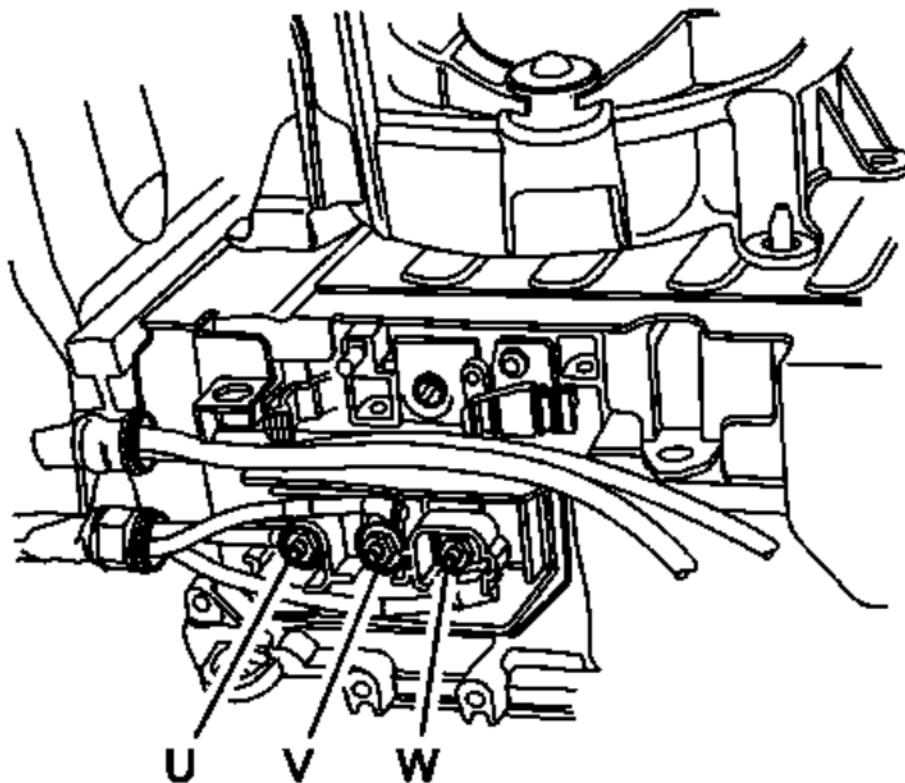


Fig. 8: Phase Terminal V, U And W
Courtesy of GENERAL MOTORS COMPANY

12. Verify that the voltage has been disabled at the energy storage system. Using the DMM on the DC voltage scale, test for less than 3 V at the following points:

- High voltage 3-Phase terminal V to vehicle chassis ground
 - High voltage 3-Phase terminal W to vehicle chassis ground
 - High voltage 3-Phase terminal U to vehicle chassis ground
 - High voltage 3-Phase terminal U to High voltage 3-Phase terminal V
 - High voltage 3-Phase terminal V to High voltage 3-Phase terminal W
 - High voltage 3-Phase terminal W to High voltage 3-Phase terminal U
- If 3 V or greater

A contactor is stuck closed or a loss of isolation has occurred within the A4 Hybrid/EV Battery Pack. Refer to **Hybrid\EV Battery Voltage Present**.

- If less than 3 V

NOTE: A 9 V DC battery can be used to test the DMM.

13. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.

- **If the DMM does not properly measure a 12 V battery**

Repair or replace the DMM and perform Step 11 again.

- **If the DMM properly measures a 12 V battery**

14. If all the test results were less than 3 V, the A4 Hybrid/EV Battery Pack, A15 Starter/Generator, high voltage 3-phase cables, or general vehicle can now be serviced.

Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack

This disabling procedure should be used when any service is being performed on components that are internal to the A4 Hybrid/EV Battery Pack, such as the K59 Starter/Generator Control Module and K16 Battery Energy Control Module. If a diagnostic instructs to perform any testing or replacement of components within the A4 Hybrid/EV Battery Pack, this procedure must be used. This procedure will completely disconnect and isolate the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 from the vehicle, allowing testing or replacement to occur in a safer environment.

1. Review the high voltage safety information. Refer to **High Voltage Safety**.
2. Disconnect and remove any 12 V battery chargers.
3. Turn the ignition OFF and wait 5 minutes to allow the high voltage capacitors to discharge.
4. Remove all vehicle keys and secure in a location outside the vehicle. If the vehicle is equipped with push button start, the keys must remain at least 3 meters (10 feet) away from the vehicle.
5. Disconnect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection**.
6. Lower the rear seatback and reposition the trunk liner to gain access to the A4 Hybrid/EV Battery Pack.

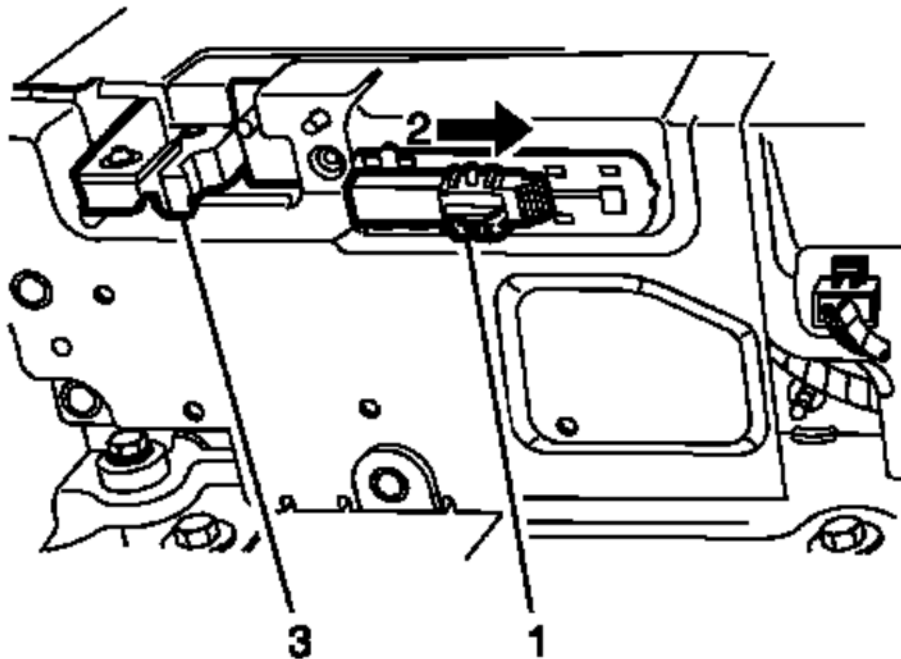


Fig. 9: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

7. Disengage the blue connector position assurance (1) from the high voltage interlock switch by pulling the CPA straight out. Do not fully remove the CPA from the switch or damage to the CPA will result.

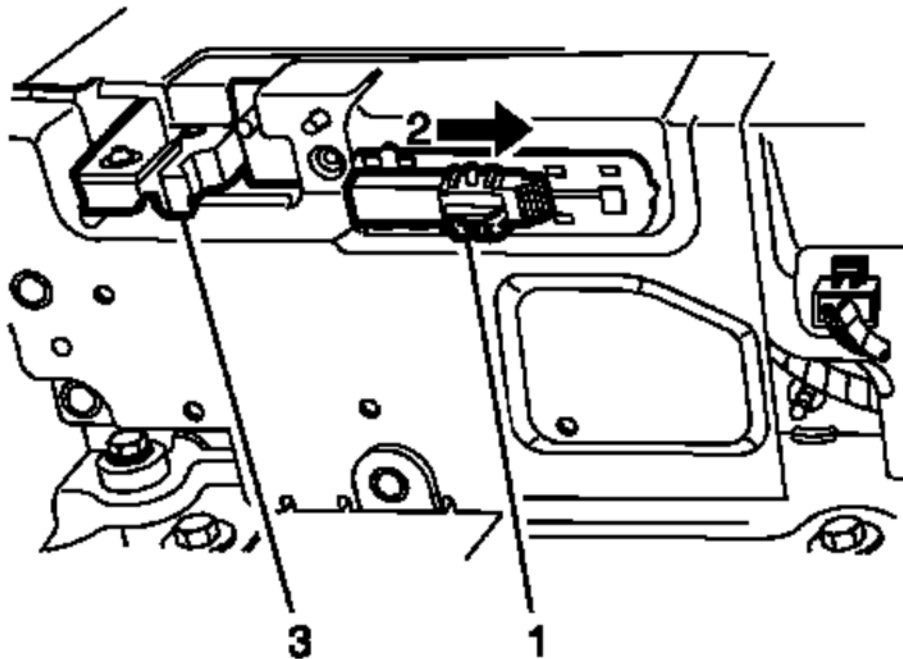


Fig. 10: Blue Connector Position Assurance
Courtesy of GENERAL MOTORS COMPANY

8. Depress the tab on the high voltage interlock switch and slide the interlock switch (2) toward the left side of the vehicle.

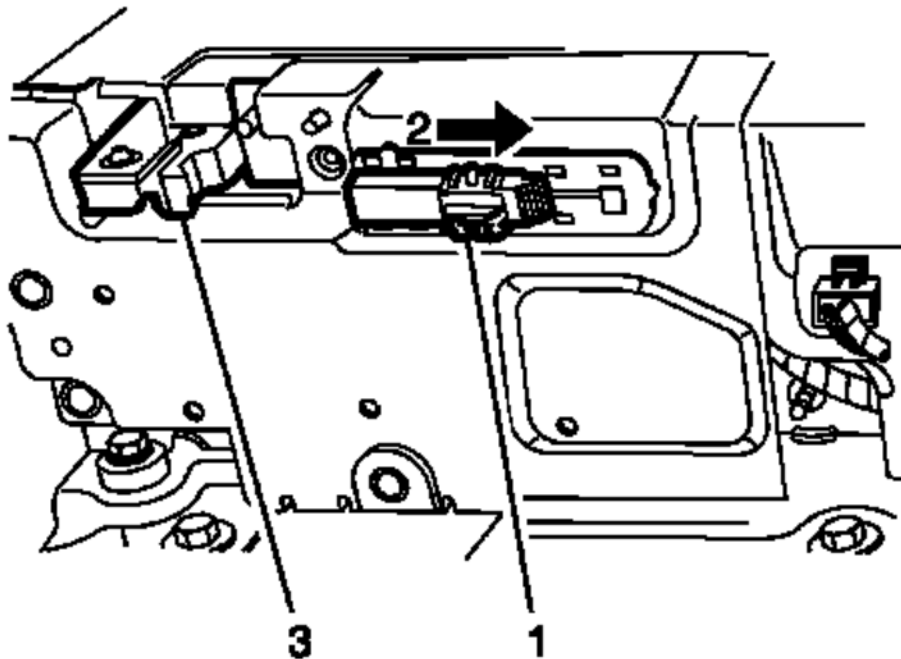


Fig. 11: Blue Connector Position Assurance
 Courtesy of GENERAL MOTORS COMPANY

9. Flip the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, located on the A4 Hybrid/EV Battery Pack, toward the right side of the vehicle and secure in the open position with a zip tie (3).

WARNING: Wear high voltage insulation gloves with leather protectors until it has been determined that a high voltage exposure risk is no longer present. Failure to follow the procedures exactly as written may result in serious injury or death.

10. Remove the F102 Hybrid/EV Battery Pack Cable Cover from the A4 Hybrid/EV Battery Pack.

NOTE: A 9 V DC battery can be used to test the DMM.

11. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.
 - If the DMM does not properly measure a 12 V battery

Repair or replace the DMM.

- If the DMM properly measures a 12 V battery

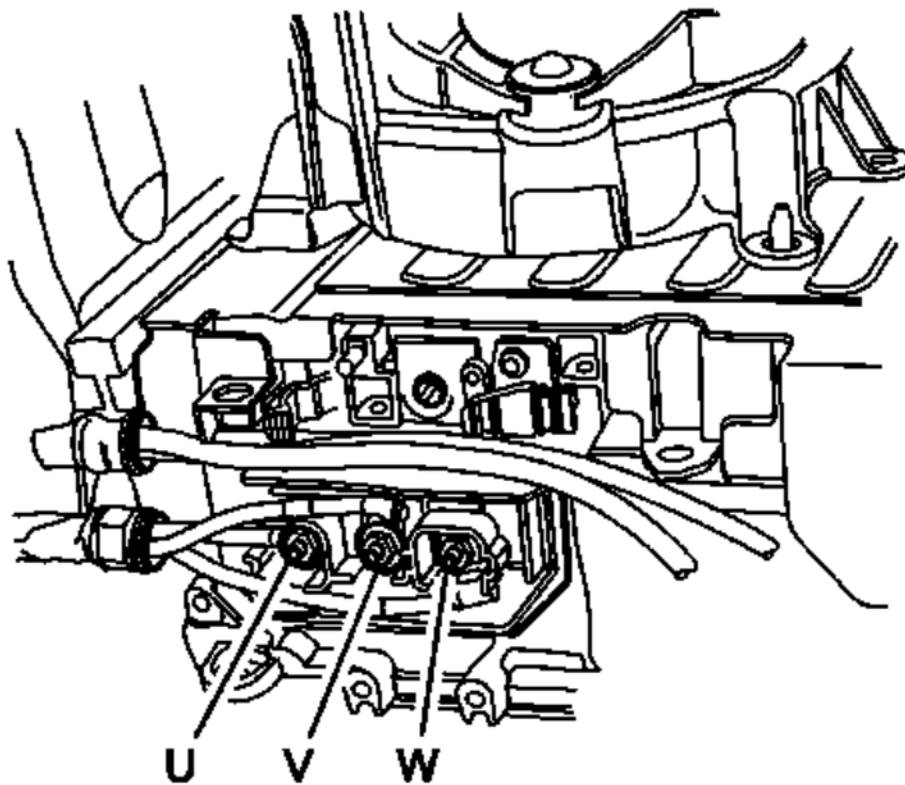


Fig. 12: Phase Terminal V, U And W
Courtesy of GENERAL MOTORS COMPANY

12. Verify that the voltage has been disabled at the energy storage system. Using the DMM on the DC voltage scale, test for less than 3 V at the following points:

- High voltage 3-Phase terminal V to vehicle chassis ground
- High voltage 3-Phase terminal W to vehicle chassis ground
- High voltage 3-Phase terminal U to vehicle chassis ground
- High voltage 3-Phase terminal U to High voltage 3-Phase terminal V
- High voltage 3-Phase terminal V to High voltage 3-Phase terminal W
- High voltage 3-Phase terminal W to High voltage 3-Phase terminal U
- If 3 V or greater

A contactor is stuck closed or a loss of isolation has occurred within the A4 Hybrid/EV Battery Pack. Refer to **Hybrid\EV Battery Voltage Present**.

- If less than 3 V

NOTE: A 9 V DC battery can be used to test the DMM.

13. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.

- If the DMM does not properly measure a 12 V battery

Repair or replace the DMM and perform Step 11 again.

- If the DMM properly measures a 12 V battery

WARNING: High voltage insulation gloves with leather protectors **MUST** be worn at all times when the A4 hybrid/EV battery pack cover has been removed. When testing within the A4 hybrid/EV battery pack, 60 V WILL be present. If the S15 hybrid/EV battery pack high voltage manual disconnect lever is compromised and stuck closed, 120 V WILL be present. Failure to follow the procedures exactly as written may result in serious injury or death.

14. Remove the A4 Hybrid/EV Battery Pack cover. Refer to Generator Control Module Cover Replacement.

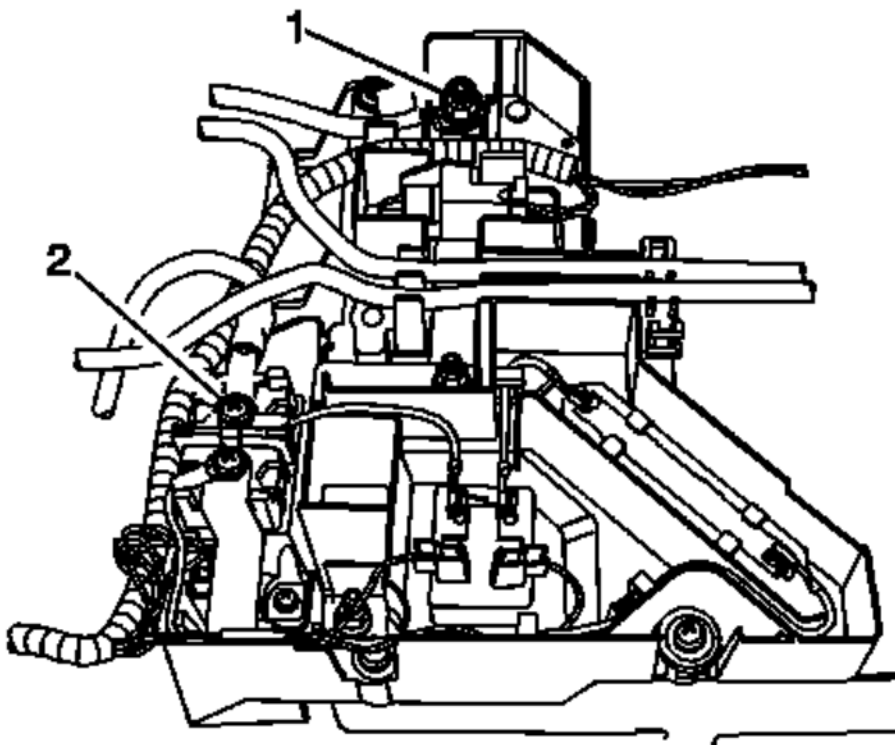


Fig. 13: High Voltage DC Terminal
Courtesy of GENERAL MOTORS COMPANY

15. Verify that the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever is functioning properly. Using the DMM on the DC voltage scale, test for less than 3 V between the High Voltage DC terminal (1) and the High Voltage DC terminal (2).

- **If 3 V or greater**

The S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever is stuck closed. Replace the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever immediately after completing this disabling procedure.

- **If less than 3 V**

WARNING: High voltage insulation gloves with leather protectors **MUST** be worn at all times when the A4 hybrid/EV battery pack cover has been removed. 120 V WILL be present at the battery terminals. Failure to follow the procedures exactly as written may result in serious injury or death.

16. Flip open the orange battery terminal covers at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

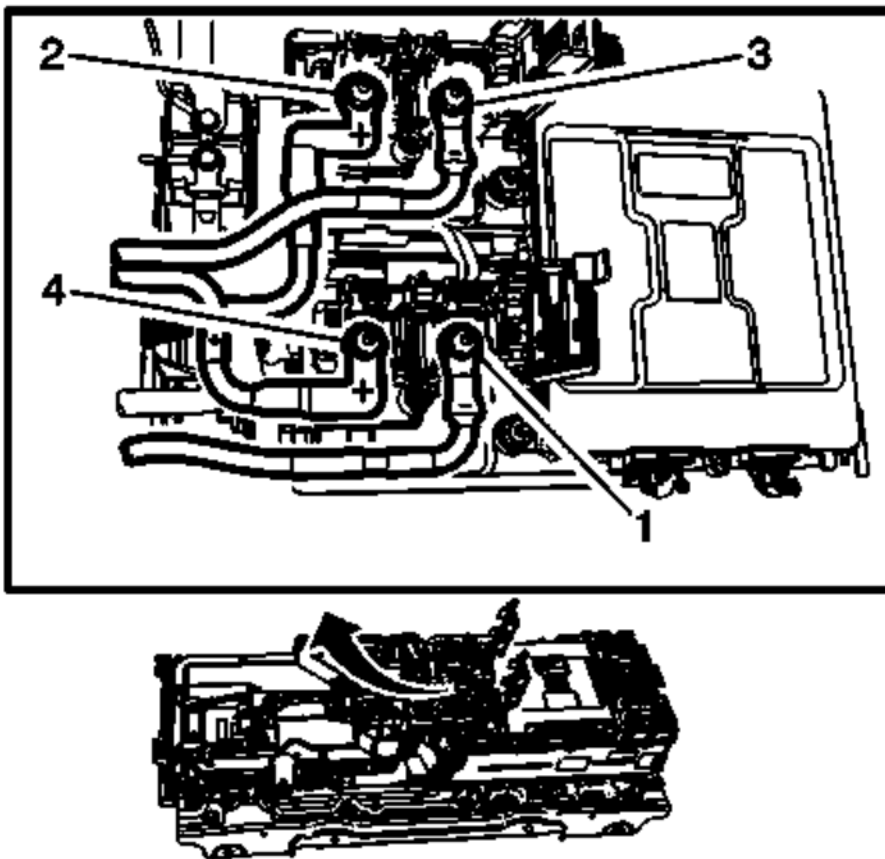


Fig. 14: C4A Hybrid/EV Battery Section And Battery Terminals
 Courtesy of GENERAL MOTORS COMPANY

17. Disconnect the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 in the order specified in the above graphic.
18. Remove the high voltage cables from the battery terminals and close the battery terminal covers, with the cables on the outside of the closed terminal covers.
19. Tape the battery terminal covers closed with UL® listed, or equivalent, insulation tape rated at a minimum of 600 V.

NOTE: A 9 V DC battery can be used to test the DMM.

20. Test the DMM by measuring a 12 V battery. The reading on the DMM should accurately reflect the battery voltage.
 - If the DMM does not properly measure a 12 V battery

Repair or replace the DMM and perform the disabling procedure again.
 - If the DMM properly measures a 12 V battery
21. Test for less than 1 ohms across the 125 A fuse located under the clear cover in the S15 Hybrid/EV

Battery Pack High Voltage Manual Disconnect Lever.

- **If 1 ohms or greater**

The 125 A fuse is open. If the fuse is open, verify the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever is also open by testing for infinite resistance across the switch terminals. Replace the fuse after high voltage testing is complete and a system repair has been made. Torque fasteners to 9 Y (80 lb in).

- **If less than 1 ohms**

22. With the high voltage cables disconnected and the battery terminal covers secured, the K59 Starter/Generator Control Module, K16 Battery Energy Control Module, S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, KR38 Main Contactor, R25 Hybrid/EV Battery Pre-Charge Resistor, KR134 Pre-Charge Contactor, B30 Hybrid/EV Battery Pack Current Sensor, C4A Hybrid/EV Battery Section 1, C4B Hybrid/EV Battery Section 2, and any components within the A4 Hybrid/EV Battery Pack can now be serviced.

HIGH VOLTAGE ENABLING

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: 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.

Review the high voltage safety information prior to performing the High Voltage Enabling procedure. Refer to **High Voltage Safety**.

1. Verify that the 12 V battery is disconnected.

- **If the 12 V battery is connected**

Disconnect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection** .

- **If the 12 V battery is disconnected**

NOTE: **Always tighten the high voltage fasteners to the specified torque. Insufficient or excessive torque will cause malfunctions or damage.**

2. After completing testing or any repairs on the high voltage systems and before closing the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever, inspect for the following:
 - Verify that all tools and loose components have been removed from the A4 Hybrid/EV Battery Pack area and all items are accounted for.
 - Verify high voltage system integrity and that all connectors are installed.
 - Install any components or connectors that have been removed or replaced during diagnosis.

WARNING: High voltage insulation gloves with leather protectors **MUST** be worn at all times when the A4 hybrid/EV battery pack cover has been removed. When testing within the A4 hybrid/EV battery pack, 60 V WILL be present. If the S15 hybrid/EV battery pack high voltage manual disconnect lever is compromised and stuck closed, 120 V WILL be present. Failure to follow the procedures exactly as written may result in serious injury or death.

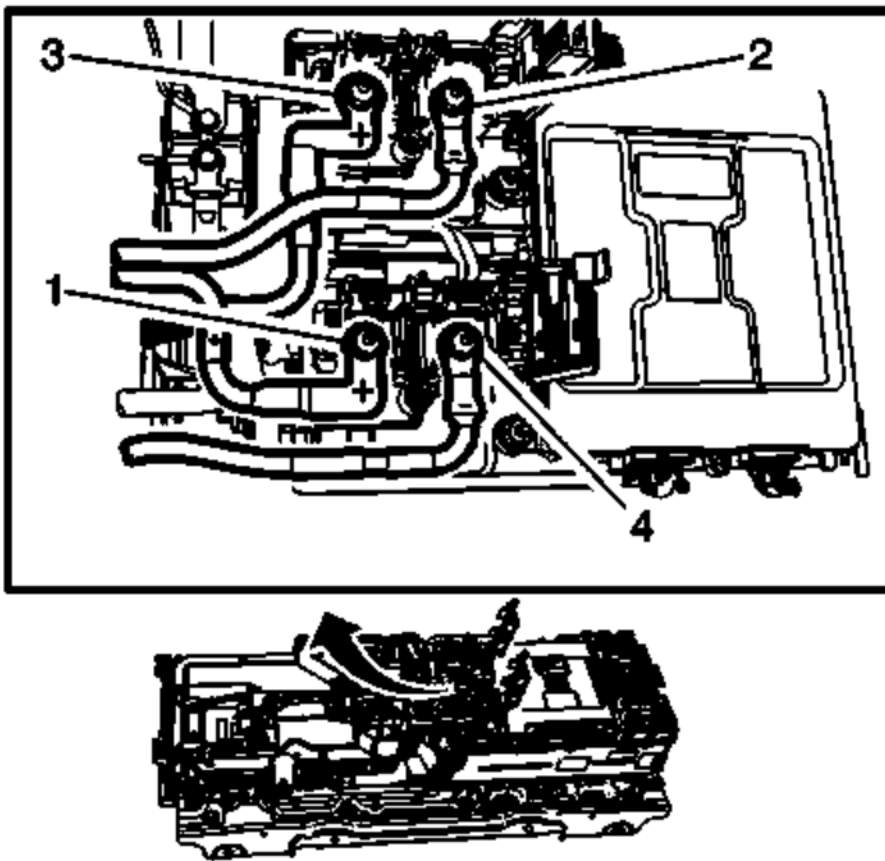


Fig. 15: C4A Hybrid/EV Battery And C4B Hybrid/EV Battery Section
 Courtesy of GENERAL MOTORS COMPANY

3. If the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 have been removed, reconnect the high voltage battery cables in the order shown above and close the battery terminal covers. Torque fasteners to 9 Y (80 lb in).
4. If the A4 Hybrid/EV Battery Pack cover has been removed, reinstall the cover. Refer to **Generator Control Module Cover Replacement**.
5. Connect the U, V, and W 3-phase cables. Torque fasteners to 9 Y (80 lb in).
6. Connect the 12 V battery cable at the K59 Starter/Generator Control Module. Torque fastener to 9 Y (80 lb in).
7. Install the F102 Hybrid/EV Battery Pack Cable Cover. Torque fastener to 9 Y (80 lb in).

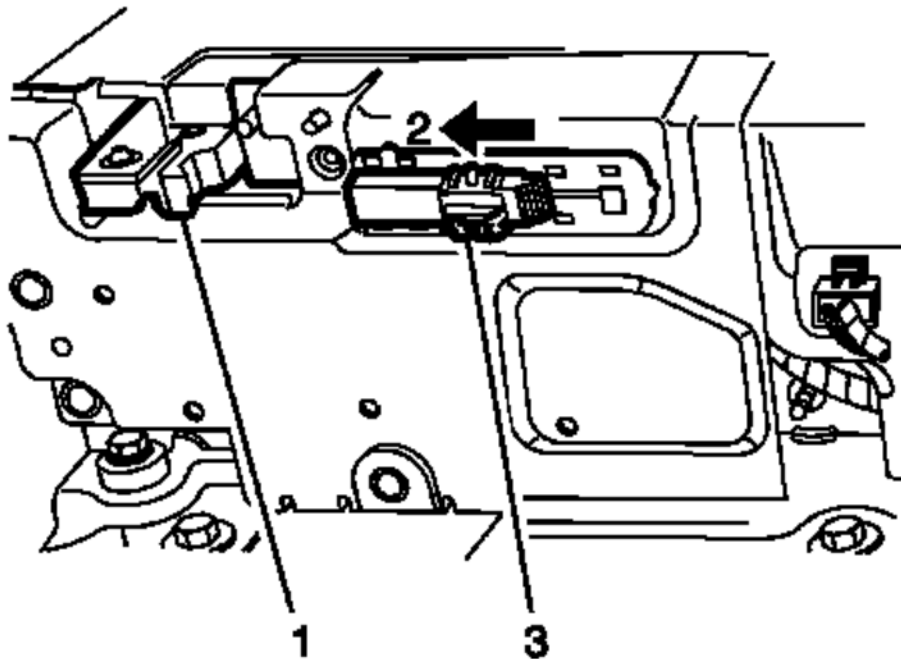


Fig. 16: S15 hybrid/EV Battery Pack High Voltage Manual Disconnect Lever
 Courtesy of GENERAL MOTORS COMPANY

8. Push in the red safety plunger and flip the S15 Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever (1) to the closed position.
9. Slide the interconnect switch (2) to the closed position and push in the blue CPA (3).
10. Connect the 12 V battery. Refer to **Battery Negative Cable Disconnection and Connection** . If a control module has been replaced, it should be programmed now. Refer to **Control Module References** .
11. Start the engine, then turn the ignition OFF.
12. Ignition ON, clear all DTC Information with a scan tool.
13. Ignition OFF, wait 2 minutes, ignition ON.
14. Verify no DTCs are set.

○ **If any DTCs are set**

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

○ **If no DTCs are set**

15. Start and idle the engine for 2 minutes.
16. Ignition OFF, wait 5 minutes, ignition ON.

17. Verify that the following DTCs have Ran Since Code Clear and have not set:

- Contactor DTCs P0ADB, P0ADC, P0AE6, or P0AE7
- Discharge and Pre-charge DTCs P0C77 or P0AFB.
- High voltage loss of isolation DTCs P0AA6 or P1AF0

○ If any of the DTCs are set

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

○ If any of the DTCs have not Ran Since Code Clear

Review and operate the vehicle according to the DTC Conditions for Running and ensure the DTCs run and pass.

○ If all the DTCs have Ran Since Code Clear and are not set

18. All OK.

DIAGNOSTIC CODE INDEX

DIAGNOSTIC CODE INDEX

DTC	Description
<u>DTC P0641</u>	DTC P0641 5V Reference 1 Circuit
<u>DTC P0651, P0A0C, or P0A0D</u>	DTC P0651 5V Reference 2 Circuit DTC P0A0C High Voltage System Interlock Circuit 1 Low Voltage DTC P0A0D High Voltage System Interlock Circuit 1 High Voltage
<u>DTC P0A1F, P1A01, P1A05, P1A06, or P1A5C</u>	DTC P0A1F Battery Energy Control Module Performance DTC P1A01 Battery Energy Control Module Long Term Memory Performance DTC P1A05 Battery Energy Control Module Random Access Memory DTC P1A06 Battery Energy Control Module Read Only Memory DTC P1A5C Battery Energy Control Module Main Processor Performance
<u>DTC P0A80</u>	DTC P0A80 Replace Hybrid/EV Battery Pack
<u>DTC P0AA6</u>	DTC P0AA6 Hybrid/EV Battery Voltage System Isolation Lost
<u>DTC P0AA8-P0AAA</u>	DTC P0AA8 Hybrid/EV Battery Voltage Isolation Sensing Performance DTC P0AA9 Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage DTC P0AAA Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 High Voltage

<u>DTC P0ABB, P0ABC, or P0ABD</u>	DTC P0ABB Hybrid/EV Battery Voltage Sensor Performance DTC P0ABC Hybrid/EV Battery Voltage Sensor Circuit Low Voltage DTC P0ABD Hybrid/EV Battery Voltage Sensor Circuit High Voltage
<u>DTC P0AC1, P0AC2, P1A07, or P1EBA</u>	DTC P0AC1 Hybrid/EV Battery Current Sensor Circuit Low Voltage DTC P0AC2 Hybrid/EV Battery Current Sensor Circuit High Voltage DTC P1A07 Battery Energy Control Module 5V Reference Circuit DTC P1EBA Hybrid/EV Battery Current Sensor Exceeded Learning Limit
<u>DTC P0ADB or P0ADC</u>	DTC P0ADB Hybrid/EV Battery Positive Contactor Control Circuit Low Voltage DTC P0ADC Hybrid/EV Battery Positive Contactor Control Circuit High Voltage
<u>DTC P0AE6 or P0AE7</u>	DTC P0AE6 Hybrid/EV Battery Precharge Contactor Control Circuit Low Voltage DTC P0AE7 Hybrid/EV Battery Precharge Contactor Control Circuit High Voltage
<u>DTC P0AF8</u>	DTC P0AF8 Hybrid/EV System Voltage
<u>DTC P0AFA or P0AFB</u>	DTC P0AFA Hybrid/EV Battery System Voltage Low Voltage DTC P0AFB Hybrid/EV Battery System Voltage High Voltage
	DTC P0B3B Hybrid/EV Battery 1 Circuit Performance DTC P0B3C Hybrid/EV Battery 1 Circuit Performance DTC P0B3D Hybrid/EV Battery 1 Circuit Low Voltage DTC P0B3E Hybrid/EV Battery 1 Circuit High Voltage DTC P0B40 Hybrid/EV Battery 2 Circuit Performance DTC P0B41 Hybrid/EV Battery 2 Circuit Performance DTC P0B42 Hybrid/EV Battery 2 Circuit Low Voltage DTC P0B43 Hybrid/EV Battery 2 Circuit High Voltage DTC P0B45 Hybrid/EV Battery 3 Circuit Performance DTC P0B46 Hybrid/EV Battery 3 Circuit Performance DTC P0B47 Hybrid/EV Battery 3 Circuit Low Voltage DTC P0B48 Hybrid/EV Battery 3 Circuit High Voltage

Voltage
DTC P0B4A Hybrid/EV Battery 4 Circuit
DTC P0B4B Hybrid/EV Battery 4 Circuit
Performance
DTC P0B4C Hybrid/EV Battery 4 Circuit Low
Voltage
DTC P0B4D Hybrid/EV Battery 4 Circuit High
Voltage
DTC P0B4F Hybrid/EV Battery 5 Circuit
DTC P0B50 Hybrid/EV Battery 5 Circuit
Performance
DTC P0B51 Hybrid/EV Battery 5 Circuit Low
Voltage
DTC P0B52 Hybrid/EV Battery 5 Circuit High
Voltage
DTC P0B54 Hybrid/EV Battery 6 Circuit
DTC P0B55 Hybrid/EV Battery 6 Circuit
Performance
DTC P0B56 Hybrid/EV Battery 6 Circuit Low
Voltage
DTC P0B57 Hybrid/EV Battery 6 Circuit High
Voltage
DTC P0B59 Hybrid/EV Battery 7 Circuit
DTC P0B5A Hybrid/EV Battery 7 Circuit
Performance
DTC P0B5B Hybrid/EV Battery 7 Circuit Low
Voltage
DTC P0B5C Hybrid/EV Battery 7 Circuit High
Voltage
DTC P0B5E Hybrid/EV Battery 8 Circuit
DTC P0B5F Hybrid/EV Battery 8 Circuit
Performance
DTC P0B60 Hybrid/EV Battery 8 Circuit Low
Voltage
DTC P0B61 Hybrid/EV Battery 8 Circuit High
Voltage
DTC P0B63 Hybrid/EV Battery 9 Circuit
DTC P0B64 Hybrid/EV Battery 9 Circuit
Performance
DTC P0B65 Hybrid/EV Battery 9 Circuit Low
Voltage
DTC P0B66 Hybrid/EV Battery 9 Circuit High
Voltage
DTC P0B68 Hybrid/EV Battery 10 Circuit
DTC P0B69 Hybrid/EV Battery 10 Circuit
Performance
DTC P0B6A Hybrid/EV Battery 10 Circuit Low
Voltage

DTC P0B3B-P0BBB, P1B16-P1B2D, P1B3D, or

P1B3E

DTC P0B6B Hybrid/EV Battery 10 Circuit High Voltage
DTC P0B6D Hybrid/EV Battery 11 Circuit
DTC P0B6E Hybrid/EV Battery 11 Circuit Performance
DTC P0B6F Hybrid/EV Battery 11 Circuit Low Voltage
DTC P0B70 Hybrid/EV Battery 11 Circuit High Voltage
DTC P0B72 Hybrid/EV Battery 12 Circuit
DTC P0B73 Hybrid/EV Battery 12 Circuit Performance
DTC P0B74 Hybrid/EV Battery 12 Circuit Low Voltage
DTC P0B75 Hybrid/EV Battery 12 Circuit High Voltage
DTC P0B77 Hybrid/EV Battery 13 Circuit
DTC P0B78 Hybrid/EV Battery 13 Circuit Performance
DTC P0B79 Hybrid/EV Battery 13 Circuit Low Voltage
DTC P0B7A Hybrid/EV Battery 13 Circuit High Voltage
DTC P0B7C Hybrid/EV Battery 14 Circuit
DTC P0B7D Hybrid/EV Battery 14 Circuit Performance
DTC P0B7E Hybrid/EV Battery 14 Circuit Low Voltage
DTC P0B7F Hybrid/EV Battery 14 Circuit High Voltage
DTC P0B81 Hybrid/EV Battery 15 Circuit
DTC P0B82 Hybrid/EV Battery 15 Circuit Performance
DTC P0B83 Hybrid/EV Battery 15 Circuit Low Voltage
DTC P0B84 Hybrid/EV Battery 15 Circuit High Voltage
DTC P0B86 Hybrid/EV Battery 16 Circuit
DTC P0B87 Hybrid/EV Battery 16 Circuit Performance
DTC P0B88 Hybrid/EV Battery 16 Circuit Low Voltage
DTC P0B89 Hybrid/EV Battery 16 Circuit High Voltage
DTC P0B8B Hybrid/EV Battery 17 Circuit
DTC P0B8C Hybrid/EV Battery 17 Circuit Performance
DTC P0B8D Hybrid/EV Battery 17 Circuit Low

Voltage
DTC P0B8E Hybrid/EV Battery 17 Circuit High Voltage
DTC P0B90 Hybrid/EV Battery 18 Circuit
DTC P0B91 Hybrid/EV Battery 18 Circuit Performance
DTC P0B92 Hybrid/EV Battery 18 Circuit Low Voltage
DTC P0B93 Hybrid/EV Battery 18 Circuit High Voltage
DTC P0B95 Hybrid/EV Battery 19 Circuit
DTC P0B96 Hybrid/EV Battery 19 Circuit Performance
DTC P0B97 Hybrid/EV Battery 19 Circuit Low Voltage
DTC P0B98 Hybrid/EV Battery 19 Circuit High Voltage
DTC P0B9A Hybrid/EV Battery 20 Circuit
DTC P0B9B Hybrid/EV Battery 20 Circuit Performance
DTC P0B9C Hybrid/EV Battery 20 Circuit Low Voltage
DTC P0B9D Hybrid/EV Battery 20 Circuit High Voltage
DTC P0B9F Hybrid/EV Battery 21 Circuit
DTC P0BA0 Hybrid/EV Battery 21 Circuit Performance
DTC P0BA1 Hybrid/EV Battery 21 Circuit Low Voltage
DTC P0BA2 Hybrid/EV Battery 21 Circuit High Voltage
DTC P0BA4 Hybrid/EV Battery 22 Circuit
DTC P0BA5 Hybrid/EV Battery 22 Circuit Performance
DTC P0BA6 Hybrid/EV Battery 22 Circuit Low Voltage
DTC P0BA7 Hybrid/EV Battery 22 Circuit High Voltage
DTC P0BA9 Hybrid/EV Battery 23 Circuit
DTC P0BAA Hybrid/EV Battery 23 Circuit Performance
DTC P0BAB Hybrid/EV Battery 23 Circuit Low Voltage
DTC P0BAC Hybrid/EV Battery 23 Circuit High Voltage
DTC P0BAE Hybrid/EV Battery 24 Circuit
DTC P0BAF Hybrid/EV Battery 24 Circuit Performance

DTC P0BB0 Hybrid/EV Battery 24 Circuit Low Voltage
DTC P0BB1 Hybrid/EV Battery 24 Circuit High Voltage
DTC P0BB3 Hybrid/EV Battery 25 Circuit
DTC P0BB4 Hybrid/EV Battery 25 Circuit Performance
DTC P0BB5 Hybrid/EV Battery 25 Circuit Low Voltage
DTC P0BB6 Hybrid/EV Battery 25 Circuit High Voltage
DTC P0BB8 Hybrid/EV Battery 26 Circuit
DTC P0BB9 Hybrid/EV Battery 26 Circuit Performance
DTC P0BBA Hybrid/EV Battery 26 Circuit Low Voltage
DTC P0BBB Hybrid/EV Battery 26 Circuit High Voltage
DTC P1B16 Hybrid/EV Battery 27 Circuit Performance
DTC P1B17 Hybrid/EV Battery 27 Circuit Low Voltage
DTC P1B18 Hybrid/EV Battery 27 Circuit High Voltage
DTC P1B19 Hybrid/EV Battery 28 Circuit Performance
DTC P1B1A Hybrid/EV Battery 28 Circuit Low Voltage
DTC P1B1B Hybrid/EV Battery 28 Circuit High Voltage
DTC P1B1C Hybrid/EV Battery 29 Circuit Performance
DTC P1B1D Hybrid/EV Battery 29 Circuit Low Voltage
DTC P1B1E Hybrid/EV Battery 29 Circuit High Voltage
DTC P1B1F Hybrid/EV Battery 30 Circuit Performance
DTC P1B20 Hybrid/EV Battery 30 Circuit Low Voltage
DTC P1B21 Hybrid/EV Battery 30 Circuit High Voltage
DTC P1B22 Hybrid/EV Battery 31 Circuit Performance
DTC P1B23 Hybrid/EV Battery 31 Circuit Low Voltage
DTC P1B24 Hybrid/EV Battery 31 Circuit High Voltage

	DTC P1B25 Hybrid/EV Battery 32 Circuit Performance DTC P1B26 Hybrid/EV Battery 32 Circuit Low Voltage DTC P1B27 Hybrid/EV Battery 32 Circuit High Voltage DTC P1B28 Hybrid/EV Battery 27 Circuit DTC P1B29 Hybrid/EV Battery 28 Circuit DTC P1B2A Hybrid/EV Battery 29 Circuit DTC P1B2B Hybrid/EV Battery 30 Circuit DTC P1B2C Hybrid/EV Battery 31 Circuit DTC P1B2D Hybrid/EV Battery 32 Circuit DTC P1B3D Hybrid/EV Battery Voltage Sense Low Reference 1 Circuit DTC P1B3E Hybrid/EV Battery Voltage Sense Low Reference 2 Circuit
<u>DTC P0BBE</u>	DTC P0BBE Hybrid/EV Battery Pack Voltage
<u>DTC P0C77 or P0C78</u>	DTC P0C77 Hybrid/EV Battery System Precharge Time Too Short DTC P0C78 Hybrid/EV Battery System Precharge Time Too Long
<u>DTC P1A0C</u>	DTC P1A0C Battery Energy Control Module System Voltage Low Voltage
<u>DTC P1A5D</u>	DTC P1A5D Battery Energy Control Module 5V Reference 2 Circuit
<u>DTC P1A5E or P1A5F</u>	DTC P1A5E Battery Energy Control Module Ignition On/Start Switch Circuit Low Voltage DTC P1A5F Battery Energy Control Module Ignition On/Start Switch Circuit High Voltage
<u>DTC P1A60</u>	DTC P1A60 Battery Energy Control Module Ignition Accessory Switch Circuit Low Voltage
<u>DTC P1B11</u>	DTC P1B11 Drive Motor Control Module Hybrid/EV AC Voltage System Isolation Lost
<u>DTC P1B33-P1B39</u>	DTC P1B33 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Circuit DTC P1B34 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 1 Performance DTC P1B35 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 2 Performance DTC P1B36 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 3 Performance DTC P1B37 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 4 Performance

	DTC P1B38 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 5 Performance DTC P1B39 Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 6 Performance
<u>DTC P1B3F or P1B40</u>	DTC P1B3F High Voltage System Interlock Circuit 2 Low Voltage DTC P1B40 High Voltage System Interlock Circuit 2 High Voltage
<u>DTC P1E0C or P1E0D</u>	DTC P1E0C Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage DTC P1E0D Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 High Voltage
<u>DTC P1E0F-P1E11</u>	DTC P1E0F Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 Low Voltage DTC P1E10 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 High Voltage DTC P1E11 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 Performance
<u>DTC P1E12-P1E14</u>	DTC P1E12 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Low Voltage DTC P1E13 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 High Voltage DTC P1E14 Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Performance
<u>DTC P1E3D</u>	DTC P1E3D Control Module Calculated Hybrid/EV Battery Performance
<u>DTC P1EAA</u>	DTC P1EAA Hybrid/EV Battery Voltage Balance Processor Multiplexer Performance
<u>DTC P1EAB</u>	DTC P1EAB Battery Energy Control Module Hybrid/EV Battery Cell High Voltage
<u>DTC P1EAC</u>	DTC P1EAC Hybrid/EV Battery Cell Overvoltage Signal Circuit Performance
<u>DTC P1EC0</u>	DTC P1EC0 Hybrid/EV Battery System Contactor (s) Stuck Open

DTC P0641

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 P0641

5V Reference 1 Circuit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P057C, P1B3F	P1B3F	P0641, P1B40	-
Signal	P1B3F	P1B3F	P1B40	-

Circuit/System Description

The high voltage interlock circuits are utilized to verify high voltage component integrity. The high voltage interlock circuits are two circuit loops that pass through certain high voltage components. The high voltage interlock circuits are used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes the high voltage interlock circuit to open. The Starter/Generator Control Module monitors both the high voltage interlock 5 V reference circuit voltage and the high voltage interlock signal circuit voltage in order to detect circuit faults. When the Starter/Generator Control Module detects a loss of high voltage interlock circuit voltage, the high voltage contactors are commanded open.

The service cover for the Starter/Generator and the service cover for the Hybrid/EV Battery Pack each contain a high voltage interlock switch. When either cover is removed, the Starter/Generator Control Module will respond by opening the high voltage contacts. The 5 V reference circuits and signal circuits for each of the two high voltage interlock loops are completely separate from one another and are monitored as two separate loops, with each setting a specific DTC to indicate a circuit fault. The 5 V reference circuit that feeds the high voltage interlock switch on the Starter/Generator also supplies the 5 V reference to the Brake Pedal Position Sensor.

Conditions for Running the DTC

Ignition voltage is greater than 10 V

Conditions for Setting the DTC

Voltage on the 5 V reference circuit 1 is less than 4.39 V or greater than 5.43 V

Action Taken When the DTC Sets

DTCs P0641 is a type A DTC

Conditions for Clearing the DTC

DTCs P0641 is a type A DTC

Diagnostic Aids

- When a circuit fault is detected on the high voltage interlock loop that feeds the Starter/Generator and the

vehicle hood is opened, the Starter/Generator Control Module will respond by turning off inverter switching. This will prevent the Starter/Generator from charging the Hybrid/EV Battery Pack and supplying voltage to the Starter/Generator Control Module 12 V output. Operating in this manner will cause an eventual discharge of both the high voltage Hybrid/EV Battery Pack and the 12 V battery.

- Because the 5 V reference circuit also supplies voltage to the brake pedal position sensor, a circuit fault on the high voltage interlock loop that feeds the Starter/Generator will also cause hybrid functions that rely on the brake pedal position, such as auto-stop and regenerative braking, to be disabled.

Reference Information

Schematic Reference

- **Hybrid/EV Energy Storage Schematics**
- **Exterior Lights 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

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

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the harness connector at the B22 Brake Pedal Position Sensor and disconnect the X1 harness connector at the A15 Starter/Generator, ignition ON.
2. Test for 4.3-5.5 V between the A15 Starter/Generator 5 V reference circuit terminal 12 X1 and ground.
 - If less than 4.3 V
 1. Ignition OFF, disconnect the X2 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the A15 Starter/Generator 5 V reference circuit terminal 12 X1 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for infinite resistance between the B22 Brake Pedal Position Sensor 5 V reference circuit

terminal 6 and ground.

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

4. Test for less than 2 ohms in the A15 Starter/Generator 5 V reference circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K59 Starter/Generator Control Module.

○ **If greater than 5.5 V**

1. Ignition OFF, disconnect the X2 harness connector at the K59 Starter/Generator Control Module.

2. Test for less than 1 V between the A15 Starter/Generator 5 V reference circuit terminal 12 X1 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V

3. Test for less than 1 V between the B22 Brake Pedal Position Sensor 5 V reference circuit terminal 6 and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the K59 Starter/Generator Control Module.

○ **If between 4.3-5.5 V**

3. Ignition OFF, connect the harness connector at the A15 Starter/Generator, ignition ON.

4. Verify DTC P0641 does not set while operating the vehicle within the conditions for running the DTC.

○ **If the DTC sets**

Replace the A15 Starter/Generator.

○ **If the DTC does not set**

5. Test or replace the B22 Brake Pedal Position Sensor.

Repair Instructions

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

- **Starter Generator Replacement**
- **Brake Pedal Position Sensor Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P0651, P0A0C, OR P0A0D

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 P0651

5V Reference 2 Circuit

DTC P0A0C

High Voltage System Interlock Circuit 1 Low Voltage

DTC P0A0D

High Voltage System Interlock Circuit 1 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0651, P0A0C	P0A0C	P0651, P0A0D	-
Signal	P0A0C	P0A0C	P0651, P0A0D	-

Circuit/System Description

The high voltage interlock circuit is utilized to verify high voltage component integrity. High voltage interlock circuit is a circuit loop that passes through certain high voltage components. High voltage interlock circuit is used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes high voltage interlock circuit to open. The starter/generator control module monitors both the high voltage interlock 5 V reference circuit voltage and the high voltage interlock signal circuit voltage in order to detect circuit faults. When the starter/generator control module detects a loss of high voltage interlock circuit voltage, the high voltage contactors are commanded open.

Conditions for Running the DTC

Battery voltage is greater than 6 V

Conditions for Setting the DTC

DTC P0651

Voltage on the 5 V reference circuit 2 is less than 4.39 V or greater than 4.61 V

DTC P0A0C

Voltage on the high voltage interlock signal circuit is less than 0.5 V

DTC P0A0D

Voltage on the high voltage interlock signal circuit is greater than 4.5 V

Action Taken When the DTC Sets

DTCs P0651, P0A0C, and P0A0D are type B DTCs

Conditions for Clearing the DTC

DTCs P0651, P0A0C, and P0A0D are type B DTCs

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery, ignition ON.

NOTE: Testing is performed at the interlock connector that the F102 Hybrid/EV Battery Pack Cable Cover secures to. The F102 Hybrid/EV Battery Pack Cable Cover was removed as part of the high voltage disabling procedure.

4. Test for 4.8-5.2 V between the 5 V reference circuit terminal A and ground.

○ **If less than 4.8 V**

1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4 harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.
2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
3. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
4. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.

○ **If greater than 5.2 V**

1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4 harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.
2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
3. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.

○ **If between 4.8-5.2 V**

5. Verify DTC P0A0D is not set.

○ **If the DTC is set**

1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4 harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.
2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
3. Test for less than 1 V between the signal circuit terminal B and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.

○ **If the DTC is not set**

6. Ignition OFF, connect a 3 A fused jumper wire between the 5 V reference circuit terminal A and the signal circuit terminal B, ignition ON.

7. Verify DTC P0A0C is not set.

○ **If the DTC is set**

1. Ignition OFF, disable high voltage at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. Refer to **High Voltage Disabling**. Perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. This will allow for safe access to the X4

harness connector, which is located under the A4 Hybrid/EV Battery Pack cover.

2. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
3. Test for infinite resistance between the signal circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
- **If the DTC is not set**
8. Test or replace the F102 Hybrid/EV Battery Pack Cable Cover.

Component Testing

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.

NOTE:

- The high voltage interlock switch is part of the F102 Hybrid/EV Battery Pack Cable Cover, which was removed as part of the High Voltage Disabling procedure.
- Slightly flexing the switch while performing the measurement may assist in identifying a damaged switch.

2. Test for 2.850k to 3.150k ohms between the high voltage interlock switch terminal A and terminal B.
 - **If not between 2.850k and 3.150k ohms**

Replace the F102 Hybrid/EV Battery Pack Cable Cover.

- **If between 2.850k and 3.150k ohms**
3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Generator Control Module Cable Cover Replacement
- Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2), Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)
- Control Module References for starter/generator control module replacement, programming, and setup

DTC P0A1F, P1A01, P1A05, P1A06, OR P1A5C

Diagnostic Instructions

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

- Review **Strategy Based Diagnosis** for an overview of the diagnostic approach.
- **Diagnostic Procedure Instructions** provides an overview of each diagnostic category.

DTC Descriptors

DTC P0A1F

Battery Energy Control Module Performance

DTC P1A01

Battery Energy Control Module Long Term Memory Performance

DTC P1A05

Battery Energy Control Module Random Access Memory

DTC P1A06

Battery Energy Control Module Read Only Memory

DTC P1A5C

Battery Energy Control Module Main Processor Performance

Circuit/System Description

The Battery Energy Control Module performs various internal fault detection test to determine if a software or hardware concern exists within the module. No external circuits are involved.

Conditions for Running the DTC

P0A1F, P1A01, P1A05, P1A06

12 V battery voltage is greater than 8.8 V.

P1A5C

- Ignition ON
- 12 V battery voltage is greater than 8.8 V.

Conditions for Setting the DTC

An internal fault is detected in the Battery Energy Control Module.

Action Taken When the DTC Sets

No action is taken.

Conditions for Clearing the DTC

No internal faults are detected in the Battery Energy Control Module.

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1A01, P1A05, P1A06, or P1A5C is not set.

- If any of the DTCs are set

Replace the K16 Battery Energy Control Module

- If none of the DTCs are set

3. All OK.

Repair Instructions

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

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P0A80

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 P0A80

Replace Hybrid/EV Battery Pack

Circuit/System Description

The Starter/Generator Control Module monitors the internal battery resistance of the battery pack as a means to determine if the battery has reached its end of life.

Conditions for Running the DTC

- Average battery temperature is greater than -10° C.
- Battery state estimator mode is active.
- Battery state of charge is greater than 10%, but less than 90%.
- None of the following DTCs are set: P0A9C, P0A9D, P0A9E, P0AC6, P0AC7, P0AC8, P0ACB, P0ACC, P0ACD, P0AE9, P0AEA, P0AEB, P0B45, P0B46, P0B47, P0B48, P0B4F, P0B50, P0B51, P0B52, P0B63, P0B64, P0B65, P0B66, P0B95, P0B96, P0B97, P0B98, P0B9F, P0BA0, P0BA1, P0BA2, P0BC3, P0BC4, P0BC5, P0C34, P0C35, P0C36, P1ASD, or P1A5D.

Conditions for Setting the DTC

The battery pack internal resistance is greater than the end of life battery pack resistance.

Action Taken When the DTC Sets

DTC P0A80 is a type A DTC.

Conditions for Clearing the DTC

DTC P0A80 is a type A 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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P0A80 is not set.
 - If the DTC is set

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

- If the DTC is not set
3. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Generator Battery Replacement

DTC P0AA6

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 P0AA6

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. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

- Engine idling
- Contactors are closed

Conditions for Setting the DTC

Active isolation resistance is less than 150 kohms

OR

Case isolation resistance is less than 300 kohms

Action Taken When the DTC Sets

- DTC P0AA6 is a type A DTC.
- If the DTC sets while there is a loss of communication with the Inflatable Restraint Sensing and Diagnostic Module, 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 P0AA6 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

Connector End View Reference

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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
- **EL-50772** Insulation Multimeter

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.

- If greater than 400K ohms

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

- Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud
 - 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
 - Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
 - Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms
 - Replace the two wiring junction blocks.
 - **If greater than 400K ohms**
- Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

Repair Instructions

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

- **Drive Motor Generator Battery Cable Replacement**
- **Starter Generator Replacement**
- **Generator Battery Replacement**
- **Drive Motor Battery Wire Junction Block Relay Replacement**
- **Control Module References** for Starter/Generator Control Module replacement, programming, and setup

DTC P0AA8-P0AAA

Diagnostic Instructions

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

DTC Descriptors

DTC P0AA8

Hybrid/EV Battery Voltage Isolation Sensing Performance

DTC P0AA9

Hybrid/EV Battery Voltage Isolation Sensing Circuit 1 Low Voltage

DTC P0AAA

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 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. These voltage values are used by the starter/generator control module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P0AA8

- Power mode is RUN or CRANK.
- The starter/generator control module internal voltage sensor has no reported faults.
- None of the following DTCs are set: P0AA9, P0AAA, P1E0C, or P1E0D.

P0AA9

- Power mode is RUN or CRANK.
- Contactors are closed.

P0AAA

- Power mode is RUN or CRANK.
- None of the following DTCs are set: P0AA9, P0AAA, P1E0C, or P1E0D.

Conditions for Setting the DTC

P0AA8

The difference between the voltage measured at the starter/generator control module internal motor control processor and the sum of the mid-pack voltage positive sensor value and mid-pack voltage negative sensor value is greater than 15 V.

P0AA9

Voltage measured at the negative mid-pack voltage sensor is less than 5 V.

P0AAA

The difference between the voltage measured at the negative mid-pack voltage sensor and the starter/generator control module internal motor control processor high voltage value is greater than 15 V.

Action Taken When the DTC Sets

- DTCs P0AA8-P0AAA are type B DTCs.
- If the DTC sets while there is a loss of communication with the inflatable restraint 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

- DTCs P0AA8-P0AAA are type B DTCs.
- 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

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P0AA8, P0AA9, or P0AAA is not set.
 - **If any of the DTCs are set**

Replace the K59 Starter/Generator Control Module.

- **If none of the DTCs are set**
3. All OK.

Repair Instructions

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

Control Module References for starter/generator control module replacement, programming, and setup

DTC P0ABB, P0ABC, OR P0ABD

Diagnostic Instructions

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

DTC Descriptors

DTC P0ABB

Hybrid/EV Battery Voltage Sensor Performance

DTC P0ABC

Hybrid/EV Battery Voltage Sensor Circuit Low Voltage

DTC P0ABD

Hybrid/EV Battery Voltage Sensor Circuit High Voltage

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense

circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack. The Battery Energy Control Module also monitors the Hybrid/EV Battery Pack voltage in its entirety. The Battery Energy Control Module compares the voltage of the entire pack to that of the sum of the voltages measured at each cell.

Diagnostics and system status are communicated from the Battery Energy Control Module to Hybrid Powertrain Control Module through serial data.

Conditions for Running the DTC

P0ABB

None of the following DTCs are set: P0ABC, P0ABD, P0B3D, P0B42, P0B47, P0B4C, P0B51, P0B56, P0B5B, P0B60, P0B65, P0B6A, P0B6F, P0B74, P0B79, P0B7E, P0B83, P0B88, P0B8D, P0B92, P0B97, P0B9C, P0BA1, P0BA6, P0BAB, P0BB0, P0BB5, P0BBA, P1B17, P1B1A, P1B1D, P1B20, P1B23, P1B26, P0B3E, P0B43, P0B48, P0B4D, P0B52, P0B57, P0B5C, P0B61, P0B66, P0B6B, P0B70, P0B75, P0B7A, P0B7F, P0B84, P0B89, P0B8E, P0B93, P0B98, P0B9D, P0BA2, P0BA7, P0BAC, P0BB1, P0BB6, P0BBB, P1B18, P1B1B, P1B1E, P1B21, P1B24, P1B27, P0B3B, P0B40, P0B45, P0B4A, P0B4F, P0B54, P0B59, P0B5E, P0B63, P0B68, P0B6D, P0B72, P0B77, P0B7C, P0B81, P0B86, P0B8B, P0B90, P0B95, P0B9A, P0B9F, P0BA4, P0BA9, P0BAE, P0BB3, P0BB8, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D, P0B3C, P0B41, P0B46, P0B4B, P0B50, P0B55, P0B5A, P0B5F, P0B64, P0B69, P0B6E, P0B73, P0B78, P0B7D, P0B82, P0B87, P0B8C, P0B91, P0B96, P0B9B, P0BA0, P0BA5, P0BAA, P0BAF, P0BB4, P0BB9, P1B16, P1B19, P1B1C, P1B1F, P1B22, P1B25.

P0ABC or P0ABD

- Battery voltage is greater than 9.6 V.
- Battery energy control module is awake and communicating.

Conditions for Setting the DTC

P0ABB

The calculated battery pack voltage based on the average cell voltage values is more than 5.49 V different than the actual measured battery pack voltage.

P0ABC

The battery pack voltage is less than 30 V.

P0ABD

The battery pack voltage is greater than 190 V.

Action Taken When the DTC Sets

- DTCs P0ABB, P0ABC, and P0ABD are type B DTCs.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid

functions will occur.

Conditions for Clearing the DTC

DTCs P0ABB, P0ABC, and P0ABD are type B DTCs.

Diagnostic Aids

Opening the service disconnect without first disconnecting the 12 V battery or reconnecting the 12 V battery while the service disconnect is open may result in the setting of DTC P0ABB or P0ABC. Due to the nature of the Hybrid/EV Battery Pack design, the vehicle's 12 V electrical system will continue to discharge the high voltage battery, even though the service disconnect is open. This will eventually lower the voltage of the Hybrid/EV Battery Pack and set DTC P0ABB or P0ABC. If this occurs, close the service disconnect and operate the vehicle as normal. The Hybrid/EV Battery Pack will be charged and the voltage will return to normal.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Description and Operation

Drive Motor Battery System Description

Electrical Information Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify the 12 V battery is not connected while the service disconnect is open.
 - If the 12 V battery is connected and the service disconnect is open

It is normal to set DTC P0ABB or P0ABC when the service disconnect is open and the 12 V

battery is connected. After service is complete, return the vehicle to its normal state, close the service disconnect, connect the 12 V battery, and clear all DTCs.

- If the 12 V battery is connected and the service disconnect is closed

3. Verify DTC P0ABB, P0ABC, or P0ABD is not set.

- If any of the DTCs are set

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Verify the Battery Energy Control Module high voltage measuring harness is not cut, chafed, or otherwise damaged.
 - If the harness is damaged, replace the harness.
 - If the harness is not damaged
3. Replace the K16 Battery Energy Control Module
 - If none of the DTCs are set

4. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2), Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)
- Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P0AC1, P0AC2, P1A07, OR P1EBA

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 P0AC1

Hybrid/EV Battery Current Sensor Circuit Low Voltage

DTC P0AC2

Hybrid/EV Battery Current Sensor Circuit High Voltage

DTC P1A07

Battery Energy Control Module 5V Reference Circuit

DTC P1EBA

Hybrid/EV Battery Current Sensor Exceeded Learning Limit

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P1A07	P0AC2	P1A07	-
Signal	P0AC1	P0AC2	P1A07	-
Low Reference	-	P0AC2	-	-

Circuit/System Description

The Battery Energy Control Module uses a single battery current sensor to determine the current flow out of the Hybrid/EV Battery Pack. The Battery Energy Control Module applies 5 volts and provides a low reference to power the sensor. Current measurement is communicated to the Battery Energy Control Module via a signal circuit.

Conditions for Running the DTC

P0AC1, P0AC2

- 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating
- DTC P1A07 is not set.

P1A07

- 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating

P1EBA

- 12 V battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating
- Contactors are open

- DTC P1A07 is not set.

Conditions for Setting the DTC

P0AC1

Current sensor signal voltage is less than 0.2 V

P0AC2

Current sensor signal voltage is greater than 4.8 V

P1A07

- Current sensor 5 volt reference voltage is greater than 5.2 V
- Current sensor 5 volt reference voltage is less than 4.8 V

P1EBA

- Current sensor value is more than 2.43 V greater than sensor offset upper limit
- Current sensor value is more than 2.57 V less than sensor offset lower limit

Action Taken When the DTC Sets

DTC P0AC1, P0AC2, P1A07, and P1EBA are type B DTCs

Conditions for Clearing the DTC

DTC P0AC1, P0AC2, P1A07, and P1EBA are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Hybrid/EV Battery Pack Low Resolution Current Sensor parameter is between 85 A and -85 A and varies as the vehicle is driven.
 - If not between 85 A and -85 A or does not vary
Refer to Circuit/System Testing below.
 - If between 85 A and -85 A and varies
3. 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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery.
4. Ignition OFF and all vehicle systems OFF, disconnect the harness connector at the B30 Hybrid/EV Battery Pack Current Sensor. It may take up to 2 min for all vehicle systems to power down.
5. Test for less than 10 ohms between the low reference circuit terminal 3 and ground.
 - **If 10 ohms or greater**
 1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module.
 2. Test for less than 2 ohms in the low reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K16 Battery Energy Control Module.
 - **If less than 10 ohms**
6. Ignition ON.
7. Test for 4.8-5.2 V between the 5 V reference circuit terminal 2 and ground.
 - **If less than 4.8 V**
 1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module.

2. Test for infinite resistance between the 5 V reference circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
3. Test for less than 2 ohms in the 5 V reference circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K16 Battery Energy Control Module.
- **If greater than 5.2 V**
1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module, ignition ON.
2. Test for less than 1 V between the 5 V reference circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K16 Battery Energy Control Module.
- **If between 4.8-5.2 V**
8. Verify the scan tool Hybrid/EV Battery Pack Low Resolution Current Sensor parameter is greater than 25 A.
 - **If 25 A or less**
 - 1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module.
 - 2. Test for infinite resistance between the signal circuit terminal 4 and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance, replace the K16 Battery Energy Control Module.
- **If greater than 50 A**
9. Install a 3 A fused jumper wire between the signal circuit terminal 4 and the low reference circuit terminal 3.
10. Verify the scan tool Hybrid/EV Battery Pack Low Resolution Current Sensor parameter is less than -25 A.
 - **If -25 A or greater**
 - 1. Ignition OFF, disconnect the harness connector at the K16 Battery Energy Control Module, ignition ON.
 - 2. Test for less than 1 V between the signal circuit terminal 4 and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 - 3. Ignition ON.
 - 4. Test for less than 2 ohms in the signal circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K16 Battery Energy Control Module.
- **If less than -25 A**
11. Test or replace the B30 Hybrid/EV Battery Pack Current Sensor.

Repair Instructions

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

- **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2), Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P0ADB OR P0ADC

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 P0ADB

Hybrid/EV Battery Positive Contactor Control Circuit Low Voltage

DTC P0ADC

Hybrid/EV Battery Positive Contactor Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0293, U1817*	P0ADB, P0AE6	-	-
Pre-charge Contactor Control	P0AE6, P0C76**	P0AE6	P1A56***	-
Main Contactor Control	P0ADB, P0C76**	P0ADB	P1A56***	-
*Fuse F23UA open; no communication with starter generator control module				
**The starter generator control module cannot control the contactor to disable high voltage				
***The starter generator control module cannot control the contactor to enable high voltage				

Circuit/System Description

The hybrid battery system voltage is controlled by two high voltage contactors. The high voltage contactors allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the Hybrid/EV Battery Pack assembly. Of the two contactors, one is a pre-charge contactor and the other is the primary contactor. The two contactors are closed in a specific sequence by the Starter/Generator Control Module. The pre-charge contactor is closed first. This causes high voltage to flow through the pre-charge resistor, allowing system voltage to build slowly. Once the system voltage has raised and stabilized, the primary

contactor is closed. Both contactors are controlled by the Starter/Generator Control Module. The Starter/Generator Control Module supplies B+ to each contactor at all times. When the contactors are to be closed, the Starter/Generator Control Module will provide a ground to the contactor through a low side driver.

Conditions for Running the DTC

The 12 V battery voltage is greater than 6.0 V

Conditions for Setting the DTC

P0ADB

- An open is detected on the primary contactor control circuit when the contactor control is commanded ON and measured resistance is greater than 200K ohms
- A short to voltage is detected on the primary contactor control circuit when the contactor control is commanded ON and current sense feedback is less than 0.5 A

P0ADC

A short to ground is detected on the primary contactor control circuit when the contactor control is commanded OFF and current sense feedback is less than 0.5 A

Action Taken When the DTC Sets

DTCs P0ADB and P0ADC are type B DTCs

Conditions for Clearing the DTC

DTCs P0ADB and P0ADC are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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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

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0AE6 or P0AE7 is not set.
 - **If either of the DTCs are set**

Refer to DTC P0AE6 or P0AE7.

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

3. Refer 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 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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery.
4. Disconnect the X1 harness connector at the KR38 Main Contactor, ignition ON.
5. Verify a test lamp illuminates between the B+ circuit terminal 1 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
6. Ignition OFF, connect the harness connector at the KR38 Main Contactor. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module, ignition ON.
7. Test for less than 1 V between the control circuit terminal 5 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 2. Test for less than 1 V between the control circuit and ground.

- If 1 V or greater, repair the short to voltage on the circuit.
- If less than 1 V, replace the KR38 Main Contactor.
- **If less than 1 V**
- 8. Ignition OFF.
- 9. Test for infinite resistance between the control circuit terminal 5 and ground.
 - **If less than infinite resistance**
 1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 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, test or replace the KR38 Main Contactor.
 - **If infinite resistance**
- 10. Test for 20-40 ohms between the B+ circuit terminal 4 and the control circuit terminal 5.
 - **If not between 20-40 ohms**
 1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the KR38 Main Contactor.
 - **If between 20-40 ohms**
- 11. Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

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

DTC P0AE6 OR P0AE7

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 P0AE6

Hybrid/EV Battery Precharge Contactor Control Circuit Low Voltage

DTC P0AE7

Hybrid/EV Battery Precharge Contactor Control Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
B+	U0293, U1817*	P0ADB, P0AE6	-	-
Pre-charge Contactor Control	P0AE6, P0C76**	P0AE6	P1A56***	-
Main Contactor Control	P0ADB, P0C76**	P0ADB	P1A56***	-

*Fuse F23UA open; no communication with starter generator control module

**The starter generator control module cannot control the contactor to disable high voltage

***The starter generator control module cannot control the contactor to enable high voltage

Circuit/System Description

The hybrid battery system voltage is controlled by two high voltage contactors. The high voltage contactors allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the Hybrid/EV Battery Pack assembly. Of the two contactors, one is a pre-charge contactor and the other is the primary contactor. The two contactors are closed in a specific sequence by the Starter/Generator Control Module. The pre-charge contactor is closed first. This causes high voltage to flow through the pre-charge resistor, allowing system voltage to build slowly. Once the system voltage has raised and stabilized, the primary contactor is closed. Both contactors are controlled by the Starter/Generator Control Module. The Starter/Generator Control Module supplies B+ to each contactor at all times. When the contactors are to be closed, the Starter/Generator Control Module will provide a ground to the contactor through a low side driver.

Conditions for Running the DTC

The 12 V battery voltage is greater than 6.0 V

Conditions for Setting the DTC

P0AE6

- An open is detected on the Pre-Charge Contactor control circuit when the contactor control is commanded ON and measured resistance is greater than 200K ohms
- A short to voltage is detected on the Pre-Charge Contactor control circuit when the contactor control is commanded ON and current sense feedback is less than 0.5 A

P0AE7

A short to ground is detected on the Pre-Charge Contactor control circuit when the contactor control is commanded OFF and current sense feedback is less than 0.5 A

Action Taken When the DTC Sets

DTCs P0AE6 and P0AE7 are type B DTCs

Conditions for Clearing the DTC

DTCs P0AE6 and P0AE7 are type B DTCs

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Connect the 12 V battery.
4. Disconnect the X1 harness connector at the KR134 Pre-Charge Contactor, ignition ON.
5. Verify a test lamp illuminates between the B+ circuit terminal A and ground.
 - If the test lamp does not illuminate
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms in the B+ circuit end to end.

- If 2 ohms or greater, repair the open/high resistance in the circuit.
- If less than 2 ohms, replace the K59 Starter/Generator Control Module.
- **If the test lamp illuminates**
- 6. Ignition OFF, connect the harness connector at the KR134 Pre-Charge Contactor. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module, ignition ON.
- 7. Test for less than 1 V between the control circuit terminal 6 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the KR134 Pre-Charge Contactor.
 - **If less than 1 V**
- 8. Ignition OFF.
- 9. Test for infinite resistance between the control circuit terminal 6 and ground.
 - **If less than infinite resistance**
 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor
 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, test or replace the KR134 Pre-Charge Contactor.
 - **If infinite resistance**
- 10. Test for 90-115 ohms between the B+ circuit terminal 4 and the control circuit terminal 6.
 - **If not between 90-115 ohms**
 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the KR134 Pre-Charge Contactor.
 - **If between 20-40 ohms**
- 11. Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

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

DTC P0AF8

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 P0AF8

Hybrid/EV System Voltage

Circuit/System Description

As a means to verify the Battery Energy Control Module's voltage measuring ability, the Battery Energy Control Module compares it's own measurement of the Hybrid/EV Battery Pack voltage to that measured internally at the Starter/Generator Control Module when the contactors are closed. This provides a second source of the Battery Energy Control Module's Hybrid/EV Battery Pack voltage rationality.

Conditions for Running the DTC

- Main contactor is closed
- None of the following DTCs are set: P0ABB, P0ABC, P0ABD, P1A5D, U182A

Conditions for Setting the DTC

The difference between the high voltage battery voltage measured at the Battery Energy Control Module and the voltage measured at the motor controller, internal to the Starter/Generator Control Module, is greater than 5.77 V.

Action Taken When the DTC Sets

- DTC P0AF8 is a type B DTC
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur

Conditions for Clearing the DTC

DTC P0AF8 is a type B DTC

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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- **Wiring Repairs**

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify no other DTCs are set in the in the K59 Starter/Generator Control Module.

- If other DTCs are set

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

- If no other DTCs are set

2. Ignition ON, observe and record the 32 scan tool Hybrid Battery Cell Voltage parameters. Add the values together to calculate Hybrid/EV Battery Pack voltage based on the cell voltages.
3. Verify the calculated Hybrid/EV Battery Pack voltage from step 2 is within 5.77 V of the scan tool High Voltage Battery Voltage parameter.

- If not within 5.77 V

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Verify the Battery Energy Control Module high voltage measuring harness is not cut, chafed, or otherwise damaged.
 - If the harness is damaged, replace the harness.
 - If the harness is not damaged

3. Replace the K16 Battery Energy Control Module

- If within 5.77 V

4. All OK.

Repair Instructions

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

- **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2), Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P0AFA OR P0AFB

Diagnostic Instructions

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

DTC Descriptors

DTC P0AFA

Hybrid/EV Battery System Voltage Low Voltage

DTC P0AFB

Hybrid/EV Battery System Voltage High Voltage

Circuit/System Description

The hybrid/EV battery pack contains a total of 32 cells. These cells are electrically connected in series. Each individual cell is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cells.

The battery energy control module monitors the voltage of the 32 battery cells. A voltage sense circuit is attached to each individual cell. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable high voltage measuring harness connects the voltage sense circuits to the battery energy control module, located directly above the hybrid battery section 1 and hybrid battery section 2. The battery energy control module also monitors the hybrid/EV battery pack voltage in its entirety. The battery energy control module compares the voltage of the entire pack to that of the sum of the voltages measures at each cell.

Conditions for Running the DTC

None of the following DTCs are set: P0ABB, P0ABC, P0ABD, P0AF8, P1A5D, U182A

OR

None of the following DTCs are set: P0B3B, P0B3C, P0B3D, P0B3E, P0B40, P0B41, P0B42, P0B43, P0B45,

P0B46, P0B47, P0B48, P0B4A, P0B4B, P0B4C, P0B4D, P0B4F, P0B50, P0B51, P0B52, P0B54, P0B55, P0B56, P0B57, P0B59, P0B5A, P0B5B, P0B5C, P0B5E, P0B5F, P0B60, P0B61, P0B63, P0B64, P0B65, P0B66, P0B68, P0B69, P0B6A, P0B6B, P0B6D, P0B6E, P0B6F, P0B70, P0B72, P0B73, P0B74, P0B75, P0B77, P0B78, P0B79, P0B7A, P0B7C, P0B7D, P0B7E, P0B7F, P0B81, P0B82, P0B83, P0B84, P0B86, P0B87, P0B88, P0B89, P0B8B, P0B8C, P0B8D, P0B8E, P0B90, P0B91, P0B92, P0B93, P0B95, P0B96, P0B97, P0B98, P0B9A, P0B9B, P0B9C, P0B9D, P0B9F, P0BA0, P0BA1, P0BA2, P0BA4, P0BA5, P0BA6, P0BA7, P0BA9, P0BAA, P0BAB, P0BAC, P0BAE, P0BAF, P0BB0, P0BB1, P0BB3, P0BB4, P0BB5, P0BB6, P0BB8, P0BB9, P0BBA, P0BBB, P1B16, P1B17, P1B18, P1B19, P1B1A, P1B1B, P1B1C, P1B1D, P1B1E, P1B1F, P1B20, P1B21, P1B22, P1B23, P1B24, P1B25, P1B26, P1B27, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

Conditions for Setting the DTC

DTC P0AFA

Battery pack voltage is less than 61.91 V.

OR

Any individual cell voltage is less than 1.93 V.

DTC P0AFB

Battery pack voltage is greater than 136.49 V.

OR

Any individual cell voltage is greater than 4.26 V.

Action Taken When the DTC Sets

- DTCs P0AFA and P0AFB are type B DTCs.
- The vehicle operates without any hybrid functions with the high voltage contactors open, but it will continue to charge the 12V battery with the starter/generator acting as a conventional generator.

Conditions for Clearing the DTC

- DTCs P0AFA and P0AFB are type B DTCs.
- DTCs P0AFA and P0AFB are secure DTCs. The **Clear Secured High Voltage DTCs** procedure must be performed to prevent resetting the DTC.

Diagnostic Aids

The following two tables should be used to determine the switch setting when using the **EL-48571-30** High Voltage Battery Pin Out Box.

Battery Cells (1-16)		
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Connector X5		
Switch Designation	Switch Position	Battery Cell
A	1	16
A	2	15
A	3	14
A	4	13
A	5	12
A	6	11
B	7	10
B	8	9
B	9	8
B	10	7
B	11	6
B	12	5
C	13	4
C	14	3
C	15	2
C	16	1

Battery Cells (17-32)		
Connector X4		
Switch Designation	Switch Position	Battery Cell
A	1	32
A	2	31
A	3	30
A	4	29
A	5	28
A	6	27
B	7	26
B	8	25
B	9	24
B	10	23
B	11	22
B	12	21
C	13	20
C	14	19
C	15	18
C	16	17

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View 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 for scan tool information

Special Tools

- **EL-48571-30** High Voltage Battery Pin Out Box
- **EL-48900** HEV Safety Kit

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

Circuit/System Verification

1. Ignition ON.
2. Verify that each of the scan tool Hybrid Battery Cell Voltage 1-32 parameters are between 3.0-4.1 V and all parameters are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**

Refer to Circuit/System Testing below.
 - **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**
3. 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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the X4 and X5 harness connectors at the K16 Battery Energy Control Module.
3. Connect the **EL-48571-30** High Voltage Battery Pin Out Box to the appropriate K16 Battery Energy Control Module harness connector.
4. Insert the DMM probes into the EL-48571-30 test cavities.

NOTE:

- The DMM must be set to the DC voltage setting.
- Not all 24 switch positions of the EL-48571-30 will be used.

5. Measure and record the voltage of each of the cells by cycling the EL-48571-30 through each of the 16 switch positions.
6. Verify that each cell voltage reading is 3.0-4.1 V and all cell voltage readings are within 0.1 V of each other.
 - If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others
 1. Inspect the appropriate voltage signal circuit and low reference circuit for a short to ground or an open/high resistance.
 - If a short to ground or an open/high resistance is found, replace the appropriate K16 Battery Energy Control Module high voltage measuring harness.
 - If a short to ground or an open/high resistance is not found
 2. Replace the C4A Hybrid/EV Battery Section 1, C4B Hybrid/EV Battery Section 2, and K16 Battery Energy Control Module.
 - If all parameter are between 3.0-4.1 V and are within 0.1 V of each other
7. Replace the K16 Battery Energy Control Module.

Repair Instructions

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

- **Generator Battery Replacement**
- **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2), Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)**
- **Control Module References** for battery energy control module replacement, programming, and setup.

DTC P0B3B-P0BBB, P1B16-P1B2D, P1B3D, OR P1B3E**Diagnostic Instructions**

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

DTC Descriptors**DTC P0B3B**

Hybrid/EV Battery 1 Circuit

DTC P0B3C

Hybrid/EV Battery 1 Circuit Performance

DTC P0B3D

Hybrid/EV Battery 1 Circuit Low Voltage

DTC P0B3E

Hybrid/EV Battery 1 Circuit High Voltage

DTC P0B40

Hybrid/EV Battery 2 Circuit

DTC P0B41

Hybrid/EV Battery 2 Circuit Performance

DTC P0B42

Hybrid/EV Battery 2 Circuit Low Voltage

DTC P0B43

Hybrid/EV Battery 2 Circuit High Voltage

DTC P0B45

Hybrid/EV Battery 3 Circuit

DTC P0B46

Hybrid/EV Battery 3 Circuit Performance

DTC P0B47

Hybrid/EV Battery 3 Circuit Low Voltage

DTC P0B48

Hybrid/EV Battery 3 Circuit High Voltage

DTC P0B4A

Hybrid/EV Battery 4 Circuit

DTC P0B4B

Hybrid/EV Battery 4 Circuit Performance

DTC P0B4C

Hybrid/EV Battery 4 Circuit Low Voltage

DTC P0B4D

Hybrid/EV Battery 4 Circuit High Voltage

DTC P0B4F

Hybrid/EV Battery 5 Circuit

DTC P0B50

Hybrid/EV Battery 5 Circuit Performance

DTC P0B51

Hybrid/EV Battery 5 Circuit Low Voltage

DTC P0B52

Hybrid/EV Battery 5 Circuit High Voltage

DTC P0B54

Hybrid/EV Battery 6 Circuit

DTC P0B55

Hybrid/EV Battery 6 Circuit Performance

DTC P0B56

Hybrid/EV Battery 6 Circuit Low Voltage

DTC P0B57

Hybrid/EV Battery 6 Circuit High Voltage

DTC P0B59

Hybrid/EV Battery 7 Circuit

DTC P0B5A

Hybrid/EV Battery 7 Circuit Performance

DTC P0B5B

Hybrid/EV Battery 7 Circuit Low Voltage

DTC P0B5C

Hybrid/EV Battery 7 Circuit High Voltage

DTC P0B5E

Hybrid/EV Battery 8 Circuit

DTC P0B5F

Hybrid/EV Battery 8 Circuit Performance

DTC P0B60

Hybrid/EV Battery 8 Circuit Low Voltage

DTC P0B61

Hybrid/EV Battery 8 Circuit High Voltage

DTC P0B63

Hybrid/EV Battery 9 Circuit

DTC P0B64

Hybrid/EV Battery 9 Circuit Performance

DTC P0B65

Hybrid/EV Battery 9 Circuit Low Voltage

DTC P0B66

Hybrid/EV Battery 9 Circuit High Voltage

DTC P0B68

Hybrid/EV Battery 10 Circuit

DTC P0B69

Hybrid/EV Battery 10 Circuit Performance

DTC P0B6A

Hybrid/EV Battery 10 Circuit Low Voltage

DTC P0B6B

Hybrid/EV Battery 10 Circuit High Voltage

DTC P0B6D

Hybrid/EV Battery 11 Circuit

DTC P0B6E

Hybrid/EV Battery 11 Circuit Performance

DTC P0B6F

Hybrid/EV Battery 11 Circuit Low Voltage

DTC P0B70

Hybrid/EV Battery 11 Circuit High Voltage

DTC P0B72

Hybrid/EV Battery 12 Circuit

DTC P0B73

Hybrid/EV Battery 12 Circuit Performance

DTC P0B74

Hybrid/EV Battery 12 Circuit Low Voltage

DTC P0B75

Hybrid/EV Battery 12 Circuit High Voltage

DTC P0B77

Hybrid/EV Battery 13 Circuit

DTC P0B78

Hybrid/EV Battery 13 Circuit Performance

DTC P0B79

Hybrid/EV Battery 13 Circuit Low Voltage

DTC P0B7A

Hybrid/EV Battery 13 Circuit High Voltage

DTC P0B7C

Hybrid/EV Battery 14 Circuit

DTC P0B7D

Hybrid/EV Battery 14 Circuit Performance

DTC P0B7E

Hybrid/EV Battery 14 Circuit Low Voltage

DTC P0B7F

Hybrid/EV Battery 14 Circuit High Voltage

DTC P0B81

Hybrid/EV Battery 15 Circuit

DTC P0B82

Hybrid/EV Battery 15 Circuit Performance

DTC P0B83

Hybrid/EV Battery 15 Circuit Low Voltage

DTC P0B84

Hybrid/EV Battery 15 Circuit High Voltage

DTC P0B86

Hybrid/EV Battery 16 Circuit

DTC P0B87

Hybrid/EV Battery 16 Circuit Performance

DTC P0B88

Hybrid/EV Battery 16 Circuit Low Voltage

DTC P0B89

Hybrid/EV Battery 16 Circuit High Voltage

DTC P0B8B

Hybrid/EV Battery 17 Circuit

DTC P0B8C

Hybrid/EV Battery 17 Circuit Performance

DTC P0B8D

Hybrid/EV Battery 17 Circuit Low Voltage

DTC P0B8E

Hybrid/EV Battery 17 Circuit High Voltage

DTC P0B90

Hybrid/EV Battery 18 Circuit

DTC P0B91

Hybrid/EV Battery 18 Circuit Performance

DTC P0B92

Hybrid/EV Battery 18 Circuit Low Voltage

DTC P0B93

Hybrid/EV Battery 18 Circuit High Voltage

DTC P0B95

Hybrid/EV Battery 19 Circuit

DTC P0B96

Hybrid/EV Battery 19 Circuit Performance

DTC P0B97

Hybrid/EV Battery 19 Circuit Low Voltage

DTC P0B98

Hybrid/EV Battery 19 Circuit High Voltage

DTC P0B9A

Hybrid/EV Battery 20 Circuit

DTC P0B9B

Hybrid/EV Battery 20 Circuit Performance

DTC P0B9C

Hybrid/EV Battery 20 Circuit Low Voltage

DTC P0B9D

Hybrid/EV Battery 20 Circuit High Voltage

DTC P0B9F

Hybrid/EV Battery 21 Circuit

DTC P0BA0

Hybrid/EV Battery 21 Circuit Performance

DTC P0BA1

Hybrid/EV Battery 21 Circuit Low Voltage

DTC P0BA2

Hybrid/EV Battery 21 Circuit High Voltage

DTC P0BA4

Hybrid/EV Battery 22 Circuit

DTC P0BA5

Hybrid/EV Battery 22 Circuit Performance

DTC P0BA6

Hybrid/EV Battery 22 Circuit Low Voltage

DTC P0BA7

Hybrid/EV Battery 22 Circuit High Voltage

DTC P0BA9

Hybrid/EV Battery 23 Circuit

DTC P0BAA

Hybrid/EV Battery 23 Circuit Performance

DTC P0BAB

Hybrid/EV Battery 23 Circuit Low Voltage

DTC P0BAC

Hybrid/EV Battery 23 Circuit High Voltage

DTC P0BAE

Hybrid/EV Battery 24 Circuit

DTC P0BAF

Hybrid/EV Battery 24 Circuit Performance

DTC P0BB0

Hybrid/EV Battery 24 Circuit Low Voltage

DTC P0BB1

Hybrid/EV Battery 24 Circuit High Voltage

DTC P0BB3

Hybrid/EV Battery 25 Circuit

DTC P0BB4

Hybrid/EV Battery 25 Circuit Performance

DTC P0BB5

Hybrid/EV Battery 25 Circuit Low Voltage

DTC P0BB6

Hybrid/EV Battery 25 Circuit High Voltage

DTC P0BB8

Hybrid/EV Battery 26 Circuit

DTC P0BB9

Hybrid/EV Battery 26 Circuit Performance

DTC P0BBA

Hybrid/EV Battery 26 Circuit Low Voltage

DTC P0BBB

Hybrid/EV Battery 26 Circuit High Voltage

DTC P1B16

Hybrid/EV Battery 27 Circuit Performance

DTC P1B17

Hybrid/EV Battery 27 Circuit Low Voltage

DTC P1B18

Hybrid/EV Battery 27 Circuit High Voltage

DTC P1B19

Hybrid/EV Battery 28 Circuit Performance

DTC P1B1A

Hybrid/EV Battery 28 Circuit Low Voltage

DTC P1B1B

Hybrid/EV Battery 28 Circuit High Voltage

DTC P1B1C

Hybrid/EV Battery 29 Circuit Performance

DTC P1B1D

Hybrid/EV Battery 29 Circuit Low Voltage

DTC P1B1E

Hybrid/EV Battery 29 Circuit High Voltage

DTC P1B1F

Hybrid/EV Battery 30 Circuit Performance

DTC P1B20

Hybrid/EV Battery 30 Circuit Low Voltage

DTC P1B21

Hybrid/EV Battery 30 Circuit High Voltage

DTC P1B22

Hybrid/EV Battery 31 Circuit Performance

DTC P1B23

Hybrid/EV Battery 31 Circuit Low Voltage

DTC P1B24

Hybrid/EV Battery 31 Circuit High Voltage

DTC P1B25

Hybrid/EV Battery 32 Circuit Performance

DTC P1B26

Hybrid/EV Battery 32 Circuit Low Voltage

DTC P1B27

Hybrid/EV Battery 32 Circuit High Voltage

DTC P1B28

Hybrid/EV Battery 27 Circuit

DTC P1B29

Hybrid/EV Battery 28 Circuit

DTC P1B2A

Hybrid/EV Battery 29 Circuit

DTC P1B2B

Hybrid/EV Battery 30 Circuit

DTC P1B2C

Hybrid/EV Battery 31 Circuit

DTC P1B2D

Hybrid/EV Battery 32 Circuit

DTC P1B3D

Hybrid/EV Battery Voltage Sense Low Reference 1 Circuit

DTC P1B3E

Hybrid/EV Battery Voltage Sense Low Reference 2 Circuit

Circuit/System Description

The hybrid/EV battery pack contains a total of 32 cell groups in the hybrid/EV battery pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The battery energy control module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the battery energy control module, located directly above the hybrid/EV battery pack.

Diagnostics and system status are communicated from the battery energy control module to hybrid powertrain control module through serial data.

Conditions for Running the DTC

DTC P0B3B, P0B40, P0B45, P0B4A, P0B4F, P0B54, P0B59, P0B5E, P0B63, P0B68, P0B6D, P0B72, P0B77, P0B7C, P0B81, P0B86, P0B88, P0B90, P0B95, P0B9A, P0B9F, P0BA4, P0BA9, P0BAE, P0BB3, P0BB8, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

- 12 V battery voltage is greater than 9 V.
- None of the following DTCs are set: P0B3D, P0B42, P0B47, P0B4C, P0B51, P0B56, P0B5B, P0B60, P0B65, P0B6A, P0B6F, P0B74, P0B79, P0B7E, P0B83, P0B88, P0B8D, P0B92, P0B97, P0B9C, P0BA1, P0BA6, P0BAB, P0BB0, P0BB5, P0BBA, P1B17, P1B1A, P1B1D, P1B20, P1B23, P1B26, P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

DTC P0B3C, P0B41, P0B46, P0B4B, P0B50, P0B55, P0B5A, P0B5F, P0B64, P0B69, P0B6E, P0B73, P0B78, P0B7D, P0B82, P0B87, P0B8C, P0B91, P0B96, P0B9B, P0BA0, P0BA5, P0BAA, P0BAF, P0BB4, P0BB9, P1B16, P1B19, P1B1C, P1B1F, P1B22, P1B25

All of the following conditions exist:

- Average cell voltage movement is greater than 0.045 V.
- DTC U182A is not set.

DTC P0B3D, P0B3E, P0B42, P0B43, P0B47, P0B48, P0B4C, P0B4D, P0B51, P0B52, P0B56, P0B57, P0B5B, P0B5C, P0B60, P0B61, P0B65, P0B66, P0B6A, P0B6B, P0B6F, P0B70, P0B74, P0B75, P0B79, P0B7A, P0B7E, P0B7F, P0B83, P0B84, P0B88, P0B89, P0B8D, P0B8E, P0B92, P0B93, P0B97, P0B98, P0B9C, P0B9D, P0BA1, P0BA2, P0BA6, P0BA7, P0BAB, P0BAC, P0BB0, P0BB1, P0BB5, P0BB6, P0BBA, P0BBB, P1B17, P1B18, P1B1A, P1A1B, P1B1D, P1B1E, P1B20, P1B21, P1B23, P1B24, P1B26, P1B27

- 12 V battery voltage is greater than 9 V.
- The battery energy control module is awake and communicating.
- None of the following DTCs are set: P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

P1B3D, P1B3E

- 12 V battery voltage is greater than 8.8 V.
- None of the following DTCs are running: P1EAA, P1EAC.
- None of the following DTCs are set: P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

Conditions for Setting the DTC

DTC P0B3B, P0B40, P0B45, P0B4A, P0B4F, P0B54, P0B59, P0B5E, P0B63, P0B68, P0B6D, P0B72, P0B77, P0B7C, P0B81, P0B86, P0B88, P0B90, P0B95, P0B9A, P0B9F, P0BA4, P0BA9, P0BAE, P0BB3, P0BB8, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

The appropriate battery voltage sense circuit is open.

DTC P0B3C, P0B41, P0B46, P0B4B, P0B50, P0B55, P0B5A, P0B5F, P0B64, P0B69, P0B6E, P0B73, P0B78, P0B7D, P0B82, P0B87, P0B8C, P0B91, P0B96, P0B9B, P0BA0, P0BA5, P0BAA, P0BAF, P0BB4,

P0BB9, P1B16, P1B19, P1B1C, P1B1F, P1B22, P1B25

Measured individual battery cell voltage movement is not in the same direction as the average battery cell voltage movement.

P0B3D, P0B42, P0B47, P0B4C, P0B51, P0B56, P0B5B, P0B60, P0B65, P0B6A, P0B6F, P0B74, P0B79, P0B7E, P0B83, P0B88, P0B8D, P0B92, P0B97, P0B9C, P0BA1, P0BA6, P0BAB, P0BB0, P0BB5, P0BBA, P1B17, P1B1A, P1B1D, P1B20, P1B23, P1B26

Measured individual battery cell voltage is less than 1.4 V.

P0B3E, P0B43, P0B48, P0B4D, P0B52, P0B57, P0B5C, P0B61, P0B66, P0B6B, P0B70, P0B75, P0B7A, P0B7F, P0B84, P0B89, P0B8E, P0B93, P0B98, P0B9D, P0BA2, P0BA7, P0BAC, P0BB1, P0BB6, P0BBB, P1B18, P1B1B, P1B1E, P1B21, P1B24, P1B27

Measured individual battery cell voltage is greater than 4.65 V.

P1B3D

Cell sense voltage is less than 1.4 V.

AND

Battery 16 cell voltage change is greater than 0.5 V over a 200ms sample time.

P1B3E

Cell sense voltage is less than 1.4 V.

AND

Battery 32 cell voltage change is greater than 0.5 V over a 200ms sample time.

Action Taken When the DTC Sets

- DTC P0B3B-P0BBB, P1B16-1B2D, P1B3D, and P1B3E are type B DTCs.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P0B3B-P0BBB, P1B16-1B2D, P1B3D, and P1B3E are type B DTCs.

Diagnostic Aids

The following two tables should be used to determine the switch setting when using the **EL-48571-30** High Voltage Battery Pin Out Box.

Battery Cells (1-16)		
Connector X5		
Switch Designation	Switch Position	Battery Cell
A	1	16
A	2	15
A	3	14
A	4	13
A	5	12
A	6	11
B	7	10
B	8	9
B	9	8
B	10	7
B	11	6
B	12	5
C	13	4
C	14	3
C	15	2
C	16	1

Battery Cells (17-32)		
Connector X4		
Switch Designation	Switch Position	Battery Cell
A	1	32
A	2	31
A	3	30
A	4	29
A	5	28
A	6	27
B	7	26
B	8	25
B	9	24
B	10	23
B	11	22
B	12	21
C	13	20
C	14	19
C	15	18
C	16	17

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48571-30** High Voltage Battery Pin Out Box
- **EL-48900** HEV Safety Kit

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

Circuit/System Verification

1. Ignition ON.
2. Verify that each of the scan tool Hybrid Battery Cell Voltage 1-32 parameters are between 3.0-4.1 V and all parameters are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**

Refer to Circuit/System Testing below.

- **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**

3. 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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the X4 and X5 harness connectors K16 Battery Energy Control Module.
3. Connect the **EL-48571-30** High Voltage Battery Pin Out Box to the appropriate K16 Battery Energy Control Module harness connector.

4. Insert the DMM probes into the EL-48571-30 test cavities.

NOTE:

- The DMM must be set to the DC voltage setting.
- Not all 24 switch positions of the EL-48571-30 will be used.

5. Measure and record the voltage of each of the cells by cycling the EL-48571-30 through each of the 16 switch positions.
6. Verify that each cell voltage reading is 3.0-4.1 V and all cell voltage readings are within 0.1 V of each other.
 - If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others
1. Inspect the appropriate voltage signal circuit and low reference circuit for a short to ground or an open/high resistance.
 - If a short to ground or an open/high resistance is found, replace the appropriate K16 Battery Energy Control Module high voltage measuring harness.
 - If a short to ground or an open/high resistance is not found
2. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.
 - If all parameter are between 3.0-4.1 V and are within 0.1 V of each other
7. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

- Generator Battery Replacement
- Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2), Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)
- Control Module References for battery energy control module replacement, programming, and setup.

DTC P0BBE

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 P0BBE

Hybrid/EV Battery Pack Voltage

Circuit/System Description

The hybrid/EV battery pack contains a total of 32 cell groups in the hybrid/EV battery pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The battery energy control module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the battery energy control module, located directly above the hybrid/EV battery pack.

Conditions for Running the DTC

None of the following DTCs are set: P0B3B, P0B3C, P0B3D, P0B3E, P0B40, P0B41, P0B42, P0B43, P0B45, P0B46, P0B47, P0B48, P0B4A, P0B4B, P0B4C, P0B4D, P0B4F, P0B50, P0B51, P0B52, P0B54, P0B55, P0B56, P0B57, P0B59, P0B5A, P0B5B, P0B5C, P0B5E, P0B5F, P0B60, P0B61, P0B63, P0B64, P0B65, P0B66, P0B68, P0B69, P0B6A, P0B6B, P0B6D, P0B6E, P0B6F, P0B70, P0B72, P0B73, P0B74, P0B75, P0B77, P0B78, P0B79, P0B7A, P0B7C, P0B7D, P0B7E, P0B7F, P0B81, P0B82, P0B83, P0B84, P0B86, P0B87, P0B88, P0B89, P0B8B, P0B8C, P0B8D, P0B8E, P0B90, P0B91, P0B92, P0B93, P0B95, P0B96, P0B97, P0B98, P0B9A, P0B9B, P0B9C, P0B9D, P0B9F, P0BA0, P0BA1, P0BA2, P0BA4, P0BA5, P0BA6, P0BA7, P0BA9, P0BAA, P0BAB, P0BAC, P0BAE, P0BAF, P0BB0, P0BB1, P0BB3, P0BB4, P0BB5, P0BB6, P0BB8, P0BB9, P0BBA, P0BBB, P1B16, P1B17, P1B18, P1B19, P1B1A, P1B1B, P1B1C, P1B1D, P1B1E, P1B1F, P1B20, P1B21, P1B22, P1B23, P1B24, P1B25, P1B26, P1B27, P1B28, P1B29, P1B2A, P1B2B, P1B2C, P1B2D

Conditions for Setting the DTC

The maximum cell voltage and minimum cell voltage differ by more than 0.3 V.

Action Taken When the DTC Sets

- DTC P0BBE is a type B DTC.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P0BBE is a type B DTC.

Diagnostic Aids

The following two tables should be used to determine the switch setting when using the **EL-48571-30** High Voltage Battery Pin Out Box.

Battery Cells (1-16)		
Connector X5		
Switch Designation	Switch Position	Battery Cell
A	1	16
A	2	15

A	3	14
A	4	13
A	5	12
A	6	11
B	7	10
B	8	9
B	9	8
B	10	7
B	11	6
B	12	5
C	13	4
C	14	3
C	15	2
C	16	1

Battery Cells (17-32)		
Connector X4		
Switch Designation	Switch Position	Battery Cell
A	1	32
A	2	31
A	3	30
A	4	29
A	5	28
A	6	27
B	7	26
B	8	25
B	9	24
B	10	23
B	11	22
B	12	21
C	13	20
C	14	19
C	15	18
C	16	17

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48571-30** High Voltage Battery Pin Out Box
- **EL-48900** HEV Safety Kit

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

Circuit/System Verification

1. Ignition ON.
2. Verify that each of the scan tool Hybrid Battery Cell Voltage 1-32 parameters are between 3.0-4.1 V and all parameters are within 0.1 V of each other.
 - **If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others**

Refer to Circuit/System Testing below.
 - **If all parameter are between 3.0-4.1 V and are within 0.1 V of each other**
3. 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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the X4 and X5 harness connectors K16 Battery Energy Control Module.
3. Connect the **EL-48571-30** High Voltage Battery Pin Out Box to the appropriate K16 Battery Energy Control Module harness connector.
4. Insert the DMM probes into the EL-48571-30 test cavities.

NOTE:

- The DMM must be set to the DC voltage setting.
- Not all 24 switch positions of the EL-48571-30 will be used.

5. Measure and record the voltage of each of the cells by cycling the EL-48571-30 through each of the 16 switch positions.
6. Verify that each cell voltage reading is 3.0-4.1 V and all cell voltage readings are within 0.1 V of each other.
 - If any parameter is not between 3.0-4.1 V or is not within 0.1 V of the others
 1. Inspect the appropriate voltage signal circuit and low reference circuit for a short to ground or an open/high resistance.
 - If a short to ground or an open/high resistance is found, replace the appropriate K16 Battery Energy Control Module high voltage measuring harness.
 - If a short to ground or an open/high resistance is not found
 2. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.
 - If all parameter are between 3.0-4.1 V and are within 0.1 V of each other
7. Replace the K16 Battery Energy Control Module.

Repair Instructions

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

- **Generator Battery Replacement**
- **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2), Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)**
- **Control Module References** for battery energy control module replacement, programming, and setup.

DTC P0C77 OR P0C78

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 P0C77

Hybrid/EV Battery System Precharge Time Too Short

DTC P0C78

Hybrid/EV Battery System Precharge Time Too Long

Circuit/System Description

The hybrid battery system voltage is controlled by two high voltage contactors. The high voltage contactors

allow the high voltage DC batteries to be connected to the vehicle or safely contain the high voltage DC within the Hybrid/EV Battery Pack assembly. Of the two contactors, one is a pre-charge contactor and the other is the primary contactor. The two contactors are closed in a specific sequence by the Starter/Generator Control Module. The pre-charge contactor is closed first. This causes high voltage to flow through the pre-charge resistor, allowing system voltage to build slowly. Once the system voltage has raised and stabilized, the primary contactor is closed. Both contactors are controlled by the Starter/Generator Control Module. The Starter/Generator Control Module supplies B+ to each contactor at all times. When the contactors are to be closed, the Starter/Generator Control Module will provide a ground to the contactor through a low side driver.

Conditions for Running the DTC

P0C77

- No faults are set against the battery current sensor
- No faults are set against the internal bus voltage sensor
- Bus voltage is less than 50% before the start of precharge

P0C78

- No faults are set against the battery current sensor
- No faults are set against the internal battery voltage sensor
- No faults are set against the internal bus voltage sensor

Conditions for Setting the DTC

P0C77

Bus voltage is greater than 95% in less than 75 ms after the start of precharge

P0C78

Bus voltage has not reached 95% in less than 1 second after the start of precharge

OR

Battery current is greater than 5 A for longer than 100 ms after the start of precharge

Action Taken When the DTC Sets

DTCs P0C77 and P0C78 are type B DTCs

Conditions for Clearing the DTC

DTCs P0C77 and P0C78 are type B DTCs

Diagnostic Aids

Some conditions than may cause a too long pre-charge are:

- Pre-charge contactor that is inoperative and does not close
- Excessive resistance in the closed contacts of the pre-charge contactor
- Excessive resistance in the pre-charge resistor
- An open or excessive resistance in any of the high voltage (orange) circuits or terminal supplying voltage to the pre-charge resistor and contactor

Some conditions than may cause a too short pre-charge are:

- Primary contactor or pre-charge contractor stuck in the closed position
- Primary contactor control circuit shorted to ground, causing the primary contactor to remain closed even when not commanded closed by the Starter/Generator Control Module
- Too little resistance in the pre-charge resistor

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Disconnect the X1 and X2 harness connectors at the KR134 Pre-Charge Contactor.
4. Connect the 12 V battery, ignition ON.
5. Verify a test lamp illuminates between the B+ circuit terminal A X1 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 2 ohms in the B+ circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
6. Test for less than 1 V between the control circuit terminal A X2 and ground.
 - **If 1 V or greater**
 1. Ignition OFF, disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 2. Test for less than 1 V between the control circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If less than 1 V**
7. Install a 10 A fused jumper wire between the B+ terminal A X1 and 12 V. Install a jumper wire between the control terminal A X2 and ground.

NOTE: This step checks the resistance of the closed contactor. Excessive resistance in the closed contacts may cause a slow pre-charge. To verify the resistance, the contactor must be closed. To close the contactor, all terminals at the contactor must be removed and the contactor B+ and control circuits jumpered to B+ and ground. This will close the contacts and allow the resistance of the contacts to be measured.

8. Test for less than 2 ohms between the high voltage terminals of the closed KR134 Pre-Charge Contactor.
 - **If 2 ohms or greater**

Replace the KR134 Pre-Charge Contactor.
 - **If less than 2 ohms**
9. Ignition OFF, connect the X1 and X2 harness connectors at the KR134 Pre-Charge Contactor. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
10. Test for infinite resistance between the control circuit terminal 6 and ground.
 - **If less than infinite resistance**
 1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor
 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, test or replace the KR134 Pre-Charge Contactor.
 - **If infinite resistance**
11. Test for 90-115 ohms between the B+ circuit terminal 4 and the control circuit terminal 6.
- **If not between 90-115 ohms**
1. Ignition OFF, disconnect the X2 harness connector at the KR134 Pre-Charge Contactor.
 2. Test for less than 2 ohms in the control circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the KR134 Pre-Charge Contactor.
- **If between 90-115 ohms**
12. Test for infinite resistance between the control circuit terminal 5 and ground.
- **If less than infinite resistance**
1. Ignition OFF, disconnect the X1 harness connector at the KR38 Main Contactor.
 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, test or replace the KR38 Main Contactor.
- **If infinite resistance**
13. Test for infinite resistance between the high voltage terminals of the open KR38 Main Contactor.
- **If not infinite resistance**
- Replace the KR38 Main Contactor.
- **If infinite resistance**
14. Test for 5-10 ohms between the R25 Hybrid/EV Battery Pre-Charge Resistor terminals.
- **If not between 5-10 ohms**
- Replace the R25 Hybrid/EV Battery Pre-Charge Resistor.
- **If between 5-10 ohms**
15. Test each of the high voltage circuits and terminals supplying the R25 Hybrid/EV Battery Pre-Charge Resistor and KR134 Pre-Charge Contactor for less than 2 ohms end to end.
- **If 2 ohms or greater**
- Replace the appropriate harness.
- **If less than 2 ohms**
16. Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

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

DTC P1A0C

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 P1A0C

Battery Energy Control Module System Voltage Low Voltage

Circuit/System Description

The Battery Energy Control Module is the interface and controller for the Hybrid/EV Battery Pack. The Battery Energy Control Module monitors and balances the cell voltages and also monitors the cell temperatures.

Conditions for Running the DTC

Battery energy control module is awake and communicating.

Conditions for Setting the DTC

12 V battery voltage is less than 8.8 V.

Action Taken When the DTC Sets

- DTCs P1A0C is a type C DTC.
- 12 V battery voltage is greater than 8.8 V.

Conditions for Clearing the DTC

DTCs P1A0C is a type C 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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify that DTC P1A0C is not set.
 - If the DTC is set

Test and inspect the 12 V battery. Refer to Battery Inspection/Test.

- If the DTC is not set
3. All OK.

DTC P1A5D

Diagnostic Instructions

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

DTC Descriptors

DTC P1A5D

Battery Energy Control Module 5V Reference 2 Circuit

Circuit/System Description

The Hybrid/EV Battery Pack has 6 battery temperature sensors. The battery temperature sensors are located on the top of the batteries. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The Battery Energy Control Module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the

temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The Battery Energy Control Module uses the battery temperature sensors to determine the temperature of the Hybrid/EV Battery Pack assembly. The Hybrid Powertrain Control Module will control the Hybrid/EV Battery Pack cooling fan based on the Hybrid/EV Battery Pack temperature.

Conditions for Running the DTC

- Battery voltage is greater than 8.8 V
- Battery energy control module is awake and communicating

Conditions for Setting the DTC

- Temperature sensor 5 volt reference voltage is greater than 5.15 V
- Temperature sensor 5 volt reference voltage is less than 4.85 V

Action Taken When the DTC Sets

DTC P1A5D is a type A DTC

Conditions for Clearing the DTC

DTC P1A5D is a type A DTC

Reference Information

Schematic Reference

Hybrid/EV Cooling Schematics

Connector End View Reference

COMPONENT CONNECTOR END VIEWS - INDEX

Description and Operation

Hybrid Cooling System Description and Operation

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are

identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1A5D is not set.
 - o If the DTC is set

Replace the K16 Battery Energy Control Module

- o If the DTC is not set
3. All OK.

Repair Instructions

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

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P1A5E OR P1A5F

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 P1A5E

Battery Energy Control Module Ignition On/Start Switch Circuit Low Voltage

DTC P1A5F

Battery Energy Control Module Ignition On/Start Switch Circuit High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P1A5E, P0AC4, P2534	P1A5E, P0AC4	P1A5F, P0AC4, P2535	-

Circuit/System Description

The RUN/CRANK relay applies ignition voltage to the ignition 1 circuit when the ignition is in the RUN or CRANK position. The ignition 1 circuit supplies ignition voltage to the Starter/Generator Control Module. The ignition 1 circuit also continues through the Starter/Generator Control Module in a pass-thru manner and continues to the Battery Energy Control Module. The Battery Energy Control Module also monitors the power mode message which is broadcast via serial data and compares the power mode message to the actual power mode as indicated by voltage on the ignition 1 circuit.

Controlled by the Body Control Module (BCM), the accessory wakeup circuit supplies voltage to the Starter/Generator Control Module as a means to wake the control module and initiate serial data communications. Like the ignition 1 circuit, the accessory wakeup circuit continues through the Starter/Generator Control Module in a pass-thru manner and continues to the Battery Energy Control Module.

Conditions for Running the DTC

- 12 V battery voltage is greater than 8.86 V
- Battery energy control module is awake and communicating
- Serial data indicates the power mode is RUN/CRANK
- DTC U180B is not set

Conditions for Setting the DTC

The power mode message received via serial data does not match the power mode indicated by the status of the ignition 1 circuit.

Action Taken When the DTC Sets

DTC P1A5E and P1A5F are type B DTCs

Conditions for Clearing the DTC

DTC P1A5E and P1A5F are type B DTCs

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

1. Ignition ON.
2. Verify the scan tool Hybrid Powertrain Control Module Ignition 1 parameter is 0 V with the ignition OFF and B+ with the ignition ON.
 - **If not 0 V with the ignition OFF and B+ with the ignition ON**

Refer to Circuit/System Testing below.

- **If 0 V with the ignition OFF and B+ with the ignition ON**
3. Verify the scan tool Battery Energy Control Module Power Mode parameter matches the actual vehicle power mode as the ignition is turned ON and OFF.
 - **If the parameter does not match the actual power mode**

Refer to Circuit/System Testing below.

- **If the parameter matches the actual power mode**
4. 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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the X3 harness connector at the K59 Starter/Generator Control Module.
2. Verify a test lamp does not illuminate between the ignition circuit terminal 10 and ground.
 - **If the test lamp illuminates**
 1. Disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for less than 1 V between the ignition circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, refer to **Power Mode Mismatch** .
 - **If the test lamp does not illuminate**
3. Ignition ON.
4. Verify a test lamp illuminates between the ignition circuit terminal 10 and ground.
 - **If the test lamp does not illuminate**
 1. Disconnect the X2 harness connector at the X50A Fuse Block - Underhood.
 2. Test for infinite resistance between the ignition circuit and ground.

- If less than infinite resistance, repair the short to ground on the circuit.
- If infinite resistance
- 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, refer to **Power Mode Mismatch** .
- **If the test lamp illuminates**
- 5. Connect the X3 harness connector at the K59 Starter/Generator Control Module.

NOTE: In **High Voltage Disabling**, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

- 6. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
- 7. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
- 8. Disconnect the X1 harness connector at the K16 Battery Energy Control Module.
- 9. Connect the 12 V battery.
- 10. Verify a test lamp does not illuminate between the ignition circuit terminal 9 and ground.
 - **If the test lamp illuminates**
 - 1. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 - 2. Test for less than 1 V between the ignition circuit and ground.
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V, replace the K59 Starter/Generator Control Module.
 - **If the test lamp does not illuminate**
- 11. Ignition ON.
- 12. Verify a test lamp illuminates between the ignition circuit terminal 9 and ground.
 - **If the test lamp does not illuminate**
 - 1. Disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 - 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 - 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
- 13. Replace the K16 Battery Energy Control Module.

Repair Instructions

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

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

DTC P1A60

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 P1A60

Battery Energy Control Module Ignition Accessory Switch Circuit Low Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
Ignition	P1A60	P1A60	-	-

Circuit/System Description

The RUN/CRANK relay applies ignition voltage to the ignition 1 circuit when the ignition is in the RUN or CRANK position. The ignition 1 circuit supplies ignition voltage to the Starter/Generator Control Module. The ignition 1 circuit also continues through the Starter/Generator Control Module in a pass-thru manner and continues to the Battery Energy Control Module. The Battery Energy Control Module also monitors the power mode message which is broadcast via serial data and compares the power mode message to the actual power mode as indicated by voltage on the ignition 1 circuit.

Controlled by the Body Control Module (BCM), the accessory wakeup circuit supplies voltage to the Starter/Generator Control Module as a means to wake the control module and initiate serial data communications. Like the ignition 1 circuit, the accessory wakeup circuit continues through the Starter/Generator Control Module in a pass-thru manner and continues to the Battery Energy Control Module.

Conditions for Running the DTC

- Battery voltage is greater than 9.6 V
- Battery energy control module is awake and communicating
- Serial data indicates the power mode is RUN/CRANK
- Propulsion system is active

Conditions for Setting the DTC

The accessory wakeup serial data circuit is not active

Action Taken When the DTC Sets

DTC P1A60 is a type B DTC

Conditions for Clearing the DTC

DTC P1A60 is a type B DTC

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Drive Motor Battery System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

1. Ignition ON.
2. Verify DTC U2099 is not set.
 - If the DTC is set

Refer to **DTC U2099** .

- If the DTC is not set
3. Refer to Circuit/System Testing below

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the A4 Hybrid/EV Battery Pack. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Disconnect the X1 harness connector at the K16 Battery Energy Control Module.
4. Connect the 12 V battery, ignition ON.
5. Verify a test lamp illuminates between the ignition circuit terminal 20 and ground.
 - **If the test lamp does not illuminate**
 1. Ignition OFF, disconnect the X4 harness connector at the K59 Starter/Generator Control Module.
 2. Test for infinite resistance between the ignition circuit and ground.
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Test for less than 2 ohms in the ignition circuit end to end.
 - If 2 ohms or greater, repair the open/high resistance in the circuit.
 - If less than 2 ohms, replace the K59 Starter/Generator Control Module.
 - **If the test lamp illuminates**
6. Replace the K16 Battery Energy Control Module.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

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

DTC P1B11

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 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 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. These voltage values are used by the starter/generator control module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

This DTC runs at all times.

Conditions for Setting the DTC

The starter/generator control module detects an AC voltage short to chassis ground.

Action 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 inflatable restraint sensing and diagnostic module, 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.

Diagnostic Aids

For intermittent concerns, drive the vehicle while monitoring the scan tool Drive Motor Control Module Negative Supply Isolation Voltage parameter and the scan tool Drive Motor Control Module Positive Supply Isolation Voltage parameter using the Graphical Data Display function of the scan tool. An intermittent loss of isolation will result in a large spike in the graph. This spike will correspond with the setting of the DTC. If normal isolation testing reveals no isolation faults and testing indicates an intermittent isolation fault while driving the vehicle, replace the A15 Starter/Generator.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48900** HEV Safety Kit
- **EL-50772** Insulation Multimeter

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.

- If greater than 400K ohms

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

- Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud
 - 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
 - Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
 - Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms
 - Replace the two wiring junction blocks.
 - **If greater than 400K ohms**
- Replace the A15 Starter/Generator.

Repair Instructions

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

- **Drive Motor Generator Battery Cable Replacement**
- **Starter Generator Replacement**
- **Generator Battery Replacement**
- **Drive Motor Battery Wire Junction Block Relay Replacement**
- **Control Module References** for starter/generator control module replacement, programming, and setup

DTC P1B33-P1B39

Diagnostic Instructions

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

DTC Descriptors

DTC P1B33

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Circuit

DTC P1B34

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 1 Performance

DTC P1B35

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 2 Performance

DTC P1B36

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 3 Performance

DTC P1B37

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 4 Performance

DTC P1B38

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 5 Performance

DTC P1B39

Battery Energy Control Module Hybrid/EV Battery Voltage Balance Processor 6 Performance

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack.

To ensure proper battery function and lengthen battery life, the Battery Energy Control Module balances the voltage of the cells so that each cells maintains the same voltage level. The Battery Energy Control Module uses internal voltage gates to transfer voltage from cells with a higher voltage level to those cells with a lower voltage level. To maintain a similar state of charge on the cell groups, the Starter/Generator Control Module monitors the cell voltages and determines which cells need energy removed in order to maintain the cells at a similar state of charge. A resistor wired in parallel with the cell and a transistor switch in series with the resistor internal to the Battery Energy Control Module. The Starter/Generator Control Module sends a command to the Battery Energy Control Module to begin cell balancing.

Conditions for Running the DTC

DTC P1B33

- Battery voltage is greater than 8.8 V.
- Battery energy control module is awake and communicating.
- Internal cell balancing is not in progress.

DTC P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

- Battery voltage is greater than 9.6 V.
- Battery energy control module is awake and communicating.

Conditions for Setting the DTC

DTC P1B33

The balancing switch status does not equal the balancing switch command.

DTC P1B34, P1B35, P1B36, P1B37, P1B38, P1B39

An internal communication fault has occurred within the Battery Energy Control Module.

Action Taken When the DTC Sets

- DTCs P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, and P1B39 are type B DTCs.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTCs P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, and P1B39 are type B DTCs.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify there are no customer installed devices located near the A4 Hybrid/EV Battery Pack and that any customer installed antenna or antenna cables are routed away from the A4 Hybrid/EV Battery Pack.
 - If any customer installed devices, antenna, or antenna cables are located near the A4 Hybrid/EV Battery Pack

Remove or relocated the devices, antenna, or antenna cables.

- If no customer installed devices, antenna, or antenna cables are located near the A4 Hybrid/EV Battery Pack
2. Ignition ON.
 3. Verify DTC P1B33, P1B34, P1B35, P1B36, P1B37, P1B38, or P1B39 is not set.
 - If any of the DTCs are set

Replace the K16 Battery Energy Control Module

- If none of the DTCs are set
4. All OK.

Repair Instructions

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

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P1B3F OR P1B40

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 P1B3F

High Voltage System Interlock Circuit 2 Low Voltage

DTC P1B40

High Voltage System Interlock Circuit 2 High Voltage

Diagnostic Fault Information

Circuit	Short to Ground	Open/High Resistance	Short to Voltage	Signal Performance
5 V Reference	P0641, P057C, P1B3F	P1B3F	P0641, P1B40	-
Signal	P1B3F	P1B3F	P1B40	-

Circuit/System Description

The high voltage interlock circuits are utilized to verify high voltage component integrity. The high voltage interlock circuits are two circuit loops that pass through certain high voltage components. The high voltage interlock circuits are used to determine if access to high voltage components is being attempted. The opening of these high voltage components causes the high voltage interlock circuit to open. The Starter/Generator Control Module monitors both the high voltage interlock 5 V reference circuit voltage and the high voltage interlock signal circuit voltage in order to detect circuit faults. When the Starter/Generator Control Module detects a loss of high voltage interlock circuit voltage, the high voltage contactors are commanded open.

The service cover for the Starter/Generator and the service cover for the Hybrid/EV Battery Pack each contain a high voltage interlock switch. When either cover is removed, the starter/generator control module will respond by opening the high voltage contacts. The 5 V reference circuits and signal circuits for each of the two high voltage interlock loops are completely separate from one another and are monitored as two separate loops, with each setting a specific DTC to indicate a circuit fault. The 5 V reference circuit that feeds the high voltage interlock switch on the Starter/Generator also supplies the 5 V reference to the brake pedal position sensor.

Conditions for Running the DTC

The Starter/Generator Control Module is awake and communicating

Conditions for Setting the DTC

DTC P1B3F

Voltage on the high voltage interlock signal circuit is less than 0.5 V

DTC P1B40

Voltage on the high voltage interlock signal circuit is greater than 4.5 V

Action Taken When the DTC Sets

DTCs P1B3F and P1B40 are type B DTCs

Conditions for Clearing the DTC

DTCs P1B3F and P1B40 are type B DTCs

Diagnostic Aids

- When a circuit fault is detected on the high voltage interlock loop that feeds the Starter/Generator and the vehicle hood is opened, the Starter/Generator Control Module will respond by turning off inverter switching. This will prevent the Starter/Generator from charging the Hybrid/EV Battery Pack and supplying voltage to the Starter/Generator Control Module 12 V output. Operating in this manner will cause an eventual discharge of both the high voltage battery pack and the 12 V battery.
- Because the 5 V reference circuit also supplies voltage to the brake pedal position sensor, a circuit fault on the high voltage interlock loop that feeds the Starter/Generator will also cause hybrid functions that rely on the brake pedal position, such as auto-stop and regenerative braking, to be disabled.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

1. Ignition ON.
2. Verify DTC P0641 is not set.
 - o **If the DTC is set**

Refer to DTC P0641.

- o **If the DTC is not set**
- 3. Refer to Circuit/System Testing below.

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.
 - o Visually and functionally inspect the gloves before use.
 - o 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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available

in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, disconnect the X2 harness connector at the K59 Starter/Generator Control Module, ignition ON.
2. Test for less than 1 V between the following circuit terminals and ground:
 - 5 V Reference circuit terminal 2
 - Signal circuit terminal 1
 - **If 1 V or greater**
 1. Disconnect the harness connector at the A15 Starter/Generator.
 2. Test for less than 1 V between the following circuit terminals and ground:
 - K59 Starter/Generator Control Module 5 V reference circuit terminal 2 X2
 - K59 Starter/Generator Control Module signal circuit terminal 1 X2
 - If 1 V or greater, repair the short to voltage on the circuit.
 - If less than 1 V
 3. Replace the A15 Start/Generator.
 - **If less than 1 V**
3. Ignition OFF.
4. Test for infinite resistance between the following circuit terminals and ground:
 - 5 V Reference circuit terminal 2
 - Signal circuit terminal 1
 - **If less than infinite resistance**
 1. Disconnect the harness connector at the A15 Starter/Generator.
 2. Test for infinite resistance between the following circuit terminals and ground:
 - K59 Starter/Generator Control Module 5 V reference circuit terminal 2 X2
 - K59 Starter/Generator Control Module signal circuit terminal 1 X2
 - If less than infinite resistance, repair the short to ground on the circuit.
 - If infinite resistance
 3. Disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
 4. Remove the A15 Starter/Generator battery cable access cover.

NOTE: **The 5 V reference and signal circuits pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block before connecting to a resistor located in the A15 Start/Generator battery cable access cover.**

5. Verify the terminal integrity of the 5 V reference and signal circuits as they pass through the A15

Starter/Generator and the A15 Starter/Generator battery cable block. Verify none of these terminals are not damaged in a manner that would cause them to be shorted to ground.

- If any of the terminals are damaged, repair or replace the appropriate component as necessary.
 - If none of the terminals are damaged.
6. Replace the A15 Start/Generator.
 - **If infinite resistance**
 5. Test for 2.5k - 3.5k ohms between the 5 V reference circuit terminal 2 and the signal circuit terminal 1.
 - **If less than 2.5k ohms**
 1. Disconnect the harness connector at the A15 Starter/Generator.
 2. Test for infinite resistance between the K59 Starter/Generator Control Module 5 V reference circuit terminal 2 and the K59 Starter/Generator Control Module signal circuit terminal 1.
 - If less than infinite resistance, repair the shorted together circuits.
 - If infinite resistance
 3. Connect the harness connector at the A15 Starter/Generator.
 4. Disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
 5. Remove the A15 Starter/Generator battery cable access cover,
 6. Test for infinite resistance between the K59 Starter/Generator Control Module 5 V reference circuit terminal 2 and the K59 Starter/Generator Control Module signal circuit terminal 1.
 - If less than infinite resistance, verify the terminal integrity of the 5 V reference and signal circuits as they pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block. Verify these terminals are not damaged in a manner that would cause them to be shorted to together.
 - If infinite resistance
 7. Test the A15 Starter/Generator battery cable access cover. Refer to Component Testing below.
 - If the A15 Starter/Generator battery cable access cover does not pass the Component Test, replace the A15 Starter/Generator battery cable access cover.
 - If the A15 Starter/Generator battery cable access cover passes the Component Test
 8. Replace the A15 Starter/Generator.
 - **If greater than 3.5k ohms**
 1. Disconnect the harness connector at the A15 Starter/Generator.
 2. Test for infinite resistance between the K59 Starter/Generator Control Module 5 V reference circuit terminal 2 and the K59 Starter/Generator Control Module signal circuit terminal 1.
 - If less than infinite resistance, repair the shorted together circuits.
 - If infinite resistance
 3. Test for less than 2 ohms between the following circuit terminals:
 - K59 Starter/Generator Control Module 5 V reference circuit terminal 2 X2 and the A15 Start/Generator 5 V reference circuit terminal 12
 - K59 Starter/Generator Control Module signal circuit terminal 1 X2 and the A15 Start/Generator signal circuit terminal 11

- If 2 ohms or greater, repair the open circuit.
- If less than 2 ohms
- 4. Connect the harness connector at the A15 Starter/Generator.
- 5. Disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
- 6. Remove the A15 Starter/Generator battery cable access cover.
- 7. Test the A15 Starter/Generator battery cable access cover. Refer to Component Testing below.
 - If the A15 Starter/Generator battery cable access cover does not pass the Component Test, replace the A15 Starter/Generator battery cable access cover.
 - If the A15 Starter/Generator battery cable access cover passes the Component Test

NOTE: **The 5 V reference and signal circuits pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block before connecting to a resistor located in the A15 Start/Generator battery cable access cover.**

- 8. Verify the terminal integrity of the 5 V reference and signal circuits as they pass through the A15 Starter/Generator and the A15 Starter/Generator battery cable block. Verify none of these terminals are not damaged in a manner that would cause them to be open.
 - If any of the terminals are damaged, repair or replace the appropriate component as necessary.
 - If none of the terminals are damaged
- 9. Replace the A15 Starter/Generator.
 - **If between 2.5k - 3.5k ohms**
- 6. Test or replace the K59 Starter/Generator Control Module

Component Testing

- 1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
- 2. Remove the A15 Starter/Generator battery cable access cover.
- 3. Test for 2.5k-3.5k ohms between the A15 Starter/Generator battery cable access cover high voltage interlock 5 V reference terminal and the A15 Starter/Generator battery cable access cover high voltage interlock signal terminal.
 - **If not between 2.5k-3.5k ohms**

Replace the A15 Starter/Generator battery cable access cover

- **If between 2.5k-3.5k ohms**
- 4. All OK.

Repair Instructions

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

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

DTC P1E0C OR P1E0D

Diagnostic Instructions

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

DTC Descriptors

DTC P1E0C

Hybrid/EV Battery Voltage Isolation Sensing Circuit 2 Low Voltage

DTC P1E0D

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 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. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P1E0C

- Power mode is RUN or CRANK.
- Contactors are closed.

P1E0D

- Power mode is RUN or CRANK.
- The Starter/Generator Control Module internal voltage sensor has no reported faults.

Conditions for Setting the DTC

P1E0C

Voltage measured at the negative mid-pack voltage sensor is less than 5 V.

P1E0D

The difference between the voltage measured at the negative mid-pack voltage sensor and the Starter/Generator Control Module internal motor control processor high voltage value is greater than 15 V.

Action Taken When the DTC Sets

- DTCs P1E0C and P1E0D are type B DTCs.
- If the DTC sets while there is a loss of communication with the Inflatable Restraint 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

- DTCs P1E0C and P1E0D are type B DTCs.
- 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

Connector End View Reference

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Drive Motor Battery System Description

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1E0C or P1E0D is not set.

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

Replace the K59 Starter/Generator Control Module.

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

3. All OK.

Repair Instructions

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

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

DTC P1E0F-P1E11

Diagnostic Instructions

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

DTC Descriptors

DTC P1E0F

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 Low Voltage

DTC P1E10

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 High Voltage

DTC P1E11

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 1 Performance

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. These voltage values are used by the Starter/Generator Control Module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too

low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P1E0F

- Power mode is RUN or CRANK.
- Contactors are closed.

P1E10

- Power mode is RUN or CRANK.
- The Starter/Generator Control Module internal voltage sensor has no reported faults.
- Mid-pack voltage positive sensor is less than 7.5 V.
- DTC P0AAA is not set.

P1E11

- Mid-pack voltage positive sensor is less than 7.5 V.
- DTC P1E0F or P1E10 is not set.

Conditions for Setting the DTC

P1E0F

Voltage measured at the positive mid-pack high resolution voltage sensor is less than 3 V.

P1E10

The difference between the voltage measured at the positive mid-pack high resolution voltage sensor and the Starter/Generator Control Module internal motor control processor high voltage value is greater than 5 V.

P1E11

The difference between the mid-pack voltage positive sensor and the positive mid-pack high resolution voltage sensor is greater than 3 V.

Action Taken When the DTC Sets

- DTCs P1E0F-P1E11 are type B DTCs.
- If the DTC sets while there is a loss of communication with the Inflatable Restraint 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

- DTCs P1E0F-P1E11 are type B DTCs.
- 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

Connector End View Reference

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- Wiring Repairs

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1E0F, P1E10, or P1E11 is not set.
 - If any of the DTCs are set

Replace the K59 Starter/Generator Control Module.

- If none of the DTCs are set
3. All OK.

Repair Instructions

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

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

DTC P1E12-P1E14

Diagnostic Instructions

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

DTC Descriptors

DTC P1E12

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Low Voltage

DTC P1E13

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 High Voltage

DTC P1E14

Hybrid/EV Battery Voltage Isolation High Resolution Sensing Circuit 2 Performance

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. These voltage values are used by the starter/generator control module to calculate a resistance value between the high voltage bus and the chassis ground. If this resistance value is too low, a high voltage isolation fault has occurred.

Conditions for Running the DTC

P1E12

Contactors are closed.

P1E13

- Power mode is RUN or CRANK.
- The starter/generator control module internal voltage sensor has no reported faults.
- Mid-pack voltage negative sensor is less than 7.5 V.
- DTC P1E0D is not set.

P1E14

- Mid-pack voltage negative sensor is less than 7.5 V.
- DTC P1E10 or P1E11 is not set.

Conditions for Setting the DTC

P1E12

Voltage measured at the negative mid-pack high resolution voltage sensor is less than 3 V.

P1E13

The difference between the voltage measured at the negative mid-pack high resolution voltage sensor and the starter/generator control module internal motor control processor high voltage value is greater than 5 V.

P1E14

The difference between the mid-pack voltage negative sensor and in the negative mid-pack high resolution voltage sensor is greater than 3 V.

Action Taken When the DTC Sets

- DTCs P1E12-P1E14 are type B DTCs.
- If the DTC sets while there is a loss of communication with the inflatable restraint 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

- DTCs P1E12-P1E14 are type B DTCs.
- 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

Connector End View Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure..

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.
 - **If greater than 400K ohms**

NOTE: The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.

4. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:

- 3 phase terminal U - K59 Starter/Generator Control Module stud
- 3 phase terminal V - K59 Starter/Generator Control Module stud
- 3 phase terminal W - K59 Starter/Generator Control Module stud

- **If 400K ohms or less**

1. Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
2. Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms
3. Replace the two wiring junction blocks.

- **If greater than 400K ohms**

5. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

Repair Instructions

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

Control Module References for starter/generator control module replacement, programming, and setup

DTC P1E3D

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 P1E3D

Control Module Calculated Hybrid/EV Battery Performance

Circuit/System Description

As a means of checking microprocessor integrity, the Starter/Generator Control Module calculates and compares voltage at various locations within itself. The Starter/Generator Control Module calculates three separate voltage values, representing voltage measured at different locations within the Hybrid/EV Battery Pack. The Starter/Generator Control Module performs these calculations at different locations within the microprocessor. As an indicator of microprocessor integrity, the voltage calculations should all be the same.

Conditions for Running the DTC

This DTC runs continuously.

Conditions for Setting the DTC

The difference between the calculated voltages is greater than 1 V.

Action Taken When the DTC Sets

- DTC P1E3D is a type A DTC.
- The high voltage contactors open and hybrid functions are disabled.
- 12 V output from the Starter/Generator Control Module is maintained.

Conditions for Clearing the DTC

DTC P1E3D is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1E3D is not set.
 - If the DTC is set

Replace the 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.

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

DTC P1EAA

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 P1EAA

Hybrid/EV Battery Voltage Balance Processor Multiplexer Performance

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack.

To ensure proper battery function and lengthen battery life, the battery energy control processor balances the voltage of the cells so that each cells maintains the same voltage level. The Battery Energy Control Module uses internal voltage gates to transfer voltage from cells with a higher voltage level to those cells with a lower voltage level. This voltage balancing is an internal function to the Battery Energy Control Module.

The cell voltages are read through multiplexer circuits which take the voltages from multiple battery cells and supplies them to one single analog to digital converter. To determine if the multiplexer is operating correctly, the balancing gates are operated by the Battery Energy Control Module one at a time, shifting each cell voltage while the balance gate is on. This cell voltage pattern is analyzed by the Starter/Generator Control Module to determine if there is a cell voltage multiplexer malfunction.

Conditions for Running the DTC

- Ignition mode transitions from RUN or CRANK to OFF.

- Contactor status is open.
- Propulsion system active while contactors are open for greater than 2.5 seconds is not true.
- DTC U182A is not set.

Conditions for Setting the DTC

- The balance process did not occur at ignition OFF.
- The balance process occurred at any time other than ignition OFF.
- The cell voltage movement during the balance process is more than 0.1 V from the expected voltage movement.

Action Taken When the DTC Sets

- DTC P1EAA is a type A DTC.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P1EAA is a type A DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify no communication DTCs are set in the K59 Starter/Generator Control Module.
 - **If any communication DTCs are set in the K59 Starter/Generator Control Module**

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

- **If no communication DTCs are set in the K59 Starter/Generator Control Module**
2. Verify DTC P1A5E or P1A5F are not set.
 - **If DTC P1A5E or P1A5F is set**

Refer to **DTC P1A5E or P1A5F**.

- **If DTC P1A5E and P1A5F are not set**
3. Verify DTC P1A60 is not set.
 - **If DTC P1A60 is set**

Refer to **DTC P1A60**.

- **If DTC P1A60 is not set**
4. Verify DTC P1EAA or P1EAC is not set as current.
 - **If DTC P1EAA or P1EAC is set as current**

Replace the K16 Battery Energy Control Module.

NOTE: **DTC P1EAA or P1EAC may be difficult to reproduce and no repair should be made unless the DTC is set as current. Operate the vehicle within the Conditions for Running the DTC when attempting to reproduce the DTC.**

- **If DTC P1EAA or P1EAC is not set or is set as history**
5. All OK.

Repair Instructions

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

Control Module References for Battery Energy Control Module replacement, programming, and setup

DTC P1EAB

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 P1EAB

Battery Energy Control Module Hybrid/EV Battery Cell High Voltage

Circuit/System Description

The Hybrid/EV Battery Pack contains a total of 32 cell groups in the Hybrid/EV Battery Pack assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC. The battery cells are grouped together into two sections, each with 16 cell groups.

The Battery Energy Control Module monitors the voltage of the 32 battery cell groups. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connectors the voltage sense circuits to the Battery Energy Control Module, located directly above the Hybrid/EV Battery Pack.

The Battery Energy Control Module also monitors the cell voltage with internal hardware that is independent from the normal cell voltage path. This alternate method produces a true and false signal that indicates whether or not any cell voltage is too high. This signal is encoded and transmitted via serial data to the Starter/Generator Control Module.

Conditions for Running the DTC

The DTC monitor runs at all times, except when the control module self test is running or DTC P1EAC or U182A is set.

Conditions for Setting the DTC

Battery cell voltage is greater than 4.35 V

Action Taken When the DTC Sets

- DTC P1EAB is a type A DTC
- The vehicle operates without any hybrid functions with the high voltage contactors open, but it will continue to charge the 12V battery with the starter/generator acting as a conventional generator.

Conditions for Clearing the DTC

- DTC P1EAB is a type A DTC
- DTC P1EAB is a secure DTC. The **Clear Secured High Voltage DTCs** procedure must be performed to prevent resetting the DTC.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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Drive Motor Battery System Description

Electrical Information Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

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

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Ignition ON.
2. Verify DTC P1B34, P1B35, P1B36, P1B37, P1B38, or P1B39 is not set.
 - If any of the DTCs are set

Refer to **DTC P1B33-P1B39**. After the repair is complete, the **Clear Secured High Voltage DTCs** procedure must be performed to clear the secured DTC P1EAB.

- If none of the DTCs are set

3. Verify DTC P0B3B-P0BBB or P1B16-P1B2D is not set.
 - If any of the DTCs are set

Refer to **DTC P0B3B-P0BBB, P1B16-P1B2D, P1B3D, or P1B3E**. After the repair is complete, the **Clear Secured High Voltage DTCs** procedure must be performed to clear the secured DTC P1EAB.

- If none of the DTCs are set

4. Verify DTC P1EAB is not set.
 - If the DTC is set and any scan tool Hybrid/EV Battery voltage parameter is greater than 4.35 V

Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2. After the repair is complete, the **Clear Secured High Voltage DTCs** procedure must be performed to clear the secured DTC P1EAB.

- If the DTC is set and all the scan tool Hybrid/EV Battery voltage parameters are 4.35 V or

less

1. Program the K16 Battery Energy Control Module.
2. Clear any DTCs. It may be necessary to perform the **Clear Secured High Voltage DTCs** procedure to clear any secured DTCs.
3. Operate the vehicle within the Conditions for Running the DTC.
4. Verify the DTC does not set.
 - If the DTC sets, replace the K16 Battery Energy Control Module.
 - If the DTC does not set
5. All OK.
 - **If the DTC is not set**
5. All OK.

Repair Instructions

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

- **Generator Battery Replacement**
- **Control Module References** for Battery Energy Control Module replacement, programming, and setup

DTC P1EAC

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 P1EAC

Hybrid/EV Battery Cell Overvoltage Signal Circuit Performance

Circuit/System Description

The 2nd protection is a redundant method to monitor cell group overvoltage. The battery energy control modules independently reads and tests each cell group and communicates this to the hybrid powertrain control module. The hybrid powertrain control module diagnoses this message to determine when a cell group overvoltage condition exists.

The battery energy control module diagnoses the function of the redundant monitor, once, every power down cycle. When run/crank input signal transitions low and after a calibrated delay, the battery energy control module informs the hybrid powertrain control module, via serial data, that it is about to run the diagnostics on the 2nd protection circuit. The battery energy control module then proceeds to run the check on the serial data cell overvoltage true or false message. If any pulses are missing from the serial data message, the

starter/generator control module will report this as a fault.

Conditions for Running the DTC

- Ignition mode transitions from RUN or CRANK to OFF.
- 2nd protection fault test bit is active.
- No faults are set that would cause the contactors to become open when propulsion is active.
- DTC U182A is not set.

Conditions for Setting the DTC

- The test active bit is active for 12 seconds.

OR

- The test active bit does not transition to active.

OR

- The enumerated results does not match the expected result or not enough "True" responses are received.

Action Taken When the DTC Sets

- DTC P1EAC is a type A DTC.
- The vehicle operates in a low battery mode with the high voltage contactors closed, but no hybrid functions will occur.

Conditions for Clearing the DTC

DTC P1EAC is a type A 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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Circuit/System Verification

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

1. Verify no communication DTCs are set in the K59 Starter/Generator Control Module.
 - If any communication DTCs are set in the K59 Starter/Generator Control Module

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

- If no communication DTCs are set in the K59 Starter/Generator Control Module
2. Verify DTC P1A5E or P1A5F are not set.
 - If DTC P1A5E or P1A5F is set

Refer to DTC P1A5E or P1A5F.

- If DTC P1A5E and P1A5F are not set
3. Verify DTC P1A60 is not set.
 - If DTC P1A60 is set

Refer to DTC P1A60.

- If DTC P1A60 is not set
4. Verify DTC P1EAA or P1EAC is not set as current.
 - If DTC P1EAA or P1EAC is set as current

Replace the K16 Battery Energy Control Module.

NOTE: DTC P1EAA or P1EAC may be difficult to reproduce and no repair should be made unless the DTC is set as current. Operate the vehicle within the Conditions for Running the DTC when attempting to reproduce the DTC.

- If DTC P1EAA or P1EAC is not set or is set as history
5. All OK.

Repair Instructions

Perform the Diagnostic Repair Verification after completing the repair.

Control Module References for battery energy control module replacement, programming, and setup

DTC P1EC0

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 P1EC0

Hybrid/EV Battery System Contactor(s) Stuck Open

Circuit/System Description

At times, it may be necessary to disconnect high voltage from the vehicle, both during normal operation and when a system fault is identified. The Starter/Generator Control Module controls the Main Contactor and pre-charge contactor to disconnect and connect high voltage from the vehicle. The high voltage contactors are switches that are controlled much like a relay. To disable high voltage from the vehicle, the main and pre-charge contactors are commanded open. This will open the contactors and physically disconnect the hybrid/EV battery positive cable. To connect high voltage to the vehicle, first the pre-charge contactor is closed. With the pre-charge contactor closed, current flows through the pre-charge resistor. This allows high voltage to slowly build in the system, as the resistor decreases current flow. Once high voltage is brought up through the pre-charge contactor, the Main Contactor is close and high voltage is active. If the high voltage builds too quickly or too slowly, the Starter/Generator Control Module will set a fault.

If a system fault occurs that does not allow the contactors to open, the Starter/Generator Control Module will be unable to disconnect high voltage from the vehicle. In instances such as this, the manual disconnect lever will disconnect high voltage from the vehicle when servicing.

Conditions for Running the DTC

Contactors are commanded closed

Conditions for Setting the DTC

The Starter/Generator Control Module does not detect high voltage after the contactors have been commanded closed.

Action Taken When the DTC Sets

DTC P1EC0 is a type A DTC.

Conditions for Clearing the DTC

DTC P1EC0 is a type A DTC.

Diagnostic Aids

- This diagnostic is used when high voltage has not been disabled when the contactors have been commanded closed. This indicates that one or both contactors are stuck open. The High Voltage Disabling procedure should still be completed, using the procedure for Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack. This will disconnect the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 and limit high voltage exposure when performing diagnosis.
- Be sure to check for any DTCs that may be set. These DTCs may lead to the cause of the stuck contactors and DTC diagnosis should be performed before enabling high voltage. This will help ensure a repeat fault with the contactors does not occur. After diagnosis any DTCs, return to this procedure to test and repair any contactor that may be mechanically stuck open.

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Connect the X1, X2, and X3 harness connectors at the K59 Starter/Generator Control Module.
3. Verify DTC P0ADB, P0ADC, P0AE6, or P0AE7 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**

NOTE: **The following steps will test the KR38 Main Contactor, KR134 Pre-Charge Contactor, and the S15 Manual Service Disconnect as a type of component test. These components must be removed from the A4 Hybrid/EV Battery Pack to ensure proper test results.**

4. Remove the KR38 Main Contactor, KR134 Pre-Charge Contactor, and the S15 Manual Service Disconnect from the A4 Hybrid/EV Battery Pack.
5. Install a 10 A fused jumper wire between the KR38 Main Contactor B+ terminal 1 X1 and 12 V. Install a jumper wire between the KR38 Main Contactor control terminal 2 X1 and ground.
6. Test for less than 10 ohms between the high voltage terminals at the KR38 Main Contactor.

- **If 10 ohms or greater**

The KR38 Main Contactor is stuck in the open position. Replace the KR38 Main Contactor.

- **If less than 10 ohms**

7. Install a 10 A fused jumper wire between the KR134 Pre-Charge Contactor B+ terminal A X1 and 12 V. Install a jumper wire between the KR134 Pre-Charge Contactor control terminal A X2 and ground.
8. Test for less than 10 ohms between the high voltage terminals at the KR134 Pre-Charge Contactor.

- **If 10 ohms or greater**

The KR134 Pre-Charge Contactor is stuck in the open position. Replace the KR134 Pre-Charge Contactor.

- **If less than 10 ohms**

9. Test for less than 10 ohms between the high voltage terminals at the S15 Manual Service Disconnect with the lever in the closed position.

- **If 10 ohms or greater**

The S15 Manual Service Disconnect is stuck in the open position. Replace the S15 Manual Service Disconnect.

- **If less than 10 ohms**

10. Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

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

LOSS OF ISOLATION IN THE HIGH VOLTAGE SYSTEM

Diagnostic Instructions

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

Circuit/System Description

The 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.

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

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

- **EL-48900** HEV Safety Kit
- **EL-50772** Insulation Multimeter

For equivalent regional tools, refer to Special Tools.

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery

Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**.
2. Disconnect the U, V, and W three phase lugs at the K59 Starter/Generator Control Module.

NOTE: **The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.**

3. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase cable terminal U - cable side lug
 - 3 phase cable terminal V - cable side lug
 - 3 phase cable terminal W - cable side lug
 - **If 400K ohms or less**
 1. Disconnect the U, V, and W three phase lugs at the A15 Starter/Generator.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the A15 Starter/Generator and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the A15 Starter/Generator.
 - If greater than 400K ohms
 3. Replace the high voltage 3 phase cables.
 - **If greater than 400K ohms**

NOTE: **The following continuity tests must be performed using the EL-50772 Insulation Multimeter. Select the Isolation test setting, then select the 500 V range.**

4. Test for greater than 400K ohms between the terminals listed below and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting:
 - 3 phase terminal U - K59 Starter/Generator Control Module stud
 - 3 phase terminal V - K59 Starter/Generator Control Module stud
 - 3 phase terminal W - K59 Starter/Generator Control Module stud
 - **If 400K ohms or less**
 1. Disconnect and remove the two wiring junction blocks from the A4 Hybrid/EV Battery Pack.
 2. Test for greater than 400K ohms between the U, V, and W three phase studs at the K59 Starter/Generator Control Module and chassis ground with the **EL-50772** Insulation Multimeter set on the Isolation test setting.
 - If 400K ohms or less, replace the K59 Starter/Generator Control Module.
 - If greater than 400K ohms

3. Replace the two wiring junction blocks.
 - o **If greater than 400K ohms**
5. Replace the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2.

Repair Instructions

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

- **Drive Motor Generator Battery Cable Replacement**
- **Starter Generator Replacement**
- **Generator Battery Replacement**
- **Control Module References** for hybrid powertrain control module replacement, programming, and setup

HYBRID\EV BATTERY VOLTAGE PRESENT

Diagnostic Instructions

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

Circuit/System Description

At times, it may be necessary to disconnect high voltage from the vehicle, both during normal operation and when a system fault is identified. The starter/generator control module controls the Main Contactor and pre-charge contactor to disconnect and connect high voltage from the vehicle. The high voltage contactors are switches that are controlled much like a relay. To disable high voltage from the vehicle, the main and pre-charge contactors are commanded open. This will open the contactors and physically disconnect the hybrid/EV battery positive cable. To connect high voltage to the vehicle, first the pre-charge contactor is closed. With the pre-charge contactor closed, current flows through the pre-charge resistor. This allows high voltage to slowly build in the system, as the resistor decreases current flow. Once high voltage is brought up through the pre-charge contactor, the Main Contactor is close and high voltage is active. If the high voltage builds too quickly or too slowly, the starter/generator control module will set a fault.

If a system fault occurs that does not allow the contactors to open, the starter/generator control module will be unable to disconnect high voltage from the vehicle. In instances such as this, the manual disconnect lever will disconnect high voltage from the vehicle when servicing.

Diagnostic Aids

- This diagnostic is used when high voltage has not been disabled after following the High Voltage Disabling procedure. This indicates that one or both contactors are stuck closed and the manual service disconnect is also stuck closed. The High Voltage Disabling procedure should still be completed, using the procedure for Servicing Any Internal Components Within the A4 Hybrid/EV Battery Pack. This will disconnect the battery terminals at the C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 and limit high voltage exposure when performing diagnosis.

- Be sure to check for any DTCs that may be set. These DTCs may lead to the cause of the stuck contactors and DTC diagnosis should be performed before enabling high voltage. This will help ensure a repeat fault with the contactors does not occur. After diagnosis any DTCs, return to this procedure to test and repair any contactor that may be mechanically stuck closed.

Reference Information

Schematic Reference

Hybrid/EV Energy Storage Schematics

Connector End View Reference

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

DTC Type Reference

Powertrain Diagnostic Trouble Code (DTC) Type Definitions

Scan Tool Reference

Control Module References for scan tool information

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

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.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance Center (1-877-446-8227) if you have any questions.

NOTE: In High Voltage Disabling, perform the disabling procedure for servicing components within the energy storage system. The C4A Hybrid/EV Battery Section 1 and C4B Hybrid/EV Battery Section 2 will be disconnected as part of the disabling procedure.

1. Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to High Voltage Disabling.
2. Verify no high voltage system DTCs are set.

- If any high voltage system DTCs are set

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

- If no high voltage system DTCs are set

3. Test for infinite resistance between the high voltage terminals at the KR38 Main Contactor.
 - If not infinite resistance

The KR38 Main Contactor is stuck in the closed position. Replace the KR38 Main Contactor.

- **If infinite resistance**

4. Test for infinite resistance between the high voltage terminals at the KR134 Pre-Charge Contactor.

- **If not infinite resistance**

The KR134 Pre-Charge Contactor is stuck in the closed position. Replace the KR134 Pre-Charge Contactor.

- **If infinite resistance**

5. Test for infinite resistance between the high voltage terminals at the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever.

- **If not infinite resistance**

The S15 Hybrid/EV Battery Pack high voltage manual disconnect lever is stuck in the closed position. Replace the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever.

- **If infinite resistance**

6. Replace the K59 Starter/Generator Control Module.

Repair Instructions

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

Control Module References for starter/generator control module replacement, programming, and setup

REPAIR INSTRUCTIONS

HIGH VOLTAGE SYSTEM INSPECTION

A complete inspection of the high voltage system and components must be performed if the vehicle has been involved in a collision.

Vehicle Collision Detection

The Supplemental Inflatable Restraint (SIR) sensors are designed to identify the severity of a collision and from what direction a collision has occurred. The SIR sensors typically detect collision conditions for occupant impact-protection reasons. The Starter/Generator Control Module will open the high voltage contactor relays and disable the vehicle whenever an SIR deployment occurs.

The Inflatable Restraint Sensing and Diagnostic Module transmits through serial data to the Starter/Generator Control Module whenever a sensor fault is detected or a collision event has been detected. The Starter/Generator Control Module will set a Crash Event Detected event and enter into a disable condition.

The Crash Event Detected condition will remain active until cleared by the Starter/Generator Control Module Clear Secured High Voltage DTCs output control function of the scan tool.

Special Tools

EL-48900 HEV Safety Kit

For equivalent regional tools, refer to Special Tools.

Inspection Procedure

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.

WARNING: High voltage circuits should only be tested using a digital multimeter (DMM) and test leads with at least a CAT III rating, such as the J 39200-A Digital Multimeter. Failure to follow the procedures may result in serious injury or death.

WARNING: The eAssist battery pack assembly will utilize an exchange program. Please consult the most recent revision of bulletin/PI# PIC5520, available in Service Information (SI), for a list of approved eAssist battery pack assembly service procedures. Components that may be removed and serviced without exchanging the complete battery pack assembly are identified in the bulletin/PI. Please contact the GM Technical Assistance

Center (1-877-446-8227) if you have any questions.

1. Ignition OFF, perform a visual inspection of the following high voltage components listed. Remove any trim covers, carpet, or shields to gain access. DO NOT remove the metal A4 Hybrid/EV Battery Pack cover. Inspect the assembly and verify there are no case cracks, dents, pinched, cut or frayed high voltage cables, low voltage cables, or other physical damage.

- A4 Hybrid/EV Battery Pack
- A15 Starter/Generator
- G14 Hybrid/EV Battery Pack Cooling Fan
- G14 Hybrid/EV Battery Pack Cooling Fan inlet and outlet ducts for proper positioning to the A4 Hybrid/EV Battery Pack. Refer to **Drive Motor Battery Cooling Air Inlet Upper Duct Replacement** ,, **Drive Motor Battery Cooling Blower Outlet Duct Replacement** ,, and **Drive Motor Battery Cooling Air Outlet Duct Replacement** for proper duct installation and routing.
- High voltage cables between the K59 Starter/Generator Control Module and the A15 Starter/Generator

- **If any damage is found**

Ignition OFF, disable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Disabling**. If vehicle damage does not allow for access to the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever, disconnect the 12V battery and remove the damaged portion of the vehicle until the S15 Hybrid/EV Battery Pack high voltage manual disconnect lever can be accessed and the **High Voltage Disabling** procedure can be completed. Replace any components and cables that have been identified as damaged. Continue to step 2 after repairs have been completed.

- **If no damage is found**

2. Enable high voltage at the A4 Hybrid/EV Battery Pack. Refer to **High Voltage Enabling**.
3. Ignition ON.
4. Verify no DTCs are set.

- **If any DTCs are set**

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

- **If no DTCs are set**

5. Clear the Crash Event Detected disable condition after all damaged high voltage components have been replaced. Refer to **Clear Secured High Voltage DTCs**.
6. Perform the required body repairs using the approved service procedures.

BATTERY ENERGY CONTROL MODULE REPLACEMENT

Removal Procedure

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: 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 hybrid battery. Refer to [High Voltage Disabling](#).

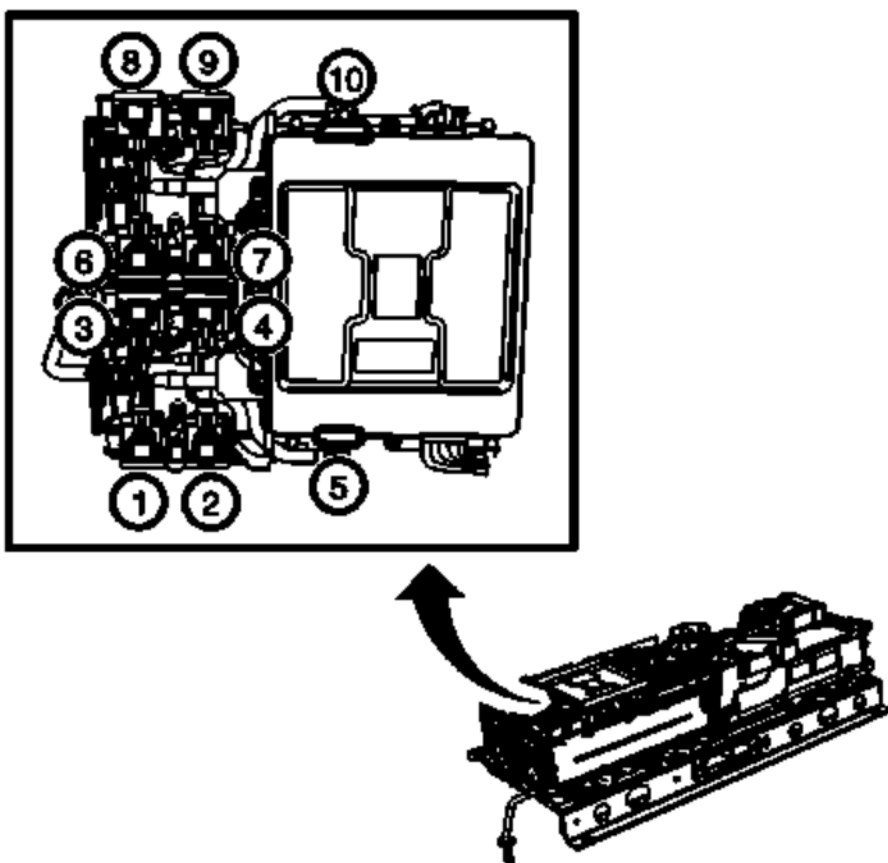


Fig. 17: Identifying Connectors Sequence
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the following connectors, in the above sequence shown, from the battery energy control module.

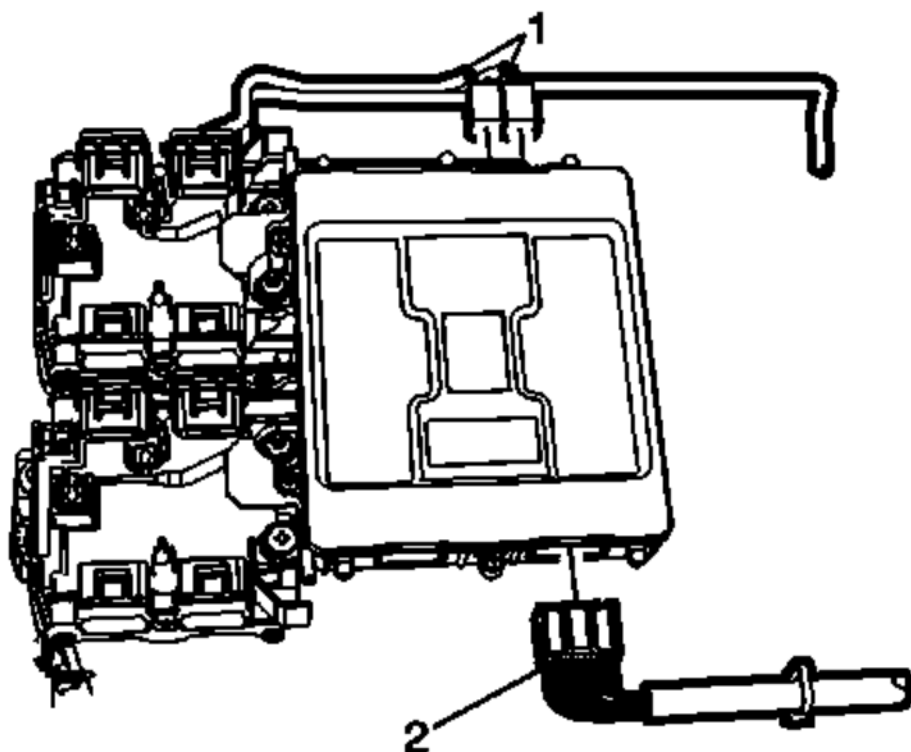


Fig. 18: Connectors

Courtesy of GENERAL MOTORS COMPANY

3. Remove the connectors (1) and the connector (2).

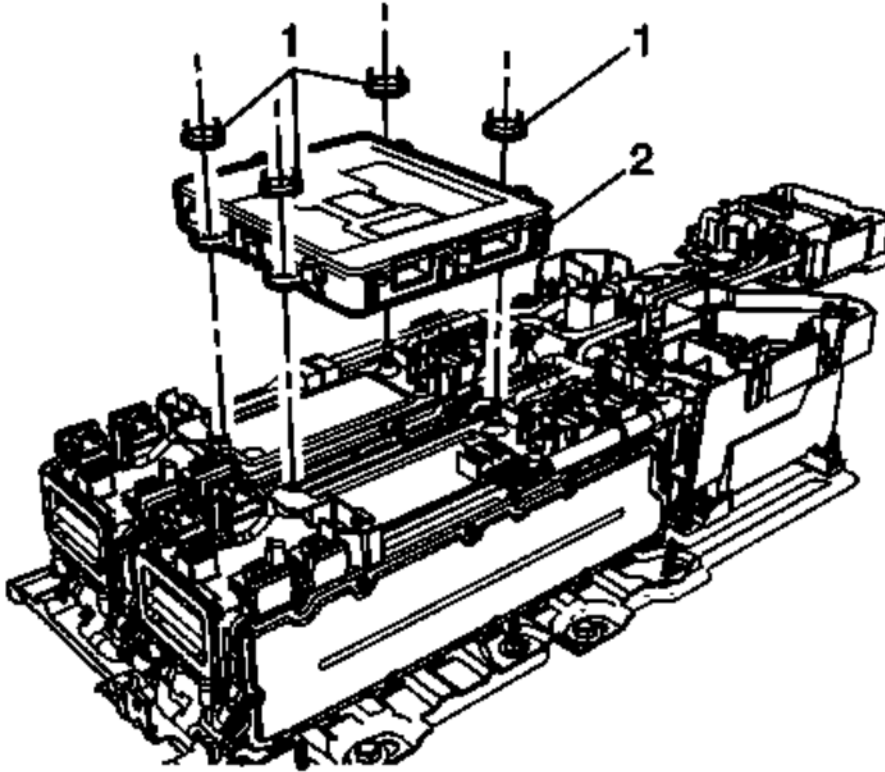


Fig. 19: Battery Energy Control Module Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery energy control module fasteners (1) and remove the battery energy control module (2) from the mounting studs.

Installation Procedure

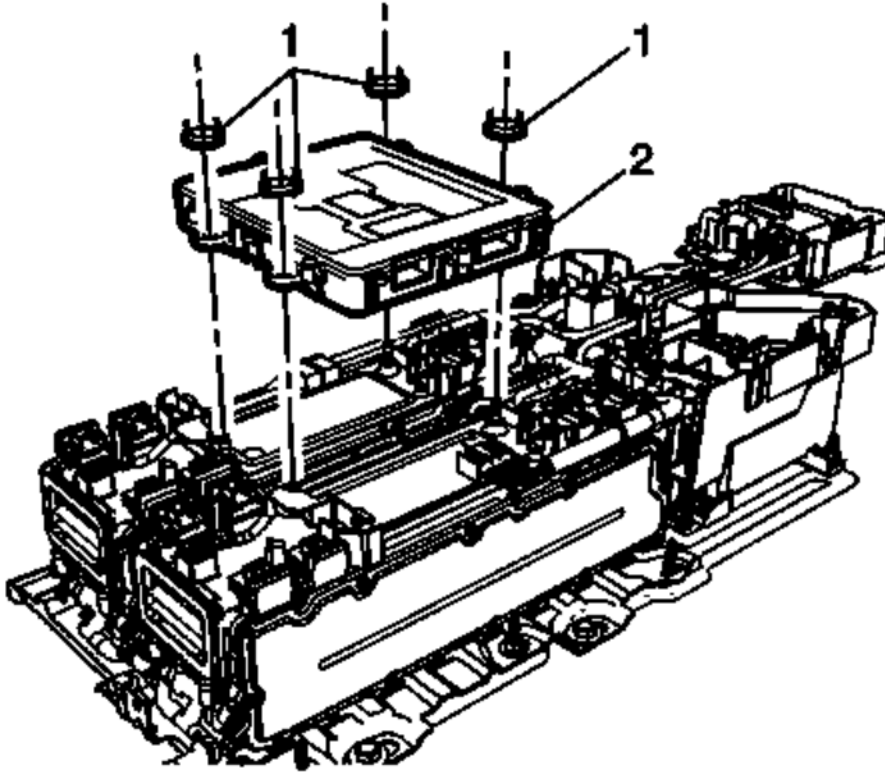


Fig. 20: Battery Energy Control Module Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the battery energy control module (2) to the mounting studs and tighten the fasteners (1) to 9 N.m (80 lb in).

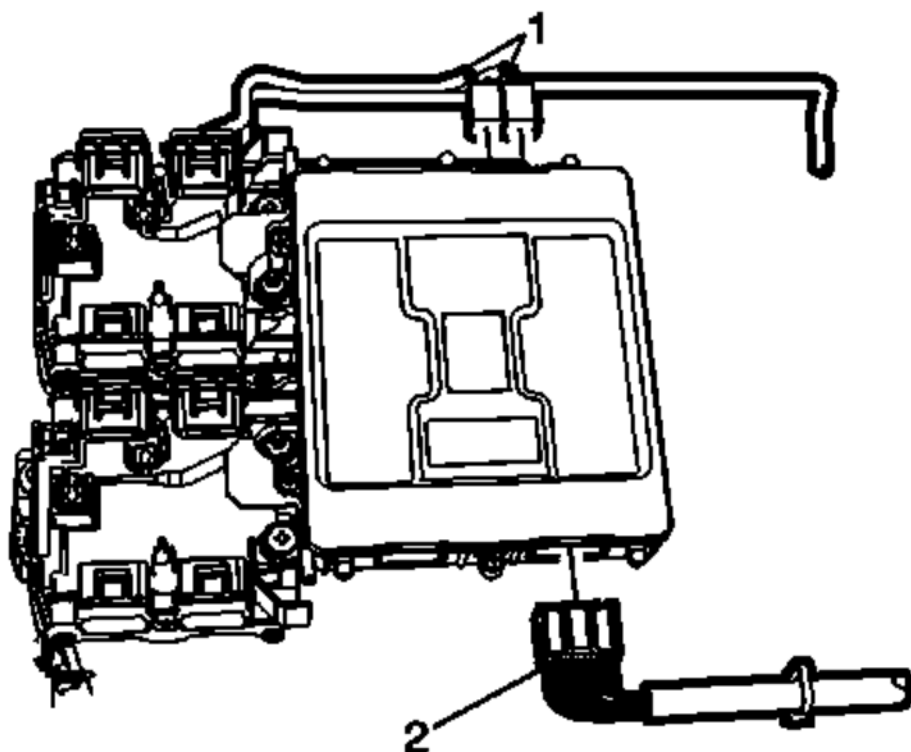


Fig. 21: Connectors

Courtesy of GENERAL MOTORS COMPANY

2. Install the connectors (1) and connector (2).

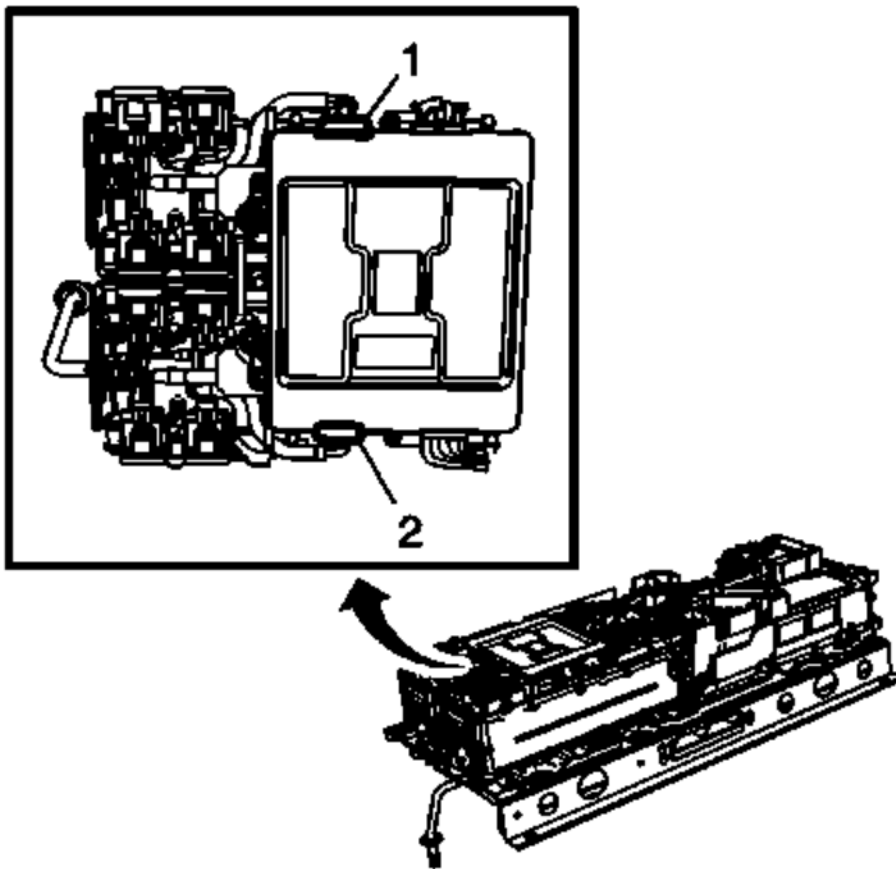


Fig. 22: Identifying Connectors Sequence
Courtesy of GENERAL MOTORS COMPANY

3. Connect the remaining connectors, in the above sequence, to the battery energy control module.
4. Enable the hybrid battery. Refer to High Voltage Enabling.
5. Program the battery energy control module. Refer to Battery Energy Control Module Programming and Setup.

GENERATOR CONTROL AND BATTERY MODULE REPLACEMENT AND SHIPPING PREPARATION

Special Tools

- EL-48264 Battery Pack Lifting Adapter
- EL-48900 High Voltage Safety Kit

For equivalent regional tools, refer to Special Tools.

Removal Procedure

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: 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. Remove both rear compartment floor trim panels. Refer to **Rear Compartment Floor Panel Trim Replacement (With Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (With Blower Cover, HP6)** .
2. Ignition OFF, disable high voltage at the A4 hybrid battery pack. Refer to **High Voltage Disabling**.
3. Remove the rear end trim finish panel. Refer to **Rear End Trim Finish Panel Replacement** .

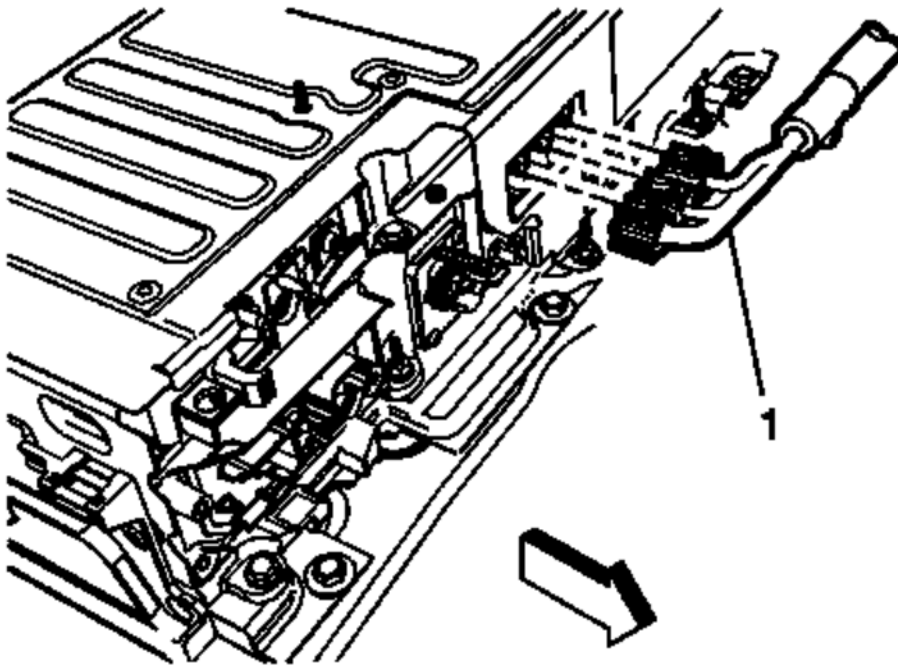


Fig. 23: Body Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

4. Remove the body harness connectors (1) from the generator control and battery module.

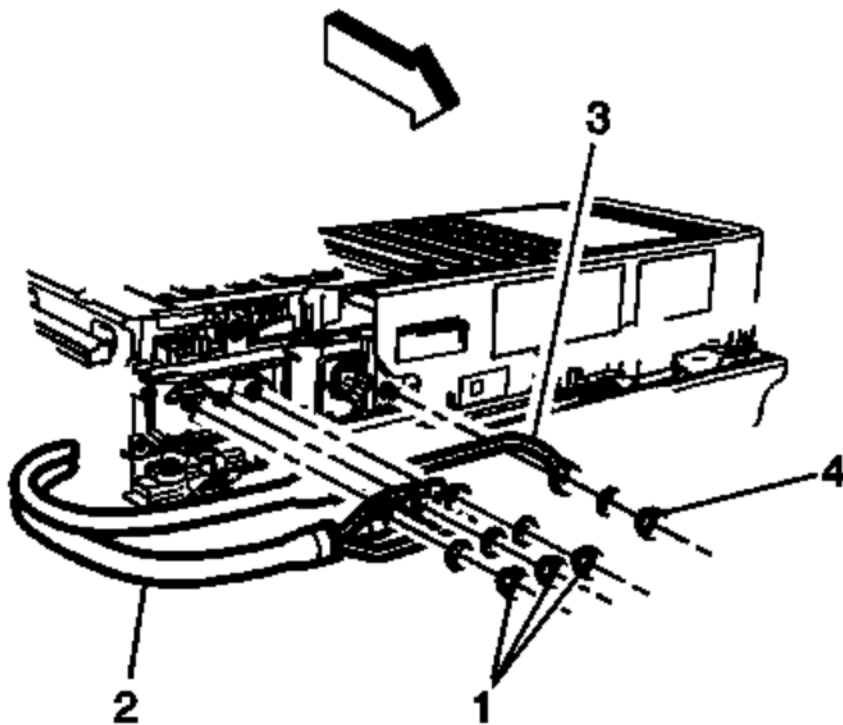


Fig. 24: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove the high voltage 3-phase cable terminal nuts (1) and the 12V terminal branch nut (4).
6. Remove the high voltage cable (2) and the 12V cable (3) from the generator control and battery module.

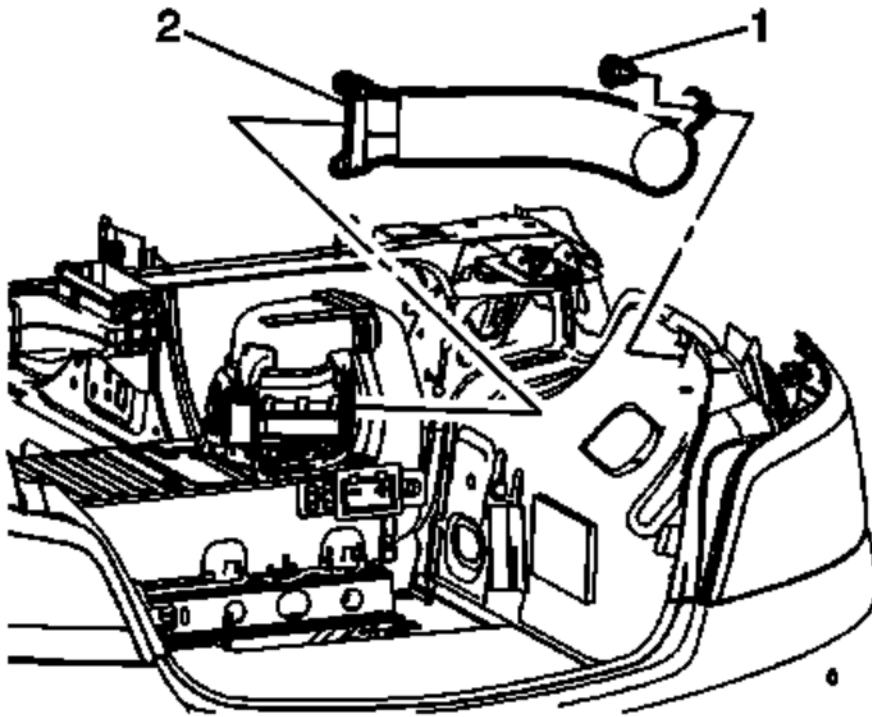


Fig. 25: Drive Motor Battery Cooling Air Outlet Duct
Courtesy of GENERAL MOTORS COMPANY

7. Remove the drive motor battery cooling air outlet duct (2). Refer to **Drive Motor Battery Cooling Air Outlet Duct Replacement**.

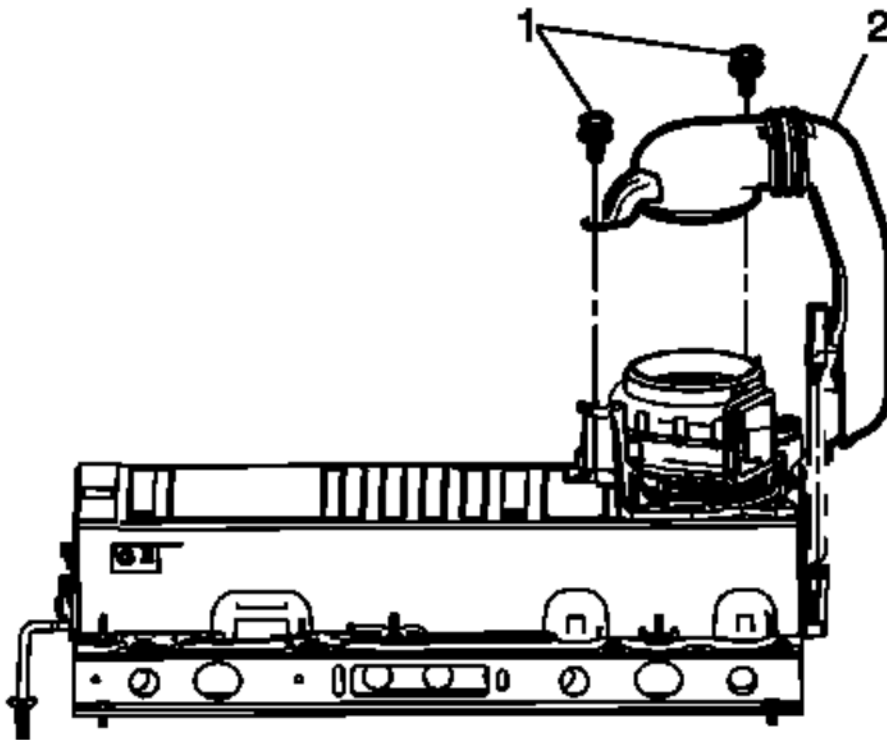


Fig. 26: Drive Motor Battery Cooling Blower Outlet Upper Duct Fasteners
Courtesy of GENERAL MOTORS COMPANY

8. Remove the drive motor battery cooling blower outlet upper duct fasteners (1) and remove the drive motor battery cooling blower outlet upper duct (2). Refer to **Drive Motor Battery Cooling Blower Outlet Duct Replacement** .

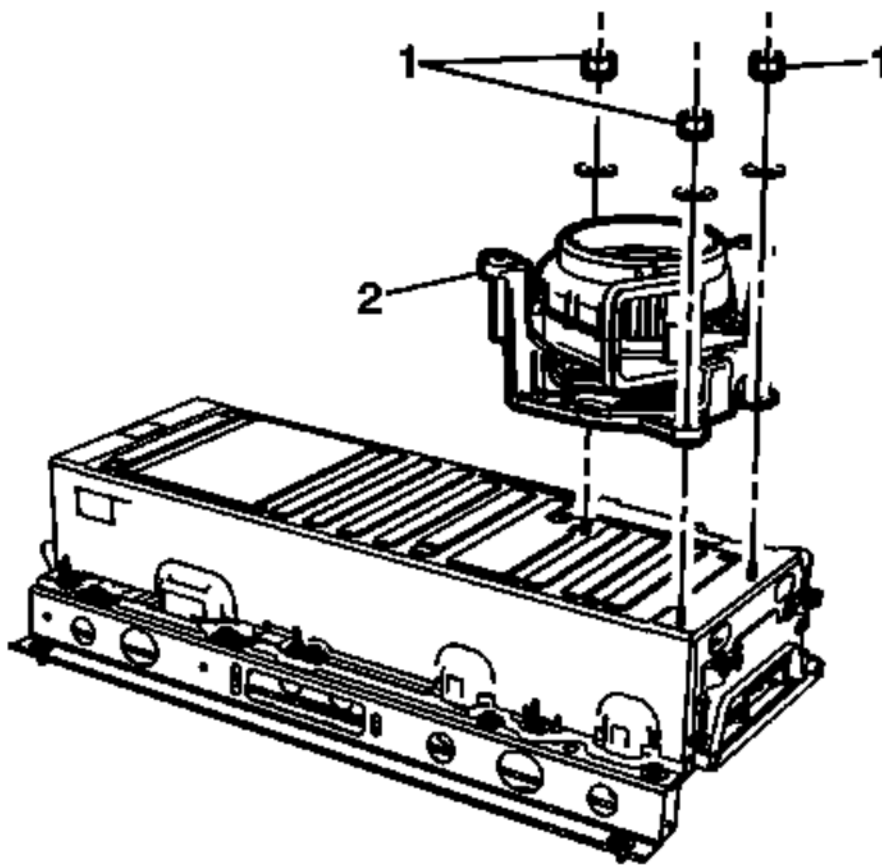


Fig. 27: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

9. Remove the drive motor generator bracket and cooling blower fasteners (1).
10. Remove the drive motor battery cooling blower assembly (2).

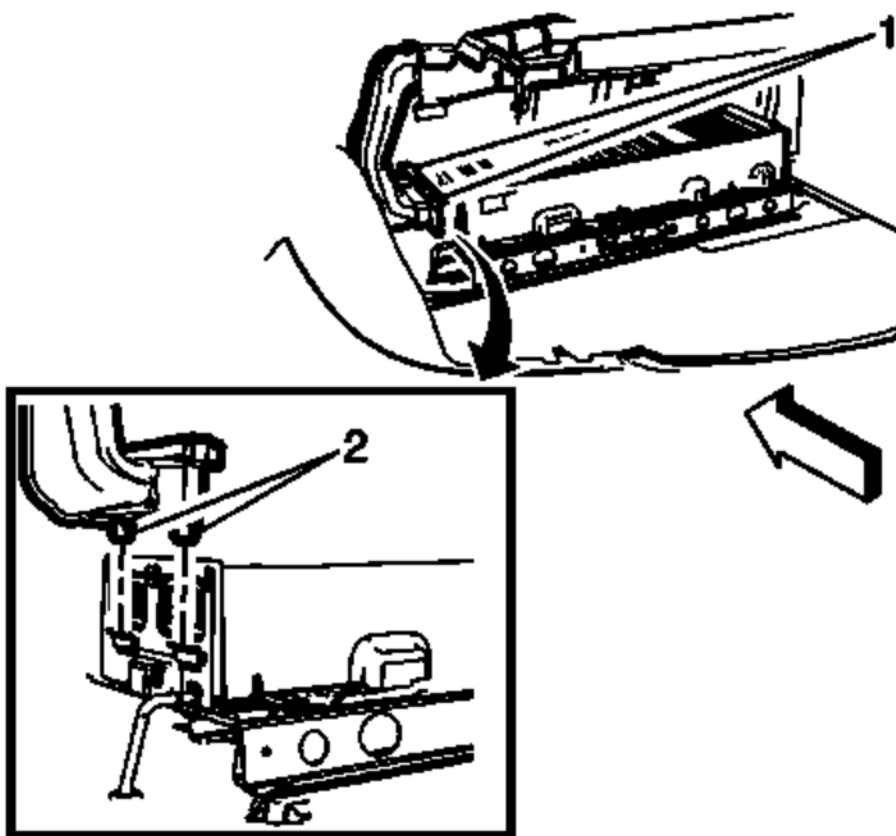


Fig. 28: Battery Cooling Air Inlet Duct And Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

11. Remove the drive motor battery cooling air inlet lower duct retainers (1).

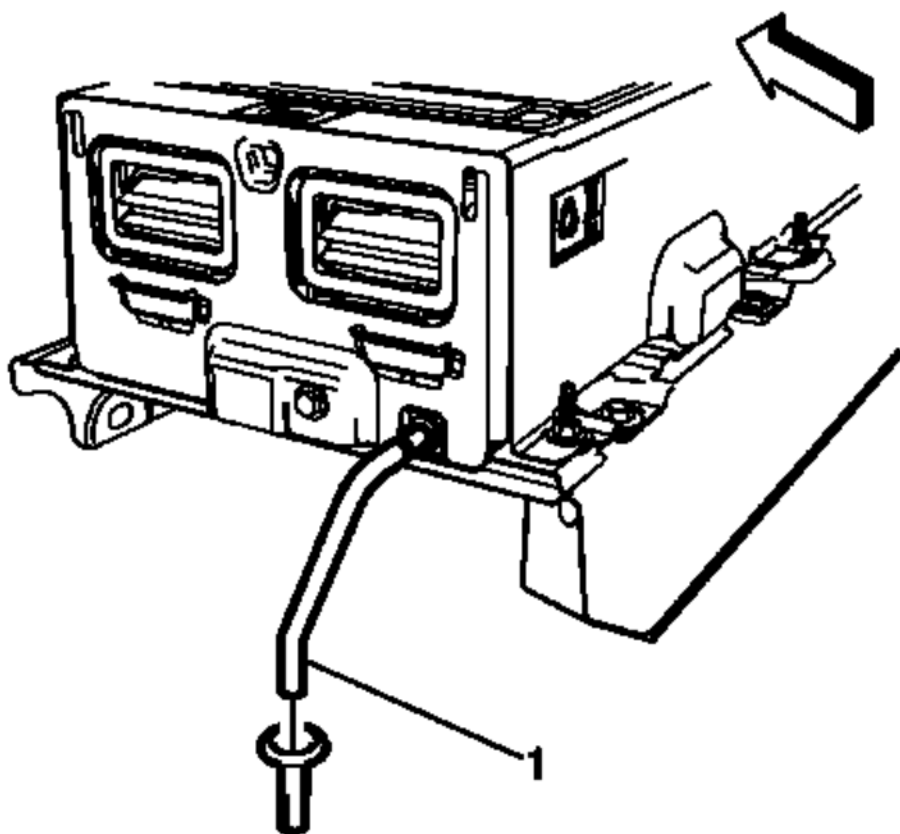


Fig. 29: Generator Control And Battery Module Vent Tube
Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not bend the vent tube.

12. Remove the generator control and battery module vent tube (1).

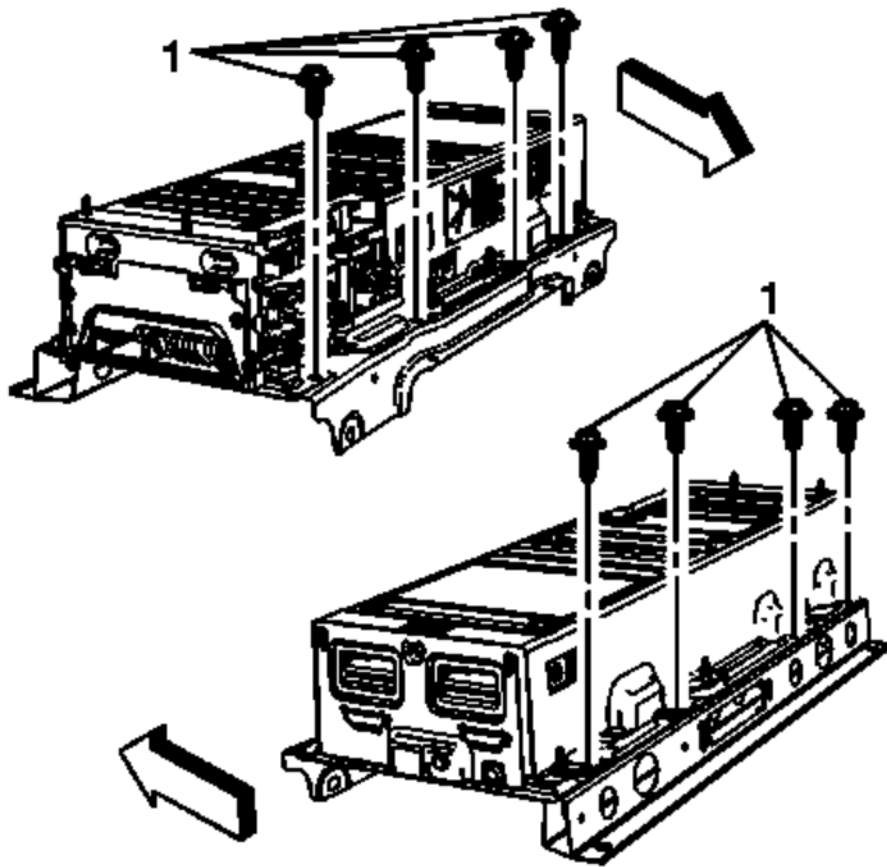


Fig. 30: Generator Control And Battery Module Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

13. Remove the generator control and battery module mounting bolts (1).

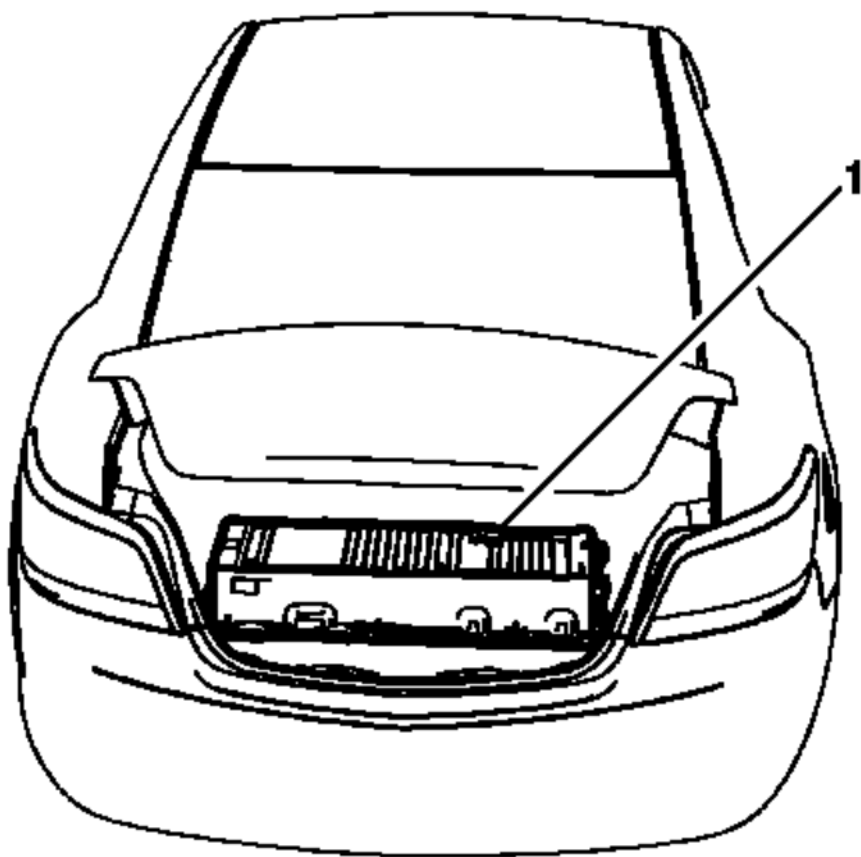


Fig. 31: Protective Cloth Over Trunk-To-Rear Bumper Area
Courtesy of GENERAL MOTORS COMPANY

14. Place a protective cloth over the trunk-to-rear bumper area.

NOTE: Do not insert fingers into vent area of the generator control and battery module while rotating.

15. With assistance, use gloves to slide the generator control and battery module (1) into the trunk area.

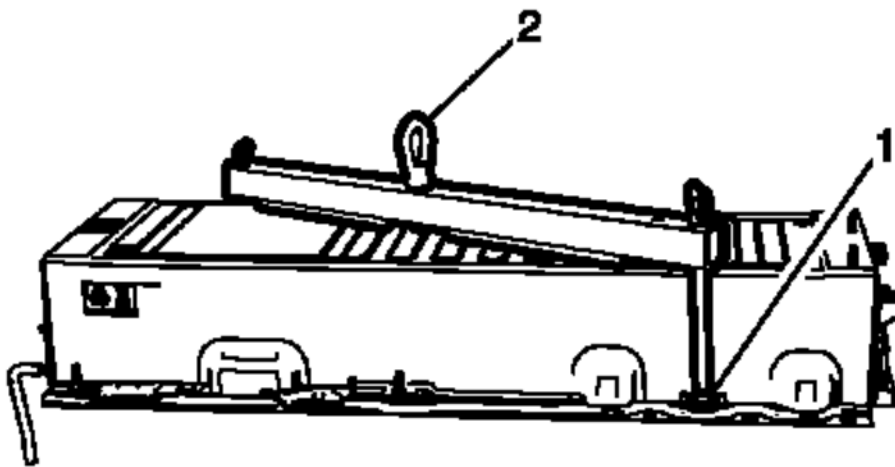


Fig. 32: Battery Pack Lifting Adapter Center Eye Bolt
Courtesy of GENERAL MOTORS COMPANY

16. Using the **EL-48264** battery pack lifting adapter center the eye bolt (2) on the generator control and battery module and insert the hooks (1) into the generator control and battery module holes.
17. Attach a portable lift to the center eye bolt (2) of the battery pack lifting adapter.

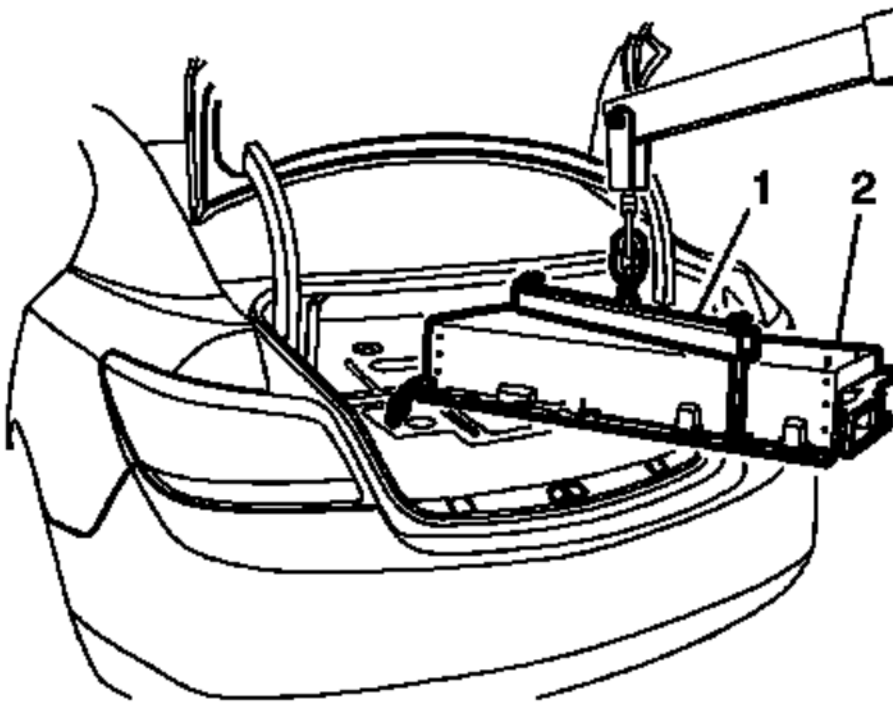


Fig. 33: Generator Control And Battery Module
Courtesy of GENERAL MOTORS COMPANY

18. Remove the generator control and battery module (2) from the rear trunk area.

Installation Procedure

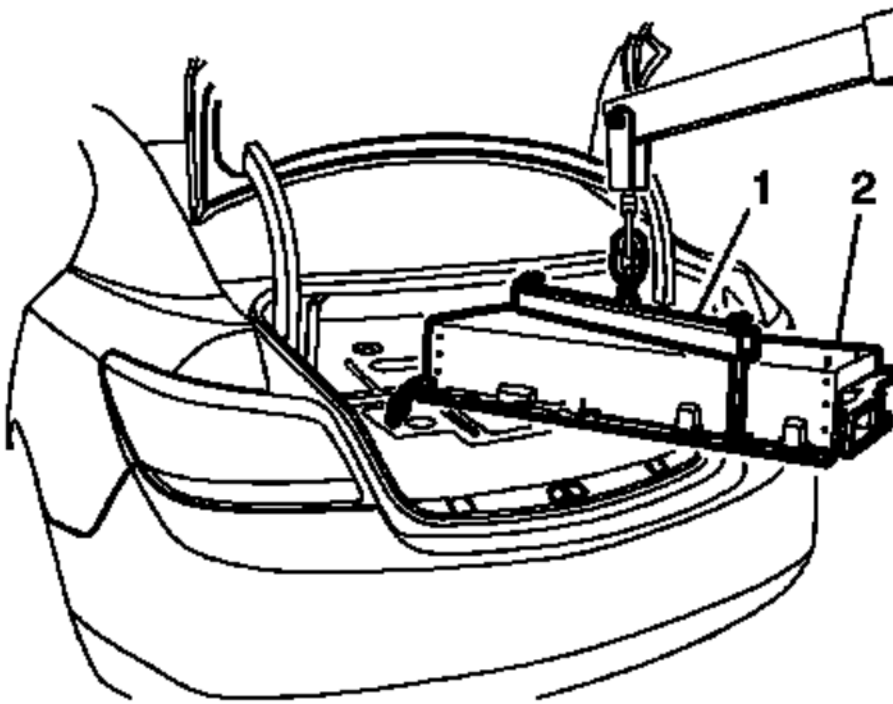


Fig. 34: Generator Control And Battery Module
Courtesy of GENERAL MOTORS COMPANY

1. Install the generator control and battery module (2) in through the trunk opening.

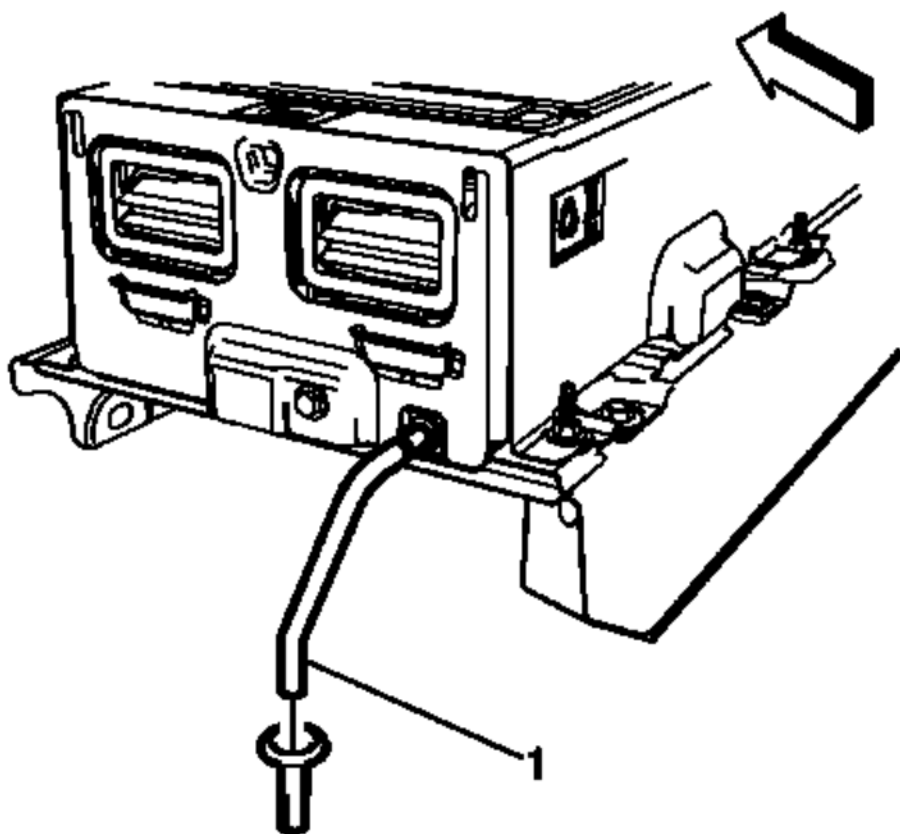


Fig. 35: Generator Control And Battery Module Vent Tube
Courtesy of GENERAL MOTORS COMPANY

2. Slide the generator control and battery module into position and install the vent tube (1) into the floor.
3. Remove the **EL-48264** battery pack lifting adapter.

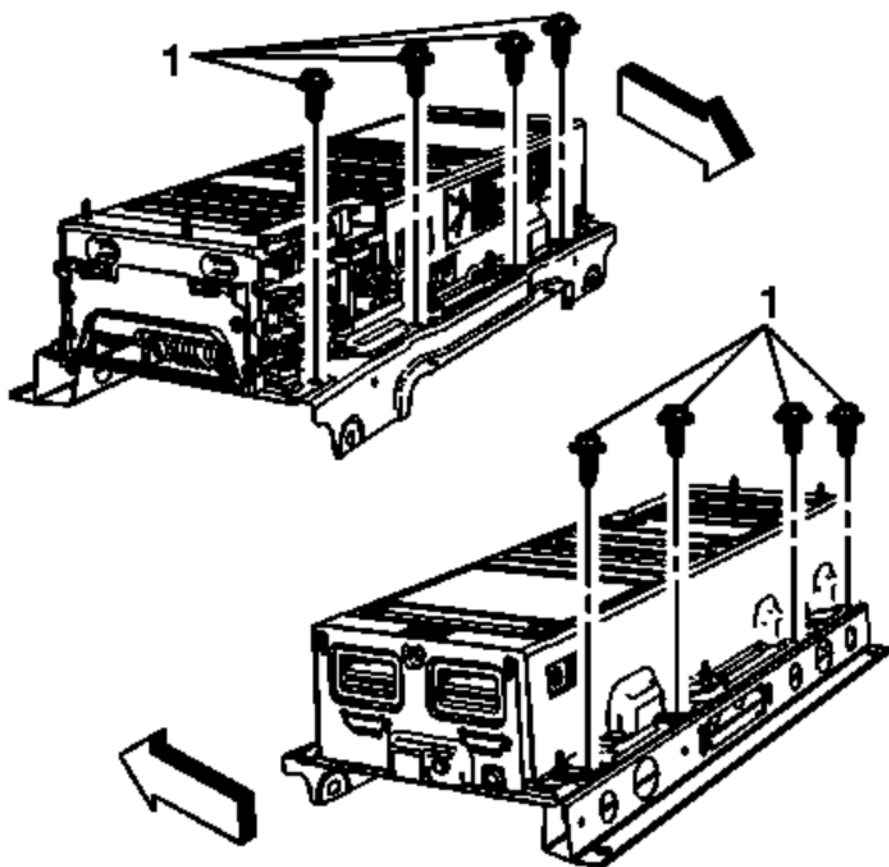


Fig. 36: Generator Control And Battery Module Mounting Bolts
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

4. Install the generator control and battery module into position and tighten the mounting bolts (1) to 22 N.m (16 lb ft).

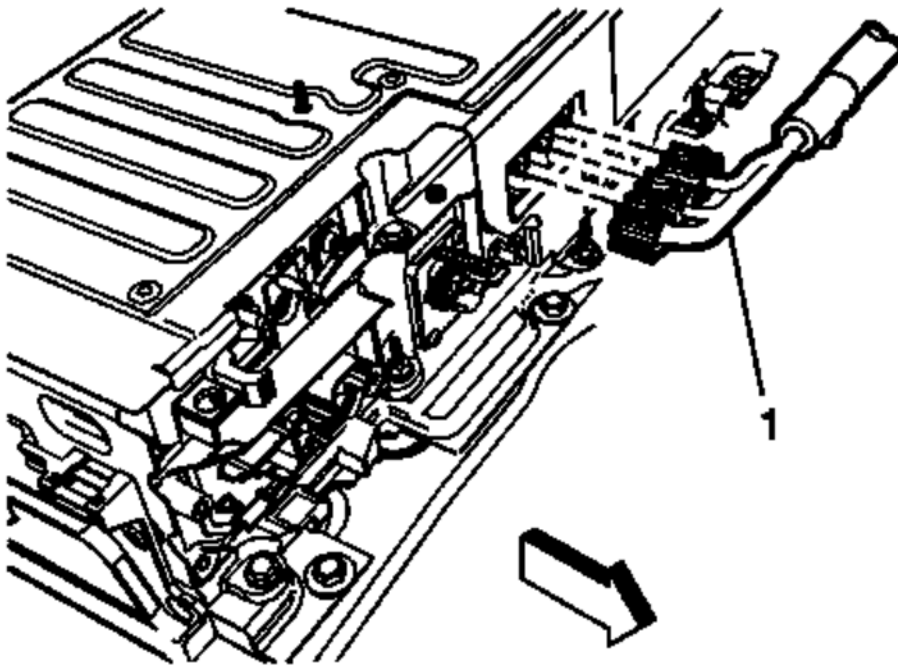


Fig. 37: Body Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

5. Install the body harness connectors (1).

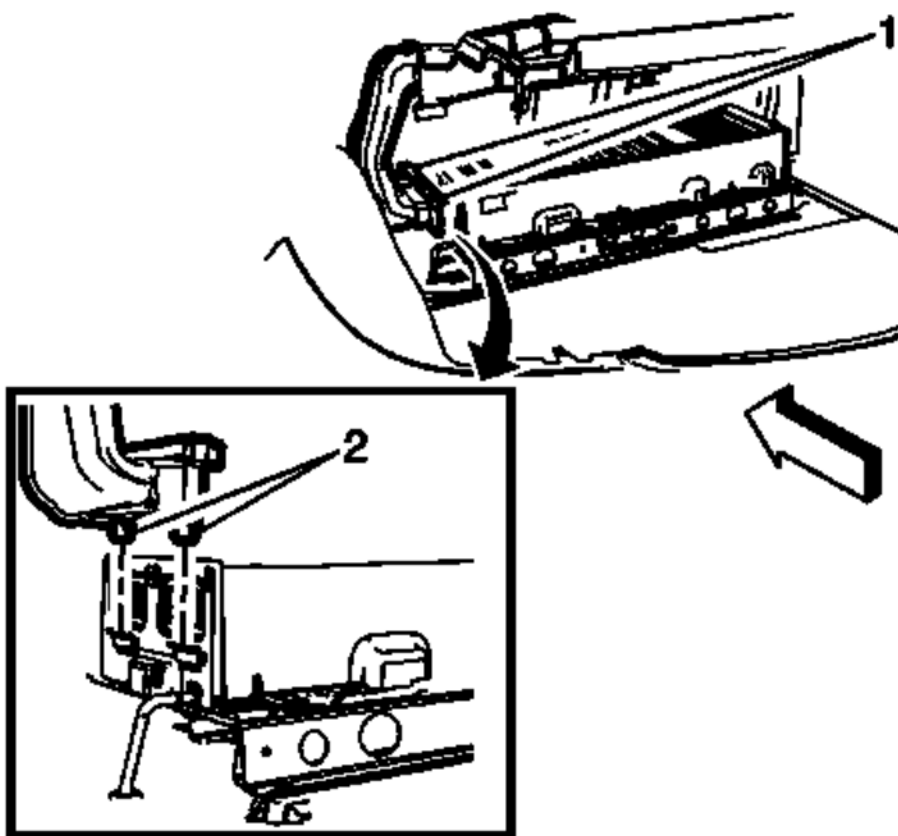


Fig. 38: Battery Cooling Air Inlet Duct And Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

6. Install the drive motor battery cooling air inlet lower duct retainers (1).

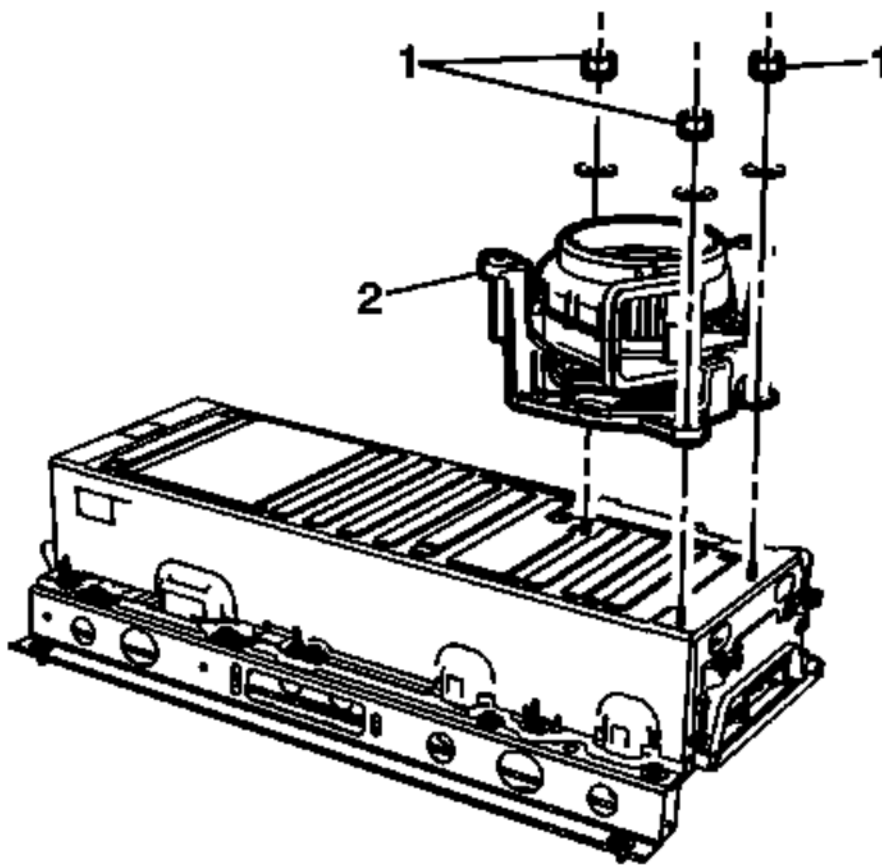


Fig. 39: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

7. Install the drive motor generator bracket and drive motor battery cooling blower (2). Tighten the fasteners (1) to 9 N.m (80 lb in).

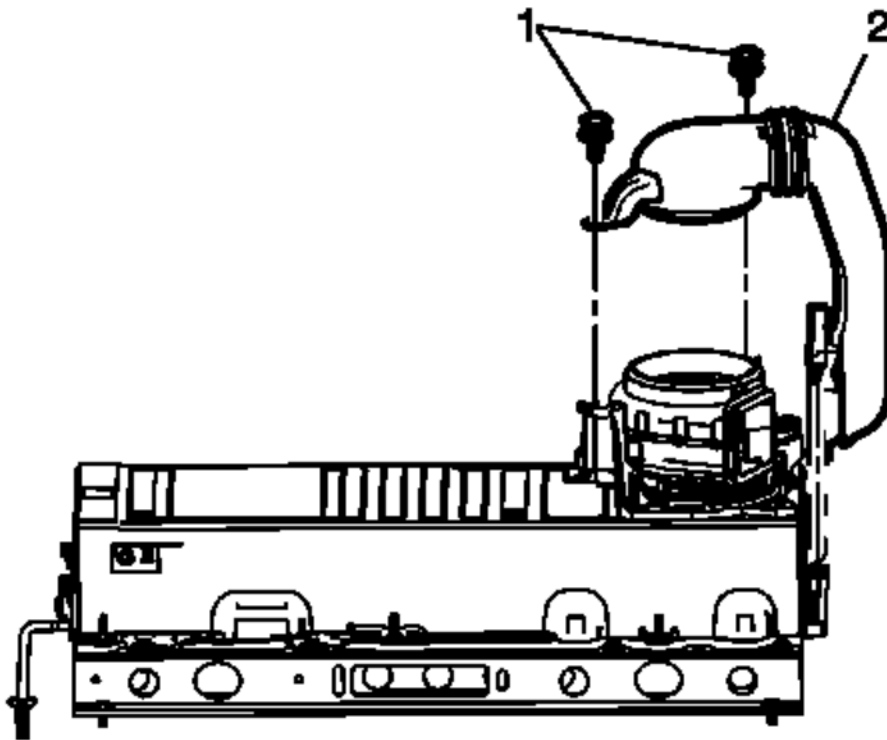


Fig. 40: Drive Motor Battery Cooling Blower Outlet Upper Duct Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

8. Install the drive motor battery cooling blower outlet upper duct (2) and tighten the fasteners to 9 N.m (80 lb in).

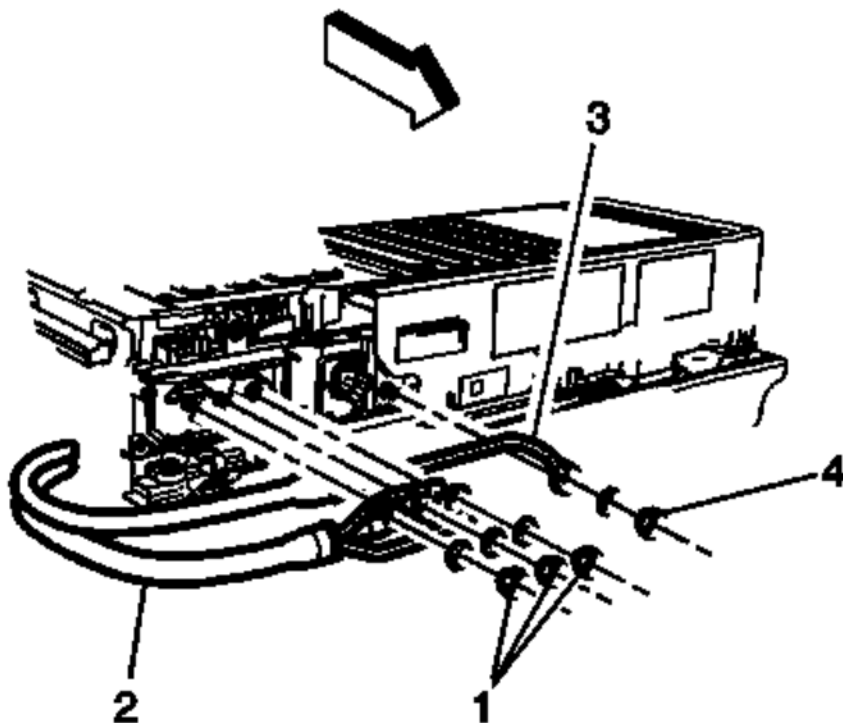


Fig. 41: High Voltage 3-phase Cable
 Courtesy of GENERAL MOTORS COMPANY

9. Install the high voltage 3-phase cable (2) to the generator control and battery module. Tighten the nuts (1) to 9 N.m (80 lb in).
10. Install the 12V cable (3) to the generator control and battery module. Tighten the nut (4) to 9 N.m (80 lb in).
11. Install both rear compartment floor panels. Refer to **Rear Compartment Floor Panel Trim Replacement (With Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (With Blower Cover, HP6)** .
12. Install the rear end trim finish panels. Refer to **Rear End Trim Finish Panel Replacement** .
13. Enable the high voltage battery. Refer to **High Voltage Enabling**.
14. Program the generator control module, if replaced. Refer to **Control Module References** .
15. Program the battery energy control module, if replaced. Refer to **Battery Energy Control Module Programming and Setup** .

DRIVE MOTOR GENERATOR BATTERY CABLE REPLACEMENT

Removal Procedure

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: 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 A4 hybrid battery pack. Refer to **High Voltage Disabling**.
2. Remove the fuel tank. Refer to **Fuel Tank Replacement**.
3. Remove the left front underbody air deflector. Refer to **Underbody Front Air Deflector Replacement - Left Side**.
4. Remove the left front frame reinforcement. Refer to **Drivetrain and Front Suspension Frame Replacement**.

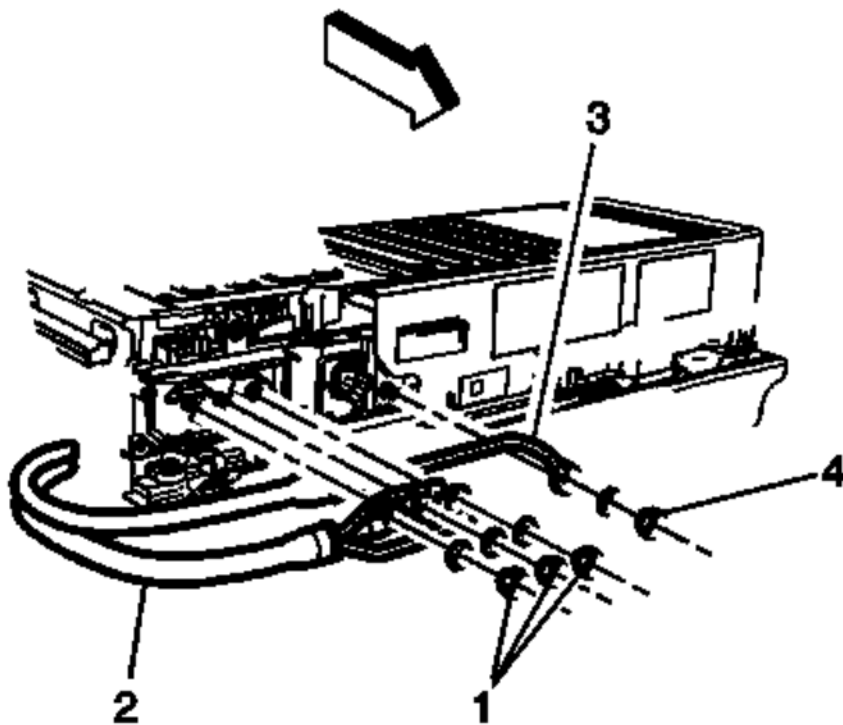


Fig. 42: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

5. Remove the high voltage 3-phase cable terminal nuts (1) and the 12V terminal branch nut (4).
6. Remove the high voltage cable (2) and the 12V cable (3) from the generator battery.

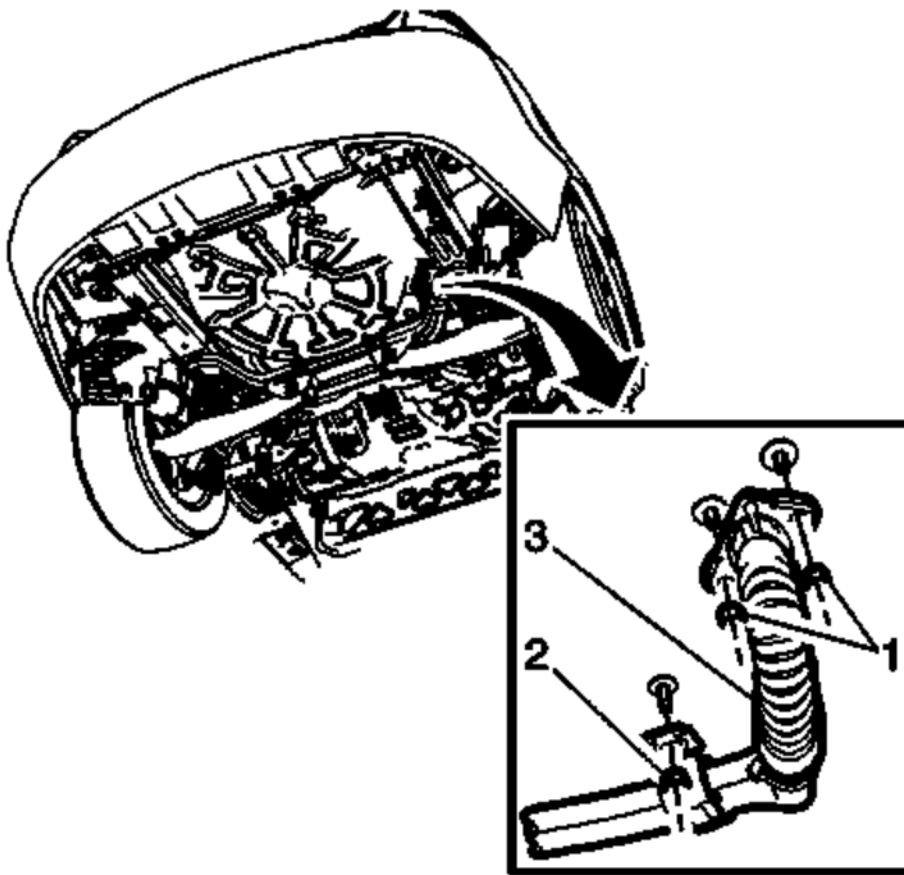


Fig. 43: Drive Motor Generator Cable
Courtesy of GENERAL MOTORS COMPANY

7. Remove the drive motor generator battery bracket nuts (1) and the cable retainer nut (2).
8. Pull the drive motor generator cable (3) through the grommet opening.

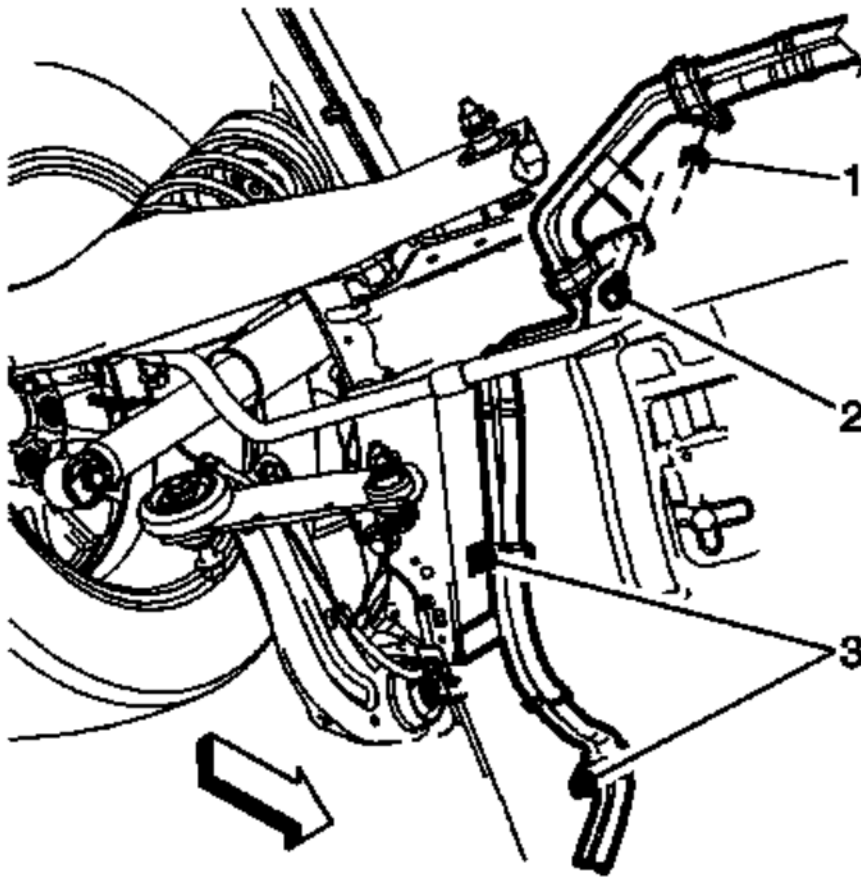


Fig. 44: Drive Motor Generator Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

9. Remove the drive motor generator retainer nut (1) and bolt (2).

NOTE: Replace the fasteners (3) if re-using the drive motor generator battery cable.

10. Detach the drive motor generator battery cable fasteners (3).

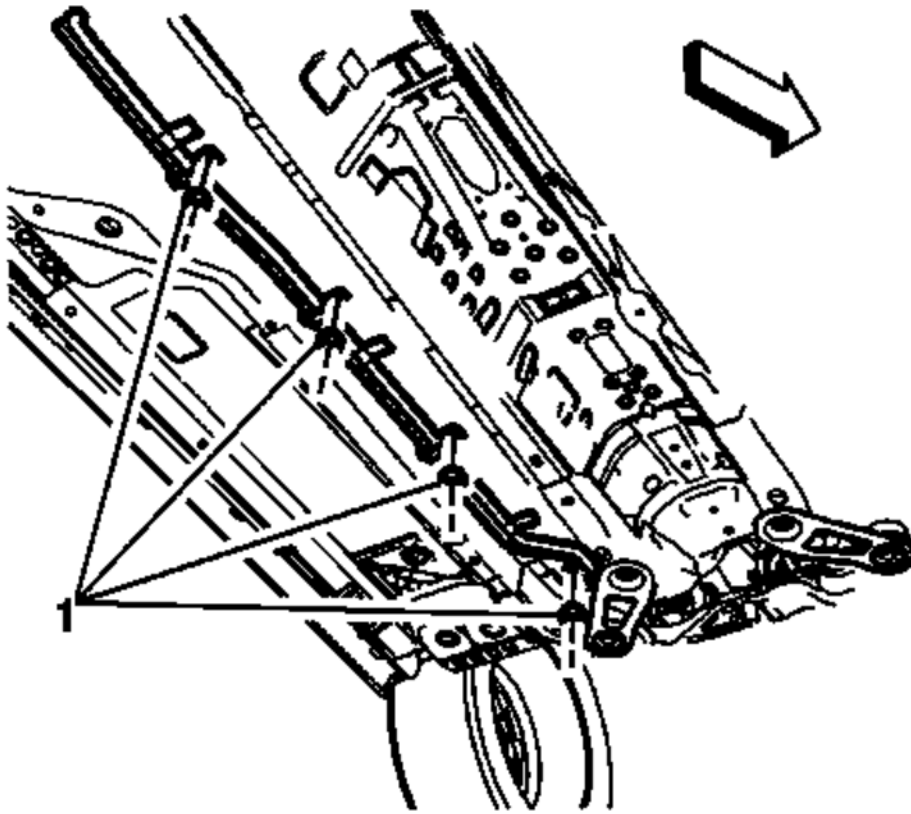


Fig. 45: Drive Motor Generator Battery Fastener Bolts
Courtesy of GENERAL MOTORS COMPANY

11. Remove the drive motor generator battery fastener bolts (1).

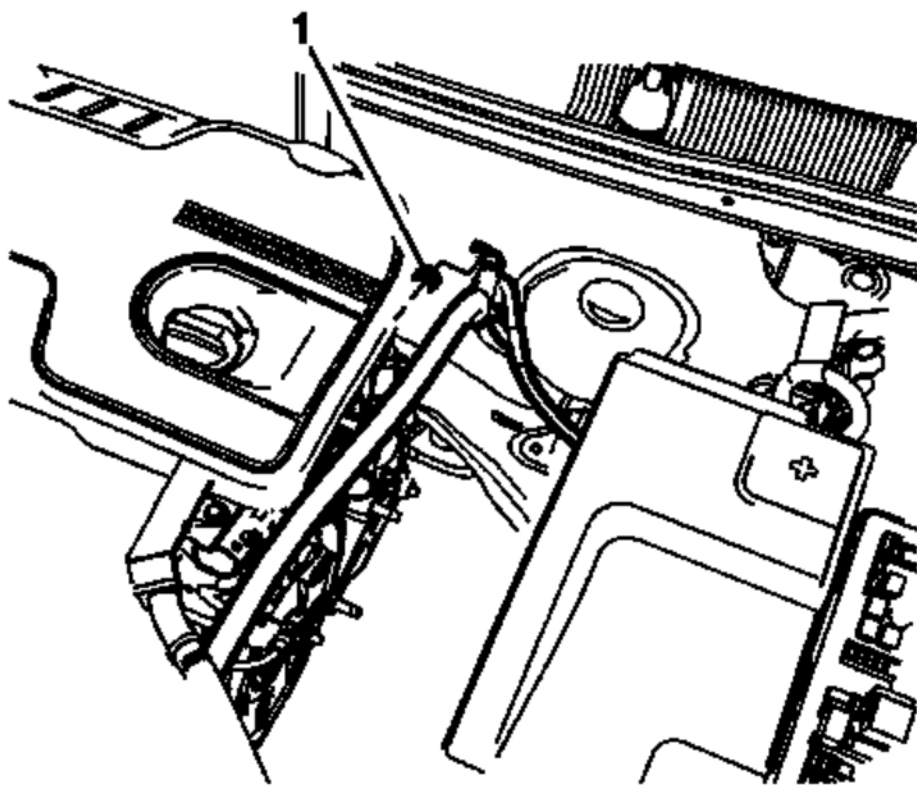


Fig. 46: Drive Motor Generator Battery Cable Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

12. Within the rear engine compartment, remove the drive motor generator battery cable retainer nut (1).

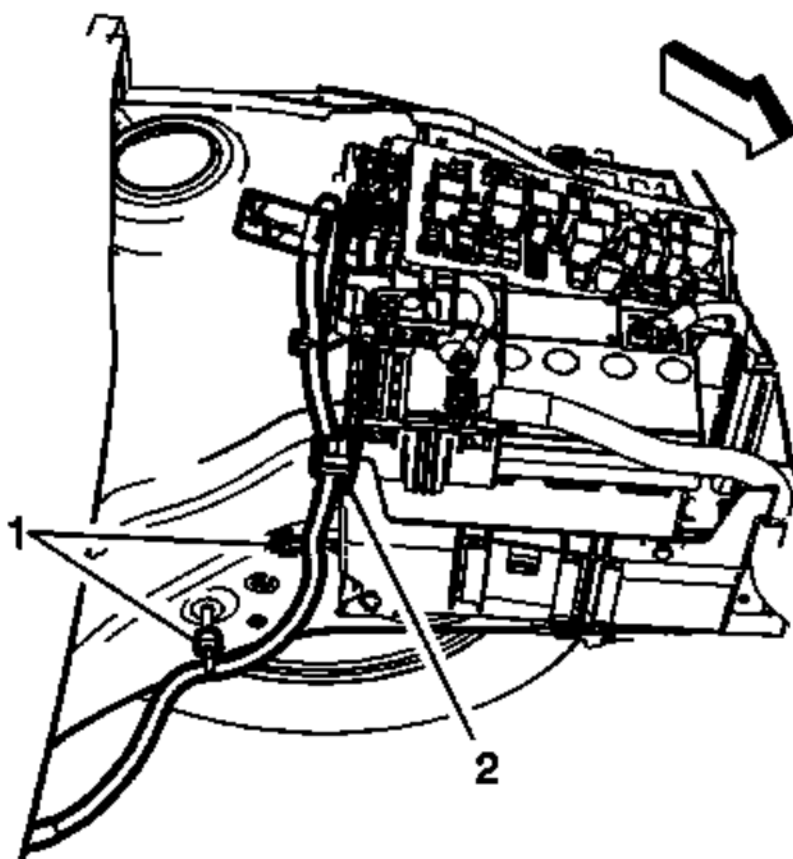


Fig. 47: Drive Motor Generator Battery Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Replace the retainers (1) if re-using the drive motor generator battery cable.

13. Disconnect the drive motor generator battery cable retainers (1) and the battery tray cable clip (2).

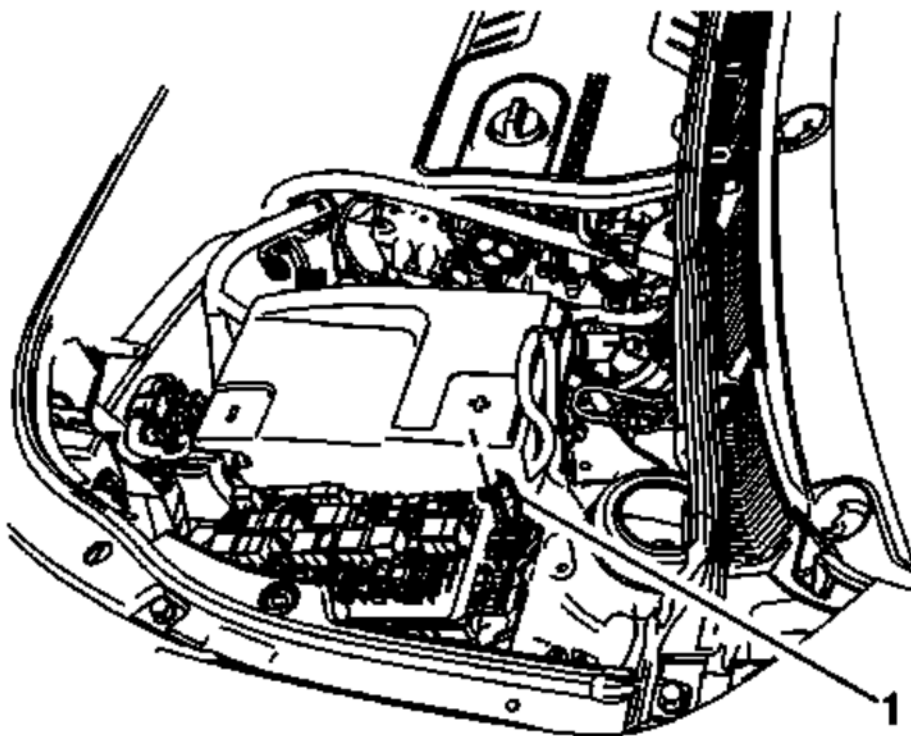


Fig. 48: Drive Motor Generator Battery Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

14. Remove the drive motor generator battery cable terminal (1), from the underhood fuse block.

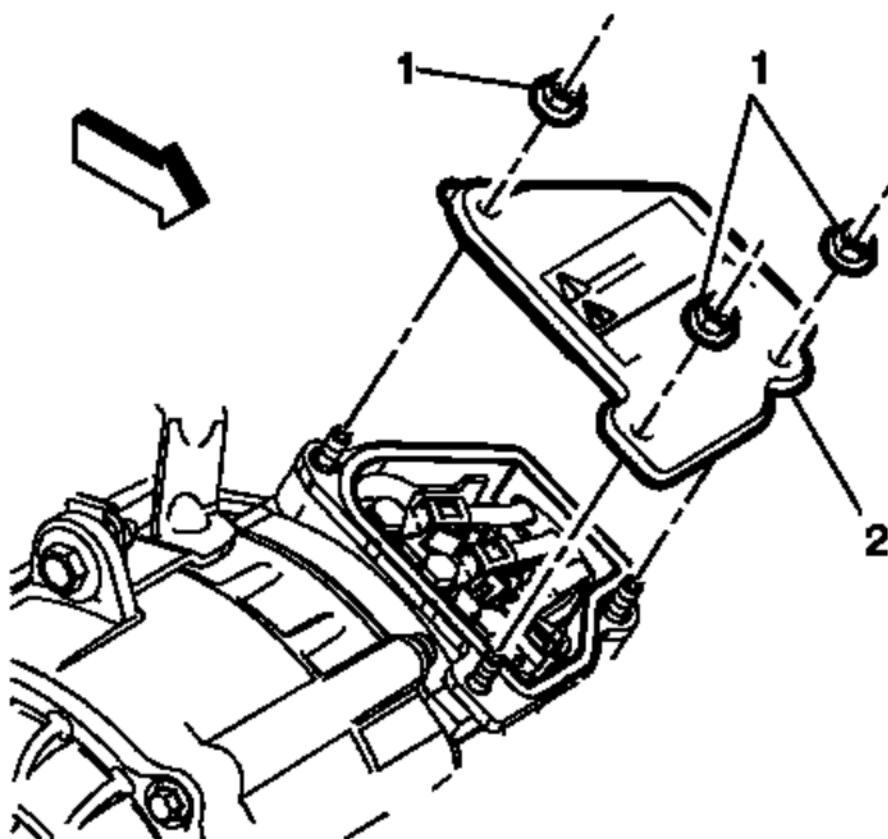


Fig. 49: Generator Starter Cover Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Remove the generator starter cover nuts (1) and remove the cover (2).

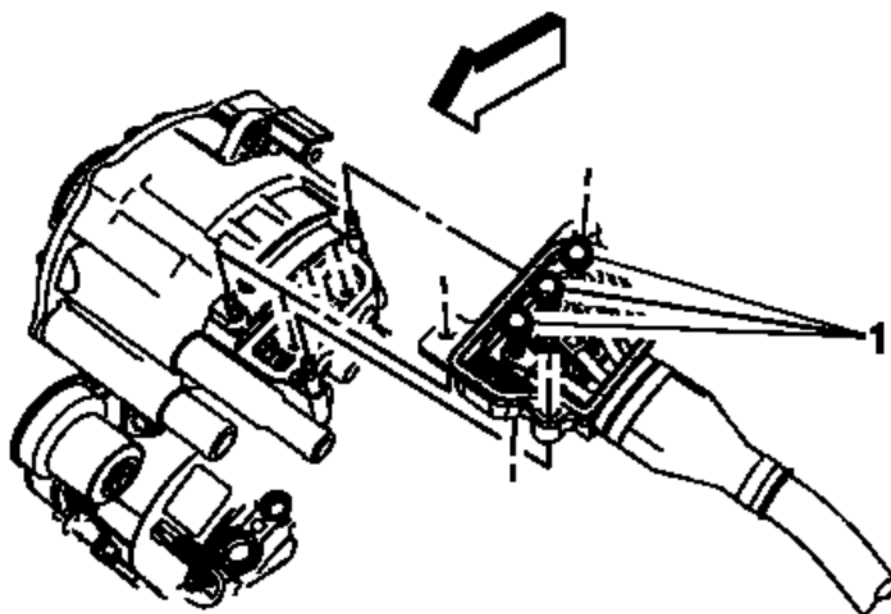


Fig. 50: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

16. Remove the bolts (1) and detach the drive motor generator battery cable from the generator starter.

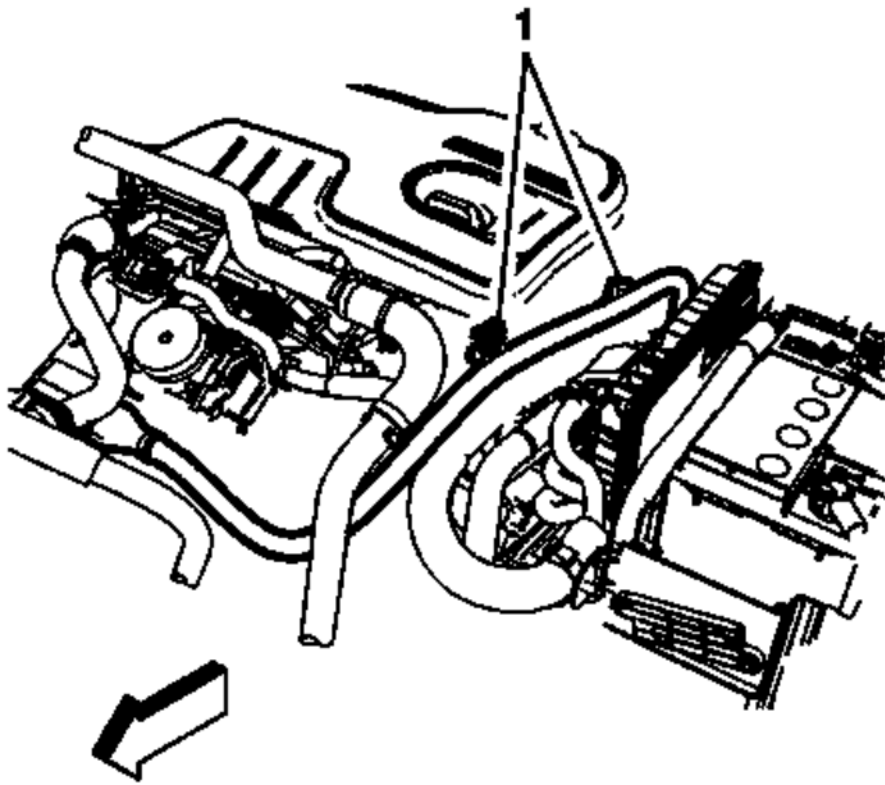


Fig. 51: Drive Motor Generator Battery Cable
Courtesy of GENERAL MOTORS COMPANY

17. Detach the retainers (1) holding the drive motor generator battery cable to the fuel pump cover and the heater outlet bracket.

NOTE: Replace the retainers (1) if re-using the drive motor generator battery cable.

18. Remove the drive motor generator battery cable from the vehicle.

Installation Procedure

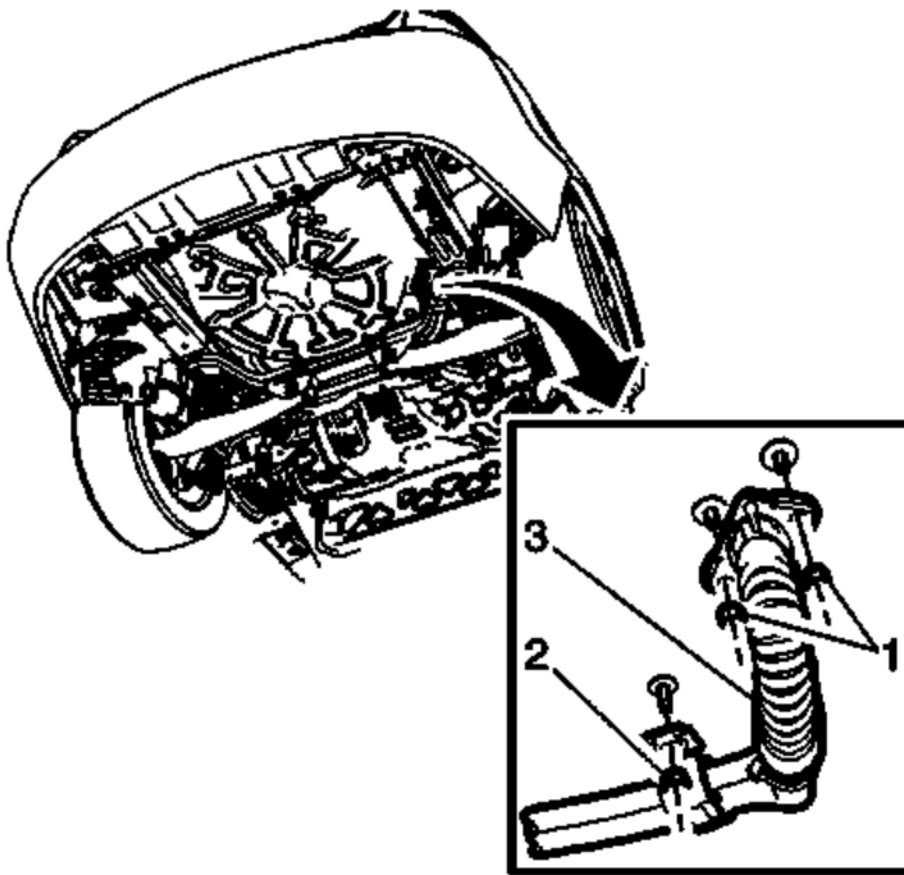


Fig. 52: Drive Motor Generator Cable
Courtesy of GENERAL MOTORS COMPANY

1. Starting at the rear of the vehicle, feed the drive motor generator battery cable through the opening in the floor.

CAUTION: Refer to Fastener Caution .

2. Position the pass-through grommet seal and bracket. Tighten the bracket nuts (1) to 22 N.m (16 lb ft).
3. Tighten the retainer nut (2) to 22 N.m (16 lb ft).

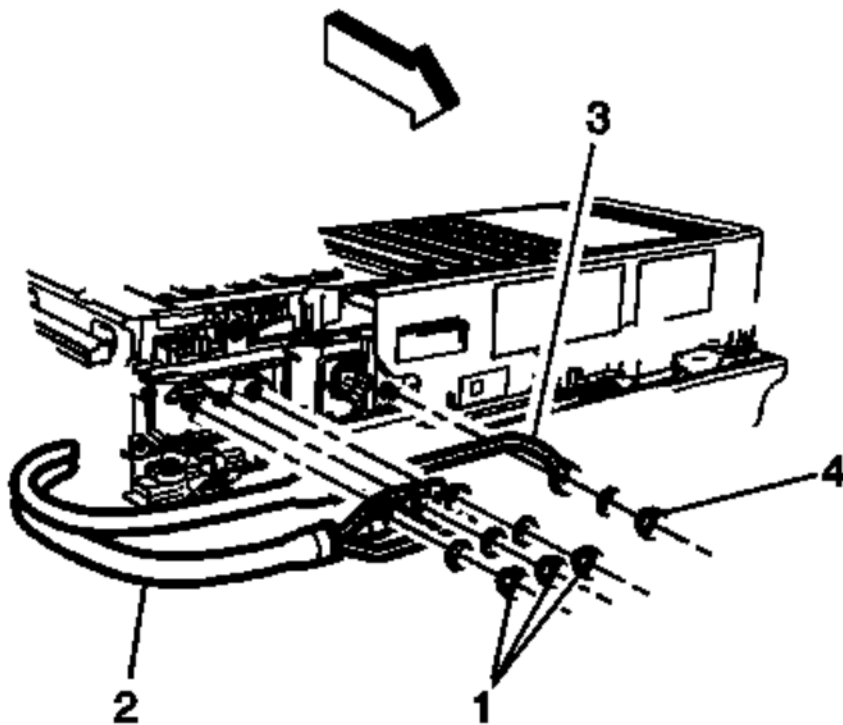


Fig. 53: High Voltage 3-phase Cable

Courtesy of GENERAL MOTORS COMPANY

4. Install the high voltage 3-phase branch terminals (2) to the generator battery. Tighten the nuts (1) to 9 N.m (80 lb in).
5. Install the 12V cable (3) and tighten the nut (4) to 9 N.m (80 lb in).

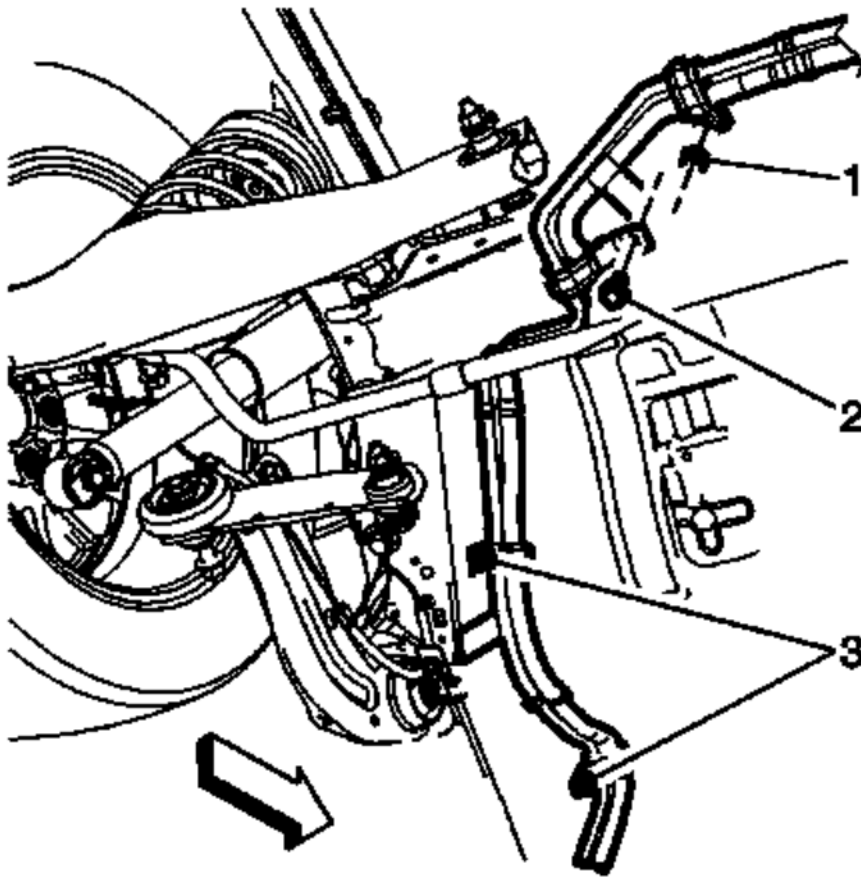


Fig. 54: Drive Motor Generator Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

6. At the left rear frame rail, attach the drive motor generator battery cable to the frame with NEW fasteners (3).
7. Install the retainer nut (1) and bolt (2) to the underbody. Tighten to 22 N.m (16 lb ft).

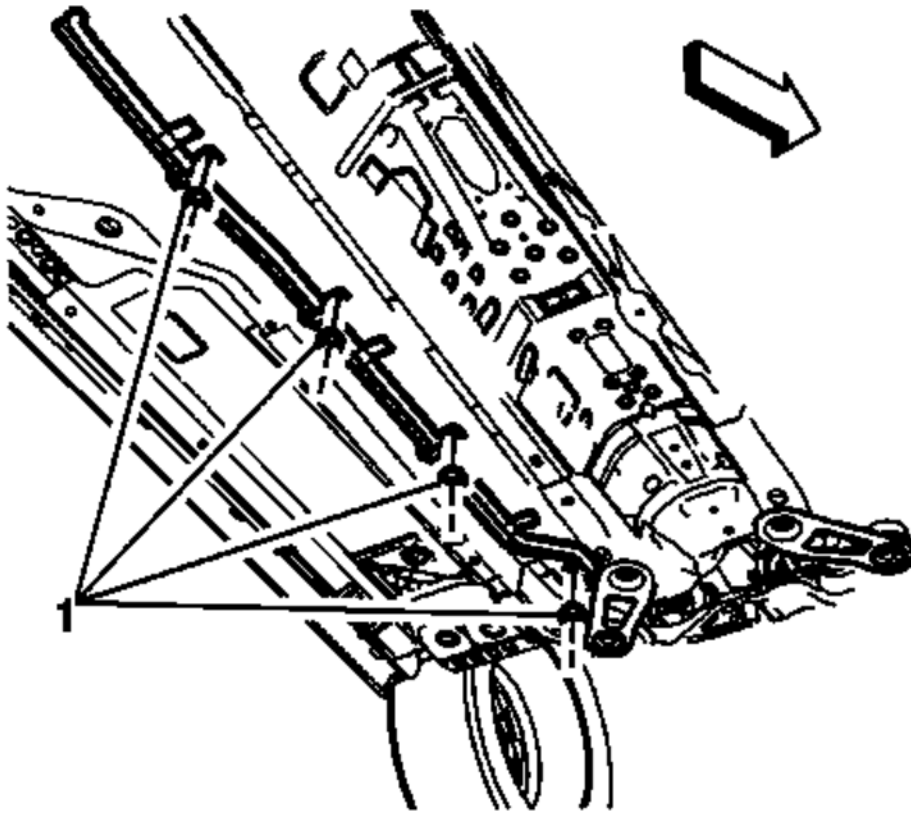


Fig. 55: Drive Motor Generator Battery Fastener Bolts
Courtesy of GENERAL MOTORS COMPANY

8. Working towards the front of the vehicle, attach the drive motor generator battery cable to the underbody. Tighten the nuts (1) to 22 N.m (16 lb ft).

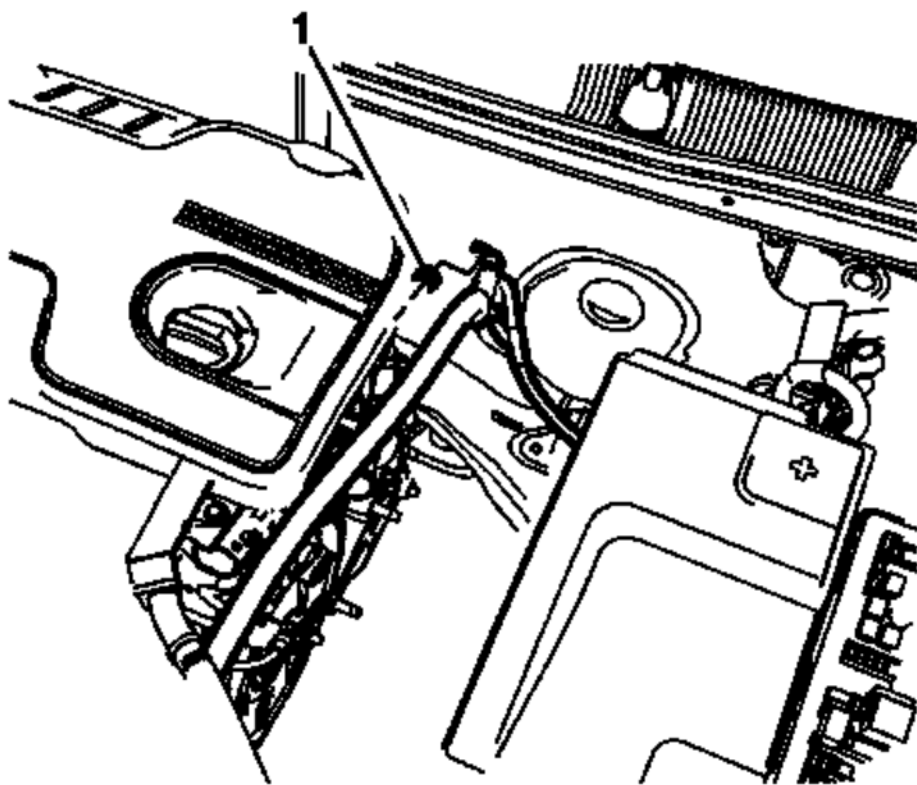


Fig. 56: Drive Motor Generator Battery Cable Retainer Nut
Courtesy of GENERAL MOTORS COMPANY

9. Feed the drive motor generator battery cable into the engine compartment and install to the plenum. Tighten the nut (1) to 22 N.m (16 lb ft).

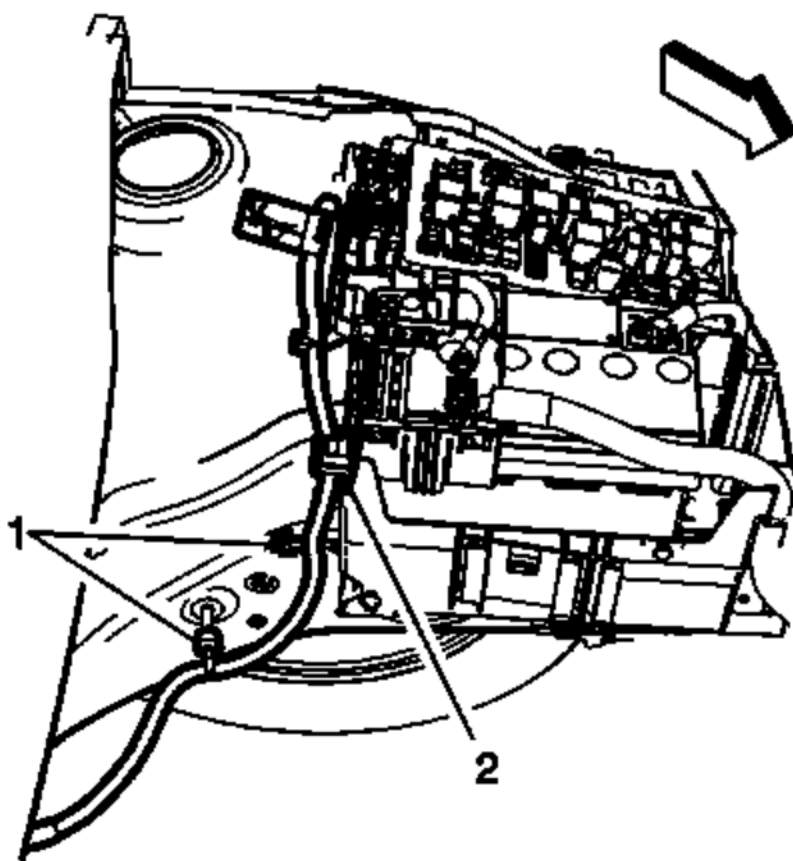


Fig. 57: Drive Motor Generator Battery Cable Retainers
Courtesy of GENERAL MOTORS COMPANY

10. Install the drive motor generator battery 12V branch, to the left front frame rail, with NEW fasteners (1).
11. Secure the cable to the battery tray with clip (2).

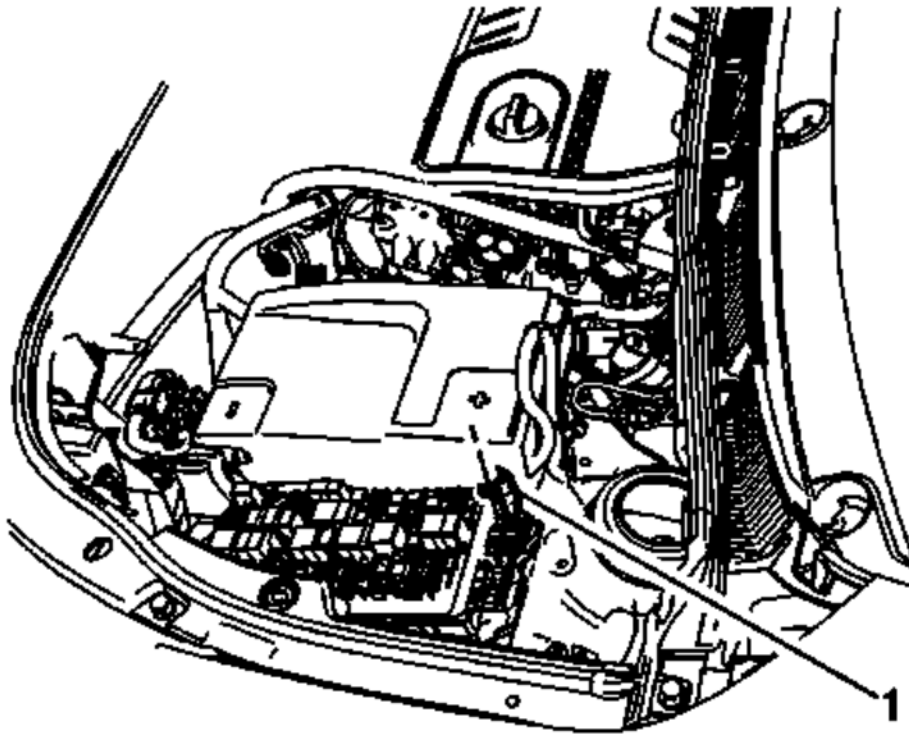


Fig. 58: Drive Motor Generator Battery Cable Terminal
Courtesy of GENERAL MOTORS COMPANY

12. Install the 12V terminal (1) to the underhood fuse block and tighten the nut to 9 N.m (80 lb in).

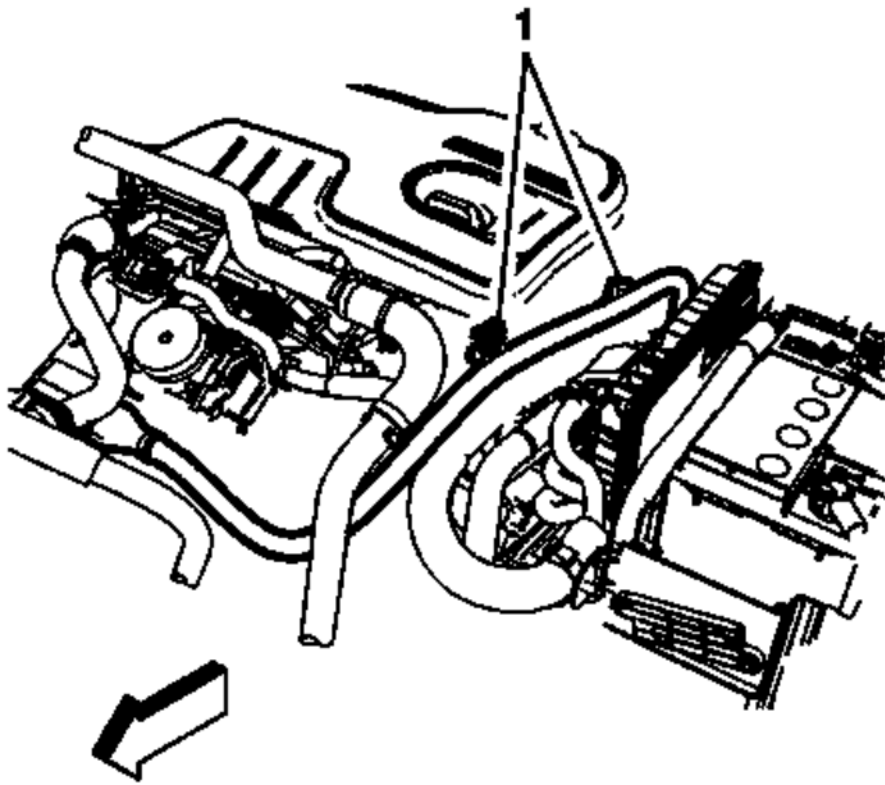


Fig. 59: Drive Motor Generator Battery Cable
Courtesy of GENERAL MOTORS COMPANY

13. Fasten the drive motor generator battery cable to the heater outlet bracket and fuel pump cover with NEW fasteners (1).

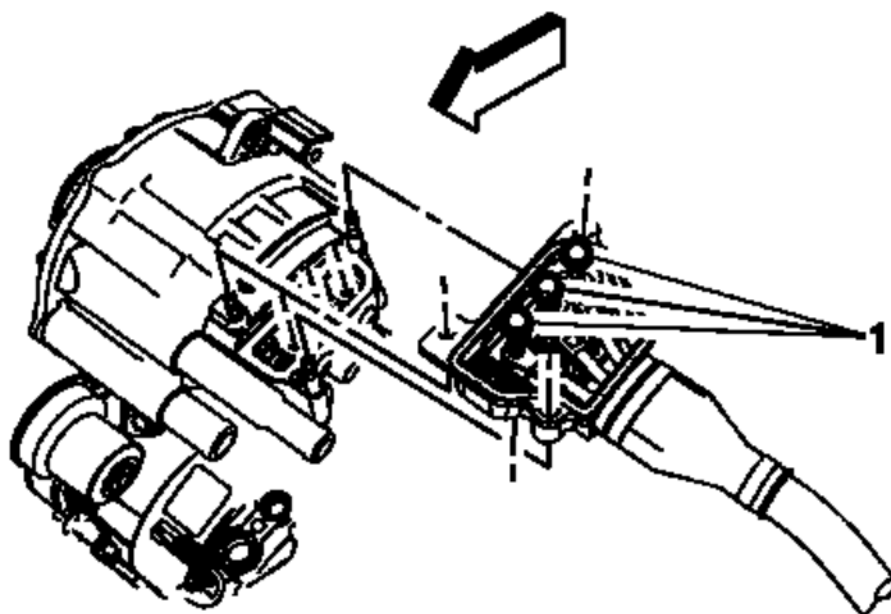


Fig. 60: Starter Generator

Courtesy of GENERAL MOTORS COMPANY

NOTE: Be sure the drive motor generator battery cable cover is fully seated against the drive motor generator battery cable housing prior to installing and fastening the nuts. This will ensure proper alignment and engagement of HVIL terminals.

14. Position the drive motor generator battery cable to the starter generator assembly studs. Tighten the bolts (1) to 9 N.m (80 lb in).

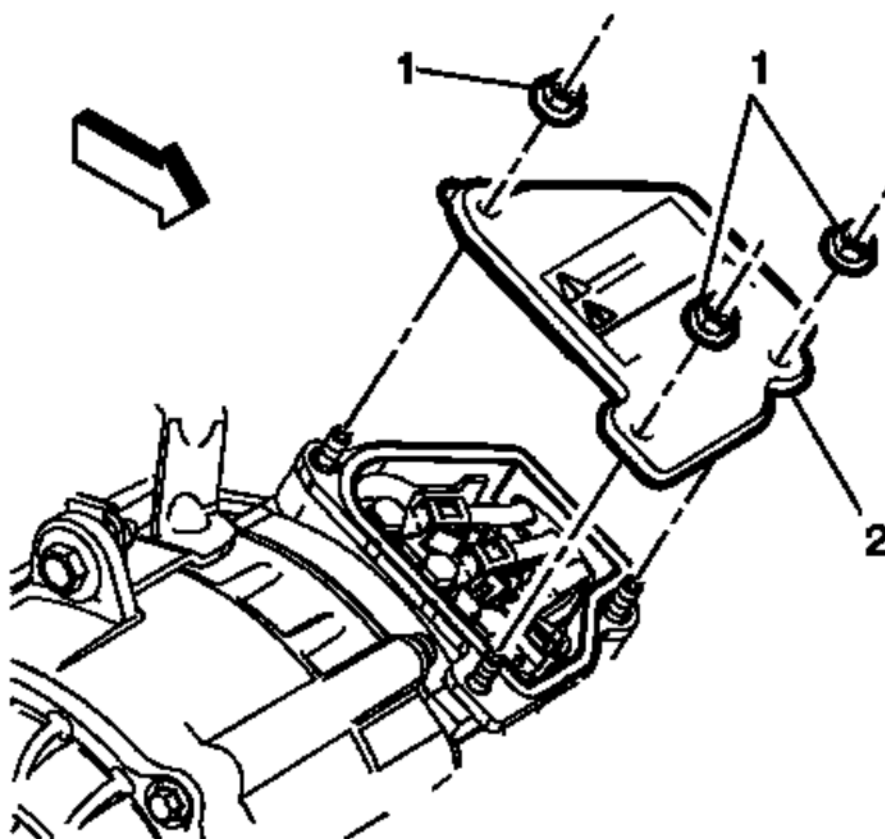


Fig. 61: Generator Starter Cover Nuts
Courtesy of GENERAL MOTORS COMPANY

15. Install the cover (2) and tighten the nuts (1) to 9 N.m (80 lb in).
16. Install the left front frame reinforcement. Refer to **Drivetrain and Front Suspension Frame Replacement** .
17. Install the left front underbody air deflector. Refer to **Underbody Front Air Deflector Replacement - Left Side** .
18. Install the fuel tank. Refer to **Fuel Tank Replacement** .
19. Enable the high voltage system. Refer to **High Voltage Enabling**.

BATTERY ENERGY CONTROL MODULE WIRING HARNESS REPLACEMENT (HV MEASURING HARNESS 1 AND 2)

Removal Procedure

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: 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 A4 hybrid battery pack. Refer to **High Voltage Disabling**.

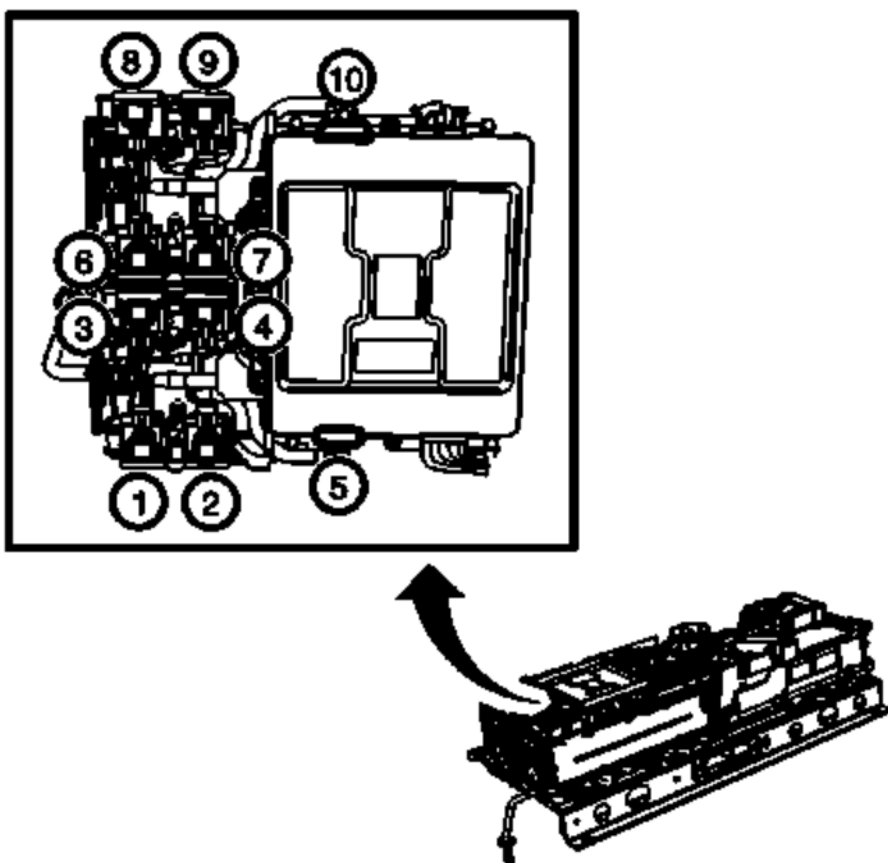


Fig. 62: Identifying Connectors Sequence
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the following connectors, in the above graphic sequence shown, from the battery energy control module.

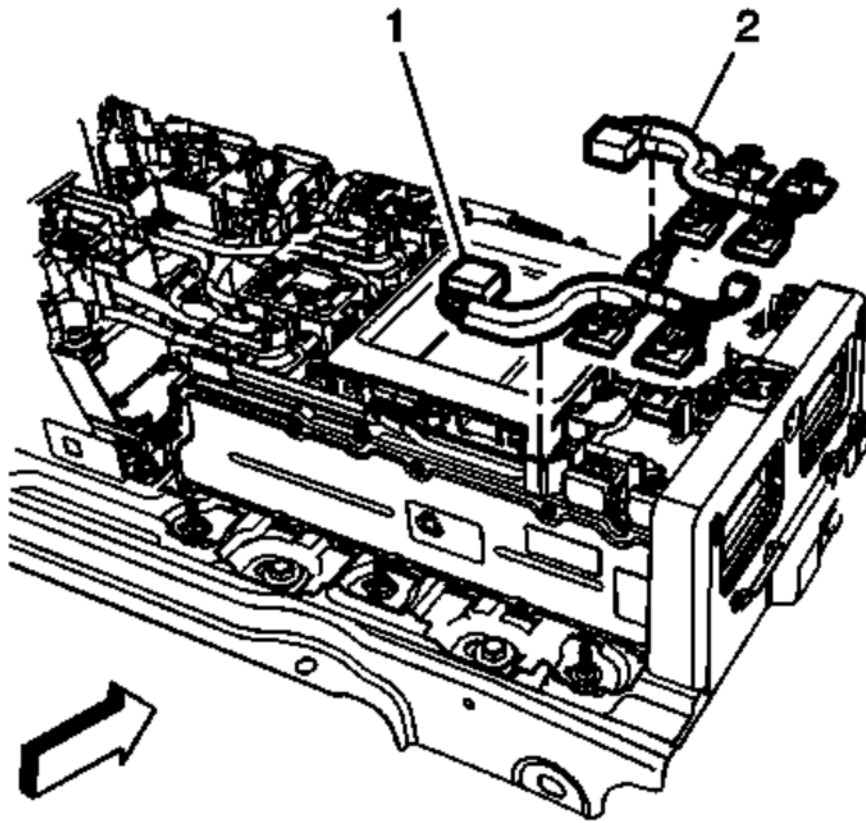


Fig. 63: Battery Energy Control Module Right Side Harness
Courtesy of GENERAL MOTORS COMPANY

3. Remove the battery energy control module right side harness (1) and the left side harness (2).

Installation Procedure

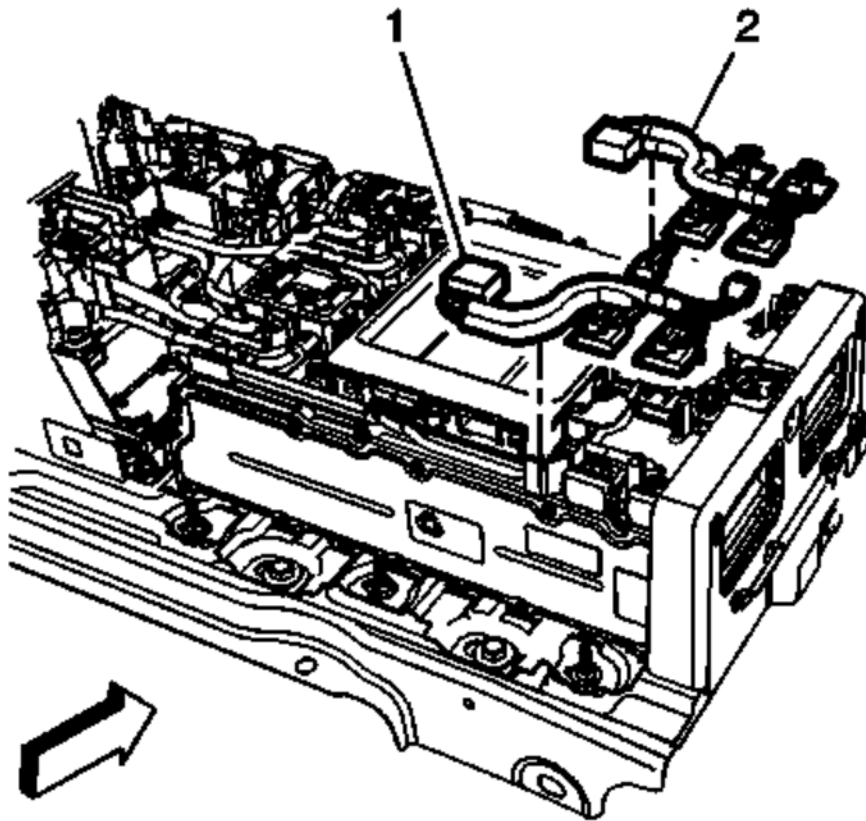


Fig. 64: Battery Energy Control Module Right Side Harness
Courtesy of GENERAL MOTORS COMPANY

1. Install the right side battery energy control module harness (1) and the left side harness (2), into the harness conduit.

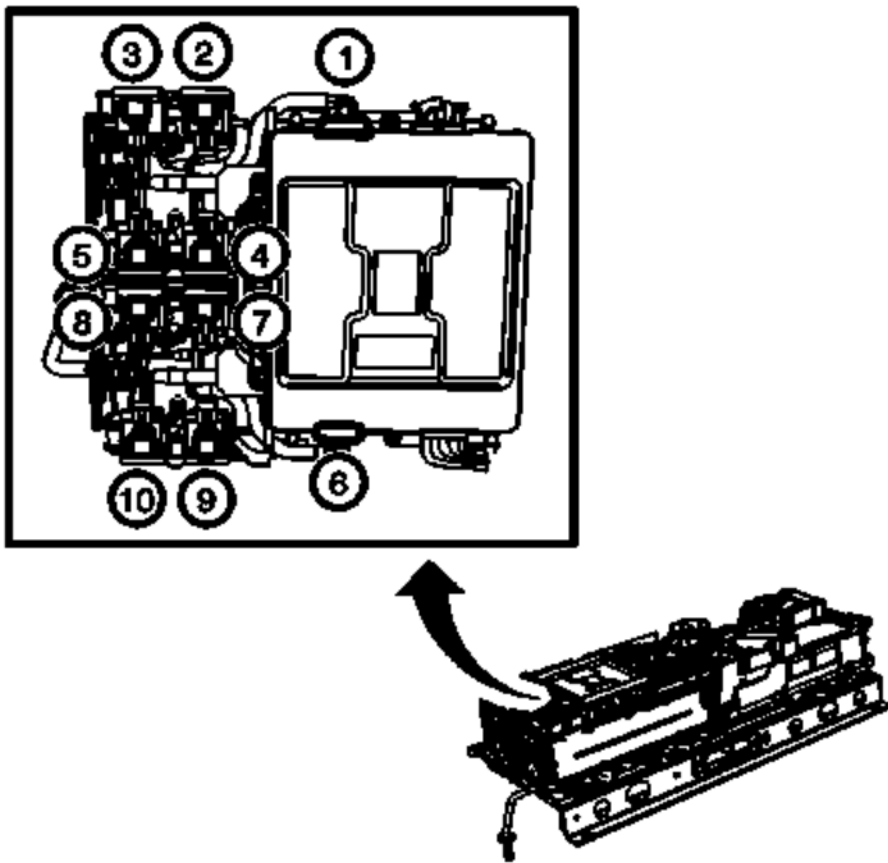


Fig. 65: Battery Energy Control Module Connector Sequence
Courtesy of GENERAL MOTORS COMPANY

2. Connect the battery energy control module connectors in the above graphic sequence.
3. Enable the hybrid battery. Refer to High Voltage Enabling.

BATTERY ENERGY CONTROL MODULE WIRING HARNESS REPLACEMENT (BDU, BECM AND BPIM)

Removal Procedure

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: 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 A4 hybrid battery pack. Refer to High Voltage Disabling.

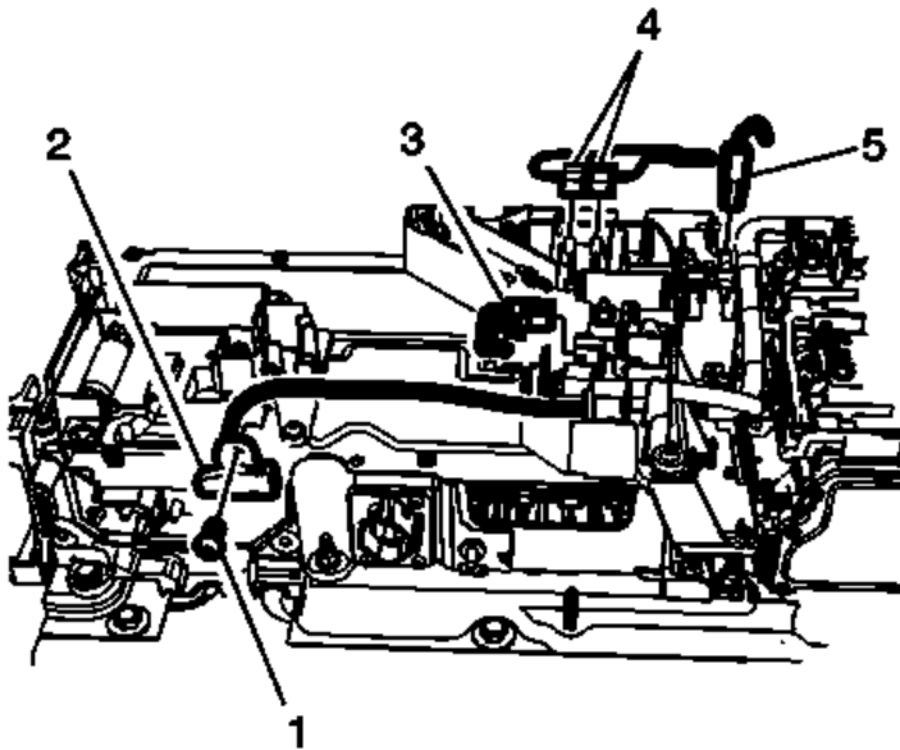


Fig. 66: Cut-Off Switch Fastener

Courtesy of GENERAL MOTORS COMPANY

2. Remove the cut-off switch fastener (1) and the cut-off switch (2) from the battery energy control module wiring junction block.
3. Remove the current sensor connector (3); the pre-charge contacts (4) and the contactor connector (5).

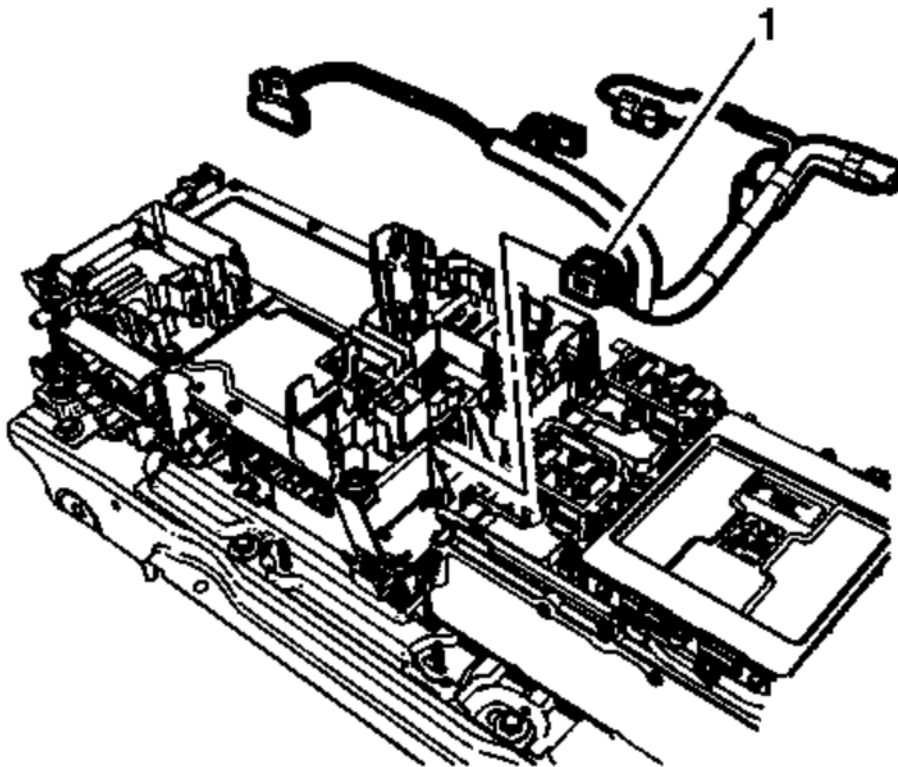


Fig. 67: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

4. Remove the generator control module connector (1).

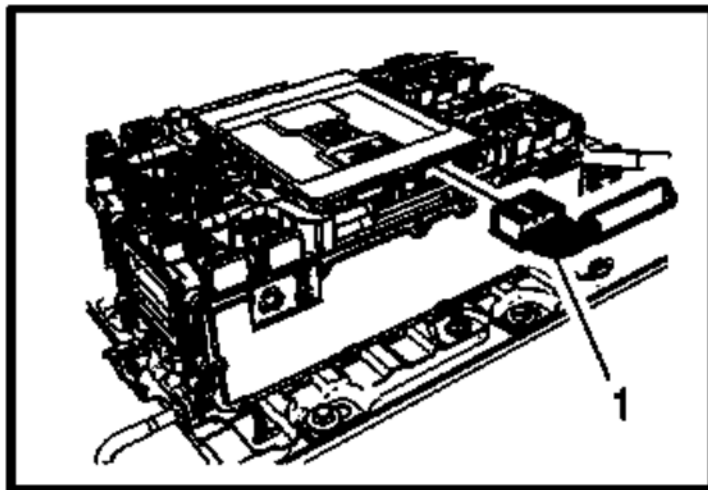
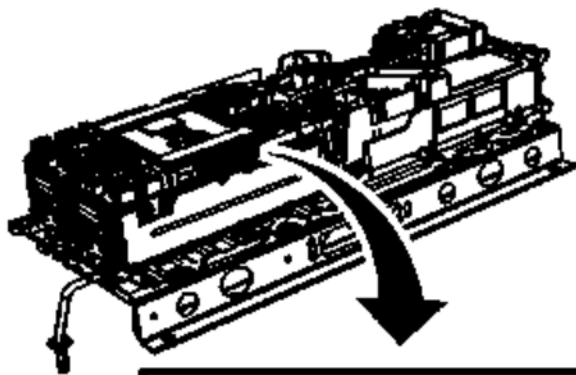


Fig. 68: Battery Energy Control Module
Courtesy of GENERAL MOTORS COMPANY

5. Remove the connector (1) from the battery energy control module.

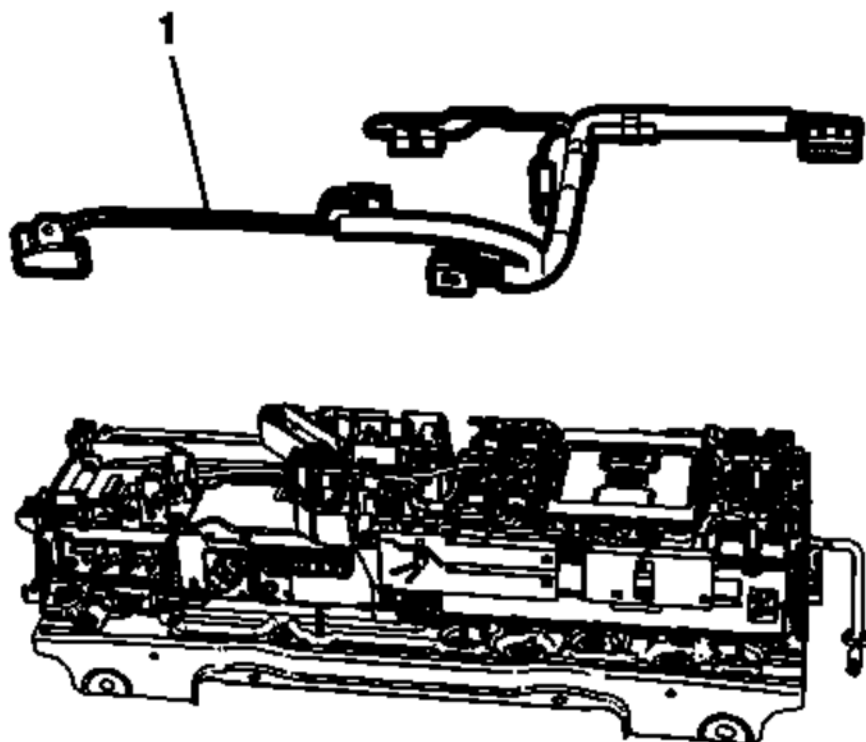


Fig. 69: Battery Energy Control Harness
Courtesy of GENERAL MOTORS COMPANY

6. Remove the battery energy control harness (1).

Installation Procedure

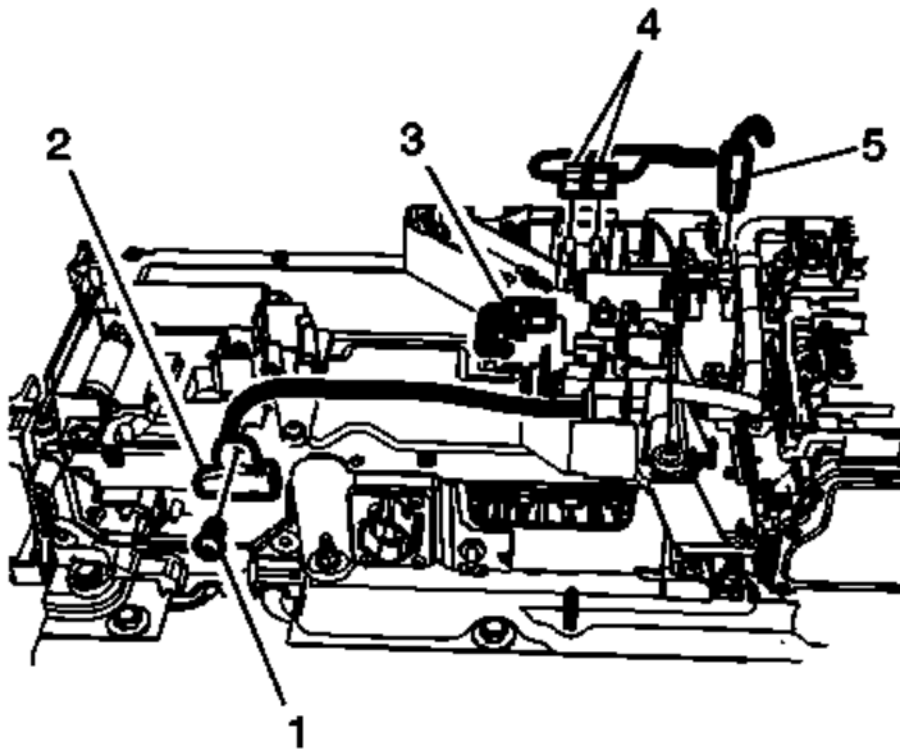


Fig. 70: Cut-Off Switch Fastener

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the cut-off switch (2) to the battery energy control module wiring harness junction block and tighten the fasteners (1) to 4 N.m (35 lb in).
2. Connect the following to the generator battery disconnect relay block:
 - Current Sensor Connector (3).
 - Pre-Charge Contacts (4).
 - Contactor Connector (5).

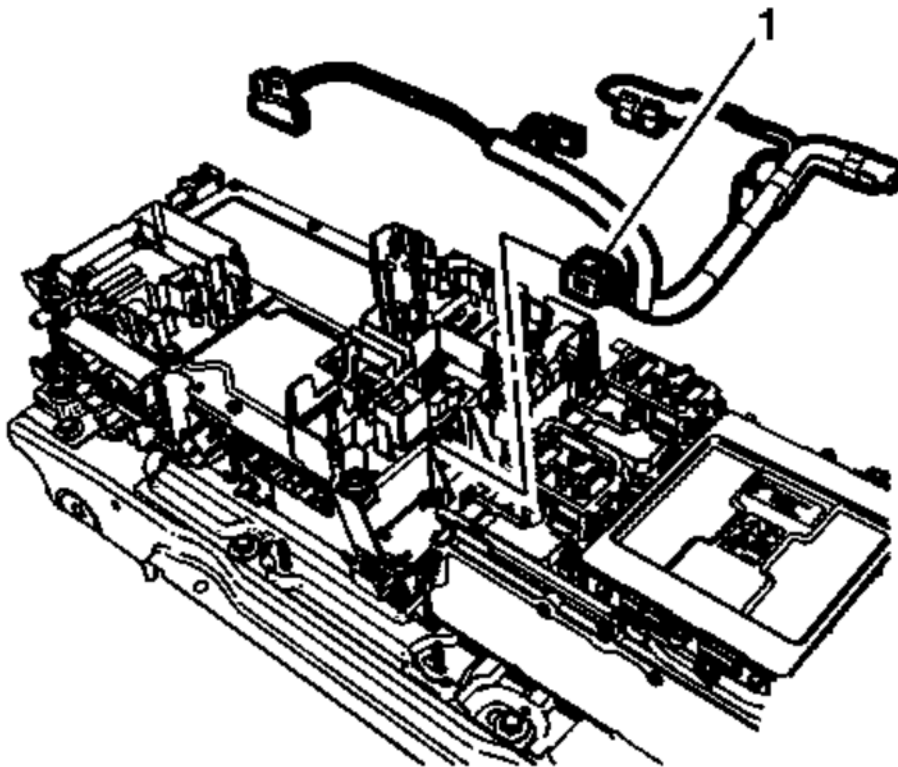


Fig. 71: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the connector (1) to the generator control module.

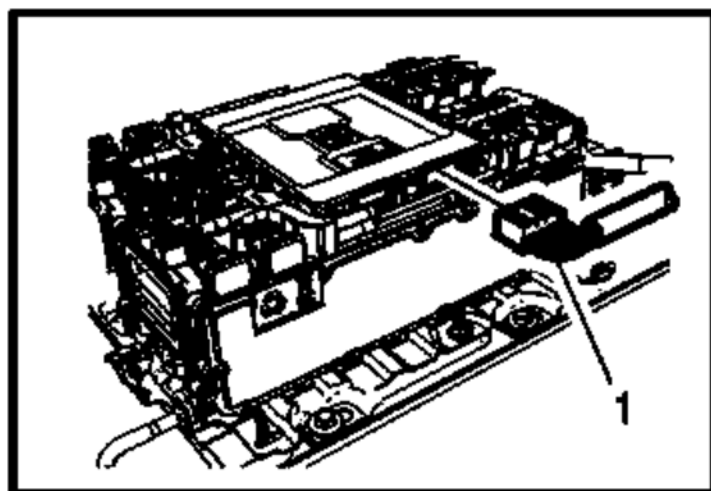
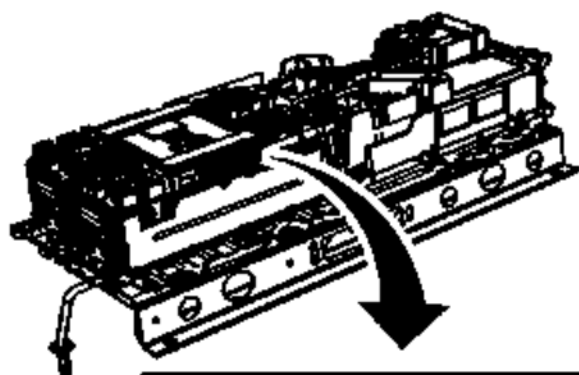


Fig. 72: Battery Energy Control Module
Courtesy of GENERAL MOTORS COMPANY

4. Install the connector (1) to the battery energy control module.
5. Enable the hybrid battery. Refer to High Voltage Enabling.

GENERATOR BATTERY REPLACEMENT

Removal Procedure

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: 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 hybrid battery. Refer to **High Voltage Disabling**.
2. Remove the battery energy control module. Refer to **Battery Energy Control Module Replacement**.
3. Remove the battery energy control module wiring harness - BDU, BECM and BPIM. Refer to **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**, **Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)**.

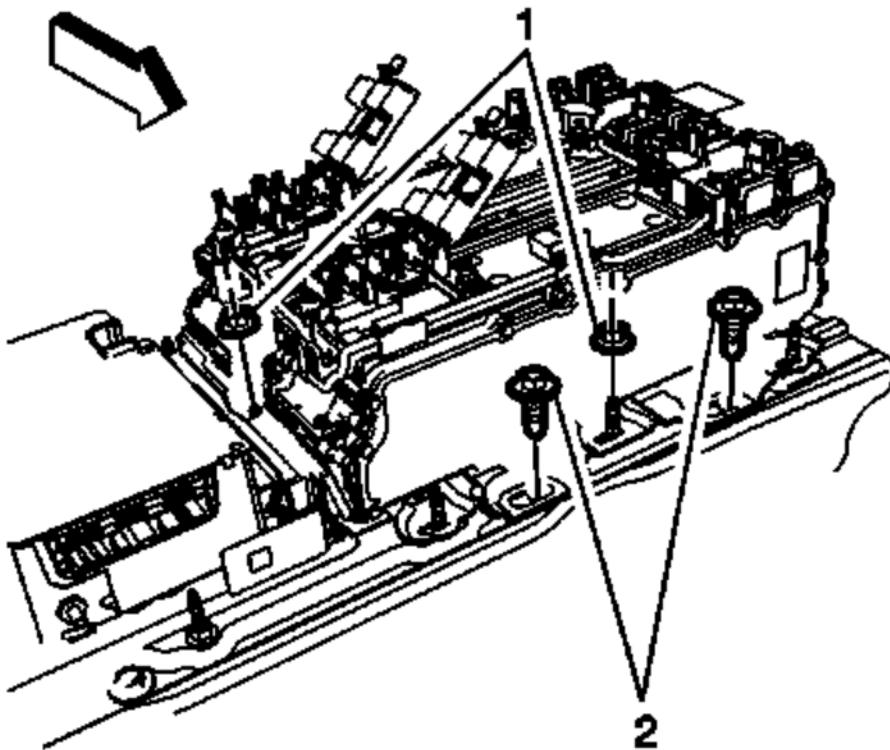


Fig. 73: Generator Battery Fasteners
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remember the location of fastener (1) as not to interfere with the installation of the generator control and battery module cover.

4. Remove the generator battery fasteners (1) and (2).

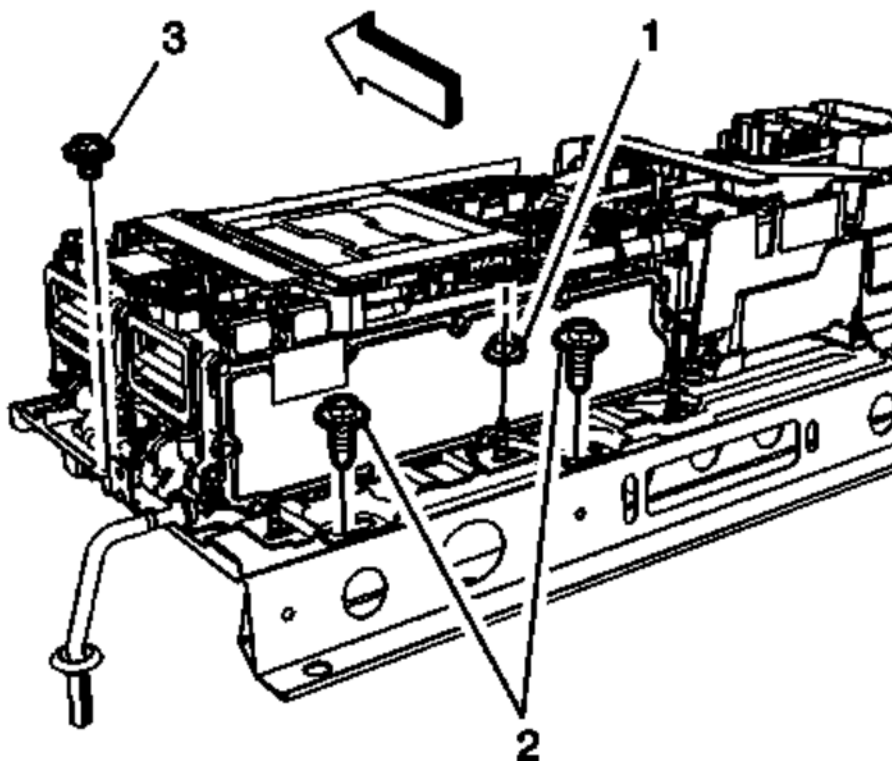


Fig. 74: Mounting Location Fastener
Courtesy of GENERAL MOTORS COMPANY

NOTE: Remember the location of fastener (1) as not to interfere with the installation of the generator control and battery module cover.

5. Remove the fasteners (1) and (2).
6. Remove the mounting location fastener (3).

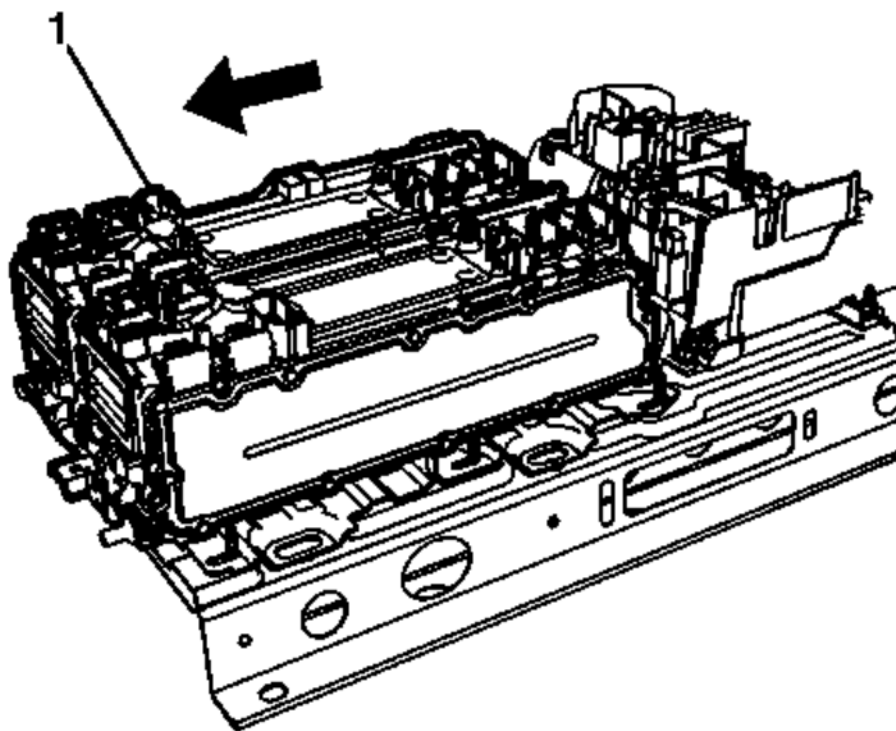


Fig. 75: Generator Battery

Courtesy of GENERAL MOTORS COMPANY

NOTE: Use high voltage protective gloves.

7. Slide the generator battery (1) in the direction shown.

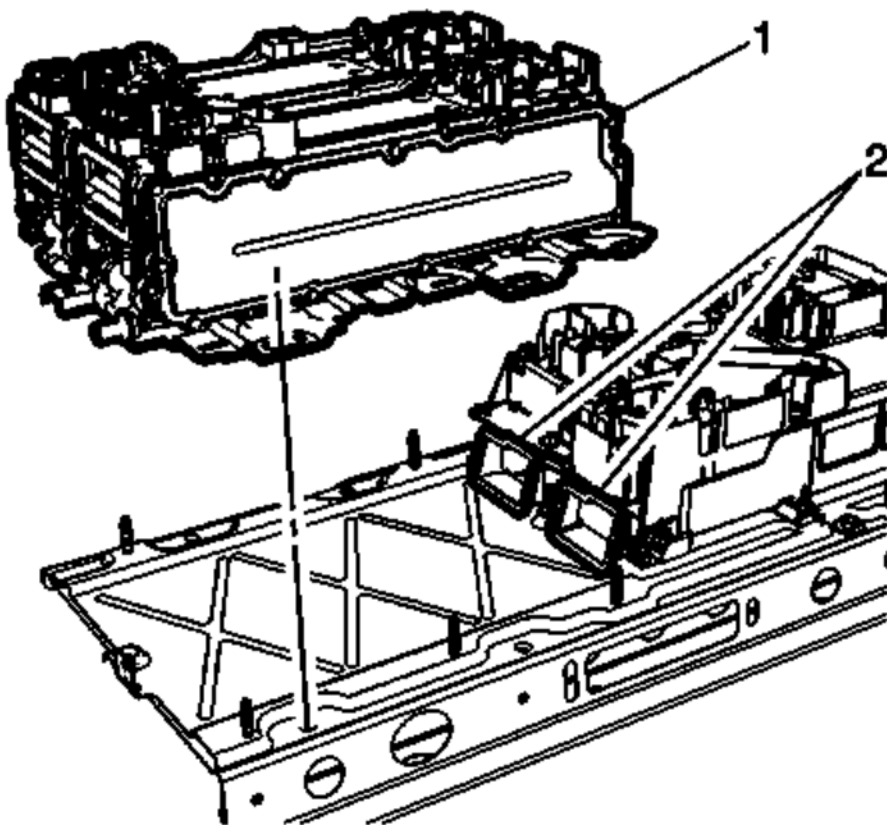


Fig. 76: Intermediate Duct Seals

Courtesy of GENERAL MOTORS COMPANY

8. With the help of a second technician, lift the generator battery (1) into the rear compartment area.
9. Inspect the intermediate duct seals (2) and replace if damaged.

Installation Procedure

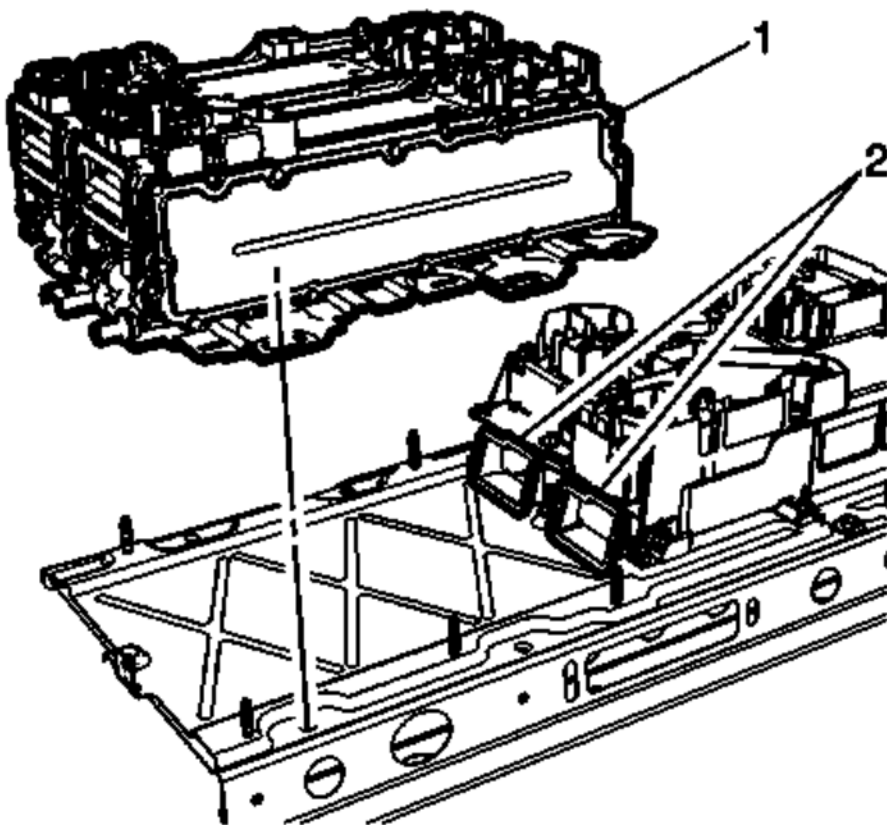


Fig. 77: Intermediate Duct Seals

Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. With the help of a technician, install the generator battery (1) to the mounting studs.

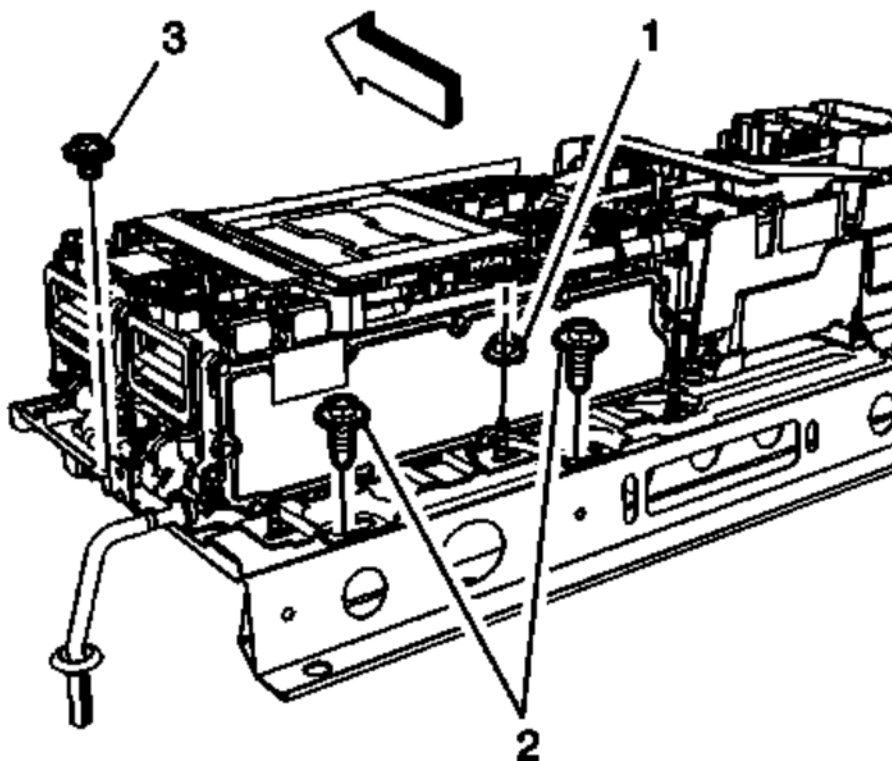


Fig. 78: Mounting Location Fastener
Courtesy of GENERAL MOTORS COMPANY

2. Slide the generator battery towards the intermediate duct seals and install the locating fastener (3). Tighten the fastener (3) to 22 N.m (16 lb ft).
3. Install the generator battery fastener (2) and tighten to 22 N.m (16 lb ft).
4. Install the generator battery fasteners (2) and tighten to 22 N.m (16 lb ft).

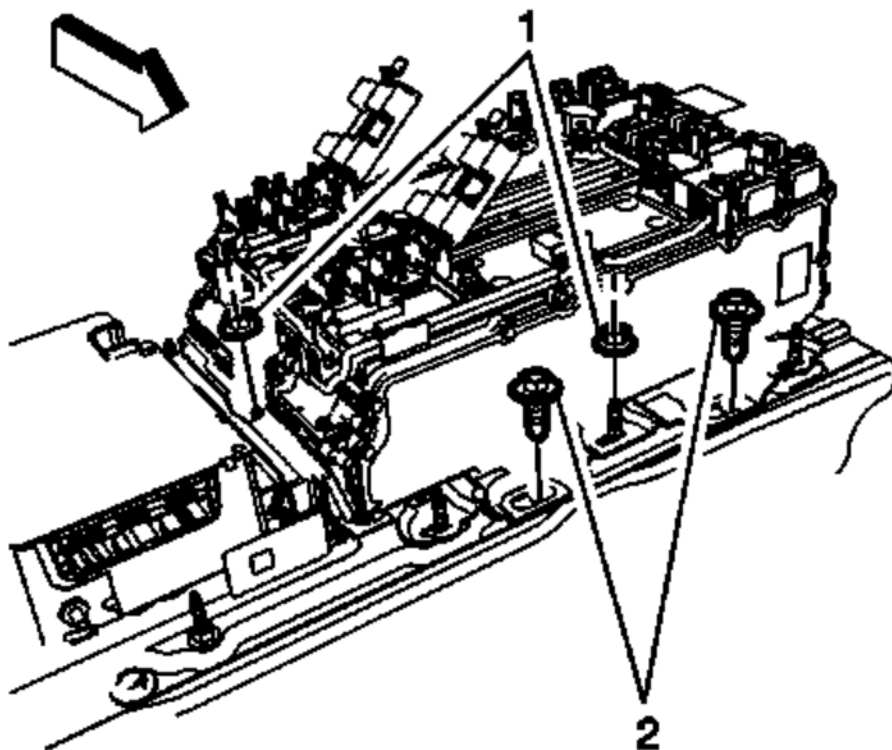


Fig. 79: Generator Battery Fasteners
 Courtesy of GENERAL MOTORS COMPANY

5. Install the generator battery fasteners (1) and tighten to 22 N.m (16 lb ft).
6. Install the generator battery fasteners (2) and tighten to 22 N.m (16 lb ft).
7. Install the battery energy control module. Refer to **Battery Energy Control Module Replacement**.
8. Install the battery energy control module harness - BDU, BECM and BPIM. Refer to **Battery Energy Control Module Wiring Harness Replacement (HV Measuring Harness 1 and 2)**, **Battery Energy Control Module Wiring Harness Replacement (BDU, BECM and BPIM)**.
9. Enable the hybrid battery. Refer to **High Voltage Enabling**.

BATTERY VENT TUBE REPLACEMENT

Removal Procedure

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

1. Remove the rear compartment floor panel with battery cover. Refer to **Rear Compartment Floor Panel Trim Replacement (With Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (With Blower Cover, HP6)** .

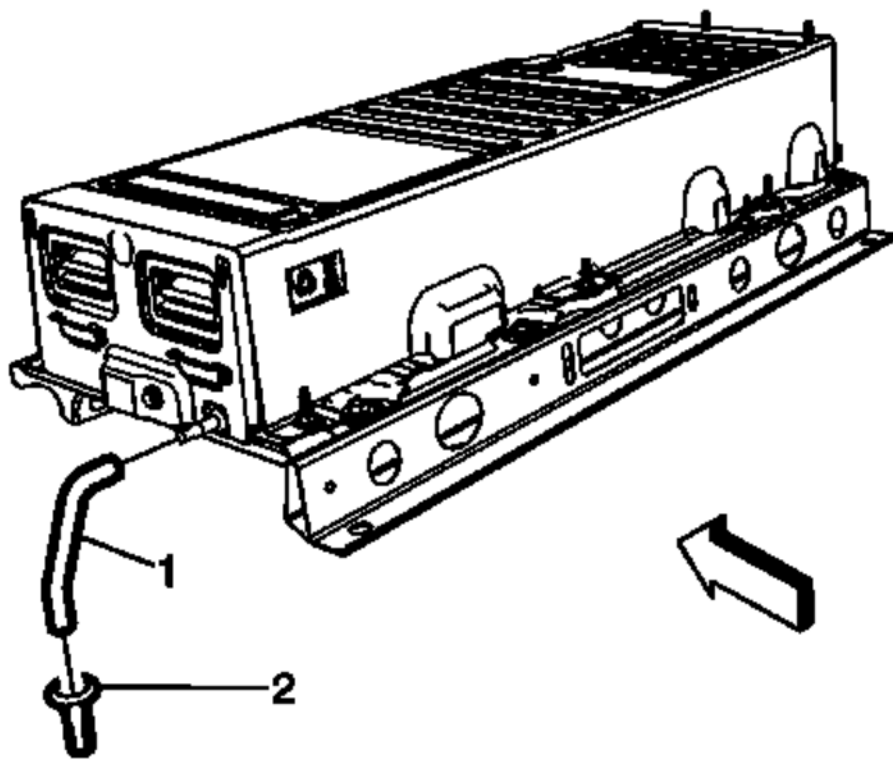


Fig. 80: Battery Vent Tube

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not bend or disfigure the battery vent tube.

NOTE: Battery vent tube and rear compartment grommet are replaced as an assembly.

2. Remove the battery vent tube (1) with the rear compartment grommet (2).

Installation Procedure

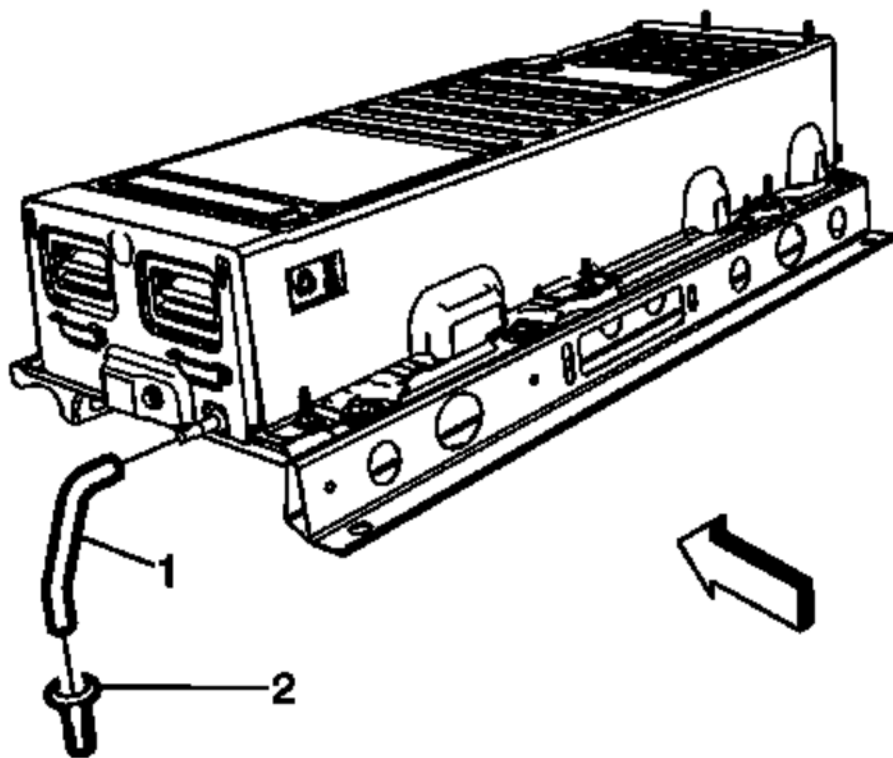


Fig. 81: Battery Vent Tube

Courtesy of GENERAL MOTORS COMPANY

NOTE: Do not bend or disfigure the battery vent tube.

NOTE: Battery vent tube and rear compartment grommet are replaced as an assembly.

1. Install the battery vent tube (1) with the rear compartment grommet (2).
2. Install the rear compartment floor panel with battery cover. Refer to **Rear Compartment Floor Panel Trim Replacement (With Battery Cover, HP6)** , **Rear Compartment Floor Panel Trim Replacement (With Blower Cover, HP6)** .

DRIVE MOTOR BATTERY WIRE JUNCTION BLOCK RELAY REPLACEMENT

Removal Procedure

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: 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 A4 hybrid battery pack. Refer to **High Voltage Disabling**.

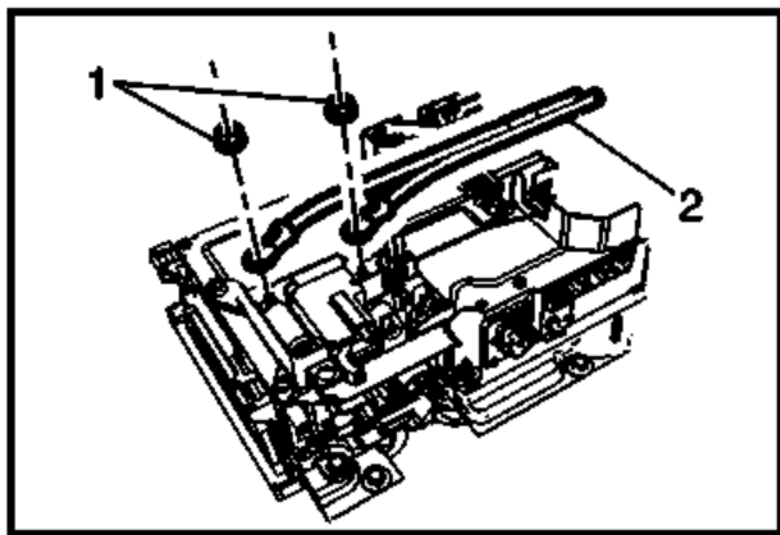
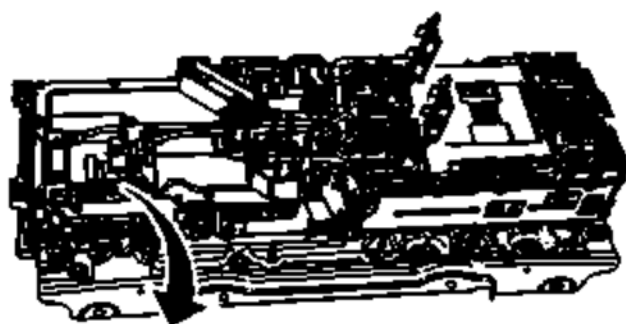


Fig. 82: High Voltage Fasteners And Cables
Courtesy of GENERAL MOTORS COMPANY

2. Remove the high voltage fasteners (1) and the high voltage cables (2) from the battery energy control module wiring junction block.

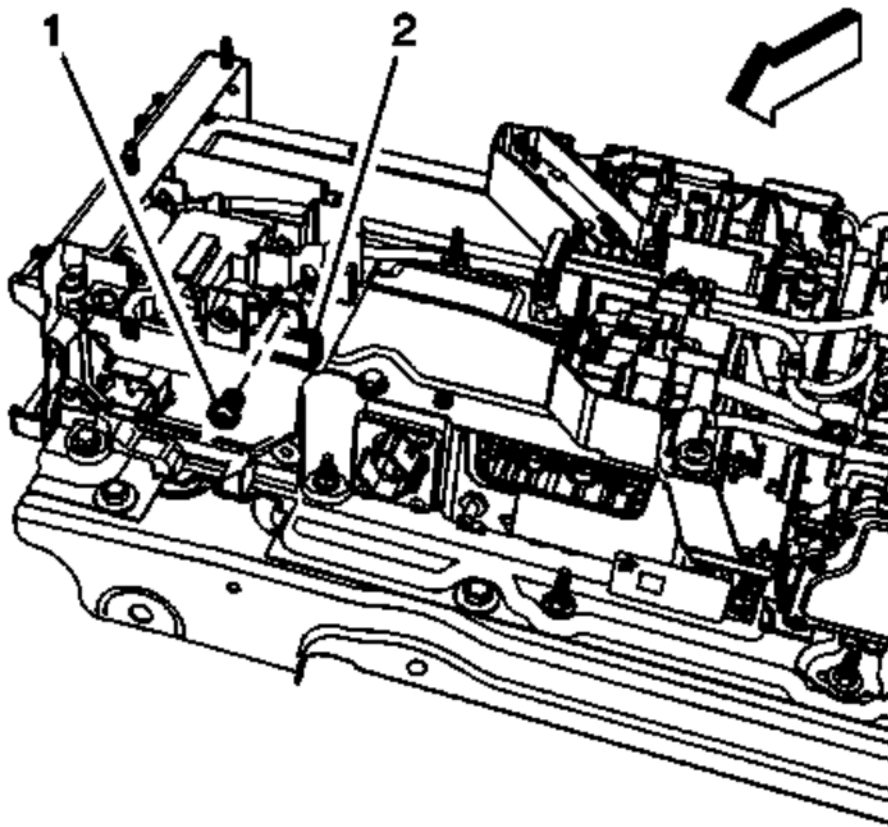


Fig. 83: Cut-Off Switch Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the cut-off switch fastener (1) and set aside the cut-off switch (2).

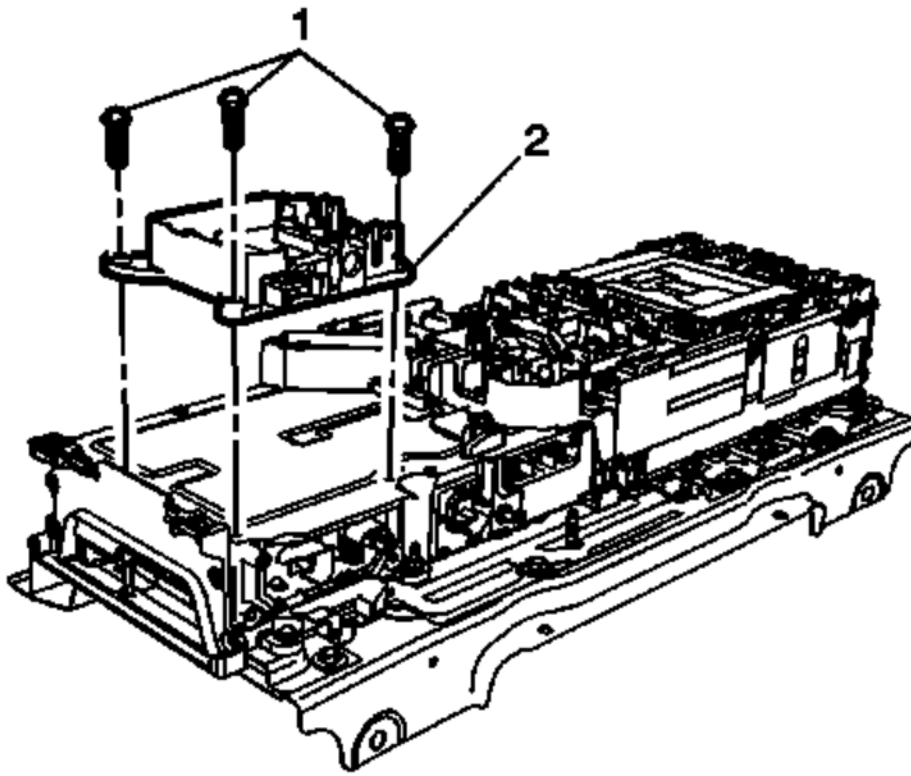


Fig. 84: Generator Battery Disconnect Relay Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the battery energy control module wiring junction block fasteners (1) and remove the battery energy control module wiring junction block (2).

Installation Procedure

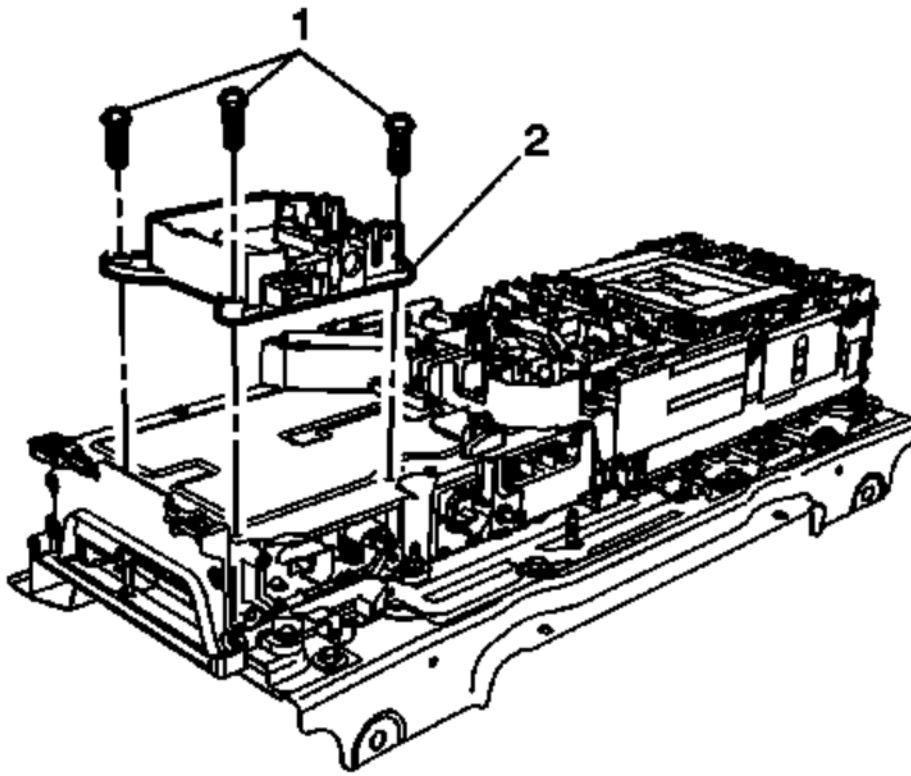


Fig. 85: Generator Battery Disconnect Relay Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the battery energy control module wiring junction block (2) to the generator control module and tighten the fasteners (1) to 9 N.m (80 lb in).

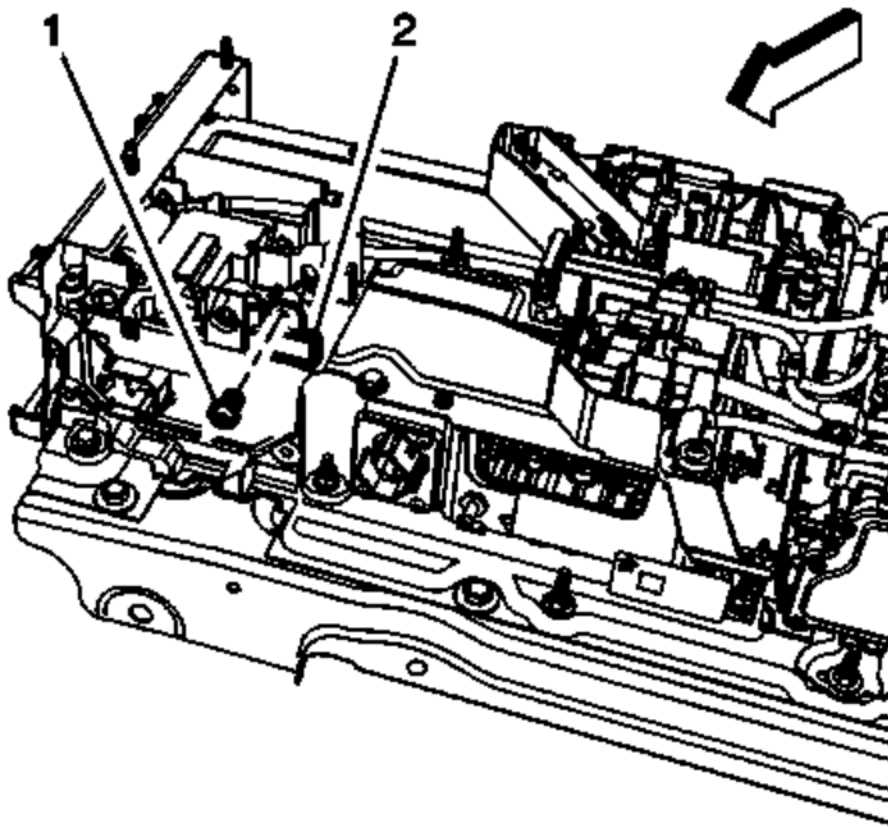


Fig. 86: Cut-Off Switch Fastener

Courtesy of GENERAL MOTORS COMPANY

2. Install the cut-off switch (2) to the drive motor battery junction block relay and tighten the fastener (1) to 4 N.m (35 lb in).

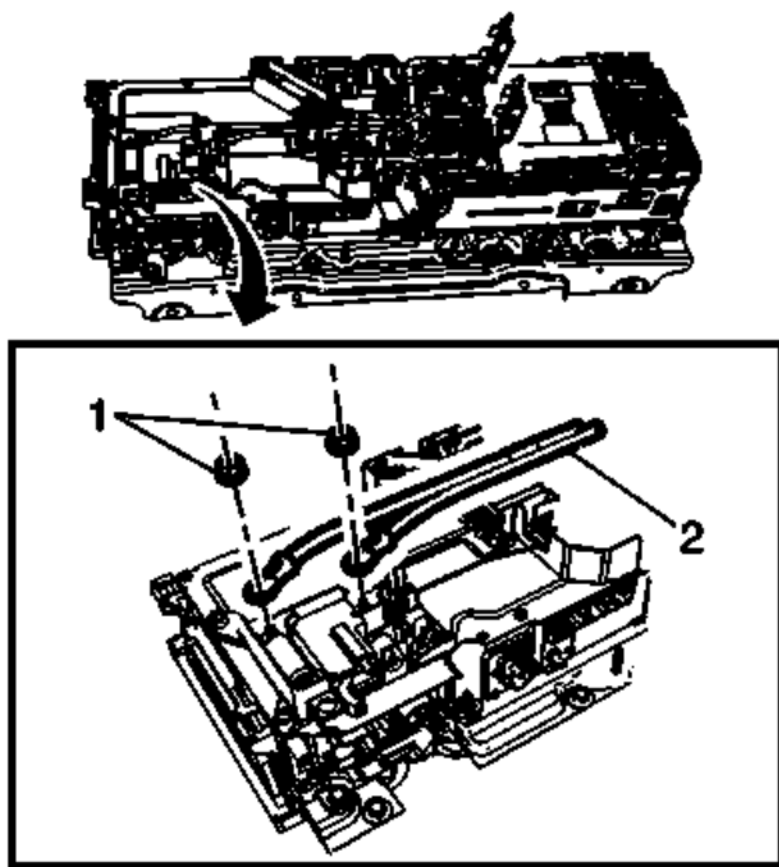


Fig. 87: High Voltage Fasteners And Cables
Courtesy of GENERAL MOTORS COMPANY

3. Install the high voltage cables (2) to the battery energy control module wiring junction block and tighten the fasteners (1) to 9 N.m (80 lb in).
4. Enable the hybrid battery. Refer to **High Voltage Enabling**.

BATTERY ENERGY CONTROL MODULE WIRING JUNCTION BLOCK REPLACEMENT

Removal Procedure

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: 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 A4 hybrid battery pack. Refer to High Voltage Disabling.

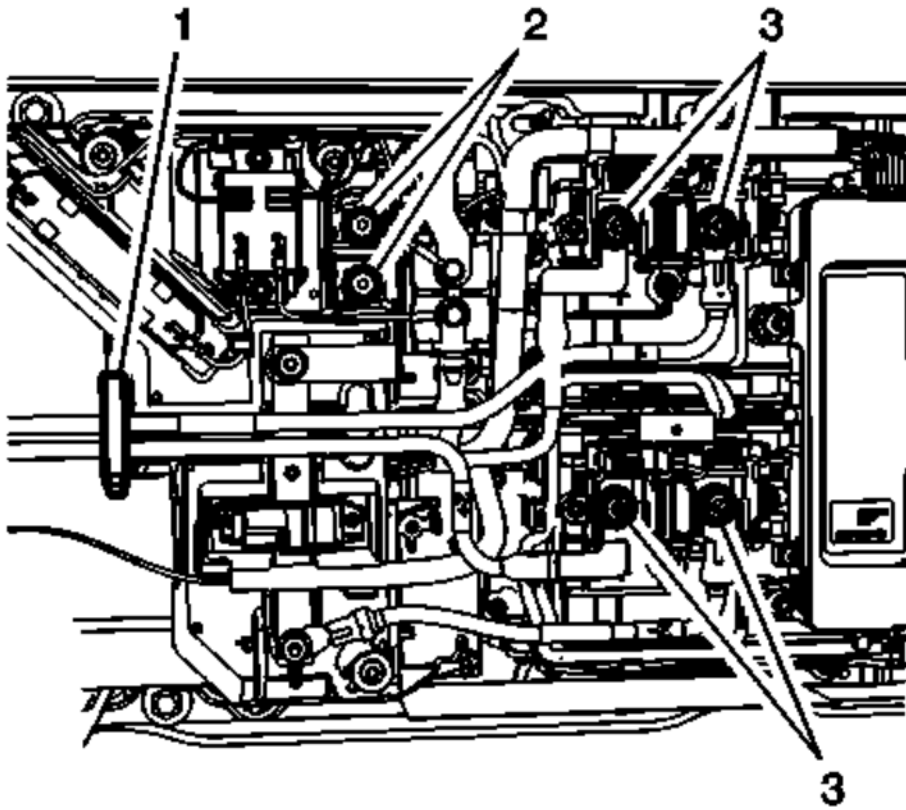


Fig. 88: High Voltage Battery Cables-To-Batteries Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Remove the fasteners (3) retaining the high voltage battery cables to the batteries.
3. Disengage the cable retaining clip (1) and reposition the high voltage cables.
4. Remove the fasteners (2) retaining the junction block to the generator control module.

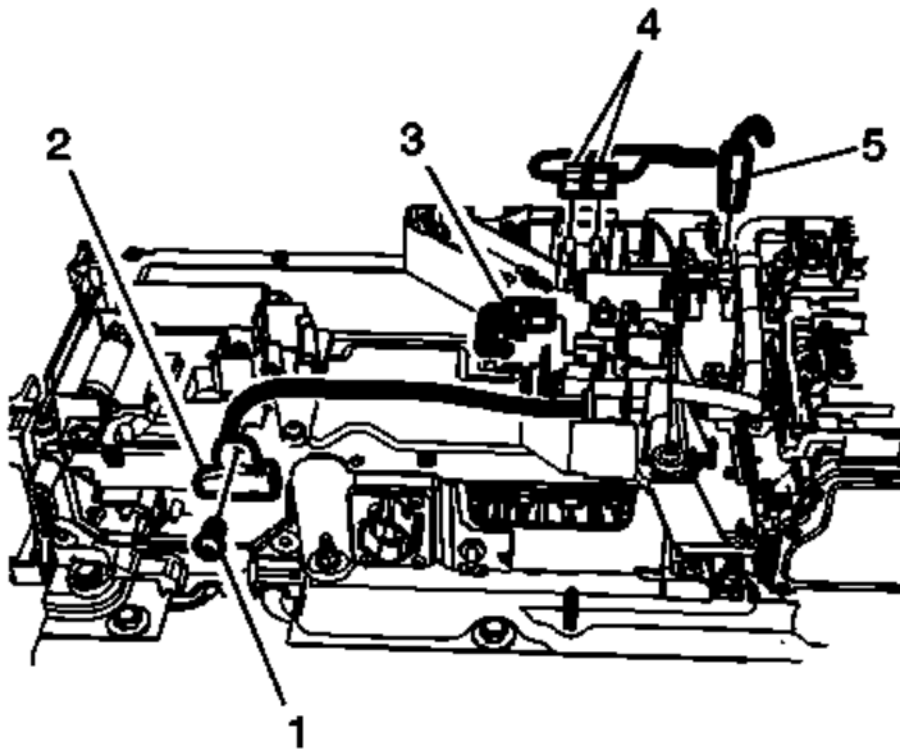


Fig. 89: Cut-Off Switch Fastener

Courtesy of GENERAL MOTORS COMPANY

5. Remove the current sensor connector (3), the pre-charge contacts (4) and the contactor connector (5).

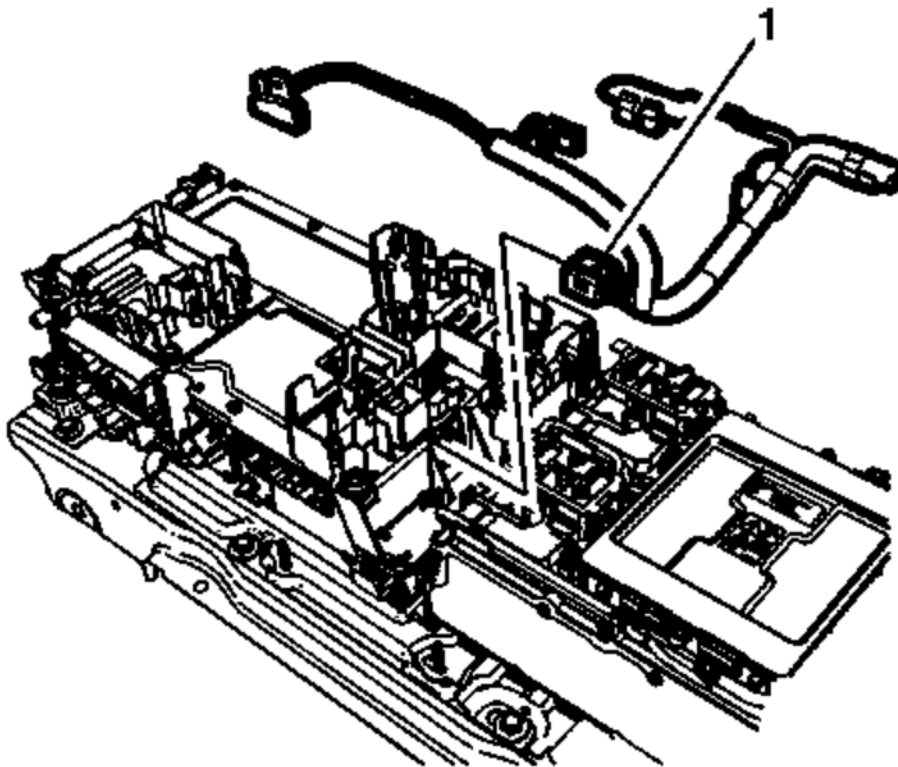


Fig. 90: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

6. Remove the generator control module connector (1).

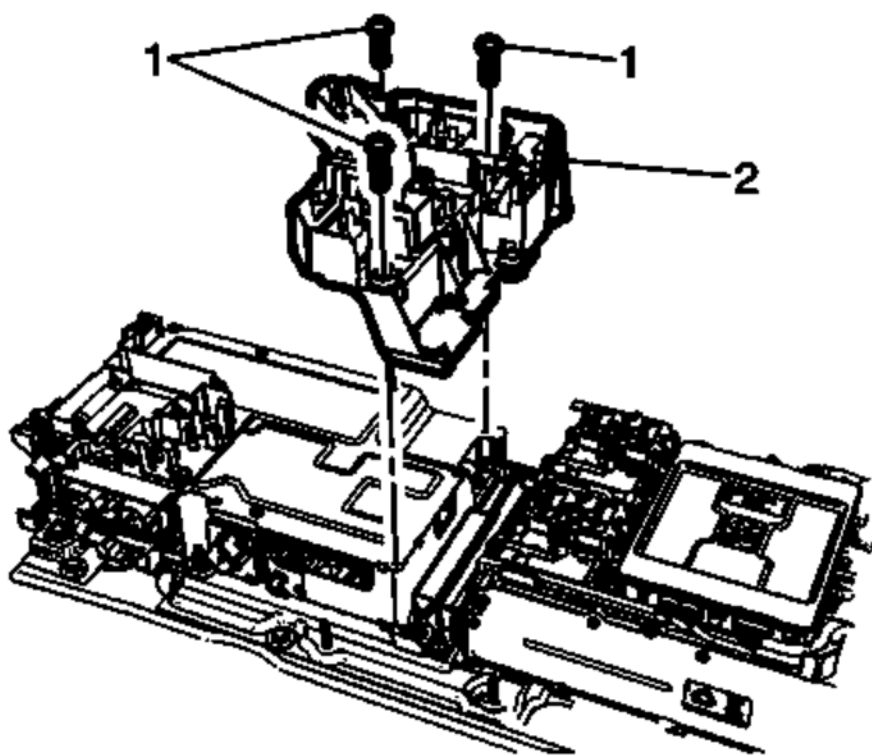


Fig. 91: Battery Energy Control Module Junction Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

7. Remove the drive motor battery wire junction block relay fasteners (1) and remove the drive motor battery wire junction block relay (2).

Installation Procedure

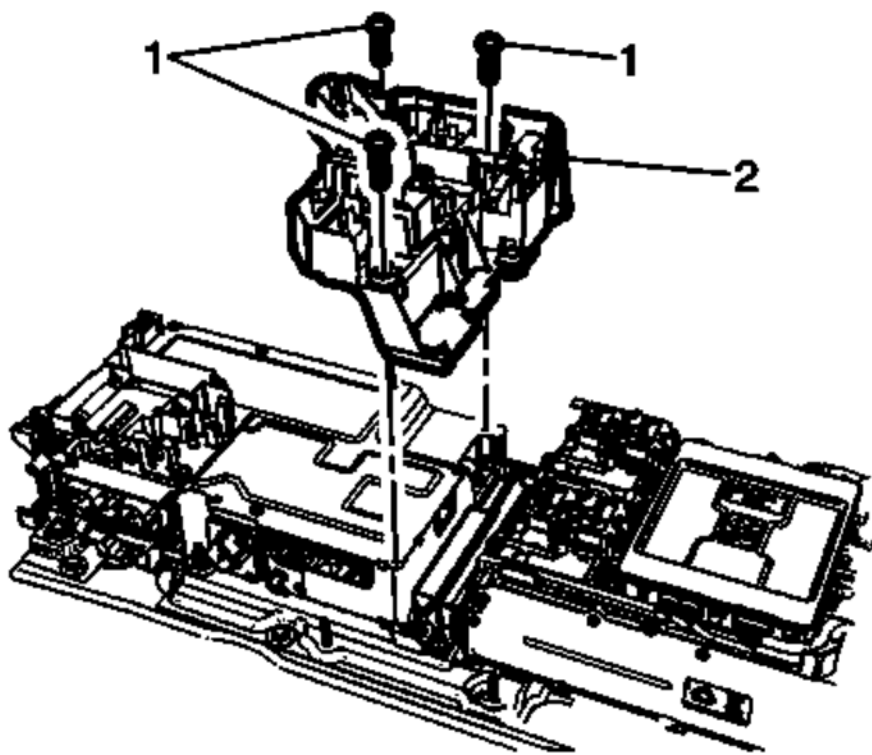


Fig. 92: Battery Energy Control Module Junction Block Fasteners
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

1. Install the drive motor battery wire junction block relay (2) and tighten the fasteners (1) to 9 N.m (80 lb in).

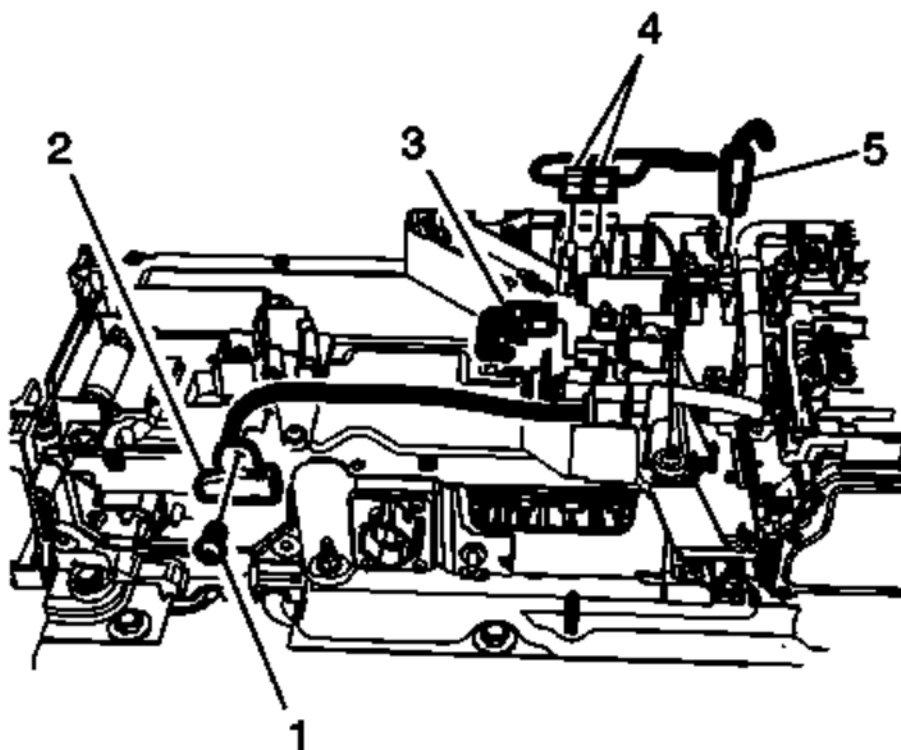


Fig. 93: Cut-Off Switch Fastener

Courtesy of GENERAL MOTORS COMPANY

2. Connect the following to the generator battery disconnect relay junction block :
 - Current Sensor Connector (3).
 - Pre-Charge Contacts (4).
 - Contactor Connector (5).

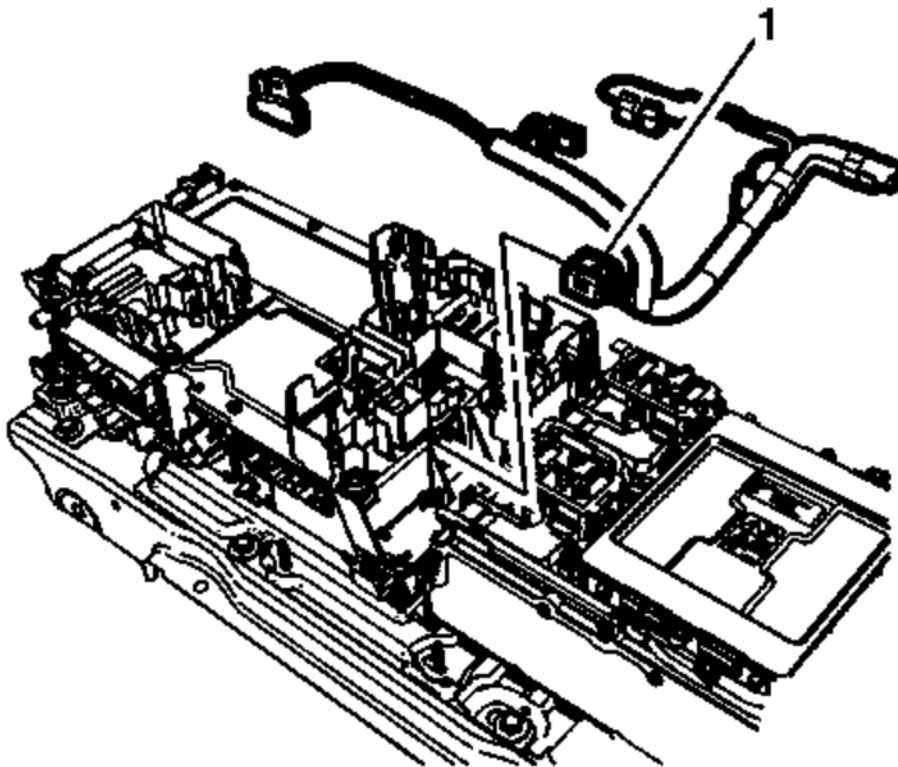


Fig. 94: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

3. Install the connector (1) to the generator control module.

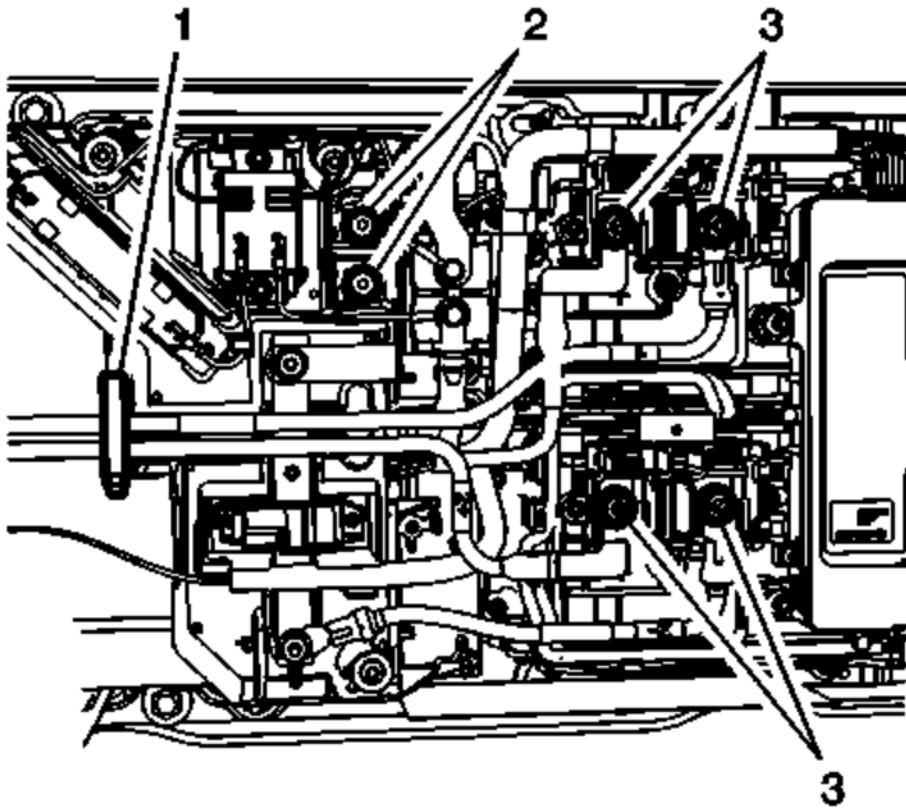


Fig. 95: High Voltage Battery Cables-To-Batteries Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Install the fasteners (2) retaining the junction block to the generator control module.
5. Position the high voltage cables through the cable retaining clip (1).
6. Install the high voltage cables to the batteries and tighten the fasteners (3) to 9 N.m (80 lb in).
7. Enable the hybrid battery. Refer to **High Voltage Enabling**.

DRIVE MOTOR GENERATOR CONTROL MODULE TRAY REPLACEMENT

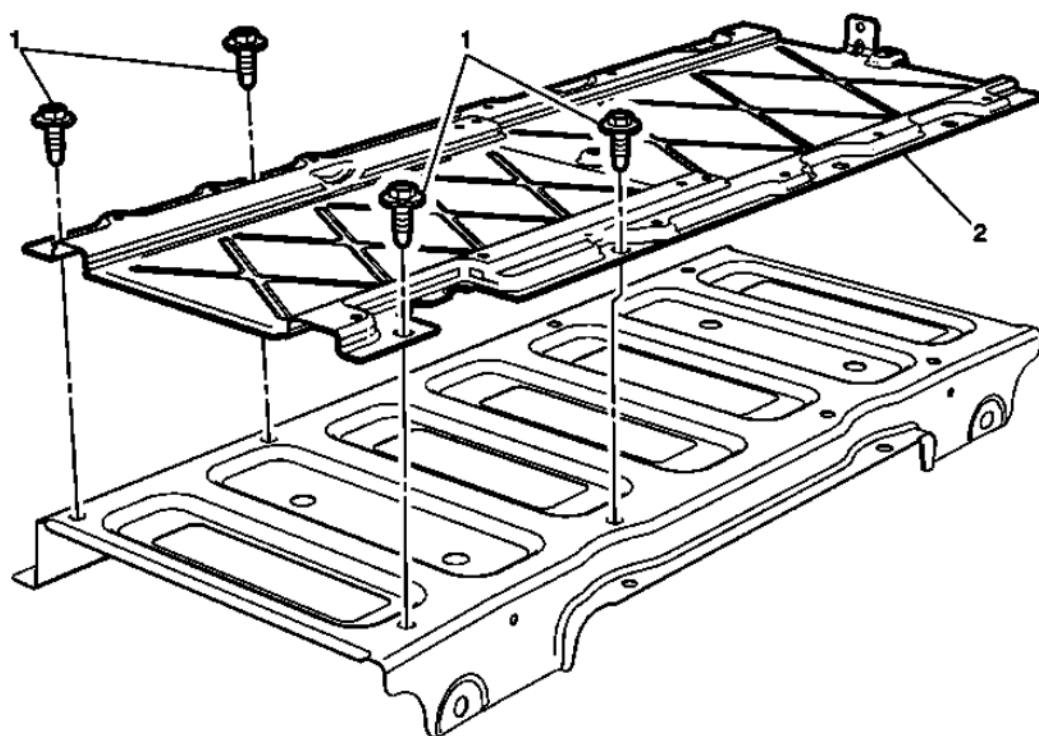


Fig. 96: Drive Motor Generator Control Module Tray
 Courtesy of GENERAL MOTORS COMPANY

Drive Motor Generator Control Module Tray Replacement

Callout	Component Name
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: 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.

Preliminary Procedure

1. Remove the generator battery. Refer to **Generator Battery Replacement**.
2. Remove the generator control module. Refer to **Generator Control Module Replacement**.

1	Drive Motor Generator Control Module Cable Tray Fasteners (Qty: 4) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft).
2	Drive Motor Generator Control Module Cable Tray NOTE: Replace the drive motor generator control module seal.

GENERATOR CONTROL MODULE REPLACEMENT

Removal Procedure

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: 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 A4 hybrid battery pack. Refer to High Voltage Disabling, for Servicing Internal Components within the A4 Hybrid/EV Battery Pack **High Voltage Disabling**.

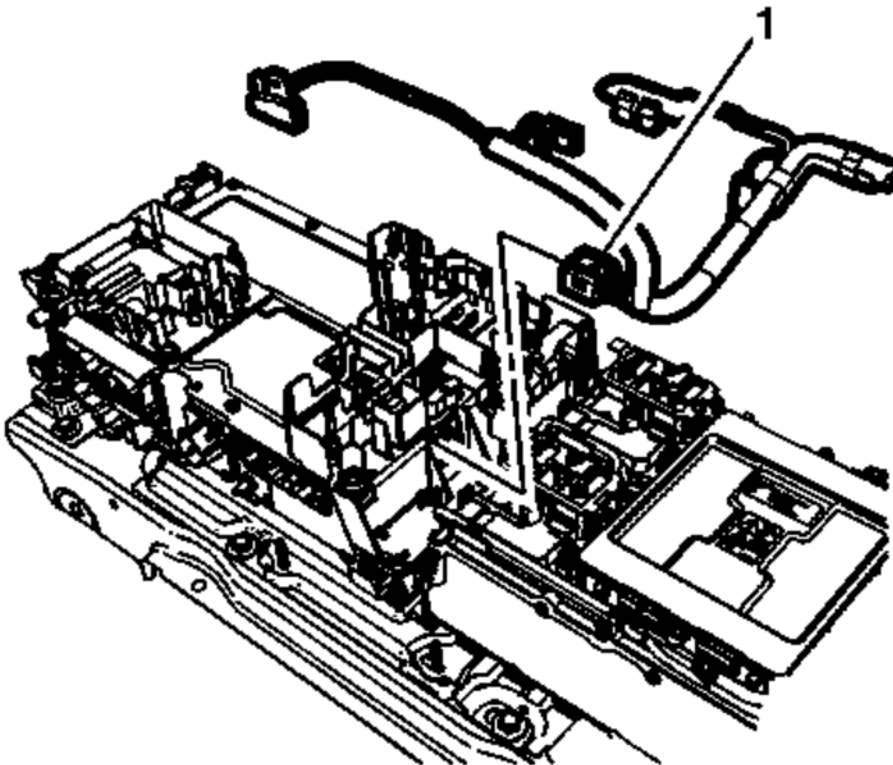


Fig. 97: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

2. Disconnect the generator control module X4 connector (1).

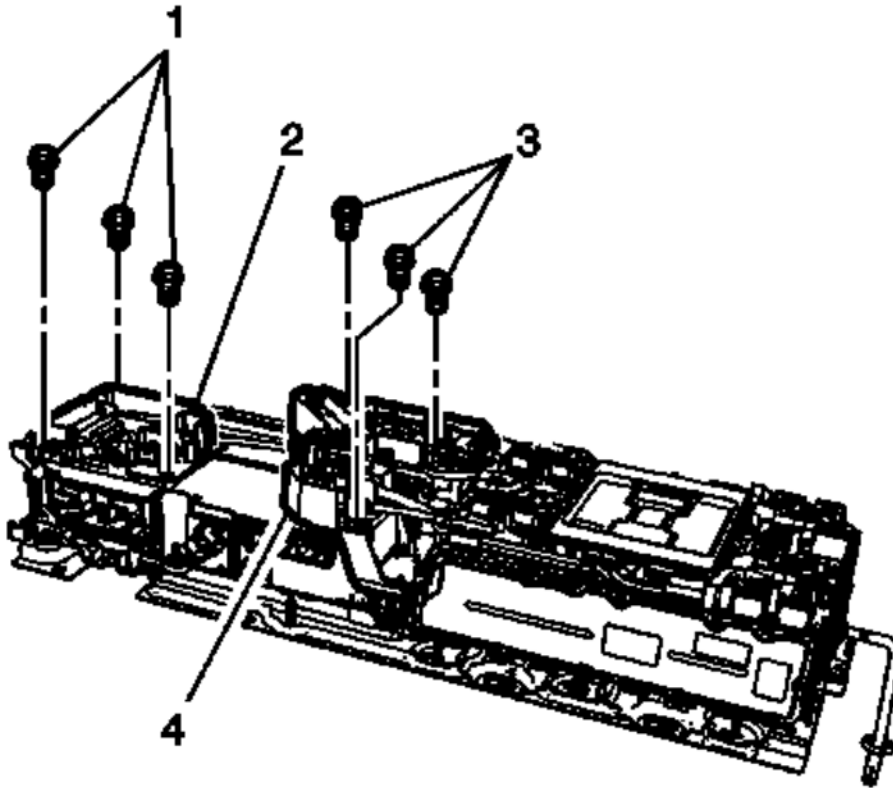


Fig. 98: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

3. Remove the fasteners (1) securing the battery energy control module wiring junction block assembly (2), to the top of the generator control module.
4. Remove the fasteners (3), securing the drive motor battery wire junction block relay assembly (4), to the top of the generator control module.

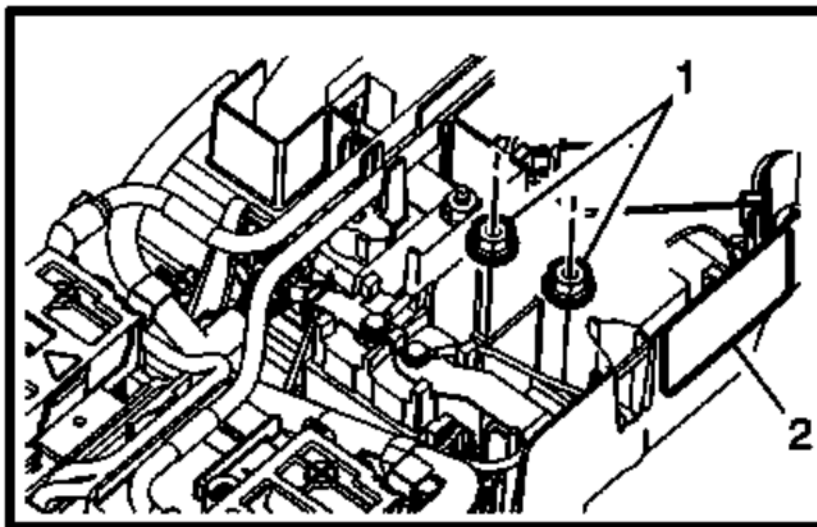
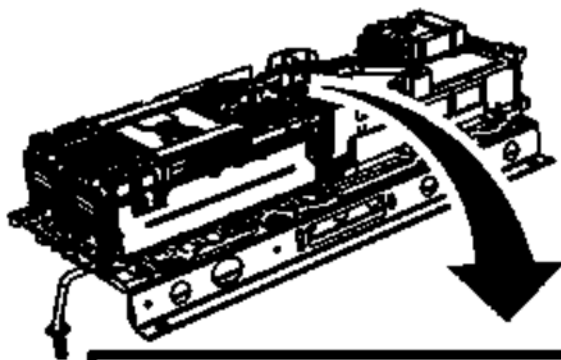


Fig. 99: High Voltage Bus Fasteners

Courtesy of GENERAL MOTORS COMPANY

5. Remove the high voltage bus fasteners (1) from the drive motor battery wiring junction block relay assembly (2).

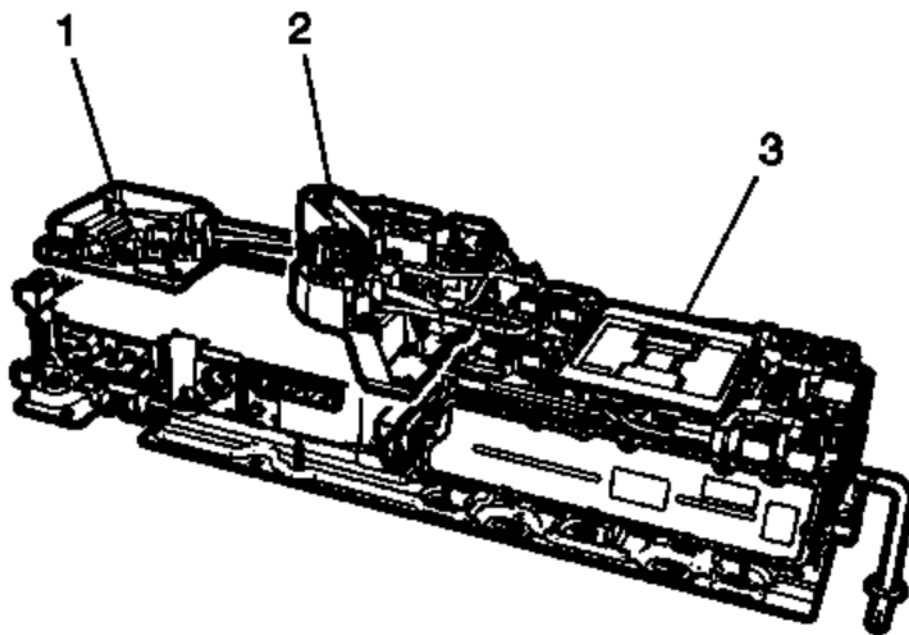


Fig. 100: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

6. Lift the drive motor battery wire junction block relay (2) and the battery energy control module wiring junction block (1) with the harness attached, and place on top of the battery energy control module (3).

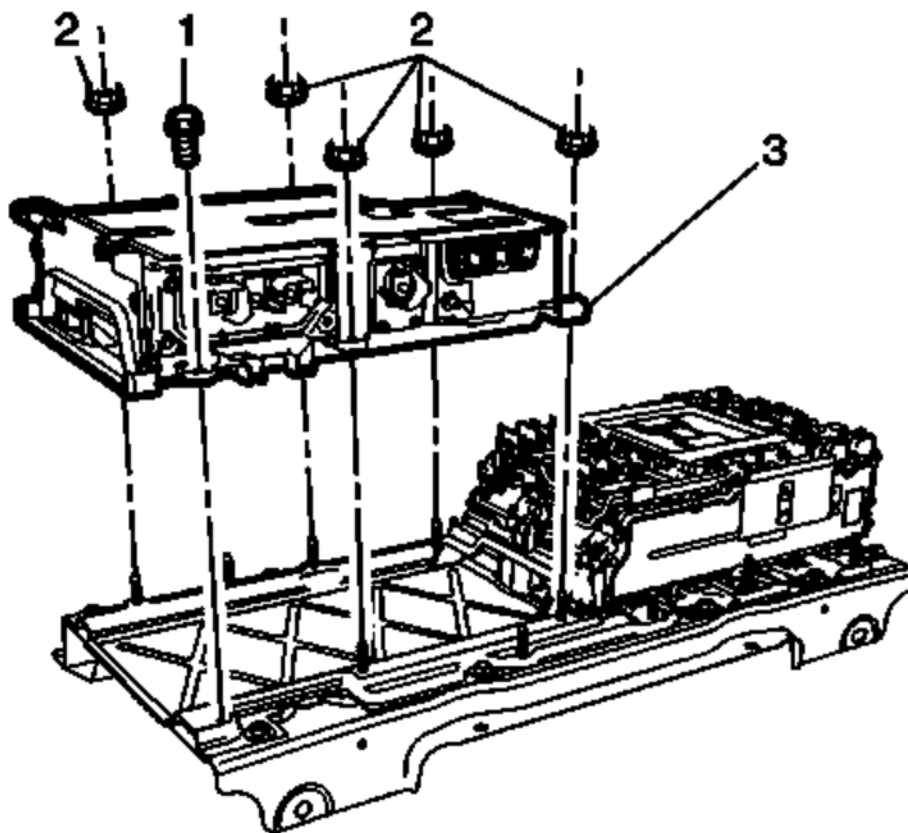


Fig. 101: Generator Control Module
Courtesy of GENERAL MOTORS COMPANY

7. Remove the generator control module mounting fasteners (1) and (2).
8. Remove the generator control module (3) from the support tray.

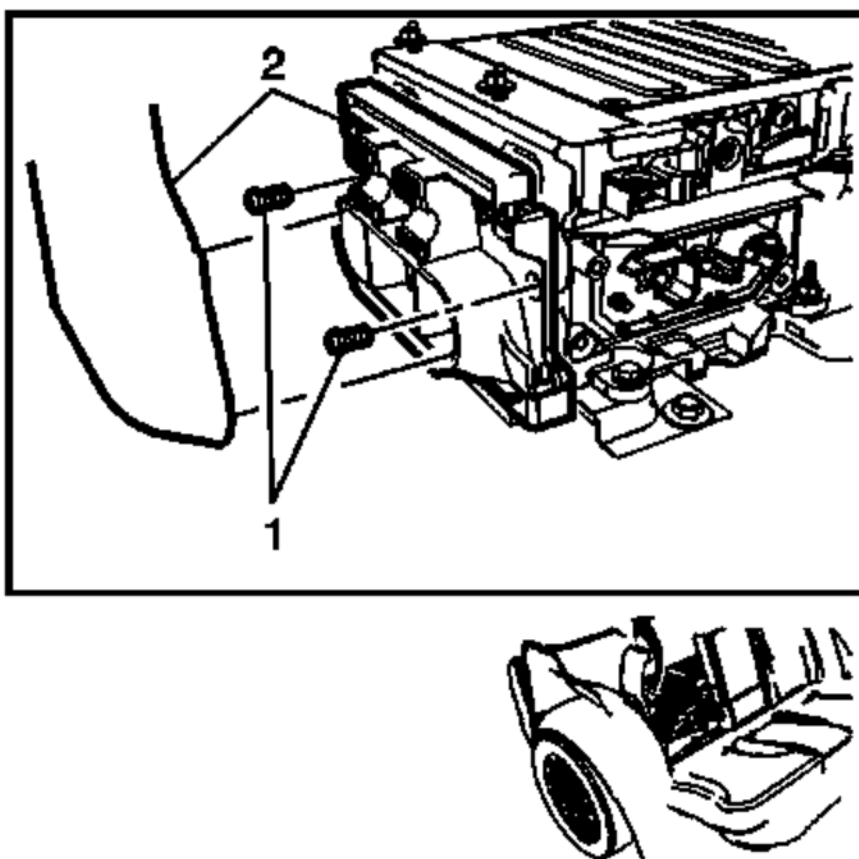


Fig. 102: Drive Motor Battery Cooling Blower Outlet Duct Fastener
Courtesy of GENERAL MOTORS COMPANY

9. Remove the generator control module cooling air outlet duct (2) from the generator control module. Refer to **Drive Motor Battery Cooling Blower Outlet Duct Replacement** .

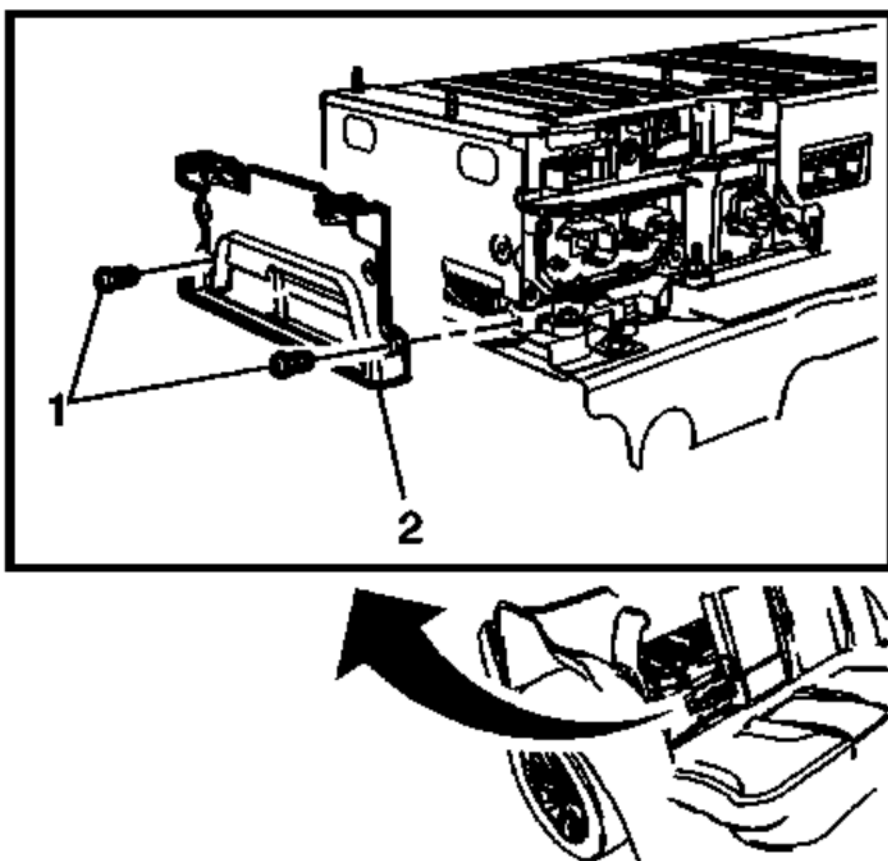


Fig. 103: Generator Control Module Cooling Air Outlet Duct And Tighten Fasteners
Courtesy of GENERAL MOTORS COMPANY

10. Remove the generator control module cooling air outlet duct lower fasteners (1) and remove the generator control module cooling air outlet duct (2).

Installation Procedure

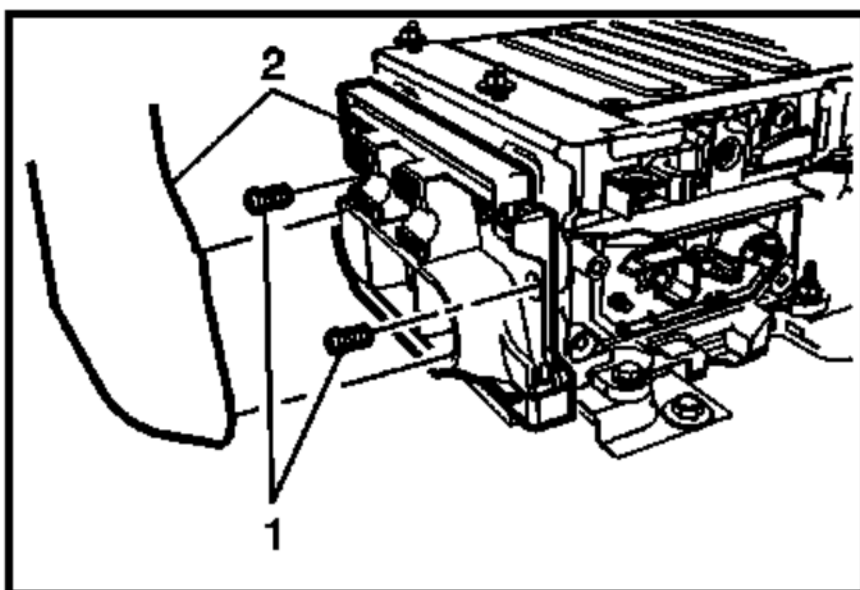


Fig. 104: Drive Motor Battery Cooling Blower Outlet Duct Fastener
 Courtesy of GENERAL MOTORS COMPANY

1. Install the generator control module cooling air outlet duct (2).

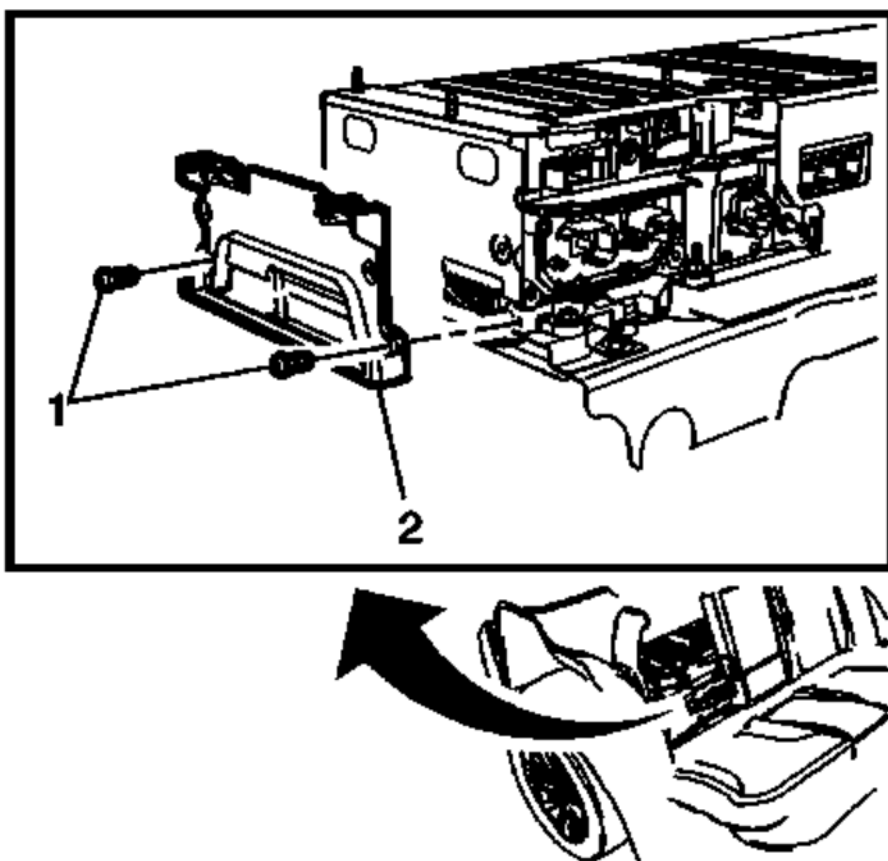


Fig. 105: Generator Control Module Cooling Air Outlet Duct And Tighten Fasteners
Courtesy of GENERAL MOTORS COMPANY

2. Install the lower fasteners (1) but do not tighten.
3. Inspect the foam seals for tears and leak paths, to ensure they will not compromise the internal air flow through the generator control module assembly.

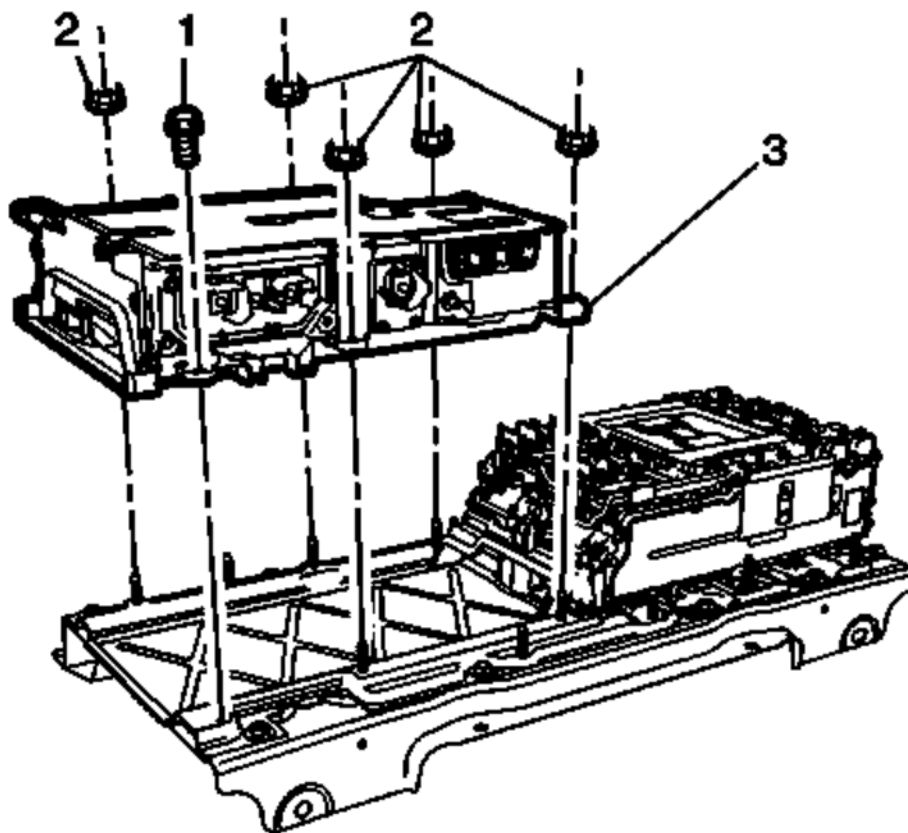


Fig. 106: Generator Control Module
Courtesy of GENERAL MOTORS COMPANY

CAUTION: Refer to Fastener Caution .

NOTE: Do not slide the generator control module on the foam seals as the seals may become damaged.

4. Install the generator control module (3) to the support tray studs. Tighten the fastener (1) to 9 N.m (80 lb in).
5. Tighten the remaining fasteners (2) to 9 N.m (80 lb in).

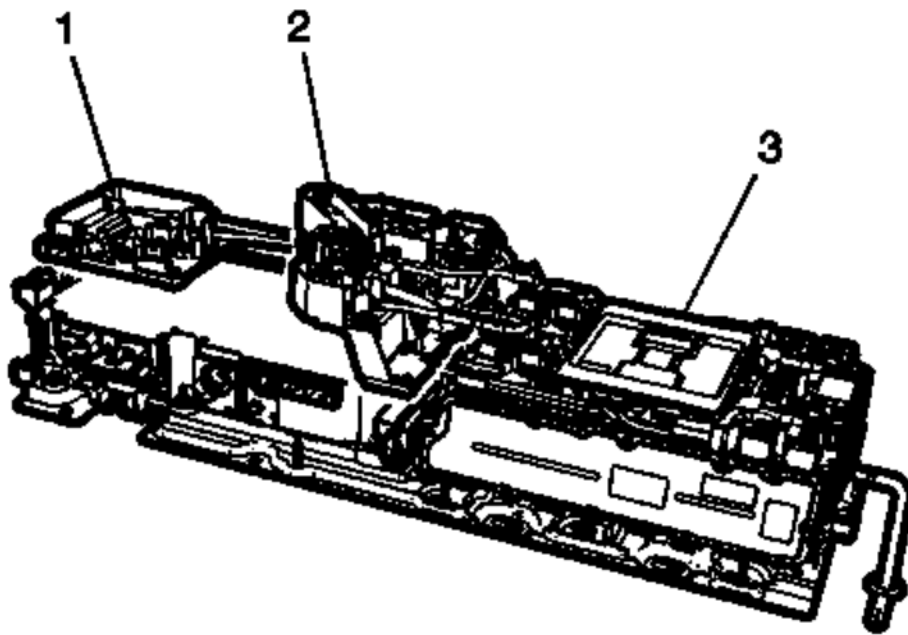


Fig. 107: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

6. Place the drive motor battery wire junction block relay (2) and the battery energy control module wiring junction block (1), on top of the generator control module.

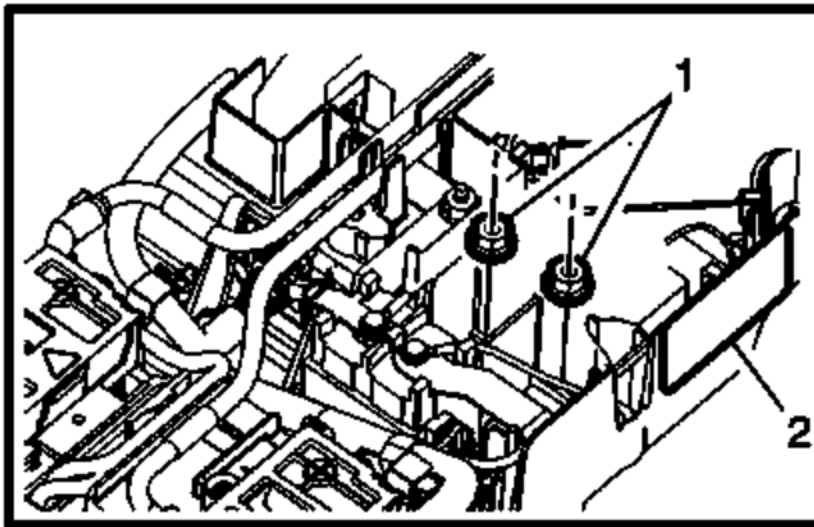
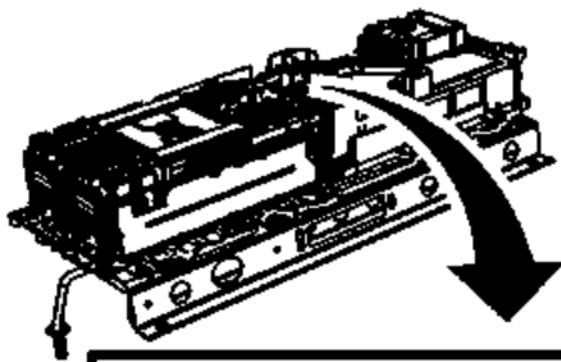


Fig. 108: High Voltage Bus Fasteners

Courtesy of GENERAL MOTORS COMPANY

7. Install the high voltage bus fasteners (1) to the drive motor battery wiring junction block relay assembly (2) and tighten to 9 N.m (80 lb in).

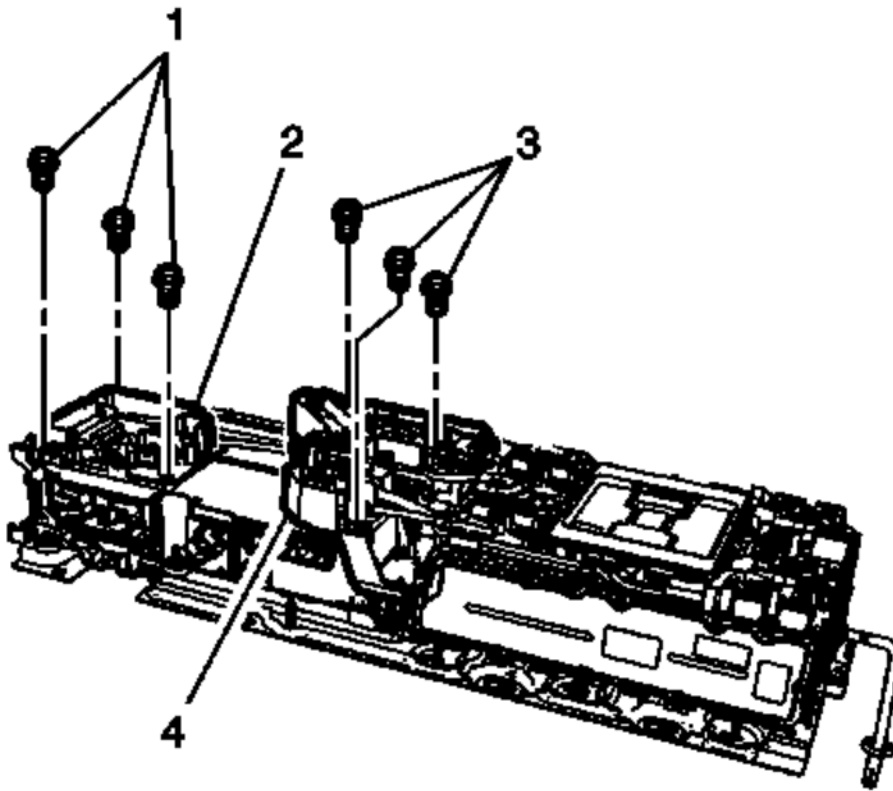


Fig. 109: Drive Motor Battery Wire Junction Block Relay
Courtesy of GENERAL MOTORS COMPANY

8. Install the battery energy control module wiring junction block fasteners (1) and tighten to 9 N.m (80 lb in).
9. Install the drive motor battery wiring junction block relay fasteners (3) and tighten to 9 N.m (80 lb in).

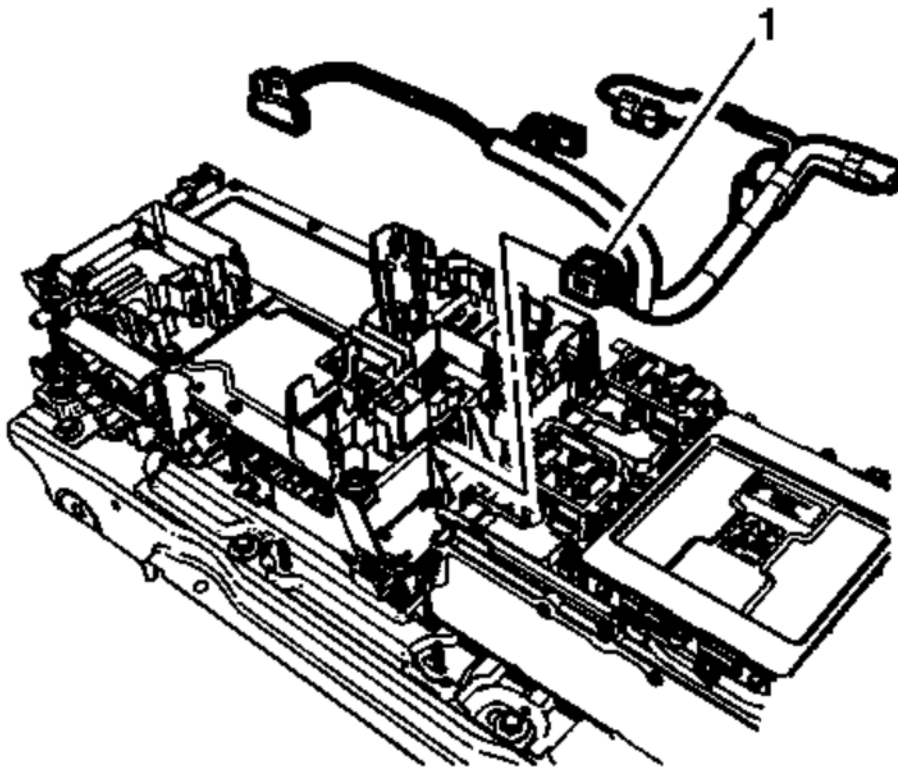


Fig. 110: Generator Control Module Connector
Courtesy of GENERAL MOTORS COMPANY

10. Connect the generator control module X4 connector (1).
11. Enable the high voltage at the A4 hybrid battery pack. Refer to High Voltage Enabling.
12. Program the generator control module. Refer to Control Module References.

GENERATOR CONTROL MODULE COVER REPLACEMENT

Removal Procedure

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: 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. Remove both rear compartment floor panels. Refer to Rear Compartment Floor Panel Trim Replacement (With Battery Cover, HP6) , Rear Compartment Floor Panel Trim Replacement (With Blower Cover, HP6) .
2. Remove the drive motor battery cooling blower outlet duct. Refer to Drive Motor Battery Cooling Blower Outlet Duct Replacement .

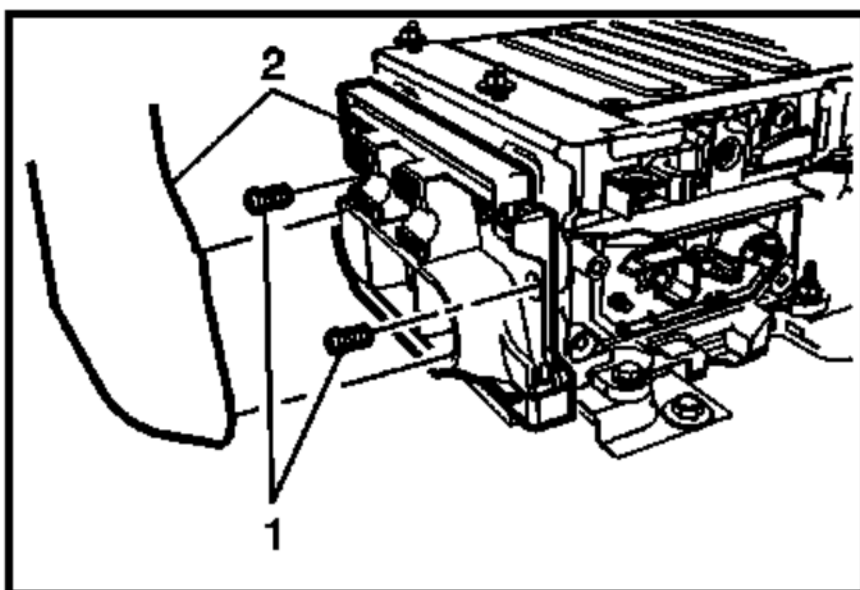


Fig. 111: Drive Motor Battery Cooling Blower Outlet Duct Fastener
Courtesy of GENERAL MOTORS COMPANY

3. Remove the upper fasteners (1) on the generator control module cooling air outlet duct.

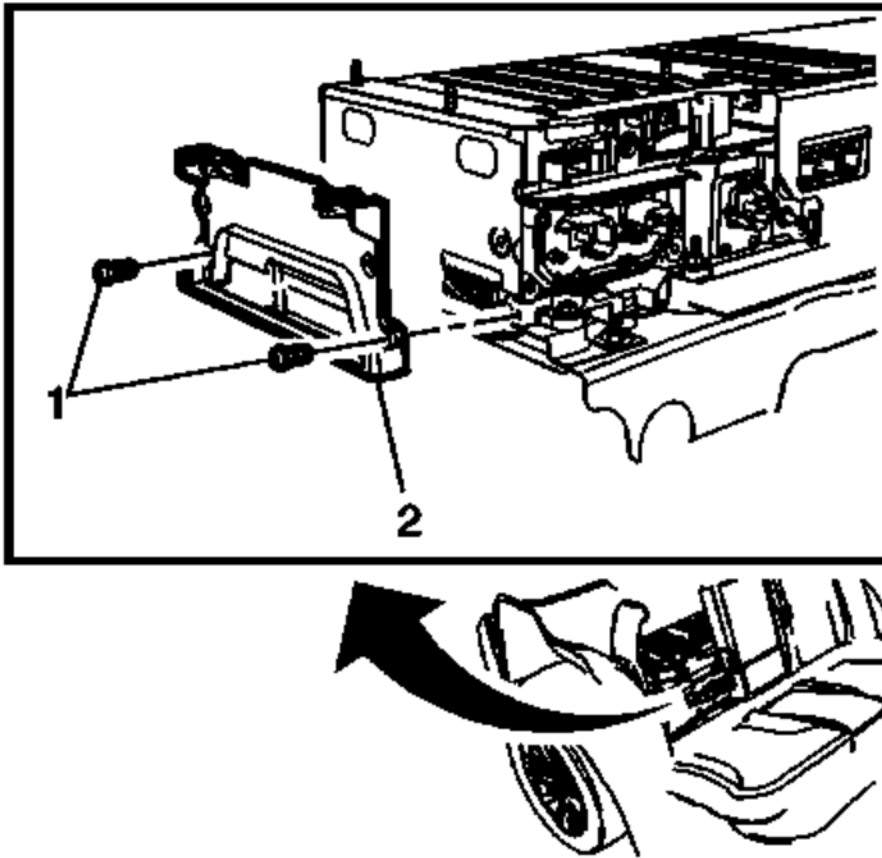


Fig. 112: Generator Control Module Cooling Air Outlet Duct And Tighten Fasteners
Courtesy of GENERAL MOTORS COMPANY

4. Remove the lower fasteners (1) holding the generator control module cooling outlet duct (2) to the generator control module and remove the duct.

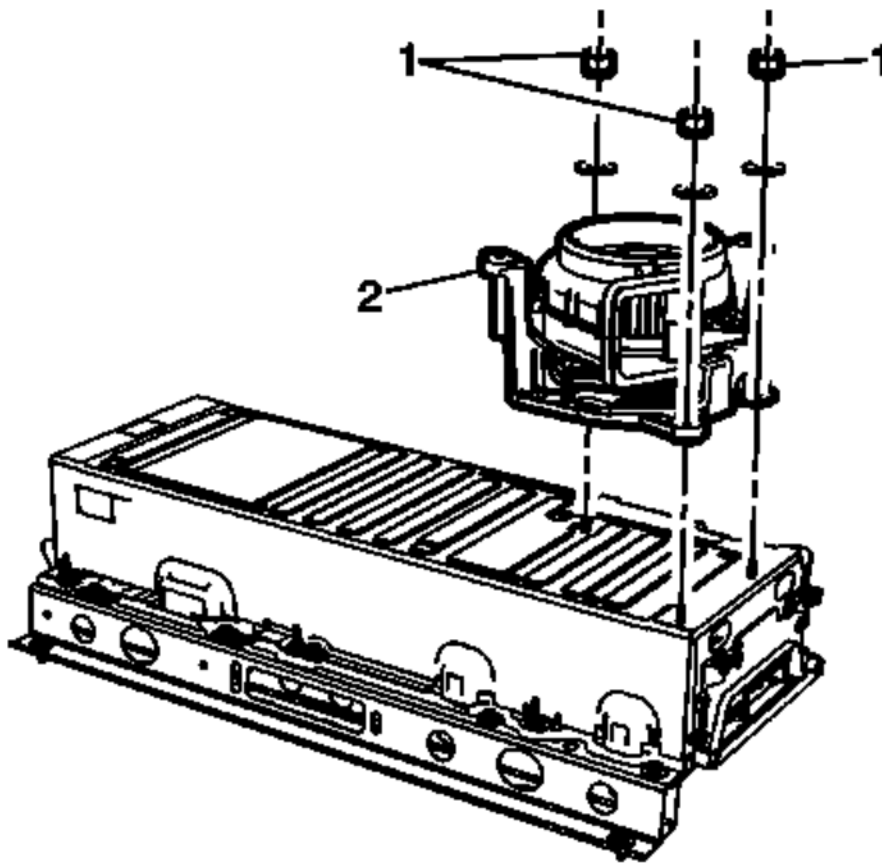


Fig. 113: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

5. Disconnect and unclip the drive motor battery cooling blower electrical harness.
6. Remove the drive motor battery cooling blower and bracket fasteners (1).
7. Remove the drive motor battery cooling blower and bracket (2) as an assembly.
8. If the hybrid battery has not been disabled in a previous step, disable the hybrid battery. Refer to high voltage disabling for servicing any internal components within the A4 Hybrid/EV Battery Pack. **High Voltage Disabling.**

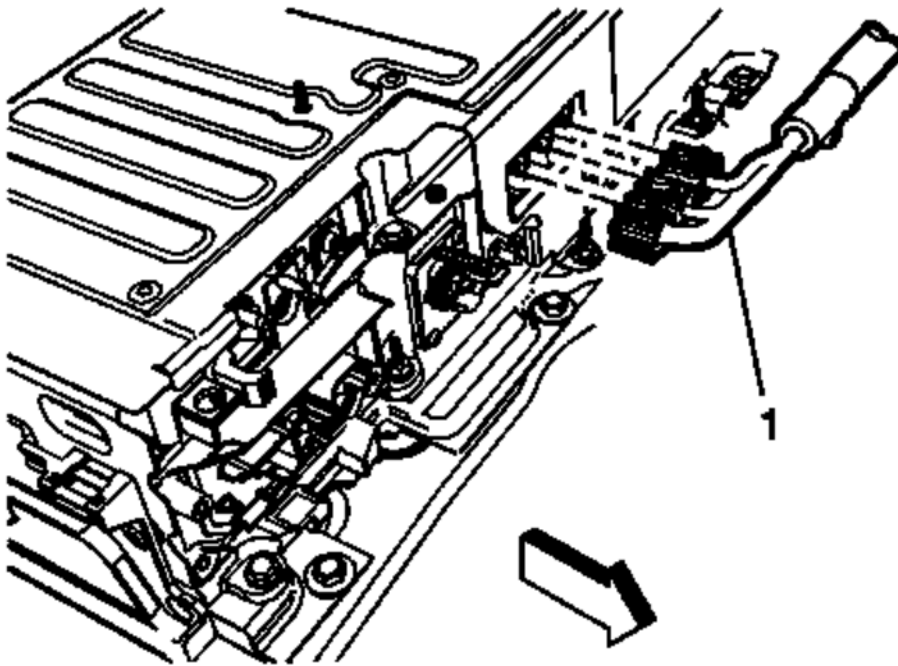


Fig. 114: Body Harness Connectors
Courtesy of GENERAL MOTORS COMPANY

9. Remove the body harness connectors (1) from the generator control and battery module.

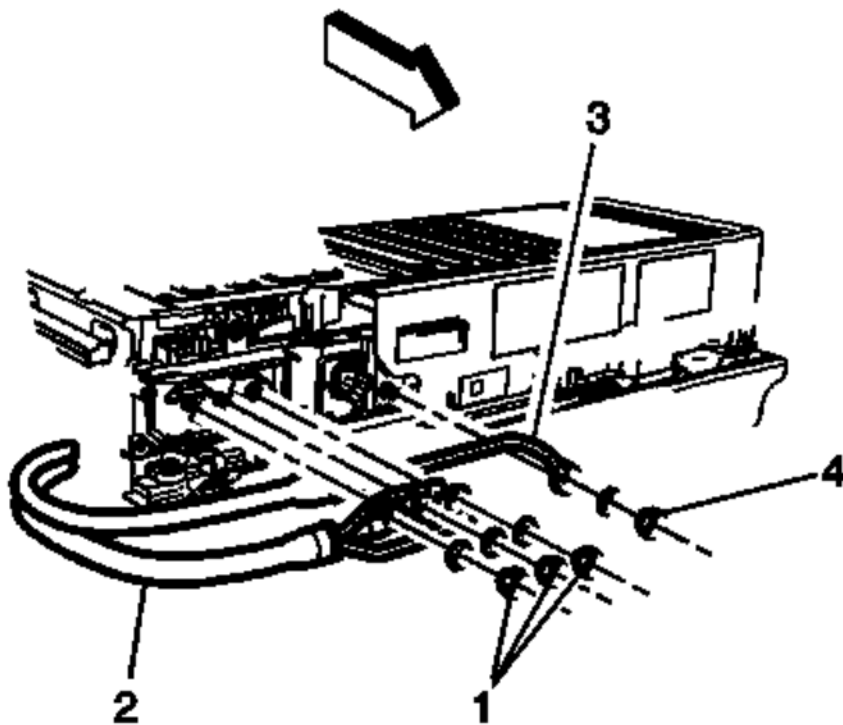


Fig. 115: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

10. Remove the high voltage 3-phase cable terminal nuts (1) and the 12V terminal branch nut (4).
11. Remove the high voltage cable (2) and the 12V cable (3) from the generator control and battery module.
12. Remove the drive motor battery cooling air inlet upper duct. Refer to **Drive Motor Battery Cooling Air Inlet Upper Duct Replacement** .

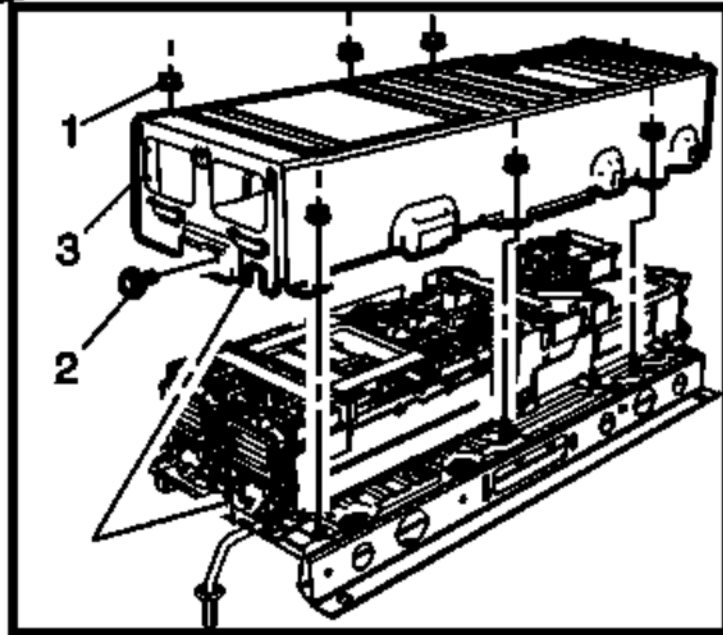


Fig. 116: Generator Control Module Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

13. Remove the generator control module cover fasteners (1).
14. Remove the generator control module cover fastener (2) and remove the generator control module cover (3).

Installation Procedure

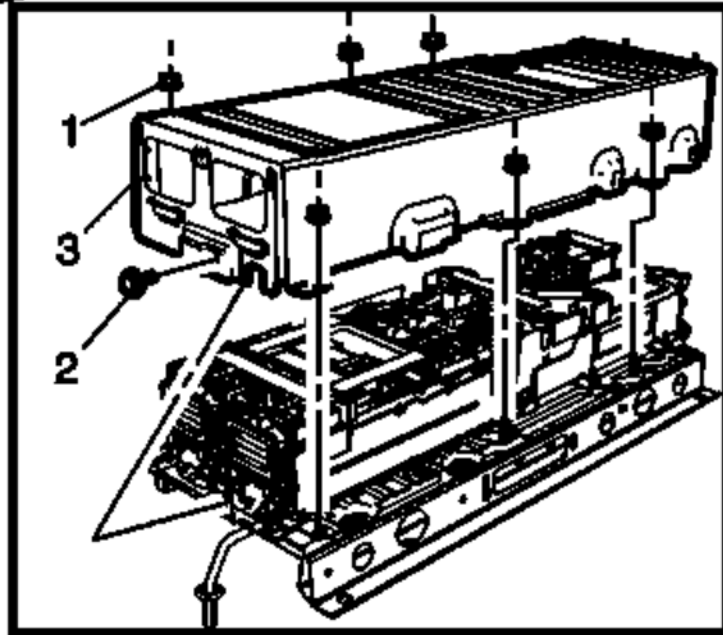


Fig. 117: Generator Control Module Cover Fasteners
Courtesy of GENERAL MOTORS COMPANY

1. Install the generator control module cover (3).
2. Install the generator control module cover fasteners (1) and tighten to 9 N.m (80 lb in).
3. Install the generator control module cover fastener (2) and tighten to 9 N.m (80 lb in).

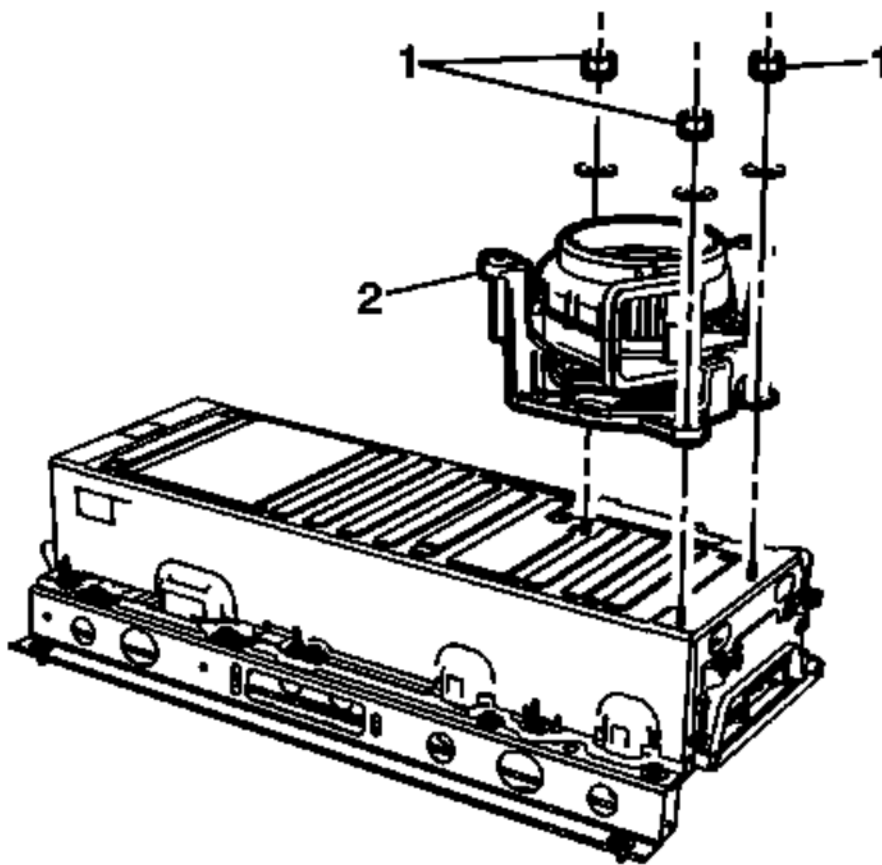


Fig. 118: Drive Motor Battery Cooling Blower Assembly
Courtesy of GENERAL MOTORS COMPANY

4. Install the drive motor battery cooling blower motor and bracket (2). Tighten the fasteners (1) to 9 N.m (80 lb in).

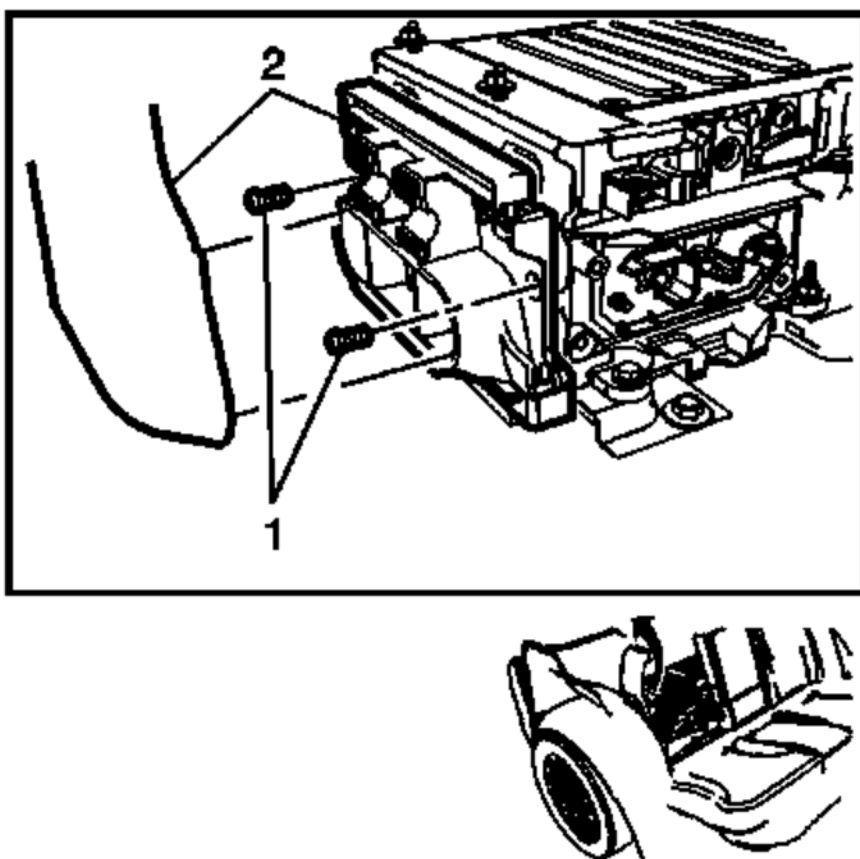


Fig. 119: Drive Motor Battery Cooling Blower Outlet Duct Fastener
Courtesy of GENERAL MOTORS COMPANY

5. Install the generator control module air outlet duct (2) and tighten the upper fasteners (1) to 9 N.m (80 lb in).

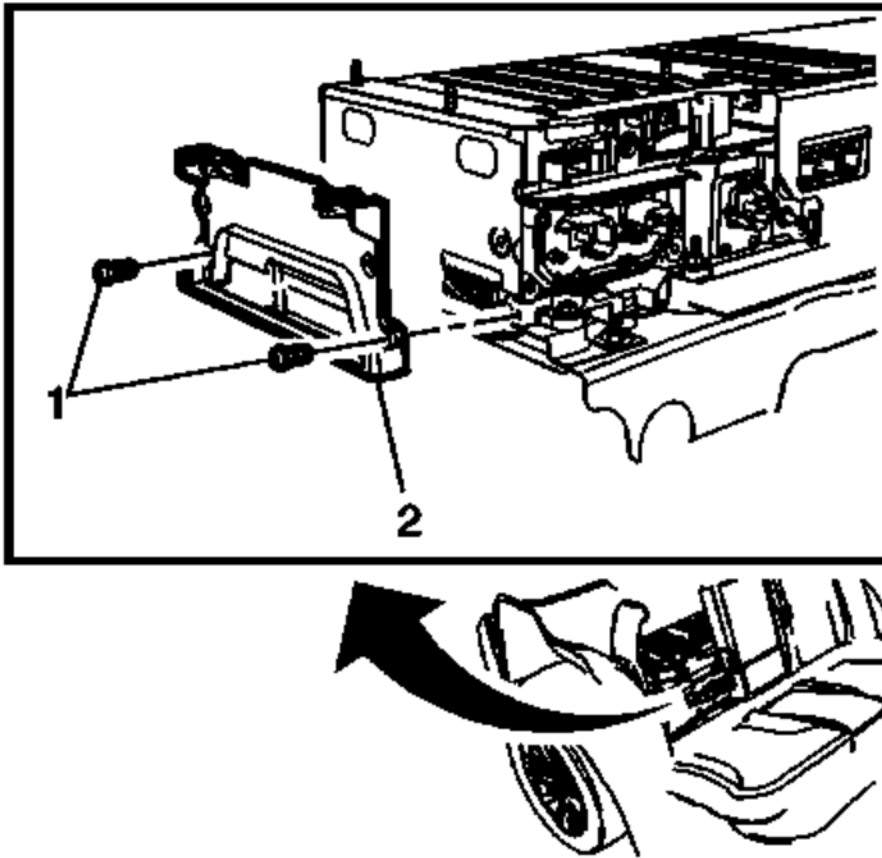


Fig. 120: Generator Control Module Cooling Air Outlet Duct And Tighten Fasteners
Courtesy of GENERAL MOTORS COMPANY

6. Install the lower generator control module cooling air outlet duct lower fasteners (1) and tighten to 9 N.m (80 lb in).

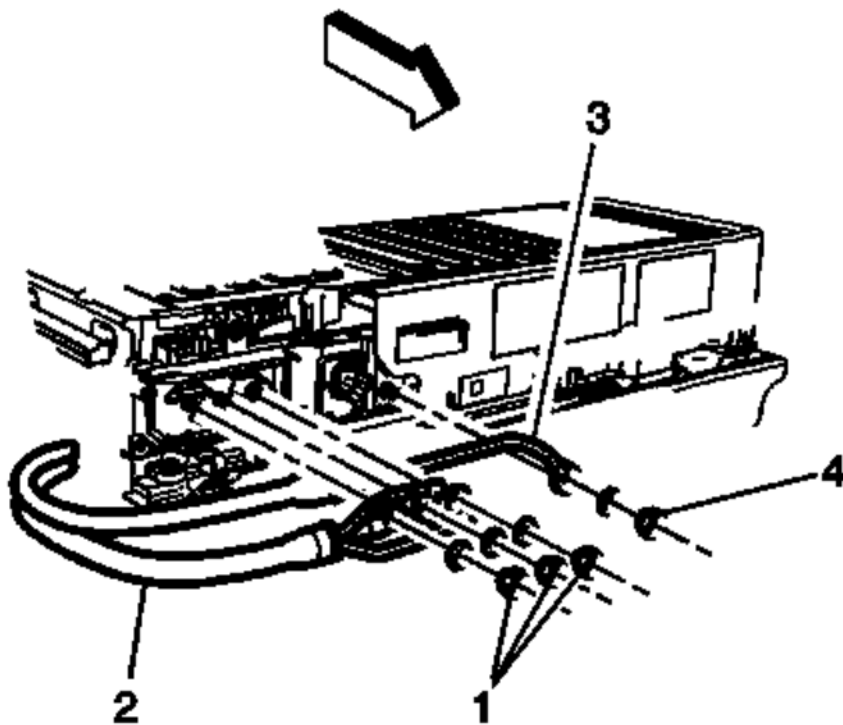


Fig. 121: High Voltage 3-phase Cable
Courtesy of GENERAL MOTORS COMPANY

7. Install the high voltage 3-phase cable (2) to the generator control and battery module. Tighten the nuts (1) to 9 N.m (80 lb in).
8. Install the 12V cable (3) to the generator control and battery module. Tighten the nut (4) to 9 N.m (80 lb in).

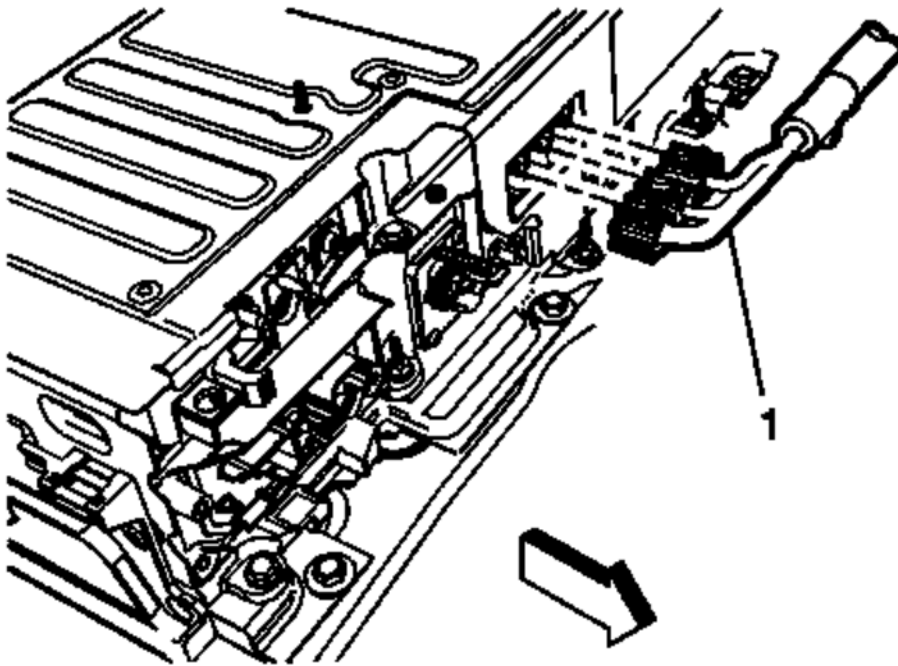


Fig. 122: Body Harness Connectors

Courtesy of GENERAL MOTORS COMPANY

9. Install the body harness connectors (1).
10. Install the drive motor battery cooling air inlet upper duct. Refer to **Drive Motor Battery Cooling Air Inlet Upper Duct Replacement** .

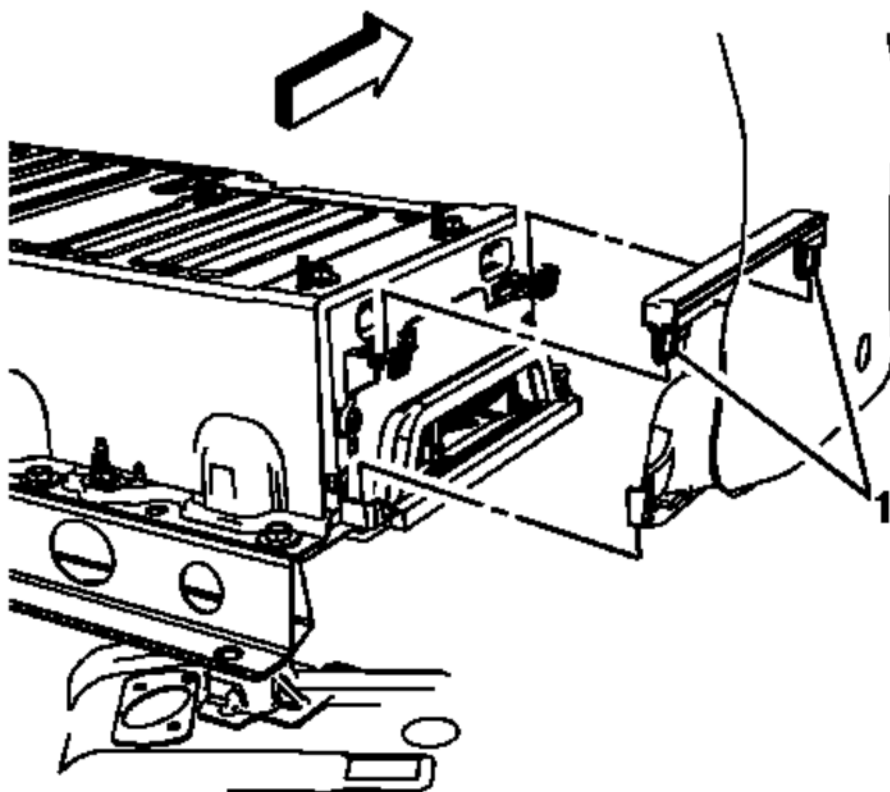


Fig. 123: Intermediate Duct Retainers
Courtesy of GENERAL MOTORS COMPANY

NOTE: Make sure the duct is flush against the seal for efficient generator control and battery module cooling.

11. Install the drive motor battery cooling blower outlet duct (1). Refer to **Drive Motor Battery Cooling Blower Outlet Duct Replacement** .
12. Enable the hybrid battery. Refer to **High Voltage Enabling**.

GENERATOR CONTROL MODULE CABLE COVER REPLACEMENT

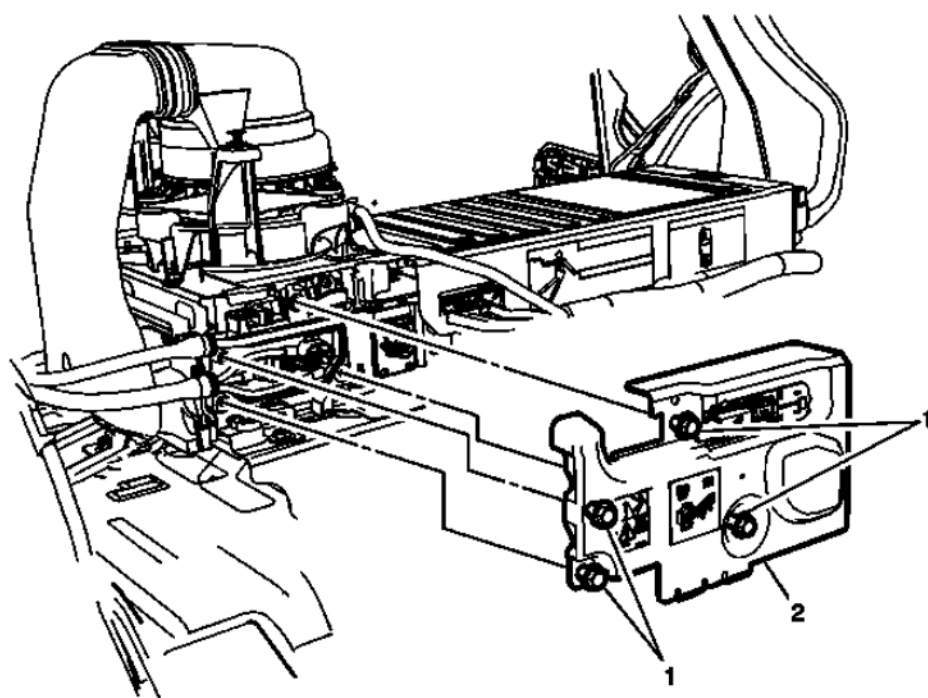


Fig. 124: Generator Control Module Cable Cover
 Courtesy of GENERAL MOTORS COMPANY

Generator Control Module Cable Cover Replacement

Callout	Component Name
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: 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.

Preliminary Procedure Disable the high voltage system. Refer to **High Voltage Disabling**.

1	Generator Control Module Cable Cover Fasteners (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 9 (80 lb in)
2	Generator Control Module Cable Cover

GENERATOR BATTERY FUSE REPLACEMENT

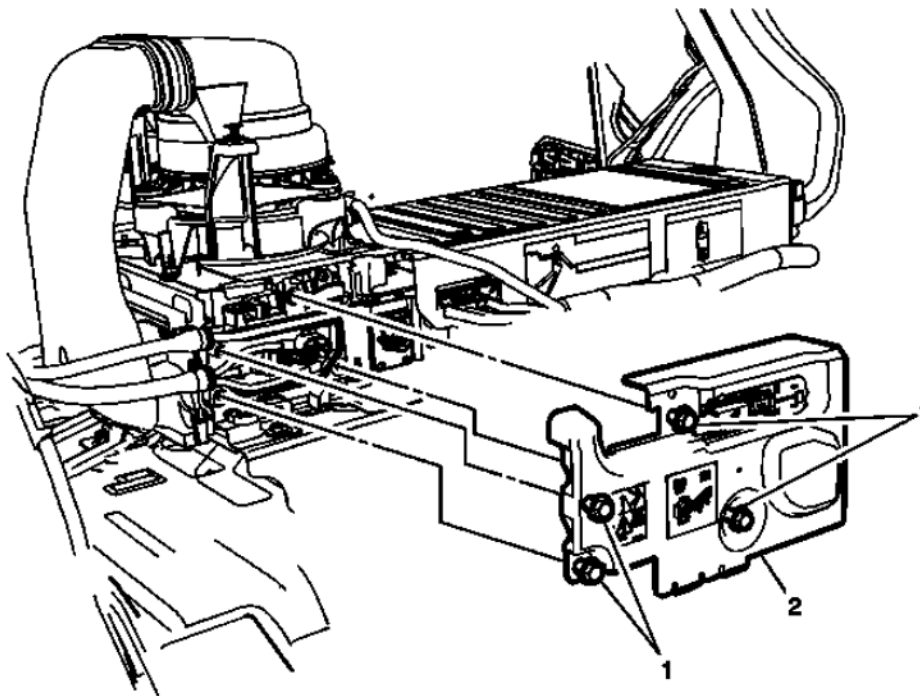


Fig. 125: Generator Control Module Cable Cover
 Courtesy of GENERAL MOTORS COMPANY

Generator Battery Fuse Replacement

Callout	Component Name
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: 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. Preliminary Procedure Disable the high voltage system. Refer to High Voltage Disabling.	
1	Generator Control Module Cable Cover Fasteners (Qty: 4) CAUTION: Refer to Fastener Caution . Tighten 9 (80 lb in)
2	Generator Control Module Cable Cover

BATTERY AUXILIARY TRAY REPLACEMENT

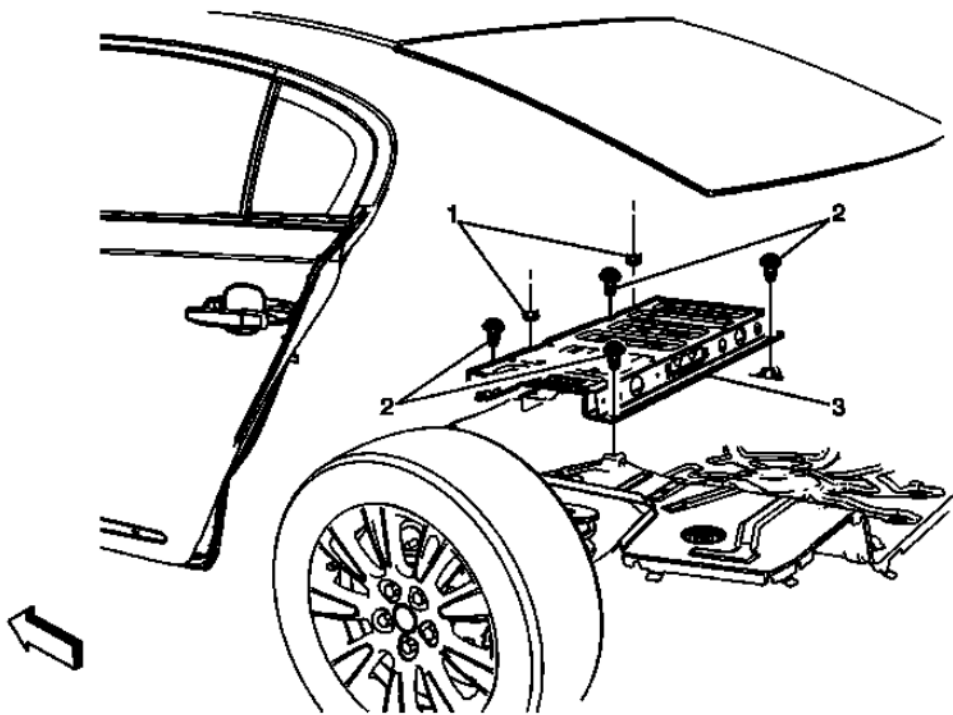


Fig. 126: Battery Auxiliary Tray And Fasteners
 Courtesy of GENERAL MOTORS COMPANY

Battery Auxiliary Tray Replacement

Callout	Component Name
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: 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.

Preliminary Procedure Remove the generator control and battery module. Refer to **Generator Control and Battery Module Replacement and Shipping Preparation**.

1	Battery Auxiliary Tray Fasteners (Qty: 2) CAUTION: Refer to <u>Fastener Caution</u> . Tighten 22 N.m (16 lb ft).
2	Battery Auxiliary Tray Fasteners (Qty: 4) Tighten 58 N.m (43 lb ft).
3	Battery Auxiliary Tray

CLEAR SECURED HIGH VOLTAGE DTCS

The Clear Secured High Voltage DTCs procedure must be completed when a latched DTC is set, a vehicle crash event has been detected, or when the Starter/Generator Control Module has been replaced.

Clearing DTCs After a Vehicle Crash Event

NOTE: Before clearing any DTCs after a vehicle crash event, inspect and ensure the high voltage system integrity has not been compromised during the crash event. Refer to **High Voltage System Inspection**.

1. Connect a scan tool to the vehicle.
2. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
3. Select Hybrid Powertrain Control Module.

NOTE: A command reject may appear on the scan tool after the first Clear Secured High Voltage DTCs request. If this occurs, ignore this command reject and continue to the next step.

4. Follow the scan tool directions to complete the procedure.
5. When complete, exit out of the Clear Secured High Voltage DTCs menu.

6. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
7. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
8. Select Battery Energy Control Module.
9. Follow the scan tool directions to complete the procedure.
10. When complete, exit out of the Clear Secured High Voltage DTCs menu.
11. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
12. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
13. Select Hybrid Powertrain Control Module.

NOTE: **A command reject may appear on the scan tool after the first Clear Secured High Voltage DTCs request. If this occurs, ignore this command reject and continue to the next step.**

14. Follow the scan tool directions to complete the procedure.
15. When complete, exit out of the Clear Secured High Voltage DTCs menu.
16. Ignition OFF and all vehicle systems OFF. It may take up to 2 min for all vehicle systems to power down.
17. Ignition ON, clear any DTCs that may be set.

Clearing High Voltage DTCs

1. Connect a scan tool to the vehicle.
2. Ignition ON, select Clear Secured High Voltage DTCs in the Hybrid Powertrain Control Module Control Functions list.
3. Select Battery Energy Control Module.
4. Follow the scan tool directions to complete the procedure.
5. Clear any DTCs that may be set.
6. Ignition OFF and all vehicle systems OFF. Wait 2 min.
7. Ignition ON, clear any DTCs that may be set.

DESCRIPTION AND OPERATION

DRIVE MOTOR BATTERY SYSTEM DESCRIPTION

The hybrid energy storage system uses a number of modules and components to store electricity for use by the eAssist system. The hybrid energy storage system stores 115 V DC in two lithium-ion battery sections. Current flows from the battery sections through a series of contactors and a service disconnect. This allows the system to control the disconnect of high voltage from the vehicle and also creates a redundant disconnect to ensure voltage is disabled when servicing high voltage components. To ensure optimum life of the lithium-ion batteries, the hybrid energy storage system monitors the state of charge of each battery cell. The system will equalize the state of charge of each cell through a balancing process. The hybrid energy storage system is also responsible for monitoring and controlling the charging and the discharging of the high voltage battery.

The high voltage battery is charged during normal vehicle driving. During normal operation, the high voltage battery is kept at or near an optimum level of charge. In some case, such as the installation of a replacement high voltage battery, the battery state of charge may be low and require charging before the eAssist system functions begin to operate normally. To charge the battery, drive the vehicle or allow the vehicle to idle with the transmission in Park or Neutral. To decrease charging time, raise the engine speed to 2, 500 - 3, 000 RPM with the transmission in Neutral. This will increase the charging rate and decrease charging time.

The primary component of the hybrid energy storage system is the Hybrid/EV Battery Pack. The Hybrid/EV Battery Pack is a modular battery pack assembly that not only contains the lithium-ion battery sections, but also many of the control modules and components used by the eAssist system.

The Hybrid/EV Battery Pack contains the following serviceable components:

- Hybrid/EV Battery Section 1
- Hybrid/EV Battery Section 2
- Battery Energy Control Module
- Starter/Generator Control Module
- Main Contactor - located in the generator battery disconnect relay assembly
- Pre-Charge Contactor - located in the generator battery disconnect relay assembly
- Hybrid/EV Battery Pre-Charge Resistor - located in the generator battery disconnect relay assembly
- Hybrid/EV Battery Pack Current Sensor - located in the generator battery disconnect relay assembly
- Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever - located in the battery energy control module wiring junction block assembly
- Generator Battery Fuse - located in the battery energy control module wiring junction block assembly
- High Voltage Interlock Switch

Hybrid/EV Battery Pack

The Hybrid/EV Battery Pack is located in the rear compartment of the vehicle, directly behind the rear passenger seat, and serves as a modular assembly to contain many of the eAssist control modules and system components. The Hybrid/EV Battery Pack may also be referred to as the following names:

- Energy Storage System
- Power Pack
- Generator Control and Battery Module Assembly

The Hybrid/EV Battery Pack first consists of a metal tray that is fixed to the vehicle floor. This provides a strong mount for other components to secure to. Within the Hybrid/EV Battery Pack, the hybrid/EV battery section 1 and hybrid/EV battery section 2 are located nearest to the left side of the vehicle. Directly above the battery sections is the battery energy control module. To the right of the battery sections and nearest to the right side of the vehicle is the Starter/Generator Control Module. Above the Starter/Generator Control Module is the generator battery disconnect relay assembly and battery energy control module wiring junction block assembly. A case cover is secured over the top of all components, effectively creating the Hybrid/EV Battery Pack and preventing access to any high voltage components without first disabling the high voltage system.

The Hybrid/EV Battery Pack is also integral to the hybrid/EV cooling system. Foam gaskets are adhered to the metal battery pack tray. This seals the underside of the Starter/Generator Control Module to ensure proper airflow under the control module for cooling purposes. The Hybrid/EV Battery Pack case cover also provides a mounting surface for the Hybrid/EV Battery Pack Cooling Fan and has openings where the plastic vents are allowed to pass into the Hybrid/EV Battery Pack to direct air through components which require cooling.

Hybrid/EV Battery Section 1 and Hybrid/EV Battery Section 2

The hybrid/EV battery section 1 and hybrid/EV battery section 2 are a pair of lithium-ion batteries connected in series to make up the 115 V DC battery. The two sections are diagnosed and serviced as a single battery assembly. The individual battery sections are not serviced separately.

The hybrid battery contains a total of 32 cell groups, with each section containing 16 cells that are connected in series using internal bus bars. The two battery sections are externally connected in series using high voltage cable. Each individual cell group is rated at 3.7 V, for a nominal system voltage of 118 V DC.

The hybrid battery sections are air cooled. Each battery case has an air inlet and an air outlet. Air is drawn through the battery case to cool the individual cells. Attached to each case is a vent tube. In the event of a damaged or ruptured battery, any outgassing will be vented to the outside of the vehicle.

A voltage sense circuit is attached to each individual cell. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connects the voltage sense circuits to the battery energy control module, located directly above the battery sections. The sensor itself is a part of the battery cell and is not serviceable.

Battery Energy Control Module

The battery energy control module is located directly above the hybrid/EV battery section 1 and hybrid/EV battery section 2. The module is responsible for monitoring the hybrid/EV battery section 1 and hybrid/EV battery section 2 parameters and reporting this to the Starter/Generator Control Module. The battery energy control module may also be referred to as the following names:

- BECM
- Voltage Current Temperature Module
- Voltage Temperature Interface Module (VTIM)

The battery energy control module monitors the voltage of each battery cell section. A voltage sense circuit is attached to each individual cell group. Each of these circuits terminate at a connector located on the top surface of the battery section. A serviceable auxiliary battery wiring harness connects the voltage sense circuits to the battery energy control module, located directly above the battery sections. The sensor itself is a part of the battery cell and is not serviceable.

The battery energy control module also measures critical temperatures within the two battery sections and at the hybrid/EV battery section 1 air inlet. Six temperature sensors are used to monitor the battery temperature. The battery temperature sensors are located in the battery sections. Two of the temperature sensors are located on the top of the battery section and the remaining four are located on the bottom of the section. The temperature sensor is a variable resistor that measures the temperature of the battery cell group. The battery energy control

module supplies 5 V to the signal circuit and a ground for the low reference circuit. The battery temperature sensor resistance changes with battery temperature. As the temperature decreases, the sensor resistance increases. As the temperature increases, the sensor resistance decreases. The air inlet temperature sensor operates in much the same way, except that it measures the temperature of the incoming air used to cool the Hybrid/EV Battery Pack at the hybrid/EV battery section 1 air inlet. None of the temperature sensors or the temperature sensor harness is serviceable. They are all serviced as part of the battery sections.

The battery energy control module is responsible for the cell balancing process. During operation, individual cells may charge or discharge at different rates. To ensure proper battery health and optimal life, these voltages are balanced, with energy from a higher voltage cell being transferred to a lower voltage cell. This keeps the voltage consistent between all 32 cell groups. Cell balancing is an internal process of the battery energy control module. Internal gates allow energy to flow between cells using the same circuits that are used to monitor cell voltage.

Starter/Generator Control Module

The Starter/Generator Control Module is a multifunction module that is involved in many eAssist system operations. The Starter/Generator Control Module contains two internal microprocessors: a battery control processor and a motor control processor. The battery control processor is responsible for the following:

- Communicating with the battery energy control module to determine the status of the high voltage battery
- Controlling the battery and Starter/Generator cooling systems
- Controlling the main and pre-charge contactors
- Monitoring the high voltage interlock loops
- Monitoring for isolation faults
- Supplying 12 V to the vehicle

Internal to the Starter/Generator Control Module, the motor control processor is responsible for propulsion activities and the 14 V control module is responsible for maintaining 12 V to the vehicle. The Starter/Generator Control Module may also be referred to as the following names:

- SGCM
- Hybrid Powertrain Control Module (HPCM)
- Accessory Power Module (APM)
- Battery Power Inverter Module (BPIM)
- Power Inverter Module (PIM)

Hybrid/EV Battery Control

The Starter/Generator Control Module interfaces with the battery energy control module to determine the status of the battery voltage and battery temperature. The Starter/Generator Control Module uses voltage information from the battery energy control module to make decisions about the battery state of health, how the battery should be charged or discharged, and when to initiate cell balancing.

Hybrid/EV Battery and Starter/Generator Cooling

The Starter/Generator Control Module uses temperature information from the battery energy control module to control the Hybrid/EV Battery Pack Cooling Fan. The Starter/Generator Control Module also monitors the Starter/Generator coolant temperature sensor and will control the Starter/Generator coolant pump relay, which controls the Starter/Generator coolant pump.

High Voltage Contactors

At times, it may be necessary to disconnect high voltage from the vehicle, both during normal operation and when a system fault is identified. The Starter/Generator Control Module controls the main contactor and pre-charge contactor to disconnect and connect high voltage from the vehicle.

High Voltage Interlock

The high voltage interlock is a fail-safe to disable high voltage when the Starter/Generator Control Module identifies that a high voltage area has been accessed. The Hybrid/EV Battery Pack has a high voltage interlock switch located on the service access cover. The Starter/Generator also has a high voltage interlock switch on the access cover. When either cover is removed, the interlock loop is opened. The Starter/Generator Control Module will open the contactors to prevent technician contact with high voltage.

High Voltage Isolation

The Starter/Generator Control Module monitors the electrical potential between high voltage and the vehicle chassis. High voltage should always be isolated from the vehicle chassis by a certain amount of resistance to avoid the potential for a life threatening current path. In the event that a high voltage leak path is detected to the vehicle chassis, the Starter/Generator Control Module will set a DTC and open the contactors to remove high voltage.

Testing for loss of isolation requires special tools and procedures. Because of the high voltages present in the hybrid system, a loss of isolation may occur due to insulation breakdown. Insulation breakdown typically occurs only when high voltage is present. Conditions such as insulation breakdown cannot be diagnosed with a typical DMM because high voltage is not used by the DMM when measuring resistance.

12 V Output

The Starter/Generator Control Module essentially takes the place of the generator on a traditional vehicle. The Starter/Generator Control Module converts high voltage DC to a 12 V DC for accessory electrical operation and to charge the 12 V battery.

Main Contactor, Pre-Charge Contactor, and Pre-Charge Resistor

The high voltage contactors are switches that are controlled like a relay. To disable high voltage from the vehicle, the main and pre-charge contactors are commanded open. This will open the contactors and physically disconnect the hybrid/EV battery positive cable. To connect high voltage to the vehicle, first the pre-charge contactor is closed. With the pre-charge contactor closed, current flows through the pre-charge resistor. This allows high voltage to slowly build in the system. Once high voltage is brought up through the pre-charge contactor, the main contactor is close and high voltage is active. If the high voltage builds too quickly or too slowly, the Starter/Generator Control Module will set a fault.

Both the main contactor and the pre-charge contactor are controlled in a similar manner. B+ is applied at all times to each contactor. Each contactor is controlled by an independent low side driver in the Starter/Generator Control Module. When the Starter/Generator Control Module commands the contactor closed, ground is applied to the contactor through the low side driver and the contactor is closed.

Both contactors and the pre-charge resistor are located in the generator battery disconnect relay assembly. The generator battery disconnect relay assembly is a plastic tray that is secured to the top of the Starter/Generator Control Module. The generator battery disconnect relay assembly also contains the Hybrid/EV Battery Pack current sensor and a series of bus bars and cables that electrically connect the hybrid/EV battery to the Starter/Generator Control Module.

Hybrid/EV Battery Pack Current Sensor

The Hybrid/EV Battery Pack current sensor is a three-wire hall effect sensor that measures current flow from the hybrid/EV battery. The battery energy control module applies 5 volt and provides a low reference to power the sensor. Current measurement is communicated to the battery energy control module via a signal circuit.

The Hybrid/EV Battery Pack current sensor is located in the generator battery disconnect relay assembly. The generator battery disconnect relay assembly is a plastic tray that is secured to the top of the Starter/Generator Control Module. The generator battery disconnect relay assembly also contains the high voltage contactors, pre-charge resistor, and a series of bus bars and cables that electrically connect the hybrid/EV battery to the Starter/Generator Control Module. The Hybrid/EV Battery Pack current sensor monitors current on the hybrid/EV battery negative bus bar.

Hybrid/EV Battery Pack High Voltage Manual Disconnect Lever and Generator Battery Fuse

The Hybrid/EV Battery Pack high voltage manual disconnect lever provides a redundant method to disconnect high voltage from vehicle when performing service on the system. With the switch open, high voltage is physically disconnected from the hybrid/EV battery positive cable. Together with the high voltage interlock and the high voltage contactors, the manual disconnect provides a means of disconnecting high voltage at two points in the system. This provides a double-layer of protection.

The generator battery fuse is a 125 A fuse to prevent an overcurrent condition in the 115 V DC system.

The Hybrid/EV Battery Pack high voltage manual disconnect lever and generator battery fuse are located in the battery energy control module wiring junction block assembly. The battery energy control module wiring junction block assembly is a plastic tray that is secured to the top of the Starter/Generator Control Module.

High Voltage Interlock Switch

The high voltage system uses two high voltage interlock switches to indicate that an area of the vehicle that contains a high voltage connection has been exposed. These locations are at the Starter/Generator and the Hybrid/EV Battery Pack. The two interlock switches are completely separate and are not tied together.

The Starter/Generator Control Module applies a constant 5 V reference to the high voltage interlock switch and monitors the voltage. Each high voltage interlock switch contains a resistor. With the high voltage interlock connected, the 5 V reference voltage travels through the resistor and is reduced by a specific amount. This indicates that the high voltage interlock switch is closed and no circuit faults have occurred. If the high voltage

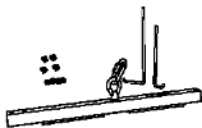
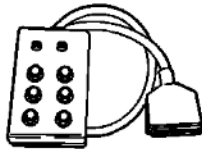
interlock switch is removed or a circuit fault occurs, the voltage will change and the Starter/Generator Control Module will open the contactors.

The Hybrid/EV Battery Pack high voltage interlock switch is part of the Hybrid/EV Battery Pack cable cover. When the cover is removed, the high voltage interlock switch is also removed. To remove the cover, the Hybrid/EV Battery Pack high voltage manual disconnect lever must also be opened, providing a second means of disconnecting high voltage.

The Starter/Generator high voltage interlock switch is part of the Starter/Generator cable cover. When the cover is removed, the high voltage interlock switch is also removed.

SPECIAL TOOLS AND EQUIPMENT

SPECIAL TOOLS

Illustration	Tool Number/ Description
	EL-48264 Battery Pack Lifting Adapter
	EL-48571-1 High Voltage Battery Pin Out Box
	EL-48900 High Voltage Safety Kit
	EL-50772 Insulation Multimeter

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